



Mitigate+: Research
for Low-Emission
Food Systems

Forest stakeholders and forestry-based mitigation options

Contributions to low-emission food systems
in the Mekong Delta, Vietnam

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Abbreviations

MFF	Mangroves for the Future
MAM	Mangroves and Markets (MAM) project
JICA	Japan International Cooperation Agency
ICMP/GIZ	Integrated Coastal Management Programme/German Agency for International Cooperation (GIZ)
FMCR	Forest Sector Modernization and Coastal Resilience Enhancement Project
REDD+	Reducing emissions from deforestation and forest degradation in developing countries
GCF	Green Climate Fund
SP-RCC	Support Program to Respond to Climate Change

Executive summary

This report was developed based on a literature review of existing laws and policies, and reports on forestry stakeholders, forestry-based mitigation options and their linkages to food systems in the Mekong Delta in Vietnam.

The report shows that despite forests playing a vital role in providing food security, this is often overlooked by policymakers and current national and provincial policies. Only a limited number of studies have explored this linkage across the 13 provinces of the Mekong Delta region. This highlights the need for future research to address the knowledge gap to ensure better low-emission food systems in the region. While the Government of Vietnam has acknowledged the important roles forests play in its Nationally Determined Contribution (NDC), and has developed forestry-based mitigation options including afforestation/reforestation; protecting natural forests; forest restoration; and agroforestry development, the area of forest in the Mekong Delta region has fallen over the last 20 years and continues to face pressures from socioeconomic development, pollution, coastal squeeze, weak implementation of policies, and mismatches between funding needs and available resources. The viability of these forestry-based mitigation options needs to be examined carefully in the context of climate change; the absence of natural conditions for mangrove restoration due to coastal squeeze; and hydrological conditions due to upstream hydropower plant development.

Although forestry-based mitigation options are now being supported and co-funded by a wide range of actors, including forest owners, government agencies, international organizations, donors and private sector parties, their outcomes have been ineffective due to unclear tenure, conflicts of interest and weak coordination between different actors. Most Mekong Delta provinces have developed plans to address these challenges, but doing so will require macro policy changes and political commitment to protect mangroves, which do not always fall within the sphere of influence of provincial governments.

Forestry-based mitigation options have direct impacts on the earnings and food consumption of the poor, women and Indigenous Peoples in the Mekong Delta. However, these vulnerable groups are rarely involved in decision making over policies and practices. They also have difficulties participating in and benefitting from government, international, private and public-private partnership programmes as they are landless or live on contested areas of land.

Ensuring forestry-based mitigation options can contribute to low-emission food systems but will require cross-sectoral approaches, participatory decision-making processes and evidence-based analyses for determining viable options. Social inclusion and social safeguards will be essential for ensuring forestry-based mitigation and future low-emission food systems leave no one behind and do not result in social marginalization of vulnerable groups.

1 Introduction

The Mekong Delta accounts for 12% of Vietnam's total area and 19% of its population (MARD 2021). The region yields more than 50% of the country's total food, seafood and fruit production, making an important contribution to ensuring national food security (MARD 2021). GDP growth in the Mekong Delta is higher than before the Covid-19 pandemic. The region contributes 50% of the nation's rice output, 95% of its rice exports, 65% of its aquaculture output, and 70% of its fruits (Trung Duy 2021). Agricultural production in the Mekong Delta has been transformed towards establishing large-scale concentrated production areas specializing in key agricultural products such as shrimp, rice and fruits, together with associated processing technologies. However, Vietnamese agriculture remains fragmented and highly sensitive to climate change. Sea level rise is expected to create negative impacts for more than 40% of the Mekong Delta area and cause the loss of around 10% of national GDP over the next decade (Day et al. 2011; MARD 2021). Moreover, agriculture is a primary source of greenhouse gas (GHG) emissions in Vietnam.

Farmers in the Mekong Delta are technologically less efficient than in other regions of Vietnam. At the same time, the region's infrastructure system remains underdeveloped, unable to meet economic development requirements, and struggles to attract foreign investment (Thu Cuc 2021). Sustainable agriculture development in the Mekong Delta is also impeded by overexploitation of sand and water resources in the upper reaches. The construction of hydroelectric dams, in particular, has changed river flows, reduced the amount of silt, depleted aquatic resources, lowered groundwater levels, and caused coastal erosion, landslides and coastal deforestation and forest degradation (Nhat Binh 2023). The average erosion rate of 20 to 25 metres per year in Ben Tre and the erosion of the province's coastline, for example, damaged 260 hectares (ha) of mangrove forests in the ten years from 2011 to 2020 (Ben Tre Department of Agriculture and Rural Development (DARD) 2022).

With the Mekong Delta as its main food hub, Vietnam aims to produce and supply food in a transparent, responsible and sustainable manner (Thanh Lam 2022). An agricultural transformation strategy is being developed for the Mekong Delta with the reformulation of a strategic vision with appropriate strategies for nature-based solutions (Nhat Binh 2023). The climate change response for Vietnam in general, and the Mekong Delta region in particular, necessitates reducing emissions and increasing economic resilience, which will require a minimum of USD 114 million initially, and USD 254 million by 2040 (Nhat Binh 2023).

Policy initiatives are in place to provide financial incentives and technical support for Mekong Delta farmers to employ more technologically efficient methods and/or shift to more balanced farming approaches to reduce GHG emissions. These include increasing seafood and fruit, and reducing rice production. As the conservation and restoration of forest and coastal wetland ecosystems are well-demonstrated and effective climate change mitigation options (Coppenolle and Temmerman 2020; Schlesinger and Bernhardt 2020) and contribute to sustainable food systems (HLPE 2017a), the Government of Vietnam has afforded significant political attention to protecting these vital ecosystems. Nevertheless, much still needs to be done – from the farm and landscape to global levels, and at different timescales – to fully integrate the different functions of forests and trees for enhanced food security and nutrition, and sustainable development (HLPE 2017b). This will require a comprehensive understanding of the potential of forestry for emissions reduction, its contribution to food security and transformative agriculture, and which stakeholders are influenced and impacted by decisions made regarding forests.

Based on a literature review, this report provides an overview of the forestry sector, forestry stakeholders and forestry-based mitigation options in the Mekong Delta region, and discusses how these can help contribute to low-emission food systems in Vietnam.

2 The role of forests in food security and food systems

Forests play an important role in low-emission food systems (HLPE 2017a, b, c). Avoiding and reversing deforestation, land degradation and desertification are key food system-related solutions for mitigating climate change (IPCC 2019).

With increasing demand from a growing world population projected to reach nine billion by 2050, ensuring all people and nations have access to adequate and nutritious food produced in an environmentally, economically and socioculturally sustainable manner is one of the greatest challenges of the twenty-first century (Vinceti et al. 2013). Food security is defined as when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (WFS 1996). Even with enough food, a country can still be considered to be in a state of food insecurity if its food is unaffordable for the poor. Forests play a vital role in providing food, ensuring nutrition, and bringing cultural conservation values and income to people around the world (Temu and Msanga 1994; Härkönen and Vainio-Mattila 1998, Kajembe et al. 2000; Ruffo et al. 2002; Nyambo et al. 2005; Caspersen et al. 2018; Chamberlain 2020; Miller et al. 2020).

Studies have shown that over 30% of the world's population depends directly on forest-based food sources. Estimates suggest that globally, non-timber forest products provide 16.5 kcal per person per day, while firewood is an energy source for at least 2.4 billion people worldwide (FAO 2018). Forest foods contribute 30% of earnings for households living in and around forests (Seymour and Busch 2016). In the Congo Basin, 80% of people's fat and protein needs come from animals living in the surrounding forests (Smith 2012). Asian leaders have recognized the role of forests in food security and economic development for decades (Guerrero et al. 2015). Fruits, vegetables, mushrooms, wild game meat, fish, nuts and insects, flowers, stems, roots, leaves and tubers have all contributed to diversifying and ensuring nutrition in the diets of local communities and seasonal urban dwellers living near forests (Ruffo et al. 2002; Msuya et al. 2004; Vinceti et al. 2008; Jamnadass et al. 2015).

