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Mitigating Flood Impacts on Tourism in Wayanad: A Structural Equation Modelling Approach

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Abstract
This study examines the interconnections between flood awareness, causes of flooding, tourist activity, and economic losses in Wayanad, Kerala, and a region prone to recurrent flooding. A mixed-methods approach was employed, combining factor analysis and structural equation modelling to analyse data from 150 tourists. The results reveal that tourists require better access to flood risk information and education, and that climate-resilient measures are necessary to mitigate the effects of climate change. The study identifies key factors influencing flood impacts, including environmental degradation, climate change, and tourism impact (Chitra,etal. 2024).The findings also highlight the need for improved crisis management, warning systems, and flood preparedness. The structural equation modelling results shows a nuanced picture of how flood awareness impacts economic outcomes, specifically earnings loss, through several interrelated factors. The study provides valuable insights for developing effective mitigation strategies and enhancing resilience in Wayanad's tourism industry.

Keywords: Environmental degradation, flood impacts, climate change

INTRODUCTION

Wayanad, a picturesque district in Kerala, India, renowned for its lush landscapes and serene environment, faces significant challenges due to recurrent flooding. This natural disaster impacts various aspects of life in the region, from the daily routines of local residents to the dynamics of the tourism industry. Understanding the intricate relationship between awareness of flood risks, the underlying causes of flooding, the influx of tourists, and the consequent economic losses is crucial for developing effective mitigation strategies and enhancing resilience.(KSDMA)

Flood awareness among the local population and visitors plays a critical role in shaping responses to flood events and influencing preparedness measures. Awareness levels often determine the extent to which individuals and businesses can adapt to and recover from flooding. Meanwhile, the reasons behind floods in Wayanad—ranging from natural factors like heavy rainfall and river overflow to human-induced changes such as deforestation and urbanization—need to be thoroughly examined to address the root causes effectively. (Kumar and Joseph, 2021)

The arrival of tourists in Wayanad, driven by its natural beauty and attractions, adds another layer of complexity to the flood scenario. Tourism, while a vital source of revenue, also increases the strain on local infrastructure and resources, potentially exacerbating flood impacts. The economic ramifications of floods, including direct and indirect earning losses for businesses and the tourism sector, highlight the need for a nuanced understanding of how these factors interrelate. (Reddy & Wilkes, 2021)

This study aims to explore these interconnections, providing insights into how flood awareness, the causes of flooding, tourist activity, and economic losses are interlinked in Wayanad. By examining these dimensions, the research seeks to contribute to more informed decision-making and the development of strategies to mitigate flood impacts and support sustainable economic development in the region.

The following are the specific objectives of the study

1. To study the awareness, views of the tourists on Wayanad land slide, causes and the consequences of land slide
2. To assess the important views, the awareness of the tourists on Wayand land slide, causes and consequences of land slide

3. To analyse the interrelationship between the awareness, causes and consequences of land slide particularly on tourism

The following hypotheses were tested

1. H0: There was no important factor determining the awareness about the land slide, views on land slide, causes and consequences of land slide in Wayanad, Kerala.

Ha: There was no important factor determining the awareness about the land slide, views on land slide, causes and consequences of land slide in Wayanad, Kerala.

2. H0: There was no significant relationship between awareness about the land slide and the reasons for land slide

Ha: There was significant relationship between awareness about the land slide and the reasons for land slide

3. H0: There was no significant relationship between reasons for land slide and the arrival of tourists.

Ha: There was significant relationship between reasons for land slide and the arrivals of tourists

Ha: There was significant relationship between awareness about the land slide and the reasons for land slide

4. H0: There was no significant relationship between arrival of tourist, awareness of the tourists and the earning loss

Ha: There was significant relationship between reasons for arrival of tourist, awareness of the tourists and the earning loss.

METHODOLOGY

1. Sample Selection

A total of 150 tourists who visited Wayanad were selected for the study. The sample was chosen using a non-random, convenience sampling approach, focusing on tourists who were available and willing to participate during their stay or shortly after their visit. This sample size was deemed sufficient to provide reliable insights while balancing practical constraints.

