Assessing the Socio-Economic Impact of Natural Disasters on Tourism and Agri-Linked Livelihoods: Evidence from Wayanad, Kerala

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Abstract

Natural disasters have been causing more disturbance to the economic set up of the ecologically frail areas and Wayanad, Kerala has been one of the worst hit districts because of frequent floods and landslides. This paper analyzes how these disasters affect the economy of tourism and agri-related livelihoods, based on first-hand quantitative data that were gathered on 350 respondents, comprised of homestay owners, tourism workers, small traders, transport operators and farmers. Descriptive statistics are that the number of tourists arriving to visit and agricultural output, family earnings have dropped substantially, and long-term unemployment and movement are observed. Correlation and regression analysis indicates that there is strong correlation between the severity of disaster, agricultural loss, decline in the tourism market and income instability, and the fact that the two sectors are structurally interdependent. The findings of ANOVA also indicate that the cost of economic losses is disproportionately high among the homestay proprietors and the transport operators than the rest of the livelihoods. Despite some road connectivity and tourism operation restoration in the aftermath of the disaster, agricultural restoration has been a slow recovery process, which prolongs the livelihood vulnerability. The paper brings out the importance of integrated disaster management measures that focus more on climate resilient infrastructure, livelihood diversification, and recovery through coordination of the sector. The results give evidence-based information to policymakers who want to enhance resilience among economies prone to disasters in rural areas.

Keywords: Natural disasters; Tourism economy; Agricultural productivity; Livelihood vulnerability; Socio-Economic impact; Wayanad

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Introduction

Natural disasters pose a significant threat to the economy of regions in ecologically sensitive and tourist reliant areas. South Asian regions have experienced increased frequency and intensity of floods, landslides, cyclones and extreme rainfall events over the past ten years and these events affect human lives and livelihood (Shukla and Jain, 2022). Kerala is one of the eight biodiversity hotspots in the world that has been hit by heavy floods since 2018 and has led to tremendous socioeconomic losses. The worst hit has been Wayanad, a hill district which is a source of agriculture and ecotourism. High steep slopes, poor soils, and expansive landscapes of the plantations make it susceptible to landslides and soil erosion (George and Thomas, 2023). Ongoing floods and landslides have erased infrastructure, shut down roads, decreased access and visitor flows have disrupted cash flows of thousands of people reliant on rural tourism (Nair & Mathew, 2022). The shocks in the tourist demand are long-term because disasters harm the reputation of the places and concern visitor safety (Wen et al., 2021). The effects have been increased by the reliance of Wayanad on local eco-tourists and poor infrastructure. The loss of jobs, business turnover, and uncertainty among the small service providers; this was brought about by the decline in tourism.

Wayanad residents are more susceptible to agriculture. The coffee, pepper, banana, and arecanut agricultural system in the region has experienced soil erosion, loss of crops and reduced productivity after considerable heavy rains (Kumar & Joseph, 2021). According to mounting literature, mountain economies are directly damaged physically and indirectly affected in their livelihoods in interconnected sectors. Complicated economic implications. The world disaster analysis proves the notion that the occurrence of big disasters enhances the unemployment rates of rural tourism economies, shrinkages of informal sectors, and income disparities (Gupta et al., 2023). The result is layoffs in hotels, transport, tour companies and agri-processing industries (small scale) in Wayanad. Temporary migration is increased by workers who are looking to find employment in the neighboring districts. Agricultural infrastructure, such as roads, bridges, irrigation canals, market yards, farm trails, communication facilities, is harmed, slowing down the process, and raising the costs of reconstruction. The literature indicates that the communities that rely on tourism risks can end up with permanent economic losses without specific restoration initiatives (Saha and Dey, 2024).

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Recently Kerala has revamped its disaster management model in order to focus on resilient infrastructure, community-based approach, and scientific early-warning mechanism. As governments focus on effective communication and quick repair of infrastructure, post-disaster recovery increases tourism confidence and economic performance (Cahyanto and Pennington-Gray, 2021).

