Published in the Russian Federation
Oriental Studies (Previous Name: Bulletin of the Kalmyk Institute for Humanities of the Russian Academy of Sciences)
Has been issued as a journal since 2008
ISSN: 2619-0990; E-ISSN: 2619-1008
Vol. 18, Is. 4, Pp. 821–835, 2025
Journal homepage: https://kigiran.elpub.ru

UDC / УДК 304.8:551

Climate Change-Related Migration in the Mekong Delta of Vietnam — Challenges to Regional Sustainable Development

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Миграция, обусловленная изменением климата, в дельте реки Меконг во Вьетнаме — вызовы для устойчивого развития региона

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Abstract. *Introduction*. The Mekong Delta of Vietnam (VMD) is a key agricultural region vital for national food security. In recent years, the region has faced significant outmigration driven by economic challenges and climate change impacts, such as droughts, saltwater intrusion, and extreme weather events. *Goals*. This study examines the relationship between climate change and migration in the VMD and its implications for sustainable regional development. *Methods*. Using a political-environmental perspective, the paper analyzes quantitative and qualitative data from the 2019 Population and Housing Census and the 2022 Mekong Delta Economic Annual Report. Migration patterns, demographic shifts, and regional development indicators are assessed to understand how environmental stressors influence human mobility. *Results*. Findings reveal that climate change is a major driver of migration reshaping population structures, labor supply, and the region's long-term development capacity. Over 1.3 million people migrated from the VMD in the past decade, posing challenges to demographic stability and socio-economic resilience. *Conclusions*. The study recommends strengthening climate-adaptive sustainable development policies and enhancing local human resource capacity. These measures aim to stabilize migration, promote inclusive development, and ensure climate-resilient growth in the Mekong Delta.

Keywords: Mekong Delta of Vietnam (VMD), migration, climate change, sustainable development, policy, human resources.

For citation: Phan Thi Phuong Anh, Dang Thi Minh Phuong, Ngo Minh Hiep, Nguyen Thi Tuy, Bui Thi Huyen. Climate Change-Related Migration in the Mekong Delta of Vietnam — Challenges to Regional Sustainable Development. *Oriental Studies.* 2025. Vol. 18. Is. 4. Pp. 821–835. (In Eng.). DOI: 10.22162/2619-0990-2025-80-4-821-835

Аннотация. *Введение.* Дельта Меконга во Вьетнаме является ключевым сельскохозяйственным регионом, жизненно важным для национальной продовольственной безопасности. В последние годы регион столкнулся со значительной миграцией населения, вызванной экономическими трудностями и последствиями изменения климата, такими как засухи, засоление почв и экстремальные погодные явления. Настоящее исследование направлено на изучение взаимосвязи между изменением климата и миграцией в дельте Меконга, а также ее влияния на устойчивое развитие региона. *Методы.* Используя политико-экологический подход, исследование анализирует количественные и качественные данные из Переписи населения и жилищ 2019 г. и Годового отчета о состоянии экономики дельты Меконга 2022 г. Оценены миграционные тенденции, демографические изменения и показатели регионального развития для понимания влияния экологических стрессоров на перемещение населения. *Результаты.* Результаты показывают, что изменение климата является главным фактором миграции, влияя на демографическую структуру, трудовые ресурсы и долгосрочные возможности развития региона. Более 1,3 млн человек покинули дельту Меконга за последнее десятилетие, что создает вызовы для демографической стабильности и социально-экономической устойчивости. *Выводы.* Рекомендуется укрепление политики устойчивого развития с учетом адаптации к изменению климата и повышение качества и потенциала местных человеческих ресурсов. Эти меры направлены на

стабилизацию миграционных процессов, продвижение инклюзивного развития и обеспечение климатоустойчивого роста в дельте Меконга.

Ключевые слова: дельта Меконга во Вьетнаме, миграция, изменение климата, устойчивое развитие, политика, человеческие ресурсы

Для цитирования: Фан Тхи Фыонг Ань, Данг Тхи Минь Фыонг, Нго Минь Хьеп, Нгуен Тхи Туй, Буй Тхи Хуен. Миграция, обусловленная изменением климата, в дельте реки Меконг во Вьетнаме — вызовы для устойчивого развития региона // Oriental Studies. 2025. Т. 18. № 4. С. 821–835. DOI: 10.22162/2619-0990-2025-80-4-821-835

1. Introduction

In recent decades, the relationship between climate change and migration has garnered increasing attention from scientists, policymakers, and global development organizations. A growing body of evidence suggests that severe environmental disruptions — such as prolonged droughts, saltwater intrusion, sea level rise, and extreme weather events — have become key drivers of both internal and cross-border migration. In Vietnam, the Mekong Delta (VMD) is among the most vulnerable regions to these environmental stressors.

The VMD is a vital agricultural zone that plays a crucial role in national food security and the livelihoods of millions of rural households. However, over the past decade, the region has witnessed a marked outmigration trend, primarily from rural areas to urban centers and, increasingly, to other countries. According to the 2019 Population and Housing Census and the 2022 Annual Mekong Delta Economic Report, more than 1,3 million people left the region in the span of a decade — posing serious challenges to regional demographic stability and socio-economic development.

