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Assessing Government Policy Effectiveness and Community Participation in the Conservation of the Kodaikanal Hill Ecosystems

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Abstract

This study assessed stakeholder perceptions of government policy effectiveness, community participation, and environmental awareness in conserving the Kodaikanal hill ecosystems, Western Ghats, India. A cross-sectional survey was conducted among 100 respondents using a structured questionnaire containing 22 Likert-scale items to evaluate ecological concerns, governance effectiveness, and societal preparedness. Descriptive statistical analysis was used to interpret responses. The findings revealed strong public concern regarding environmental degradation and ecosystem sustainability. Seventy-seven percent of respondents agreed that biodiversity in Kodaikanal is threatened by human activities (mean = 1.95 ± 0.845), while 80% identified deforestation as a major ecological threat (mean = 1.91 ± 0.877). Climate-related concerns were also substantial, with 70% reporting that climate change threatens ecological balance (mean = 2.08 ± 0.872) and 75% identifying climate change as a major concern affecting hill ecosystems (mean = 2.05 ± 0.914). Tourism pressure was widely recognized, with 73% agreeing that tourism development negatively affects the natural environment and 69% reporting that tourist activities disturb ecological balance. Although 51% perceived local communities as participating in conservation efforts, only 40% believed that government effectively involves communities in environmental decision-making. Furthermore, only 34% expressed satisfaction with pollution control measures. The results indicate a disconnect between public environmental awareness and confidence in governance mechanisms. Strengthening participatory governance, improving conservation policies, enhancing environmental education, and integrating sustainable tourism practices are necessary to improve ecological resilience and long-term conservation outcomes in Kodaikanal.

Keywords: Community participation; Government policy; Hill ecosystem conservation; Tourism impact; Biodiversity; Kodaikanal

Introduction

Mountains are valued for their significant environmental services and for being centers of biodiversity (Chakraborty, 2020). As cradles of biodiversity, mountains play a crucial ecological role (Chakraborty, 2020; Noroozi et al., 2018). Mountains are also recognized as the primary sources of many of the world's major drainage networks (Immerzeel et al., 2020). In addition to representing the Earth's abiotic diversity, mountains have recently gained attention for their extensive geodiversity. Due to their steep gradients and associated climatic variations, mountains are particularly important because they connect abiotic and biotic diversity by compressing "life zones" and creating numerous local niches that support diverse biomes (Chakraborty, 2020; Körner and Spehn, 2019).

Soil productivity is negatively affected by land degradation through processes such as erosion, nutrient depletion, acidity, salinity, and loss of organic matter. Soil degradation processes are influenced by various biophysical, socioeconomic, and political factors and are further intensified by inappropriate land-use practices (Talukder, 2017; Lebuy et al., 2022). Many of these practices are associated with intensive agriculture and over-specialization, resulting in resource depletion, reduced soil productivity, and deterioration of landscapes as environmental, cultural, and economic resources. Agricultural industrialization has contributed to socioeconomic instability in rural regions, weakened agricultural competitiveness relative to other sectors, and degraded traditional landscapes and their associated biodiversity. It has also disrupted the transmission of traditional knowledge essential for maintaining local landscapes (Agnoletti, 2014).

Mountain ecosystems are highly temperature-sensitive; therefore, mountain regions are particularly vulnerable to climate change (Pepin et al., 2015). Recent environmental changes have pushed numerous ecosystems toward the boundaries of their historical range of variability (Duncan et al., 2010; Keane et al., 2009; Albrich et al., 2020), increasing the likelihood of abrupt shifts in ecosystem structure and functioning (Scheffer et al., 2001). Given projected future climate changes, one of the central goals of contemporary ecological research is to understand whether ecosystems respond gradually or undergo sudden transitions under rising temperatures (Albrich et al., 2020; Turner et al., 2020; Van Nes et al., 2016).

Communities residing within hill ecosystems have historically maintained a close relationship with their natural surroundings. These resources formed the foundation of traditional economies before the transition toward tourism-based development and the social and cultural transformations of the twentieth century. Nevertheless, local communities continue to preserve valuable traditional knowledge and cultural heritage that have been sustainably maintained. These include agricultural practices, regional production systems, environmentally sustainable construction methods, local customs, and community institutions developed over generations through adaptation to environmental conditions (Bertolino and Corrado, 2022).

Although the role of culture in local development processes within mountainous regions remains largely unexplored, there is substantial potential for research to support territorial development agendas based on cultural practices, as demonstrated by successful examples from other regions (Bertolino and Corrado, 2022; Grodach, 2007).

Materials and methods

Study Site

Kodaikanal, a well-known hill station located in the Palani Hills, was selected as the study area (Fig. 1). It is situated at an elevation of approximately 6,990 feet (2,133 m) above sea level between the Parappar and Gundar valleys on a plateau along the southern escarpment of the Upper Palani Hills (Srilekha, 2014). The study area covers approximately 1,039.46 km² in the Western Ghats region of Tamil Nadu.

Geographically, the area extends between 10°06′25″ and 10°26′54″ N latitude and 77°14′26″ and 77°45′28″ E longitude (Christina, 2012). Historically, the Kodai highlands possessed rich biodiversity. However, increasing cultivation of non-native vegetation for economic purposes has contributed to changes in native vegetation patterns. Kodaikanal still contains important stretches of Shola forests, which are globally recognized ecosystems occurring in limited regions. Dense evergreen forests occur where sufficient soil moisture and depth are available. The rapid increase in tourism has led to growing pressure on land use and changes in vegetation cover, resulting in reduced forest boundaries and impacts on local wildlife (Athithi and Sivaperuma, 2025). Kodaikanal attracts a large number of tourists annually and forms part of the eastern extension of the Western Ghats in southern India (Srilekha, 2014).

