Unveiling the Link Between Climate Change Perceptions and Migration: A Case Study in Takeo Province, Cambodia

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https://www.doi.org/10.61945/cjbar.2024.6.2.01

សង្ខិត្តន័យ

ការសិក្សានេះស្វែងយល់ពីទំនាក់ទំនងរវាងការយល់ឃើញ ពី ការប្រែប្រួលអាកាសធាតុ និងការធ្វើចំណាកស្រុកក្នុងប្រទេស កម្ពុជាដែលជាប្រទេសងាយរងគ្រោះខ្លាំងពីផលប៉ះពាល់នៃ ការប្រែប្រួលអាកាសធាតុ។ ការស្រាវជ្រាវនេះបានសិក្សាដែលផ្តោត លើខេត្តតាកែវដែលជាខេត្តមួយស្ថិតនៅក្នុងដីសណ្តទន្លេមេគង្គ ប្រទេសកម្ពុជាដោយការសិក្សានេះប្រើប្រាស់ វិធីសាស្ត្រស្រាវជ្រាវ ចម្រុះដោយរួមបញ្ចូលគ្នានូវវិធីសាស្ត្រស្រាវជ្រាវរួម្មមាន បែប បរិមាណវិស័យនិងគុណវិស័យ។ លទ្ធផលការសិក្សាបានបង្ហាញថា អ្នកធ្វើយតបភាគច្រើនយល់ឃើញថាសីតុណ្ហភាពនៅក្នុងតំបន់ មានការកើនឡើងស្របទៅតាមទិន្នន័យអាកាសធាតុក្នុងពីរ ទសវត្សរ៍ចុងក្រោយនេះ។ ដោយឡែកការយល់ឃើញពីកម្រិត ទឹកភ្លៀងនៅក្នុងតំបន់មានការចម្រុះដែលផ្ទុយពីទិន្នន័យកម្រិត ទឹកភ្លៀងដែលបង្ហាញថាកម្រិត ទឹកភ្លៀងកើនឡើង។ កត្តាដូចជា ការពឹងផ្អែកលើកសិកម្មជាកម្មង់ លំនៅភាពទន្ទួលបានពីប្រព័ន្ធ ធារាសាស្ត្រនៅមានកម្រិតបានរួមចំណែកដល់ភាពខុសគ្នានេះ។ កត្តាទាំងនេះរួមចំណែកផងដែលក្នុងការជម្រុញឱ្យមានកើនឡើងនូវ ការ ប្រែ ប្រួល អា កា ស ធាតុ ដែល ភា ព ងា យ រង គ្រោះ របស់ ប្រជាពលរដ្ឋទៅនឹងគ្រោះធម្មជាតិ។ លើសពីនេះ ទៅទៀតកត្តា សេដ្ឋកិច្ចនិងសង្គម រួមមានអាយុមេគ្រួសារនិងទំហំកាន់កាប់ដីធ្លី ជាមួយនឹងគ្រោះមហន្តរាយធម្មជាតិដែលកើតឡើងយឺតៗដូចជា គ្រោះរាំងស្ងួតបានដើរតួនាទីសំខាន់លើការសម្រេចចិត្តក្នុងការធ្វើ ចំណាកស្រុករបស់ប្រជាពលរដ្ឋនៅក្នុងតំបន់។ ការសិក្សានេះ សង្កត់ធ្ងន់ លើសារៈសំខាន់នៃកត្តាបរិស្ថានក្នុងការសម្រេចចិត្តធ្វើ ចំ ណា ក ស្រុកដោយបង្កើនការយល់ដឹងអំពីការប្រែប្រួល អាកាសធាតុនិងការចំណាកស្រុកនៅកម្ពុជា។ អនុសាសន៍ មួយចំនួនត្រូវបានស្នើឡើងដើម្បីដោះស្រាយ បញ្ហាទាំងនេះ។

Abstract

This study investigates the relationship between climate change perception and migration in Cambodia, a country highly vulnerable to climate change impacts. The research focuses on Takeo province, located in the Mekong Delta. Data collection involved a mixed

research method, combining quantitative and qualitative approaches. The study findings reveal a perceived increase in average temperature over the past two decades but differing perceptions of annual average rainfall. Factors such as reliance on rainfed agriculture and limited access to irrigation contribute to this discrepancy and influence vulnerability to weather extremes. Socio-economic characteristics, including household head age and landholding size, impact migration decisions, with slow-onset environmental events playing a significant role. The study emphasizes the importance of environmental factors in migration decisions by enhancing the understanding of climate change perceptions and migration in Cambodia. Several recommendations are proposed to address these issues.

Background

Cambodia has been extremely impacted by climate change (World Bank, 2024). Based on the National Climate Change Committee (2013), temperatures in the country are rising and are predicted to increase by 0.013 to 0.036°C per year until 2099, with more pronounced increases in lower latitudes. Projections also suggest a rise in both annual and seasonal rainfall, with more precipitation expected in the Northwest from June to August and less in the Northeast. The effects of climate change in Cambodia are evident through more frequent floods and droughts, which are crucial factors exacerbating the socio-economic vulnerabilities of rural households (Oudry et al., 2016). The country is particularly susceptible to climate change due to its limited adaptive capacity, inadequate infrastructure, and insufficient institutional support (World Bank, 2024).

The impacts of climate change are further eroding livelihoods and exacerbating a process of migration, either in the form of internal or international, as smallholder farmers are compelled to seek non-farm work to support themselves in the face of changing conditions (Bylander, 2015; Parsons & Nielsen, 2021). In this regard, people would adopt various adaptation strategies to cope with the climate change impacts such as changing cultivation practices (Shrestha et al., 2018) and engaging in non-farm activities (Oo et al., 2019). Migration is also seen as a form of adaptation strategy to climate change impacts as it can enable individuals to diversify their income and strengthen resilience in situations where environmental changes put livelihoods at risk (Bylander, 2015; Tacoli, 2009). The connection between climate change and migration patterns is often viewed as deterministic, with all populations in climate change-affected areas being compelled to relocate (Édes et al., 2012). People may be compelled to move to other areas in response to sudden environmental incidents, such as floods and droughts (Asmita, 2009), as well as gradual environmental changes, such as rising sea level, soil erosion, deforestation, and desertification (Leighton, 2009). Climate change-induced migration can occur on a short-term basis, such as when people evacuate areas affected by severe storms or droughts, or on a permanent basis, such as when entire communities, cities, or countries become uninhabitable, as is the case with small island states (Docherty & Giannini, 2009).

While it is generally agreed that environmental factors can influence migration alongside other factors, the extent of their importance remains debated (Perch-Nielsen et al., 2008; Wiegel et al., 2019). The study of climate change and migration in this regard has garnered increasing attention among scholars in Cambodia (Bylander, 2015; Parsons & Nielsen, 2021) and internationally (Bohra-Mishra et al., 2017; Mastrorillo et al., 2016). Traditional approaches have focused on analyzing climate data sets and migration statistics to explore the relationship between climate change and migration (Bohra-Mishra et al., 2017). Parsons and Nielsen (2021) refer to this approach as "Top-Down Analysis," which generally excludes quantitative analysis of climate migration at the community scale, a scale familiar to migration and adaptation research. However, it is crucial to understand local perceptions of climate change, existing adaptation practices, and their underlying causes to inform effective climate change adaptation policies (Nhemachena & Hassan, 2007).

