

Gloomy Gangotri Glaciers: Delving the Dynamics of Doomsday Tourism

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Abstract:- This study investigates the factors influencing the desire to visit the Gangotri Glacier, a major source of the Ganges River in the Indian Himalayas. The glacier has become a popular destination for "Doomsday Tourism" due to its rapid retreat, which is linked to climate change. The research objectives were to examine the impact of the glacier's environmental status, cultural and religious significance, information availability, and environmental concerns on people's intention to visit.

The study employed a quantitative research approach using a survey-based design. Data was collected from participants through a survey instrument that included questions related to various factors influencing the desire to visit the Gangotri Glacier. Linear regression analysis, hypothesis testing, and descriptive statistics were used to analyze the data.

➤ The Key Findings of the Study Are:

- The cultural and religious significance of the Gangotri Glacier is the strongest predictor of the desire to visit, followed by the availability of reliable information and environmental concerns.
- Awareness of the glacier's shrinkage due to climate change has a marginally significant positive effect on the desire to visit.
- The difference in the impact of cultural/religious significance and environmental concerns on the desire to visit is not statistically significant.

The results suggest that preserving the cultural heritage, promoting effective communication and outreach, and addressing environmental concerns are crucial in maintaining visitor interest in the Gangotri Glacier. The study also highlights the potential for "last-chance tourism" as people seek to experience the glacier before it undergoes further dramatic changes due to climate change.

I. INTRODUCTION

One of the main sources of the Ganges River is the Gangotri Glacier, which is situated in the Himalayas in Uttarakhand, India. Since its initial discovery in 1818, it has grown to be an important Hindu Pilgrimage Site. The enormous amphitheater-like structure of the glacier is its defining feature. It is encircled by high peaks like Mana

Parbat and Shivling, which climb to a height of 6,500–7,000 meters above sea level.

The glacier's alternating layers of clays, sands, and marls are indicative of a diverse environmental history, as are peat and lignite deposits. The Bhagirathi River, which is essential to the Ganges River System, is formed by the glacier's meltwater.

The glacier's retreat has a significant negative influence on the environment since it alters not just the Ganges River's hydrology but also the ecosystems and communities that depend on it. Concerns over the quantity and quality of water in the area have been highlighted by the erosion of the glacial catchment areas.

Ongoing studies on the Gangotri Glacier's mass balance and the effects of climate change on it have yielded new insights. Nevertheless, the contexts that are available do not provide specific recent findings or in-depth studies. All things considered, the Gangotri Glacier is an essential natural resource that has major geological, environmental, and cultural significance. It also continues to be a topic of environmental concern and scientific research.

The Gangotri-Gurumukhi glacier, a significant body of ice in the Indian Himalayas, is experiencing notable retreat, which poses ecological risks and disrupts local livelihoods. As tourists visit the area, they are confronted with the consequences of global warming, which may enhance their understanding of the urgent need for climate action. However, the influx of visitors can also exacerbate local environmental issues, such as increased heat generation and resource consumption, due to the growing population and infrastructure development in the region.

Seeing the striking changes in the surroundings is a common experience for visitors to the Gangotri Glacier, and it might make them feel more urgently concerned about climate change. Increased understanding and advocacy for environmental conservation among tourists could result from this interaction. Nevertheless, data regarding precise visitor demographic trends and the in-depth effects of apocalypse tourism on nearby communities are lacking.

The search results presented a general picture of apocalyptic tourism associated to the Gangotri glacial, showing the impact of glacial retreat on travel trends and environmental concerns. Nevertheless, extensive information

about visitor demographics and affects was not discovered, suggesting a gap in the literature that needs to be filled.

Places like Glacier Gangotri are impacted by doomsday tourism since it often involves visiting regions that are believed to be susceptible to natural disasters or climate change. Traveller trends to Glacier Gangotri have changed as a result of growing awareness of climate change; more people are now visiting the glacier before it may recede due to global warming. This inclination to increase foot traffic may exacerbate local environmental degradation, including soil erosion and disturbances to wildlife habitats.