Research Design

This study was conducted in Kodaikanal, Dindigul district, Tamil Nadu, India, during the period from March to June. Data were collected using a structured questionnaire administered through Google Forms. The questionnaire consisted of 22 items measured using a five-point Likert scale (ranging from strongly agree to strongly disagree) to evaluate participants' perceptions of ecological impacts and societal preparedness. The study included 100 respondents (N = 100) from the Kodaikanal region. Demographic information including age, gender, and educational qualification was also collected. A random sampling technique was adopted to obtain a representative sample of the study population. A total of 100 valid responses were collected and included in the analysis. Informed consent was obtained from all participants before they completed the Google Form.

The questionnaire was designed to obtain comprehensive information regarding respondents' perceptions of ecological concerns and societal preparedness in the Kodaikanal hill ecosystems. The survey included questions addressing key environmental and governance issues, such as the impact of human activities on biodiversity, the

involvement of local communities in environmental conservation, the adequacy of wildlife conservation efforts, societal sustainability, and the effects of infrastructure development and tourism on the ecosystem.

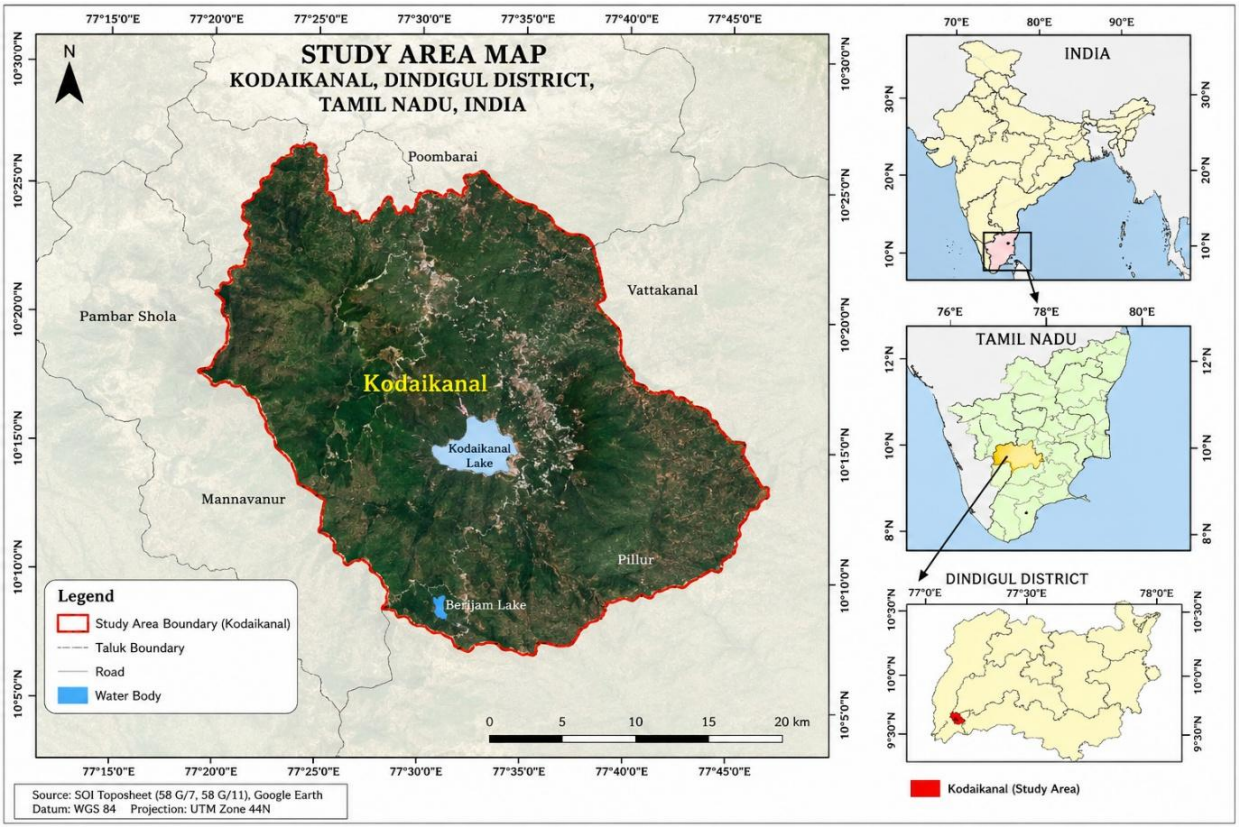

Fig. 1. Study area

The findings section included an analysis of respondents' demographic characteristics, including age, gender, and educational level. It also examined perceived changes in Kodaikanal's ecological environment and assessed community responses to these changes. The analysis focused on identifying relationships between ecological impacts and societal vulnerability and generated policy recommendations aimed at improving community resilience and reducing ecological pressures in the region.

The study further summarized the major findings related to ecological impacts and societal vulnerability and proposed directions for future research in Kodaikanal and other comparable hill ecosystems. Ethical standards were strictly followed throughout the study to ensure that participants were adequately informed about the purpose of the survey and voluntarily agreed to participate. The confidentiality of participants' personal information was maintained, and all collected data were used exclusively for research purposes.

Result and discussion

The survey respondents showed a slightly uneven gender distribution, with male participants marginally outnumbering female participants in the total sample. Despite this imbalance, the sample reflects a reasonably broad representation of the population, which supports obtaining diverse perspectives in the survey responses. The observed gender distribution may be influenced by social, cultural, or situational factors specific to the Kodaikanal region that affected participation rates.

Gender is an important factor in understanding ecological and societal perceptions, as men and women may differ in their experiences, responsibilities, and interactions with environmental issues. These differences can influence how ecological challenges and community preparedness are perceived and addressed. Therefore, considering gender dynamics provides valuable insight into interpreting community responses and developing inclusive environmental policies.

An overview of the age distribution of survey participants is presented in Fig. 2. The largest proportion of respondents belonged to the 18–25 years age group (42%), followed by participants aged 46–55 years (22%). Respondents aged 26–35 years accounted for 17%, while those in the 36–45 years category represented 9% of the total sample. Participants aged 56 years and above constituted 10%, making this the least represented age group. The predominance of younger respondents (18–25 years) may indicate greater participation of younger individuals in environmental and social issues, possibly reflecting their higher engagement in educational, community, and environmental activities. At the same time, the participation of middle-aged respondents (46–55 years) provides

additional perspectives that may reflect greater familiarity with long-term environmental changes and local ecological conditions. The inclusion of participants across different age groups enhances the diversity of viewpoints represented in the study and contributes to a broader understanding of ecological concerns and societal preparedness in Kodaikanal.

