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CHALLENGES OF WINTER TOURISM UNDER CLIMATE CHANGE CONDITIONS: PERCEPTIONS OF EMPLOYEES IN SKI CENTERS OF NORTHERN MONTENEGRO

IZAZOVI ZIMSKOG TURIZMA U USLOVIMA KLIMATSKIH PROMENA: PERCEPCIJE ZAPOSLENIH U SKI-CENTRIMA SEVERNE CRNE GORE

Abstract: *This paper examines employees' perceptions of the impacts of climate change on winter tourism in the ski centers of Bjelasica and Durmitor in Montenegro, utilizing a comparative approach. The research was conducted using a quantitative, cross-sectional research design. Data were collected via a structured questionnaire from a sample of 213 employees engaged in various sectors and job positions within the ski centers. Descriptive statistical methods and Pearson's chi-square test were used for data processing and analysis. The research results indicate a high level of awareness among employees regarding climate risks and their consequences for winter tourism. Respondents perceive winter seasons as shorter, less reliable, and increasingly unpredictable, which directly affects operational planning, economic stability, and tourism demand. The majority of employees believe that artificial snowmaking systems cannot fully compensate for the lack of natural snow, particularly under higher temperature conditions. The results also point to the need for diversifying the tourism offer outside the winter season and adapting destinations to contemporary trends*

Apstrakt: *U radu se ispituju percepcije zaposlenih o uticajima klimatskih promena na zimski turizam na području ski-centara Bjelasice i Durmitora u Crnoj Gori, uz implementaciju komparativnog pristupa. Istraživanje je sprovedeno uz primenu kvantitativnog, transversalnog istraživačkog dizajna. Podaci su prikupljeni putem strukturisanog upitnika na uzorku od 213 zaposlenih angažovanih u različitim sektorima i pozicijama u ski-centrima. Za obradu i analizu podataka korištene su deskriptivne statističke metode i Pearsonov hi-kvadrat test. Rezultati istraživanja ukazuju na visok nivo svesti zaposlenih o klimatskim rizicima i njihovim posledicama po zimski turizam. Ispitanici percipiraju zimske sezone kao kraće, manje pouzdane i krajnje nepredvidive, što je u direktnoj međuzavisnosti sa operativnim planiranjem, ekonomskom stabilnošću i turističkom tražnjom. Većina zaposlenih smatra da sistemi za veštačko osnežavanje ne mogu u potpunosti nadomestiti nedostatak prirodnog snega, posebno u uslovima višojih temperatura. Rezultati takođe ukazuju na potrebu diverzifikacije turističke ponude van zimske sezone i prilagođavanja destinacija*

in tourism demand. The comparative analysis revealed no statistically significant differences between the observed destinations, confirming that climate challenges are perceived as a regional phenomenon. The paper emphasizes the importance of the employees' perspective for creating sustainable adaptation strategies in winter tourism.

Keywords: *winter tourism; climate change; employee perceptions; ski centers; adaptation strategies*

Introduction

Winter tourism represents one of the key drivers of economic and social development in mountain regions, particularly in areas with limited alternative economic activities (Leal Filho et al., 2024). Its importance is reflected in employment generation, stimulation of local entrepreneurship, and the creation of public revenues, as well as in investments in infrastructure that improve accessibility and support broader regional development (Bichler & Pikkemaat, 2021). Beyond its direct economic effects, winter tourism contributes to strengthening regional cohesion and sustaining the socio-economic vitality of rural and mountainous communities (Zeng et al., 2022). In the Balkan context, winter tourism plays an especially important role in mitigating depopulation trends and economic marginalization, which remain persistent challenges in mountain areas (Protić et al., 2024; Mihajlović et al., 2025; Rakočević et al., 2025b). At the same time, winter tourism is increasingly exposed to the impacts of climate change (Mitrić et al., 2025). Rising average temperatures, decreasing and less stable snow cover, and growing climatic variability pose serious threats to the reliability, duration, and predictability of winter tourism seasons (Xiao et al., 2020; Wu et al., 2026). These changes directly affect operational planning, visitor numbers, and the long-term sustainability of ski resorts, particularly those located at lower altitudes (Willibald et al., 2021). The winter season of 2023/2024 clearly illustrated these challenges, as skiing activities in many Alpine

savremenim trendovima turističke tražnje. Komparativna analiza nije pokazala statistički značajne razlike između posmatranih destinacija, što potvrđuje da se klimatski izazovi posmatraju kao regionalni fenomen. Rad naglašava značaj perspektive zaposlenih za kreiranje održivih strategija adaptacije u zimskom turizmu.