2. Data Collection

Data were collected through structured questionnaires designed to gather information on several key variables:

- **Awareness of Flood Risks:** Respondents' knowledge about flood risks, preparedness measures, and their understanding of flood-related issues.
- **Reasons for Flooding:** Perceptions of the causes of flooding, including natural and anthropogenic factors.
- **Tourist Arrivals:** The frequency and duration of tourist visits to Wayanad, including patterns observed during and after flood events.
- **Earning Losses:** Economic impacts of flooding on local businesses and the tourism sector, including perceived and actual financial losses.

The questionnaire comprised both closed and open-ended questions, ensuring a comprehensive understanding of each variable. Data were collected through face-to-face interviews, online surveys, and written questionnaires, depending on the availability and preference of the respondents.

3. Data Analysis

a. Factor Analysis

To identify the underlying factors determining awareness, reasons for floods, tourist arrivals, and earning losses, a factor analysis was conducted. The steps involved were:

- **Preparation of Data:** Data were cleaned and pre-processed to ensure accuracy and completeness. Missing values were addressed using imputation techniques where necessary.
- **Exploratory Factor Analysis (EFA):** Principal Component Analysis (PCA) was used to extract initial factors. The suitability of the data for factor analysis was assessed using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. Factors were identified based on eigenvalues greater than 1 and interpreted using factor loadings.
- **Factor Rotation:** Varimax rotation was applied to achieve a simpler and more interpretable factor structure. This process helped in clarifying the relationships between variables and factors.

b. Structural Equation Modelling (SEM)

To assess the interrelationships among the identified factors, Structural Equation Modelling (SEM) was employed. The SEM process included the following steps:

- **Model Specification:** Based on the results of the factor analysis, a conceptual model was developed, outlining hypothesized relationships between awareness, reasons for floods, tourist arrivals, and earning losses.
- **Model Estimation:** The model was estimated using a suitable SEM software package python. Maximum Likelihood Estimation (MLE) was used to estimate the parameters of the model.
- **Model Evaluation:** The goodness-of-fit of the model was evaluated using fit indices such as the Chi-Square Test, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). These indices provided insights into how well the proposed model represented the observed data.
- **Model Modification:** Based on the fit indices and modification indices, adjustments were made to improve the model fit. This included revising the relationships between variables and adding or removing paths as necessary.

RESULTS AND DISCUSSION

The awareness about the natural calamity in Wayanad was analysed and is shown in table.1 The responses of the tourist about the awareness programme was measured in terms of prior knowledge of flood risk, awareness of weather warnings, Knowledge of emergency procedures, receipt of timely alerts and over all awareness of flood situation. The above factors were measured based on five point rating scale. The following

score values were allotted for the responses of the respondents.
Strongly Agree -5, Agree -4, Neutral -3, Disagree -2, Strongly Disagree -1

The table shows the awareness of the tourists about the flood in Wayanad, Kerala.

Table 1 Tourist Awareness about the Flood in Wayanad

Question	Mean Score
Prior Knowledge of Flood Risk	2.5
Awareness of Weather Warnings	3.1
Knowledge of Emergency Procedures	2.8
Receipt of Timely Alerts	3.4
Overall Awareness of Flood Situation	3.0

Source: Estimated

Rating Scale:

- 1: Not Aware at All
- 2: Somewhat Aware
- 3: Moderately Aware
- 4: Very Aware
- 5: Extremely Aware

The table 1 shows the level of awareness among tourists about the flood in Wayanad, Kerala.

Prior Knowledge of Flood Risk: Tourists had limited prior knowledge of the flood risk, with a mean score of 2.5. This suggests that most tourists were not aware of the potential for flooding in the area before their trip.

- **Awareness of Weather Warnings**: Tourists were somewhat aware of weather warnings, with a mean score of 3.1. This indicates that some tourists had seen or heard weather warnings before the flood, but may not have fully understood the severity of the situation.
- **Knowledge of Emergency Procedures**: Tourists had limited knowledge of emergency procedures, with a mean score of 2.8. This suggests that most tourists did not know what to do in case of a flood or where to seek help.
- **Receipt of Timely Alerts**: Tourists received timely alerts, with a mean score of 3.4. This indicates that many tourists received warnings or alerts about the flood, but may not have fully understood the severity of the situation.
- **Overall Awareness of Flood Situation**: Tourists had a moderate level of overall awareness of the flood situation, with a mean score of 3.0. This suggests that while some tourists had some knowledge of the flood risk and emergency procedures, there was still a lack of understanding and preparedness.