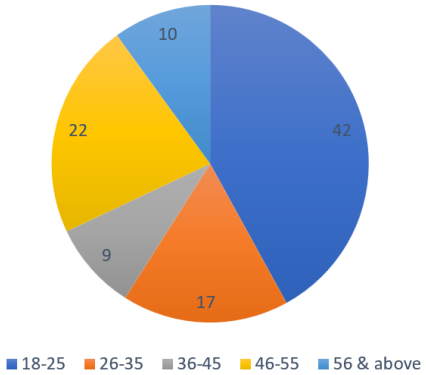

Fig. 2. Age distribution

The respondents were further categorized according to their educational qualifications, as shown in Table 1. The majority of participants (57%) were undergraduates, followed by 20% postgraduates. Respondents with education below the undergraduate level represented 17% of the sample, whereas 6% had qualifications above the postgraduate level. The educational profile of respondents indicates a relatively well-educated sample population, which may contribute to informed responses and improved understanding of environmental and societal issues addressed in the survey. The inclusion of participants with postgraduate and higher qualifications further strengthens the study by providing perspectives that may reflect greater awareness of ecological and social challenges affecting the Kodaikanal hill ecosystem.

Table 1. Educational Qualification

Educational Qualification	Frequency	Percentage (%)
Below undergraduate	17	17
Undergraduate	57	57
Postgraduate	20	20
Above postgraduate	6	6

Survey responses on environmental issues and societal resilience

Table 2. Survey responses on environmental issues and societal resilience

Questions	Response	Frequency	Percentage	Mean	Standard deviation
The biodiversity of Kodaikanal hill ecosystems is under threat due to human activities.	Strongly Agree	33	33	1.95	0.845
	Agree	44	44		
	Neutral	18	18		
	Disagree	5	5		
	Strongly Disagree	0	0		
Local communities in Kodaikanal are actively involved in conservation efforts.	Strongly Agree	8	8	2.53	0.834
	Agree	43	43		
	Neutral	39	39		
	Disagree	8	8		
	Strongly Disagree	2	2		
Government policies adequately address the ecological challenges faced by Kodaikanal hill ecosystems	Strongly Agree	6	6	2.71	0.924
	Agree	42	42		
	Neutral	28	28		
	Disagree	23	23		
	Strongly Disagree	1	1		
Tourism development has a significant negative impact on the natural environment in Kodaikanal	Strongly Agree	36	36	2.07	1.075
	Agree	37	37		
	Neutral	13	13		
	Disagree	12	12		
	Strongly Disagree	2	2		
The local population's awareness of	Strongly Agree	18	18	2.39	1.014
	Agree	43	43		
	Neutral	24	24		
	Disagree	12	12		

environmental issues is high in Kodaikanal	Strongly Disagree	3	3		
Climate change poses a serious threat to the ecological balance of Kodaikanal hill ecosystems.	Strongly Agree	28	28	2.08	0.872
	Agree	42	42		
	Neutral	24	24		
	Disagree	6	6		
	Strongly Disagree	0	0		
Pollution levels in Kodaikanal are a major concern for environmental sustainability	Strongly Agree	26	26	2.18	0.988
	Agree	44	44		
	Neutral	17	17		
	Disagree	12	12		
	Strongly Disagree	1	1		
The government effectively involves local communities in decision-making regarding environmental policies in Kodaikanal	Strongly Agree	11	11	2.79	1.028
	Agree	29	29		
	Neutral	33	33		
	Disagree	24	24		
	Strongly Disagree	3	3		
Infrastructure development in Kodaikanal balances economic growth with environmental conservation.	Strongly Agree	8	8	2.81	0.950
	Agree	28	28		
	Neutral	43	43		
	Disagree	17	17		
	Strongly Disagree	4	4		
Wildlife conservation efforts in Kodaikanal are sufficient to protect endangered species.	Strongly Agree	12	12	2.61	1.033
	Agree	40	40		
	Neutral	27	27		
	Disagree	17	17		
	Strongly Disagree	4	4		
The community resilience of Kodaikanal hill ecosystems is high in the face of environmental challenges	Strongly Agree	13	13	2.34	0.794
	Agree	47	47		
	Neutral	33	33		
	Disagree	7	7		
	Strongly Disagree	0	0		
Public education and awareness programs effectively promote sustainable practices among tourists visiting Kodaikanal	Strongly Agree	16	16	2.35	0.892
	Agree	44	44		
	Neutral	30	30		
	Disagree	9	9		
	Strongly Disagree	1	1		
The local biodiversity in Kodaikanal is being adequately protected	Strongly Agree	11	11	2.59	0.944
	Agree	38	38		
	Neutral	34	34		
	Disagree	15	15		
	Strongly Disagree	2	2		
Tourist activities harm the ecological balance of Kodaikanal	Strongly Agree	31	31	2.16	1.061
	Agree	38	38		
	Neutral	17	17		
	Disagree	12	12		
	Strongly Disagree	2	2		
Local communities have access to sustainable livelihood options in Kodaikanal	Strongly Agree	16	16	2.42	0.945
	Agree	40	40		
	Neutral	32	32		
	Disagree	10	10		
	Strongly Disagree	2	2		
Climate change is a major concern affecting the hill ecosystem in Kodaikanal	Strongly Agree	29	29	2.05	0.914
	Agree	46	46		
	Neutral	17	17		
	Disagree	7	7		
	Strongly Disagree	1	1		
Land use practices are managed	Strongly Agree	12	12	2.69	1.041
	Agree	35	35		

