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LINKING CLIMATIC RESOURCES AND GREEN TOURISM GROWTH UNDER CLIMATE CHANGE ADAPTATION CONTEXTS: EVIDENCE FROM HUE CITY

Abstract: This study examines the relationship between climate resources and green tourism growth in Hue City in the context of climate change adaptation. Data were collected from 174 valid tourist questionnaires at Bach Ma, the Hue Imperial Citadel, and the Chuon Lagoon–Thuan An area from April 2024 to March 2025, and analyzed using SPSS version 27. The dataset included 29 climatic variables and five green tourism growth variables. The results show that the scales were reliable and suitable for exploratory factor analysis. The regression model explains 35.3% of the variance in green tourism growth. All five climatic factor groups have positive and statistically significant effects, ranked as follows: wind conditions, rainfall conditions, thermal conditions, extreme weather events, and humidity conditions. The findings highlight the need to integrate climate information, seasonal planning, weather-risk management, and adaptive tourism products into green tourism governance in Hue City.

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Key words: Climate resources, green tourism growth, climate change adaptation, tourist perceptions, Hue City

INTRODUCTION

In the current global context, climate is not only a natural factor shaping socio-economic activities but is increasingly regarded as a strategic resource for sustainable tourism development and green growth. International studies indicate that climatic elements such as temperature, precipitation, humidity, wind, and extreme weather events directly influence destination attractiveness, accessibility, and tourist experiences (Scott et al. 2012; Becken, Hay 2012; Gössling et al. 2023; Peeters et al. 2024). According to the World Tourism Organization (UNWTO 2022), favorable climate and weather conditions constitute a fundamental determinant of destination competitiveness and provide a foundation for formulating sustainable tourism development strategies in the era of climate change (OECD 2020). At the same time, a growing body of research emphasizes the need for tourism to transition toward a low-carbon economy, in which the effective use of climate resources plays a crucial role in reducing emissions and enhancing the long-term sustainability of destinations (Gössling et al. 2013).

Climate change has become one of the most significant challenges to global tourism development, particularly in countries whose economies depend heavily on natural resources. The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2021) indicates that the global mean temperature has increased by approximately 1.1°C compared with the pre-industrial period, accompanied by rising frequency and intensity of extreme weather events such as storms, heatwaves, floods, and droughts. In this context, climate change adaptation in the tourism sector has become increasingly urgent in order to sustain growth, mitigate risks, and enhance destination resilience (Moreno, Becken 2009; Njoroge 2015; Scott et al. 2019; UNWTO 2023). Recent studies further suggest that the climate–tourism relationship should be examined not only from the perspective of vulnerability and risk, but also through climate comfort, climate suitability, adaptive capacity, and destination resilience, particularly in destinations where outdoor activities and seasonal visitor flows are highly sensitive to weather conditions (Tao et al. 2021; Dube 2024; Torabi et al. 2024; Papageorgiou 2025).

Urban tourism destinations are increasingly exposed to climate-related pressures, including heat stress, heavy rainfall, flooding, storms, high humidity, and seasonal weather variability. These pressures directly affect tourist mobility, outdoor activities, destination image, infrastructure performance, and the quality of visitor experience. Empirical evidence from urban tourism research shows that weather conditions can influence tourists' spatial behavior, movement patterns, and activity choices within cities (McKercher et al. 2015). In heritage and coastal cities, climate-related risks are particularly relevant because tourism activities often depend on open-air cultural sites, historical landscapes, waterfront areas, public spaces, and climate-sensitive transport and service systems (Markham et al. 2016; Quesada-Ganuza et al. 2021). Therefore, climate change adaptation in urban tourism should not be limited to risk reduction but should also include the identification and sustainable use of climate resources as a basis for destination planning, product diversification, visitor management, and green tourism growth.

In this regard, tourism climate indices and climate comfort assessments have become increasingly useful tools for evaluating climatic suitability, tourism seasonality, and destination planning. The Tourism Climate Index and the Holiday Climate Index have been widely applied and compared to assess the suitability of climatic conditions for tourism, particularly in urban, coastal, and beach destinations (Scott et al. 2016; Demiroglu et al. 2020; Adıgüzel 2023; Samarasinghe et al. 2023). These approaches provide important evidence for climate-sensitive tourism planning and adaptation under changing climatic conditions, especially in destinations where tourist experience is shaped by the combined effects of temperature, rainfall, humidity, wind, and extreme weather events.

Viet Nam, characterized by a tropical monsoon climate with pronounced spatial and temporal variability, possesses substantial potential for the development of diverse forms of tourism. However, the country is also experiencing increasingly severe impacts of climate change, manifested in more frequent natural disasters, prolonged heatwaves, and saline intrusion (Asian Development Bank 2021;

World Bank 2021; UNDP 2022; UNFCCC 2025). Within the framework of the National Green Growth Strategy for the 2021–2030 period, identifying and sustainably harnessing climate resources has become an important approach to reducing vulnerability while enhancing destination competitiveness (OECD 2020; Amelung, Nicholls 2021; Son, Quan 2021; UNEP 2023).

Hue City, the cultural and tourism center of central Viet Nam, is the first city in the country oriented toward development as a "heritage, green, and sustainable city." Located in a transitional climatic zone between northern and southern Viet Nam, Hue City features diverse terrain including mountains, plains, lagoon systems, and coastal areas. This spatial diversity gives rise to distinctive climatic sub-regions that serve as valuable resources for ecological, resort, and cultural tourism, while simultaneously posing challenges due to extreme weather phenomena such as heavy rainfall, tropical storms, and hot, dry foehn winds (Moreno, Becken 2009; Scott et al. 2019; Thua Thien Hue Statistical Office 2025). As a heritage city with tourism spaces extending from the mountainous Bach Ma area to the urban heritage core, the Tam Giang–Cau Hai lagoon system, and the Thuan An coastal area, Hue provides a relevant case for examining how climate resources can simultaneously create competitive advantages and generate adaptation requirements for green tourism development. This is particularly important because heritage and coastal tourism spaces are often more exposed to climate-related risks and require stronger integration of climate resilience into tourism planning and destination governance (Markham et al. 2016; Quesada-Ganuza et al. 2021; Papageorgiou 2025). Hue City's designation as a centrally governed municipality in 2025 further underscores the need for scientific research to clarify the potential and impacts of climate resources on tourism development oriented toward green growth and climate change adaptation.

