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RESEARCH ARTICLE

The Impact of Climate Change on Tourism in Nepal: A Causality Analysis

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ABSTRACT

Tourism is one of the leading sectors contributing to the countries' economic growth worldwide. It requires the ideal weather conditions, but climate change can significantly affect this sector. This study examines the causal, long-run, and short-run relationship between climatic factors and tourism demand under the given economic conditions based on data from 1990 to 2021. The climatic variables are maximum temperature, rainfall, and CO_2 emission, and the economic variables, the consumer price index (CPI), are studied based on data availability. The Autoregressive Distributed Lag model is applied to estimate the long-run and short-run relationships and to investigate the causality; the Granger-Causality test is used. The findings show that there is a long-run as well as short-run relationship between the variables. The consumer price index (CPI) is the key factor for tourist arrivals in Nepal in the long and short run. The climatic variables (maximum temperature and rainfall) have a negative but insignificant impact on tourist arrivals. There is an association between the emission of carbon dioxide and tourist arrivals. Granger's causality test investigates the causality between rainfall, consumer price index, and tourist arrival, which is unidirectional. The causality between tourist arrival and carbon dioxide emission is unidirectional. Climate change weakens the tourism industry and may affect economic development. In the long run, this research can pioneer assessing climate change's economic and environmental impacts in the tourism sector based on sustainable developments.

KEYWORDS: Climate change, causality, consumer price index, sustainable development, tourism

INTRODUCTION

Climate plays a vital role in selecting tourism destinations, serving as a key factor in travelers' decision-making regarding when and where to travel (Crompton, 1979; Reddy, 2012; Saarinen, 2012; Rosselló & Santana-Gallego, 2014). A warm and pleasant climate acts as a pull factor, encouraging tourists to visit (Turnbull & Uysal, 1995), while weather and atmospheric conditions significantly influence tourism operations business (Boniface & Cooper, 2005; Kozak, 2002; Witt & Witt, 1995). Climate also affects tourist behaviour, with sunny days motivating travel and humidity levels impacting activity performance (Allen & Fischer, 1978). Tourist perception further reinforces climate's importance, as it is often highlighted in destination marketing (Mill & Morrison, 2002; Day et al., 2013). Climate variability shaped by location, time, and natural factors cannot be controlled or stored, making it a unique consideration in tourism planning (Martín, 2005). Beyond immediate preferences, climate influences tourist satisfaction, with unfavorable conditions posing a risk to the industry (Hartman & Spit, 2014).

The relationship between climate change and tourism is complex, as shifting weather patterns alter seasonality, affect key variables (temperature, rainfall, wind, and sunshine), and introduce uncertainties (Becken & Hay, 2008; Goh, 2012). While research on tourism climate change correlations remains limited (IPCC, 2007), evidence suggests that rising temperatures, sea levels, and melting ice threaten natural attractions, potentially devastating the sector (Ehmer, 2008; K.C. & Ghimire, 2015). To assess climatic suitability, the Tourism Climatic Index (TCI) evaluates temperature, sunshine, humidity, precipitation, and wind, with a score above 60 indicating favorable conditions and 90+ representing an ideal travel climate (Mieczkowski, 1985). Thus, climate remains a central multifaceted factor shaping tourism demand, operations, and long-term sustainability.

The nature-based and weather-dependent livelihoods of local communities in the mountain regions of South Asia are highly vulnerable to climate change. These communities rely heavily on agriculture, livestock, and natural resources, making them particularly sensitive to shifting weather patterns. Several factors exacerbate their vulnerability, including small landholding, low agricultural productivity due to traditional farming practices, lack of access to improved seeds and fertilizer, insufficient irrigation, and poor infrastructure (Tiwari & Joshi, 2012). Additionally, physical isolation, rugged terrain, limited market access, and the high cost of food production and transportation further intensify their exposure to climate risks.

The situation is worsened by the increasing frequency and intensity of extreme weather events such as erratic rainfall, prolonged droughts, flash floods, and landslides, which disrupt food security and income sources (Younus & Harvey, 2014; Younus, 2017; Morton, 2007). With limited adaptive capacity, these communities struggle to cope with environmental shocks, leading to heightened economic instability and out-migration.