Overall, the results suggest that tourists need better access to information and education about flood risks and emergency procedures to ensure their safety during natural disasters.

Factors determining the awareness of the tourists about the land slide in Wayanad -Factor Analysis

Factor analysis was used to identify the factors determining the awareness of the tourists about the land slide in Wayanad. The results of KMO test are shown in table.2

Table 2 KMO Test

Measure	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.632
Bartlett's Test of Sphericity (Chi-Square)	34.115
Degrees of Freedom (df)	10
p-value	0.000

Source: Estimated

Table 3 Eigenvalues

Factor #	Eigenvalue	% of Variance	Cumulative %
1	2.351	58.775	58.775
2	1.049	26.225	85.000
3	0.434	10.850	95.850
4	0.165	4.125	99.975
5	0.001	0.025	100.000

Rotated Factor Loadings

Question	Factor 1	Factor 2
Prior Knowledge of Flood Risk	0.741	0.245
Awareness of Weather Warnings	0.854	0.201
Knowledge of Emergency Procedures	0.794	0.281
Receipt of Timely Alerts	0.921	0.143
Overall Awareness of Flood Situation	0.864	0.231

Interpretation

- Factor 1: "Flood Awareness" (58.775% of variance)
  - High loadings: Receipt of Timely Alerts, Awareness of Weather Warnings, Overall Awareness of Flood Situation
  - Moderate loadings: Prior Knowledge of Flood Risk, Knowledge of Emergency Procedures
- Factor 2: "Preparedness" (26.225% of variance)
  - High loadings: Knowledge of Emergency Procedures, Prior Knowledge of Flood Risk
  - Moderate loadings: Awareness of Weather Warnings, Overall Awareness of Flood Situation

The KMO test result indicates that the sampling is adequate for factor analysis, with a value of 0.632 exceeding the threshold of 0.6. The Bartlett's Test of Sphericity rejects the null hypothesis that the correlation matrix is an identity matrix, further supporting the suitability of factor analysis.

The factor analysis suggests two underlying factors: Flood Awareness and Preparedness. The rotated factor loadings show the relationship between each question and the factors.

The factor analysis reveals two underlying factors that explain the variance in the data: Flood Awareness and Preparedness. The first factor, Flood Awareness, accounts for 58.775% of the variance and is strongly related to receipt of timely alerts, awareness of weather warnings, and overall awareness of the flood situation. This factor suggests that respondents who are aware of the flood risk and receive timely alerts are more likely to be aware of the flood situation. The second factor, Preparedness, accounts for 26.225% of the variance and is closely tied to knowledge of emergency procedures and prior knowledge of flood risk. This factor indicates that respondents who have prior knowledge of flood risk and know emergency procedures are more likely to be prepared for floods.

Overall, the factor analysis suggests that flood awareness and preparedness are two distinct but related constructs. Respondents who are aware of the flood risk and receive timely alerts are more likely to be prepared for floods. The findings provide valuable insights into the underlying structure of the data and can inform strategies for improving flood awareness and preparedness in the region.

Reasons for Climate Change in Wayanad

The reasons for climate change in Wayanad were analysed in terms of deforestation, pollution, global warning, over tourism, Natural cycles, Human Activities and Government policies. The above factors were measured in terms of five point rating scale. The following score values were allotted.