Gangotri Glacier has seen a notable increase in tourism, with over 25,000 hikers and over 250,000 Hindu pilgrims visiting each year in addition to many mountaineering trips. Trekking, mountaineering, and religious pilgrimages are popular pursuits that draw tourists looking for adventure and spiritual fulfilment.

However, the increase in visitors brings up environmental issues such pollution, habitat loss, soil erosion, and the depletion of local supplies like firewood. The unregulated aspect of tourism may surpass the region's environmental capability, resulting in adverse effects on the delicate ecosystem.

Redefining glacier tourism as a type of gloomy tourism can have a cultural impact by highlighting themes of loss and the eerie aspects of climate change, which can affect how people react to these glaciers. This viewpoint draws attention to the psychological and emotional ties that people have with glaciers, which are increasingly seen as places of grief because of their retreat and the effects of climate change.

➤ Objectives

- To provide an in-depth discussion of "Doomsday Tourism" at the Gangotri Glacier, a major Ganges River source in the Indian Himalayas, and its connection to climate change.
- To explore the cultural and religious significance of the Gangotri Glacier, and how its rapid retreat due to climate change is making it a popular destination for "Doomsday Tourists".
- To investigate the factors that influence the desire to visit the Gangotri Glacier, such as awareness of its environmental status, perception of its cultural and religious significance, availability of information from reliable sources, environmental concerns, and interest in adventure activities and tourism

II. METHODOLOGY

The study employed a quantitative research approach using a survey-based design to collect data from participants. The primary method of data collection was through a survey instrument, which included questions related to various factors influencing the desire to visit the Gangotri Glacier. These factors encompassed awareness of the glacier's environmental status and climate change impacts, perception

of its cultural and religious significance, availability of information from reliable sources, environmental concerns, and interest in adventure activities and tourism around the glacier. It can be inferred that participants were likely drawn from a population interested in or aware of the Gangotri Glacier, potentially including local residents and students. The research employed several analytical techniques to examine the data, including regression analysis, hypothesis testing, and descriptive statistics. Linear regression analysis was conducted to explore the relationship between independent variables, such as cultural/religious significance and environmental concerns, and the dependent variable, which is the desire to visit the Gangotri Glacier. The model's performance was evaluated using metrics like R-squared, adjusted R-squared, and the F-statistic. Hypothesis testing involved formulating two hypotheses regarding the influence of cultural/religious significance and environmental concerns on the desire to visit the glacier. Correlation analysis and a paired t-test were conducted, along with the calculation of effect size using Cohen's d. Descriptive statistics reported mean scores for key variables, including cultural/religious significance, environmental concerns, and the desire to visit the Gangotri Glacier.

III. REVIEW OF LITERATURE

Research has consistently shown that the Gangotri Glacier is retreating at an alarming rate, primarily due to climate change. Bhambri and Bolch (2009) highlighted the use of remote sensing techniques to map glacier changes, noting significant retreat over the past few decades.

Similarly, Negi et al. (2012) used ground observations and remote sensing to monitor the glacier's retreat, emphasizing the role of rising temperatures.

Mass Balance and Hydrology Studies on the glacier's mass balance, such as those by Bhattacharya et al. (2016), have documented a negative mass balance, indicating more ice loss than gain. This has implications for the hydrology of the region, affecting water availability downstream.

Singh et al. (2012) analysed the chemical characteristics of meltwater, providing insights into the glacier's contribution to river systems.

IV. ENVIRONMENTAL AND CULTURAL SIGNIFICANCE

The Gangotri Glacier holds significant cultural and religious importance, being a pilgrimage site for Hindus. However, Bisht et al. (2011) noted that tourism and pilgrimage activities contribute to environmental degradation, necessitating sustainable management practices.

The glacier's retreat also poses a threat to its cultural heritage, as discussed by Srivastava (2012).