Although numerous domestic and international studies have examined the climate–tourism relationship (De Freitas 2003; Scott et al. 2012; Day et al. 2013; Fang, Yin 2015), quantitative research on the linkage between climate resources and green tourism growth in the context of climate change adaptation at the urban scale remains limited, particularly in heritage cities such as Hue. Most existing studies have focused on climate vulnerability, tourism seasonality, destination comfort, tourist behavior under weather variability, or tourism climate indices, whereas fewer studies have quantitatively examined tourists' perceptions of multiple climatic factors and their combined contribution to green tourism growth at the city scale (McKercher et al. 2015; Scott et al. 2016; Tao et al. 2021; Adıgüzel 2023; Samarasinghe et al. 2023; Dube 2024). Moreover, studies focusing on central Viet Nam have highlighted the vulnerability of coastal communities and economic sectors to climate change as a critical consideration in sustainable development planning (Son et al. 2019; Huynh, Piracha 2019; Son, Quan 2021; Kowalczyk, Quan 2023). This gap points to the need for quantitative studies that provide empirical evidence to support the integration of climatic considerations into tourism planning and policy-making (OECD 2020; UNWTO 2023).

To address this gap, the novelty of the present study lies in approaching climate resources as a strategic resource for green tourism growth at the urban scale, rather than treating climate merely as a background environmental condition or a source of risk. The study simultaneously examines five groups of climatic factors, including thermal conditions, humidity conditions, rainfall conditions, wind conditions, and extreme weather events, based on tourists' perceptions across three representative tourism spaces in Hue City. This approach makes it possible to clarify the role of climate resources in green tourism growth in a tropical monsoon heritage city, where tourism activities are shaped by seasonal climatic variation, topographic differentiation, coastal exposure, and the need for destination resilience and climate change adaptation.

Against this background, the present study aims to analyze and quantify the relationship between climate resources and green tourism growth in the context of climate change adaptation in Hue City. The study employs meteorological data, sociological surveys, and quantitative analytical methods using the Statistical Package for the Social Sciences to identify climatic factors influencing tourism activities and to assess the potential for climate to be harnessed as a resource for sustainable local tourism development. In this regard, the application of information technology and data-driven approaches in tourism and environmental management is increasingly recognized as an important supporting tool for improving resource use efficiency, minimizing environmental impacts, and promoting sustainable tourism development (Gössling 2016). The findings are expected to provide empirical evidence for climate-adaptive tourism policy formulation in Hue City and to contribute to refining the theoretical framework linking climate resources, urban tourism, tourism climate comfort, climate resilience, green growth, and sustainable development in Viet Nam's tourism sector.

RESEARCH METHODS

Survey and field investigation methods

This study employs a sociological survey combined with field investigation to collect primary data for analyzing the relationship between climate resources and green tourism growth in Hue City, consistent with tourism–climate research approaches based on tourist perceptions (De Freitas 2003; Fang, Yin 2015). The survey was conducted in three areas representing distinct local climate sub-regions and characteristic tourism types in Hue City, including Bach Ma Tourism Area, the Hue Imperial Citadel, and the Chuon Lagoon–Thuan An area (Kowalczyk, Quan 2023; Moreno, Becken 2009; Son, Quan 2021). The three survey sites were selected to reflect the climatic and tourism diversity of Hue City. Bach Ma represents a mountainous tourism space with cooler climatic conditions and strong potential for ecotourism and resort tourism. The Hue Imperial Citadel represents the urban heritage tourism core, where visitor experience is closely related to outdoor thermal comfort, rainfall, and mobility conditions. The Chuon Lagoon–Thuan An area represents lagoon and coastal tourism spaces that are more directly exposed to wind, rainfall, storms, and other climate-related risks. This site selection therefore makes it possible to examine tourists' perceptions of climate resources across different tourism environments within the same urban destination.

Data were collected using standardized questionnaires combined with semi-structured interviews administered to both domestic and international tourists. The data collection was implemented over a twelve-month period, from April 2024 to March 2025, with three field survey rounds conducted in April 2024, August 2024, and January 2025. These survey rounds were designed to capture different seasonal conditions in Hue City, including the dry-season transition, summer conditions, and the cooler period after the main rainy season. The questionnaire consisted of a demographic information section and an assessment of tourist perceptions of 29 observed variables representing five groups of climatic factors, along with five variables reflecting green tourism growth, measured using a five-point Likert scale (Day et al. 2013). The full survey questionnaire is provided in Appendix 1 to improve transparency and replicability.

After data screening, 174 valid questionnaires were retained for quantitative analysis, meeting the sample size requirements for exploratory factor analysis and multiple regression analysis (Hair et al. 2010; Kline 2016; Tabachnick, Fidell 2019). Although the final sample size was relatively modest, it was considered acceptable for the exploratory purpose of this study. For exploratory factor analysis, J.F. Hair et al. (2010) suggest that a minimum ratio of five observations per observed variable is commonly acceptable, although larger ratios are preferable. In this study, the ratio between the number of valid responses and the 29 climate-related observed variables was approximately 6 : 1. Even when all 34 observed variables are considered, including 29 climatic variables and five variables measuring green tourism growth, the ratio remains slightly above 5 : 1. Therefore, the sample size satisfies the commonly used minimum requirement for exploratory factor analysis.

In addition, for multiple regression analysis, the sample size exceeds the commonly used rule of $N \geq 50 + 8m$, where m represents the number of independent variables. With five independent variables in the regression model, namely thermal conditions, humidity conditions, rainfall conditions, wind conditions, and extreme weather events, the minimum recommended sample size is 90, whereas this study used 174 valid responses (Tabachnick and Fidell 2019). The adequacy of the dataset was further supported by the subsequent statistical results, particularly the Kaiser–Meyer–Olkin values of 0.798 for the independent variables and 0.863 for the dependent construct, indicating that the data were suitable for factor analysis. Nevertheless, the sample size of 174 valid questionnaires is acknowledged as a limitation; therefore, the findings should be interpreted as exploratory evidence rather than as fully representative of all tourist markets in Hue City.

Data analysis methods

Survey data were processed using the Statistical Package for the Social Sciences version 27, following the quantitative analysis procedure illustrated in Fig. 1.