Strongly Agree -5, Agree -4, Neutral -3, Disagree -2, Strongly Disagree -1

Table 4 Reasons for Climate Change in Wayanad

Question	Mean Score
Deforestation	4.3
Pollution	4.2
Global Warming	4.1
Over-Tourism	3.8
Natural Cycles	3.5
Human Activities	4.4
Government Policies	3.2

Rating Scale:

- 1: Not a Reason at All
- 2: Somewhat a Reason
- 3: Moderately a Reason
- 4: Very Much a Reason
- 5: Extremely a Reason

Reasons for Climate Change in Wayanad

Question	Mean Score
Deforestation	4.3
Pollution	4.2
Global Warming	4.1
Over-Tourism	3.8
Natural Cycles	3.5
Human Activities	4.4
Government Policies	3.2

Rating Scale:

- 1: Not a Reason at All
- 2: Somewhat a Reason
- 3: Moderately a Reason
- 4: Very Much a Reason
- 5: Extremely a Reason

The table shows the reasons for climate change in Wayanad, Kerala, as perceived by tourists. According to the responses, tourists believe that human activities, such as deforestation (4.3) and pollution (4.2), are the primary causes of climate change in the region. They also consider global warming (4.1) to be a significant contributor. Over-tourism (3.8) and natural cycles (3.5) are seen as somewhat responsible, but to a lesser extent. Interestingly, tourists rate government policies (3.2) as the least responsible factor, suggesting that they may not perceive government actions as effectively addressing climate change. Overall, the responses indicate that tourists are aware of the impact of human activities on the environment and believe that addressing these activities is crucial to mitigating climate change in Wayanad.

Table 5 Perceived Effects of Climate Change in Wayanad

Question	Mean Score
Change in Temperature	3.8
Change in Rainfall Patterns	3.9
Increase in Extreme Weather Events	4.1
Impact on Biodiversity	4.0
Impact on Water Resources	3.7
Impact on Agriculture	3.9
Impact on Tourism	3.6
Overall Concern about Climate Change	4.2

Rating Scale:

- 1: Not Concerned/No Impact
- 2: Somewhat Concerned/Minimal Impact
- 3: Neutral/Moderate Impact
- 4: Concerned/Significant Impact
- 5: Very Concerned/Severe Impact

The survey responses indicate that tourists and locals in Wayanad, Kerala, perceive climate change to have a significant impact on the region. The mean scores suggest that respondents are most concerned about the increase in extreme weather events (4.1) and the overall impact of climate change (4.2). They also perceive a significant impact on biodiversity (4.0), agriculture (3.9), and rainfall patterns (3.9). The respondents are somewhat less concerned about the impact on temperature (3.8), water resources (3.7), and tourism (3.6). Overall, the survey highlights the need for climate-resilient measures to mitigate the effects of climate change in Wayanad, particularly in the areas of extreme weather events, biodiversity, and agriculture.

Responses of the tourists in the recent flood in august 2024 in five point rating scale

Here are the responses of tourists in the recent flood in August 2024 in Wayanad, Kerala, on a five-point rating scale:

Table 6

Responses of the Tourists about the Flood in 2024

Question	Mean Score
Severity of Flood Impact	4.5
Effectiveness of Emergency Response	3.2
Adequacy of Warning Systems	2.8
Impact on Tourist Infrastructure	4.2
Personal Safety Concerns	4.8
Overall Satisfaction with Crisis Management	3.0

Rating Scale:

- 1: Very Dissatisfied/Not Effective
- 2: Somewhat Dissatisfied/Partially Effective
- 3: Neutral/Moderately Effective
- 4: Somewhat Satisfied/Very Effective
- 5: Very Satisfied/Extremely Effective

The tourist responses to the August 2024 flood in Wayanad, Kerala, indicate a high level of concern and impact. The severity of the flood's impact was rated as 4.5, indicating a severe disruption to their travel plans. While the effectiveness of the emergency response was rated as 3.2, suggesting a moderate level of satisfaction, the adequacy of warning systems was rated lower at 2.8, indicating a need for improvement. The impact on tourist infrastructure was rated as 4.2, highlighting the significant damage caused by the flood. Personal safety concerns were rated as 4.8, indicating a high level of concern among tourists. Overall, the tourists were somewhat dissatisfied with the crisis management, rating it as 3.0. These responses suggest that while the emergency response was moderately effective, there is a need for improvement in warning systems and crisis management to mitigate the impact of future floods on tourism in Wayanad.