➤ *Conservation Efforts*

There is a growing recognition of the need for conservation efforts to protect the Gangotri Glacier. Pratap et al. (2016) emphasized the importance of long-term monitoring and the implementation of conservation strategies to mitigate the impacts of climate change.

Bahuguna et al. (2014) called for integrated approaches combining scientific research and policy measures to address the challenges facing Himalayan glaciers.

➤ *Hypothesis:*• *Null hypothesis (H0):*

Awareness of the Gangotri Glacier's environmental status does not significantly influence the likelihood of visiting the glacier within the next year.

• *Alternate Hypothesis (H1):*

Awareness of the Gangotri Glacier's environmental status significantly influences the likelihood of visiting the glacier within the next year.

Table 1: Mean, Median and Mode

	MEAN	MEDIAN	MODE
I am aware that Gangotri glacier is shrinking due to climate change	2.82	4	4
The Gangotri glacier marks the importance in Hinduism	3.1	4	4
I believe that more efforts should be made to conserve the Gangotri glaciers	3.416	4	4
tourism has a negative impact on the Gangotri glacier environment	3.5	4	4
I feel knowledgeable about the current environmental status of the Gangotri glacier	3.362903	4	4
I regularly received information about the Gangotri glacier from reliable sources	3.38 5542	4	4
I have a strong desire to visit the Gangotri glacier	3.392	4	4
The cultural and the religious significance of the Gangotri glacier motivated me to visit	3.48	4	4
Environmental concern about the Gangotri glacier influence my decision to visit	3.506024	4	4
I'm likely to visit the Gangotri glacier within next year	3.4	4	4
I'm interested in adventure activities available around the Gangotri glacier	3.524	4	4
The accessibility of the Gangotri glacier effects my intention to travel there.	3.445344	4	4

➤ *Standard Deviation*

Standard Deviation is a statistical measurement that indicates how spread out a set of values are around their mean.

Table 2: Represents Standard Deviation

I am aware that Gangotri glacier is shrinking due to climate change	1.007801
the Gangotri glacier marks the importance in Hinduism	1.172818
I believe that more efforts should be made to conserve the Gangotri glacier	1.236552
tourism has a negative impact on the Gangotri glaciers environment	1.206575
I feel knowledgeable about the current environmental status of the Gangotri glacier	1.274697
I regularly receive the information about the Gangotri glacier from reliable sources	1.206481
I have a strong desire to visit the Gangotri glacier	1.28567
The cultural and religious significance of the Gangotri glacier motivated me to visit	1.271245
Environmental concern about the Gangotri glacier influence my decision to visit	1.205232
I am likely to visit the Gangotri glacier within next year	1.257907
I am interested in adventure activities available around the Gangotri glacier	1.286875
The accessibility of the Gangotri glacier affects my intention to travel there	1.292587

- Model Performance: Mean
- Squared error: 1.4405
- Model Fit:

- R-squared: 0.308
- Adjusted R-squared: 0.276
- R-Squared Score: 0.0823

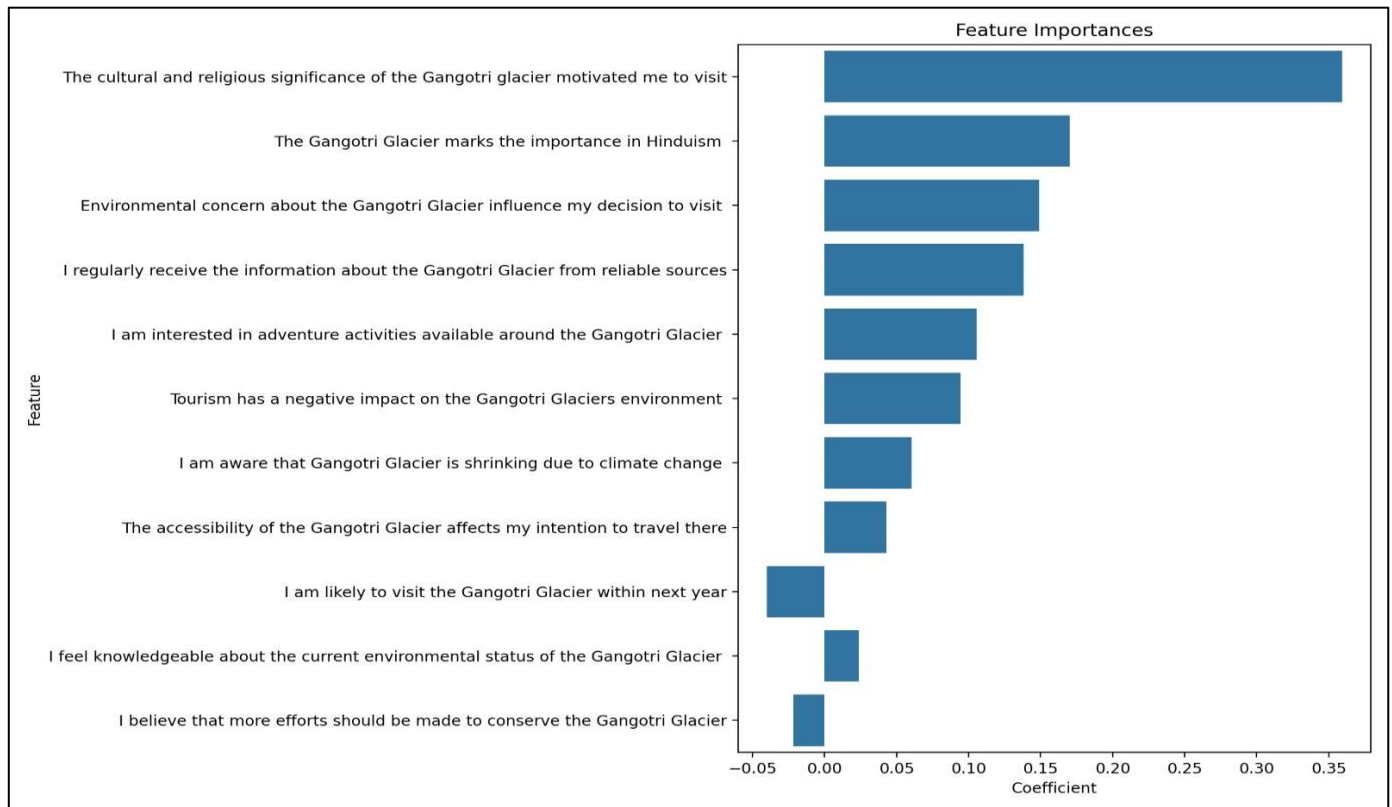


Fig 1: R-Square

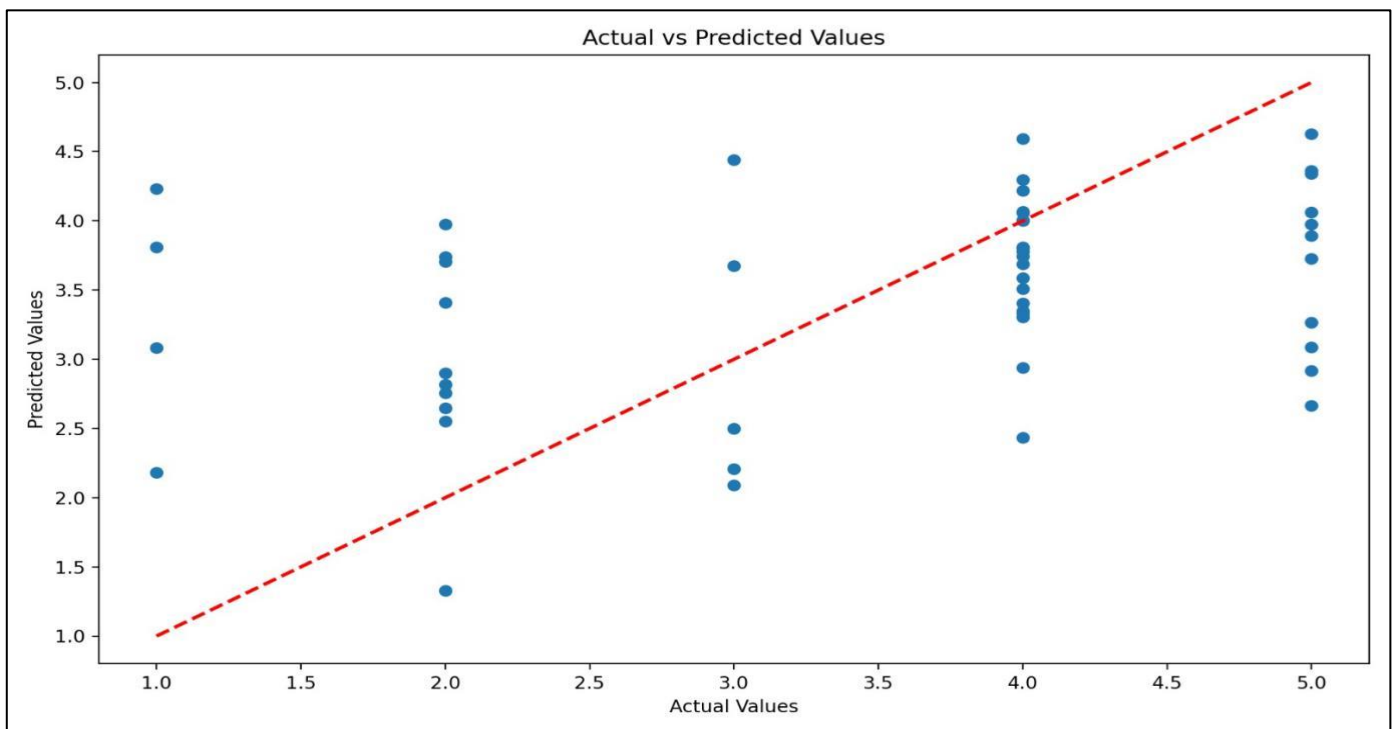


Fig 2: Graph for R-Squared

The R-squared score of 0.0823 indicates that only about 8.23% of the variance in the target variable ("I have a strong desire to visit the Gangotri Glacier") is explained by the model. This suggests that the linear regression model may not

be the best fit for this data, and there might be non-linear relationships or other factors not captured in the survey that influence people's desire to visit the glacier.

Table 3: R Squared Table

FEATURE	COEFFICIENT
The cultural and religious significance of the Gangotri glacier motivated me to visit	0.359263
The Gangotri Glacier marks the importance in Hinduism	0.170171
Environmental concern about the Gangotri Glacier influence my decision to visit	0.149142
I regularly receive the information about the Gangotri Glacier from reliable sources	0.138202
I am interested in adventure activities available around the Gangotri Glacier	0.105487
Tourism has a negative impact on the Gangotri Glaciers environment	0.094351
I am aware that Gangotri Glacier is shrinking due to climate change	0.06036
The accessibility of the Gangotri Glacier affects my intention to travel there	0.043164
I am likely to visit the Gangotri Glacier within next year	-0.03987
I feel knowledgeable about the current environmental status of the Gangotri Glacier	0.023757
I believe that more efforts should be made to conserve the Gangotri Glacier	-0.0215

- The cultural and religious significance of the Gangotri glacier seems to be the strongest predictor of people's desire to visit.
- The glacier's importance in Hinduism and environmental concerns also play significant roles in influencing visit intentions.
- Information availability and interest in adventure activities around the glacier are also positively associated with the desire to visit