At present, there is limited attention has been dedicated to exploring local people's perception of climate change and migration among recent scholars (De Longueville et al., 2020; Jha et al., 2018; Koubi et al., 2016; Zander et al., 2019) with a small number of studies focusing on the case of Cambodia (Bylander, 2015; Nguyen & Sean, 2021; Parsons & Nielsen, 2021). It is crucial to acknowledge that the perception of climate change is a complex phenomenon influenced by diverse factors, including personal expectations that may not align with empirical data collected through scientific instruments (Libarkin et al., 2018; Roco et al., 2014). Consequently, there is a pressing need for further examination of the relationship between climate change impacts and migration, specifically by considering the potential of locally gathered perception data to develop more robust models of migration in the context of a changing climate (Koubi et al., 2016; Parsons & Nielsen,

2021). This paper thus aims to investigate the potential discrepancy between local perceptions of climate change and empirical data and to understand the factors influencing migration decisions, including perceptions of climate change, thereby addressing the gap in empirical evidence concerning the relationship between climate change perceptions and migration in Cambodia.

Conceptualizing the impact of climate change on migration Decisions

Climate change, as defined by the Intergovernmental Panel on Climate Change (IPCC), refers to "a statistically significant variation in either the mean states of the climate or in its variability, persisting for an extended period (typically decades or longer)" (IPCC, 2007). The urgent global challenge of climate change manifests through increasing global temperatures, altered precipitation patterns, ice melt, and rising ocean temperatures and acidity, all of which pose serious implications for environmental stability and human well-being. The impacts of climate change are particularly acute in Asia, where it threatens food security, water resources, and human health, as outlined in the IPCC's Sixth Assessment Report (Chaturvedi et al., 2022).

Numerous explanations have been put forth to elucidate the factors driving human migration, and each explanation carries its own implications for predicting the effects of migration on the households that send migrants, including its impact on income diversification (Wouterse & Taylor, 2008). Neoclassical migration models posit that rational individuals make migration decisions based on the expected wages at the destination and the costs associated with migrating. In such models, migration primarily affects the sending area by causing a loss of labor, which incurs an opportunity cost contingent on local labor supply, as well as a reduction in human or financial capital. When migrants continue to maintain connections with their households of origin even after migration, it is more appropriate to examine migration within the framework of a household model (Stark, 1991).

The New Economics of Labor Migration (NELM) theory suggests that migration can be a strategy employed by households to overcome market failures that limit local production. Implicit in this theory is a contractual arrangement whereby the household forgoes the migrant's labor and may even provide financial support for migration, with the expectation of receiving remittances at a later stage. The NELM theory posits that migration serves as a household-level approach to diversify livelihoods and mitigate risks and uncertainties (Stark & Bloom, 1985). The NELM framework is particularly relevant for explaining scenarios in which a household sends some of its members to generate remittances that diversify income sources and facilitate consumption smoothing. Sok and Young's (2021) study exemplifies this theory in the context of Cambodia, suggesting that migration decisions are frequently driven by the potential for higher wages, improved living conditions, and the opportunity to send remittances to their families.

In the specific context of Southeast Asia, particularly the Mekong delta, migration has been identified as a significant response of households to both economic opportunities and livelihood challenges. Several studies conducted in the region have emphasized the important role of households in shaping migration decisions for their members. For example, Phan (2012) developed an agricultural household model to examine whether credit constraints act as motivators or deterrents to migration. Analyzing survey data from four provinces in Vietnam, the study revealed that households with a strong need for agricultural investments and high returns from migration utilized migration as a means to finance capital investments. Bylander (2015) aimed to comprehend how environmental distress drives migration in rural Cambodia. The findings demonstrated that households, including both landless and poor households, as well as those with more resources, viewed migration as a substitute for local livelihood strategies. These households perceived the relative risks associated with agriculture as considerably higher than the risks linked to migration, leaving them with few meaningful or secure alternatives for sustaining their livelihoods locally.

Recent empirical studies have increasingly aimed to examine the relationship between climate change and migration. Unlike physical, climatic data, subjective perceptions of climate change are shaped not only by actual climate changes but also by socio-economic factors and processes that shape the experience of climate change at the community, household, and individual levels (Nielsen & Reenberg, 2010; Žurovec & Vedeld, 2019). Scholars have thus become interested in studying climate change perceptions, although the focus has primarily been on assessing the degree of correspondence between perceived and recorded climate data. There have been relatively few studies exploring the specific impact of climate perception on migration (De Longueville et al., 2020; Parsons & Nielsen, 2021).

The literature on climate-migration demonstrates that climate impacts tend to disproportionately affect the migration decision-making process among individuals with varying socio-economic characteristics (Bohra-Mishra et al., 2017; Parsons & Nielsen, 2021). For example, younger, wealthier, landholding, and better-educated individuals are more likely to engage in international migration compared to their older, poorer, and less-educated counterparts. This suggests that the economic status of households indeed influences perceptions of climate change and subsequent migration decisions. Wealthier households may perceive migration as a viable adaptation strategy due to their access to financial resources and

networks, while poorer households may view migration as a necessity driven by immediate survival needs.

Individual choices regarding migration destinations are influenced by the costs incurred throughout the migration process (Hoang, 2011; Massey, 1990). In response to these challenges, migrant households adopt strategies to seek out and reduce migration costs, such as leveraging migration networks (Hoang, 2011) or selling assets while seeking financial support from relatives or financial institutions (Neelim & Siddiqui, 2015). These strategies reflect how socio-economic status shapes both the perception of climate change and the ability to respond through migration.

Therefore, it is essential to consider how climate change perceptions shape migration decisions in function of socio-economic and demographic variables. For instance, wealthier households might perceive climate change as an opportunity to relocate and secure better economic prospects, whereas poorer households might be forced to migrate due to deteriorating local conditions. Understanding these dynamics helps in understanding more comprehensive migration-related drivers that address the varied needs and capacities of different socio-economic groups.

Materials and Methods

The study area selected for this research is Takeo province in Cambodia, as shown in Fig. 1. Takeo province, located in the Mekong Delta, has been recognized by the National Committee for Disaster Management (2024) as a province highly impacted by various natural disasters, including storms, droughts and floods with records of these events dating from 1996 to 2022.

Takeo province, located in the southern part of Cambodia, spans an area of approximately 3,563 square kilometers and is home to a predominantly agricultural population. The province's geographical location in the Mekong lowland makes it susceptible to flooding and droughts, which are exacerbated by climate change. Additionally, the political economy and migration history of Cambodia and the Mekong region play significant roles in shaping the livelihoods and migration patterns of its residents. Historically, Cambodia has faced socio-economic challenges, including political instability and poverty, which have driven migration both within and outside the country. The interplay between these factors and the impacts of climate change makes Takeo a compelling case study for examining migration and climate adaptation strategies.