responsibly to prevent soil erosion in Kodaikanal	Neutral	28	28		
	Disagree	22	22		
	Strongly Disagree	3	3		
Water resources in Kodaikanal are managed effectively to meet local needs.	Strongly Agree	4	4	2.69	0.761
	Agree	36	36		
	Neutral	48	48		
	Disagree	11	11		
	Strongly Disagree	1	1		
Deforestation is a significant threat to the hill ecosystems of Kodaikanal	Strongly Agree	36	36	1.91	0.877
	Agree	44	44		
	Neutral	13	13		
	Disagree	7	7		
	Strongly Disagree	0	0		
Infrastructure development projects prioritize ecological conservation in Kodaikanal	Strongly Agree	8	8	2.74	0.894
	Agree	30	30		
	Neutral	44	44		
	Disagree	16	16		
	Strongly Disagree	2	2		
Pollution levels in Kodaikanal are well-controlled and monitored	Strongly Agree	5	5	2.9	0.904
	Agree	29	29		
	Neutral	39	39		
	Disagree	25	25		
	Strongly Disagree	2	2		
There is a balance between tourism development and ecological preservation in Kodaikanal	Strongly Agree	8	8	2.71	0.935
	Agree	35	35		
	Neutral	38	38		
	Disagree	16	16		
	Strongly Disagree	3	3		

The survey data collected from Kodaikanal reveal diverse perceptions and attitudes toward environmental concerns, including biodiversity conservation, tourism impacts, climate change, government policies, and community participation. These findings provide insights into community perceptions regarding the sustainability and environmental health of the Kodaikanal hill ecosystem. A total of 100 respondents participated in the survey. Frequencies represent the actual number of responses, while percentages facilitate comparison across response categories, as presented in Table 2.

The results indicate a strong perception that human activities threaten biodiversity in Kodaikanal's hill ecosystems. A majority of respondents (77%) agreed or strongly agreed with this statement (33% strongly agreed and 44% agreed), with a mean response score of 1.95 ± 0.845, indicating strong consensus regarding anthropogenic impacts on biodiversity. Community participation in environmental conservation received mixed responses. Approximately 51% of respondents believed that local communities actively participate in conservation efforts, while 39% remained neutral and 10% disagreed. The mean score (2.53 ± 0.834) suggests moderate recognition of community involvement but highlights variability in public perceptions.

Perceptions of government effectiveness were comparatively less positive. Only 48% of respondents considered existing environmental policies adequate for addressing ecological challenges, whereas 28% remained neutral and 24% expressed disagreement. The mean score (2.71 ± 0.924) reflects limited confidence in current governance mechanisms. Tourism emerged as a major environmental concern. About 73% of respondents agreed that tourism development negatively affects Kodaikanal's natural environment (mean = 2.07 ± 1.075), while 69% reported that tourism activities disturb ecological balance (mean = 2.16 ± 1.061). These findings indicate widespread concern regarding tourism-related ecological pressures.

Environmental awareness within the community was moderately positive, with 61% of respondents agreeing that environmental awareness among local residents is adequate (mean = 2.39 ± 1.014). However, 24% remained neutral and 15% disagreed, suggesting opportunities for strengthening awareness programs. Climate change and pollution were identified as critical environmental threats. Approximately 70% of respondents believed climate change threatens ecological balance (mean = 2.08 ± 0.872), while an equal proportion viewed pollution as a serious environmental issue (mean = 2.18 ± 0.988). Furthermore, 75% strongly recognized climate change as a significant challenge affecting Kodaikanal (mean = 2.05 ± 0.914), indicating substantial concern regarding future environmental conditions. Government involvement in environmental decision-making received relatively low support, with only 40% agreeing that authorities sufficiently involve local communities, while 33% remained neutral and 27% disagreed (mean = 2.79 ± 1.028). Similarly, perceptions regarding balancing infrastructure development

and environmental conservation were divided, with 36% agreement, 43% neutrality, and 21% disagreement (mean = 2.81 ± 0.950).

Regarding conservation measures, 52% believed wildlife conservation efforts are adequate (mean = 2.61 ± 1.033), whereas opinions on biodiversity protection remained varied, with 49% expressing positive views and 17% expressing dissatisfaction (mean = 2.59 ± 0.944). Community resilience and environmental education received comparatively favorable responses. About 60% of respondents expressed confidence in community resilience toward environmental challenges (mean = 2.34 ± 0.794), while 60% also considered environmental awareness and public education campaigns effective in promoting sustainable behavior (mean = 2.35 ± 0.892). Sustainable livelihood opportunities were supported by 56% of respondents (mean = 2.42 ± 0.945), indicating recognition of the importance of integrating environmental conservation with socioeconomic development. However, opinions regarding responsible land-use practices (mean = 2.69 ± 1.041) and water resource management (mean = 2.69 ± 0.761) remained comparatively divided.

Deforestation emerged as the strongest environmental concern identified in the study, with 80% of respondents agreeing that it poses a significant threat to the ecosystem (mean = 1.91 ± 0.877). Additionally, only 34% expressed satisfaction with pollution monitoring and management efforts (mean = 2.90 ± 0.904), suggesting concerns regarding current environmental management practices. Overall, the findings demonstrate widespread concern regarding biodiversity loss, tourism pressure, pollution, climate change, and governance effectiveness in Kodaikanal. Although community participation and environmental awareness are moderately recognized, concerns regarding policy implementation and environmental management highlight the need for integrated, participatory, and evidence-based conservation strategies to improve ecological sustainability and community resilience.

Perceptions of tourism impact and sustainability efforts

The first category, "Negative Effects of Tourism on the Kodaikanal Environment," reflects respondents' perceptions regarding the environmental consequences of tourism, as presented in Fig. 3. A substantial proportion of respondents expressed concern regarding tourism-related environmental degradation, with 36% strongly agreeing and 37% agreeing that tourism negatively affects the environment. Collectively, 73% of respondents acknowledged the adverse environmental impacts of tourism on the Kodaikanal hill ecosystem. Meanwhile, 13% remained neutral, indicating uncertainty or a balanced perception of tourism's environmental effects. In contrast, 12% disagreed and 2% strongly disagreed with the statement. The high level of agreement suggests widespread concern among residents regarding the ecological pressures associated with tourism development in the region.

