

SUBMERGING RICE BOWL: AN ANALYTICAL STUDY ON FARMER MIGRATION FROM KUTTANAD, KERALA, INDIA

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Abstract

Climate-induced migration has emerged as a significant socioeconomic and environmental challenge, particularly in vulnerable agrarian regions. Kuttanad, known as the rice bowl of Kerala, India, is increasingly experiencing pressures from recurring floods, environmental degradation, inadequate infrastructure, and livelihood insecurity, compelling farming households to consider migration. This study examines the economic, social, and environmental push factors influencing farmer migration from Kuttanad. A quantitative research design was employed, and structural equation modelling was used to assess the reliability and validity of the measurement model and to examine the influence of the identified push factors. The findings indicate that economic, social, and environmental factors significantly contribute to migration pressures among Kuttanad farmers. Among the economic factors, low income emerged as the most prominent push factor, contributing to indebtedness and vulnerability in the absence of adequate institutional support. Lack of infrastructure was identified as the major social push factor, while recurring floods, inadequate drainage systems, limited access to quality drinking water, and unsustainable tourism practices constituted important environmental pressures. The study concludes that farmer migration in Kuttanad is shaped by the interconnected effects of livelihood insecurity, infrastructural deficiencies, and environmental vulnerability. Strengthening climate-resilient infrastructure, flood and water management, institutional and financial support, diversified livelihood opportunities, and sustainable agricultural practices is essential to enhance community resilience and sustain Kuttanad as a viable agricultural region.

Keywords: Kuttanad wetland ecosystem, Climate-induced migration, Environmental displacement, Agrarian livelihoods, Farmer migration dynamics, Socio-economic push factors, Climate change adaptation

1. Introduction

Human activities across the world contributed much to the degradation of the earth and the resultant environmental disasters. Associated with this is climate change which has resulted in the uprooting and displacement of millions of people from their homeland. Climate change is a significant threat to sustainable development, affecting food security and agriculture. Livelihoods globally. South Asia has

the highest proportion of vulnerable sectors. Climate change will negatively impact agricultural production and economics, with declining wheat yields and temperature inconsistencies causing significant yield declines. The global impact of human activities in creating climate change has sparked discussions on displacement and migration. Climate migration or climate-induced migration describes the permanent or temporary change of location of an individual or group of people due to environmental changes caused by global warming. Climate migration has led to widespread and often involuntary migration to urban areas and other regions, eroding social structures and worsening living and working conditions for migrants. This scenario has led to the emergence of the concept of climate refugees. The problem of climate refugees is an ever-increasing phenomenon and as per the estimate by the IPCC, about 20 million have been displaced from their homeland due to climate migration since 2018. Also, it is estimated by the IOM (International Organization for Migration) that there will be 200 million climate migrants by the year 2050. India, one of the world's most climate-vulnerable countries, is seeing a significant rise in environment-induced displacement, but the country's policies still fail to recognize climate migrants. The Global Climate Index 2021 has placed India among the top 10 countries affected by climate change. Among all states in India, Kerala has been frequently experiencing severe environmental problems like floods, and landslides over the past few years. One of the prominent cases in regard is the case of Kuttanad. Kuttanad wetland of Kerala is identified as a flood-prone area as this area is low lying, having a coastal location, comprising of reclaimed polders and some naturally formed polders which reports high density of population. Consequently, the annual flood hazards here often turn into disaster leading to life and property loss. Kuttanad is the downstream deltaic formation of five in flowing rivers that originate in the Western Ghats. These rivers debouch into the Vembanad Lake, one of the largest brackish-water lakes in the country, which flows into the Lakshadweep Sea at Kochi. It thus forms part of the ecological continuum that links the Western Ghats and the sea. Kuttanad is experiencing an exodus of local people who are unable to withstand the effects of climate change. Efforts to develop Kuttanad as a rice-growing area began more than a century ago. Since the flood waters carry a large volume of fertile silt, it was recognised quite early that much of the low-lying land could be used to grow a rich rice crop if the flood waters were effectively regulated. Kuttanad wetland is rich in wetland bird species. Degradation of this unique wetland ecosystem, hunting and habitat alteration is still prevailing in this part of the Vembanad-Kole Ramsar this threatens the birdlife directly as well as indirectly the lowlands of Kerala are under high threat of landscape modification due to population growth, tourism and other infrastructure developmental activities. Regular monitoring of wetland should be taken up. In-depth studies on the avifauna, especially endangered birds, should be undertaken. Hence urgent conservation measures must be implemented, and a protected area has to be evolved for preserving the remaining tract of mangroves and faunal heritage of this unique region. Kuttanad is turning into a cluster of ghost villages surrounded by water. As per the state government's estimates, over 6000 families have abandoned their homes in the last 2 years. People are migrating to nearby, Alappuzha, Cherthala, and Changanacherry. One of the major reasons behind this is the frequency of floods caused by climate change. Farmers say that the land area in Kuttanad is fast sinking and even ripples caused by moving boats cause water to enter their compound. Another problem that they face is that despite living amidst water, they do not have access to safe and pure drinking water. This is because water is being polluted by the problem of sewage and pesticide residues that are released into the same water bodies. Other factors such as a decline in paddy cultivation, and unsustainable infrastructure have also worsened their living conditions and have led to an increasing