Many reports have estimated that around 53% of fruit available for consumption globally is produced in mixed forest and agroforestry ecosystems. Forests provide 15% of the fruits and vegetables, and 106% of the meat and fish that people need to consume according to health agency recommendations (Rowland et al. 2017). As communities living around forests mainly collect firewood for cooking, it also constitutes an important component in ensuring human health (Jamnadass et al. 2015). Many studies have shown that, thanks to their harvesting of forest products, people have a source of income to buy other types of food (Ruffo et al. 2002), and in emergency situations such as the global Covid-19 pandemic or droughts, famines and wars (Vinceti et al. 2008), forests provide people with a source of nutrition to cope with food shortages resulting from economic shutdowns and job losses. Forest biodiversity also helps the sustainability of agriculture, especially in promoting and providing environmental services such as pollination, supplying water, and improving soil fertility and genetic resources, thereby increasing food production (Jamnadass et al. 2015).

Each year, around 3.1 million children die from hunger and malnutrition around the world. Malnutrition also causes problems with motor and cognitive development, leading to poor educational outcomes and limited productivity in later life for many other children (Rasolofoson et al. 2020). Ensuring and supplementing nutrition for women and children is considered an important policy for many countries (Bronwen et al. 2013).

Forest foods are not only more affordable, but are also important sources of vitamin A, vitamin C, folic acid, minerals, protein, carbohydrates and fats for many communities living around forests (Ogle 1996; Kilonzo 2009). A study conducted in 25 countries around the world showed that when people have access to forest resources, the incidence of stunting in children decreases by at least 7.11% per year on average (Rasolofoson et al. 2020). Okia et al. (2019) also found that countries with higher forest cover and people with access to forest resources have higher essential nutrition indicators than other countries. Forest foods currently provide 93% of the daily recommended intake of vitamin A for women and children in forest-dependent rural communities in many African countries, including Cameroon (Fungo et al. 2016a, 2016b; Rasolofoson et al. 2020).

In Laos, wild foods are consumed daily by 80% of the population. Similarly, in Cambodia, 50%–70% of meat and vegetables consumed are sourced from forests (Guerrero et al. 2015). In Nigeria, non-timber forest products appear in the meals of 47 million, or 43.20% of households (Chukwuone and Okeke 2012). In Europe and Africa, edible wild fruits are some of the most widely used non-timber forest products, and are important sources of nutrition, medicine and income (Sardeshpande and Shackleton 2019).

Wild fruits also contain important organic acids such as malic, citric, and tartaric, which are essential for human health (Kochhar 1981). In addition, wild fruits and vegetables often contain fermented substances and prebiotic compounds that stimulate the growth of probiotics, which are highly beneficial for human health and help prevent various diseases. The demand for a healthy and sustainable diet that aims to eradicate poverty; improve environmental health; enhance human well-being and health; strengthen local food networks; adapt to poverty, increasing food demand and weather-related food shortages; enhance sustainable livelihoods; and preserve cultural heritage, is becoming increasingly popular among urban residents, and forests have the ability to supply sustainable dietary products (Ruffo et al. 2002; Vinceti et al. 2013). In addition to providing plant species, forests are also major sources of bush meat, nutrition and incomes for many local communities around the world (Wicander and Coad 2015; Alves and van Vliet 2018). In addition, with insects being considered delicacies in some cultures (470 insect species are eaten in Africa, for example) and sometimes being higher in micro and macronutrients than some animal-based foods, insect production is a growing industry in countries like Thailand and Cambodia for mitigating the negative impacts of climate change, improving biodiversity and contributing to food security (Imathiu 2020).

Forests and forest products also play important roles in ensuring nutrition and livelihoods for people in Vietnam (Dang and Tran 2006). The collection and sale of non-timber forest products such as bamboo shoots, broom grass and wild vegetables have helped people overcome severe food shortages in many localities in Vietnam (Jakobsen 2006). Vietnam's Northern Highlands region has rapidly-developing commodity markets for forest products such as black cardamom (*Amomum aromaticum*), which is now the main source of income for many ethnic minority households in the region (Tugault-Lafleur and Turner 2009). In the Northwest region, ethnic H'mong people use at least 249 plant species for food, medicine and income generation (Dao and Hölscher 2018). Despite forests playing an important role in food security, they have been overlooked in food sector policies in Vietnam and the Mekong Delta region. Only a limited number of studies have explored the linkage, which highlights the need for future research to enrich our understanding of forests and the forest nexus in the Mekong Delta.

3 An overview of the forestry sector in the Mekong Delta

3.1 Forest area and forest cover

Of the 13 provinces in the Mekong Delta region, Ca Mau, Kien Giang, Long An, An Giang and Soc Trang are the top five for forestry (Figures 1 and 2).

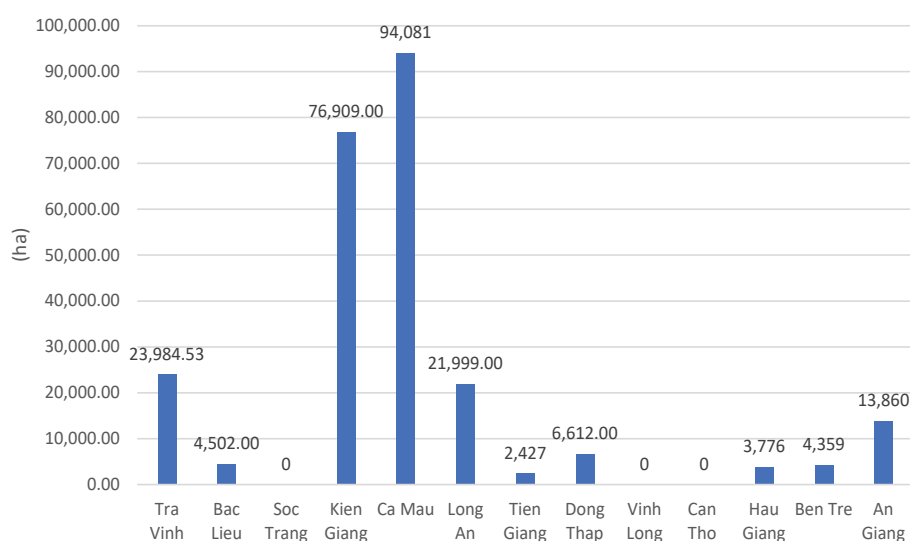


Figure 1. Forest area in Mekong Delta provinces in 2021

Sources: Tra Vinh DARD 2020; Bac Lieu DARD 2022; Kien Giang DARD 2022; MARD 2022; Ca Mau Provincial People’s Committee 2023; Hai Nhu 2023; Soc Trang Provincial Forest Protection 2023

Forest cover in most Mekong Delta provinces is generally low compared to those in the North and Central Coast regions of Vietnam. Kien Giang and Ca Mau have the highest forest cover, at 12% and 18% respectively (Figure 2).