Beyond affecting local livelihoods, climate change threatens mountain tourism, a critical economic sector in Nepal, Bhutan, and northern India. Rising temperatures accelerate glacier retreat, altering water availability and destabilizing fragile ecosystems (Scott et al., 2007). The loss of snow cover, reduced biodiversity, and increased natural hazards (such as avalanches and glacier lake outbursts floods) diminish scenic beauty and safety of these destinations, potentially deterring tourists.

This study investigates the causal relationships between climatic variables, economic factors, and tourist arrivals in Nepal. It examines cointegration among these variables to determine whether long-term equilibrium relationships exist. It also estimates long-run and short-run elasticities to assess how changes in climate and economic conditions influence tourism demand over different time horizons.

MATERIALS AND METHODS

This study utilizes an annual dataset covering the period from 1990 to 2021, selected based on data availability and consistency across all relevant variables. The time frame is particularly significant as it captures Nepal's post-liberalization tourism growth, major political transitions, and recent disruptions, including the 2015 earthquake and the COVID-19 pandemic. The dependent variable, international tourist arrivals (TA**),** serves as the primary indicator of tourism demand and sector performance, with the data sources from Nepal Tourism Statistics reports. for independent variables, three key climatic factors were selected: Maximum Temperature (Tmx) for its impact on trekking conditions and visitors' comfort, rainfall (Rn) for its influence on travel accessibility and seasonal appeal, and carbon di-oxide (CO_2) emission as a proxy for global climate change effects on Nepal's environment. The Consumer Price Index (CPI) of major source markets was included as a control variable to account for economic fluctuations in tourist-generating countries. All climatic and economic data were obtained from the World Bank's World Development Indicators to ensure consistency and reliability. The study acknowledges that additional climatic variables like humidity, sunshine duration, and snowfall depth were excluded due to incomplete historical records. The selected variables provide a robust foundation for analyzing climate tourism relationships, as evidenced by their use in comparable studies of mountain tourism destinations. This data framework allows for comprehensive analysis of both short-term fluctuation and long-term trends in Nepal's tourism sector, with climatic and economic factors.

Theoretical Framework

This study employs an integrated econometric framework to analyze the impact of climate change on the tourism sector, combining an econometric model, an auto-regressive distributed lag model, and a Granger causality test.

Econometric Model

Building on the work of Mieczkowski (1985) and Scott et al. (2012), it is conceptualized that tourist arrival is a function of climatic suitability (maximum temperature and rainfall) as key determinants of destination attractiveness. The model incorporates the consumer price index as a control variable, acknowledging the price-elastic nature of tourism demand (Song & Witt, 2006). Carbon dioxide emission is a proxy for global climate change effects on Nepal's environment. The functional relationship between climatic variables and international tourist arrivals:

$$TA_t=f(Tmx_{t,}, Rn_t, CO_2, CPI) \qquad (1)$$

where TA is Nepal's annual international tourist arrival, Tmx is the maximum temperature, R_{nt} is the total annual rainfall, the destination's consumer price index (CPI), and the country's CO_2 emissions. The regression model uses total tourist arrivals as a dependent variable, and climatic and economic variables are independent. The relationship between climatic variables and tourist arrivals has been expressed in natural logarithms.

$$LTA_t=\beta_0+\beta_1 LTmx_t++\beta_2 LRn_t+\beta_3 LCPI_t+\beta_4 LCO_{2t}+\varepsilon_t \qquad (2)$$

Where the subscript t indicates the period, β's represent the long-run elasticities to be estimated, ε_t represents the error terms, and L represents the natural logarithm. It also captures the relationship between tourist arrivals, maximum temperature, rainfall, CPI, and CO_2.