Climate change not only undermines agricultural production and ecological infrastructure but also directly affects population structures, labor markets, and the long-term viability of regional development strategies. These impacts are interconnected and multifaceted, complicating migration decisions and contributing to risks such as social inequality, livelihood insecurity, and potential resource conflicts in receiving areas.

In this context, this paper investigates the relationship between climate change and migration in the Mekong Delta, employing a political-environmental perspective to assess its implications for sustainable development. Drawing on both quantitative and qualitative data, the paper also provides evidence-based policy recommendations to enhance adaptive capacity, stabilize demographic trends, and promote inclusive, climate-resilient development in the region.

The following research questions guide the analysis:

1) How is migration in the Mekong Delta related to climate change?

2) What impact does migration have on the region's sustainable development?

3) What policy measures are needed to manage migration and support long-term development in the VMD?

2. Literature review

The nexus between migration and environmental change has become an important area of academic inquiry over the past three decades. The Intergovernmental Panel on Climate Change (IPCC), in its First Assessment Report (1990), already highlighted the potential for climate change to significantly affect human mobility [Climate Change 1990]. Since then, the literature has debated whether environmental stressors directly threaten human security and compel displacement.

A large number of studies have examined how climate-induced phenomena such as drought, desertification, and sea level rise influence population movements. This line of research includes works such as *Environmental Refugees* by E. El-Hinnawi [El-Hinnawi 1985], *Ultimate Security: The Environmental Basis of Political Stability* by A. Jordan [Jordan 1994], and the overview report by B. Kavanagh and

S. Lonergan on environmental degradation and displacement [Kavanagh, Lonergan 1992]. D. Bates provided a framework for classifying environmentally driven migration, distinguishing between forced and voluntary movements [Bates 2002: 465–477]. The consensus among many researchers is that these stressors act as direct or indirect drivers of migration [Döös 1997: 41–61; Castles 2002; Meze-Hausken 2000: 379–406; Tyson et al. 2002: 129–135; Huang et al. 2003: 361–378; McLeman, Smit 2006: 31–53].

Recent literature provides empirical case studies linking climate change to specific migration patterns. For example, T. Halliday explored how environmental risk shaped migration decisions in El Salvador [Halliday 2006: 893–925], while C. Myers, T. Slack, and J. Singelmann analyzed social vulnerability and population shifts after Hurricanes Katrina and Rita [Myers, Slack, Singelmann 2008: 271–291]. C. Gray and V. Mueller assessed population mobility in Bangladesh and Ethiopia under disaster and drought stress [Gray, Mueller 2012a: 6000–6005; Gray, Mueller 2012b: 134–145]. K. Warner, T. Afifi, K. Henry, T. Rawe, C. Smith, and A. de Sherbinin discussed how changing rainfall patterns affect food and livelihood security, driving migration in vulnerable regions [Warner et al. 2012]. K. Rigaud, B. Jones, J. Bergmann, V. Clement, K. Ober, J. Schewe, S. Adamo, B. McCusker, S. Heuser, and A. Midgley argue that climate change is becoming a primary driver of migration, urging proactive planning to accommodate internal climate migrants [Rigaud et al. 2018].

However, assessing the direct causal relationship between climate change and migration remains challenging due to the complex, multi-causal nature of migration decisions. As T. Trinh emphasized in a doctoral study on Vietnam's Mekong Delta [Trinh 2021], and O. Brown pointed out in his global review [Brown 2008], isolating environmental drivers from economic, social, and political factors demands sophisticated models and high-quality datasets.

Moreover, some scholars caution against overlooking individuals who choose not to migrate despite environmental pressures. This introduces a selection bias that can distort conclusions drawn solely from studying migrant populations [Hunter 2005: 273–302; Halliday 2006: 893–925; Black et al. 2011: S3-S11; Raleigh 2011: S82–S93; Koubi et al. 2016: 134–163]. The capacity of households and communities to respond to climate stressors varies significantly depending on factors such as social capital, economic resources, and governance [Hunter et al. 2015: 377–397].

Vietnam is widely recognized as one of the countries most severely affected by climate change and extreme weather [Margulis et al. 2010; Berlemann, Tran 2020: 385–409]. The Mekong Delta, a rural, low-lying region in the country's southwest, is particularly vulnerable to sea level rise and salinization. Its exposure to climate hazards has been thoroughly documented [Padilla 2011; Mekong Delta Climate 2009]. It is also the region with the highest internal migration rates in Vietnam, with large numbers of people relocating from rural communities due to both environmental and economic pressures [Entzinger, Scholten 2016; Nguyen, Raabe, Grote 2015: 79–93].

This paper situates the Mekong Delta within this broader scholarly context, highlighting the close connection between climate change and migration. It argues that climate-induced migration presents significant challenges for sustainable development in the region and calls for targeted policy responses to address these issues.