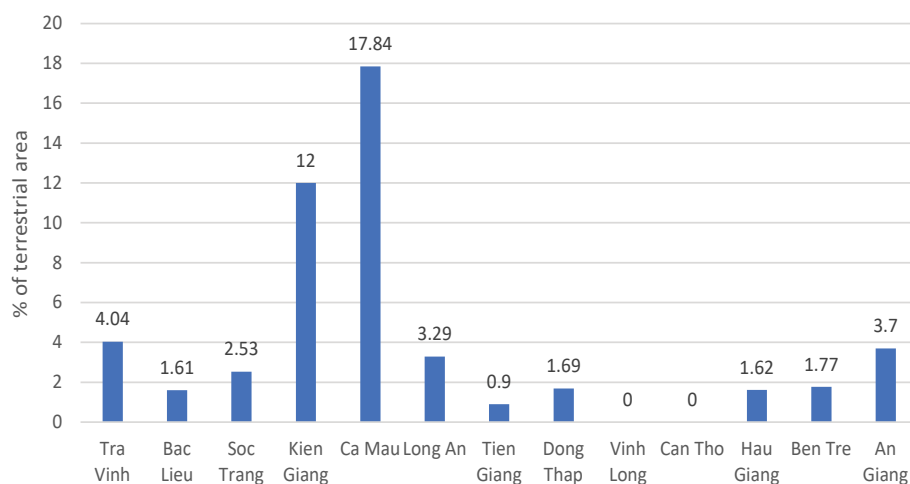


Figure 2. Forest cover in Mekong Delta provinces

Sources: Tra Vinh DARD 2020; Bac Lieu DARD 2022; Kien Giang DARD 2022; MARD 2022; Ca Mau Provincial People’s Committee 2023; Hai Nhu 2023; Soc Trang Provincial Forest Protection 2023

Figure 3 shows natural forests in the Mekong Delta being concentrated in a few provinces, with plantation forests being more widespread.

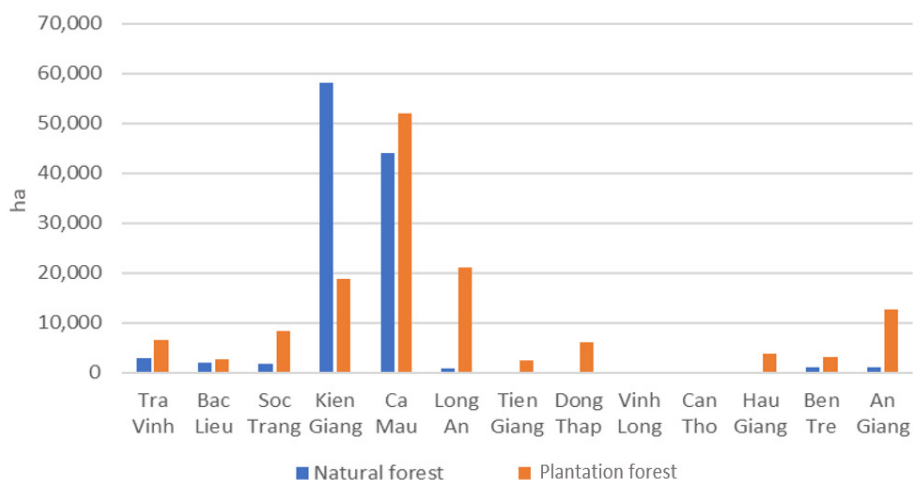


Figure 3. Forest area in the Mekong Delta by forest category

Sources: Tra Vinh DARD 2020; Bac Lieu DARD 2022; Kien Giang DARD 2022; MARD 2022; Ca Mau Provincial People’s Committee 2023; Hai Nhu 2023; Soc Trang Provincial Forest Protection 2023

According to Vietnam’s latest NDC, Mekong Delta provinces will contribute 3.4% of forestry-based mitigation outcomes for emission reduction with domestic resources, and 0.1% if the country receives international support (Government of Vietnam 2022). Mangroves are the dominant forest type in the Mekong Delta region and play important roles in protecting its coastlines against soil erosion and strong waves, supplying seafood, and accumulating carbon. Mangroves also play an important role in socioeconomic development in the Mekong Delta. In Ca Mau province, which has the largest area of mangroves in the region, its 187,533 ha of mangrove ecosystems have an estimated value of USD 600 million annually with a mean value of USD 3,000 ha⁻¹ year⁻¹, which is significantly higher than the province’s gross domestic product (GDP) of USD 1.25 million in 2010 (Vo 2013).

Forests in the Mekong Delta have significant carbon potential (Table 1).

Table 1. Carbon potential in some parts of the Mekong Delta

Location	Forest ecosystem	Carbon potential	Source
Can Gio Mangrove Forest Park (CGM), Ho Chi Minh	Growing mangrove forests, typhoon disturbed forest, and mudflat	Mean above-ground C storage of 102 ± 24.7, 298.1 ± 14.1 and 243.6 ± 40.4 MgC ha ⁻¹ for fringe, transition and interior forests, respectively. High above- and below-ground C stocks resulting in high ecosystem C storage, ranging from 765 to 1026 MgC ha ⁻¹ , with an overall mean of 910.7 ± 32.3 MgC ha ⁻¹ . Ecosystem C storage of the typhoon disturbed forest and mudflat less than that of mangrove forests, with values of 573.5 MgC ha ⁻¹ and 619.8 ± 24.3 MgC ha ⁻¹ , respectively. At the regional scale, CGM can store up to 41.5 Tg C, equivalent to 152.3 Tg of CO ₂ e.	Luu et al. 2016
Can Gio	Planted mangrove	Mean total ecosystem C stock of 889 ± 111 MgC ha ⁻¹	Vien et al. 2016
Kien Vang Protection Forest	Natural regeneration	Mean total ecosystem C stock of 844 ± 58 MgC ha	Vien et al. 2016

Pham et al. (2022d) have also highlighted the important role of Mekong Delta mangroves in offsetting carbon emissions from the transportation and logistics sector, and called for further research in this area.

3.2 Drivers of deforestation and forest degradation

Mangrove area in the Mekong Delta region fell from 185,800 ha in 1973 to 102,160 ha in 2020, at an average rate of 2,150 ha yr⁻¹ (Phan and Stive 2022). Mangrove loss in the region has been due mainly to land-use conversion; water pollution; sedimentation; coastal erosion and coastal mangrove squeeze (Weiler and McDonnell 2004; Phan and Stive 2022); resettlement and economic development policies; population growth and urbanization; demand for food and reclaiming wetland for agriculture; landslides; construction of canals and flood dyke protection systems; and expansion of travel systems (waterways and roads) (Nguyen et al. 2016; Luom and Nguyen 2021).

Conversion of mangroves for commercial agriculture production: Mangroves in the Mekong Delta have often been converted to aquaculture production, mostly shrimp farms (Ben Tre DARD 2022; Ca Mau DARD 2022; Tra Vinh DARD 2022). Aquaculture area in the region increased rapidly from 445,300 ha in 2000 to 699,200 ha in 2006, with a total aquaculture output of 1,171,001 tons, accounting for over 70% of national aquaculture output and 60% of the country's seafood export turnover (Tran 2008). Hau Giang DARD (2022) also reported mangroves being converted for rice production.

Conversion of mangroves for infrastructure facilities: A large area of mangroves in Bac Lieu has been converted for wind power plant and LNG gas power plant projects (Bac Lieu DARD 2022), while others in Hau Giang have been converted to ecotourism sites (Hau Giang DARD 2022). Upstream hydropower development and sand mining have also led to riverbed incision and mangrove loss in the Mekong Delta (Boretti 2020; Doan et al. 2020).

Natural drivers of mangrove loss: An average of 140 m was found to be the minimum critical width to sustain healthy mangrove forest for the southeastern and eastern Mekong Delta coast (Phan et al. 2015). In many areas, however, estuarine mangroves have degraded into narrow strips of <50 m. Riverbanks along the Mekong River have been eroding at a rate of 2–4 m year⁻¹ (Truong et al. 2017). In Vinh Chau Town, Soc Trang Province, erosion rates of 3.0–16.9 m year⁻¹ have led to gradual loss of mangrove forests and farmland (Tran et al. 2022). Further, the Mekong Delta is sinking and shrinking due to excessive groundwater withdrawal for agriculture and other uses; reduced water flow and sediments due to upstream dams; growing upstream water use and riverbed mining; reduced replenishment of aquifers (Gamboa-Álvarez et al. 2020); and thermo-steric sea level rise (Day et al. 2011). Food production from agriculture and fisheries has become more difficult due to the salinization of soil and aquifers (Eswar et al. 2021); depletion of aquifers; constraints to fish migration; increased pollution; reduced nutrient flows, deterioration of coastal mangrove belts; general degradation of ecosystems; and loss of emerged land (Zimdahl 2006). These have also limited the availability of clean fresh water for domestic use.