The Autoregressive Distributed Lag Model Approach

This study follows the Autoregressive Distributed Lag Regression (ADRL) approach to explore the long-run and short-run relationship for tourist arrivals and their determinants. Engle and Granger's (1987) techniques and Johansen and Juselius's (1990) techniques were used to analyze cointegration between variables. The ARDL approach of cointegration does not need all variables to be stationary in the same order of integration; rather, it is suitable for I (0), I (1), or a combination of I (0) and I (1). Keeping these limitations of other models in view, we have deployed the ARDL test for cointegration

At first, all the data are collected, and the results may show nonstationary characteristics. To eliminate the nonstationary problem, the Augmented Dicky-Fuller (ADF) technique is applied to confirm that the tested variable is either I (1) or I (0). The suitable lag is selected to prevent spurious regression, preserve the long-run equilibrium relationship among the variables, reduce the problem of serial correlation in the residual, and provide a consistent estimate in the presence of a dependent variable. To examine the correlation and causality between the international tourist arrival, the climatic and economic variables, first, the unit root test was applied to confirm the stationary level by the Augmented Dicky-Fuller test; second, the Autoregressive Distributed lags Bound test was used for the cointegration test to find the long-run and short-run linkage among the variables based on Akaike Information Criteria. Finally, the Granger causality method was applied to observe the direction of the relationship between the variables. ARDL represents increments of equation [2] expressed as follows

$$\Delta LTA = \beta o + \beta_1 LTmx_t + \beta_2 LRn + \beta_3 LCPI_t + \beta_4 LCO_2 + \sum_{i=1}^{P} \beta 5 \Delta LTAt - i + \sum_{i=0}^{P} \beta 6 \Delta LTmxt - i + \sum_{i=0}^{P} \beta 7 \Delta LRnt - i + \sum_{i=0}^{p} \beta 8 \Delta LCPIt - i + \sum_{i=0}^{P} \beta 9 \Delta LCO2t - i + \varepsilon_t \quad (3)$$

Where β_1, β_2, β_3, and β_4 represent long-run elements, and β_5, β_6, β_7, β_8, and β_9 represent short-run elasticity Δ, Ln, and p denote the first difference, natural logarithm, and optimum lag length, respectively. Equation (3) examines the results of the bound test by using F-statistics through lower and upper bound values. The null hypothesis is accepted if the F-statistic value is less than the lower bound. The null hypothesis is rejected if the F-statistic value exceeds the upper bound. The result is inconclusive if the F-statistic value falls between the lower and upper bound values. When the result is inconclusive, an Error correction model is appropriate for cointegration (Kremers et al., 1992; Banerjee et al., 1998).

The Granger causality method is used to explain the association among all variables:

$$\Delta LTA_t = \alpha_1 + \sum_{i=1}^{P} \alpha 2i \Delta LTAt - i \sum_{i=1}^{P} \alpha 3i \Delta LTmxt - i + \sum_{i=1}^{P} \alpha 4i \Delta LRnt - i + \sum_{i=1}^{P} \alpha 5i \Delta LCPIt - i + \sum_{i=1}^{P} \alpha 6i \Delta LCO2t - i + \varepsilon_{1t} \quad (4)$$

$$\Delta LTmxt = \beta_1 + \sum_{i=1}^{P} \beta 2i \Delta LTmxt - i + \sum_{i=1}^{P} \beta 3i \Delta LTAt - i + \sum_{i=0}^{P} \beta 4i \Delta LRnt - i + \sum_{i=1}^{P} \beta 15i \Delta LCPIt - i + \sum_{i=1}^{P} \beta 6i \Delta LCO2t - i + \varepsilon_{2t} \quad (5)$$

$$\Delta LRnt = \beta_1 + \sum_{i=1}^{P} \beta 2i \Delta LRnt - i + \sum_{i=1}^{P} \beta 3i \Delta LTAt - i + \sum_{i=0}^{P} \beta 4i \Delta LTmxt - i + \sum_{i=1}^{P} \beta 5i \Delta LnCO2t - i + \sum_{i=1}^{P} \beta 6i \Delta LCPIt - i\varepsilon_{4t} \quad (6)$$

$$\Delta LCPIt = \delta_1 + \sum_{i=1}^{P} \delta 2i \Delta LCPIt - i + \sum_{i=1}^{P} \delta 3i \Delta LTAt - i + \sum_{i=0}^{P} \delta 4i \Delta LTmxt - i + \sum_{i=1}^{P} \delta 5i \Delta LRnt - i + \sum_{i=1}^{P} \delta 6i \Delta LCO2t - i + \varepsilon_{6t} \quad (7)$$