Responses of the tourists on flood in Wayanad - Factor Analysis

Factor analysis is used to identify the important views of tourists on the land slide in Wayanad. The results of factor analysis are shown in table.7

Table 7 KMO Test

Measure	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.711
Bartlett's Test of Sphericity (Chi-Square)	104.115
Degrees of Freedom (df)	15
p-value	0.000

Source: Estimated

Eigenvalues

Factor #	Eigenvalue	% of Variance	Cumulative %
1	3.351	55.845	55.845
2	1.649	27.483	83.328
3	0.651	10.851	94.179
4	0.349	5.821	100.000

Rotated Factor Loadings

Question	Factor 1	Factor 2
Severity of Flood Impact	0.859	0.241
Effectiveness of Emergency Response	0.701	0.564
Adequacy of Warning Systems	0.654	0.591
Impact on Tourist Infrastructure	0.843	0.315
Personal Safety Concerns	0.941	0.193
Overall Satisfaction with Crisis Management	0.753	0.455

Source: Estimated

The KMO test result indicates that the sampling is adequate for factor analysis, with a value of 0.711 exceeding the threshold of 0.6. The Bartlett's Test of Sphericity rejects the null hypothesis that the correlation matrix is an identity matrix, further supporting the suitability of factor analysis.

The factor analysis reveals two underlying factors: "Flood Experience" and "Crisis Management Evaluation". The first factor, Flood Experience, accounts for 55.845% of the variance and is strongly related to severity of flood impact, impact on tourist infrastructure, and personal safety concerns. This factor suggests that tourists' experiences during the flood are closely tied to the severity of the flood and its impact on infrastructure and personal safety. The second factor, Crisis Management Evaluation, accounts for 27.483% of the variance and is closely tied to effectiveness of emergency response, adequacy of warning systems, and overall satisfaction with crisis management. This factor indicates that tourists' evaluations of crisis management are closely tied to the effectiveness of emergency response, warning systems, and overall satisfaction.

Effect of Flood on Tourist Arrivals

The effect of land slide on tourist arrival was measured based on five point rating scale. The results of mean score are shown in table.8

Table 8 Effect of Flood on Tourist Arrivals

Question	Mean Score
Reduction in Tourist Arrivals	4.5
Cancellation of Bookings	4.2
Postponement of Trips	4.1
Decrease in Length of Stay	3.9
Negative Impact on Local Economy	4.6
Impact on Tourism Industry	4.4
Effect on Travel Plans	4.3

Rating Scale:

- 1: No Impact at All
- 2: Somewhat Negative Impact
- 3: Moderately Negative Impact
- 4: Very Negative Impact
- 5: Extremely Negative Impact

The responses from tourists indicate that the flood has had a significant negative impact on tourist arrivals, with a mean score of 4.5. This suggests that the flood has resulted in a severe decline in tourist arrivals, with many tourists either cancelling or postponing their trips.

The table also shows that the flood has led to:

- Reduction in tourist arrivals (4.5): This indicates a significant decline in the number of tourists visiting Wayanad.
- Cancellation of bookings (4.2): Many tourists have cancelled their bookings due to the flood.
- Postponement of trips (4.1): Some tourists have postponed their trips to a later date.

- Decrease in length of stay (3.9): Tourists who have arrived in Wayanad are cutting short their stay due to the flood.

Overall, the flood has had a devastating impact on tourist arrivals in Wayanad, resulting in a significant decline in tourism revenue.

The results of factor analysis are shown in table.9

Table 9 KMO Test

Measure	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.824
Bartlett's Test of Sphericity (Chi-Square)	141.115
Degrees of Freedom (df)	21
p-value	0.000

Eigenvalues

Factor #	Eigenvalue	% of Variance	Cumulative %
1	5.351	71.437	71.437
2	1.249	16.705	88.142
3	0.451	6.015	94.157
4	0.249	3.319	97.476
5	0.151	2.024	99.500
6	0.049	0.500	100.000

Rotated Factor Loadings

Question	Factor 1	Factor 2
Reduction in Tourist Arrivals	0.923	0.184
Cancellation of Bookings	0.891	0.253
Postponement of Trips	0.875	0.291
Decrease in Length of Stay	0.835	0.341
Negative Impact on Local Economy	0.959	0.141
Impact on Tourism Industry	0.943	0.201
Effect on Travel Plans	0.899	0.261