Three specific communes were purposefully chosen within Takeo province: Prambei Mum commune in Treang district, Cheoung Kuon commune in Samroang district, and Prey Kabbas commune in Prey Kabbas district. These three districts have a higher rate of out-migration (13.3% in Treang, 11.4% in Prey Kabbas, and 12.1% in
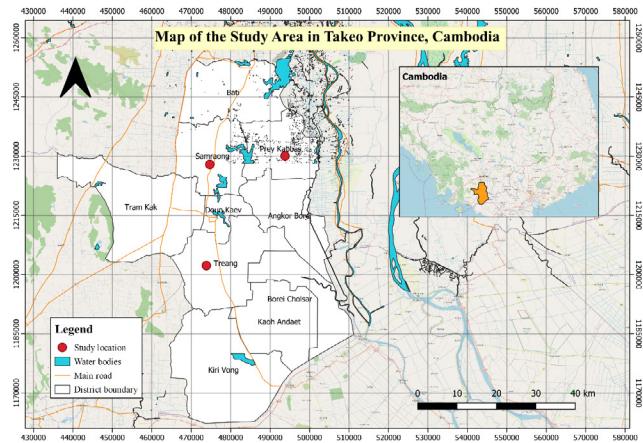
Source: Author's design

Fig. 1: Map of Takeo province highlighting the study area

Samroang) compared to the provincial out-migration rate (11%), elaborated from the 2021 Cambodia Socio-Economic Survey (Ministry of Planning, 2021). This high out-migration rate is indicative of the socio-economic pressures and environmental challenges faced by these communities, making them pertinent for studying the interplay between migration and climate change.

A systematic approach was employed to select households from the three target communes. The total number of households in the three communes was 4,982, from which a sample size of 261 households was determined using the Cochran sample size formula (Cochran, 1977) at a 90 percent confidence interval, see Table 1. This formula enabled the calculation of an appropriate sample size that would provide reliable statistical estimates for the population under investigation.

$$n_0 = \frac{z^2.p.(1-p)}{e^2} \ (1)$$

Where represents the sample size, z is the z-value, p denotes the estimated proportion of an attribute that is present in the population, e is the margin of error.

Cochran noted that if the population is finite, the sample size can be slightly reduced. He suggested a correction formula to calculate the final sample size in such cases, as shown below:

Table 1: Sample size

Communes	Total households	Sample households
Prambei Mum	1,752	90
Cheung Kuon	1,562	81
Prey Kabbas	1,668	90
Overall	4,982	261

Source: National Committee for Sub-National Democratic Development, (2018)

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} \quad (2)$$

where, n_0 is the sample size derived from equation (1) and N is the population size.

To ensure the representativeness of the sample, a stratified sampling technique was employed, considering the classification of households within each commune into two distinct groups: migrant and non-migrant households. In this regard, operational definitions were established to differentiate clearly between migrant and non-migrant households for data collection and analysis purposes. In this study, migrant households were defined as those having at least one member who moved outside of the district of origin within the last three years. Adapted from Keshri and Bhagat (2010) and the International Organization for Migration (2019), non-migrant households were characterized by the absence of any member migrating during the same period. Migration was defined as the movement of a household member to another location, either within the country or internationally, for a period exceeding six months. Circular migration, where individuals move back and forth between locations, was included in the definition of migration if the cumulative absence exceeded six months over the last three years.

Following the stratification process, households were randomly selected from each group within the communes. Household lists obtained from local authorities served as the sampling frame for the selection process. By using a random sampling method, a subset of households was chosen to participate in the study, ensuring a diverse representation of the population of interest. The advantages of using a stratified sampling technique include ensuring that both migrant and non-migrant households are adequately represented in the sample, which enhances the reliability and validity of the study's findings. This approach also allows for more precise comparisons between the two groups.

To capture the complexities of the phenomenon, this paper employed a mixed research method incorporating both quantitative and qualitative approaches. The advantages of using a mixed research method lie in its ability to provide a comprehensive understanding of the research questions by leveraging the strengths of both quantitative and qualitative approaches. The quantitative approach establishes broad trends and statistical correlations, while the qualitative approach explores the complexities and subtleties of human behavior and decision-making. Together, these methods complement each other, resulting in a more holistic and insightful analysis of the phenomenon under investigation.

To gain insight into household socio-economic conditions, migration patterns, and perceptions of climate change, a household survey questionnaire was developed.

Key sections included household demographics, socio-economic conditions, migration patterns, perceptions of climate change, and adaptation strategies. The demographics section collected basic information about household members, while the socio-economic section assessed income sources and agricultural practices. Migration patterns documented migration history, occupations, and destinations. Perceptions of climate change gauged awareness and perceived impacts, and adaptation strategies aimed to understand responses to climate change.

Capturing individual perceptions of climate change within households presents challenges, especially when migrants are absent during the survey. Therefore, the questionnaire was administered to the household head. While this may introduce potential biases, as the household head may not fully represent all members' views, aggregating responses can still provide valuable insights into the collective perception of climate change within the household. The questionnaire focused on household-level data, revealing the interplay between climate change perceptions, household dynamics, and migration decisions. Migration decisions, often made individually, can be collectively driven within a household. Analyzing these responses helps explore how a collective understanding of climate change impacts influences migration decisions and shapes migration discourse.

Future studies could include interviews or surveys targeting individual household members, including migrants, for a more nuanced understanding of individual perceptions. Despite its limitations, the household survey questionnaire offers a structured method for collecting data on socio-economic conditions, migration patterns, and climate change perceptions, providing insights into how households perceive and respond to climate change and how this influences migration strategies.

To analyze the factors affecting migration decisions within households, a logistic regression model will be applied. The model can be represented as:

$$\text{Log} \left[P/(1-P) \right] = B0 + B1X1 + B2X2 + B3X3 + B4X4 + \ldots + BNXN$$

In the above equation, the ratio (P/1-P) represents the probability of a household having at least one migrant. The dependent variable takes a value of 1 for households with long-term or short-term migrants and 0 otherwise.

The independent variables X1 through XN represent the factors considered in the model to analyze their influence on the dependent variable. Independent variables in this study are described in the following Table 2.