$$\Delta LCO2t = \varphi_1 + \sum_{i=1}^{P} \varphi 2i \Delta LCO2xt - i + \sum_{i=1}^{P} \varphi 3i \Delta LTAt - i \sum_{i=0}^{P} \varphi 4i \Delta LTmxt - i \sum_{i=0}^{P} \varphi 5i \Delta LRnt - i + \sum_{i=1}^{P} \sum_{i=1}^{P} \varphi 6i \Delta LCO2t - i\varepsilon_{7t} \quad (8)$$

Where L denotes the natural logarithm, Δ, the first difference and preference to the lag variables, and ε_{it} are the error terms.

RESULTS AND DISCUSSION

This paper analyses Nepal's climatic variables and international tourist arrivals from 1990 to 2021. The descriptive statistics of variables analyzed in this study are presented in Table 1, which shows that the average natural logarithm of tourist arrival is 13.037 with a standard deviation of 0.479, the average maximum temperature is 3.017 with a standard deviation of 0.02, and the average rainfall sum is 7.138 with a standard deviation of 0.142. Similarly, the results of Jarque - bera and probability state residuals LTA, LRn, LCPI, and LCO_2 are not normally distributed, but LTmx is normally distributed.

Table 1

Descriptive Statistics of Climatic Variables and Tourist Arrivals in Nepal

Year	LTA	LTmx	LRn	LCPI	LCO2
Mean	13.037	3.017	7.138	4.335	8.238
Median	13.000	3.016	7.167	4.260	8.057
Maximum	13.995	3.065	7.410	5.330	9.628
Minimum	11.925	2.953	6.593	3.162	6.846
Standard dev	0.479	0.022	0.142	0.628	0.783
Skewness	0.128	-0.183	-1.617	0.008	0.285
Kurtosis	- 0.436	0.847	4.593	-1.199	-0.945
Jarque-Bera	15.829	6.001	17.32	23.509	21.184
Probability	0.000365	0.049762	0.000173	7.853E-06	2.512E-05

The correlation matrix reveals several important relationships between tourist arrivals (LTA) and climatic/economic variables in Nepal from 1990-2-21. Tourist arrivals show a weak negative variable with rainfall (LRn; -0.0470), suggesting precipitation has minimal influence on tourism flows. In contrast, a moderate positive correlation exists between tourism and maximum temperature (LTmx: 0.221), indicating warmer periods tend to attract more visitors, likely due to favorable trekking conditions. More significantly, a strong positive correlation emerges between tourist arrivals and economic indicators, the consumer price index (CPI; 0.510) and CO_2 emission (LCO_2: 0,497), highlighting tourism's close ties to broader economic activity. There is an extremely high correlation between LCPI and LCO_2 (0.976), indicating that macroeconomic conditions appear more influential in shaping tourism patterns than climatic variables, with important implications for balancing tourism promotion with environmental conservation.

Table 2

Tourism and Climate Change Correlation Matrix Results, Sample Period 1990–2021

	LTA	LRn	LTmx	LCPI	LCO_2
LTA	1.0000				
LRn	-0.04693	1.00000			
LTmx	0.22085	0.01350	1.00000		
LCPI	0.51000	0.02886	0.33063	1.0000	
LCO_2	0.49710	0.07173	0.26193	0.97585	1.00000

For Autoregressive Distributed Lag model analysis and causality test, stationarity is necessary. The stationarity properties were tested through the Augmented Dickey-

Fuller unit root test for all variables. The null hypothesis is that a unit root exists (i.e., the Series is nonstationary). All the variables are not stationary at their level I (0) after the natural logarithm. Table 3 shows all the variables tourist arrival (LTA), maximum temperature (LTmx), rainfall (LRn), consumer price index (CPI), and CO2 emission (LCO_2), were non-stationary at their level, as evidenced by their p-values being above conventional levels. However, when the first differences were taken, all variables became stationary, with p-values indicating the null hypotheses were rejected at a five percent significance level. This pattern leads to the conclusion that all five variables are integrated of order one I (1), meaning they require first differencing to achieve stationarity.