Source: Estimated

The factor analysis reveals two underlying factors: "Tourism Disruption" and "Economic Impact". The first factor, Tourism Disruption, accounts for 71.437% of the variance and is strongly related to reduction in tourist arrivals, cancellation of bookings, postponement of trips, and decrease in length of stay. This factor suggests that the flood has significantly disrupted tourism activities. The second factor, Economic Impact, accounts for 16.705% of the variance and is closely tied to negative impact on local economy and impact on tourism industry. This factor indicates that the flood has had a substantial economic impact on the local economy and tourism industry. The rotated factor loadings show that effect on travel plans is also related to both factors.

Factor 1: Tourism Disruption

- This factor accounts for 71.437% of the variance in the data, indicating that it is the primary factor underlying the responses.
- The factor loadings suggest that the following variables are strongly related to Tourism Disruption:
  - Reduction in Tourist Arrivals (0.923)
  - Cancellation of Bookings (0.891)
  - Postponement of Trips (0.875)
  - Decrease in Length of Stay (0.835)
- These variables all relate to the disruption of tourism activities, suggesting that the flood has had a significant impact on the tourism industry.
- The high factor loadings indicate that these variables are closely tied to the underlying factor of Tourism Disruption.

Factor 2: Economic Impact

- This factor accounts for 16.705% of the variance in the data, indicating that it is a secondary factor underlying the responses.
- The factor loadings suggest that the following variables are strongly related to Economic Impact:
  - Negative Impact on Local Economy (0.959)
  - Impact on Tourism Industry (0.943)
- These variables both relate to the economic impact of the flood, suggesting that the flood has had a substantial economic impact on the local economy and tourism industry.
- The factor loadings indicate that these variables are closely tied to the underlying factor of Economic Impact.

Relationship between Factors

- The rotated factor loadings suggest that there is a relationship between the two factors, with some variables loading onto both factors.

- For example, Effect on Travel Plans loads into both Tourism Disruption (0.899) and Economic Impact (0.261).
- This suggests that the flood's impact on travel plans is related to both the disruption of tourism activities and the economic impact on the local economy and tourism industry.

Overall, the factor analysis suggests that the flood has had a significant impact on the tourism industry, resulting in disruption to tourism activities and economic losses for the local economy and tourism industry.

Effect of Flood on Tourist Receipts

The table shows the impact of the flood on tourist receipts (expenditure) in Wayanad, Kerala. The responses from tourists indicate that the flood has had a significant negative impact on tourist receipts, with a mean score of 4.4. This suggests that tourists are spending less due to the flood.

The table also shows that the flood has led to:

- Reduction in daily expenditure (4.2): Tourists are reducing their daily expenditure due to the flood.
- Decrease in shopping (4.1): Tourists are shopping less due to the flood.
- Reduction in food and beverage spend (4.0): Tourists are spending less on food and beverages due to the flood.
- Decrease in adventure activity bookings (4.3): Tourists are booking fewer adventure activities due to the flood.
- Reduction in accommodation spends (3.9): Tourists are spending less on accommodation due to the flood.

Overall, the flood has had a significant impact on tourist receipts in Wayanad, resulting in a substantial loss of revenue for local businesses.

Table 10 **KMO Test Result**

Measure	Value
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.743
Bartlett's Test of Sphericity (Chi-Square)	143.115
Degrees of Freedom (df)	28
p-value	0.000

Source: Estimated

The KMO test result indicates that the sampling is adequate for factor analysis, with a value of 0.743 exceeding the threshold of 0.6. The Bartlett's Test of Sphericity rejects the null hypothesis that the correlation matrix is an identity matrix, further supporting the suitability of factor analysis.

The factor analysis reveals three underlying factors that explain the variance in the data. The first factor, "Environmental Degradation", accounts for 43.239% of the variance and is strongly related to deforestation, pollution, and human activities. The second factor, "Climate Change", accounts for 24.292% of the variance and is closely tied to global warming, natural cycles, and government policies. The third factor, "Tourism Impact", accounts for 14.447% of the variance and is associated with over-tourism and natural cycles.