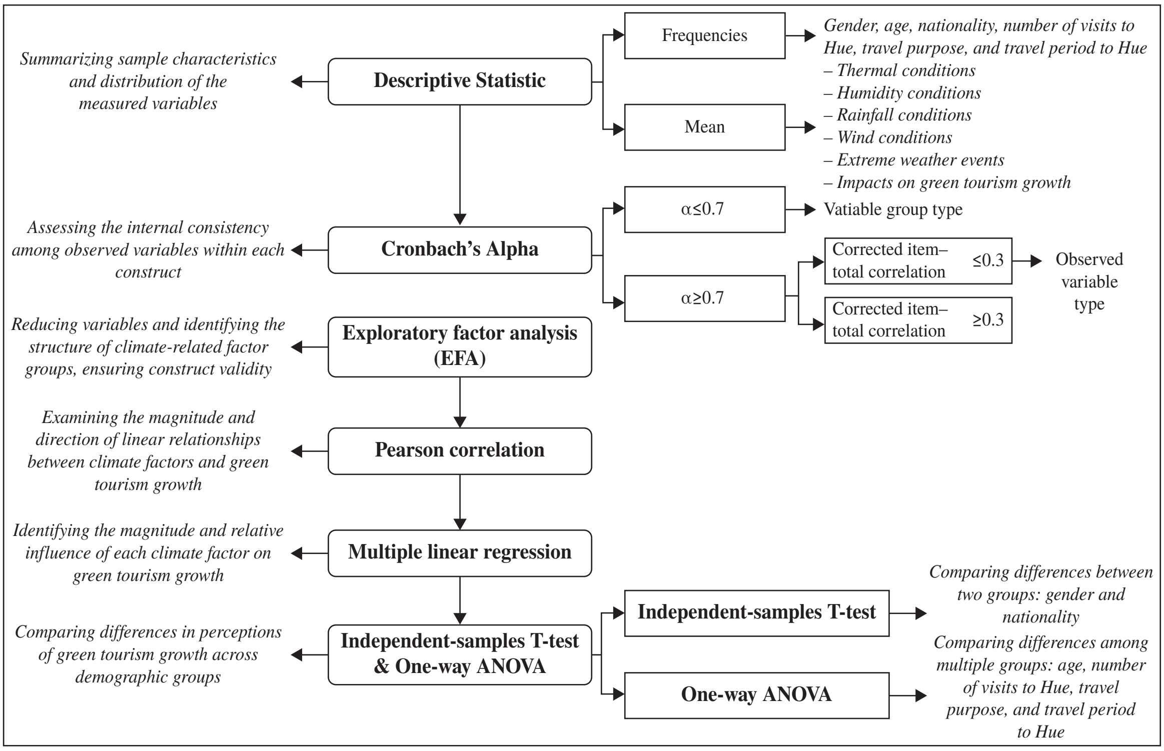

Fig. 1. Steps of the quantitative analysis procedure
Source: own elaboration.

Descriptive statistics were used to summarize sample characteristics and tourists' evaluations of climate resource factors. Reliability testing using Cronbach's Alpha was then applied to assess the internal consistency of the measurement scales. Exploratory factor analysis was conducted to identify the factor structure of climatic resource groups and the green tourism growth construct. The suitability of the data for factor analysis was assessed using the Kaiser–Meyer–Olkin measure and Bartlett's Test of Sphericity (Hair et al. 2010; Tabachnick, Fidell 2019; Fang, Yin 2015).

Pearson correlation analysis and multiple linear regression were applied to assess the magnitude and relative influence of climatic factors on green tourism growth. The regression model was designed to examine the effects of five independent variables, namely thermal conditions, humidity conditions, rainfall conditions, wind conditions, and extreme weather events, on the dependent variable representing green tourism growth. In addition, Independent-Samples T-tests and one-way analysis of variance were employed to examine differences in perceptions among tourist groups based on demographic characteristics, including gender, nationality, age, number of visits, travel purpose, and travel period (Peeters et al. 2024; UNWTO 2023). On this basis, the research hypotheses regarding the impacts of climatic factors on green tourism growth in Hue City were tested.

STUDY AREA

Hue City is located between 15°59'30" and 16°44'30" north latitude, near the center of the Northern Hemisphere's inner tropical belt, and is directly influenced by the Asian monsoon circulation. With its eastern boundary facing the sea and its position at the transition between tropical and subtropical climatic zones, Hue City is characterized by a transitional tropical monsoon climate with pronounced spatial and temporal differentiation, leading to the formation of distinct local climatic sub-regions (De Freitas 2003; Fang and Yin 2015) (Fig. 2). The city lies along the central coastal axis of Viet Nam, within the Central Key Economic Region, and occupies a strategic position on the North–South transport corridor and the East–West Economic Corridor, providing advantages in interregional connectivity and international integration (UNWTO 2022).

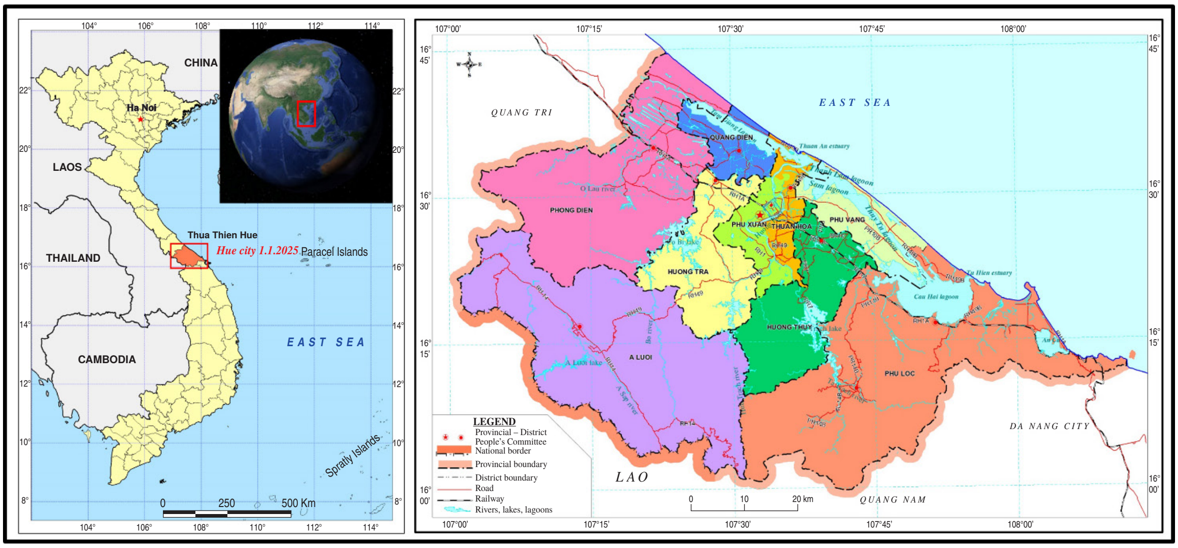

Fig. 2. Location of the study area
Source: own elaboration.

According to resolutions of the Central Government and the National Assembly, from 1 January 2025 Hue officially became a centrally governed municipality, covering an area of 4,947.11 km² with a population of approximately 1.24 million people (*Resolution No. 175/2024/QH15 on the establishment of Hue City as a centrally governed city* 2024; Thua Thien Hue Statistical Office 2025). The territorial space exhibits clear topographic differentiation, comprising mountainous areas in the west, a central lowland plain, and a lagoon–coastal system in the east, resulting in high landscape and ecosystem diversity. Recent studies indicate that the area is also highly sensitive and vulnerable to climate change, particularly under the impacts of heavy rainfall, tropical storms, and extreme weather events (IPCC 2021; Son, Quan 2021). In this context, socio-economic development in Hue City, particularly tourism, is increasingly linked to the requirements of climate change adaptation and green growth (Njoroge 2015; Peeters et al. 2024).

These topographic and coastal characteristics create substantial climatic differentiation within Hue City. The mountainous western area, the central lowland and heritage core, and the eastern lagoon–coastal zone are exposed to different combinations of temperature, rainfall, humidity, wind, and extreme weather events. Such differentiation is directly relevant to tourism because it shapes outdoor comfort, seasonal accessibility, tourism product suitability, and climate-related risks.