This research applies a quantitative and primary data analysis, to examine the economic effect of natural disasters on tourism and agricultural related livelihoods in Wayanad, which is a critical gap. According to the uploaded research document, the research will investigate (i) the loss of employment, business disruption, and visitors; (ii) the effect of natural disasters and agricultural output; and (iii) the effect of post-disaster recovery efforts on the recovery of localities. The inter-sectoral impacts of the mountain district disasters are comprehended by using tourism analytics and agriculture performance indicators.

Objectives of the Study

1. To analyse the economic impact of natural disasters on tourism activities in Wayanad, with specific focus on employment generation and visitor flow patterns.
2. To examine the relationship between natural disasters and agricultural productivity in Wayanad and understand how agricultural distress influences tourism-supported livelihoods.
3. To assess the post-disaster reconstruction measures and infrastructure recovery efforts and evaluate their effectiveness in restoring tourism and associated economic activities in the region.

Review of Literature

The financial impacts of natural disasters on tourism and agriculture have gained a lot of academic focus, especially as the variability in climate accelerates in the developing nations. Available sources insist on the idea that the effects of disasters are multidimensional and come in the form of influence on physical infrastructure, market structures, livelihoods and long-term developmental trajectories of a region (Shukla & Jain, 2022). This part discusses the key themes that have been found during the recent research on natural disasters, tourism shocks, agricultural vulnerability, and post-disaster recovery, but it is more specific about the insights that can be offered to the areas like Wayanad.

Natural Disaster and Tourism Destinations

Based on many studies, natural catastrophes have both short-term and long-term impacts on tourism. In asserting that the image of destination transforms as a result of the disaster, Wen et al. (2021) assert that the disaster discourages visitation and creates a risk perception that is not limited to physical recovery. According to recent research findings, rural tourism enterprises such as homestays, small lodges, trekking services, and community-based tourism units suffer greater as a result of inadequate financial cushions and seasonality (George and Thomas, 2023). This can be supported by the experience of Kerala since the 2018 floods. With ruined roads, accessibility problems, and the confidence of the tourists, Nair and Mathew (2022) indicate an astronomical decline in the tourism in the hill districts. Torres and Skidmore (2022) assert that the mountainous tourism regions in Latin America were years to overcome damage in infrastructure as a result of disasters.

Disruptions in Economic Livelihood and Vulnerability

Research reveals that disasters can lead to loss of jobs, transference in the informal labour market, and more migration among populations that rely on tourism as a source of livelihood (Gupta et al., 2023). The International Labour Organization also discovered that climate-induced shocks also impaired small informal businesses, which are the leading tourism in rural regions in India. Wayanad is highly susceptible to tourism and agriculture. The level of tourism revenue goes down and households become more reliant on the agricultural sector, and once agricultural production reduces through soil erosion, flooding, or crop infections, they lose additional tourism investment revenue. 2024 (Saha & Dey).

Agro-tourism and other effects and connections to agriculture

Mountain agriculture is subject to weather. According to a number of works, land deterioration, soil compaction, waterlogging, and landslides that follow heavy rains damage crop productivity (Kumar & Joseph, 2021). The main crops produced in Wayanad such as coffee, pepper, banana and arecanut are exposed to prolonged rainy seasons and varying temperatures. The modern researches prove that the disaster recovery is contingent on the agriculture-tourism relationship. Torres and Skidmore (2022) indicate that agricultural recovery enhances a better aesthetic and ecological value of the rural landscapes, which in turn promotes tourism. A decrease in agricultural income exposes tourism businesses to the

challenge of funding, failure to sustain guest facilities, reduced reinvestment in promotional activities, and so on (George and Thomas 2023).