Population growth: The population in the Mekong Delta region increased from 15.33 million in 1995 to 17.42 million in 2022. The region has an unemployment rate of 4.52%, poverty rate of 9.25%, and average annual per capita income of only USD 560; lower than the national average (Tran 2008). These, and limited land, have led to significant pressures on natural resources, notably mangroves, as they are often considered low in economic value.

Environmental pollution: Waste from households, industrial estates and business activities causes pollution and affects mangroves (Tran 2008). The total volume of sludge and aquaculture waste in the Mekong Delta reaches around 456 million m³ year⁻¹. Approximately two million tons of chemical fertilizers and 500,000 tons of pesticides and aquaculture products are used annually in agriculture (Tran 2008). Oil and gas exploration also cause environmental incidents and pollute rivers and coastal areas. The Mekong Delta has 81 locations where riverbank and coastal erosion and 37 where sedimentation pose environmental incident risks. In recent years, and especially in 2007, oil spills have affected marine and coastal environments in Ca Mau, Bac Lieu, Soc Trang, Tra Vinh and Tien Giang provinces, causing economic and environmental damage (Tran 2008).

Production, businesses and services have developed rapidly in the Mekong Delta region, growing from 10,900 establishments in 2003 to 14,258 in 2007. In 2003, 68 industrial parks and industrial clusters covered a total area of 15,154 ha, but by 2007 the number had grown to 151 industrial parks and concentrated manufacturing clusters (Tran 2008).

3.3 Forests and food security in the Mekong Delta

Forests in the Mekong Delta not only provide income sources for people, but also wild meat and vegetables (Ogle et al. 2009; Nuwer and Bell 2013) and medicines (Ogle et al. 2003) for local people, and play an essential role in providing important nutrients for women in the region (Ogle et al. 2010). In Cat Tien National Park, people harvest over 100 plant species for daily consumption and sale (Dinh et al. 2012). In the Mekong Delta and Central Highlands regions, wild forest vegetables contribute significantly to overall micronutrient intake, mainly carotenoids, vitamin C, and calcium for women in these areas (Britta et al. 2001). *Melaleuca* forests in the Mekong Delta provide a valuable harvest of honey from wild bees' nests, amounting to five or six litres of honey per hectare annually (Ministry of Natural Resources and Environment (MONRE) 2016). Mangroves also serve as natural wastewater treatment areas for shrimp farming and aquaculture in the Mekong Delta (MONRE 2016).

The production of foods, such as shrimps and rice, has led to mangrove loss in the Mekong Delta (Phan and Populus 2007; Tran et al. 2014; WBCSD 2023). Yet, the sustainability of rice-based and aquaculture-based production systems in the region depends to a large extent on the health of the landscapes they are part of (Thai 2019; WBCSD 2023). In particular, watershed wetlands and forests are vital for ensuring the stability of water supply needed by rice paddy systems (WBCSD 2023). While intensification and dyke construction programmes have significantly increased rice production, conversely farm household catches, collection and consumption of wild foods (animals, fish, vegetables) have all decreased (Nguyen et al. 2018; Nguyen et al. 2020). Stakeholders in the Mekong Delta have also expressed concerns over the loss of wildlife, including fish and plant species, in the Mekong Delta (VNA 2020). There has been significant wet and dry season variation in food availability, with poor households experiencing the greatest difficulties. Rice intensification policies aimed at global food security need to balance the wider population's access to this staple food with rice farming communities' need to access high quality wild foods from the fields and waterways of rice farming landscapes (Nguyen et al. 2018).

Although most local people in the Mekong Delta earn their incomes from rice production, when their crops are damaged by natural disasters they often resort to harvesting wild mangrove resources as a strategy for dealing with livelihood stress (Fly 2002).

4 Forestry stakeholders in the Mekong Delta

4.1 Forest owners

According to the 2017 Forestry Law (Government of Vietnam 2017), Vietnamese forest owners are special-use forest management boards; protection forest management boards; economic organizations; the armed forces; science, technology and education organizations; households and individuals; and local communities. In the Mekong Delta, however, people's committees in communes, wards and towns take on the role of forest owners, though not all perform their forest protection and management roles (Soc Trang DARD 2022).

The 2017 Forestry Law specifies that forest owners have the following rights:

- To have their rights to use forests and the rights to own planted production forests recognized by competent state agencies in accordance with law;
- To enjoy forest products as a result of their investments in natural forests or planted special-use or protection forests;
- To use forests within the forest allocation or lease terms and the land allocation or lease terms for afforestation in accordance with this Law and the legislation on land;
- To be provided with forest environmental services and benefit from such services;
- To be provided with technical guidance and other support under regulations to protect and develop forests and conserve biodiversity; to benefit from state-invested infrastructure facilities serving forest protection and development;
- To be compensated by the state for the values of forests and assets which they have lawfully invested in or built by the time of issuance of decisions to recover their forests;
- To be provided with financial support by the state when their production forests are damaged due to a natural disaster;
- To enter into cooperation and partnerships with organizations and individuals at home and abroad to protect and develop their forests;
- To have other lawful rights and interests guaranteed.

Depending on forest type (special-use, protection or production), forest owners have different rights and functions in the management, protection and utilization of forests and forest resources. Mangrove management in the Mekong Delta's coastal provinces is currently driven by two types of state-owned organizations – protection forest management boards and forest protection departments – either directly, which is most frequently the case, or by contracting households to protect mangrove areas, commonly with forest owners allocating forests to households for direct protection (Tran and Dinh 2021). In some localities, however, forest management and protection is allocated to private enterprises or police departments.

Table 2 details the roles, rights and responsibilities assigned to forest owners in Mekong Delta provinces.

Table 2. Roles, rights and obligations of forest owners in Mekong Delta provinces

Province	Roles, rights and obligations
Bac Lieu	<ul style="list-style-type: none"> • Forest owners perform inventories, monitor developments in forest resources and report them to the Forest Protection Department. • In the event of a forest fire, the forest owner must promptly extinguish the fire and immediately report it to the competent state agency. • Forest owners take measures to prevent and eliminate organisms harmful to forests; If harmful organisms are detected in assigned or leased forest areas, they must immediately notify the nearest plant protection and quarantine agency for guidance and support in conducting prevention measures. • Forest owners take responsibility for the spread of any harmful forest epidemics resulting from their failure to take measures to prevent and eliminate them according to provisions of the Forestry Law, the law on plant protection and quarantine, and veterinary law; state recovery of forests is regulated in the 2017 Forestry Law. • When the state recovers all or part of a forest, the forest owner shall be compensated for their labour, investment, and recovered assets, except in cases specified in the Forestry Law.
Soc Trang	<ul style="list-style-type: none"> • Forest owners shall undertake fire prevention and firefighting preparatory work. • Forest owners shall implement forest protection contracts when funded.
Kien Giang	<ul style="list-style-type: none"> • Forest owner units organize 113 stations, checkpoints and camps with 928 personnel on standby 24 hours a day in key areas. • Forest ranger forces, in coordination with local authorities, relevant agencies and forest owners, shall organize promotion and education on forest management law. • Forest owners report the status of forest and forest environment leases to the Department of Agriculture and Rural Development.
Ca Mau	<ul style="list-style-type: none"> • Forest owners coordinate with the authorities to conduct routine patrols and inspect the management of the three forest types, ensuring the correct use of forests in management areas. • Forest owners develop sustainable forest management plans and submit them to competent authorities for approval in accordance with legislation. • Forest owners organize and implement plans for forest product exploitation, afforestation and other silvicultural projects, and promptly rectify any errors detected during the organization and implementation of procedures and processes. • All forest owners, whether organizations, households or individuals shall develop fire prevention plans in accordance with the provisions of Decree No. 156/2018/ND-CP dated 16 November 2018 and the rules of proactive localities.
Tien Giang	<ul style="list-style-type: none"> • Forest owners must fully comply with, and proactively implement measures to prevent and eliminate organisms harmful to forests, and shall be held responsible when not doing so. • Forest owners are responsible for protecting forest areas allocated or leased by the State.
Dong Thap	<ul style="list-style-type: none"> • Forest owners shall strengthen patrols and control of high fire risk areas; detect fires early; promptly prevent any acts violating forest resources and causing forest fires; and proactively handle any forest fire occurrences.