Cljučne reči: *zimski turizam; klimatske promene; percepcije zaposlenih; ski-centri; strategije prilagodavanja.*

and European destinations were severely limited or entirely suspended due to insufficient snowfall and unusually warm weather (Happ et al., 2023; Blok & Fuerst, 2025). Under such conditions, artificial snowmaking systems were often unable to operate, as temperatures exceeded the thresholds required for snow production.

Similar circumstances were observed in Montenegro during the 2024/2025 winter season, when ski resorts in the northern part of the country experienced exceptionally low snowfall (Županović & Pezelj, 2024). For large parts of the season, tourism activities were reduced primarily to panoramic lift operations, while skiing was restricted or completely absent. These developments further confirm the high climate sensitivity of ski tourism, which is widely recognized as one of the most vulnerable forms of tourism in the context of climate change (Dašić & Jovičić, 2011; Vujko et al., 2025). Even relatively small climatic shifts can result in shorter seasons, increased dependence on artificial snowmaking, and higher operational costs, thereby intensifying economic risks and complicating investment and management decisions in ski destinations (Kater & Baxter, 2025). Northern Montenegro represents a particularly relevant context for examining these issues (Rakočević et al., 2025a). Winter tourism constitutes an important source of income and a key factor of regional economic stability in this area, with activities currently developed on several mountains, including Durmitor, Bjelasica, Lokve, Hajla, and Vučje (Cerović Smolović



et al., 2018). The region encompasses ski centers at different stages of development, ranging from more established destinations to moderately developed ones, which allows for comparative analysis of management practices and adaptation approaches in response to climate-related challenges. Despite the significance of winter tourism for regional development (Turčinović et al., 2024), empirical research focusing on the impacts of climate change on winter tourism in northern Montenegro remains limited, justifying the focus of this study on the regional scale.

An important yet underexplored perspective in climate change research on winter tourism is that of ski resort employees. Employees are directly involved in daily operations and are often among the first to observe climate-induced changes affecting season length, snow reliability, and work organization (Wilkins et al., 2025). Their perceptions offer valuable insights into operational challenges, seasonal uncertainty, and adaptive responses, providing an important complement to climate data and demand-based analyses (Rice et al., 2024). Previous research on climate change and winter tourism has predominantly focused on climatic indicators, tourism demand trends, or destination-level performance measures (Yang & Wan, 2010; Margaryan et al., 2025). There is a notable lack of empirical studies that examine climate change through the lens of ski resort employees, as well as insufficient attention to comparative analyses of perceptions across different winter tourism destinations. This gap limits understanding of how climate-related risks are experienced and interpreted at the operational level of winter tourism systems.

Against this background, the aim of this study is to examine employees' perceptions of the impacts of climate change on winter tourism and to compare these perceptions across ski resorts in northern Montenegro. By providing empirical evidence from the perspective of employees, the study contributes to a more comprehensive understanding of climate-related challenges in winter tourism and offers

insights relevant for destination management and the development of effective adaptation strategies aimed at long-term sustainability.

Literature review

2.1. Socio-Economic Significance of Winter Tourism in Mountain Regions

Winter tourism represents one of the primary drivers of economic growth, infrastructure development, and social transformation in mountainous and rural areas, which is particularly pronounced in regions facing a lack of alternative economic activities (Bichler & Pikkemaat, 2021; Leal Filho et al., 2024; Zeng et al., 2022). By generating direct and indirect jobs, stimulating local entrepreneurship, and attracting foreign and domestic investments, this form of tourism directly contributes to population retention and the strengthening of regional cohesion.

In the context of the Balkan Peninsula, the development of mountain tourism has been recognized as a strategic mechanism for mitigating long-term challenges of depopulation, economic marginalization, and the economic stagnation of rural communities (Mihajlović et al., 2025; Protić et al., 2024; Rakočević et al., 2025b). Continuous investments in skiing infrastructure not only enhance the destination's competitiveness on the international market but also generate substantial public revenues that can be further directed toward improving the local standard of living and municipal utilities.