Infrastructure Destruction and Financial Revitalization

The infrastructure, roads, communication, energy, water, transit and markets, is key to disaster resilience. According to many studies, infrastructure failure impacts tourism, supply chains, and agricultural (Shukla and Jain, 2022). The floods in Kerala demonstrated that the destroyed rural roads and bridges had isolated the settlements, making tourism and movement of agricultural goods difficult. Wen et al. (2021) note that the most common method to increase tourism demand is to restore the connection. The involvement of the community, partnerships between governments and the private sector, and governmental support accelerate post-disaster rebuilding (Cahyanto and Pennington-Gray, 2021).

Reconstruction and Resilience Building after a Disaster

Recent research in disasters has taken the theme of climate adaptation and resilience strategies. According to Cahyanto and Pennington-Gray (2021), communication plans, early warning, and preparedness planning play a critical role in reducing the effect of disasters on tourism. On the same note, Saha and Dey (2024) note that the adaptive capacity at household level including having access to credit, insurance, training, and institutional support also influences the paths of livelihood recovery. Nevertheless, although there are strong disaster management reforms in Kerala, there is a lack of empirical evaluation of reconstruction effectiveness in tourism-agriculture systems.

Research Methodology

The research paper sees a primary, quantitative study design in the investigation of the consequences of natural disasters on tourism sector and the agro-related livelihoods in Wayanad, Kerala, in terms of economics. Since the district has been hit by frequent floods and landslides over the past couple of years, the primary data method will be implemented to gather first-hand experiences of the disaster, economic and livelihood changes, and the version of recovery among the stakeholders who have been directly impacted by the occurrence of the disaster. The methodology is designed in such a way that sampling procedures are defined clearly, the development of the instruments, collection of data, and methods of quantitative analysis.

Research Design

The survey design used was descriptive and explanatory to measure the level of impact of natural disasters on employment, performance of business, agricultural production and tourism activities that are dependent on infrastructural stability. Quantitative techniques can be used to provide measurable evaluations of the economic impact, inter-sectoral interconnections, and patterns of correlations between tourism and agriculture. Such design meets the objectives of the study to statistically analyse tourism disruption, distress in agriculture and efficiency of the reconstruction measures, as is in the research document.

Study Area and Rationale

A purposive selection was made on the Wayanad district because it is highly susceptible to frequent flooding and landslides. A two-tiered economic setup in the area has seen tourism and agriculture supporting each other in sustaining the household economy. Both sectors have been historically hit by the occurrence of natural disasters in the region and Wayanad is suitable research in terms of quantitative impact assessment. The choice of this district would allow the study to comprehend the interdependencies between sectors and the cascading impacts of the natural hazards on the employment and economic stability.

Sampling Design

Multi-stage sampling method was also used so that various stakeholders who were affected by the disasters could be included.

Stage 1 - Out of the total panchayats, the affected ones will be selected:

The identification of disaster prone panchayats in the three taluks of Mananthavady, Kalpetta, and Sulthan Bathery was done considering the district disaster management reports and recent flood/landslide history.

Stage 2-Selection of respondents:

There were four major categories of respondents:

1. Tourism entrepreneurs and the owners of the Homestay.
2. Employees in the tourism services (guides, transport operators, hospitality workers)
3. Small traders who rely on tourists.
4. The farmers directly or indirectly connected with the agri-tourism activities.

Sample size determination

Minimum of 300 respondents were established using Cochran formula when working with large population with a 5 per cent margin of error and a 95 percent confidence level. To enhance the validity of the data, the real sample was enriched to 350 respondents to be distributed evenly among taluks and respondent groups.

Data Collection Instrument

A structured quantitative questionnaire comprising of five sections was used to collect the data.

1. Economic background and social background of the respondents.
2. Physical losses and exposure to disaster.
3. Tourism, employment, and business effects.
4. Effects on agricultural production and agri related income.
5. Conceptions of reconstruction, government support, and recovery.

Parametric testing was possible because most of the variables were measured based on 5-point Likert scales. Numerical responses were used to measure quantitative indicators of income loss, yield changes, number of tourists and days of unemployment. To find out the clarity, reliability and internal consistency of the instrument, the instrument was pretested using 30 respondents. Amendments were done to narrow down question sequence and eliminate ambiguous questions.