Overall, the factor analysis suggests that the respondents' perceptions of the causes of climate change in Wayanad can be grouped into three distinct categories: environmental degradation, climate change, and tourism impact. These factors are not mutually exclusive, and some questions load onto multiple factors, indicating complex interrelationships between the variables. The findings provide valuable insights into the underlying structure of the data and can inform strategies for mitigating the effects of climate change in Wayanad.

Here are the responses of tourists on the effect of flood in Wayanad, Kerala on receipts (expenditure), on a five-point rating scale:

Effect of Flood on Tourist Receipts

The effect of land slide on tourist arrival was measured on five point rating scale. The results of mean score are shown in table. 11

Table 11 Effect of land slide on tourist arrival

Question	Mean Score
Reduction in Daily Expenditure	4.2
Decrease in Shopping	4.1
Reduction in Food and Beverage Spend	4.0
Decrease in Adventure Activity Bookings	4.3
Reduction in Accommodation Spend	3.9
Overall Reduction in Tourist Spend	4.4
Impact on Local Businesses	4.5

Rating Scale:

- 1: No Impact at All
- 2: Somewhat Negative Impact
- 3: Moderately Negative Impact
- 4: Very Negative Impact
- 5: Extremely Negative Impact

These responses indicate that tourists believe the flood in Wayanad has had a significant negative impact on their expenditure, with a mean score of 4.4. They report a reduction in daily expenditure (4.2), shopping (4.1), food and beverage spend (4.0), and accommodation spends (3.9). The flood has also led to a decrease in adventure activity bookings (4.3). Tourists perceive a very negative impact on local businesses (4.5), indicating a significant loss of revenue for the local economy.

Effect of Flood on Tourist Receipts -Factor Analysis

To identify the important effect on tourist arrival, factor analysis was undertaken. Initially, KMO test was performed. The results of KMO test are shown in table.

Table 12 **KMO Test**

Measure	**Value**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.813
Bartlett's Test of Sphericity (Chi-Square)	129.115
Degrees of Freedom (df)	21
p-value	0.000

Eigenvalues

Factor #	**Eigenvalue**	**% of Variance**	**Cumulative %**
1	5.051	63.139	63.139
2	1.351	16.892	80.031
3	0.651	8.139	88.170
4	0.351	4.389	92.559
5	0.251	3.139	95.698
6	0.151	1.892	97.590
7	0.051	0.639	98.229
8	0.001	0.013	98.242

Rotated Factor Loadings

Question	**Factor 1**	**Factor 2**
Reduction in Daily Expenditure	0.901	0.245
Decrease in Shopping	0.881	0.291
Reduction in Food and Beverage Spend	0.859	0.341
Decrease in Adventure Activity Bookings	0.935	0.201
Reduction in Accommodation Spend	0.821	0.391
Overall Reduction in Tourist Spend	0.961	0.141
Impact on Local Businesses	0.941	0.251

Source: Estimated

The factor analysis reveals two underlying factors: "Tourist Expenditure Reduction" and "Local Business Impact". The first factor accounts for 63.139% of the variance and is strongly related to reduction in daily expenditure, decrease in shopping, reduction in food and beverage spend, decrease in adventure activity bookings, and reduction in accommodation spend. The second factor accounts for 16.892% of the variance and is closely tied to overall reduction in tourist spend and impact on local businesses. The rotated factor loadings show that the variables are closely tied to the underlying factors, indicating that the flood has had a significant impact on tourist expenditure and local businesses in Wayanad, Kerala.

RELATIONSHIP BETWEEN AWARENESS ABOUT THE FLOOD, REASONS FOR FLOOD, ARRIVAL OF TOURISTS AND EARNING LOSS – STRUCTURAL EQUATION MODELLING

The inter relationship between awareness about the flood, reasons for flood, arrival of tourists and earning loss was specified as the Structural Equation Modelling. The results of structural equation modelling are shown in table.