trend of migration. Therefore, the study aims to explore the impact of push factors on the migration of farmers from Kuttanad.

2. Literature Review and Theoretical Framework

Rajalekshmi (2010) in her paper explores the environmental and socio-economic challenges in Kuttanad arising from intensive rice cultivation and development strategies. The paper points out that environmental degradation. Salinity issues and labour shortages are the major problems faced by paddy cultivators. The study recommends cooperative farming and sustainable farming methods to overcome these problems. Jacob, M., Mathew, M. M., & Ray, J. G. (2018) finds out that Kuttanad's ecological and agricultural heritage is under significant threat due to modern practices and mismanagement. To preserve GIAHS (Globally Important Agricultural Heritage System) status immediate and sustained efforts in conservation, sustainable development, and community participation are required. Geetha Lakshmi (2019), in her study examining the socio-economic conditions of the farmers in Kuttanad, pointed out that, compared with farmers in wealthy states like Punjab and Haryana, farmers in Kuttanad are small landholders who depend on government support and bank loans. The agriculture sector has been further strained by the lack of interest among the younger generation in farming. Nithin Raj, K., Lazarus, T. P., Vijayan, A., Durga, A. R., Aparna, B., Joseph, B., & Stephen, R. (2020) focuses on the constraints faced by farmers in upper Kuttanad. It was found that in the case of salt water unaffected areas, the most severe constraint is the weed problem whereas salinity intrusion which leads to a reduction in the quality of water is the major constraint faced by salt water affected areas. To prevent this improvement in irrigation management stronger institutional support is required. Richa Sen (2024) in her study about climate variation and migration in Bihar focuses on the relationship between climate variability, floods, and migration in Bihar and identifies floods as the major reason behind climate migration in Bihar. Walef Pena Guedes (2024) in their article examines the pattern of climate migration and issues faced by the climate migrants and how this problem can create pressure on water and sanitation.

Naseef, M. N. K. (2024) states that the Kerala Migration Survey 2023 conducted by the Gulati Institute of Finance Taxation (GIFT) with technical support from the International Institute of Migration and Development (IIMAD) has found that Alappuzha is the most vulnerable place in the State with around 45% of the households in the coastal district reporting one or other sort of climatic event.

2.1. Objectives

1. To examine the impact of economic, social, and environmental push factors on migration of farmers from Kuttanad.

2.2. Hypothesis

H1: Economic factors exert a significant impact on the migration of farmers in Kuttanad.

H2: Social factors exert a significant impact on the migration of farmers in Kuttanad.

H3: Environmental factors exert a significant impact on the migration of farmers in Kuttanad.