3. Migration in the Mekong Delta of Vietnam

Numerous studies have been conducted in Vietnam to elucidate the socio-economic impacts of climate change on local populations. L. Thuy and P. Nam (2015) investigated the repercussions of climate change on agricultural production, demonstrating that climate variability constitutes a significant socio-economic factor influencing both agricultural yields and farmer migration [Thuy, Nam 2015]. Recent research indicates that the Vietnamese Mekong Delta (VMD) is projected to experience profound effects from climate change, with estimates suggesting that within the next 50 years, approximately 50 % of arable land and millions

of residents may suffer severe consequences, including the loss of homes and livelihoods [Warner et al. 2009]. It is anticipated that one in ten individuals in the VMD will face the risk of displacement due to rising sea levels [Dasgupta et al. 2007]. A projected rise in sea levels of 1 meter could result in the submersion of 40 % of the VMD's land area [Lan Anh 2016]. In response to the threats posed by climate change and environmental pressures, residents of the VMD have employed various adaptive strategies, one of which is migration, which serves as a significant pull factor toward urban areas [Oanh, Truong 2017].

Climate change introduces new risks to human security and establishes a complex context for migration issues. Empirical studies on Vietnam indicate that the Mekong Delta remains a major sending region for internal migrants to Ho Chi Minh City [Huy 2012], while flood-related environmental stresses have been identified as important push factors driving migration within the delta [Dun 2009]. T. Trinh (2021) employed the choice experiment (CE) method to investigate the causal relationship between climate change and migration decisions from rural to urban areas in the Mekong Delta. In addition to climate impacts, the study examined other critical factors influencing migration choices, including income, social networks, neighborhood preferences, and constraints related to crop selection. The research also modeled heterogeneity in these preferences by incorporating socio-demographic variables and their interactions with key migration attributes. The CE results confirmed that the increasing intensity and frequency of climate-related phenomena significantly enhance the likelihood of migration, with severe drought identified as the most influential factor affecting individuals' decisions [Trinh 2021].

The VMD is confronting significant challenges related to mass migration as a consequence of climate change. Rising sea levels exacerbate the risk of flooding in the VMD, particularly in its low-lying areas, while increased precipitation and enhanced flow of the Mekong River — resulting from glacial melt in the Tibetan Plateau — further contribute to this risk. The escalating threat of flooding, combined with heightened salinity intrusion, poses a substantial danger to the region's agricultural productivity. As agricultural yields decline, average per capita income in the VMD may also decrease. Consequently, residents may be compelled to migrate to neighboring regions within Vietnam or to adjacent countries as they lose their livelihoods due to the impacts of climate change.

The Annual Economic Report 2020 on Enhancing Competitive Capacity for Sustainable Development, produced by the Vietnam Chamber of Commerce and Industry (VCCI) and the Fulbright School of Public Policy and Management (FSPPM), underscores the increasingly complex trends in labor migration within VMD region over the decade from 2009 to 2019 [VCCI & Fulbright 2020]. These trends pose significant risks to the region's sustainable development. During this period, the VMD has had the highest net migration rate in the country (0,39 %), significantly surpassing the second-ranked region, the North Central Coast (0,25 %). As a result, after 10 years, the population of the VMD remained almost unchanged, increasing only from 17,2 to 17,3 million people (the population growth rate in the VMD was a mere 0,1 %), causing the population share of the VMD in the total national population to decrease from 20 % to 18 %. Meanwhile, net migration out of the region reached nearly 1,1 million individuals. By 2022, this figure had escalated to approximately 1,3 million, as reported in the Annual Economic Report 2022 [VCCI & Fulbright 2023]. If current migration patterns continue, the population of the VMD is projected to decline to fewer than 17 million by 2030, with urbanization rates unlikely to exceed 30 % by the same year.

From 2018 to 2021, the trend of population movement from the VMD to major cities became increasingly pronounced, as illustrated in fig. 1. This figure demonstrates a significantly higher emigration rate from the VMD compared to immigration. Specifically, the immigration rate rose slightly from 1 % in 2018 to 1,2 % in 2021, while the emigration rate reached 13,8 % in 2021, effectively doubling from the 2018 rate. Consequently, the net migration rate for 2021 was recorded at 12,5 %,