To further validate and gain deeper insights into the local context and migration patterns, three focus group discussions (FGDs) were conducted as part of the qualitative approach. FGDs were chosen for this study

Table 2: Independent variables in the study

Variables	Definition	Value
AGE_HH	Age of household head	Years old
GEN_HH	Gender of household head	0=Female, 1=Male
EDU_HH	Education level of household head	1= Illiterate, 2= Primary, 3=Secondary, 4=University
EMP_HH	Employment status of household head	0=unemployed or inactive, 1=self-employed/employed
FEM_PRO	Female labor proportion to the total number of labors in the household	
IDPoor	Households who are under IDPoor scheme	0= No IDPoor, 1=IDPoor
LAND	Total landholding	Hectares
NET_INT	Number of internal migrants among the household head's close relatives	Persons
NET_EXT	Number of international migrants among the household head's close relatives	Persons
SUD_EVN	Individuals reported experiencing heavy rain, storms, floods, typhoons, and landslides and rate the impacts from these events.	1=Trivial, 2=Moderate, 3=Severe
SLO_EVN	Individuals reported experiencing salinity, drought, or desertification and rate the impacts from these events	1=Trivial, 2=Moderate, 3=Severe
PER_TEMP	Perception of increase in the average temperature over the last 20 years	7-point Likert scale ranging from 1: strongly disagree to 7: Strongly agree.
PER_PRE	Perception of increase in the rainfall over the last 20 years	7-point Likert scale ranging from 1: strongly disagree to 7: Strongly agree.

because they allow for interactive discussions among participants, enabling the exploration of collective views and social dynamics that might not surface in individual interviews. This method complements the quantitative data collected in the survey by providing a richer, more nuanced understanding of migration patterns and their impacts. The interactive nature of FGDs fosters a deeper exploration of shared experiences, motivations, and challenges, enhancing the overall analysis.

These FGDs took place in June 2022 and involved households from three communes. Each FGD included a diverse group of participants representing different roles and backgrounds within the community, which helped to capture a wide range of perspectives and experiences. The first FGD in Prambei Mum Commune included five participants: a migrant, a return migrant, a housewife, a casual laborer, and a farmer. It aimed to gather diverse perspectives on migration, personal experiences, challenges, and its impact on households. The second FGD in the Cheung Kuon Commune involved five participants, including casual laborers, housewives, and petty business owners, to explore their views on migration and its effects on their livelihoods and community. The third FGD in Prey Kabbas Commune included casual laborers and farmers, focusing on how climate variability influences migration decisions and the challenges faced by these households.

This study has a number of limitations that should be taken into account. First, since the research focuses exclusively on Takeo province in Cambodia, the findings might not be fully applicable to other regions with different environmental and socio-economic conditions, especially those with varying topographies or climate impacts. Secondly, the sample size was determined using a 90% confidence interval, which may not adequately represent the entire population of the study area. Thirdly, data collection primarily involved interviewing household heads, which could introduce bias because their perspectives might not accurately reflect the experiences and views of all household members, particularly those who are absent migrants. This reliance on household heads could lead to incomplete insights into the collective perceptions of climate change and migration decisions. These limitations highlight the importance of caution when interpreting the results and point to the need for future research to expand the geographic and population scope, as well as incorporate diverse household perspectives.

Results and Findings

Characteristics and perceptions of migrant and non-migrant households

Table 3 presents a comprehensive comparison of the characteristics of the surveyed households, aiming to discern any significant differences between migrant and non-migrant households. To assess the statistical significance of these differences, the chi-square test and independent t-test were employed.

The results of the analysis indicate notable distinctions between migrant and non-migrant households within the study area. Specifically, the proportion of male and female household heads exhibited a similar distribution between the two groups. Similarly, there were no substantial discrepancies in the educational attainment of household heads among migrant and non-migrant households. However, it is worth noting that households with elder household heads appeared to have a higher propensity for member migration. This finding suggests that age-related factors may influence migration decisions within households. Moreover, migrant households demonstrated certain distinguishing characteristics when compared to their non-migrant counterparts. Firstly, migrant households tended to possess smaller land sizes, implying a potential relationship between landholding and migration decisions. Additionally, migrant households exhibited a higher prevalence of internal and external migrant networks, highlighting the significance of social connections in facilitating migration. These findings were supported by the FGDs, which noted that the gender or educational level of household heads does not necessarily influence migration. Instead, age plays a more critical role, as older household heads are typically economically inactive and require their members to earn more income to support the household. As a result, younger household members may be more inclined to migrate to supplement the household's income.

Interestingly, the perceptions of climate change and environmental change impacts varied between migrant and non-migrant households. Specifically, migrant households tended to perceive more severe impacts from slow-onset events, such as drought, in comparison to non-migrant households. Furthermore, migrant households displayed a tendency to disagree with the notion that annual average rainfall had increased, in contrast to non-migrant households. Migrant households from the FDGs frequently reported facing severe challenges due to droughts. Their limited ability to cope with such impacts stems from a lack of financial resources needed to invest in water storage systems and other adaptive measures. Participants shared experiences of decreased agricultural productivity and income, which often drove them to migrate in search of income. Furthermore, these households generally disagreed with the notion that average rainfall had increased. This perception aligns with their struggles to manage the adverse effects of drought, highlighting their vulnerability to climate variability.

Factors influencing migration decisions: results from logistic regression

The empirical findings presented in Table 4 provide compelling insights into the relationship between specific types of environmental events, perceptions, and their influence on migration likelihood. Notably, the analysis reveals that long-term and slow-onset environmental events, such as drought, salinity, and desertification, have a significant positive impact on the likelihood of migration. However, it is important to consider that these environmental factors might interact with other socio-economic conditions, such as economic status, which could also drive the higher propensity for migration. Households experiencing these slow-onset environmental events may simultaneously face economic pressures that exacerbate the need to migrate as a coping strategy. The FGDs reveal that households with limited cultivated land and many family members often resort to sending members to engage in off-farm work, both locally and abroad. This necessity arises from their inability to produce and sell enough agricultural products to sustain their livelihoods due to challenges such as rising agricultural input costs natural hazards like drought, as among others.

Furthermore, the study reveals a negative association between the perception of an increase in annual average precipitation and the likelihood of migration. In other words, when households perceive a decrease in annual average precipitation over time, there is an increased tendency for household members to migrate. On the other hand, the analysis suggests that sudden-onset environmental events, such as extreme weather events, and the perception of an increase in temperature have a lesser impact on the likelihood of migration. This difference highlights the complexity of environmental impacts on migration, where slow-onset changes gradually erode livelihood stability, prompting migration, while sudden events might not provide the same long-term push due to their episodic nature. These findings align with the FGDs where households reported that insufficient water management in agriculture results in lower yields, both for consumption and sale. Consequently, engaging in off-farm activities, including migration, becomes a necessary strategy. Participants also noted that their communities are less affected by events such as severe floods. Instead, droughts are more common in the region and can significantly impact paddy production, highlighting why many perceive the effects of such slow-onset events as more critical.

The analysis of household characteristics reveals significant associations between certain factors and the likelihood of migration. Notably, households with older household heads exhibited a higher propensity for member migration. This finding aligns with established trends in the literature and suggests that age-related factors play a role in shaping migration decisions within households. As household heads age and become less productive, family members may seek migration as a means to generate income and support their families. This underscores the economic imperative of migration as a livelihood strategy for households facing reduced productivity in their later years.