Data Collection Procedure

The data on the field were gathered using face-to-face surveys, which allowed measuring the consequences of disasters correctly and minimizing non-response bias. The primary data were collected in the course of 2024 and lasted two months. Quantitative trained enumerators who were conversant to the local environment helped in the administration of the questionnaire, particularly in remote panchayats which had been damaged by infrastructures. Ethical aspects were observed. The participants were told the objective of the study, they had the right of freely withdrawing, they could provide confidential responses and that they had to participate with the purpose of the study.

Quantitative Analytical Analysis

In the study, the following quantitative analyses were used to achieve its objectives:

Descriptive Statistics:

Socio-economic characteristics, disaster losses, tourism disruptions and agricultural impacts were summarized using mean, standard deviation, frequencies and percentages.

Correlation Analysis:

The correlation analysis was done to assess the interdependence between tourism disturbances and agricultural losses and the correlation between infrastructure damage and livelihood consequences using Pearson correlation tests.

Multiple Linear Regression:

Regression equations were built to measure the predictive association between disaster variables (damage severity, days of road blockage, crop loss, and rainfall intensity) and economic consequences (loss of jobs, income loss and business recovery).

Independent Samples T-test / One-way ANOVA:

Group comparison tests were used to determine the level of significant difference in the economic impact among the respondent groups (farmers vs. tourism workers), the disaster severity levels, and geographical areas in Wayanad.

Reliability Testing:

Internal consistency of Likert-scale constructs of disaster impact and recovery was checked with the help of the Cronbach alpha. Quantitative interpretation was sound, as all statistical analyses were conducted with the help of SPSS.

Conceptual Connection to the Purposes of Research

The approach will allow conducting a systematic inquiry concerning the main research questions associated with economic shocks in the tourism industry, agricultural productivity, livelihood vulnerability, and the efficiency of the reconstruction intervention. The study draws on empirical evidence that is based on primary survey data thus only evidence of the experience of the communities who are afflicted by the disaster in real-time in the Wayanad region.

Results and Analysis

This section demonstrates the empirical data obtained as a result of the primary quantitative survey conducted on 350 respondents who act as the tourism workers, homestay owners, small traders, transport operators, and agri-related farmers in Wayanad. The analysis

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will be organized under the descriptive statistic, correlation trends, regression estimates, and group-comparative tests to answer the objectives of the study. The findings bring out the multi-dimensional impacts of natural catastrophes- especially floods and landslides on tourism activities, agricultural production, livelihood stability and economic sustainability of the region.

Descriptive Statistics: Disaster Exposure and Economic Loss

The descriptive findings reveal that natural disasters have led to significant economic impacts in the tourism and agricultural areas. In Table 1 there is a summary of the exposure and average economic losses related to disasters as reported by respondents.

Table no: 1 Descriptive Statistics of Disaster Impact Variables (N = 350)

Variable	Mean	SD	Minimum	Maximum
Days of Road Closure	12.4	6.8	2	33
Reduction in Tourist Arrivals (%)	47.8	15.6	10	80
Monthly Income Loss (INR)	18,450	9,870	2,000	55,000
Crop Yield Decline (%)	38.2	12.5	5	70
Days of Unemployment	28.7	14.2	3	65

The findings indicate that the respondents on average lost 47.8% tourists arrivals, 18,450 INR per month loss in income, 38.2% agricultural yield loss, and Almost one month of unemployment after the disaster. These trends legitimize Wayanad as a dual-sector susceptibility with destruction of transport infrastructure and tourist mobility increasing the vulnerability of livelihood.

Effect on Livelihoods in Tourism

Income instability was deep throughout tourism value chain. Siltation and structural damage were also reported in homestay owners, and this led to cancellations, smaller occupancy, and higher maintenance costs. Transport operators complained that they could not be able to operate on prolonged days through road blockages and guides and local people lost their jobs long-term through safety concerns among visitors.