3. Materials and Methods

The study made use of both primary and secondary data. The study employed a convenience sampling method to collect data from farmers in the Kuttanad region. Convenience sampling was chosen due to the accessibility and willingness of the respondents to participate in the study. A total of 200 questionnaires were distributed to farmers across various locations within Kuttanad, targeting individuals who were readily available and willing to respond. Out of the 200 distributed questionnaires, 183 were returned, yielding a response rate of 91.5%. Following this, a screening process was conducted to ensure the completeness and relevance of the responses. After removing incomplete and invalid responses, a final sample of 156 farmers was selected for analysis. These 156 respondents were chosen based on the completeness of their responses and their alignment with the study's criteria, which focused on active farmers engaged in agricultural activities within the Kuttanad region. The study employed a quantitative research design to validate the psychometric properties using a structural equation model. The analysis aimed to assess the reliability, validity and overall model fit of the measurement. To measure the fitness, the following indices were used CMIN/DF, Goodness of Fit Index, Adjusted Goodness of Fit Index, Normed Fit Index, Comparative Fit Index, Root Mean Square Residual and Root Mean Square Error of Approximation were used. The analysis was done using SPSS software. Secondary data includes books, journals, research articles, etc.

3.1. Study design and context

Based on the literature available it has been understood that Kuttanad has become a place where living has become very difficult. The main reasons are floods, worsening climatic conditions, unplanned infrastructure, an increase in pollution, and poor income from paddy cultivation. There are also many other problems such as a lack of government support, unsustainable tourism, etc. The research gap is that most of the studies identify the constraints faced by farmers but there are only a few studies analysing the impact of push factors on the migration of farmers from Kuttanad. The paper analyses how far these push factors have forced the people to abandon their homes and leave their homelands in search of better places like refugees.

3.2. Data, variables, and sampling

The study used both primary and secondary data. Primary data were collected from farmers in the Kuttanad region through a structured questionnaire. The study employed a convenience sampling method, considering respondents' accessibility and willingness to participate. A total of 200 questionnaires were distributed to farmers across various locations in the Kuttanad region. The respondents were selected based on their availability and willingness to provide the required information. Out of the 200 questionnaires distributed, 183 were returned, resulting in a response rate of 91.5 percent. The returned questionnaires were subsequently screened to assess the completeness and relevance of the responses. After excluding incomplete and invalid questionnaires, a final sample of 156 farmers was considered for the analysis. Therefore, the total number of respondents is 156. The selected respondents met the study criteria because they were actively engaged in agricultural activities in the Kuttanad region. The variables included in the study were measured using appropriate items aligned with the study's objectives and conceptual framework. The data collected from the respondents were used to examine the relationships among the study variables and to validate the proposed research model. Secondary data were collected from various sources, including books,

academic journals, research articles, reports, and other relevant published literature. These sources were used to develop the theoretical framework, identify relevant variables and measurement items, and provide support for the interpretation of the findings.

3.3. Analytical methods

The study adopted a quantitative research design to examine the relationships among the study variables and to validate the psychometric properties of the measurement model using Structural Equation Modelling (SEM). The analysis focused on assessing the reliability and validity of the measurement model and evaluating the overall model fit. The goodness of fit of the proposed model was assessed using a set of commonly used model fit indices. These included the Chi-square to degrees of freedom ratio (CMIN/DF), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI), Comparative Fit Index (CFI), Root Mean Square Residual (RMR), and Root Mean Square Error of Approximation (RMSEA). These indices were used collectively to determine the extent to which the proposed model adequately represented the observed data. The data analysis was carried out using SPSS software. The statistical analysis was used to assess the measurement properties of the constructs and to evaluate the proposed relationships within the research model.

4. Results

4.1 Demographic Profile of Farmers

Table 1 presents the demographic profile of the 156 farmers selected for the study from the Kuttanad region. The results indicate that 69.2 percent of respondents were male and 30.8 percent were female, showing that male farmers constituted the majority.