Climatic characteristics of Hue City

Hue City is characterized by a tropical monsoon climate with relatively high temperatures and substantial sunshine duration, providing favorable conditions for year-round tourism development (De Freitas 2003; Fang and Yin 2015). Total solar radiation reaches approximately 124–126 Kcal/cm²/year, while average annual sunshine duration ranges from 1,700 to 2,000 hours. These conditions are generally favorable for outdoor tourism activities, especially cultural sightseeing, ecological tourism, and community-based tourism. Mean annual temperature shows clear differentiation by elevation, ranging from 24–25°C in lowland and low-hill areas, decreasing to 20–22°C at elevations of 500–800 m, and falling below 18°C above 1,000 m. This altitudinal variation creates cooler climatic sub-regions with significant potential for resort tourism, notably in the Bach Ma area (Thua Thien Hue Statistical Office 2025).

However, Hue City is also characterized by high annual precipitation, typically ranging from 1,500 to 3,000 mm/year. The rainy season lasts approximately six months, from August to January of the following year, and usually peaks between September and December (Thua Thien Hue Statistical Office 2025). Average annual relative humidity remains high, at around 86–88%. In combination with heavy rainfall, high humidity may intensify thermal discomfort, reduce outdoor comfort, and affect the seasonality of tourism activities. Wind conditions are influenced by the Southeast Asian monsoon circulation and the Truong Son mountain range, resulting in variable wind directions, generally low average wind speeds, and frequent calm periods (De Freitas 2003; Fang, Yin 2015). In addition to these climatic characteristics, Hue City is frequently exposed to extreme weather events such as tropical storms, hot and dry westerly winds, thunderstorms, heavy rainfall, and floods, which may disrupt travel itineraries and increase risks for tourism activities (IPCC 2021; Thua Thien Hue Statistical Office 2025).

Hue City's tropical monsoon climate therefore constitutes both a tourism resource and a source of seasonal constraints. Favorable temperature conditions, abundant sunshine, and climatic differentiation by elevation support the development of cultural, ecological, community-based, and resort tourism. At the same time, prolonged rainy seasons, high humidity, tropical storms, floods, and hot dry westerly winds may reduce destination accessibility, affect tourist comfort, and increase the need for climate-adaptive tourism planning. This dual role of climate is particularly important for Hue City, where tourism spaces extend from the mountainous Bach Ma area to the urban heritage core, the Tam Giang–Cau Hai lagoon system, and the Thuan An coastal area.

Tourism in Hue City has recovered strongly following the downturn caused by the global pandemic. The city is recognized as one of the five major tourism centers of Viet Nam. By 2024, total tourist arrivals were estimated at approximately 4.5–4.8 million, approaching pre-2020 peak levels, with rapid growth in international visitors driven by improved transport connectivity and market promotion. Tourism revenue in 2024 was estimated to exceed 11,000 billion Vietnamese dong (approximately 450 million US dollars), reflecting a relatively comprehensive sectoral recovery and the increasingly prominent role of tourism in the local economic structure (Thua Thien Hue Statistical Office 2025). Tourism contributes around 7% of gross regional domestic product; although it has not yet achieved the status of a leading economic sector, it remains a key driver of service development and community livelihoods. The city hosts numerous prominent attractions, including the Complex of Hue Monuments, the Nguyen Dynasty royal tombs, Thien Mu Pagoda, Bach Ma National Park, and the Tam Giang–Cau Hai lagoon system, providing a strong foundation for the development of cultural, ecological, and community-based tourism aligned with the area's distinctive climatic conditions (Kowalczyk, Quan 2023).

Overall, the study area provides a relevant case for examining the relationship between climate resources and green tourism growth in the context of climate change adaptation. The diversity of terrain, tourism spaces, and local climatic conditions allows Hue City to develop differentiated tourism products, but it also requires stronger integration of climate information, seasonal planning, weather-risk management, and climate-adaptive infrastructure into destination governance. Therefore, understanding the role of climate resources in Hue City is essential for promoting green tourism growth while reducing vulnerability to climate variability and extreme weather events.

RESEARCH RESULTS

Impacts of climate resource factors on tourist activities in Hue City

Based on the climatic characteristics described in the Study Area section, this part analyzes tourists' perceptions of five groups of climate resource factors and their relationship with green tourism growth in Hue City. The analysis was conducted using 174 valid questionnaires, with a relatively balanced gender distribution and a dominant age group ranging from 18–45 years. Most respondents were domestic tourists and first-time visitors to Hue City, with sightseeing and leisure as their primary travel purposes. Descriptive statistical results indicate clear differences in tourists' evaluations of climate resource factor groups in Hue City (Table 1).

Among these factors, thermal conditions were rated as the most favorable for tourism activities (M = 3.61), reflecting tourists' relatively good adaptation to local climatic conditions. Humidity conditions (M = 3.15) and rainfall conditions (M = 3.03) were assessed at a neutral level, suggesting that they generally do not pose major constraints and can be moderated through tourists' adaptive behaviors.

Conversely, wind conditions were rated as the least favorable factor group (M = 2.90), reflecting tourists' sensitivity to adverse wind conditions. For extreme weather events, the mean value of 3.20 indicates that these factors have not significantly diminished the overall tourism experience. The group of variables reflecting the impacts of climate on green tourism growth was evaluated relatively positively (M = 3.49), suggesting considerable potential for leveraging Hue's climatic conditions to support long-term sustainable tourism development.

The descriptive results should be interpreted in relation to Hue City's tropical monsoon climate. The highest mean score for thermal conditions indicates that temperature remains a relatively favorable climatic resource for tourism, particularly for sightseeing and outdoor activities during cooler periods of the day. This is consistent with the tourism characteristics of Hue, where many activities, especially visits to heritage sites, ecological landscapes, and lagoon–coastal areas, are conducted outdoors or semi-outdoors.

By contrast, wind conditions received the lowest mean score, suggesting that tourists are more sensitive to adverse wind-related phenomena, including cold seasonal winds, strong winds, dusty winds, and hot, dry westerly winds. Rainfall and humidity were evaluated at a neutral level, implying that they do not completely prevent tourism activities but may require itinerary adjustment, better weather information, and more flexible tourism services.