2.2. Vulnerability of Winter Tourism to Climate Change and Operational Risks

Despite its distinct economic potential, winter tourism is categorized in contemporary scientific literature as one of the most vulnerable sectors of the tourism economy due to its direct dependence on climate factors (Dašić & Jovičić, 2011; Kater & Baxter, 2025; Vujko et al., 2025). The global increase in average temperatures, the reduced duration

and stability of natural snow cover, and pronounced climate variability destabilize the predictability of winter seasons and shorten their effective timeframe (Mitrić et al., 2025; Willibald et al., 2021; Xiao et al., 2020). Even minimal changes in temperature regimes can cause drastic economic consequences for ski resorts, primarily through reduced visitor numbers, booking cancellations, and a sharp increase in operational costs.

Empirical evidence from recent winter seasons clearly illustrates the severity of these threats on the European continent. During the 2023/2024 season, numerous alpine and continental destinations were forced to partially or completely suspend skiing operations due to extremely high temperatures and a lack of snowfall; moreover, even artificial snowmaking systems remained non-functional due to the absence of the minimum thermal conditions required for snow production (Blok & Fuerst, 2025; Happ et al., 2023).

Similar climate disruptions were documented in Montenegro during the 2024/2025 winter season. The deficit of snowfall in ski centers across the northern part of the country rendered ski slopes non-functional for most of the season, shifting tourist activities predominantly toward alternative, non-skiing contents such as panoramic cable car rides (Županović & Pezelj, 2024). These data indicate that the climate crisis is no longer a hypothetical threat but an operational reality that demands immediate adaptive strategies.

2.3. Developmental Context of the Northern Region of Montenegro

The northern region of Montenegro represents a specific and scientifically relevant spatial framework for studying the phenomenon of climate vulnerability, given that the economic development of this area heavily relies on the capacity of winter tourism developed on the massifs of Durmitor, Bjelasica, Lokve, Hajla, and Vučje (Cerović Smolović et al., 2018; Rakočević et al., 2025a; Turčinović et

al., 2024). Within this region, ski centers exist at different developmental stages—ranging from traditionally established destinations to newer, moderately developed resorts. This heterogeneity allows for an in-depth comparative analysis of management practices and climate change adaptation capacities at the regional level. Nevertheless, despite the obvious strategic importance of winter tourism for the economic survival of northern Montenegro, there is a noticeable deficit in the literature of empirical studies that systematically map and quantify the impact of climate fluctuations on local tourism operations, which justifies the need for conducting targeted regional research.

2.4. Identification of the Research Gap: Employee Perception as a Key Indicator

A review of the existing scientific literature reveals that the research focus on the relationship between climate change and winter tourism is predominantly directed toward macro-indicators, such as meteorological models, long-term snow cover projections, fluctuations in overall tourism demand, or financial performance at the destination level (Margaryan et al., 2025; Yang & Wan, 2010). Conversely, the perspective of human resources—namely, the employees in ski centers—has remained largely neglected and under-researched.

Employees in the operational, technical, and managerial sectors of ski resorts represent immediate actors who deal with the field manifestations of climate change on a daily basis. Their experiential knowledge provides specific, high-quality insights into operational challenges, logistical difficulties, and economic uncertainty caused by unpredictable weather conditions (Rice et al., 2024; Wilkins et al., 2025). Employee perceptions, therefore, serve as an essential complementary data source that enables a deeper understanding of how climate risks are interpreted and managed at the very point of their occurrence. The evident lack of comparative studies analyzing variations



in employee perceptions across different ski destinations represents a key research gap that this study aims to fill.

Building on these findings and research limitations, this study examines employees' perceptions of climate change impacts on winter tourism in ski centers of northern Montenegro, with a comparative focus on Bjelasica and Durmitor.

Methodology

Research Design

This study adopts a quantitative, cross-sectional research design aimed at examining employees' perceptions of climate change impacts on winter tourism operations. The research is based on a structured questionnaire survey administered to employees working in ski centers in northern Montenegro. A comparative approach was applied in order to identify potential differences in perceptions between destinations with different levels of tourism development. The methodological framework combines descriptive statistical analysis with inferential testing, allowing both the characterization of employee perceptions and the examination of their association with location.