The second category, "Adverse Tourist Activities," examined perceptions of specific tourist behaviors that may contribute to environmental degradation. In this category, 31% of respondents strongly agreed and 38% agreed that tourist activities negatively affect the environment, resulting in an overall agreement rate of 69%. Although slightly lower than the overall perception of tourism impacts, this finding still demonstrates substantial concern regarding tourism-related activities. Additionally, 17% of respondents remained neutral, reflecting some uncertainty regarding the direct environmental effects of tourist behavior. A total of 12% disagreed, while 2% strongly disagreed with the statement. These findings suggest that while tourism as a broader phenomenon is widely perceived as environmentally harmful, respondents also recognize that specific tourist activities contribute significantly to ecological stress within the Kodaikanal ecosystem.

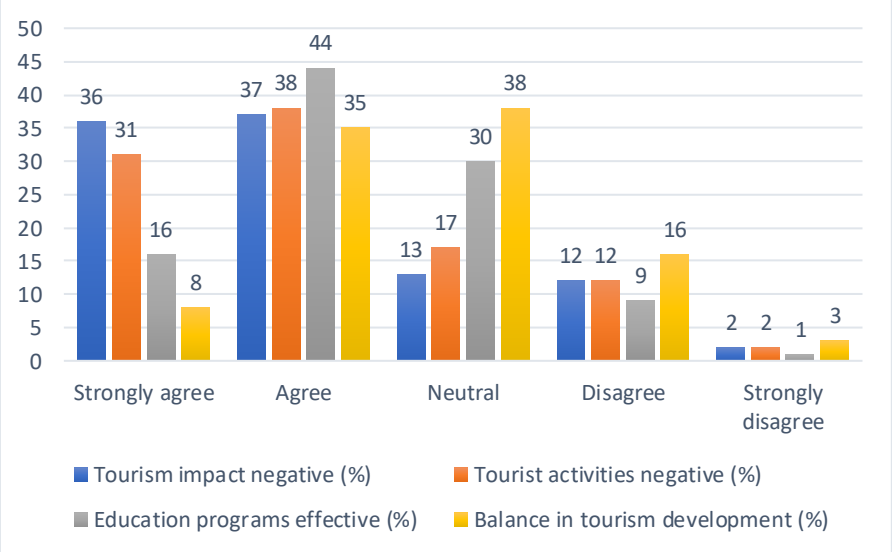

Fig. 3. Perceptions of tourism impact and sustainability

The third column, titled "Effectiveness of Educational Programs," focuses on initiatives designed to reduce the negative impacts of education. However, only 16% of respondents strongly agree with the effectiveness of educational programs, while a substantial 44% agree, bringing the overall positive perception of these programs to 60%. This indicates a moderate level of confidence in current educational processes that promote sustainable tourism practices. However, 30% of respondents remain indifferent, which may be attributed to their lack of awareness of such programs or a neutral attitude toward their effectiveness. Another 9% of respondents disagree with this statement, while 1% strongly disagree. These statistics indicate a belief in the efficacy of educational programs; however, a significant portion of the public remains skeptical or uncertain about their benefits.

The final column, "Sustainable Tourism Development Balance," examines how well sustainable tourism development is perceived to be managed. The responses show greater variation compared to the first research question. Only 8% of respondents strongly agree that there is a balance, while 35% somewhat agree, resulting in a total agreement of 43%. The analysis shows that this category has the lowest level of agreement, indicating a lack of confidence in the sustainable management of tourism development. This category also has the largest proportion of neutral responses (38%), consisting of individuals who are uncertain about whether development or preservation is being prioritized. Disagreement accounts for 16% of responses, while 3% strongly disagree. The fact that 45% of respondents are either uncertain or skeptical suggests that a significant portion of the population is not fully convinced about the effectiveness of the current system.

From the information gathered, it can be concluded that the ecosystem of Kodaikanal is perceived to be negatively affected by tourism and certain forms of tourist activity. Although there is a notable level of skepticism regarding the balance between tourism development and ecological conservation, there is some confidence in the effectiveness of educational interventions aimed at promoting sustainable behavior. The substantial evidence of perceived negative impacts suggests a need to implement stronger laws and policies to minimize environmental harm. The high number of neutral responses across several categories indicates a lack of awareness among both residents and tourists. Given the relatively high divergence in perceptions regarding tourism development balance, it is likely that current efforts are either insufficient or not effectively communicated.

Community perceptions of environmental threats and management

Fig. 4 outlines individuals' views on various environmental issues affecting Kodaikanal, with a specific emphasis on pollution and climate change. It categorizes responses into five levels: strongly disagree, disagree, neutral (neither agree nor disagree), agree, and strongly agree. Each level relates to four key concerns: the effectiveness of pollution control, the importance of pollution as a concern, the seriousness of climate change, and the prominence of climate change as a problem. This classification provides a comprehensive understanding of public opinion on these pressing environmental issues.