The mean score for extreme weather events should be interpreted with caution. It does not imply that extreme weather conditions are beneficial for tourism; rather, it suggests that many tourists either did not experience severe weather events during their trip or were able to adapt through schedule adjustment, weather information, and flexible travel decisions. Overall, these findings confirm that

Table 1. Impacts of climate resource attributes on tourist activities in Hue City

Evaluation variables	Code	Mean	Std. Deviation
Thermal conditions	**HT**	**3.61**	**0.828**
Average temperature in Hue during the trip is comfortable.	HT1	3.64	1.154
Hot weather does not make tourists feel fatigued.	HT2	3.58	1.065
Cool weather in the morning and evening is favorable for activities.	HT3	3.71	1.091
Daily temperature variation is not excessive.	HT4	3.59	1.226
I adapt well to the hot and humid climate in Hue.	HT5	3.59	1.143
I am satisfied with the temperature conditions in Hue.	HT6	3.55	1.099
Humidity conditions	**HU**	**3.15**	**0.912**
The air in Hue is fresh and pleasant.	HU1	3.18	1.147
Tourists feel comfortable despite the high humidity.	HU2	3.18	1.243
Humidity does not affect clothing choices or outdoor activities.	HU3	3.20	1.181
I adapt easily to humid conditions in Hue.	HU4	3.06	1.253
Humidity does not cause difficulties for mobility.	HU5	3.13	1.133
Rainfall conditions	**RA**	**3.03**	**0.912**
Rain occurs frequently during the trip.	RA1	3.14	1.266
Rain does not disrupt tourism activities.	RA2	3.10	1.207
Travel itineraries can be easily adjusted during rainfall.	RA3	3.03	1.162
Rain does not negatively affect the tourism experience.	RA4	2.96	1.213
I receive sufficient weather forecast information.	RA5	2.99	1.235
I visit Hue during a season (rainy or dry) that is suitable for tourism.	RA6	2.96	1.194
Wind conditions	**WI**	**2.90**	**0.873**
Light winds create a pleasant feeling during sightseeing.	WI1	2.91	1.129
Strong winds do not hinder tourism activities.	WI2	2.91	1.149
Dusty winds do not significantly affect tourism activities.	WI3	2.93	1.214
Cool winds enhance the attractiveness of Hue's weather.	WI4	2.90	1.202
Cold winter winds do not affect tourism activities.	WI5	2.91	1.192
Hot and dry summer winds do not significantly affect tourism activities.	WI6	2.79	1.169
I experienced no problems related to wind conditions during the trip.	WI7	2.96	1.150
Extreme weather events (storms, floods, hail, droughts, etc.)	**EX**	**3.20**	**0.831**
I encountered adverse weather events such as storms, floods, or extreme heat during the trip.	EX1	3.18	1.221
I am not overly concerned when facing unfavorable weather conditions.	EX2	3.26	1.079
There is no need to cancel or postpone activities due to weather conditions.	EX3	3.25	1.113
Adverse weather does not reduce the quality of the vacation.	EX4	3.11	1.135
I am willing to revisit Hue if the weather conditions are favorable.	EX5	3.20	1.186
Impacts on green tourism growth	**SU**	**3.49**	**0.579**
Hue's climate creates a positive impression on tourists.	SU1	3.52	0.677
Climate influences tourists' intention to revisit Hue.	SU2	3.42	0.731
Hue's climate is suitable for year-round tourism activities.	SU3	3.51	0.669
Climate conditions facilitate the development of ecotourism and community-based tourism.	SU4	3.46	0.734
Climate change affects green tourism growth in Hue.	SU5	3.55	0.734

Source: own elaboration.

climate resources in Hue City are not merely background environmental conditions but active factors shaping tourist experience, destination attractiveness, and green tourism growth.

Reliability testing of measurement scales (Cronbach's Alpha)

The reliability test results indicate that all measurement scales are suitable for quantitative analysis, with Cronbach's Alpha coefficients exceeding the threshold of 0.7 and corrected item–total correlations greater than 0.3. The scales measuring thermal conditions (HT), humidity conditions (HU), rainfall conditions (RA), wind conditions (WI), extreme weather events (EX), and impacts on green tourism growth (SU) all meet the required reliability criteria. Accordingly, all observed variables were retained for subsequent exploratory factor analysis.

Table 2. Results of Cronbach's Alpha reliability testing

Code	Factor	Cronbach's Alpha (α)	N of Items
HT	Thermal conditions	0.826	6
HU	Humidity conditions	0.822	5
RA	Rainfall conditions	0.846	6
WI	Wind conditions	0.866	7
EX	Extreme weather events (storms, floods, hail, droughts, etc.)	0.773	5
SU	Impacts on green tourism growth	0.874	5

Source: own elaboration.

These results indicate that the observed variables within each construct are internally consistent and can be used for further factor extraction, correlation analysis, and regression analysis. The reliability testing therefore provides an appropriate statistical basis for the subsequent quantitative analyses.

Exploratory factor analysis (EFA)

Exploratory factor analysis was conducted on 29 observed variables representing climate-related factors using the Principal Component extraction method with Varimax rotation. The results indicate that the data are suitable for EFA, with a Kaiser–Meyer–Olkin value of 0.798 and a statistically significant Bartlett's Test of Sphericity ($p = 0.000$). The total variance explained reaches 56.558%, and all observed variables exhibit factor loadings greater than 0.5.

The EFA results provide statistical support for the proposed grouping of climate-related variables. The extracted factors correspond to the five theoretical dimensions of climate resources, including thermal conditions, humidity conditions, rainfall conditions, wind conditions, and extreme weather events. The Kaiser–Meyer–Olkin value of 0.798 indicates that the dataset is appropriate for factor analysis, while the total variance explained of 56.558% is acceptable in social science and tourism perception research. These findings confirm that tourists are able to distinguish among different climatic dimensions when evaluating their tourism experience in Hue City.

For the dependent variable, impacts on green tourism growth, the EFA results show a Kaiser–Meyer–Olkin value of 0.863 and a total variance explained of 66.567%. All component variables display factor loadings exceeding 0.7, thereby supporting the use of extracted factor scores in subsequent analyses.

The high Kaiser–Meyer–Olkin value for the dependent construct further confirms that the green tourism growth scale has a coherent factor structure. This supports the use of the extracted dependent factor in the correlation and regression analyses.

Pearson correlation analysis

The results of the Pearson correlation analysis indicate that the dependent variable, SU, exhibits positive and statistically significant linear relationships with all independent variables in the model ($p < 0.05$), with correlation coefficients ranging from 0.240 to 0.332. At the same time, the correlation coefficients among the independent variables are relatively low, suggesting that multicollinearity is not present (Table 3).

Table 3. Pearson correlation coefficient matrix

	SU	**HT**	**HU**	**RA**	**WI**	**EX**
SU	1	0.297*	0.266*	0.263*	0.332*	0.240*
HT	0.297*	1	–0.022	–0.032	0.140	0.053
HU	0.266*	–0.022	1	0.137	0.055	–0.084
RA	0.263*	–0.032	0.137	1	–0.070	–0.058
WI	0.332*	0.140	0.055	–0.070	1	0.023
EX	0.240*	0.053	–0.084	–0.058	0.023	1

**Correlation is significant at the 0.01 level.*

Source: own elaboration.

The positive correlation coefficients suggest that more favorable tourist perceptions of climate-related factors are associated with more positive evaluations of green tourism growth in Hue City. Among the independent variables, wind conditions show the strongest correlation with green tourism growth, followed by thermal conditions, humidity conditions, rainfall conditions, and extreme weather events.