Study Area

The empirical research was conducted in ski centers located in northern Montenegro, with a specific focus on the mountain destinations of Bjelasica and Durmitor. These destinations were selected due to their importance for winter tourism development in the region and their differing levels of infrastructural development, tourism intensity, and institutional capacity. This context provides a suitable basis for comparative analysis of employee perceptions under similar climatic conditions but varying destination characteristics.

Sample and Data Collection

The study sample consists of 213 employees working in winter tourism operations, including ski lifts, slope maintenance, ski instruction, hospitality services, technical maintenance, and administrative and managerial functions. Data were collected during the winter season using a structured questionnaire distributed directly to employees at both destinations. Participation was voluntary, and anonymity was guaranteed to encourage honest and unbiased responses. The spatial distribution of respondents includes 98 employees from Bjelasica (46.0%) and 115 employees from Durmitor (54.0%), ensuring a balanced comparative framework. The sample demonstrates substantial diversity in terms of gender, age, occupational roles, and work experience, which enhances the analytical robustness of the findings. A majority of respondents report more than four years of experience in winter tourism, indicating that the sample is well positioned to assess climate-related changes based on long-term professional exposure rather than short-term impressions.

Survey Instrument

The questionnaire was designed to capture employees' perceptions of key climate-change-related challenges affecting winter tourism. It consisted of two main sections. The first section collected demographic and professional information, including gender, age, length of work experience, job position, and location of employment. The second section focused on perception-based statements related to climate change impacts on winter tourism operations. Employees were asked to indicate their level of agreement with a series of statements addressing: shortening of winter tourism seasons, increasing unpredictability of snow conditions, impact of climate-related factors on operational planning, decreasing reliability of winter tourism seasons, increasing economic uncertainty due to climate change, limitations of artificial snowmaking, vulnerability of

smaller ski centers, impact of climate change on winter visitor numbers, need to diversify tourism activities beyond the winter season, and need for adaptation to ensure long-term sustainability of winter tourism. Responses were measured using a five-point Likert scale ranging from strongly disagree to strongly agree. This scale allows for the assessment of both the direction and intensity of employee perceptions.

Data Analysis

Data analysis was conducted in two stages. First, descriptive statistics were used to summarize the demographic and professional characteristics of the sample, as well as the distribution of responses for each perception statement. Frequencies and percentages were calculated to provide a clear overview of dominant attitudes among employees. Second, inferential statistical analysis was applied to examine whether employees' perceptions differed significantly between the two locations. Pearson's chi-square test of independence was used to assess the association between location (Bjelasica vs. Durmitor) and each perception variable. This non-parametric test was selected due to the categorical nature of the Likert-scale data and its suitability for comparing response distributions across independent groups. The chi-square analysis focused on determining whether observed differences in response patterns could be attributed to destination-specific factors or whether perceptions reflected a shared regional experience. A significance level of $p < 0.05$ was adopted for all tests. Where p-values exceeded this threshold, differences were interpreted as statistically non-significant and attributed to random sample variation.

Methodological Considerations

The chosen methodological approach allows for a systematic examination of employee perceptions as an important but often overlooked dimension of climate change impacts on winter tourism. By integrating

descriptive and inferential analysis, the study provides both an empirical overview of perceived challenges and a comparative assessment across destinations. While the cross-sectional design does not allow for causal inference, the inclusion of employees with substantial work experience supports the interpretation of perceptions as informed assessments grounded in long-term operational realities.

Research Hypotheses

Based on the theoretical background and the empirical focus on employees' perceptions of climate change impacts on winter tourism, the study formulates one main hypothesis and three supporting sub-hypotheses. These hypotheses are designed to examine whether climate change is perceived as a systemic challenge affecting winter tourism operations and sustainability, as well as to assess whether such perceptions differ between ski destinations with different levels of development in northern Montenegro.

H: Employees in ski centers in northern Montenegro perceive climate change as a systemic factor that negatively affects the stability, reliability, and long-term sustainability of winter tourism, regardless of destination characteristics.

H1: Employees perceive a shortening and decreasing reliability of winter tourism seasons as a direct consequence of climate change.

H2: Employees perceive increasing unpredictability of snow conditions and related operational constraints as a shared regional challenge rather than a destination-specific issue.

H3: Employees perceive adaptation measures and diversification of tourism activities beyond the winter season as necessary strategic responses to climate change impacts on winter tourism.