Table 1. Demographic Profile of Farmers

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	108	69.2
	Female	48	30.8
Age	30–40 years	30	19.2
	50–60 years	86	55.1
Education	Primary School	80	51.3
	High School	46	29.5
Monthly Income	Below 10,000	96	61.5
	10,000–20,000	60	38.5
Total		156	100.0

Source: Authors

Regarding age, 55.1 percent of the respondents belonged to the 50–60 years age group, whereas 19.2 percent were in the 30–40 years age group. This indicates a relatively higher representation of older farmers among the respondents. In terms of educational attainment, 51.3 percent of the farmers had a primary school education, while 29.5 percent had completed high school. This suggests that a substantial proportion of the respondents had relatively lower levels of formal education.

Regarding monthly income, 61.5 percent of the respondents reported earning less than Rs.10,000 per month, while 38.5 percent earned between ₹10,000 and Rs.20,000 per month. The income distribution indicates that a considerable proportion of farmers fall into the lower-income category.

Overall, the demographic profile indicates that the respondents were predominantly male, relatively older, had lower levels of formal education, and belonged to the lower-income group.

These demographic characteristics are relevant to the present study, as economic, social, and environmental conditions may influence farmers' decisions regarding migration. The profile therefore provides important background for examining the impact of push factors particularly economic, social, and environmental factors—on farmers' migration decisions in the Kuttanad region.

4.2 Impact of push factors on migration

The study analyses the impact of push factors on migration such as the impact of economic, social, and environmental factors which influence the decision of the farmers to migrate.

4.3 Impact of economic factors on migration

Economic factors such as income, amount of compensation received, and debt have got significant impact on the people's decision to migrate. This has been analysed using psychometric properties as follows.

4.4 Economic Factors - Psychometric Properties

Before testing the impact of Economic factors on the migration of Farmers in Kuttanad, all those Economic factors must be tested to know the extent to which they possess convergent and construct validity.

These are tested using the Average Variance Extracted and Composite Reliability Coefficient. Table 1 demonstrates the results. As per Table 2 it can be observed that all the dimensions of Economic factors such as Income Level, Amount of Compensation received, Debt Levels, and Institutional Support, both Average Variance Extracted and Composite Reliability Coefficient have secured values above the criterion 0.50 and 0.70 respectively. So, all these factors have secured the convergent and construct validity.

Table 2. Economic Factors - Psychometric Properties

Economic Factors	Average Variance Extracted	Composite Reliability Coefficient
Income Level	0.582	0.884
Amount of Compensation received	0.514	0.802
Debt Levels	0.555	0.841
Institutional Support	0.579	0.877

Source: Primary Data

4.5 Structural Equation Model on the impact of Economic factors on the migration of farmers in Kuttanad

To analyse the impact of economic factors on migration the study has made use of a structural equation model. Based on this the hypothesis that was formulated was:

H1: Economic factors exert a significant impact on the migration of farmers in Kuttanad.

Figure 1 illustrates the Structural Equation Model on the impact of Economic factors in the migration of farmers in Kuttanad.

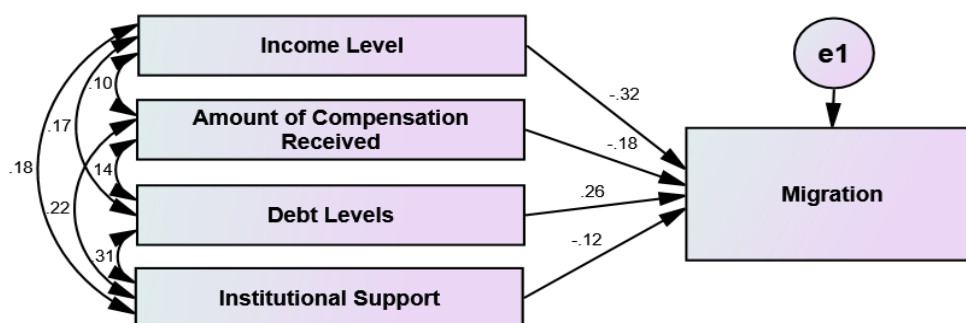


Figure 1. Structural Equation Model on the impact of Economic factors on the migration of farmers in Kuttanad

Sources: Authors

Table 3 evidenced that all the Economic Factors such as Income Level, Amount of Compensation received, Debt Levels, and Institutional Support exert a significant impact on the migration of farmers in Kuttanad as all these factors have secured P values which are significant at 1% level.