Table 3

Augmented Dickey-Fuller test for LTA, LTmx, LRn, LCPI, and LCO_2 from 1990–2021.

Variable	At levels	At first difference	Decision	Order of integration
LTA	0.607	0.04	Significant at first difference	I (1)
LTmx	0.573	0.01	Significant at first difference	I (1)
LRn	0.274	0.01	Significant at first difference	I (1)
LCPI	0.3095	0.04	Significant at first difference	I (1)
LCO_2	0.872	0.04	Significant at first difference	I (1)

Table 4 represents the lag selection criteria for further cointegration tests. The maximum lag length of four has been chosen for AIC, HQ, SC, and FPE because all the criteria have a lag length of four.

Table 4

Lag Selection Criteria

Lag	AIC	HQ	SC	FPE
1	-25.28	-24.93	-23.79	1.12e-11
2	-24.45	-23.81	-21.72	3.93e-11
3	-27.53	-26.58	-23.55	7.96e-12
4	-Inf	-Inf	-Inf	0.00

Where **AIC**: Akaike Information Criteria, **HQ**: Hannan-Quinn information criterion, **SC**: Schwarz information criterion, and **FPE**: Final prediction error.

Table 5

ARDL Bound Test Results

F-statistics	4.75416977	
Critical value bounds Significance	I (0) Lower bounds	I (1) Upper bounds
10%	2.696	3.898
5%	3.276	4.630
1%	4.590	6.368

Table 5 indicates that the lower bound value is 3.276 and the upper bound value is 4.630 at a five percent significance level. The calculated value of F-statistics is 4.75416977, which is greater than the upper bound value (4.630). Here, the null hypothesis is there is no long-run relationship among all the variables is rejected at a five percent significance level. Hence, there is cointegration among the variables. When the variables are cointegrated, long-run and short-run associations are investigated using the ARDL Model.

Table 6

Long-run Relationship of the ARDL (2,0,1,0,3) Model. Dependent Variable LTA.

Variables	Coefficient	Std. error	t-value	Pr(>|t|)
Constant	12.443	6.627	1.877	<.10
LTmx	-0.934	2.025	-0.461	>.05
LRn	0.327	0.395	0.827	>.05
LCPI	0.957	0.382	2.506	<.05
LCO_2	-0.392	0.327	-1.199	>.05

Table 6 provides the outcomes of the long-run relationship under the ARDL approach to the cointegration model (2, 0, 1, 0, 3), examining the relationship between Nepal's tourist arrivals (LTA) and climatic/economic variables. The model reveals several insights; Among the climatic variables, maximum temperature (LTmx), shows a negative but insignificant relationship with tourism (coefficient=-0.934, p>0.05), while rainfall (LRn) demonstrates a positive and insignificant association (coefficient=0.327, p>0.05). This indicates that climate factors, while directionally meaningful, do not exert statistically reliable influences on tourist arrivals in the long term. The Consumer Price Index (CPI) shows a strong positive and significant relationship with tourism (coefficient=0.957, p<0.05). CO_2 emission exhibits a negative but insignificant relationship (coefficient=-0.392, p>0.05). The model suggests that macroeconomic conditions (CPI) play a vital role than climatic variables in shaping Nepal's long-term tourist pattern, though the negative coefficient for CO_2 may hint at potential environmental sustainability concerns that could warrant further investigation with more refined data or model specification

Table 7

Short-run Relationship of ARDL (2,0,1,0,3). Dependent Variable dLTA Coefficients

Variables	Coefficient	Std. error	t-value	Pr(>|t|)
Intercept	17.8596	3.65845	4.882	<.001
dLTA,1	0.9551	0.21538	4.434	<.001
dLTmx	-1.3407	3.0205	-0.4440	>.05
dLRn	-0.1462	0.2596	-0.5630	>.05
dLCPI	1.3730	0.57154	2.4020	<.05
$dLCO_2$	0.0744	0.41797	0.178	>.05
$dLCO_2$,1	1.2010	0.40729	2.949	<.01
$dLCO_2$, 2	1.0238	0.48454	2.113	<.01
etc	-1.4354	0.29219	-4.912	<.001