Table 4: Cluster Analysis

	I am aware that Gangotri glacier is shrinking due to climate change	The Gangotri glacier marks the importance in Hinduism	I believe that more efforts should be made to conserve the Gangotri glacier	Tourism has a Negative impact on the Gangotri glacier environment	I feel knowledgeable about the environmental status of the Gangotri glacier	I regularly receive the information about the Gangotri glacier from the reliable sources	I have a strong desire to visit the Gangotri glacier	The cultural and religious significance of the Gangotri glacier motivate me to visit	Environment concern about the Gangotri glacier influence my decision to visit
Cluster 1	2.576923	2.288462	2.596154	2.596154	2.634615	2.5	1.942308	2.730769	2.586654
Cluster 2	3.369048	3.797619	4.130952	3.714286	3.135273	3.083333	3.369048	3.107143	3.238095
Cluster 3	2.526316	2.95614	3.377193	3.754386	3.862832	4.012154	4.070175	4.096491	4.122807

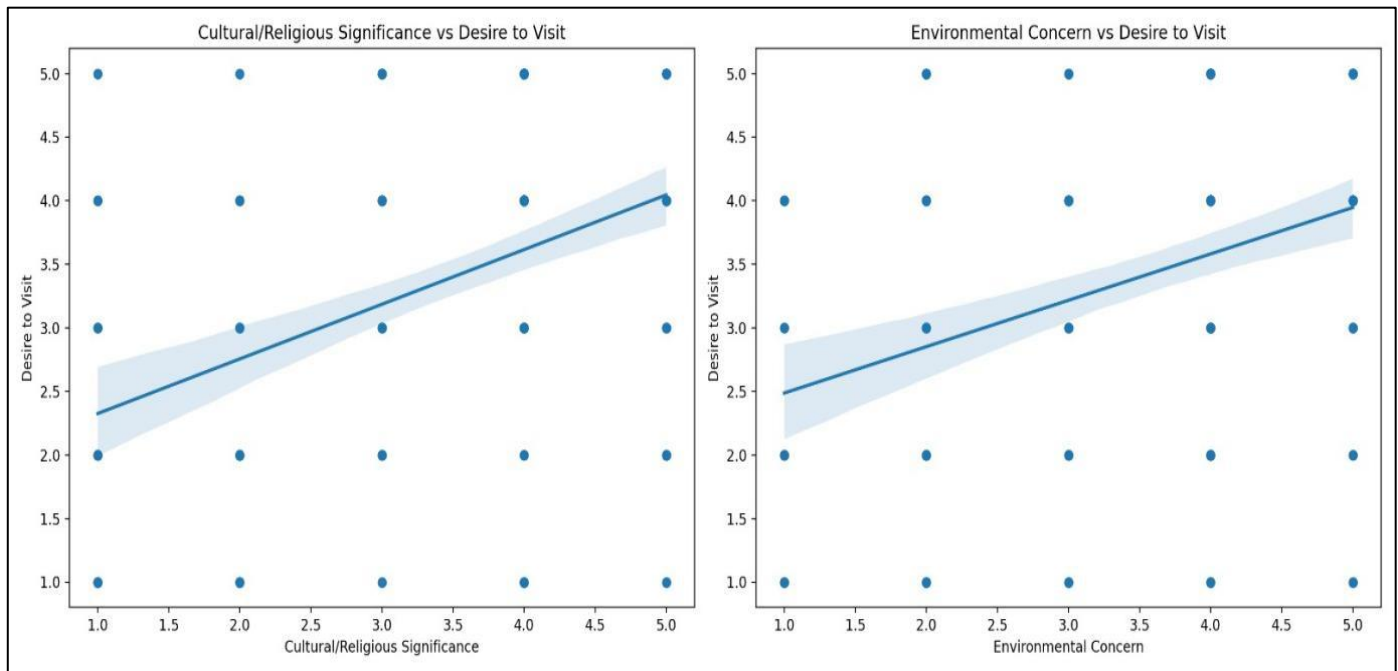


Chart 1: Cultural/ Religious Significance

- **Hypothesis 1:** Cultural and religious significance has a stronger influence on the desire to visit the Gangotri Glacier compared to environmental concerns.
- **Hypothesis 2:** There is a significant difference between the impact of cultural/religious significance and environmental concerns on people's desire to visit the Gangotri Glacier.

