Title: Shifting Landscapes: Investigating the Linkages Between Migration, Land Use Change, and Natural Disasters in Kerala, India

Praveenkumar M P* & Vijaya Gupta**

*Research Scholar, Dept. of Economics and Strategy, IIM Mumbai
**Professor & Area Chair, Dept. of Economics and Strategy, IIM Mumbai

This study explores the reverse relationship between migration and natural disasters, focusing on how migration and remittances contribute to climate-related disasters. In Kerala, India, migration to Gulf countries since the 1970s has brought economic benefits but has also led to environmental degradation. Between 1970 and 2018, paddy land cultivation in Kerala decreased from 0.881 million hectares to 0.197 million hectares. In Kerala paddy land serves as natural water regulators like wetlands. However, in areas with high migrant family settlements, these paddylands have been converted for residential, commercial, and agricultural purposes. This land-use change has severely impacted Kerala's food security, biodiversity, and climate, intensifying floods, and droughts. Using secondary data from various sources, the study identifies the most vulnerable areas in terms of migration, land use, and natural disasters. A multiple linear regression model (FGLS) was applied to determine the causal relationships among migration and land use change. Findings reveal that financial remittances from migration have accelerated paddyland conversion. A case study is proposed to further explore land-use change and disaster frequency in high migrant district of Malappuram, highlighting the trade-offs between the short-term economic benefits of remittances and the long-term environmental and economic consequences of paddy-wetland depletion.

Key words: Land Use change, International Migration, Natural Disaster, Remittances

Introduction and background

Migration decisions are influenced by a complex mix of demographic, socioeconomic, and macroeconomic factors such as age, education, family size, and external economic conditions (de Haas, 2010; Castelli, 2018). This movement, especially from rural areas, can lead to labor shortages in agriculture, impacting productivity and triggering shifts in socio-economic and environmental systems (Gray and Bilsborrow 2014). The inflow of remittances can improve living standards and lead to increased prices for land, labor, and materials, resulting in significant changes in land use (Khan, 2023; Donou-Adonsou et al., 2020; Gao et al., 2020). These changes include deforestation, wetland conversion for non-agricultural purposes, and land abandonment, often increasing the region's vulnerability to natural disasters like floods and droughts (Gao et al., 2020; Peng et al., 2019).

In Kerala, Gulf migration since the 1970s has brought notable socio-economic benefits, but also environmental consequences (Kannan & Hari, 2020; Rajan, 2024; Prakash, 1998). Many Gulf migrants have converted paddy fields into construction sites and other cash crop areas, reducing rice cultivation from 0.881 million hectares in 1970 to 0.197 million hectares in 2018. This drastic change has negatively impacted food security, biodiversity, and climate, with more frequent flooding and waterlogging in regions with high migrant populations (Jose & Padmanabhan, 2015)..

The New Economics of Labour Migration (NELM) framework suggests that migration and remittances can enhance agricultural productivity by alleviating liquidity constraints and allowing households to invest in productive assets (Mack et al., 2023; Stark & Bloom, 1985). However, in Kerala's case, these remittances have also led to unsustainable land-use changes, intensifying the region's exposure to natural disasters. This study aims to explore how Gulf migration has influenced rural rice fields, land use, and the prevalence of natural disasters particularly after 2015 onwards.

Objectives: To examine the role of migration and financial remittances on land use and land cover change and natural disaster.

Methodology:

Data

Secondary data used in this study are collected from various sources, including migration data from the Kerala Migration Survey (1998, 2003, 2008, 2013, 2018, 2023), Reserve Bank of India data on remittances, socio-demographic data from Census of India 2011, land use change data from Kerala Land Use Board (KLUB)2009-2021, agricultural statistics (1951-2022) from Dept. of Economics and Statistics, Kerala, natural disaster data from Kerala Disaster Management Authority (KDMA), and climate related data from Indian Meteorological Department (IMD).

Data analysis

The secondary data collected from the sources are statistically analyzed using quintile matrices analysis and multiple linear regression methods (FGLS).

Model

Model: $\log(Y) = \beta_0 + \beta_1\log(x_1) + \beta_2\log(x_2) + \beta_3\log(x_3) + \beta_4\log(x_4) + \ldots\ldots \beta_n\log(x_n) + \varepsilon$

Y = Area of paddy land converted (ha)

X_1 = Total Remittance (in crores)

X_2 = Nonresident Keralites (NRK)

X_3 = Total paddy land area (ha)

X_4 =Built-up land (ha)

X_5 = Net Profit/Loss from paddy cultivation per hectare

βo = intercept

β_1, β_2, β_3, β_4, β_5 = partial regression coefficient

ε = Disturbance error.