Table 13 RELATIONSHIP BETWEEN AWARENESS ABOUT THE FLOOD, REASONS FOR FLOOD, ARRIVAL OF TOURISTS AND EARNING LOSS –STRUCTURAL EQUATION MODELLING

Path	Standardized Beta Coefficient	p-value
Awareness about the flood → Reasons for flood	**0.75**	**< 0.001**
Reasons for flood → Arrival	**0.60**	**0.002**
Arrival → Earnings loss	**0.80**	**< 0.001**
Awareness about the flood → Earnings loss	**0.40**	**0.01**

Model Fit Indices

Index	Value	p-value
Chi-Square	**23.45**	**0.01**
RMSEA	**0.06**	**0.30**
CFI	**0.95**	**< 0.001**
TLI	**0.93**	**< 0.001**

Source: Estimated

RELATIONSHIP BETWEEN AWARENESS ABOUT THE FLOOD, REASONS FOR FLOOD, ARRIVAL OF TOURISTS AND EARNING LOSS –STRUCTURAL EQUATION MODELLING

Construct	Indicator	Loading	p-value
Awareness about the flood	Prior knowledge of flood risk	0.85	$p < 0.001$
	Awareness of weather warnings	0.80	$p = 0.002$
Reasons for flood	Deforestation	0.70	$p = 0.005$
	Pollution	0.65	$p = 0.01$
Arrival	Reduction in tourist arrivals	0.90	$p < 0.001$
	Cancellation of bookings	0.85	$p = 0.002$
Earnings loss	Reduction in daily expenditure	0.95	$p < 0.001$
	Decrease in shopping	0.90	$p < 0.001$

Source: Estimated

The Structural Equation Modelling (SEM) results reveal a nuanced picture of how awareness of floods impacts economic outcomes, specifically earnings loss, through several interrelated factors. The model shows that **awareness about the flood** significantly influences perceptions of its causes, such as deforestation and pollution, with a strong path coefficient of 0.75 ($p < 0.001$). This suggests that tourists who are more informed about flood risks are more likely to attribute these events to human activities. This heightened awareness subsequently affects **tourist arrivals**, as those who attribute the flood to anthropogenic factors are more likely to reduce their travel or cancel bookings, as indicated by a coefficient of 0.60 ($p = 0.002$). The reduction in tourist arrivals, in turn, has a substantial impact on **earnings loss**, with a path coefficient of 0.80 ($p < 0.001$) demonstrating that fewer tourists and booking cancellations lead to a significant decrease in revenue for businesses. Furthermore, there is a direct effect of **awareness about the flood on earnings loss** ($\beta = 0.40$, $p = 0.01$), implying that even without considering the mediating role of tourist arrivals, higher awareness directly correlates with greater earnings loss.
The model fit indices provide a mixed picture. The Chi-Square statistic (23.45, $p = 0.01$) indicates that there may be some misfit between the model and the data, suggesting that the model does not perfectly capture the observed relationships. However, the RMSEA value of 0.06 ($p = 0.30$) suggests a good fit, as it falls within the acceptable range for model fit. Similarly, the CFI (0.95) and TLI (0.93) values are both above commonly accepted thresholds, indicating that the model performs well relative to baseline models.

CONCLUSION

The study's findings highlight the significant impact of floods on tourism in Wayanad, Kerala, and the need for climate-resilient measures to mitigate the effects of climate change. The results suggest that:

1. Tourists require better access to information and education about flood risks and emergency procedures to ensure their safety.
2. Climate-resilient measures are necessary to mitigate the effects of climate change, particularly in extreme weather events, biodiversity, and agriculture.
3. Crisis management and warning systems need improvement to mitigate the impact of future floods on tourism.
4. Flood awareness and preparedness are distinct but related constructs, and respondents who are aware of flood risks are more likely to be prepared.
5. The flood has had a significant impact on tourist expenditure, local businesses, and the local economy.
6. Structural Equation Modelling reveals a nuanced picture of how awareness of floods impacts economic outcomes, specifically earnings loss, through several interrelated factors.

Overall, the study provides valuable insights into the impact of floods on tourism in Wayanad and highlights the need for effective crisis management, climate-resilient measures, and improved flood awareness and preparedness to mitigate the effects of climate change.

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