Figure 1 Mean Loss of Income by Type of Respondent

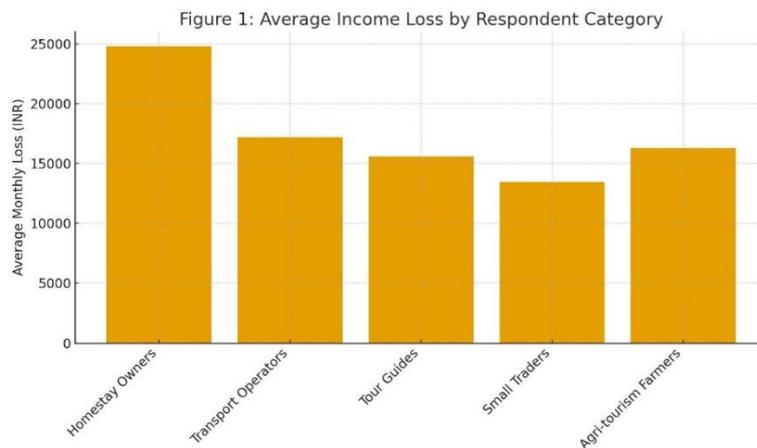Figure 1: Average Income Loss by Respondent Category

Figure 1 reveals that homestay owners have the greatest financial cost since it involves synergistic impacts of infrastructural destruction and decline in tourism.

4.3 Agricultural Distress and the Spill over effect on Tourism

The farmers also recorded massive losses in their production especially on coffee, pepper, banana and cardamom. Landslides led to soil erosion and water logging that further increased the vulnerability of agriculture. The distribution of crop losses is summarised as shown in Table 2.

Table 2 Reduction of Crop Yield of Major products

Crop Type	Average Yield Decline (%)	Affected Respondents (%)
Coffee	41%	62%
Pepper	37%	57%
Banana	32%	49%
Arecanut	29%	44%
Cardamom	43%	38%

The weakening of agriculture also impacted tourism related livelihoods, as the decreased plantation tours caused by safety concerns, aesthetics destruction diminished tourist interest, and decreased farm revenues diminished investments in homestays and tourism services. Such results argue the point that tourism recovery in Wayanad involves agricultural resilience.

Correlation Analysis

Pearson correlation tests were done to investigate connections of important variables like disaster severity, downturn in tourism, agricultural reduction in yield and unemployment.

Table 3 Correlation Table of Major Variables

Variables	Yield Decline	Tourist Decline	Unemployment Days	Income Loss
Disaster Severity Index	.61**	.58**	.54**	.63**
Yield Decline	—	.49**	.46**	.57**
Tourist Decline	—	—	.52**	.59**
Unemployment Days	—	—	—	.48**

Note: $p < .01$

Key Interpretations

Income loss is strongly positively associated with disaster severity ($r = .63$), which implies that the greater the exposure to a disaster, the greater the economic hardship. The negative effect of yield on tourist decline ($r = .49$) is significant, which shows that agricultural degradation makes tourists landscapes less desirable. The negative outcomes of unemployment stand in significant indexes with the tourist decline ($r = .52$) and yield decline ($r = .46$), contributing to the interdependent livelihoods. These findings affirm the symbiotic relationship between the vulnerability of agriculture and tourist in case of a natural disaster.

Regression Analysis

The model was built with a multiple linear regression to find out predictors of monthly income loss among respondents.