Table 3: Overview of surveyed households' characteristics

Variables	Total Sample (n = 261)	Migrant HH (n = 122)	Non-migrant HH (n = 139)	p-value
AGE_HH	52.92 (12.40)	55.21 (10.55)	50.91 (13.54)	0.00
GEN_HH				
Male	65.9%	64.8%	66.9%	0.13
Female	34.1%	35.2%	33.1%	
EDU_HH				0.99
Illiterate	11.5%	11.5%	11.5%	
Primary	50.2%	50.0%	50.4%	
Secondary	36.0%	36.1%	36.0%	
Undergraduate	2.3%	2.5%	2.2%	
EMP_HH				0.32
Unemployed/inactive	8.4%	7.4%	9.4%	
Employed/active	91.6%	92.6%	90.6%	
LAND	0.89 (1.22)	0.75 (0.87)	1.01 (1.45)	0.006
FEM_PRO	0.36 (0.29)	0.38 (0.29)	0.35 (0.29)	0.38
IDPoor	0.68 (0.46)	0.69 (0.46)	0.68 (0.46)	0.12
NET_INT	2.72 (3.33)	3.42 (3.93)	2.1 (2.58)	0.000
NET_EXT	0.83 (1.50)	1.02 (1.95)	0.66 (0.93)	0.004
SUD_EVN	1.16 (1.06)	1.21 (1.05)	1.12 (1.08)	0.623
SLO_EVN	0.93 (1.03)	1.08 (1.12)	0.81 (0.94)	0.01
PER_TEMP	6.00 (0.90)	6.07 (1.03)	5.94 (0.78)	0.06
PER_PRE	4.68 (1.78)	4.34 (1.91)	4.98 (1.62)	0.00

Value in bracket is standard deviation.

Additionally, the findings indicate that households with a greater number of internal networks exhibit a higher likelihood of migration. This underscores the influential role of social networks in shaping migration decisions. The presence of internal migrant connections within a household's network can facilitate the exchange of information, resources, and support, thereby increasing the propensity for migration. This finding is consistent with well-established trends in migration literature that highlight the critical role of networks in reducing the costs and risks associated with migration. FGDs reveal that households often send members to work elsewhere because they have relatives or friends who have already migrated, making it easier to find jobs and minimize migration expenses.

Furthermore, landholding is identified as a factor that hinders household migration decisions. Specifically, households with larger land sizes are less likely to have their members migrate. This finding suggests that land ownership and agricultural activities may serve as anchors or sources of stability, reducing the incentive for households to pursue migration as an alternative livelihood strategy. Landholding size, thus, acts as a buffer against the economic necessity to migrate, providing households with more local opportunities for income generation. This aligns with the FGDs indicating that households with large plots of land tend to invest in rice cultivation, which can generate income and profits, reducing the need to migrate.

Discussions

Observed climatic data and local perception

The climate data used in this study was obtained from the Climate Data Store (CDS), specifically by interpolating the data from the closest grid points to the local weather station under analysis (Climate Data Store, 2023). Temperature and precipitation anomalies were utilized to assess the congruence between the observed climate data and the perceptions of climate events held by the local population. This approach was chosen because relying solely on absolute levels of climate data may not be suitable, as it fails to adequately capture the migration responses to deviations from the standard climatic conditions (Beine and Parsons, 2015). To identify trends in monthly temperature and precipitation over time, the non-parametric Mann-Kendall test and the Sen's slope estimator were employed. The Mann-Kendall test is a statistical test used to determine the significance of trends, while the Sen's slope method is used to estimate the magnitude of the trend (Da Silva et al., 2015).

Table 4: Results of logistic regression

Variables	Coefficients	Marginal effects	p-value
AGE_HH	0.044**	0.009	0.001
GEN_HH	0.194	0.040	0.539
EDU_HH	1.051	0.219	0.064
EMP_HH	0.232	0.048	0.291
LAND	0.437	0.088	0.365
FEM_PRO	0.091	0.021	0.668
IDPoor	-0.350*	-0.071	0.018
NET_INT	0.108*	0.022	0.024
NET_EXT	0.132	0.027	0.223
SUD_EVN	0.088	0.017	0.545
SLO_EVN	0.444**	0.091	0.002
PER_TEMP	0.08	0.017	0.613
PER_PRE	-0.295**	-0.061	0.001
Constant	-3.787		
Log Likelihood	-176.388		
LR Chi^2	7.94		
Observation	261		

*Significant at 95%, **Significant at 99%

The surveyed respondents generally perceived an increase in average temperature over the past 20 years (Table 3). This perception aligns with the observed data, as depicted in Fig. 2, which indicates a general upward trend in the average annual temperature within the province. Given that a significant portion of the respondents rely on agriculture for their livelihoods, their perceptions of weather-related events are highly sensitive. The gradual rise in temperature over an extended period can potentially have long-term implications for local livelihoods, prompting individuals to take adaptive measures in response to this climate change. This finding aligns with other studies, such as

the study by Howe et al. (2019) found that individuals often perceive temperature changes that align with recorded data, particularly in regions where agriculture is prevalent. This consistency underscores the sensitivity of human perception to changes in temperature that affect day-to-day activities and livelihoods.

On the other hand, the observed trend of annual average rainfall in the study area has exhibited relative stability with fluctuations over the years. The lowest point in rainfall was recorded in 1990, while the highest point occurred in 1999. However, it is noteworthy that the perceptions of the surveyed respondents regarding annual average rainfall differ from the observed data. The majority of respondents perceived a decrease in annual average rainfall. According to Simelton et al. (2013), the mismatch is attributed to the fact that farmers are more attuned to short-term variability and extreme events than to long-term climatic trends.

The discrepancy observed between empirical data and perceptions regarding climate change can be attributed to various factors, as revealed through insights gained from the FDGs. Firstly, it is crucial to consider the local context of the study area, where a significant proportion of the population relies on rainfed rice farming as their primary agricultural practice. Unlike irrigated farming, rainfed agriculture is reliant solely on rainfall for crop cultivation, rendering farmers highly susceptible to variations in precipitation patterns. As a result, extreme weather events such as droughts and floods can have profound impacts on agricultural productivity and livelihoods. Various studies, such as Morton (2007) and Bryan et al. (2009) highlight that communities heavily reliant on agriculture with limited access to resources perceive climate change as more severe due to their vulnerability to weather extremes.