The hypotheses are tested using comparative statistical analysis of employee

responses across ski centers in northern Montenegro, with particular attention to differences between destinations of varying levels of tourism development.

Results and discussion

The sample structure provides a relevant basis for interpreting employees' perceptions of

climate change impacts on winter tourism. Respondents were relatively balanced between Bjelasica and Durmitor and included employees from operational, technical, service, instructional, and managerial positions. Since most respondents had several years of work experience in winter tourism, their answers can be interpreted as informed assessments based on direct professional exposure to

Table 1. Distribution of employee responses by location: Perceived shortening of winter seasons

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	5 (2.3%)	8 (3.8%)	13 (6.1%)
Disagree	12 (5.6%)	12 (5.6%)	24 (11.3%)
Neutral	22 (10.3%)	29 (13.6%)	51 (23.9%)
Agree	31 (14.6%)	33 (15.5%)	64 (30.0%)
Strongly agree	28 (13.1%)	33 (15.5%)	61 (28.6%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 2. Chi-square test of association between location and perceived shortening of winter seasons

Test	χ^2	df	p-value
Pearson Chi-square	0.774	4	0.942

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions of winter season shortening ($p > 0.05$).

changing winter season conditions.

Tables 1 and 2 show that employees in both destinations generally perceive winter seasons as becoming shorter. A total of 58.6% of respondents agreed or strongly agreed with this statement, while the chi-square test

showed no statistically significant difference between Bjelasica and Durmitor ($\chi^2 = 0.774$, $p = 0.942$). This indicates that perceived season shortening is not destination-specific, but rather reflects a broader regional experience. These results support Hypothesis H1, which assumes that employees perceive a shortening

Table 3. Distribution of employee responses by location: Perceived unpredictability of snow conditions

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	8 (3.8%)	6 (2.8%)	14 (6.6%)
Disagree	9 (4.2%)	11 (5.2%)	20 (9.4%)
Neutral	11 (5.2%)	23 (10.8%)	34 (16.0%)
Agree	38 (17.8%)	39 (18.3%)	77 (36.2%)
Strongly agree	32 (15.0%)	36 (16.9%)	68 (31.9%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 4. Chi-square test of association between location and perceived unpredictability of snow conditions

Test	χ^2	df	p-value
Pearson Chi-square	3.636	4	0.458

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions of snow condition unpredictability ($p > 0.05$).

Table 5. Distribution of employee responses by location: Perceived impact of climate-related factors on operational planning

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	6 (2.8%)	5 (2.3%)	11 (5.2%)
Disagree	15 (7.0%)	14 (6.6%)	29 (13.6%)
Neutral	14 (6.6%)	17 (8.0%)	31 (14.6%)
Agree	32 (15.0%)	45 (21.1%)	77 (36.2%)
Strongly agree	31 (14.6%)	34 (16.0%)	65 (30.5%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.



Table 6. Chi-square test of association between location and perceived impact of climate-related factors on operational planning

Test	χ^2	df	p-value
Pearson Chi-square	1.401	4	0.844

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions of the impact of climate-related factors on operational planning ($p > 0.05$).

and decreasing reliability of winter tourism seasons as a consequence of climate change. Tables 3–6 indicate that employees perceive climate variability as a direct operational challenge for winter tourism. The unpredictability of snow conditions received particularly strong agreement, with 68.1% of respondents agreeing or strongly agreeing, while 66.7% agreed or strongly agreed that climate-related factors affect operational planning. These findings show that climate change is not perceived only as a general environmental issue, but as a factor that directly influences the organization of ski

center activities, preparation of slopes, staff planning, and resource allocation.

The chi-square tests confirmed that there were no statistically significant differences between Bjelasica and Durmitor in relation to snow unpredictability ($\chi^2 = 3.636$, $p = 0.458$) or operational planning ($\chi^2 = 1.401$, $p = 0.844$). Therefore, these challenges can be interpreted as shared regional problems rather than destination-specific issues. The results support Hypothesis H2, which states that employees perceive snow unpredictability and related operational constraints as a common regional challenge.