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Table 2. Continued

Province	Roles, rights and obligations
Hau Giang	<ul style="list-style-type: none"> • Forest owners shall promptly survey and carry out dredging of main canals to clear water flow, provide water storage services, and facilitate the transportation and delivery of firefighting equipment when incidents occur. • Forest owners must ensure the deployment of forces on watch towers and command posts, as well as the readiness of firefighting forces and equipment, and increase patrols and control of people entering and exiting forests. • Forest owners must manage forests sustainably; organize effective management and use of their assigned land funds; not allow forest and forest land encroachment violations; proactively plan on site, particularly in reviewing and inspecting equipment and water supply systems for forest fire prevention and fighting; pay attention to coordination; and create conditions for Steering Committee member units and participating forces to assist when incidents occur. • Forest owners shall be proactive in inspecting and reviewing equipment and water supply systems for fire prevention and firefighting, and in patrolling and responding effectively in accordance with each unit's fire prevention plan. Individuals and organizations that cause forest fires must be dealt with strictly. Depending on the level of violation, they shall face administrative sanctions or criminal prosecution in accordance with regulations. • Forest owners shall hire people to guard their properties, thereby reducing numbers of people needed for patrols, and shall control those people guarding their properties whilst sharing benefits with a number of low-income households. • Forest rangers shall work with forest owners to organize forest protection patrols and interdisciplinary patrols commencing in the dry season.
Ben Tre	<ul style="list-style-type: none"> • Forest owners must raise awareness and take greater responsibility for protecting and developing coastal forests.
An Giang	<ul style="list-style-type: none"> • Forest protection contracts should be implemented for ethnic minorities and local communities. Locals shall be compensated for forest protection costs, and shall be able to enjoy the fruits of integrated aquaculture under forest canopies in areas assigned to them, as well as the products of thinning and exploitation when their forests mature. • Forest owner units must develop production plans and organize forest protection forces, as well as establish forest protection stations throughout their forest areas, and ensure their proper management.

Sources: Communist Party of Vietnam Online Newspaper 2016; People's Council of An Giang Province 2016; Diep and Tuan 2019; Khanh 2019; My 2019; Minh Tri 2020; Bach Thanh 2021; Cam Uot 2021; Le Hung 2021; People's Committee of Ben Tre Province 2021; SNN&PTNT Đồng Tháp 2021; Xuan Huy 2021; TH 2022; An Nhien 2023; Dang 2023; Hong Thai 2023; Huu Phuoc 2023a, b; Nguyen 2023; Quoc Hung 2023; Thanh Binh 2023; Thanh Dung 2023; Thanh Sang 2023; Trung Phong Su 2023

4.2 Forest management agencies

Forest management in the Mekong Delta is governed by central and provincial government agencies. Central government agencies include:

- The **Ministry of Agriculture and Rural Development (MARD)**, which is responsible for developing and guiding provinces in implementing forestry-based mitigation measures.
- The **Ministry of Science and Technology**, which promulgates national standards for planting forests to protect against waves and for sea reclamation (TCVN 12510-2:2018); planting forests as windbreaks to protect sandbars (TCVN 12510-1:2018); plantation forests - forests after basic construction - mangrove species group (TCVN 12509-3:2018).
- The **Ministry of Planning and Investment**, which develops investment policies like the "Public investment program to respond to climate change and green growth in the period of 2021–2025" for integrating projects on coastal forest protection, restoration and development in the 2021–

2025 period in the Green Growth component of the programme. It also cooperates with MARD in positioning projects on planting and protecting forests in coastal areas on the priority list for use of international grants and loans.

- The **Ministry of Finance**, which develops guidelines on cost norms related to forest protection and development activities.
- The **Ministry of Natural Resources and Environment**, which develops national land-use plans, including for forestry land, and issues land-use rights certification.
- The **Ministry of Defence**, which instructs agencies and units of the armed forces to participate in, and closely coordinate with departments and local authorities in the protection of forests in coastal areas, especially maritime border areas, and uninhabited areas.
- The **Ministry of Public Security**, which instructs agencies and police force units to coordinate closely with departments, forest rangers and local authorities in providing information on, preventing and fighting violations of forestry law.

These central government agencies have departments in each province to mainstream their central vision into local practice. Provincial Department of Agriculture and Rural Development (DARD) offices are responsible for forestry-based mitigation in their provinces, and assigned the following tasks:

- Instructing forest owner units to cooperate with people's committees of communes, wards and townships in inventorying and monitoring forest resources developments, reporting them to the General Forest Protection Department, and advising provincial people's committees for the promulgation of decisions and announcements on forest resources developments;
- Surveying, reviewing and adjusting forest status maps;
- Surveying, measuring areas and determining forest types;
- Conducting evaluations of environmental protection outcomes;
- Organizing forest plantation;
- Signing forest protection contracts with forest management boards and local communities;
- Verifying and issuing licenses for newly developed seedlings;
- Enforcing forestry law and policies;
- Managing fire control;
- Verify imported and exported timber;
- Promoting government policies;
- Monitoring wildlife management;
- Organizing environmental education programmes in schools;
- Guiding the implementation of Vietnam's national Payment for Forest Environmental Services (PFES) programme by monitoring payments from the private sector;
- Providing input for environmental impact assessments on land conversion;
- Advising provincial people's committees on land allocation, forest allocation and issuance of land-use rights certificates; and advising special-use forest and coastal forest protection management boards on using special-use and protection forests, and protecting and developing them according to planning and approved plans.

All of these provincial government departments also need to report to, and follow instructions from **Provincial People's Committees (PCPs)**, which have the following responsibilities:

- Planning, developing and monitoring land-use, forest protection and development plans in coastal areas; recovering land areas belonging to dyke protection safety corridors; and restoring and replanting forests in accordance with regulations in areas planned for afforestation that have been illegally encroached upon or used by organizations and individuals, and land areas used improperly or ineffectively;
- Monitoring and updating coastal forest databases for management and supervision purposes;
- Organizing forest allocation in accordance with provisions of law, especially forest areas currently managed by commune-level people's committees, and strengthening community forest management;
- Directing promotion and education to raise awareness of the roles and functions of forests in coastal areas in all strata of society; mobilizing people and economic sectors to participate actively in protecting and developing coastal forests in response to climate change.

4.3 International projects and international donors

In addition to the above government-led forestry-based mitigation initiatives, donors and international organizations have also funded a large number of sustainable forest management projects in the Mekong Delta region (Table 3).

Table 3 also provides an overview of other key initiatives in the region.