Moreover, the absence of a comprehensive irrigation system in the study areas further hampers farmers' access to water throughout the year. This further intensifies their vulnerability to weather extremes and
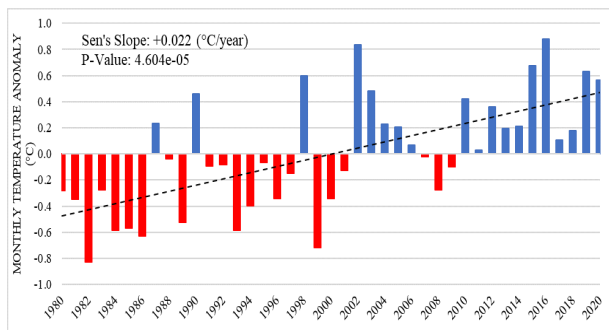
(a)
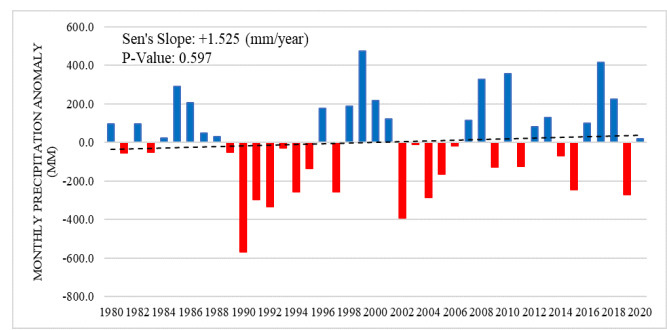
(b)

Figure 2: (a) Monthly temperature anomaly (°C) from 1980 to 2020; (b) Monthly precipitation anomaly (mm) from 1980 to 2020

reinforces their perception of a decline in annual average rainfall. Consequently, farmers may perceive a decrease in rainfall even if the observed data indicates a relatively stable trend.

Influence of socio-economic factors on migration decisions

The study findings confirm existing empirical research in the region, highlighting the influence of certain socio-economic characteristics on migration decisions. Specifically, household head age has been identified as a significant factor and internal migration networks play a crucial role in shaping migration decisions, aligning with previous studies (Bohra-Mishra et al., 2017; Görlich & Trebesch, 2006). It is noteworthy that in the context of climate change adaptation, migration decisions tend to be internal rather than international, as supported by limited literature (Lucas, 2015; Mastrorillo et al., 2016; Shi et al., 2019; Waldinger, 2015).

Furthermore, the study reveals that households with larger landholdings exhibit lower migration rates compared to those with smaller land plots. Landholding size emerges as a crucial factor negatively impacting both permanent and temporary migration (Xiao & Zhao, 2018). In Cambodia, where a significant proportion of the population resides in rural areas and relies on agriculture, land represents a valuable asset (Green, 2019). Individuals face the decision of either cultivating their land or pursuing migration opportunities. However, the analysis indicates no significant relationship between the proportion of female labor and migration decisions. In the study area, nearby districts offer employment opportunities such as garment factories, where many women opt to work locally, enabling them to fulfill their familial responsibilities effectively.

These findings are further supported by the FGDs, which highlighted the challenges faced by farmers in generating profits from rice farming. Multiple factors contribute to this situation, including high prices of agricultural inputs, fluctuations in rice prices, indebtedness, drought, and insect infestations. Remarkably, some households in the villages discontinued rice cultivation in 2021 due to the lack of profitability. Consequently, migration, particularly internal migration, serves as a strategy to sustain household livelihoods. Many young individuals choose to work as construction or garment workers in Phnom Penh, capitalizing on available employment opportunities.

Environmental and climate change: a push factor inducing people to migrate

The relationship between climate variability, environmental change, and migration is complex and non-linear, as it intertwines with various factors such as population growth, poverty, and security (Laczko & Aghazarm, 2009). Climate change exacerbates the consequences of underlying environmental, social, and governance challenges, reducing resilience and increasing the risks that motivate people to migrate (Warner et al., 2010).

In the study area, slow-onset environmental events, including drought, salinity, and desertification, emerge as significant factors driving migration decisions. Numerous studies corroborate the link between slow-onset events, such as droughts and land degradation (Makondo & Thomas, 2021) soil salinity (Chen & Mueller, 2018), and migration. This migration phenomenon reflects the vulnerability of rural areas, where the majority of livelihoods depend on natural resources. Conversely, sudden-onset environmental events have a relatively lesser impact on the likelihood of migration. Floods, in particular, may exhibit limited or non-significant effects on migration (Bohra-Mishra et al., 2017; Gray & Mueller, 2012).

These findings suggest that slow-onset environmental events gradually erode household livelihoods, prompting individuals to employ various strategies, including migration, to cope and sustain their livelihoods (Nawrotzki & DeWaard, 2016). Conversely, sudden-onset environmental events may hinder households' ability to undertake new and costly migration endeavors (Robalino et al., 2015). Individuals who perceive a reduction in annual rainfall tend to experience higher rates of migration. This observation reflects the fact that agriculture is a dominant livelihood activity in the study area, and decreased rainfall leads to crop failures and deteriorating local livelihoods (Kangalawe & Lyimo, 2013), indirectly influencing migration decisions through its impacts on livelihoods.

The FDGs further emphasized that environmental factors play a significant role in driving migration in the studied areas. Natural hazards, such as drought and soil degradation, frequently undermine rice production and quality, prompting some individuals to refrain from investing heavily in rice production. Instead, they opt for non-agricultural activities, such as casual labor and migration, to sustain their livelihoods in the face of environmental challenges and high costs associated with agricultural inputs. These discussions provide valuable context and support for understanding the local perceptions of environmental changes and their influence on migration decisions.

Conclusions and Policy Implication

This study investigated the potential discrepancy between local perceptions of climate change and empirical data, and to understand the factors influencing migration decisions, including perceptions of climate change in the study area of Takeo province. By utilizing

a household survey and analyzing climate data, the study shed light on the disparities between empirical data and perceived climate change, considering the local context and the influence of environmental factors on migration decisions.

The findings revealed that the surveyed respondents generally perceived an increase in average temperature over the past two decades, which aligns with the observed data. This perception has implications for local livelihoods, particularly for those engaged in agriculture, as rising temperatures can have long-term impacts on agricultural productivity. However, there was a discrepancy between observed and perceived trends in annual average rainfall, with the majority of respondents perceiving a decrease despite relatively stable trends in the data. Insights gained from the FGDs highlighted the influence of contextual factors, such as rainfed rice farming and limited access to irrigation, on perceptions and vulnerability to weather extremes. These factors contribute to the perception of declining rainfall and reinforce the vulnerability of farmers to climate change impacts. The study also identified socio-economic characteristics, such as household head age and landholding size, as influential factors in migration decisions. Internal migration networks were found to play a crucial role in shaping migration patterns. Additionally, slow-onset environmental events, particularly droughts, emerged as significant drivers of migration decisions, while sudden-onset events had relatively lesser impacts.

Based on these findings, some suggestions are proposed for key stakeholders, including government agencies at both national and local levels, development partners, and non-governmental organizations working in the field. Firstly, implementing programs to support agricultural productivity, particularly for households with smaller landholdings, is crucial. This could include access to affordable inputs, training on sustainable farming practices, and irrigation infrastructure development. Facilitating the development of social networks that can provide support and information to potential migrants is also essential. Community-based programs could help connect households with broader networks, enhancing their ability to migrate if necessary. Developing and promoting climate adaptation strategies that address both slow-onset and sudden-onset environmental events is vital. This could include drought-resistant crops, soil conservation techniques, and early warning systems for extreme weather events. Creating and promoting non-agricultural livelihood opportunities in rural areas can help reduce the reliance on agriculture and mitigate the need for migration. Vocational training programs and support for small businesses could be effective in this regard. Integrating migration considerations into national and local development plans such as the Commune Development Plan is also recommended. Policies should aim to create resilient communities by addressing the

root causes of migration, including economic vulnerability and environmental degradation. Last but not least, it is recommended that future research consider the complex relationship between climate change, perceptions, and migration decisions. Further exploration of individual perceptions through quantitative and qualitative methods could provide deeper insights into the diverse experiences and perspectives within households regarding the impacts of climate change on migration.