Table 7. Distribution of employee responses by location: Perceived decrease in the reliability of the winter tourism season

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	3 (1.4%)	2 (0.9%)	5 (2.3%)
Disagree	8 (3.8%)	17 (8.0%)	25 (11.7%)
Neutral	20 (9.4%)	27 (12.7%)	47 (22.1%)
Agree	39 (18.3%)	37 (17.4%)	76 (35.7%)
Strongly agree	28 (13.1%)	32 (15.0%)	60 (28.2%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 8. Chi-square test of association between location and perceived decrease in the reliability of the winter tourism season

Test	χ^2	df	p-value
Pearson Chi-square	3.467	4	0.483

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions of decreased winter season reliability ($p > 0.05$).

Table 9. Distribution of employee responses by location: Perceived increase in economic uncertainty due to climate change

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	6 (2.8%)	10 (4.7%)	16 (7.5%)
Disagree	8 (3.8%)	9 (4.2%)	17 (8.0%)
Neutral	19 (8.9%)	28 (13.1%)	47 (22.1%)
Agree	36 (16.9%)	36 (16.9%)	72 (33.8%)
Strongly agree	29 (13.6%)	32 (15.0%)	61 (28.6%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 10. Chi-square test of association between location and perceived economic uncertainty caused by climate change

Test	χ^2	df	p-value
Pearson Chi-square	1.583	4	0.812

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions of increased economic uncertainty ($p > 0.05$).

Tables 7–10 show that employees associate climate change with reduced reliability of winter tourism seasons and increased economic uncertainty. In relation to season

reliability, 63.9% of respondents agreed or strongly agreed that winter tourism seasons have become less reliable. Similarly, 62.4% of respondents agreed or strongly agreed



that climate change increases economic uncertainty. These results suggest that employees perceive climate change as a factor that affects not only natural and operational conditions, but also the economic stability of ski centers. The chi-square tests showed no statistically significant differences between Bjelasica and Durmitor for perceived season reliability ($\chi^2 = 3.467$, $p = 0.483$) or economic uncertainty ($\chi^2 = 1.583$, $p = 0.812$). This confirms that employees in both destinations share similar perceptions of climate-related

instability. These findings further support Hypothesis H1 and also contribute to the main hypothesis, since climate change is perceived as a systemic factor affecting the reliability and economic viability of winter tourism.

Tables 11 and 12 show that employees recognize the limitations of artificial snowmaking as an adaptation measure. A total of 64.8% of respondents agreed or strongly agreed that artificial snowmaking cannot fully compensate for the lack of natural snowfall, especially

Table 11. Distribution of employee responses by location: Perceived limitations of artificial snowmaking

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	5 (2.3%)	6 (2.8%)	11 (5.2%)
Disagree	10 (4.7%)	11 (5.2%)	21 (9.9%)
Neutral	19 (8.9%)	24 (11.3%)	43 (20.2%)
Agree	37 (17.4%)	33 (15.5%)	70 (32.9%)
Strongly agree	27 (12.7%)	41 (19.2%)	68 (31.9%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 12. Chi-square test of association between location and perceived limitations of artificial snowmaking

Test	χ^2	df	p-value
Pearson Chi-square	2.490	4	0.646

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions regarding the inability of artificial snowmaking to fully compensate for the lack of natural snowfall ($p > 0.05$).

under higher temperature conditions. This indicates that employees do not view artificial snowmaking as a complete solution, but rather as a limited technical measure that must be combined with broader adaptation strategies. The chi-square test showed no statistically significant difference between Bjelasica and Durmitor ($\chi^2 = 2.490$, $p = 0.646$), indicating that this perception is shared across both destinations. These findings highlight the need for a more integrated approach to adaptation, including snow management, improved slope

preparation, infrastructure planning, and diversification of tourism activities.

Tables 13 and 14 indicate that employees perceive smaller ski centers as particularly vulnerable to climate change. Overall, 66.2% of respondents agreed or strongly agreed with this statement, suggesting that limited financial, infrastructural, and technical capacities are seen as important constraints for climate adaptation. The chi-square test showed no statistically

Table 13. Distribution of employee responses by location: Perceived vulnerability of smaller ski centers to climate change

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	5 (2.3%)	8 (3.8%)	13 (6.1%)
Disagree	9 (4.2%)	12 (5.6%)	21 (9.9%)
Neutral	21 (9.9%)	17 (8.0%)	38 (17.8%)
Agree	35 (16.4%)	41 (19.2%)	76 (35.7%)
Strongly agree	28 (13.1%)	37 (17.4%)	65 (30.5%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 14. Chi-square test of association between location and perceived vulnerability of smaller ski centers to climate change

Test	χ^2	df	p-value
Pearson Chi-square	1.917	4	0.751

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions of the greater vulnerability of smaller ski centers to climate change ($p > 0.05$).



significant difference between Bjelasica and Durmitor ($\chi^2 = 1.917$, $p = 0.751$), which confirms that this perception is not tied to one specific destination.