In this the overall model significance came as F-statistic - 9.626 and the Prob(F- statistic) is 2.40e-14. The model explains approximately 30.8% of the variance in the desire to visit the Gangotri Glacier. While this indicates that our model captures some important factors, there are likely other variables not included in the survey that also influence the desire to visit.

➤ Interpretation

The very low p-value (< 0.05) for the F-statistic indicates that our model is statistically significant overall. This means that the combination of all variables in the model is better at predicting the desire to visit than just using the mean.

• Significant Predictors:

- ✓ "The cultural and religious significance of the Gangotri glacier motivated me to visit"
Here the coefficient value is 0.2871 and the p-value is 0.000. This is the strongest
Chart 2- Environmental Concern predictor in the model.
For every one-unit increase in the perceived cultural and religious significance, the desire to visit increases by 0.2871 units, holding other factors constant. This effect is highly statistically significant ($p < 0.001$).
- ✓ "I regularly receive the information about the Gangotri Glacier from reliable sources"

In this case the coefficient value is 0.1827 and the p-value is 0.008. Regular receipt of information from reliable sources is positively associated with the desire to visit. For every one-unit increase in this variable, the desire to visit increases by 0.1827 units, holding other factors constant. This effect is statistically significant ($p < 0.01$).

- ✓ "Environmental concern about the Gangotri Glacier influence my decision to visit"

The coefficient value is 0.1737 and the p-value is 0.016. Environmental concerns also positively influence the desire to visit. For every one-unit increase in environmental concern, the desire to visit increases by 0.1737 units, holding other factors constant. This effect is statistically significant ($p < 0.05$).

- **Marginally Significant Predictor:** "I am aware that Gangotri Glacier is shrinking due to climate change"

➤ Interpretation:

Here the coefficient value is 0.1308 and the p-value is 0.084. Awareness of the glacier shrinking due to climate change has a positive effect on the desire to visit, but it's only marginally significant ($p < 0.10$). For every one-unit increase in awareness, the desire to visit increases by 0.1308 units, holding other factors constant.

➤ Non-Significant Predictors:

Several variables, including the importance of the glacier in Hinduism, conservation efforts, tourism impact, and adventure activities, did not show statistically significant effects on the desire to visit in this model.

➤ Mean Scores

- Cultural/Religious Significance: 3.4800
- Environmental Concern: 3.5060
- Desire to Visit: 3.3920

The mean scores show that environmental concerns (3.5060) are slightly higher than cultural/religious significance (3.4800), but the difference is minimal.

➤ *Effect Size:*

Effect Size (Cohen's d): -0.0210

The Cohen's d value of -0.0210 indicates a very small effect size, suggesting that the difference between cultural/religious significance and environmental concerns is negligible.

➤ *Visual Analysis:*

The scatter plots show the relationships between cultural/religious significance, environmental concerns, and the desire to visit. Both plots show positive trends, but the differences are not visually striking.

➤ *Key Inferences*

- **Cultural and Religious Significance:** The strongest driver of the desire to visit the Gangotri Glacier is its cultural and religious significance. This suggests that preserving and promoting the cultural heritage associated with the glacier could be crucial in maintaining visitor interest.
- **Information and Awareness:** Regular access to reliable information about the glacier significantly increases the desire to visit. This highlights the importance of effective communication and outreach programs in attracting visitors.
- **Environmental Concerns:** People who are more concerned about the environmental status of the glacier are more likely to want to visit. This could indicate a form of "last-chance tourism" where people want to see the glacier before it potentially disappears or changes dramatically due to climate change.
- **Climate Change Awareness:** There's a marginal effect of climate change awareness on the desire to visit, which further supports the potential "last-chance tourism" phenomenon.
- **Multifaceted Motivations:** The desire to visit the Gangotri Glacier is influenced by a combination of cultural, informational, and environmental factors, rather than being driven by a single aspect.
- **Unexplained Variance:** While our model captures significant factors, there's still a large portion of unexplained variance (about 70%). This suggests that there might be other important factors not captured in this survey, such as personal interests, travel constraints, or broader tourism trends.