Acknowledgment

Declaration of competing interest

The author has no conflict of interest to declare.

Credit authorship contribution statement

SEAN Chanmony: Conceptualization, Writing-original draft, Writing-review & editing. The author has read and agreed to the published version of the manuscript.

References

Asmita, N. (2009). Migration and Natural Disasters, Environment and Climate Change: Assessing the Evidence, Edited by Frank Laczko/Christine Aghazarm. *International Organization for Migration-IOM, Geneva.* International Organization for Migration.

Bohra-Mishra, P., Oppenheimer, M., Cai, R., Feng, S., & Licker, R. (2017). Climate variability and migration in the Philippines. *Population and Environment, 38*(3), 286–308. https://doi.org/10.1007/s11111-016-0263-x

Bryan, E., Deressa, T. T., Gbetibouo, G. A., & Ringler, C. (2009). Adaptation to climate change in Ethiopia and South Africa: Options and constraints. *Environmental Science & Policy, 12*(4), 413–426. https://doi.org/10.1016/j.envsci.2008.11.002

Bylander, M. (2015). Depending on the Sky: Environmental Distress, Migration, and Coping in Rural Cambodia. *International Migration, 53*(5), 135–147. https://doi.org/10.1111/imig.12087

Chaturvedi, S., Cheong, T. S., Luo, Y., Singh, C., & Shaw, R. (2022). *IPCC Sixth Assessment Report (AR6): Climate Change 2022-Impacts, Adaptation and Vulnerability: Regional Factsheet Asia.* Policy Commons. https://policycommons.net/artifacts/2264289/ipcc_ar6_wgii_factsheet_asia/3023343/

Chen, J., & Mueller, V. (2018). Coastal climate change, soil

salinity and human migration in Bangladesh. *Nature Climate Change, 8*(11), 981-985. https://doi.org/10.1038/s41558-018-0313-8

Climate Data Store. (2023). *Temperature and precipitation gridded data for global and regional domains derived from in-situ and satellite observations*. Climate Data Store. https://cds.climate.copernicus.eu/#!/home

Cochran, W. G. (1977). *Sampling techniques*. (3rd ed.) New York, NY: Wiley.

Da Silva, R. M., Santos, C. A. G., Moreira, M., Corte-Real, J., Silva, V. C. L., & Medeiros, I. C. (2015). Rainfall and river flow trends using Mann-Kendall and Sen's slope estimator statistical tests in the Cobres River basin. *Natural Hazards, 77*(2), 1205-1221. https://doi.org/10.1007/s11069-015-1644-7

De Longueville, F., Ozer, P., Gemenne, F., Henry, S., Mertz, O., & Nielsen, J. Ø. (2020). Comparing climate change perceptions and meteorological data in rural West Africa to improve the understanding of household decisions to migrate. *Climatic Change, 160*(1), 123-141. https://doi.org/10.1007/s10584-020-02704-7

Docherty, B., & Giannini, T. (2009). Confronting a rising tide: A proposal for a convention on climate change refugees. *Harvard Environmental Law Review, 33, 349.*

Édes, B. W., Gemenne, F., Hill, J., & Reckien, D. (2012). *Addressing climate change and migration in Asia and the Pacific: Open access e-book. Asian Development Bank.* http://www.adb.org/sites/default/files/publication/29662/addressing-climate-change-migration.pdf

Görlich, D., & Trebesch, C. (2006). *Mass migration and seasonality: Evidence on Moldova's labour exodus*. Center for European, Governance and Economic Development Research, University of Göttingen. https://www.econstor.eu/handle/10419/3823

Gray, C. L., & Mueller, V. (2012). Natural disasters and population mobility in Bangladesh. *Proceedings of the National Academy of Sciences, 109*(16), 6000-6005. https://doi.org/10.1073/pnas.1115944109

Green, W. N. (2019). From rice fields to financial assets: Valuing land for microfinance in Cambodia. *Transactions of the Institute of British Geographers, 44*(4), 749-762. https://doi.org/10.1111/tran.12310

Hoang, L. A. (2011). Gender Identity and Agency in Migration Decision-Making: Evidence from Vietnam. *Journal of Ethnic and Migration Studies, 37*(9), 1441-1457. https://doi.org/10.1080/1369183X.2011.623618

Howe, P. D., Marlon, J. R., Mildenberger, M., & Shield, B. S. (2019). How will climate change shape climate opinion? *Environmental Research Letters, 14*(11), 113001. https://doi.org/10.1088/1748-9326/ab466a

International Organization for Migration. (2019). *International migration law No. 34 - Glossary on migration. International Organization for Migration.* https://publications.iom.int/books/international-migration-law-ndeg34-glossary-migration

IPCC. (2007). AR4 climate change 2007: The physical science basis. https://www.ipcc.ch/site/assets/uploads/2018/05/ar4_wg1_full_report-1.pdf

Jha, C. K., Gupta, V., Chattopadhyay, U., & Sreeraman, B. A. (2017). Migration as adaptation strategy to cope with climate change. International Journal of Climate Change Strategies and Management, 10(1), 121-141. https://doi.

org/10.1108/ijccsm-03-2017-0059

Kangalawe, R. Y., & Lyimo, J. G. (2013). *Climate change, adaptive strategies and rural livelihoods in semiarid Tanzania.* Natural Resources, 4(3), 266-278.

Keshri, K., & Bhagat, R. B. (2010). Temporary and seasonal migration in India. *Genus, 66*(3), 25-45.

Koubi, V., Stoll, S., & Spilker, G. (2016). Perceptions of environmental change and migration decisions. *Climatic Change, 138*(3-4), 439-451. https://doi.org/10.1007/s10584-016-1767-1

Laczko, F., & Aghazarm, C. (2009). *Migration, environment and climate change: Assessing the evidencehttps://www.cabdirect.org/cabdirect/abstract/20103136708*

Leighton, M. (2009). Migration and slow-onset disasters: Desertification and drought. In F. Laczko & C. Aghazarm (Eds.), *Migration, Environment and Climate Change: (pp. 319-351). Geneva: International Organization for Migration.*

Libarkin, J. C., Gold, A. U., Harris, S. E., McNeal, K. S., & Bowles, R. P. (2018). A new, valid measure of climate change understanding: Associations with risk perception. *Climatic Change, 150*(3-4), 403-416. https://doi.org/10.1007/s10584-018-2279-y

Lucas, R. E. (2015). Internal migration in developing economies: An overview. *KNOMAD's Working Paper, 6.* https://www.knomad.org/sites/default/files/2017-04/KNOMAD%20Working%20Paper%206_Lucas_Internal%20Migration.pdf

Makondo, C. C., & Thomas, D. S. G. (2021). Environmental change and migration as adaptation in rural economies: Evidence from Zambia's rural-rural migration. *Migration and Development, 10*(3), 359-387. https://doi.org/10.1080/21632324.2019.1646534

Massey, D. S. (1990). The Social and Economic Origins of Immigration. *The ANNALS of the American Academy of Political and Social Science, 510*(1), 60-72. https://doi.org/10.1177/0002716290510001005

Mastrorillo, M., Licker, R., Bohra-Mishra, P., Fagiolo, G., Estes, L. D., & Oppenheimer, M. (2016). The influence of climate variability on internal migration flows in South Africa. *Global Environmental Change, 39,* 155-169.