Tables 15 and 16 show that employees also recognize the influence of climate change on winter visitor numbers. A total of 66.2% of respondents agreed or strongly agreed that climate change affects winter tourism demand. This suggests that unstable snow conditions

and uncertain season duration influence not only ski center operations, but also visitor behavior and destination competitiveness.

The chi-square test again showed no statistically significant difference between the two destinations ($\chi^2 = 0.537$, $p = 0.970$). Therefore, the perceived impact of climate change on visitor numbers can be interpreted as a shared regional concern rather than a destination-specific issue.

Table 15. Distribution of employee responses by location: Perceived impact of climate change on winter visitor numbers

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	3 (1.4%)	4 (1.9%)	7 (3.3%)
Disagree	10 (4.7%)	15 (7.0%)	25 (11.7%)
Neutral	18 (8.5%)	22 (10.3%)	40 (18.8%)
Agree	39 (18.3%)	43 (20.2%)	82 (38.5%)
Strongly agree	28 (13.1%)	31 (14.6%)	59 (27.7%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 16. Chi-square test of association between location and perceived impact of climate change on winter visitor numbers

Test	χ^2	df	p-value
Pearson Chi-square	0.537	4	0.970

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions of climate-change-related impacts on winter visitor numbers ($p > 0.05$).

Tables 17–20 show that employees strongly support strategic responses to climate change, particularly diversification beyond the winter season and long-term adaptation. A total of 64.8% of respondents agreed or strongly agreed that tourism activities should be diversified beyond winter tourism, while 66.2% agreed or strongly agreed that long-term sustainability requires adaptation to changing climatic conditions. These findings indicate that employees recognize the need to reduce dependence on skiing and to develop broader year-round tourism models.

The chi-square tests showed no statistically significant differences between Bjelasica and Durmitor regarding the need for diversification ($\chi^2 = 4.181$, $p = 0.382$) or long-term adaptation ($\chi^2 = 3.947$, $p = 0.413$). This confirms that employees in both destinations share a similar understanding of the strategic direction needed for future winter tourism development. These results support Hypothesis H3, which assumes that employees perceive adaptation measures and diversification beyond the winter season as necessary responses to climate change.

Overall, the results provide support for the

Table 17. *Distribution of employee responses by location: Perceived need to diversify tourism activities beyond the winter season*

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	4 (1.9%)	8 (3.8%)	12 (5.6%)
Disagree	9 (4.2%)	15 (7.0%)	24 (11.3%)
Neutral	16 (7.5%)	23 (10.8%)	39 (18.3%)
Agree	32 (15.0%)	39 (18.3%)	71 (33.3%)
Strongly agree	37 (17.4%)	30 (14.1%)	67 (31.5%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 18. *Chi-square test of association between location and perceived need for diversification beyond the winter season*

Test	χ^2	df	p-value
Pearson Chi-square	4.181	4	0.382

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions of the growing need to diversify tourism activities beyond the winter season ($p > 0.05$).

Table 19. *Distribution of employee responses by location: Perceived need for adaptation to ensure long-term sustainability of winter tourism*

Response category	Bjelasica (n = 98)	Durmitor (n = 115)	Total (n = 213)
Strongly disagree	2 (0.9%)	4 (1.9%)	6 (2.8%)
Disagree	13 (6.1%)	13 (6.1%)	26 (12.2%)
Neutral	15 (7.0%)	25 (11.7%)	40 (18.8%)
Agree	34 (16.0%)	45 (21.1%)	79 (37.1%)
Strongly agree	34 (16.0%)	28 (13.1%)	62 (29.1%)
Total	98 (46.0%)	115 (54.0%)	213 (100.0%)

Note: Values represent frequency and percentage of the total sample.