Table 7 shows the short-run relationship results of the ARDL model examining changes in Nepal's tourist arrivals (dLTA). The model reveals that the first lag of tourist arrivals (dLTA=0.9551, p<0.001) indicates strong momentum in tourism growth, where current changes build directly on recent trends. The CPI change (dLCPI) shows a significant positive impact (1.373, $p<0.05$), confirming the long-run finding that economic conditions strongly influence tourism fluctuation. CO_2 emissions changes display complex dynamics, while the contemporaneous effect is insignificant, the first two lags show strong positive impacts ($DLCO_2$,1 = 1.2o1, $p<0.01$; $dLCO_2$,2=1.0238, $p<0.01$), suggesting delayed responses to environmental/economic activity changes. Neither temperature (dLTmx=-1.3407) nor rainfall (dLRn=-0.1462) changes achieve statistical significance, reinforcing that short-term weather variations don't systematically affect tourist flows. The highly negative coefficient on the error correction term (-1,4354, $p<0.001$) indicates rapid adjustment to long-run equilibrium, about 1.43 percent of disequilibrium corrects within each period, suggesting strong mean reversion

Table 8

Pairwise Granger Causality Tests of Annual Data (1990–2021)

Null hypothesis	F- statistic	Probability
LRn does not granger cause LTA	3.4662	0.07355*
LTA does not granger cause LRn	0.4107	0.52700
LTmx does not granger cause LTA	0.1248	0.98460
LTA does not granger cause LTx	1.0576	0.36290
LCO_2 does not granger cause LTA	1.5872	0.22350
LTA does not granger cause LCO_2	2.7099	0.06146*
LCPI does not granger cause LTA	2.3977	0.08838*
LTA does not granger cause LCPI	0.3533	0.83840

Note. *Indicates significance at a 10% level of significance, **Indicates significance at a 5% level of significance.

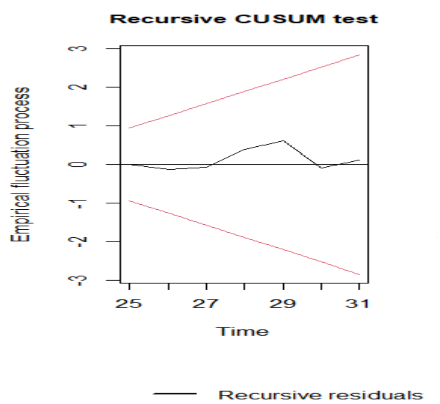
The Granger causality test is used to find the direction of association between the variables. It indicates unidirectional, bidirectional, and no causality between the variables. The results of the pairwise Granger causality test are presented in Table 8. These results indicate unidirectional causality from rainfall to tourism arrival due to the destruction of infrastructure. There is no causality from the maximum temperature to the tourist arrival. There is unidirectional causality from tourist arrival to the emission of CO_2. In addition, the causality from the consumer price index of the host country to tourist arrival is unidirectional.

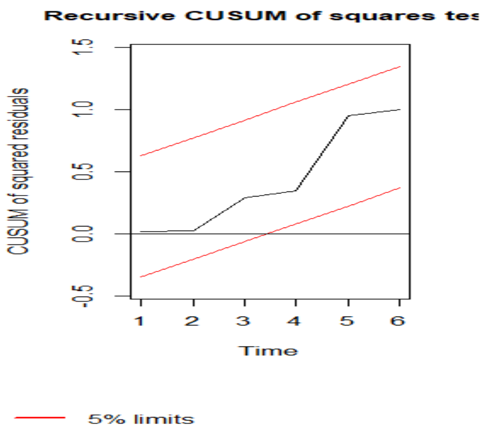
Model Stability Test

Finally, we have tested the stability of long-run and short-run coefficients. The CUSUM test, which is based on residuals, has been used to obtain the stability of the model. The graph of CUSUM in Figure 1 below indicates that all the parameters are stable at the five percent significance level because the values lie within the given confidence limit.