However, the correlation coefficients are moderate rather than high, indicating that climate-related factors contribute to tourists' perceptions of green tourism growth but do not act as the only determinants. This is theoretically reasonable because green tourism growth is also influenced by infrastructure quality, environmental management, tourism services, destination governance, communication, and tourists' environmental awareness. Therefore, the correlation results support the relevance of climate resources while also indicating the need to interpret them within a broader destination development framework.

Multiple linear regression analysis

The results of the multiple linear regression analysis indicate that the model is statistically significant ($F = 19.857$; $p = 0.001$), with an adjusted coefficient of determination of 0.353. This suggests that climate-related factors explain approximately 35.3% of the variance in perceptions of green tourism growth. All independent variables exhibit positive regression coefficients and are statistically significant ($p \leq 0.05$). In addition, no multicollinearity issues are detected, as indicated by variance inflation factor values close to one ($VIF \approx 1$) (Table 4). The unstandardized regression equation is specified as follows:

$$SU = 0.699 + 0.179 * HT + 0.152 * HU + 0.174 * RA + 0.197 * WI + 0.178 * EX$$

The adjusted R^2 value of 0.353 indicates that the five climatic factors explain 35.3% of the variance in green tourism growth perceptions. This explanatory power is meaningful in the context of tourism perception research, where tourist evaluations are shaped by multiple environmental, social, infrastructural, and service-related factors. The positive and significant coefficients of all five variables

Table 4. Results of multiple linear regression analysis

Model	Unstandardized Coefficients		Standardized Coefficients	p-value	Multicollinearity	
	B	Std. Error	Beta		Tolerance	VIF
(Constant)	0.699	0.287		0.016		
HT	0.179	0.043	0.256	0.000	0.977	1.023
HU	0.152	0.039	0.240	0.000	0.970	1.030
RA	0.174	0.039	0.274	0.000	0.973	1.028
WI	0.197	0.041	0.297	0.000	0.971	1.029
EX	0.178	0.043	0.255	0.000	0.988	1.012

Adjusted R^2: 0.353 Durbin-Watson Statistic: 1.742
F Statistic (ANOVA): 19.857 Level of significance (ANOVA sig): 0.001

Source: own elaboration.

confirm that favorable perceptions of climate resources are associated with stronger evaluations of green tourism growth in Hue City.

Based on the standardized Beta coefficients, the relative influence of climatic factors on green tourism growth is ranked as follows: wind conditions ($\beta = 0.297$), rainfall conditions ($\beta = 0.274$), thermal conditions ($\beta = 0.256$), extreme weather events ($\beta = 0.255$), and humidity conditions ($\beta = 0.240$). These results indicate that all research hypotheses are supported, although the strength of influence varies across climatic dimensions.

The strongest standardized effect of wind conditions suggests that wind-related experiences are particularly important for tourists in Hue City, especially because many tourism activities take place in outdoor, lagoon, coastal, and heritage spaces. Rainfall conditions rank second, reflecting the importance of precipitation for itinerary planning, accessibility, and outdoor comfort in a tropical monsoon climate. Thermal conditions and extreme weather events also show meaningful effects, while humidity conditions have the weakest but still statistically significant influence. This ranking highlights the need for climate-sensitive tourism planning that pays particular attention to wind, rainfall, and seasonal weather variability.

Analysis of differences by demographic characteristics (T-test and ANOVA)

The results of the independent-samples T-test indicate that there is no statistically significant difference between male and female tourists in their assessments of green tourism growth ($p > 0.05$). However, a statistically significant difference is observed between domestic and international tourists ($p = 0.009$), with domestic tourists reporting higher evaluation scores (Table 5).

Table 5. Results of an independent-samples T-test

		Mean	Std. Deviation	t	p
Gender	Male	3.46	0.578	−0.682	0.496
	Female	3.52	0.581		
Nationality	Viet Nam	3.55	0.573	2.654	0.009
	Foreign	3.27	0.551		

Source: own elaboration.

The absence of significant gender differences suggests that perceptions of climate-related green tourism growth are not strongly gender-dependent. However, the significant difference between domestic and international tourists indicates that climatic perception may be influenced by previous climatic experience, cultural expectations, and adaptive capacity. Domestic tourists, who are generally more familiar with tropical monsoon conditions, may perceive Hue's climate as less disruptive than international tourists. This finding suggests that communication strategies for international tourists should provide clearer information on seasonal weather conditions, suitable travel periods, and adaptive options during unfavorable weather.

One-way analysis of variance (ANOVA) indicates that age, number of visits to Hue, travel purpose, and travel period within the year all have statistically significant effects on tourists' evaluations of green tourism growth ($p < 0.05$). Detailed results are presented in Table 6.

Table 6. Results of one-way analysis of variance (ANOVA)

Variable	Item	Mean ± SD	df	F	p
Age	Under 18 years	3.48	0.658	3.614	0.007
	18–30 years	3.65	0.578		
	31–45 years	3.56	0.513		
	46–60 years	3.29	0.542		
	Over 60 years	3.18	0.632		
Number of visits to Hue	First visit	3.40	0.598	3.285	0.040
	2–3 visits	3.63	0.519		
	More than 3 visits	3.63	0.541		
Travel purpose	Sightseeing	3.51	0.596	2.961	0.034
	Leisure	3.35	0.583		
	Business	3.77	0.448		
	Other	3.42	0.545		
Travel period to Hue	January–March	3.81	0.586	8.403	0.000
	April–May	3.52	0.524		
	June–September	3.30	0.570		
	October–December	3.23	0.474		

Source: own elaboration.

The differences by age group suggest that younger and middle-aged tourists tend to evaluate climate-related green tourism growth more positively than older tourists. This may be because younger visitors are generally more flexible in outdoor activities, itinerary adjustment, and adaptation to variable weather conditions. The results also show that tourists who had visited Hue more than once reported higher evaluations than first-time visitors, indicating that previous travel experience may help tourists better understand local seasonal characteristics and adapt their travel plans accordingly.

The higher evaluations recorded during January–March reflect the seasonal suitability of this period for tourism activities in Hue City, when weather conditions are generally more favorable for sightseeing and outdoor experiences. Conversely, the lower scores during October–December correspond to the peak rainy season, when heavy rainfall, high humidity, and storm risks may reduce mobility and outdoor comfort. These seasonal differences reinforce the need for climate-sensitive tourism planning, flexible itinerary design, and the development of tourism products adapted to different climatic periods of the year.

DISCUSSION

The findings provide empirical evidence that climate resources play a significant role in green tourism growth in Hue City. The positive and statistically significant effects of all five climatic dimensions indicate that tourists' perceptions of temperature, rainfall, humidity, wind, and extreme weather-related conditions are closely associated with their evaluation of Hue City's potential for green tourism development. This result supports the view that climate should not be considered merely as a background environmental condition, but also as a strategic tourism resource that can shape destination attractiveness, tourist comfort, tourism seasonality, and destination competitiveness.