Concerning the income level of farmers, it can be seen a significant negative impact on the migration of farmers. This means, that as the income level of farmers increases by one unit, their tendency to migrate goes down by 0.412 units. In the case of the amount of compensation received increases by one unit, their tendency to migrate decreases by 0.244 units. As the debt level decreases their tendency to migrate reduces by .301 units. If institutional support is taken into consideration as the institutional support increases the tendency to migrate decreases by 0.172 units.

Table 3. Impact of Economic Factors on Migration of Farmers in Kuttanad - Coefficient

Factors		Unstandardized Coefficient	Standardized Coefficient	S. E.	C.R	P	Decision
Income Level	→ Migration	-0.412	-0.322	0.068	-6.060	<0.001**	H1.a Supported
Amount of Compensation received	→ Migration	-0.244	-0.178	0.074	-3.297	<0.001**	H1.b Supported
Debt Levels	→ Migration	0.301	0.257	0.072	4.180	<0.001**	H1.c Supported
Institutional Support	→ Migration	-0.172	-0.120	0.060	-2.866	0.012*	H1.d Supported

Source: Primary Data * Significant at 5% Level **Significant at 1% Level

Based on standardized coefficient it can be understood that income level creates the greatest impact followed by debt level, institutional support, and compensation received.

4.6 Impact of Economic factors on the migration of farmers in Kuttanad

To test the fitness of the model to represent the impact of Economic Factors in the migration of farmers, various model fit indices were used. These include CMIN/DF, Goodness of Fit Index, Adjusted Goodness of Fit Index, Normed Fit Index, Comparative Fit Index, Root Mean Square Residual and Root Mean Square Error of Approximation. Results are illustrated in Table No. 3.

Table 4. Impact of Economic Factors on Migration of Farmers in Kuttanad - Model Fit Indices

Indices	Value	Fit Criteria
CMIN/DF	2.532	< 5 (Hair et al., 1998)
GFI (Goodness of Fit Index)	0.969	> 0.90 (Hu & Bentler, 1999)
AGFI (Adjusted Goodness of Fit Index)	0.920	> 0.90 (Hair et al., 2006)
NFI (Normed Fit Index)	0.944	> 0.90 (Hu & Bentler, 1999)
CFI (Comparative Fit Index)	0.963	> 0.90 (Hooper et al., 2008)
RMR (Root Mean Square Residual)	0.031	< 0.08 (Hair et al., 2006)
RMSEA (Root Mean Square Error of Approximation)	0.074	< 0.08 (Hair et al., 2006)

Source: Authors

From the Table 4, it is proved that the model has attained all the fit indices and is capable enough to represent the impact of Economic Factors in the migration of farmers in Kuttanad.

4.7 Impact of Social Factors on the migration of farmers in Kuttanad

Social factors such as the quality of infrastructure that is available, whether people have proper access to waste management and the availability of government support influence the decision of farmers to migrate. Before analysing the impact of social factors on migration. all those social factors must be tested to know the extent to which they possess convergent and construct validity. These are tested using the Average Variance Extracted and Composite Reliability Coefficient. Table No 1.4 demonstrates the results.

Table 5. Social Factors: Psychometric Properties

Factors	Average Variance Extracted	Composite Reliability Coefficient
Quality of Infrastructure	0.592	0.904
Access to Proper Waste Management System	0.520	0.848
Availability of Government Support	0.574	0.870

Source: Primary Data

As per the Table 5 it can be observed that all the dimensions of social factors such as quality of infrastructure, access to proper waste management system, and availability of government support both Average Variance Extracted and Composite Reliability Coefficient have secured values above the criterion 0.50 and 0.70 respectively. So, all these factors have secured the convergent and construct validity.