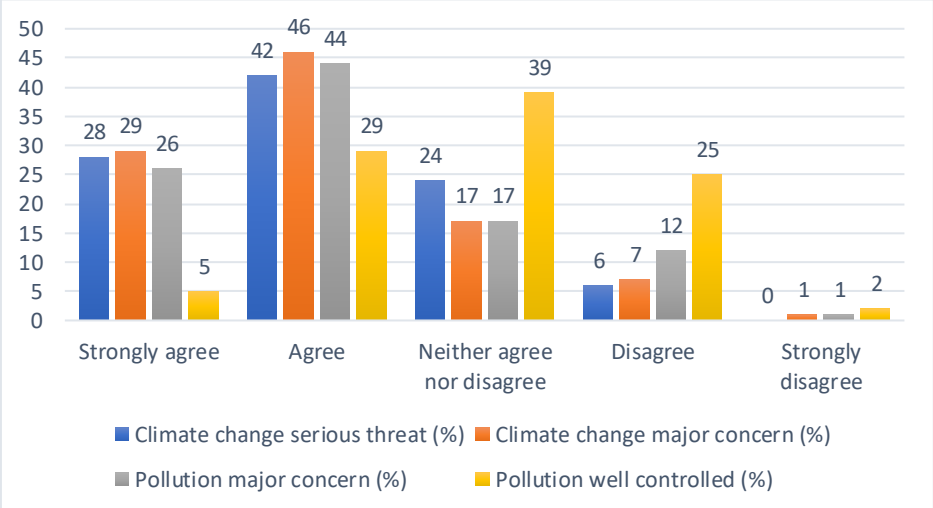

Fig. 4. Community perceptions of environmental threats and management

The first column, "Climate Change as a Serious Threat," shows that 28% of respondents strongly agree that Kodaikanal is seriously threatened by climate change. Additionally, 42% of participants agree with this statement, indicating that a total of 70% recognize the severe threat posed by climate change. Conversely, 24% of respondents remain neutral, suggesting some uncertainty or lack of strong opinion. Only 6% disagree, and none strongly disagree. This heightened level of concern highlights the community's awareness of and anxiety about the impacts of climate change on their environment. The next column, "Climate Change as a Major Concern," shows a slight increase in concern levels: 29% strongly agree and 46% agree, meaning that 75% of participants consider climate change a major issue. The neutral response decreases to 17%, while 7% disagree and 1% strongly disagree. These

results indicate that although there is already widespread agreement on the seriousness of climate change, there is even stronger recognition of it as a major concern, likely reflecting the direct impacts felt by the local population. The following column, "Pollution as a Major Concern," closely mirrors the responses regarding climate change. In this category, 26% of respondents strongly agree that pollution is a significant concern, and 44% agree, resulting in a total of 70% agreement. Seventeen percent of respondents remain neutral, which may indicate ambivalence or limited awareness of the full extent of pollution impacts. Only 1% strongly disagree, while a small proportion expresses disagreement overall (12%). These figures demonstrate a high level of awareness and concern about pollution, though slightly lower than that for climate change.

The final column, "Pollution is Well Managed," presents a contrasting perspective. Only 5% of respondents strongly agree that pollution is adequately managed, while 29% agree, meaning that 34% of respondents view pollution management positively. A significant portion of respondents remain neutral (39%), indicating uncertainty or lack of clear awareness regarding pollution control measures. Meanwhile, 25% disagree and a small proportion strongly disagree. This distribution suggests a considerable level of dissatisfaction or doubt regarding the effectiveness of current pollution control measures in Kodaikanal.

Community perception on biodiversity and conservation

The findings of the survey on conservation and biodiversity in the hill ecosystems of Kodaikanal reveal a concerning trend. A large majority of respondents (75%), as shown in Figure 4, believe that human activities pose an immediate threat to biodiversity in the region. This acknowledgment highlights the urgent need to mitigate the negative impacts of human activities on the fragile ecological balance of Kodaikanal, thereby strengthening conservation efforts.

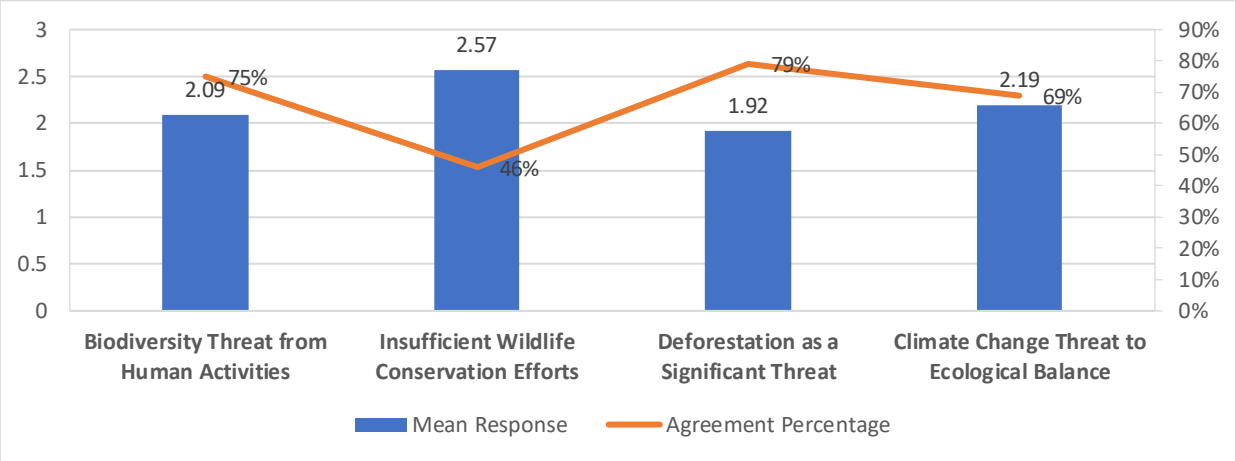

Fig. 5. Community Perception on Biodiversity and conservation

In addition, the data reflects perceptions regarding the effectiveness of local wildlife protection programs. Notably, 46% of respondents believe that these efforts are inadequate. This viewpoint indicates growing public concern about the effectiveness of existing conservation initiatives and suggests a need for policymakers and environmental agencies to reassess and strengthen current strategies to better protect Kodaikanal's rich biodiversity. Furthermore, Figure 5 shows that a convincing 79% of respondents agree or strongly agree that deforestation poses a serious threat to the region, clearly identifying it as a major concern. Deforestation intensifies other environmental issues such as soil erosion and biodiversity loss, while also reducing wildlife habitats. This finding underscores the urgent need for stricter regulations and the promotion of sustainable land management practices in Kodaikanal.

Additionally, the survey presented in Figure 5 reveals widespread awareness of the negative impacts of climate change on the ecological stability of Kodaikanal. A significant 69% of respondents agree that the region's ecological balance is seriously threatened by climate change. This concern is particularly alarming given the cascading effects of climate change, including altered weather patterns, habitat degradation, and ecosystem disruption. It highlights the urgent need for proactive measures to mitigate and adapt to climate change impacts in the region.