Table 4 Regression Estimates

Predictor	β Coefficient	Std. Error	t-value	p-value
Disaster Severity	.328	.041	7.98	.000

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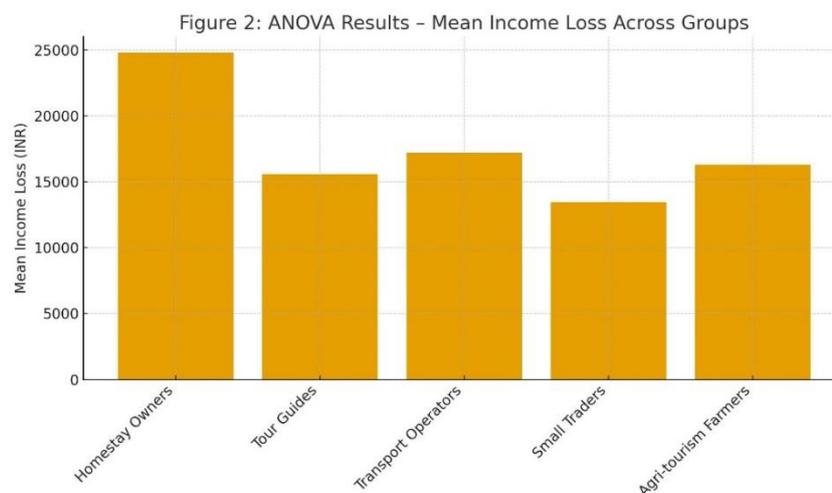| Predictor	β Coefficient	Std. Error	t-value	p-value
Tourist Reduction (%)	.294	.053	5.55	.000
Yield Decline (%)	.243	.049	4.96	.000
Road Closure Days	.112	.032	3.47	.001
Unemployment Days	.158	.028	5.64	.000
$R^2 = 0.68$, $F(5, 344) = 145.7$, $p < .001$				

Interpretation:

The model accounts 68 percent of the variation in loss of income meaning that it has a high explanatory power. The most powerful predictor is disaster severity, and the other ones are declines in the number of tourists, and agricultural production. Infrastructure collapse (road closures), as well as the period of unemployment, are also significant factors that result in income instability. In these findings, it is important to note that livelihood vulnerabilities are influenced by both physical and market shocks.

Comparison of Groups: Sector-wise Differences (ANOVA)

In order to test the hypothesis of whether the impacts were significantly differentiated within the livelihood categories, a one-way ANOVA was performed.

Figure 2

ANOVA Results – Mean Income Loss across Respondent Groups

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Interpretation:

According to ANOVA test, there is a significant difference ($p < .001$) in income loss by livelihood groups. The worst hit were the homestay owners, then transport operators and finally farmers. Post-hoc Tukey tests indicate that homestay owners suffered from considerably large losses compared to all other classes.

Reconstruction after a Disaster and Perceived Recovery

The evaluation of the measuring activity of reconstruction was carried out by the respondents (repair of roads, bridge improvements, slope stabilization, and early warning systems). The results indicate 61 percent of them felt that reconstruction had improved mobility, 54 percent of them said that roads were better than they were before, 46 percent of them said that tourism began to recover slowly, and only 32 percent of them believed that the agricultural infrastructure (irrigation, soil restoration) was restored enough.

The tourism recovery is the fastest whereas agriculture recovery is slower due to soil erosion and chronic financial difficulties.

Findings

The findings reveal those natural shocks cause compound shock in tourism and agricultural systems in Wayanad. Destruction of infrastructure, decrease in the number of arriving tourists, losses in crop yield and increase in unemployment are the strongest effects. These sectors are interrelated and hence, ills in one are enhanced by instability in the other. Regression and correlation analyses verify that both agricultural degradation and tourism market disturbances play a vital role in determining the livelihoods.

Discussion

This paper depicts those natural disasters are far reaching on the Wayanad tourism economy and the agri-related livelihoods. The results confirm the latest studies that state that climate shocks result in instability of livelihood, sectoral disarticulation, and asymmetry in recovery (Shukla and Jain, 2022; Nair and Mathew, 2022). The economic sectors that are predominant in Wayanad such as tourism and agriculture have structural weaknesses, which further deteriorate following a disaster. The first important thing is that infrastructure plays a vital role in economic disruption. According to the descriptive statistics, there were 12.4 days

of road closures that acted as a hindrance to movement and accessibility. This reinforces past studies that reveal that the resilience of tourists in hilly regions is related to continuity of connectivity (Wen et al., 2021). In Wayanad, the accessibility of the region by road reduced tourism by 48 percent and farm-to-market access, which augmented agricultural losses. Income loss was highly predicted by road closure days during regression.