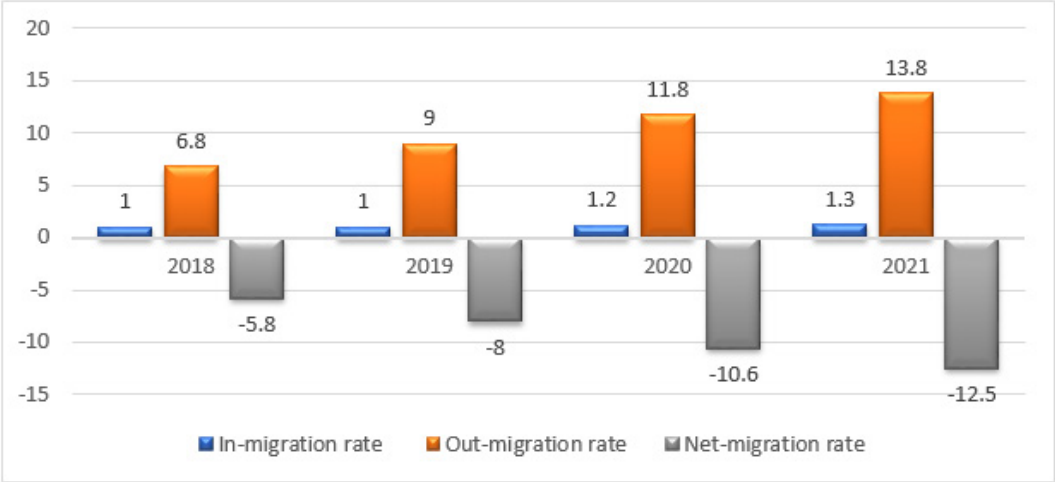

Fig. 1. Net migration rate in the VMD, 2018–2021

highlighting a pronounced imbalance in migration flows [Lam et al. 2022].

4. The impacts of migration on the sustainable development of the Mekong Delta of Vietnam

4.1. The potential for mass migration and conflict

Migration from the VMD presents a significant risk of social and political instability, primarily due to resource scarcity that adversely affects food security and livelihoods in areas where VMD refugees settle. The substantial outflow of residents from the VMD is likely to increase population density in receiving regions, which can strain critical infrastructure for water and sanitation services, thereby escalating unsustainable resource demands. The likelihood of conflict intensifies if VMD refugees migrate to resource-constrained areas. A recent report on the security implications of climate change in Southeast Asia indicates that while fleeing environmental degradation may not inherently lead to violence, the potential for conflict rises when migrants encroach upon territories inhabited by populations facing similar resource constraints [Ardiansyah, Putri 2011].

Furthermore, China's construction of dams along the upper reaches of the Mekong River exacerbates the potential for conflict. These dams, built to generate hydroelectric power to meet rising energy demands, have resulted in reduced water flow to the VMD. The hydrology of the Mekong River is influenced not only by climate change but also by various developmental activities, particularly the construction of hydropower dams along the river and its tributaries. For example, existing and planned dams in Yunnan Province, China, and the Central Highlands of Vietnam are projected to trap up to 80 % of sediment before it reaches the delta, significantly affecting local settlements and economic sectors, especially agriculture and fisheries [Mekong Delta Climate 2009]. Consequently, Vietnamese communities may perceive these dams as contributing to the anticipated decline in agricultural productivity in the VMD, thereby heightening the potential for international conflict among China, Vietnam, and other affected nations due to increased migration from VMD refugees and corresponding resource shortages [Padilla 2011].

4.2. Shortage of labor force

High levels of migration have resulted in population decline and labor force depletion in the VMD. H. Vo (2020) indicated that the proportion of the VMD's population within the country decreased from 22,4 % in the 1989 census to 17,9 % in the 2019 census [Vo 2020]. Over the ten-year period from 2009 to 2019, the region's population increased by just over 82,000 individuals, reflecting a growth rate of only 0,05 % [Results 2019]. In contrast, urban areas experienced a growth rate of 0,98 %, while rural areas saw a decline of 0,24 %. Provinces with shrinking populations, such as An Giang, Soc Trang, and Ca Mau — known for their agricultural production, particularly

in aquaculture — exhibited annual population growth rates of –1,16 %, –0,75 %, and –0,1 %, respectively. Conversely, provinces with rising populations, such as Long An, Tien Giang, and Can Tho, benefitted from significant investments in their industrial and service sectors, with annual growth rates of 1,625 %, 0,54 %, and 0,39 %, respectively, over the same period [Vo 2020].

As of the end of 2021, the population of the 13 provinces in the VMD was approximately 17 422 620, accounting for 17,7 % of the country's total population [Statistical Yearbook 2023]. In 2021, the labor force aged 15 and older in the VMD comprised nearly 9,4 million individuals, marking a decrease of 0,94 % compared to 2020 and representing 53,7 % of the region's population. Among this labor force, 14,6 % had received training. However, the share of unskilled labor in the VMD was 35,9 %, compared to 33,2 % nationally (fig. 2) [Statistical Yearbook 2023].

The rate of school-age children not attending school in the VMD is 13,3 %, the highest in the region and one and a half times higher than the national average (8,3 %) [VCCI & Fulbright 2020]. Regarding trained labor, the rate in the region during the period 2015–2019 ranged from 11,7 % to 14,6 % and was consistently the lowest in the country [VCCI & Fulbright 2023]. As of the fourth quarter of 2023, the proportion of the labor force with training, diplomas, or certificates at the secondary level and above across the entire country was 27,0 %. In contrast, this figure was significantly lower in VMD, at only 15 %, marking the lowest rate nationwide (fig. 3) [VCCI & Fulbright 2020].