Table 3. Key donors supporting sustainable forest management in the Mekong Delta

No	Year	Donor	Project name	Funding	Goals
1	2018	Government of the Federal Republic of Germany	Integrated Coastal Management Programme commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) (2011–2018)	EUR 7.5 million	Assist the Government of Vietnam in developing an innovative, coordinated and comprehensive response to climate change in the Mekong Delta, including better coordination of key actors and climate-responsive planning and budgeting Be a pilot scheme for the regulation of regional coordination in the Mekong Delta to enhance the effectiveness and efficiency of climate strategies and investments in the region's 13 provinces
2	2016–2020	Netherlands Development Organisation (SNV)	Mangroves and Markets: Scaling up Ecosystem-Based Adaptation in the Mekong Delta (MAM-II)	VND 5.3 billion for paying certified households for Payments for Forest Ecosystem Services (PFES)	Support mangrove restoration and protection in the Mekong Delta, while strengthening the livelihoods and resilience of smallholder shrimp farmers and their families (SNV 2016). The Mangroves and Markets (MAM) project worked with partners and donors to support the drafting of a national policy in Vietnam that provides the legal basis for mangrove PFES Work with major European shrimp importers to expand certification in Vietnam to support market access and consequently jobs and income
3	2019	World Bank	Integrated Climate Resilience and Sustainable Livelihoods in the Mekong Delta (WB9) - ICRSL (Pham et al. 2022a)	USD 209.814 million	Support afforestation activities and helping sustainable forest-shrimp farming, for climate change adaptation combined with coastal protection works
4	2020	Adaptation Fund	Enhancing the resilience inclusive and sustainable eco-human settlement development through small scale infrastructure interventions in the coastal regions of the Mekong Delta in Viet Nam (Kretschmer 2020)	USD 6.3 million	Focus on dealing with saltwater intrusion and coastal erosion in the Mekong Delta, both of which are major impacts of climate change

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Table 3. Continued

No	Year	Donor	Project name	Funding	Goals
5	2010–2016	SNV	Delivering Environmental and Social Multiple Benefits from REDD+ in Southeast Asia (CEC et al. 2020)	USD 3,300,000	Support the Government of Vietnam to successfully implement national REDD+ programmes that facilitate multiple social and environmental benefits in Lam Dong and Ca Mau
6	2012–2016	SNV + IUCN + GIZ	Mangroves and Markets: Supporting Mangrove Protection in Ca Mau Province, Vietnam (CEC et al. 2020)	USD 1,238,000 - German Federal Ministry of Environment, Nature Conservation and Nuclear Safety (BMU): USD 9,999 - Unknown buyers	Restore mangroves subject to clearing and degradation, and help reverse this trend by helping the authorities to access markets to pay for the multiple benefits mangroves provide. Work with shrimp importers, traders and farmers to introduce ecologically sound shrimp production in areas of high deforestation and degradation Restore abandoned shrimp ponds. Access carbon finance
7	2016–2024	World Bank	Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project (World Bank 2016)	USD 387 million	Access relevant data and information on key parameters from MONRE for informing climate resilient planning Support areas with climate resilient land and water management practices Engage provincial and central stakeholders to inform the formulation of a Mekong Integrated Regional Master Plan project Support farming households that adopt climate resilient land and water management practices
9	2016–2022	The International Development Association (IDA)	The Mekong Delta Integrated Climate Resilience and Sustainable Livelihoods Project (MD-ICRSL Project) (MARD 2023)	USD 385.9 million	Strengthen tools for planning and adapting to climate change and improving resilience to climate change for land and water resource management in selected provinces in the Mekong Delta
10	2017–2022	Federal Republic of Germany through the German Development Bank (KfW)	Integrated Coastal Protection and Mangrove Belt Rehabilitation Project for Kien Giang and Ca Mau provinces (Management Board for Forestry Projects 2020)	EUR 24,000,000	Mitigate negative impacts of sea level rise and climate change for effective, economic and sustainable coastal protection in project areas

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Table 3. Continued

No	Year	Donor	Project name	Funding	Goals
11	2018–2021	Green Climate Fund (GCF)	Improving the resilience of vulnerable coastal communities to climate change related impacts in Vietnam Component 2 (Pham et al. 2022b)	In 2021: VND 100 billion	Support afforestation, additional planting and forest protection in Ca Mau
12	2019–2024	European Union and the Food and Agriculture Organization (FAO)	Promoting climate-sensitive innovations in the Mekong Delta through diversified public-private partnerships (Even et al. 2019)	USD 49.4 million	Strengthen the enabling environment by supporting climate resilient community planning, salinity monitoring and alert systems, participatory research and extension material to promote climate resilient and salinity adapted agricultural practices Provide various lines of investment to facilitate public-private partnerships and co-investments to implement plans
13	2011–2050	JICA	Climate Change Adaptation for Sustainable Agriculture and Rural Development in the Coastal Mekong Delta in Vietnam (Government of Vietnam 2013)	USD 24.758 million	Present climate change adaptation solutions for sustainable agriculture and rural development in coastal areas in the Mekong Delta Make climate change impact predictions (mid to long term, 2020–2050) and assessments Formulate a climate change adaptation master plan based on which priority project plans are recommended Strengthen Sub-Institute for Water Resources Planning (SIWRP) capacity to plan and implement climate change adaptation measures for the agriculture and rural development sector
14	2018	The Federal Republic of Germany	Combining coastal protection and mangrove belt restoration in Kien Giang and Ca Mau provinces	EUR 7.5 million	Support forest protection contracts (Kien Giang: 1,000 ha); afforestation and restoration of 1,800 ha (Kien Giang 1,500 ha; Ca Mau 300 ha); planting five million scattered trees (Kien Giang); building two models of afforestation on eroded land (one model per province)
15	2022	SNV, MONRE and the German Ministry for Economic Affairs and Climate Action	Vietnam Nature-based Solutions for Adaptation in Agriculture through Private Sector Transformation (VN-ADAPT)	EUR 15 million - national programme	Seek solutions for conservation and restoration of biodiversity and ecosystems, by helping to improve local people’s livelihoods, and through smart agriculture that is adaptable to climate change Help promote nature-based solutions in the agricultural sector and speed up the transformation of production practices in key regions, including the Mekong Delta, to help them better adapt to climate change

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Table 3. Continued

No	Year	Donor	Project name	Funding	Goals
16	2021 – 2024	Dutch Fund for Climate and Development (DFCD), WWF Vietnam, Ca Mau DARD	Responsible shrimp-rice investment project	EUR 800,000	<p>Focus on a range of high-impact investment themes in four key areas: climate-resilient water systems and freshwater ecosystems; forestry for the future; enhancing food security with smart agriculture adapting to climate change; and environmental and human rights protection to address climate change and achieve sustainability goals</p> <p>Research and evaluate the status of rice-shrimp rotation production areas in Cuu Long province</p> <p>Assess the current status of irrigation systems, water management and water quality in shrimp-rice production areas and conduct local field surveys to select a suitable pilot location for project activities</p> <p>Assess the location’s viability and propose it to the sponsoring agency for consideration. The aims of the 500-ha pilot are to research and improve techniques for building a sustainable shrimp-rice chain, enhance the value of shrimp, rice, and especially responsible production to create positive economic, social and environmental impacts at the landscape level in the Mekong Delta coastal region (Van Bach 2021)</p>
17	2023	Ministry of Agriculture and Rural Development (MARD) and the UK Department of Environment, Food and Rural Affairs (Defra)	Biodiversity Landscape Fund in the Lower Mekong region in Vietnam	A minimum of GBP 25 million (more than VND 720 billion)	<p>The Fund’s objective is to help the Vietnamese Government to: achieve its poverty reduction goals; reduce biodiversity loss and mitigate the impacts of climate change at local and transboundary scales; and implement international commitments such as the UN Convention on Biological Diversity (CBD), UN Framework Convention on Climate Change (UNFCCC), UN Sustainable Development Goals (SDGs), UN Forests 2017–2030 and other relevant regional and inter-regional agreements. This is expected to bring important resources for biodiversity conservation in the Lower Mekong region in particular and Vietnam in general (MARD 2023)</p>
18	2021–2024	USAID, International Union for Conservation of Nature (IUCN)	Mekong Delta Coastal Habitat Conservation (Locations: Kien Giang and Soc Trang)	USD 2,900,000	<p>Work in partnership with the Government of Vietnam, provincial governments, businesses, management boards, development partners and fishing communities to protect key coastal habitats in the Mekong Delta region; increase the sustainability of fisheries; enhance climate change adaptation; and improve biodiversity conservation (USAID 2023).</p>

Sources: Government of Vietnam 2013; World Bank 2016; Even et al. 2019; CEC 2020; Kretschmer 2020; Management Board for Forestry Projects 2020; Thuy Lieu 2021; van Bach 2021; Pham 2022a, b; SNV 2022; IUCN 2023; MARD 2023; USAID 2023

4.4 The private sector

Forestry-based mitigation options are also funded by the private sector (Table 4).