Based on the regression analysis of the Gangotri Glacier survey data, the conclusion is that the cultural and religious significance of the glacier is the most significant predictor of the desire to visit, followed by reliable information sources and environmental concerns. These factors collectively explain about 30.8% of the variance in the desire to visit, indicating that while they are important, other unexplored factors also play a role.

➤ *The Results of Hypothesis Are:*

- **Correlation Analysis:** Correlation between cultural/religious significance and desire to visit: 0.4250
- Correlation between environmental concern and desire to visit: **0.3436**
- The correlation coefficients show that both cultural/religious significance and environmental concerns are positively correlated with the desire to visit. However, cultural/religious significance has a slightly stronger correlation (0.4250) compared to environmental concerns (0.3436).

V. CONCLUSION

- **Hypothesis 1:** Partially supported. While the correlation analysis shows that cultural and religious significance has a slightly stronger correlation with the desire to visit compared to environmental concerns, the difference is not substantial.
- **Hypothesis 2:** Not supported. The effect size (Cohen's d) is very small, indicating that there is no significant difference between the impact of cultural/religious significance and environmental concerns on people's desire to visit the Gangotri Glacier.

➤ *Additional Observations:*

Both cultural/religious significance and environmental concerns have moderate positive correlations with the desire to visit the Gangotri Glacier.

The mean scores for cultural/religious significance, environmental concerns, and desire to visit are all relatively close, ranging from 3.39 to 3.51 on what appears to be a 5-point scale.

The scatter plots show positive trends for both factors, but there's considerable variability in the responses.

In summary, while cultural and religious significance seems to have a slightly stronger influence on the desire to visit the Gangotri Glacier, the difference is not statistically significant. Both factors appear to play important roles in motivating people to visit the glacier, and other factors not captured in this analysis may also be influential.

REFERENCES

- [1]. Bhambri, R., & Bolch, T. (2009). Glacier mapping: a review with special reference to the Indian Himalayas. *Progress in Physical Geography*, 33(5), 672-704.
- [2]. Negi, H. S., Kanda, N., Shekhar, M. S., & Pramod, K. (2012). Recent studies on snow and glacier melt—A review. *International Journal of Water Resources and Environmental Engineering*, 4(2), 49-63.
- [3]. Bhattacharya, A., Bolch, T., Mukherjee, K., Pieczonka, T., Kropáček, J., & Buchroithner, M. F. (2016). Glacier mass changes in the Pir Panjal range, Kashmir Himalayas, 1969–2013. *Remote Sensing of Environment*, 183, 328-341.

- [4]. Singh, P., Ramasastri, K. S., Kumar, N., & Bhatnagar, N. K. (2012). Hydrochemical characteristics of the Gangotri Glacier meltwater river, Garhwal Himalaya, India. *Journal of Hydrology*, 454, 49-58.
- [5]. Bisht, M. P. S., Nautiyal, S., & Agarwal, S. K. (2011). Sustainable tourism development in the Gangotri glacier region of Uttarakhand, India. *International Journal of Environmental Sciences*, 1(7), 1560-1571.
- [6]. Srivastava, D. (2012). Gangotri glacier retreat and its impact on the biodiversity and tourism. *Journal of Environmental Research and Development*, 6(3A), 821-828.
- [7]. Pratap, B., Dobhal, D. P., Mehta, M., & Bhambri, R. (2016). Influence of debris cover and altitude on glacier surface melting: a case study on Dokriani Glacier, central Himalaya, India. *Annals of Glaciology*, 57(71), 1-9.
- [8]. Bahuguna, I. M., Rathore, B. P., Brahmabhatt, R., Sharma, M., Dhar, S., Randhawa, S. S., ... & Kumar, K. (2014). Are the Himalayan glaciers retreating?. *Current Science*, 106(7), 1008-1013.