Furthermore, the share of the labor force with university-level education in the VMD constituted approximately 7 %, compared to over 16 % in the Southeast region and 14,5 % in the Red River Delta region, both of which are also higher than the national average [Statistical Yearbook 2023]. Worryingly, only the VMD and the Central Highlands experienced a stagnant trend in the rate of trained workers, while other regions significantly improved these figures (fig. 4).

In addition, not only is there a shortage and weakness in science and technology (S&T) human resources, but the VMD is also experiencing a "brain drain" phenomenon, as S&T human resources are migrating to the southeastern provinces in search of higher-paying jobs, posing significant challenges to the economic and social development of the VMD [Huong Mai 2022].

According to Phu Khoi, from 2017 to 2021, the VMD experienced the largest decline in labor force participation rates nationwide, reaching –42 % [Phu 2022]. Notably, the VMD was the only region in the country to exhibit a downward trend in the number of labor force participants throughout this entire period. Compounding this issue, the unemployment rate among the working-age population in the

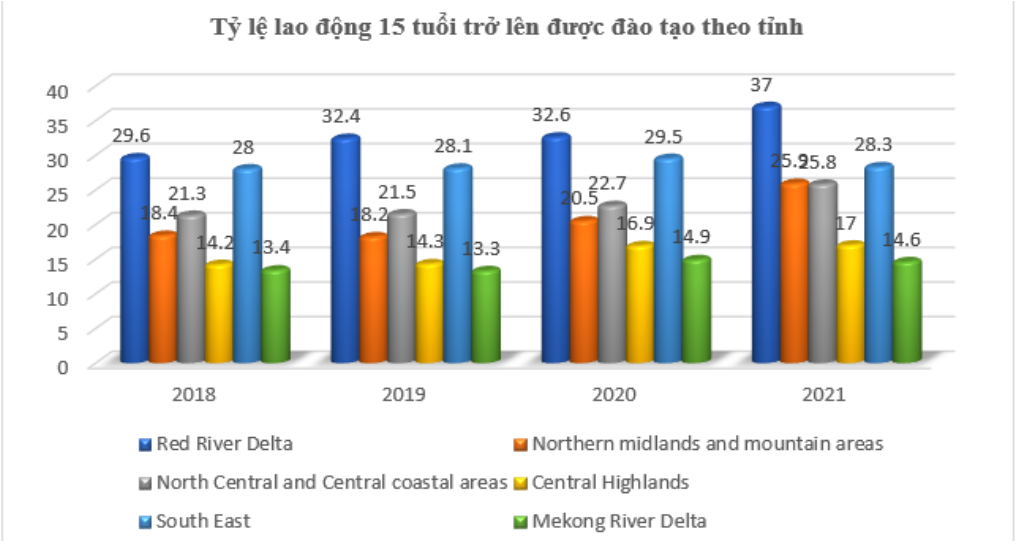

Fig. 2. Share of the labor force aged 15 and over receiving training, by province