This finding is consistent with tourism climatology studies that emphasize the role of climate in shaping destination attractiveness, tourist comfort, and tourism seasonality (De Freitas 2003; Fang, Yin 2015). It also aligns with climate change and tourism adaptation literature, which highlights the need to integrate climatic conditions into tourism planning, risk management, and sustainable destination development (Moreno, Becken 2009; Scott et al. 2012; Becken, Hay 2012). More recent studies further confirm that climate resources, climate comfort, and low-carbon transition are increasingly important for resilient and sustainable tourism development under climate change (Gössling et al. 2023; Peeters et al. 2024).

The strongest standardized effect of wind conditions, followed by rainfall conditions, reflects the specific climatic and tourism context of Hue City. This interpretation is consistent with the revised regression results, in which the standardized Beta coefficients are ranked as follows: wind conditions, rainfall conditions, thermal conditions, extreme weather events, and humidity conditions. This ranking is consistent with the standardized Beta coefficients reported in Table 4 and reflects the importance of wind and rainfall conditions in Hue City's tropical monsoon tourism context.

Many tourism activities in Hue, including heritage sightseeing, lagoon tourism, coastal recreation, and ecotourism, are conducted in outdoor or semi-outdoor settings. As a result, wind and rainfall directly affect tourist mobility, outdoor comfort, safety, accessibility, and itinerary flexibility. In a tropical monsoon city such as Hue, these two factors are also closely associated with seasonality, monsoon circulation, heavy rainfall periods, and climate-related travel constraints. Studies using the Tourism Climate Index and the Holiday Climate Index similarly show that wind, rainfall, and thermal conditions are key variables influencing the climatic suitability of urban, coastal, and beach destinations (Scott et al. 2016; Demiroglu et al. 2020). Recent applications of tourism climate indices also confirm their usefulness for climate-sensitive urban planning and for assessing tourism suitability under changing climatic conditions (Adıgüzel 2023; Samarasinghe et al. 2023).

Thermal conditions also exert a significant influence on green tourism growth, confirming that temperature comfort remains central to tourist experience. In Hue City, favorable temperature conditions, especially during cooler periods of the day and in higher-elevation areas such as Bach Ma, can support cultural tourism, ecotourism, and resort tourism. This result is consistent with studies showing that temperature and perceived thermal comfort are closely linked to outdoor tourism activities, destination image, and tourists' willingness to participate in sightseeing and recreation (De Freitas 2003; Day et al. 2013; McKercher et al. 2015).

However, humidity conditions show the weakest standardized effect among the five climatic dimensions. This may be because humidity is perceived less directly than rainfall, wind, or heat, or because tourists can partly adapt through clothing choices, activity timing, hydration, and mobility behavior. Nevertheless, high humidity should not be overlooked, as it may intensify thermal discomfort, especially during hot periods and outdoor visits to heritage sites. In this sense, humidity remains an important supporting factor in climate-sensitive tourism planning, even though its independent effect in the regression model is weaker than those of wind, rainfall, and temperature.

The positive coefficient of extreme weather-related variables should be interpreted with caution. It does not mean that storms, floods, heatwaves, or other extreme events are beneficial for tourism.

Rather, the items in this construct capture tourists' perceived ability to continue, adjust, or recover their tourism activities under unfavorable weather conditions. Therefore, this result reflects the importance of adaptive capacity, weather information, flexible itineraries, and diversified tourism products in reducing the negative impacts of climate-related risks.

This interpretation is consistent with adaptation-oriented tourism studies, which emphasize that climate risk management requires not only awareness of hazards but also institutional preparedness, visitor communication, and flexible destination governance (Njoroge 2015; Scott et al. 2019). For heritage and coastal cities, climate-related risks are especially important because tourism activities are often concentrated in open-air cultural sites, historical landscapes, waterfront spaces, and climate-sensitive infrastructure (Markham et al. 2016; Quesada-Ganuza et al. 2021). Recent studies further highlight the need to strengthen resilience and adaptation capacity in tourism businesses, destinations, and spatial planning under climate change (Dube 2024; Torabi et al. 2024; Papageorgiou 2025).

The differences in evaluations among tourist groups further indicate that climate perception is shaped by previous experience, cultural background, travel purpose, and seasonal context. Domestic tourists evaluated climate-related green tourism growth more positively than international tourists, which may reflect their greater familiarity with tropical monsoon conditions and stronger adaptive capacity. Similarly, tourists who had visited Hue more than once tended to give higher evaluations, suggesting that previous travel experience may help visitors better understand seasonal characteristics and adjust their itineraries accordingly.

The higher evaluations during January–March and the lower evaluations during October–December also confirm the importance of seasonality. The January–March period is generally more favorable for sightseeing and outdoor experiences, whereas October–December corresponds to the peak rainy season, when heavy rainfall, humidity, and storm risks may reduce mobility and outdoor comfort. These results are consistent with the broader literature showing that weather conditions influence tourist behavior, spatial movement, activity choices, and tourism performance (Day et al. 2013; McKercher et al. 2015).

These findings have practical implications for climate-adaptive tourism governance in Hue City. Tourism planners should integrate climatic information into destination management, seasonal product design, visitor communication, and risk management. Cultural and heritage tourism products in the urban core should be supported by shaded walking routes, rain shelters, drainage improvement, rest areas, and real-time weather information. Lagoon and coastal tourism should incorporate storm, rainfall, and wind risk management, while mountainous tourism areas such as Bach Ma can be promoted as climate-comfort destinations during hot periods.

In addition, communication strategies for international tourists should provide clearer information on suitable travel seasons, weather-related risks, and adaptive options during unfavorable weather. Tourism products should also be diversified according to Hue City's climatic sub-regions and seasonal conditions. Such measures would help transform climate resources into a foundation for green tourism growth while reducing vulnerability to climate variability and extreme weather events.

Overall, the study demonstrates that climate resources can serve as a strategic foundation for green tourism growth in Hue City if they are integrated into planning, governance, visitor management, and climate adaptation strategies. The results also show that climate-related risks should not be addressed only through short-term emergency responses, but through long-term adaptation, product diversification, infrastructure improvement, and climate-sensitive destination governance.

CONCLUSION

This study quantifies the relationship between climate resources and green tourism growth in Hue City within the context of climate change adaptation, based on 174 survey questionnaires collected across three representative tourism spaces during the period from April 2024 to March 2025. The findings indicate that Hue's climate resources simultaneously provide competitive advantages for tourism development and pose potential risks associated with seasonal heavy rainfall, high humidity, and extreme weather events. Measurement scales demonstrate high reliability, and the exploratory factor analysis confirms the structure of climatic factor groups as well as the green tourism growth construct, forming a robust basis for subsequent quantitative analyses.