Structural Equation Model on the impact of social factors on the migration of farmers in Kuttanad

To analyse the impact of social factors on migration the study has made use of a structural equation model. Based on this the hypothesis that was formulated was:

H2: Social factors exert a significant impact on the migration of farmers in Kuttanad

Figure 2 shows that the quality of infrastructure ($\beta = -0.58$) has the strongest relationship with migration, followed by government support ($\beta = -0.20$) and access to proper waste management ($\beta = -0.17$). The negative coefficients indicate that better social infrastructure and institutional support are associated with lower migration pressure among farmers in Kuttanad.

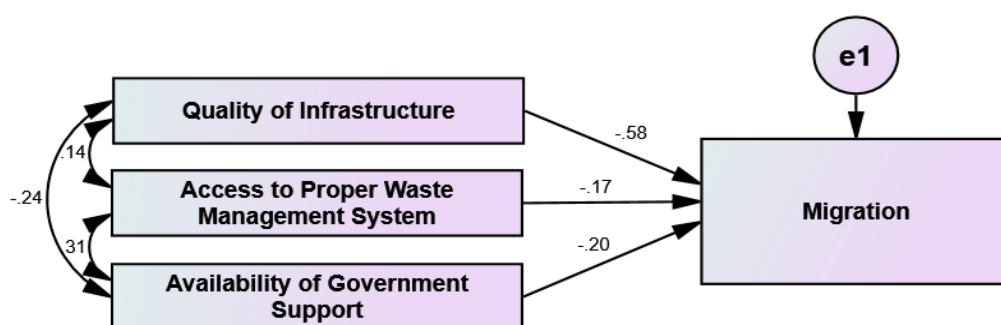


Figure 2. Structural Equation Model on the impact of factors in the migration of farmers in Kuttanad

Source: Authors

Table 6 evidenced that all the social actors such as quality of infrastructure, access to proper waste management, and availability of Government support exert a significant impact on the migration of farmers in Kuttanad as all these factors have secured P values which are significant at a 1% level.

Table 6. Impact of Social Factors on Migration of Farmers in Kuttanad - Coefficient

Factors			Unstandardized Coefficient	Standardized Coefficient	S.E.	C.R.	P	Decision
Quality of Infrastructure	→	Migration	-0.611	-0.578	0.042	14.549	<0.001**	H2.a Supported
Access to Proper Waste Management System	→	Migration	-0.246	-0.172	0.057	4.320	<0.001**	H2.b Supported
Availability of Government Support	→	Migration	-0.288	-0.202	0.050	5.771	<0.001**	H2.c Supported

Source: Primary Data ** Significant at 1% Level

Concerning the quality of infrastructure, it can be seen a significant negative impact on the migration of farmers. This means, that as the quality of infrastructure increases by one unit, their tendency to migrate goes down by 0.611 units, and as the access to proper waste management systems increases by one unit their tendency to migrate decreases by 0.246 units. As far as the availability of government support is taken into consideration as the availability of government support increases the tendency to migrate decreases by 0.288 units. Based on the standardized coefficient, infrastructure is a more influential social factor followed by lack of government support and lack of proper waste management system are the social reasons for migration. To test the fitness of the model to represent the impact of social factors on the migration of farmers, various model fit indices were used. These include CMIN/DF, Goodness of Fit Index, Adjusted Goodness of Fit Index, Normed Fit Index, Comparative Fit Index, Root Mean Square Residual and Root Mean Square Error of Approximation. Results are illustrated in Table 7.