Table 4. Key private sector actors funding forestry-based mitigation options in the Mekong Delta

No	Year	Donor	Project name	Funding	Goals
1	2017–2022	Federal Republic of Germany through the German Development Bank (KfW)	Integrated Coastal Protection and Mangrove Belt Rehabilitation Project for Kien Giang and Ca Mau provinces (Management Board for Forestry Projects 2020)	EUR 24,000,000	Mitigate negative impacts of sea level rise and climate change for effective, economic and sustainable coastal protection in project areas
2	2022–2023	C.P. Việt Nam (CPV) and Pan Group	Increasing mangroves' area in Mekong Delta provinces (VBCSD 2022)	USD 200,000	<p>Improve the value and sustainability of seafood value chains (shrimp, pangasius) by coordinating with partners for effective implementation</p> <p>Develop forests; protect land against erosion, saltwater intrusion, storms and floods; reduce CO₂ emissions; and improve livelihoods</p>
3	2023–2029	Asian Development Bank	Restore and sustainably manage coastal forests in the Mekong Delta and increase adaptability to climate change (Quynh and Tuyet 2022)	USD 64 million	<p>Plant 3,500 ha of new forests, and restore 1,000 ha of degraded forests</p> <p>Develop a sustainable forest management plan for all forest owners; demarcate forest boundaries; and implement a coastal forest co-management model for existing forest and new planting areas</p> <p>Provide technical solutions to create land; build five high-tech incubators; plant three million scattered trees; set up a forest management and monitoring system; build 25 sustainable aquaculture farming models; build 25 coastal forest eco-tourism models; conduct capacity building and institutional development for forest governance</p>
5	2018–now	SK Innovation, Manglub Vietnam, UNEP Korea, Dreamsharing and Afoco	Mangrove Reforestation Project		<p>Address climate change and preserve biodiversity through reforestation by sponsoring the establishment of MangLub, the first social enterprise in Tra Vinh Province, and organize internal volunteer programmes</p> <p>In 2019, MangLub began planting mangrove seedlings at the tip of Con Ban, a small islet near the Co Chien's confluence with the East Sea where several households live from shrimp farming. That year, they planted 1,500 mangroves over almost 1 ha. In 2020, they added 180,000 seedlings across 30 ha, both on Con Ban and along the nearby coast (Saigoneer 2021; SKinno News 2023).</p>

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Table 4. Continued

No	Year	Donor	Project name	Funding	Goals
6	2016– now	VRG Kien Giang MDF Wood Joint Stock Company	VRG Kien Giang MDF Wood Processing Factory Project	VND 1,260 billion	<p>Build on-site raw material sources through contracting to plant, protect and exploit forests, and at the same time, organize the purchasing of raw materials from people inside and outside the project area</p> <p>Determining that boat owners are long-term sources of raw materials for the factory, the company built a fair purchasing mechanism, with supporting policies that harmonize benefits. For out-of-province boat owners, the company directly supports the price of raw materials. This policy helps forest growers sell wood at high prices, while also contributing to increasing income for farmers in remote areas.</p> <p>In addition, the company ensures jobs and stable monthly salaries for people, while providing training on Melaleuca planting and maintenance techniques to generate higher incomes (Tran and Hong 2021).</p>
7	2022	Dutch Fund for Climate and Development (DFCD), SNV and Camimex	Resilient Mangrove Shrimp Project	EUR 290,250	<p>Bring 16,500 ha of forest – wetlands under sustainable management;</p> <p>Sequester a total of 10 million tons of greenhouse gases per year, of which 1.5 million tons of greenhouse gas sequestration will come from planting additional mangroves;</p> <p>Scale-up the capacity of higher-value organic certified shrimp exports, which will increase smallholder farmer livelihoods by at least 10% while protecting biodiversity and mangrove ecosystems;</p> <p>Positively impact 12,000 farmers directly and indirectly, including benefiting women, minorities and vulnerable persons;</p> <p>Assess the potential for blue carbon as a tool to further protect Vietnam’s mangrove belt, which can act as a nature-based solution protecting against erosion and providing protection for inland communities (SNV 2022).</p>

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Table 4. Continued

No	Year	Donor	Project name	Funding	Goals
8	2016–2024	IUCN, Hyundai Motor Company and Good Neighbors International (GNI)	IONIQ Forest project		<p>Plant 120,000 mangrove trees in the first year, primarily <i>Rhizophora</i> and <i>Avicennia</i> species, in Nam Can District in Ca Mau Province to build on work by IUCN and SNV on mangrove restoration as part of a German International Climate Initiative (IKI) organic shrimp project in neighbouring Ngoc Hien District</p> <p>If mangrove cover is sufficiently restored, the mangrove-shrimp landscape could be recognized as an OECM (Other Effective area-based Conservation Measure), a new designation of protected and conserved land or water outside of formal protected areas. OECMs are a part of the new Global Biodiversity Framework to which Vietnam is a signatory (IUCN 2023).</p>
9	2024	Mekong Capital	Regeneration of forests in the Mekong region	USD 200 million	<p>Establish a climate fund focussing specifically on Southeast Asia for businesses to help restore forests, including those involved in organic and seaweed farming in the Mekong region (Laos, Cambodia, Thailand and Vietnam) (Reuters 2023)</p>
10	2016–now	Minh Phu Company	Payment for Mangrove environmental services		<p>Support farmer participation in a certified organic shrimp programme that links a 10% price premium to the maintenance of 50% mangrove cover in each shrimp farm</p> <p>The company pays shrimp farmers VND 500,000 ha⁻¹ of mangrove forest and an extra VND 3000–5,000 kg⁻¹ of organic certified shrimp. It also pays VND 1,000 to the forest owner (Decision No.111/QĐ-UBND). Together, these payments represent a price premium of about 2.5% compared to the 10% originally negotiated.</p>
11	2016	Mua Vang			<p>Mua Vang was allocated 3,000 ha from the state to plant mangroves through a VND 56 billion counterpart fund with 87% from the state budget and 13% from company budget. After three years of implementation, it had planted 413 ha.</p>

Sources: Pham et al. 2019; Management Board for Forestry Projects 2020; Saigoneer 2021; Tran and Hong 2021; van Bach 2021; Quynh and Tuyet 2022; VBCSD 2022; Reuters 2023; Skinno News 2023

5 Forestry-based mitigation options in the Mekong Delta

Vietnam's latest Nationally Determined Contribution (NDC) prioritizes seven forestry-based mitigation options:

- protecting existing natural forests in mountainous areas;
- protecting coastal protection and special-use forests;
- restoring protection and special-use forests;
- improving the quality and carbon stock of poor natural forests;
- enhancing the productivity and carbon stock of large timber plantation forests;
- scaling-up agroforestry models to increase carbon stock and conserve soil;
- reducing emissions through sustainable forest management and forest certification.

Implementation of mitigation options proposed in the NDC for 2021–2030 could lead to a total emissions reduction (including increased carbon sequestration) of 82.54 Mt CO₂e through national efforts, and 186.5 Mt CO₂e with external support. Mangrove biomass in the Mekong Delta region may contribute 70–150 t ha⁻¹, but considerably larger storage of carbon occurs in sediments beneath mangroves (Warner et al. 2016), which have not been well studied. In addition to these seven forestry-based mitigation strategies, Government Decision 120 (Prime Minister 2015) and Decision 770 (Prime Minister 2019) also specify forestry-based mitigation strategies for Mekong coastal forests, including government agencies signing forest protection contracts with local communities; afforestation; restoration; and planting scattered trees.