Figure 1

Cumulative Sum (CUSUM) and the Cumulative Sum of Square Test of Residuals





DISCUSSION AND CONCLUSION

This study explores the relationship and causality between climate change indicators, economic variables, and tourist arrivals. Nepal is highly vulnerable to climate change, and tourism is a critical livelihood source for the mountainous regions. Despite the COVID-19 pandemic, international tourist arrivals have generally increased annually, potentially influencing climate change indicators, as evidenced by the unidirectional relationship from tourism to carbon dioxide emissions.

The ARDL bound test revealed that all studied variables are cointegrated, indicating significant long-run and short-run relationships between tourist arrivals and other variables. Climatic variables such as maximum temperature and rainfall negatively affect long and short-run tourist arrivals, though the impact is statistically insignificant and is similar to Mauritius's result (Fauzel, 2019). The temperature has a significant long-run relationship with tourist flow in the region of Gilgit-Baltistan in Pakistan (Baig et al., 2021). The maximum temperature trend in Nepal (0.056^{0}C/year) is alarming and more than the global rate (Shrestha et al., 2017). There is significant relationship between temperature variation and tourist arrival (Wang et al., 2023). This result is in line with (Sookram, 2009), who studied nine countries in the Caribbean and their subregions (Fauzel, 2020) on SIDS and (Baig et al., 2021b) in Pakistan. In contrast, a study Bae and Nam (2019) indicated a positive and significant association between tourist inflows and Southeast Asian temperature.

The Consumer Price Index (CPI) significantly influences tourist arrivals in the short and long term. CO_2 emissions increased significantly with rising tourist arrivals. Tourist arrivals are positively influenced by their lag values. The probability value of LCPI is 0.022, which is less than a five percent significance level, having a coefficient of 0.957. This result suggests a positive and significant association between tourist arrivals and CPI. For Southeast Asia, tourist arrivals have a positive correlation with only CPI (Bae & Nam, 2019). The association between CO_2 and tourist arrivals is negative but insignificant. CO_2 and CPI have short-run elasticity with tourist arrivals. Carbon dioxide emission has a significant association with tourist arrivals in the short-run elasticity and are significant. CPI has positive and short-run elasticity with tourist arrivals. However, the disequilibrium of the last year to the existing year's equilibrium is just 1.44 percent.

The Granger causality test highlights a unidirectional relationship between rainfall and consumer price index (CPI), and tourist arrival and from tourist arrival to CO_2 emissions. It also suggests that no Granger causality exists from maximum temperature to tourist arrival, suggesting a minimal impact of temperature and rainfall on tourism.

This study highlights the complex interplay between climate change indicators, economic variables, and tourist arrivals in Nepal. The finding reveals that while climatic factors, maximum temperature and rainfall, negatively affect tourism, their impact is statistically insignificant in the short and long run. However, the rising temperature poses a long-run threat, given Nepal's alarming warming trend. Economic factors, particularly the Consumer Price Index, significantly influence tourist arrivals, underscoring the role of affordability in tourism demand. Tourist arrivals contribute to increased CO2 emissions, indicating tourism's environmental footprint. The Granger causality test confirms a unidirectional relationship from tourism to CO2 emissions but finds no significant causality from temperature to tourism, suggesting that immediate climatic variations may not drastically alter tourist flows. These results align with some global studies while contrasting with others, emphasizing the context-specific nature of these relationships.

The findings carry important implications for policymakers and stakeholders in Nepal's tourism and environmental sectors. Given the long-term risks posed by rising temperatures, adaptive strategies such as promoting climate-resilient tourism and diversifying destinations beyond vulnerable mountainous regions are crucial. The significant influence of CPI on tourism suggests that economic stability and competitive pricing can enhance Nepal's attractiveness as a tourist destination. Meanwhile, the link between tourism and CO_2 emissions calls for sustainable tourism practices, including carbon offset programs and eco-friendly infrastructure, to mitigate environmental degradation. Since climatic factors have minimal direct impact on tourist arrivals, short-term policies can prioritize economic and environmental measures. However, long-term climate adaptation planning remains essential to safeguard Nepal's tourism-dependent communities against future climatic extremes.

AUTHOR CONTRIBUTIONS

I declare that this manuscript is originally produced by me.

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