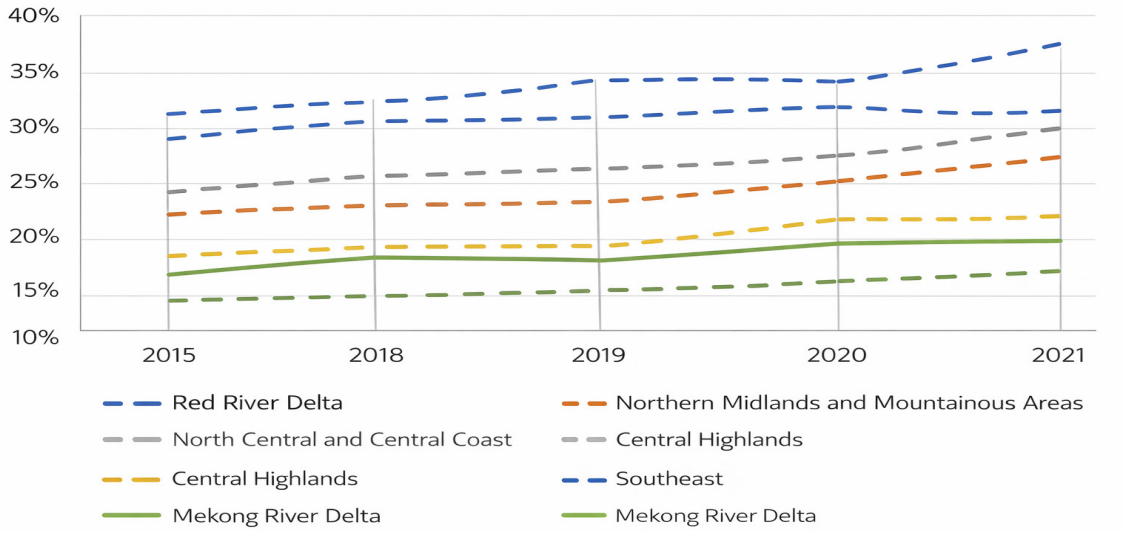

Fig. 3. Rates of trained labor force across regions, 2015–2021

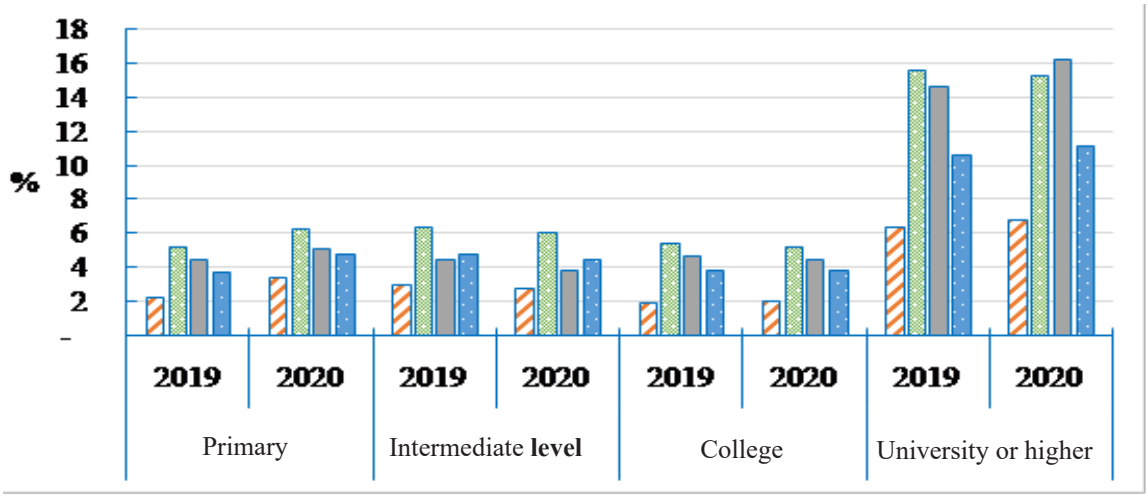

Fig. 4. Percentage of trained workers at all levels in the Mekong Delta compared to the Red River Delta, Southeast, and national

VMD in 2020 was 3,47 %, the second highest in Vietnam. Furthermore, the unemployment rate in rural areas was twice that of urban areas. This disparity can largely be attributed to the mechanization of agriculture and economic restructuring, which resulted in surplus labor in the agricultural sector, while the industrial and service sectors were slow to absorb this surplus. Additionally, the reduction of agricultural land due to factors, such as salinity intrusion and drought, has left many rural laborers without land for cultivation, contributing to rising unemployment and job loss.

4.3. Social issues arising from the impacts of migration

Migration contributes to population ageing and reduces the scale of household populations. According to the 2019 population census, the total number of households nationwide was 26,87 million, reflecting an average annual growth rate of 1,8 % [Results 2019]. In the VMD, there were 4,8 million households, comprising 1.23 million in urban areas and 3,57 million in rural areas. The average household size decreased from 4 to 3,5 individuals, indicating a declining trend. Specifically, households with four members accounted for 25,6 %, those with three members represented 22,5 %, and households with two members constituted 17,5 %. In contrast, households with five members comprised 12,3 %, which is only slightly higher than single-person households, which made up 10,5 % [Results 2019].

The number of split households is increasing, accompanied by a gradual reduction in land area per household [Vo 2020]. Population pyramids indicate a rising proportion of elderly individuals. So, the current migration patterns suggest that the majority of those remaining in rural areas are elderly individuals with low educational attainment. This demographic shift presents significant challenges for any economic development strategies targeting the Mekong Delta (VMD), challenges that have not been adequately addressed in previous planning efforts. Historically, population scenarios in the region showed an upward trend, with corresponding increases in economic growth, urban expansion, and demand for educational and healthcare facilities. However, should the population continue to decline or experience further reductions over the next decade or beyond 2030, the region will confront entirely new challenges. Vo (2020) emphasizes that demographic changes, characterized by many families lacking subsequent generations living together, combined with inadequate healthcare infrastructure and services in rural areas, will exacerbate these issues [Vo 2020].

5. Conclusion and policy implications

5.1. Conclusions

Climate change has significantly disrupted community cohesion in the VMD. The patterns of migration in the VMD are closely linked to environmental factors, such as droughts, salinity intrusion, tidal surges, tornadoes, and riverbank erosion, which have compelled many laborers to seek alternative livelihoods outside the region. Additionally, the construction of hydropower dams by upstream countries on the Mekong River has diminished local production resources, adversely affecting the livelihoods of VMD residents and degrading their habitats. This situation further drives migration from the region.

Consequently, migration trends in the VMD are intricately connected to its sustainable development, as the increasing outflow of residents has resulted in ethnic conflicts, the displacement of indigenous ethnic minorities, and even the potential for international tensions between China, Vietnam, and other countries. The problems of labor shortages, low natural population growth rates, and high net migration rates will create a serious downward spiral for the VMD's human resources, as well as other social challenges in the region, such as accelerating population aging and shrinking family sizes, etc.