Table 7. Impact of Social Factors on Migration of Farmers in Kuttanad - Model Fit Indices

Indices	Value	Fit Criteria
CMIN/DF	3.841	< 5 (Hair et al., 1998)
GFI (Goodness of Fit Index)	0.952	> 0.90 (Hu & Bentler, 1999)
AGFI (Adjusted Goodness of Fit Index)	0.908	> 0.90 (Hair et al., 2006)
NFI (Normed Fit Index)	0.934	> 0.90 (Hu & Bentler, 1999)
CFI (Comparative Fit Index)	0.949	> 0.90 (Hooper et al., 2008)

Indices	Value	Fit Criteria
RMR (Root Mean Square Residual)	0.040	< 0.08 (Hair et al., 2006)
RMSEA (Root Mean Square Error of Approximation)	0.075	< 0.08 (Hair et al., 2006)

Source: Primary Data

Table 7 indicates that the proposed model satisfies the required fit indices, confirming an acceptable model fit. Thus, the model is considered adequate for examining the impact of economic factors on farmers' migration from Kuttanad.

4.8 Impact of Environmental Factors on Migration of Farmers from Kuttanad

Environmental factors such as frequency of floods, quality of drinking water, sustainable tourism, and drainage efficiency have got significant impact on the people's decision to migrate. This has been analysed using psychometric properties as follows. Table 8 highlights that all dimensions of environmental factors, namely frequency of floods, quality of drinking water, sustainable tourism, and drainage efficiency, have AVE values exceeding 0.50 and Composite Reliability values exceeding 0.70.

Table 8. Environmental Factors - Psychometric Properties

Environmental Factors	Average Variance Extracted	Composite Reliability Coefficient
Frequency of Flood	0.602	0.900
Quality of Drinking Water	0.592	0.889
Sustainable Tourism	0.527	0.811
Drainage Efficiency	0.509	0.786

Source: Primary Data

Therefore, the measurement model demonstrates satisfactory convergent validity and construct reliability for all the environmental dimensions.

4.9 Structural Equation Model on the impact of social factors in the migration of farmers in Kuttanad

To analyse the impact of environmental factors on migration the study has made use of a structural equation model. Based on this the hypothesis that was formulated was:

H3: Environmental factors exert a significant impact in the migration of farmers in Kuttanad.

Figure 3 illustrates a Structural Equation Model (SEM) demonstrating how four key environmental factors directly influence farmers' decisions to migrate from Kuttanad.

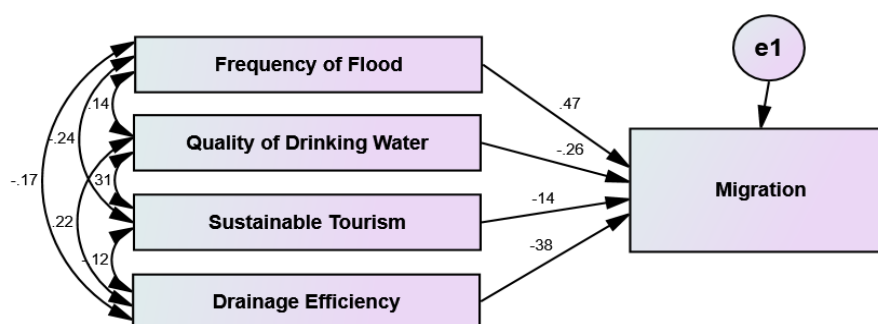


Figure 3. Structural Equation Model on the impact of Environmental factors in farmers migration in Kuttanad

Sources: Authors

Table 9 evidenced that all the environmental factors such as frequency of flood, quality of drinking water, sustainable tourism, and drainage efficiency exert significant impact on the migration of farmers in Kuttanad as all these factors have secured P values which are significant at a 1% level. The values along the single-headed arrows represent regression coefficients (impact strength), while double-headed arrows show correlations between the factors.

Table 9. Impact of Environmental Factors on Migration of Farmers in Kuttanad - Coefficient

Factors	Unstandardized Coefficient		Standardized Coefficient	S.E.	C.R.	P	Decision
Frequency of Flood	→	Migration	0.574	0.466	0.036	15.947	<0.001** H3.a Supported
Quality of Drinking Water	→	Migration	-0.341	-0.258	0.045	7.578	<0.001** H3.b Supported
Sustainable Tourism	→	Migration	-0.204	-0.144	0.042	4.862	<0.001** H3.c Supported
Drainage efficiency	→	Migration	-0.471	-0.383	0.055	8.563	<0.001** H3.d Supported

** Significant at 1% Level

As the frequency of flood decreases by one unit the tendency to migrate goes down by 0.574 units, as the quality of drinking water increases by one unit the tendency to migrate decreases by 0.341 units, as there is an increase in sustainable tourism by one unit the migration reduces by 0.204 units and as the drainage efficiency increases by one unit migration is reduced by 0.471 units. The frequency of flood ranks first among all other environment push factors. Table 10 presents the model fit indices, confirming that the structural model achieves optimal goodness of fit. This validates its suitability for representing the impact of environmental factors on farmer migration in Kuttanad.