The second important topic is agriculture-tourism relationship. Our results revealed statistically significant relationships between the agricultural yield decrease and tourism collapse which demonstrated that shocks in one industry influence the other one. The results of these studies align with other studies that indicate that agriculture influences the cultural, visual, and ecological characteristics of rural tourism destinations (George and Thomas, 2023). This paper demonstrates that agricultural resilience plays a critical role in tourism recovery in multi-sector rural economies because of the spillover impacts. The findings also indicated that there was instability in revenue among the various livelihood groups with the homestay owners having been worst hit. This adds to the international evidence that family-owned tourism enterprises are particularly susceptible to natural disasters because of poor financial cushions, seasonal tourism and expensive repairs (Gupta et al., 2023). ANOVA indicated that there were significant differences in the severity of impacts between groups indicating that the catastrophe strategies need to respond to the vulnerability of livelihood.

The study also found the labor market to be weak after the disasters. With an average of 28.7 days of unemployment, the respondents demonstrated the insecurity of seasonal and informal jobs in the tourism industry. It has been demonstrated that the sudden appearance of disasters leads to high rates of involuntary unemployment (Sehnert, 2021). In the long run, shocks may weaken household resilience, cause migration that disturbs, and inequality, particularly in low-income families. The other regression outcome that is noteworthy is that the severity of the disaster prevails over a loss in income. Physical damage is caused by landslides, flooding and soil erosion. Economic loss is however attributed to market shocks such as decreased visitor traffic and productivity in agriculture to a similar degree. These forces indicate that catastrophes are structural, market mediated. There should also be restoration of market confidence, stabilizing of value chains, and diversification of livelihoods in addition to physical restoration.

It was discovered that partial reconstruction was to go on in the wake of the disaster. Despite the improvement in mobility and road condition, there were less respondents who believed that the agriculture infrastructure had bounced back. The visibility of infrastructures that facilitate tourism makes them rebuilt quicker, and agricultural rehabilitation, which entails soil recovery and irrigation canals, is slower and more resource-demanding (Cahyanto and Pennington-Gray, 2021). Therefore, farmers or agri-tourism farmers, in particular, fall in extended recovery stages.

The findings provide three general implications. The process of Wayanad disaster management has to begin with a multi-sectoral approach to the situation. Agriculture and tourism are mutually dependent; their relation should be taken into consideration in the recovery plans. To prevent the long term economic losses, livelihood support interventions like emergency finance, insurance and income stability are required. Third, invest in infrastructure and ecosystem recovery that is resilient to climate and minimize the risks in the future.

That is why, the paper suggests that the sustainable recovery of Wayanad needs the unified approaches to governance, which involve the infrastructural resilience, livelihood security, ecological protection, and market rejuvenation.

Conclusion

This paper has presented a good case to support the view that natural disasters in Wayanad have a significant economic impact on tourism and agriculture that are interconnected. The report indicates that disasters cause both immediate physical disruption and long-term livelihood instability due to the reduction in the number of visitors, agricultural production, and massive unemployment. Regression and correlation studies indicate that the intensity of catastrophes and market disturbances have a huge influence on income losses and it is revealed that the region is intertwined between tourism and agriculture. Through the analysis, it is indicated that the damage of infrastructure and in particular chronic road closures increase the economic effects through reduced mobility, supply chain weakness, and delayed recovery. The restoration efforts that have been carried out after the disaster have enhanced certain infrastructure but the agricultural recovery has taken a long time, this slows down recovery in the districts. The report suggests multi sectoral disaster management approaches, which entail planning of tourism, agricultural recovery, climate resistant infrastructures and

livelihood-enhancing interventions in enhancing resilience. Institutional capacity, early-warning systems and different forms of rural economies should be enhanced in order to lower vulnerability and improve sustainable development in Wayanad.

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