5.2. Policy implications

5.2.1 Reinforcing the system of sustainable development policies for the VMD that adapts to climate change

The following actions are recommended for policymakers in response to migration associated with climate change:

Promoting scientific research activities is essential for forecasting and developing viable scenarios for the sustainable development of the VMD. Enhancing mechanisms and policies to attract domestic and international research groups will facilitate comprehensive studies that accurately predict sustainable development challenges in the VMD for the coming decades.

Based on research findings, it is important to formulate feasible and effective scenarios for the sustainable development of the VMD at various stages, enabling proactive responses to potential challenges.

Strengthening policy frameworks is crucial to support scientific research aimed at addressing socio-economic development challenges, protecting regional resources — especially land and water — and adapting to the increasingly diverse and severe impacts of climate change.

Additionally, enhancing policies that promote applied research in agricultural production and socio-economic activities within the region should be a priority. Focused research initiatives on the hybridization of livestock and crops that are resilient to the adverse effects of climate change in the VMD are particularly important.

Implementing economic restructuring solutions is crucial for shifting from traditional agricultural practices to a focus on industry and services, as well as transitioning from water-intensive production activities to those suited for saline conditions. If effective solutions are applied, this restructuring process can minimize the transition shocks experienced by residents of the VMD, generating more job opportunities in industrial sectors, services, and economically viable salt-adapted activities, thereby ab-

sorbing a significant number of laborers from agriculture.

It is also important to develop specific localities within the VMD region that have strengths in industry and services. Establishing connections between these localities and areas with large populations of migrant labor will provide employment opportunities, help reduce large-scale labor migration out of the region, and alleviate the pressures on urban infrastructure and social issues caused by migrant labor in major urban centers of the Southeast region.

Addressing employment support policies effectively is essential. This includes implementing credit policies for poor and near-poor households, supporting vocational training initiatives, offering loans from the National Employment Fund, and providing financial assistance such as preferential loans for laborers working abroad under contracts. Regularly disseminating information about employment opportunities and labor market conditions through various media channels will equip individuals with the necessary knowledge and preparation for future careers.

Enhancing the role of Can Tho University in building a collaborative ecosystem among universities can contribute to raising skill levels among laborers and reducing outmigration. Developing vocational training centers, as well as intermediate and college-level vocational training programs, should focus on the strengths and emerging development trends of the VMD, such as biotechnology and environmental studies.

Innovating vocational training in localities through close cooperation between businesses (labor users) and job service centers (intermediaries) can create income-generating employment and enhance the skills of laborers to meet business requirements. Local authorities should regularly collaborate with companies to organize job fairs and employment exchanges, facilitating connections between labor supply and demand, and helping laborers secure jobs on the spot. This approach will contribute to the overall development of the local labor market.

5.2.2. Enhancing the quality of human resources to meet the requirements of sustainable development

Implementing effective policies for the development of scientific and technological human resources (STHR) is crucial for the VMD. Firstly, it is urgent to develop and implement policies that focus on the training, professional development, recognition, and rewarding of STHR personnel.

The VMD needs to develop and implement comprehensive policies for the training, professional development, and growth of its STHR. Special attention should be given to recognizing and rewarding top science and technology experts, especially those entrusted with leading key national projects. In addition, it is essential to honor and create opportunities for the development of talented young STHR, placing this at the forefront of regional development efforts.

First and foremost, it is essential to establish a fair and adequate compensation policy for STHR. Additionally, policies regarding rewards and penalties must be clearly defined and transparent in order to build strong trust, ensure job security, and provide a sense of stability for employees.

Moreover, it is necessary to reform the mechanisms for the recruitment, allocation, evaluation, and appointment of STHR to ensure that these human resources are valued and compensated appropriately based on their abilities and actual contributions, while also encouraging creativity in scientific research. In addition to assigning tasks and commissioning STHR projects for scientists and research organizations, a transparent selection process should be implemented for organizations and individuals in the region to carry out STHR missions for the provinces and cities. This approach will ensure fairness and objectivity in the distribution and evaluation of scientific research projects.

Furthermore, creating a scientific work environment is a key factor in maximizing the potential of STHR. It not only attracts talent but also retains it in the long term. Implementing preferential policies, providing support, investing in modern infrastructure and equipment, and creating reasonable working conditions will offer opportunities for this workforce to freely innovate, conduct research, and develop their careers.

Finally, it is essential to increase the annual budget allocation from both local and central governments for the sectors of education and

training, and STHR, particularly for the development of STHR. High-quality human resource training programs in provinces and cities should be maintained and further developed, while fostering close connections, support, and favorable conditions for universities in the region to operate effectively and achieve sustainable growth. Universities play a crucial role not only in training and supplying human resources for STHR but also as centers for scientific research and technology transfer, contributing to the economic and social development of the VMD region, with notable examples such as Can Tho University

Secondly, it is as urgent to implement policies to attract human resources for science and technology.