Overall, the survey findings present a serious picture of the challenges facing biodiversity and conservation efforts in the Kodaikanal hill ecosystem. The perceived threats from human activities, concerns about the effectiveness of wildlife conservation efforts, widespread recognition of deforestation, and the looming impact of climate change collectively emphasize the urgent need for coordinated action. Stakeholders must work together to design and implement comprehensive strategies that prioritize conservation, sustainable development, and resilience-building initiatives. Without such collective efforts, the preservation of Kodaikanal's unique biodiversity and ecological balance for future generations may not be possible.

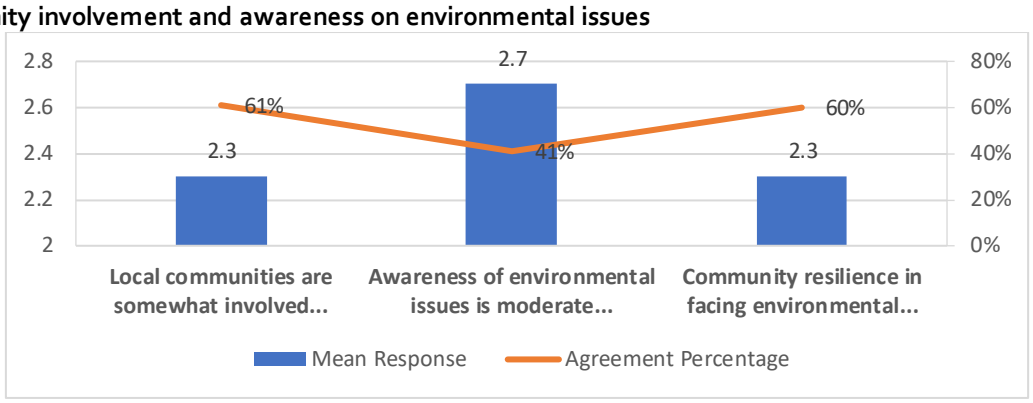

Fig. 6. Community involvement and awareness on environmental issues

The findings of the research on community involvement and awareness, as shown in Figure 6 for the Kodaikanal hill ecosystems, provide insight into the level of participation and understanding that the local population has regarding environmental issues. First and foremost, it is encouraging to note that a majority of respondents (61%) believe that local communities are actively involved in conservation efforts. This indicates a positive level of community engagement and a willingness to support conservation initiatives, reflecting an awareness of the importance of environmental stewardship.

However, the data also reveals a concerning trend regarding the level of ecological awareness among community members. As shown in Figure 6, only 41% of respondents believe that community members have a moderate level of awareness about environmental issues, despite their participation in conservation activities. This suggests that while people may be involved in environmental efforts, they may not fully understand the broader environmental challenges faced by the region. To develop a more ecologically conscious and informed community capable of actively participating in advocacy and sustainable practices, it is essential to address this knowledge gap.

Additionally, the data in Figure 6 highlights a positive perception of community resilience in the face of environmental challenges. A notable 60% of respondents consider community resilience to be moderately high. This reflects confidence in the ability of local communities to adapt to and manage environmental stresses effectively. It also indicates strong community bonds and cooperative efforts in addressing environmental concerns, suggesting a solid foundation for future collaborative sustainability initiatives.

Overall, the survey results emphasize the importance of community awareness and engagement in promoting environmental protection and resilience within the Kodaikanal hill ecosystems. While there is evidence of active participation in conservation efforts, enhanced awareness programs are needed to ensure that community members develop a deeper understanding of environmental challenges. Strengthening environmental knowledge and fostering greater stewardship will be crucial in addressing the region's environmental issues and ensuring long-term ecological stability and well-being.

Community perception on government policy and effectiveness

Important insights into the perceived efficacy of governance mechanisms and policies in addressing ecological challenges can be derived from the survey results on government and policy effectiveness within the Kodaikanal hill ecosystems, as represented in Figure 7.

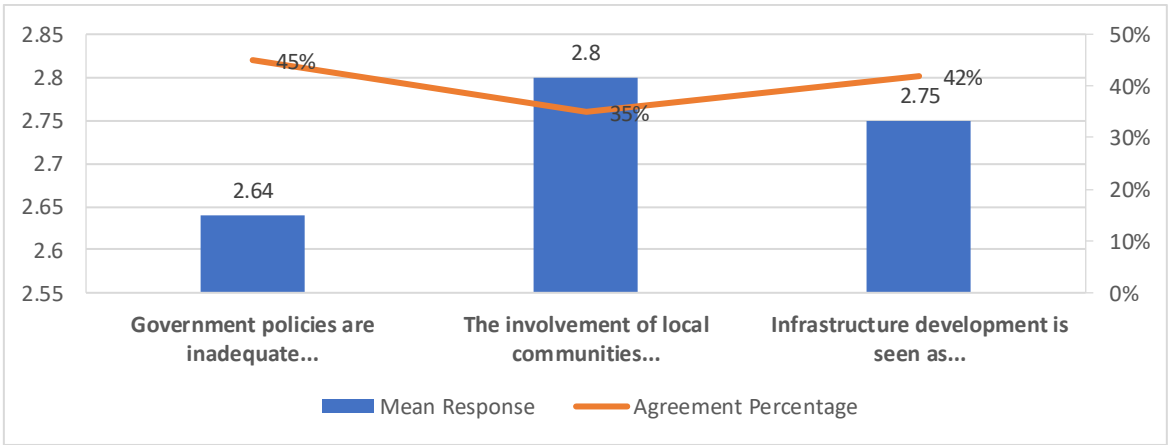

Fig. 7. Community Perception on Government policy and effectiveness

The findings indicate a general sense of dissatisfaction among respondents regarding the effectiveness of government measures in addressing environmental issues. A total of 45% of respondents agree or strongly agree that government actions fall short of meeting environmental needs. This suggests a perceived gap between policy implementation and actual environmental requirements, highlighting the need for stronger and more targeted policy interventions to protect ecological integrity.