Table 10. Impact of Environmental Factors on Migration of Farmers in Kuttanad - Model Fit Indices

Indices	Value	Fit Criteria
CMIN/DF	3.429	< 5 (Hair et al., 1998)
GFI (Goodness of Fit Index)	0.963	> 0.90 (Hu & Bentler, 1999)
AGFI (Adjusted Goodness of Fit Index)	0.917	> 0.90 (Hair et al., 2006)
NFI (Normed Fit Index)	0.941	> 0.90 (Hu & Bentler, 1999)
CFI (Comparative Fit Index)	0.956	> 0.90 (Hooper et al., 2008)
RMR (Root Mean Square Residual)	0.026	< 0.08 (Hair et al., 2006)
RMSEA (Root Mean Square Error of Approximation)	0.069	< 0.08 (Hair et al., 2006)

Source: Primary Data

5. Findings

Based on the study, it can be understood that the people of Kuttanad are forced to migrate due to the significant influence of economic, social, and environmental push factors. They are forced to migrate due to the low income as it has been ranked first among all other economic factors. The lack of income leads them to high debt levels and lack of institutional support is the major economic push factor of migration. The major reason about social factor is the lack of infrastructure facilities. A proper social as well as economic infrastructure is essential for farmers as they sole depend on agriculture and allied activities.

Floods are not new to people living in Kuttanad and these days unsustainable tourism practices, lack of availability of quality drinking water, and inadequate drainage systems are the environmental push factors that force them to become climate refugees.

5.1. Suggestions

The major problem is the meagre income that the farmers receive. They could be provided with financial and technical support to adopt sustainable practices. A robust system should be established to monitor climate change impact and adopt strategies with real-time data. The farmers can adopt organic farming to increase profit through premium markets. Better storage facilities and transport networks reduce post-harvest losses and increase access to distant markets. The main social factor is the lack of infrastructure. So, to improve infrastructure facilities, irrigation and drainage systems should be enhanced. Farm-to-market roads should be developed to connect farmlands with local markets which could reduce transportation as well as post-harvest losses. The digital infrastructure can be strengthened by developing weather and market information systems as well as making farmers adopt precision farming and IOT tools. The most important environmental concern of Kuttanad farmers is the frequent floods faced by them. Measures could be taken to upgrade structures like the Thaneermukkam bund to manage water levels effectively. Another suggestion is to increase the capacity of spillways like Thottapally Spillway to prevent waterlogging during monsoons. Developing an integrated water management system, climate climate-centric households are some other ways to overcome floods.

Based on the study the paper suggests the following measures which aim to bring a balance between ecological preservation and socio-economic development so that it ensures a sustainable future for Kuttanad.

6. Conclusion

The migration of farmers from Kuttanad is driven by economic, social, and environmental push factors that are unique to this region. Economically, the people's heavy reliance on agriculture which is combined with fluctuating income, unemployment, and limited availability of diversified job opportunities has created instability that fuels migration. As social factors, it is the poor infrastructure and environmental vulnerabilities such as recurring floods, and degradation of soil have exacerbated living conditions and further push individuals and families to leave their homes.

It is high time that targeted intervention focusing on sustainable development, flood management systems, and diversified income opportunities is required. Along with this, policies should be framed that could empower local communities and improve resilience on environmental challenges are essential. A holistic approach is required to reduce the effect of push factors leading to migration so that Kuttanad remains a viable and thriving home for its residents.

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