Ministry of Planning. (2021). *Cambodia Socio-Economic Survey 2021* [Dataset].

Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences, 104*(50), 19680-19685. https://doi.org/10.1073/pnas.0701855104

National Climate Change Committee. (2013). *Cambodia Climate Change Strategic Plan 2014-2023*. Royal Government of Cambodia.

National Committee for Disaster Management. (2024). *Cambodia Disaster Damage & Loss Information System (CamDi).* https://camdi.ncdm.gov.kh/DesInventar/profiletab.jsp?countrycode=kh2&continue=y

National Committee for Sub-National Democratic Development. (2018). *Commune Database 2017.* Ministry of Interior.

Nawrotzki, R. J., & DeWaard, J. (2016). Climate shocks and the timing of migration from Mexico. *Population and Environment, 38*(1), 72-100. https://doi.org/10.1007/s11111-016-0255-x

Neelim, A., & Siddiqui, T. (2015). Situation analysis of migration context and policy framework in Bangladesh. *International*

Organization for Migration. https://publications.iom.int/books/situation-analysis-migration-context-and-policy-framework-bangladesh

Nguyen, T. P. L., & Sean, C. (2021). Do climate uncertainties trigger farmers' out-migration in the Lower Mekong Region? *Current Research in Environmental Sustainability, 3,* 100087. https://doi.org/10.1016/j.crsust.2021.100087

Nhemachena, C., & Hassan, R. (2007). *Micro-level analysis of farmers adaption to climate change in Southern Africa.* International Food Policy Research Institute IFPRI, Discussion Paper 00714. Washington DC.

Nielsen, J. Ø., & Reenberg, A. (2010). Cultural barriers to climate change adaptation: A case study from Northern Burkina Faso. *Global Environmental Change, 20*(1), 142-152.

Oo, A. T., Minh, D. D., & Sovanndara, K. (2019). *Farming system with the adaptation to climate change: Case study focus on lowland areas in Cambodia, Myanmar and Vietnam.* (Technical Report No. CLIANDHH NO.1). International Foundation of Science (IFS).

Oudry, G., Pak, K., & Chea, C. (2016). Assessing vulnerabilities and responses to environmental changes in Cambodia. *International Organization for Migration.* https://environmentalmigration.iom.int/sites/g/files/tmzbdl1411/files/publications/MECC_Cambodia%20report.pdf

Parsons, L., & Nielsen, J. Ø. (2021). The Subjective Climate Migrant: Climate Perceptions, Their Determinants, and Relationship to Migration in Cambodia. *Annals of the American Association of Geographers, 111*(4), 971–988. https://doi.org/10.1080/24694452.2020.1807899

Perch-Nielsen, S., Bättig, M., & Imboden, D. (2008). Exploring the link between climate change and migration. *Climatic Change, 91,* 375-393.

Phan, D. (2012). Migration and Credit Constraints: Theory and Evidence from Vietnam. *Review of Development Economics, 16*(1), 31–44. https://doi.org/10.1111/j.1467-9361.2011.00644.x

Robalino, J., Jimenez, J., & Chacón, A. (2015). The effect of hydro-meteorological emergencies on internal migration. *World Development, 67,* 438–448.

Roco, L., Engler, A., Bravo-Ureta, B., & Jara-Rojas, R. (2014). Farm level adaptation decisions to face climatic change and variability: Evidence from Central Chile. *Environmental Science & Policy, 44,* 86-96.

Shi, G., Lyu, Q., Shangguan, Z., & Jiang, T. (2019). Facing climate change: What drives internal migration decisions in the karst rocky regions of Southwest China. *Sustainability, 11*(7), 2142.

Shrestha, R. P., Raut, N., Swe, L. M. M., & Tieng, T. (2018). Climate change adaptation strategies in agriculture: Cases from southeast Asia. *Sustainable Agriculture Research, 7*(3), 39-51.

Simelton, E., Quinn, C. H., Batisani, N., Dougill, A. J., Dyer, J. C., Fraser, E. D. G., Mkwambisi, D., Sallu, S., & Stringer, L. C. (2013). Is rainfall really changing? Farmers' perceptions, meteorological data, and policy implications. *Climate and Development, 5*(2), 123-138. https://doi.org/10.1080/17565529.2012.751893

Sok, S., & Yang, C. (2021). Brawn Drain from Cambodia: A Comparative Study of Transnational Labour Migration to Malaysia and South Korea. *Bandung, 8*(1), 22-44.

Stark, O. (1991). Migration in LDCs: Risk, remittances, and the family. *Finance and Development, 28*(4), 39-41.

Stark, O., & Bloom, D. E. (1985). The new economics of labor migration. *The American Economic Review, 75*(2), 173-178.

Tacoli, C. (2009). Crisis or adaptation? Migration and climate change in a context of high mobility. *Environment and Urbanization, 21*(2), Article 2.

Waldinger, R. (2015). *The Cross-Border Connection: Immigrants, Emigrants, and Their Homelands.* Harvard University Press. https://doi.org/10.4159/harvard.9780674736283

Warner, K., Hamza, M., Oliver-Smith, A., Renaud, F., & Julca, A. (2010). Climate change, environmental degradation and migration. *Natural Hazards, 55*(3), 689-715. https://doi.org/10.1007/s11069-009-9419-7

Wiegel, H., Boas, I., & Warner, J. (2019). A mobilities perspective on migration in the context of environmental change. *WIREs Climate Change, 10*(6), e610. https://doi.org/10.1002/wcc.610

World Bank. (2024). *Cambodia Historical Hazard.* Climate Change Knowledge Portal (CCKP). https://climateknowledgeportal.worldbank.org/country/cambodia/vulnerability

Wouterse, F., & Taylor, J. E. (2008). Migration and income diversification: Evidence from burkina faso. *World Development, 36*(4), 625-640.

Xiao, W., & Zhao, G. (2018). Agricultural land and rural-urban migration in China: A new pattern. *Land Use Policy, 74,* 142-150.

Zander, K. K., Richerzhagen, C., & Garnett, S. T. (2019). Human mobility intentions in response to heat in urban South East Asia. *Global Environmental Change, 56,* 18-28.

Žurovec, O., & Vedeld, P. O. (2019). Rural livelihoods and climate change adaptation in laggard transitional economies: A case from Bosnia and Herzegovina. *Sustainability, 11*(21), 6079.