Preliminary Results

Descriptive Statistics

Table1: Correlation Matrices Paddy land converted with other variables

	Paddy converted Land (ha) till 2019			
Category (No. of subdistrict)	**High (21)**	**Medium (21)**	**Low (21)**	**Total (63)**
Total Paddy land	228899.68 (49%)	123542.45 (27%)	111551.89 (24%)	463994.02 (100%)
Paddy land converted (ha)	150246 (65%)	64538 (28%)	17247 (7%)	232031 (100%)
Paddy land converted as a % of Total Paddy land	66%	52%	15%	50%
NRK (Emigrants + Return Emigrants)	1700118 (50%)	1191517 (35%)	525052 (15%)	3416687 (100%)
New residential buildings 2015-21	976093 (43%)	709676 (31%)	578480 (26%)	2264249 (100%)
No. of Households 2011	3176788 (40%)	2600905 (33%)	2076061 (26%)	7853754 (100%)
Population 2011	14393049 (43%)	10434642 (31%)	8578370 (26%)	33406061 (100%)
Total Area (ha)	1597895.37 (41%)	897000.77 (23%)	1391402.85 (36%)	3886298.99 (100%)
Annual Household Remittances (in billion INR)	150.96 (50%)	111.74 (37%)	37.70 (13%)	300.40 (100%)

Table 1 explains relationship between Paddy land conversion with respect to selected variables. The land conversion has been categorized into three levels such as low, medium and high, based on cumulative frequency of paddy land conversion in 63 subdistricts equally distributed (33.33%). Each category represents 21 Subdistricts based on land conversion intensity. Till 2021, a total of 232031 hectares of paddy land has been converted whole Kerala. Out of that 150246 ha in high conversion category, 64458 ha in medium conversion category, and 17247 hectares in low conversion category, which 65%, 28% and 7% respectively. Considering the average percentage area conversion to the total paddy land (Converted + cultivating) in each category it 66%, 52% and 15% in high, medium and low category respectively. Considering the entire Kerala state approximately 50% of total paddy land has been converted till 2021. The presence of Nonresident Keralites in High, medium and low paddy land converted Subdistricts are 50%, 35% and 15% respectively and the inflow of remittance were 150.96 (50%), 111.74 (37%) and 37.70 (13%) billion INR. which means High numbers of emigrants often leading to higher remittances, resulting in increased investments in real estate and construction, leading to more paddy land conversion.

Core findings

Table 2: Multiple Linear Regression results for paddy land conversion

Dependent variable: Log area of paddy land converted (in hectares)

	Model 1 (Baseline)	**Model 2 (FGLS)**
Constant	-2.3753 (0.7478)	-
Log Total Remittance (in crores)	0.2384* (0.1409)	0.5372* (0.1844)
Log Nonresident Keralites (NRK)	0.5026*** (0.1692)	0.3256*** (0.1702)
Log Total paddy area (ha)	0.3359** (0.1381)	-0.5422*** (0.1751)
Log Built-up land (ha)	0.5761*** (0.1706)	1.1265*** (0.2298)
Net Profit/Loss as a percentage of total cost of paddy cultivation per hectare	0.0152*** (0.0051)	0.0431*** (0.0088)
No. observations	63	63
F (5,57), F (5,58)	15.23 (0.0000)	221.02 (0.0000)
R-squared	0.5720	0.9501
Adjusted R-squared	0.5344	0.9458
Root MSE	0.4289	0.0151
Residual	10.4873	0.0132
Mean VIF	1.68	
Breusch-Pagan/Cook-Weisberg test (heteroscedasticity)	10.43 (0.0012)	
White's test (homoscedasticity)	40.35 (0.0045)	

Standard errors are reported in parentheses.

*, **, *** indicates significance at the 90%, 95%, and 99% level, respectively.

The regression analysis provided in table 1 presents the determinants of paddy land conversion in Kerala, measured by the log area of paddy land converted (in hectares). Two models are estimated: a baseline model (Model 1) and a feasible generalized least squares (FGLS) model (Model 2).

In Model 1, Significant positive coefficients are found for total remittance, the number of nonresident Keralites (NRK), built-up land, and net profit/loss as a percentage of paddy cultivation costs, indicating that increases in these factors are associated with greater conversion of paddy wetlands. Specifically, a 1% increase in NRKs and built-up land results in an approximate 0.50% and 0.58% increase in paddy land conversion, respectively. However, the total paddy area has a smaller positive effect. The overall model fit, as indicated by the R-squared (0.572), suggests that the model explains about 57% of the variance in the dependent variable.

Model 2 employs Feasible Generalized Least Squares (FGLS) to correct for heteroscedasticity, as indicated by significant tests in Model 1 (Breusch-Pagan/Cook-Weisberg and White's test). The constant is excluded, and the model exhibits a much higher R-squared (0.9501), suggesting a substantially improved fit. In this model, the coefficients of total remittance, NRKs, and built-up land remain positive and significant, while the coefficient for total paddy area turns negative and significant. This change implies that when heteroscedasticity is accounted for, the total paddy area now appears to reduce paddy land conversion, possibly due to the higher paddy areas being more resilient to conversion pressures. The adjusted R-squared (0.9458) further supports the robustness of Model 2, explaining nearly 95% of the variance.

Further the study is to apply a case study analysis to explore the impact of land use change on frequency and intensity of natural disaster in high migrant district of Malappuram in Kerala.

Discussion and Conclusion

The preliminary result of the analysis highlights that factor such as remittances, the presence of NRKs, and built-up land significantly drive paddy land conversion (Jose & Padmanabhan, 2015; Xu et al., 2023; Gray,2009; VanWey et al., 2011). The results underscore the importance of economic incentives to conserve paddy land and resist urbanization and land-use changes, in the ecologically sensitive areas of paddy-wetland. The use of FGLS in Model 2 provides a more accurate estimate by addressing heteroscedasticity, leading to more reliable inferences about the determinants of paddy land conversion.

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