Table 20. *Chi-square test of association between location and perceived need for adaptation to climate change*

Test	χ^2	df	p-value
Pearson Chi-square	3.947	4	0.413

Note: No statistically significant association was found between location (Bjelasica vs. Durmitor) and employees' perceptions that long-term sustainability of winter tourism requires adaptation to changing climatic conditions ($p > 0.05$).

main hypothesis of the study. Employees perceive climate change as a systemic factor that negatively affects the stability, reliability, economic viability, and long-term sustainability of winter tourism, regardless of destination characteristics. The absence of statistically significant differences between Bjelasica and Durmitor across all tested variables suggests that climate-related challenges should be addressed through coordinated regional adaptation strategies rather than isolated destination-level measures.

Conclusion

Winter tourism plays a significant economic and social role in mountain regions, particularly in areas with limited development opportunities such as northern Montenegro. However, the experiences and observations of employees over recent seasons indicate that climate change is increasingly affecting the stability, predictability, and operational sustainability of winter tourism. The aim of this study was to examine employees' perceptions of climate change impacts on winter tourism

and to compare these perceptions between ski centers on Bjelasica and Durmitor. The results reveal a high level of awareness among employees regarding multiple dimensions of climate-related risk. A majority of respondents recognize the declining reliability of winter seasons, increasing economic uncertainty, growing complexity of operational planning, and the technical limitations of artificial snowmaking under higher temperature conditions. Climate change is therefore not perceived as an abstract or distant threat, but as a current and operationally relevant factor shaping daily activities, resource allocation, and long-term planning in ski centers. Employees also largely acknowledge that smaller and lower-altitude ski centers are particularly vulnerable to climate-related pressures due to more limited financial, technical, and infrastructural capacities.

The findings further indicate that employees widely perceive climate change as affecting winter visitor numbers and increasing business uncertainty, highlighting the close relationship between climatic variability and tourism performance. At the same time, respondents consistently emphasize the need to diversify tourism activities beyond the winter season and to develop alternative products not exclusively dependent on skiing. These perceptions point toward a broader strategic shift toward more diversified and less season-dependent models of mountain tourism development, supported by the growing importance of summer tourism and complementary outdoor activities. Such diversification contributes to reducing seasonality and strengthening the resilience of mountain destinations. Across all analyzed variables, differences between the two destinations were small and statistically insignificant. The absence of meaningful differences in employee perceptions between Bjelasica and Durmitor suggests that climate-related challenges are experienced as a regional pattern rather than a destination-specific issue. This consistency implies that adaptation should not be approached solely at the local level, but rather as a coordinated regional development priority in winter tourism planning.

Theoretical and Practical Contributions

This study contributes to the literature on climate change and winter tourism by incorporating the perspectives of ski resort employees, a stakeholder group that remains underrepresented in existing research. By focusing on employees' experiential knowledge, the study provides insights into how climate change is perceived at the operational level, complementing research that predominantly relies on climatic data, demand-side analysis, or managerial perspectives. Empirically, the study demonstrates that employee perceptions of climate-related impacts are remarkably consistent across destinations with different levels of tourism development, reinforcing the understanding of climate change as a systemic challenge in winter tourism. From a practical perspective, the findings highlight the need for integrated adaptation strategies combining technical, organizational, and developmental measures. These include more efficient and context-sensitive use of artificial snowmaking systems, modern snow management and preservation practices, investments in infrastructure more resilient to climatic variability, flexible operational planning, diversification of tourism products, and the development of year-round tourism models. Such an integrated approach can enhance the long-term stability and sustainability of ski destinations.

Limitations and Future Research

Despite its contributions, this study has several limitations. First, the analysis is based on self-reported perceptions, which reflect subjective experiences rather than direct measurements of climatic or economic impacts. Second, the study focuses on two ski destinations in northern Montenegro, which may limit the generalizability of the findings to other mountain regions with different climatic, institutional, or economic contexts. Third, the cross-sectional design captures perceptions at a single point in time and does not allow for the examination of changes in perceptions



across multiple seasons. Future research could address these limitations by including a larger number of destinations, adopting longitudinal research designs, and integrating employee perceptions with objective climatic, operational, and economic indicators. Further studies could also explore differences between occupational groups within ski centers, examine adaptation strategies in greater depth, and investigate how employee perceptions align with managerial decision-making and policy-level responses. Such research would further strengthen the evidence base for effective climate change adaptation in winter and ski tourism.

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