Correlation and regression analyses reveal that all five groups of climatic factors exert positive and statistically significant effects on green tourism growth, with the model explaining 35.3% of the variance in the dependent variable. Among these factors, wind conditions and rainfall conditions show the strongest standardized effects, followed by thermal conditions, extreme weather events, and humidity conditions. This ranking suggests that climate-sensitive tourism planning in Hue City should give particular attention to wind-related conditions, rainfall seasonality, itinerary flexibility, and weather-risk management, especially because many tourism activities in Hue are conducted in outdoor, heritage, lagoon, coastal, and ecological spaces. Differences in evaluations across tourist groups by nationality and travel period further indicate the importance of segment-specific communication and experience management strategies. Overall, the study provides empirical evidence supporting the integration of climatic considerations into destination planning and governance, thereby contributing to the promotion of green tourism development in Hue City under conditions of increasing climate variability.

This study has several limitations. First, the sample size of 174 valid questionnaires is relatively modest; therefore, the findings should be interpreted as exploratory evidence rather than as fully representative of all tourist segments in Hue City. Second, the survey was conducted at three representative tourism spaces, namely Bach Ma, the Hue Imperial Citadel, and the Chuon Lagoon–Thuan An area, but it did not cover all tourism destinations and market segments in the city. Third, the analysis was based mainly on tourist perceptions and should be further complemented by site-specific meteorological data and longitudinal visitor data. Future research should expand the sample size, compare domestic and international tourist groups in greater depth, and integrate tourism climate indices or daily meteorological records to better assess the climate–tourism relationship under climate change.

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Appendix 1. Survey questionnaire

Survey on tourists' perceptions of climate resources and green tourism growth in Hue City

Dear respondent,

This questionnaire is designed for an academic study on the relationship between climate resources and green tourism growth in Hue City. Your responses will be used only for research purposes and will be kept confidential. There are no right or wrong answers. Please answer based on your actual experience during this trip to Hue City.

Part A. General information

1. Survey site:
☐ Bach Ma Tourism Area
☐ Hue Imperial Citadel
☐ Chuon Lagoon–Thuan An area
☐ Other: ....

2. Survey round:
☐ April 2024
☐ August 2024
☐ January 2025
☐ Other: ....

3. Gender:
☐ Male
☐ Female
☐ Other / Prefer not to say

4. Age group:
☐ Under 18 years
☐ 18–30 years
☐ 31–45 years
☐ 46–60 years
☐ Over 60 years

5. Nationality:
☐ Vietnamese
☐ International tourist

6. Number of visits to Hue City:
☐ First visit
☐ 2–3 visits
☐ More than 3 visits

7. Main travel purpose:
☐ Sightseeing
☐ Leisure / vacation
☐ Business
☐ Other: ....

8. Travel period to Hue City:
☐ January–March
☐ April–May
☐ June–September
☐ October–December

Part B. Assessment of climate resources and green tourism growth

Please indicate your level of agreement with each statement based on your actual experience during this trip to Hue City.

Scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

Code	Statement	1	2	3	4	5
I.	**Thermal conditions**					
HT1	The average temperature in Hue during my trip was comfortable.	☐	☐	☐	☐	☐
HT2	Hot weather did not make me feel seriously fatigued during the trip.	☐	☐	☐	☐	☐
HT3	Cool weather in the morning and evening was favorable for tourism activities.	☐	☐	☐	☐	☐
HT4	Daily temperature variation did not significantly affect my tourism activities.	☐	☐	☐	☐	☐
HT5	I adapted well to the hot and humid climate in Hue.	☐	☐	☐	☐	☐
HT6	I was satisfied with the temperature conditions in Hue during my trip.	☐	☐	☐	☐	☐
II.	**Humidity conditions**					
HU1	The air in Hue felt fresh and pleasant during my trip.	☐	☐	☐	☐	☐
HU2	I felt comfortable despite the high humidity in Hue.	☐	☐	☐	☐	☐
HU3	Humidity did not significantly affect my clothing choices or outdoor activities.	☐	☐	☐	☐	☐
HU4	I adapted easily to the humid conditions in Hue.	☐	☐	☐	☐	☐
HU5	Humidity did not cause major difficulties for my mobility during the trip.	☐	☐	☐	☐	☐
III.	**Rainfall conditions**					
RA1	Rain occurred during my trip to Hue.	☐	☐	☐	☐	☐
RA2	Rain did not seriously disrupt my tourism activities.	☐	☐	☐	☐	☐
RA3	My travel itinerary could be adjusted when rainfall occurred.	☐	☐	☐	☐	☐
RA4	Rain did not substantially reduce the quality of my tourism experience.	☐	☐	☐	☐	☐
RA5	I received sufficient weather forecast information during my trip.	☐	☐	☐	☐	☐
RA6	I visited Hue during a season that was generally suitable for tourism.	☐	☐	☐	☐	☐
IV.	**Wind conditions**					
WI1	Light winds created a pleasant feeling during sightseeing.	☐	☐	☐	☐	☐
WI2	Strong winds did not seriously hinder my tourism activities.	☐	☐	☐	☐	☐
WI3	Dusty winds did not significantly affect my tourism activities.	☐	☐	☐	☐	☐

Code	Statement	1	2	3	4	5
WI4	Cool winds enhanced the attractiveness of Hue's weather.	☐	☐	☐	☐	☐
WI5	Cold seasonal winds did not significantly affect my tourism activities.	☐	☐	☐	☐	☐
WI6	Hot and dry summer winds did not significantly affect my tourism activities.	☐	☐	☐	☐	☐
WI7	Overall, I experienced no major problems related to wind conditions during the trip.	☐	☐	☐	☐	☐
V.	**Extreme or unfavorable weather conditions** *This group refers to tourists' perceived exposure and adaptive responses to unfavorable or extreme weather conditions during the trip, such as storms, floods, thunderstorms, extreme heat, or other adverse weather events.*					
EX1	I encountered unfavorable weather conditions, such as storms, floods, thunderstorms, or extreme heat, during my trip.	☐	☐	☐	☐	☐
EX2	I was not overly concerned when facing unfavorable weather conditions during the trip.	☐	☐	☐	☐	☐
EX3	I did not need to cancel or postpone major tourism activities due to weather conditions.	☐	☐	☐	☐	☐
EX4	Unfavorable weather conditions did not substantially reduce the quality of my vacation.	☐	☐	☐	☐	☐
EX5	I would be willing to revisit Hue if weather conditions are favorable.	☐	☐	☐	☐	☐
VI.	**Green tourism growth**					
SU1	Hue's climate created a positive impression on me as a tourist.	☐	☐	☐	☐	☐
SU2	Climate conditions influenced my intention to revisit Hue.	☐	☐	☐	☐	☐
SU3	Hue's climate is generally suitable for developing year-round tourism activities.	☐	☐	☐	☐	☐
SU4	Climate conditions support the development of ecotourism and community-based tourism in Hue.	☐	☐	☐	☐	☐
SU5	Climate change is an important factor affecting green tourism growth in Hue.	☐	☐	☐	☐	☐

Optional open-ended question

In your opinion, what should Hue City do to improve tourist experience and promote green tourism development under changing climate conditions?

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