Additionally, the survey data indicates a concerning perception regarding the involvement of local communities in environmental policy-making processes. Notably, 34% of respondents believe that local communities are not adequately involved, suggesting limited participation in decisions that directly affect their livelihoods and environment. This underscores the importance of strengthening participatory governance approaches, where local stakeholders are actively engaged in policy formulation to ensure greater inclusiveness, relevance, and effectiveness. To some extent, the findings also indicate a moderate perception of the balance between infrastructure development, economic growth, and conservation efforts. Around 42% of respondents agree or strongly agree that infrastructure development achieves a reasonable balance between economic growth and environmental conservation. This reflects an acknowledgment of the need to balance development priorities with environmental protection, although there remains significant scope for improvement. It also suggests a willingness among respondents to support infrastructure initiatives that incorporate sustainability considerations. Overall, these findings emphasize the importance of effective governance frameworks in addressing ecological challenges. More inclusive and adaptive governance structures are needed in light of perceived shortcomings in current policies and concerns about limited community participation in decision-making processes. Furthermore, although there is recognition of the importance of balancing conservation with economic development, greater effort is required to integrate environmental considerations more effectively into development planning.

Conclusion

This study provides empirical evidence on community perceptions regarding ecological conservation, governance effectiveness, and environmental sustainability in the Kodaikanal hill ecosystems based on responses from 100 participants. The findings demonstrate strong public recognition of ecological stressors and concerns regarding existing conservation and governance approaches. A large majority (77%) perceived biodiversity to be under threat from human activities, while 80% identified deforestation as a critical environmental challenge, highlighting concern regarding land-use pressures and habitat degradation. Climate-related impacts emerged as another dominant issue, with 70–75% of respondents indicating that climate change poses a serious threat to ecological stability in Kodaikanal. Similarly, environmental pollution was considered a major concern by 70% of respondents, whereas only 34% believed that pollution management measures were effective. Tourism was also identified as a significant ecological pressure, with 73% reporting negative environmental impacts associated with tourism development and 69% indicating that tourist activities adversely affect ecological balance. Despite moderate optimism regarding community resilience (60%) and public education initiatives (60%), confidence in institutional governance remained limited. Only 48% considered government policies adequate for addressing ecological challenges, and only 40% believed that local communities are effectively involved in environmental decision-making processes. Overall, the findings suggest that environmental awareness among residents exceeds confidence in current policy implementation and governance structures. Conservation outcomes in Kodaikanal may improve through stronger community participation mechanisms, evidence-based environmental policy implementation, enhanced pollution and land-use management, and sustainable tourism planning. Future studies should include larger sample sizes and advanced statistical modelling to further evaluate relationships among governance, public participation, and ecosystem resilience.

References

Agnoletti M (2014) Rural landscape, nature conservation, and culture: some notes on research trends and management approaches from a (southern) European perspective. Landscape and Urban Planning 126:66–73.

Albrich K, Rammer W and Seidl R (2020) Climate change causes critical transitions and irreversible alterations of mountain forests. Global Change Biology 26(7):4013–4027.

Sridhar A and Sivaperuma K (2025) A study on the eco-tourism experience in Kodaikanal: assessing the role of perceived pollution and infrastructure constraints on tourist satisfaction. International Journal of Environmental Sciences 11(15):2375–2385.

Bertolino MA and Corrado F (2022) Culture-based practices as driver of local development processes in mountain areas — evidence from the Alpine region of the province of Cuneo (Italy). Sustainability 14(21):13713.

Grodach C (2007) Cultural development strategies and urban revitalization. International Journal of Cultural Policy 13(4):349–370.

Chakraborty A (2020) Mountains as a global heritage: arguments for conserving the natural diversity of mountain regions. Heritage 3(2):198–207.

Duncan SL, McComb BC and Johnson KN (2010) Integrating ecological and social ranges of variability in conservation of biodiversity: past, present, and future. Ecology and Society 15(1):art5.

Immerzeel WW, Lutz AF, Andrade M, et al. (2020) Importance and vulnerability of the world's water towers. Nature 577(7790):364–369.

Keane RE, Hessburg PF, Landres PB and Swanson FJ (2009) The use of historical range and variability (HRV) in landscape management. Forest Ecology and Management 258(7):1025–1037.

Körner C and Spehn E (2019) A Humboldtian view of mountains. Science 365(6458):1061.

Lebuy R, Mancilla-Ruiz D, Manríquez H, et al. (2022) Degraded landscapes in hillside systems with agricultural use: an integrated analysis to establish restoration opportunities in central Chile. Land 12(1):5.

Pepin N, Bradley RS, Diaz HF, et al. (2015) Elevation-dependent warming in mountain regions of the world. Nature Climate Change 5(5):424–430.

Noroozi J, Talebi A, Doostmohammadi M, et al. (2018) Hotspots within a global biodiversity hotspot — areas of endemism are associated with high mountain ranges. Scientific Reports 8(1):10345.

Nithila RCJ (2012) Service quality analysis and its implications — a study on tourism services in Kodaikanal. International Journal of Scientific Research and Management 2(12):1871–1879.

Scheffer M, Carpenter S, Foley JA, Folke C and Walker B (2001) Catastrophic shifts in ecosystems. Nature 413(6856):591–596.

Srileka (2014) Tourism impact on Kodaikanal ecosystem — a futuristic approach. International Journal of Research in Management 4(6):28–36.

Talukder B (2017) Multi-criteria decision analysis (MCDA) technique for evaluating health status of landscape ecology. In: Hong SK and Nakagoshi N (eds) Landscape ecology for sustainable society. Springer International Publishing, Cham, pp 39–49.

Turner MG, Calder WJ, Cumming GS, Hughes TP, Jentsch A, LaDeau SL, et al. (2020) Climate change, ecosystems, and abrupt change: science priorities. Philosophical Transactions of the Royal Society B 375(1794):20190105.

Dakos V (2019) Ecological transitions: regime shifts, thresholds and tipping points. Oxford Bibliographies in Environmental Science. DOI: 10.1093/OBO/9780199363445-0088

Author Contributions
CJC: executed the survey and analyzed the obtained results. NC: assisted in the interpretations of the results and validated the methodology for the study. NP: hypothesized and supervised the study.

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