The VMD region needs to focus on investing in the development and enhancement of research capabilities for key STHR organizations, such as the Biotechnology Center, the Center for the Application of Scientific and Technological Advances, and the Aquatic Species Research Center. These units will serve as critical bridges for collaborative efforts in implementing science and technology activities between local organizations, individuals, research institutes, universities, businesses, and scientific organizations. This approach will not only strengthen the effectiveness of scientific research and technological applications in the region but also contribute to attracting STHR human resources to the VMD region.

In addition to attracting long-term STHR human resources, the provinces and cities in the VMD region need to implement policies that encourage short-term consultancy contracts and collaborations with both domestic and international experts and scientists. At the same time, policies should be developed to attract overseas Vietnamese scientists and experts who possess high-level expertise and improved knowledge in modern STHR advancements, and who are willing to contribute to the region's development.

Thirdly, it is essential to implement policies that prioritize investment in and the development of STHR across various sectors in order to attract STHR resources to the VMD region.

It is essential to develop prioritized plans for investing in STHR across the region's specific industries and sectors, with clear objectives to guide the research activities of organizations and individuals. This will not only promote the development of STHR in the region but also contribute to attracting high-quality human resources to the VMD region.

In the field of social sciences and humanities, the focus should be on the following directions: research to promote administrative reform; theoretical studies and practical reviews to innovate and improve political and administrative systems, with strategic guidance for the formation and effective development of rural governance; research on the characteristics of the formation and development of culture, ethnicity, and religion in the provinces and cities; and theoretical studies, practical reviews, and the proposal of strategies for the socio-economic development of the VMD region, aimed at harnessing its potential and strengths.

In the field of natural sciences, the focus should be on conducting scientific research to establish arguments regarding the laws and natural conditions that contribute to solving critical short- and long-term issues, such as food security, public health, environmental protection, and the rational use of energy and natural resources. This includes, in particular, addressing climate change, rising sea levels, and other related challenges. The following technological development priorities should be considered:

(1) Information and Communication Technology: Promote applied research, refine and master technology, and transfer technology in the fields of software development, digital content, cybersecurity, and information confidentiality. Further enhance the application of information technology in administrative reforms, public management, and the management of production and business operations for products and services.

(2) Biotechnology: The focus should be placed on researching and applying advanced technologies such as cell technology, microbiology, enzyme-protein technologies, biotechnology, and genetic engineering. These studies will focus on the effective application of biotechnology in key sectors, such as agriculture, forestry, fisheries, medicine, food processing industries, and environmental protection, with

the aim of developing the biotechnology industry into a high-tech economic sector that makes an increasingly significant contribution to the economy. At the same time, it is necessary to research the production of biological products for food processing, animal feed, functional fertilizers, biological pesticides, and biofuels. The development of high-yield, high-quality, disease-resistant crops, livestock, and aquatic species that are adaptable to the impacts of climate change and suitable for the livelihoods of the VMD region is crucial. In addition, research and the implementation of measures to prevent dangerous diseases in agricultural and aquatic production should be prioritized. Studies on the conservation, preservation, and sustainable utilization of rare genetic resources, protection of biodiversity, and environmental pollution management must also be emphasized to ensure the sustainable development of the region.

(3) Environmental Technology: Develop technologies for wastewater treatment, solid waste, hazardous waste, and emissions, with functionality and cost-effectiveness tailored to the conditions of the VMD region. Implement clean production technologies and environmentally friendly technologies in local industries. Advance recycling technologies for waste generated from business and production processes in the VMD region.

(4) New Materials Technology and Machine Manufacturing Automation: Focus on researching, adopting, applying, and developing advanced new material technologies, including intensifying research on composite material production technologies, nanomaterials used in agriculture and environmental protection, and the production of advanced materials from biomass and agricultural by-products. Conduct research on the application and development of automation technologies for measurement and information processing.

6. Conclusions

This study has demonstrated that climate change is a significant driver of migration in the Mekong Delta of Vietnam, a region increasingly vulnerable to environmental degradation, sea-level rise, and extreme weather events. The outmigration of more than 1.3 million people over the past decade reflects the growing pressure on rural livelihoods, agricultural systems, and local socio-economic stability. Migration, while often seen as a coping strategy, also presents long-term challenges to sustainable development, including labor shortages, demographic imbalances, and weakened community resilience.

Through a review of global and regional literature and contextual analysis, this article has highlighted the complexity of the climate–migration nexus and the difficulty of isolating environmental drivers from economic and social variables. Nonetheless, the Mekong Delta provides a compelling case where climate-induced stressors intersect with socio-political vulnerabilities to influence migration dynamics.

To address these intertwined challenges, it is essential to adopt a proactive and integrated policy approach. This includes strengthening climate adaptation strategies, investing in local livelihoods and resilient infrastructure, and enhancing the quality of human resources through education and targeted support. Policies must also account for the rights, needs, and aspirations of both migrants and non-migrants, ensuring inclusive development pathways.

Future research should deepen empirical understanding of migration motivations, track post-migration impacts on both origin and destination areas, and explore innovative governance models for climate-resilient development. As the Mekong Delta stands at the frontlines of climate change, its experience offers critical lessons for other vulnerable regions worldwide.

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