In addition, with support from international organizations, Mekong Delta provinces are also developing and piloting different agroforestry production and livelihood models in coastal areas so people can be more actively engaged in co-managing forests and reducing forest loss. For example, forest co-management implemented in Ca Mau combines agriculture, forestry and fishery models involving beekeeping, chicken rearing, sea ducks, shrimp, crab and fish in mangrove forests. In the Mekong Delta region, *Rhizophora*-based agroforestry can potentially reconcile mangrove restoration and livelihood

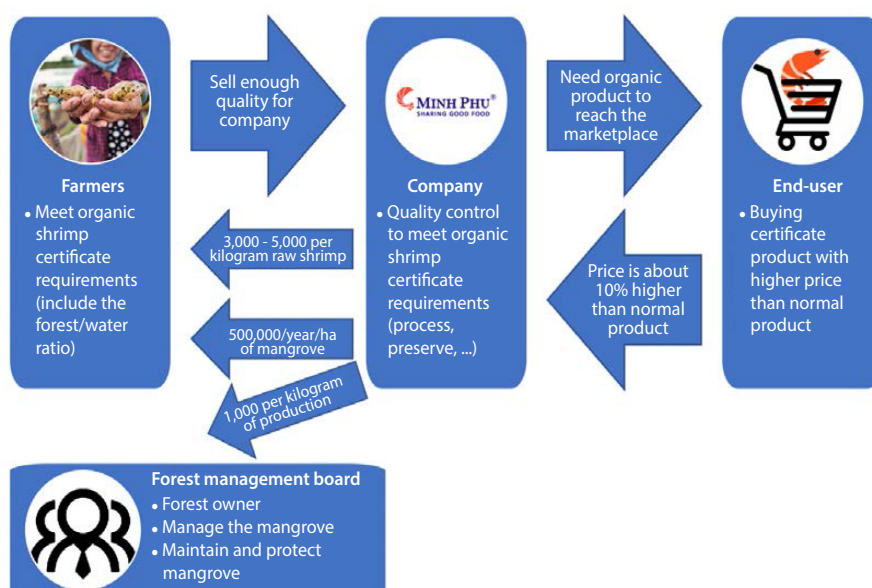


Figure 4. PES scheme for mangrove protection and development in Ca Mau

Source: Pham et al. 2019

improvements by combining mangrove planting and shrimp farming (Pham et al. 2022c). Through its mangrove forest shrimp farming model in Ca Mau province, for example, the MAM project has already expended VND 5.34 billion in payments for forest environmental services to 3,200 households certified for organic shrimp farming involved in protecting 15,600 ha of mangrove forests (Figure 4).

Mekong Delta provinces are also developing their own forestry-based mitigation approaches to align with the NDC and national policies (Tables 5 and 6). These focus mainly on allocating forest land and developing sustainable livelihoods for local people to increase stakeholder participation in forest protection, provide training, develop infrastructure, and strengthen law enforcement and fire management.

Between 2021 and 2025, the Government of Vietnam also proposed different forestry-based mitigation options (Table 6).

Table 5. Forestry-based mitigation options

	Ca Mau	Bac Lieu	Soc Trang	Kien Giang	An Giang	Long An	Dong Thap	Hau Giang	Ben Tre	Tien Giang	Tra Vinh
A. Mitigation options											
Protecting natural forests	x			x							
Afforestation	x	x	x	x	x	x		x	x	x	x
Planting protection forests	x	x	x	x					x	x	x
Accelerating Payments for Forest Environmental Services	x				x		x	x	x		
B. Approaches for achieving mitigation outcomes											
Building infrastructure for local people so they can improve trading and production systems. In return, local people will protect forests and reduce cutting	x	x	x	x							x
Strengthening law enforcement		x	x						x	x	
Allocating forestry land to local people and improving land-use planning	x	x									
Capacity building for local people	x	x	x					x			
Forest fire management		x		x							
Developing carbon projects			x								
Signing forest protection contracts with local communities				x							

Sources: Tra Vinh DARD 2020; Phuc 2021; Phuong 2021; Bac Lieu DARD 2022; Kien Giang DARD 2022; MARD 2022; Ca Mau Provincial People’s Committee 2023; Dong Thap DARD 2023; Hai Nhu 2023; Hau Giang Provincial Party Committee 2023; Huu 2023; Long An People’s Committee 2023; Minh 2023; My 2023; Soc Trang Forest Protection Department 2023

Table 6. Planned coastal forest protection and planting in the Mekong Delta for 2021–2025, by locality

No	Province	Planting new protection and special-use forests (ha)			Additional planting and enrichment of protection and special-use forests (ha)			Contract to protect forests, coastal areas (ha)
		Total	Mangroves	Forests on coastal sand and soil sites	Total	Mangroves	Forests on coastal sand and soil sites	
1	BR-VT	714	25	689	0	0	0	17,696
2	Tien Giang	80	80	0	0	0	0	1,027
3	Ben Tre	200	200	0	0		0	4,000
4	Tra Vinh	679	379	300	200	200	0	5,398
5	Soc Trang	400	400	0	150	150	0	49,901
6	Bac Lieu	400	400	0	0	0	0	5,654
7	Ca Mau	814	814	0	800	800	0	3,168

Source: MARD 2021

In Vietnam, eco-shrimp production through sustainable mangrove management is considered a key policy for avoiding further destruction of mangrove forests and maintaining national economic development rooted in aquaculture production. Järviö et al. (2017) argued that sustainable shrimp production in mangrove areas can help reduce emissions and mitigate climate change, finding that mangrove deforestation resulted in 124 tCO₂ of emissions per hectare per year, while mangrove deforestation for Asian tiger shrimp farming in mixed mangrove concurrent farms since 2000 resulted in 533 kg methane and 1.67 kg dinitrogen monoxide emissions per hectare annually. Consequently, LULUC GHG emissions per ton of live shrimp at farm gate using mass and economic allocation, were 184 and 282 tCO₂e, respectively; around an order of magnitude higher than from semi-intensive or intensive shrimp farming systems. This highlights the urgency of conserving mangrove forests, and the need to quantify uncertainties around LULUC emissions (Järviö et al. 2017).

6 Opportunities and challenges for forest conservation and low-emission food systems in the Mekong Delta

6.1 Opportunities

The Mekong Delta is transforming its agriculture towards nature-based business models (Ngo and Nguyen 2021), and its vision of green and low-emission food systems is supported by different forestry-based mitigation approaches. Most Mekong Delta provinces also have clear visions and work plans towards afforestation and forest restoration. Though not primarily for emissions reduction purposes, these policies can significantly contribute to the emissions reduction target for the whole region. Diverse financial mechanisms for funding forest protection and restoration activities in the Mekong Delta region, including the central state budget; provincial state budgets; the national Payment for Forest Environmental Services scheme; foreign projects; public-private partnerships; and private sector funding (Pham et al. 2019), also provide forest owners with different funding sources to implement forestry-based mitigation strategies.

6.2 Challenges

Pham et al. (2021) summarized the challenges for mangrove restoration and forestry-based mitigation options in their earlier research (Table 7).

Table 7. Challenges for mangrove restoration and forestry-based mitigation options

Challenge	Details
Institutional	<ul style="list-style-type: none">• Many projects have been implemented much slower than planned due to poor and untimely guidance from policymakers.• Weak law enforcement has been a problem with poor implementation of afforestation and construction of dykes and embankments as required by laws.• Weak monitoring of newly planted mangroves and mangrove quality.• Statistics and reports on the current status of forest areas, changes and implementation results of coastal afforestation projects are still inadequate, inaccurate and inconsistent, leading to decisions that are not evidence based.• 2015 was the first year of implementing the new Law on Public Investment and Law on Bidding, so many localities are still confused in the appraisal and approval of silvicultural investment projects, bidding organizations, and contractor selection, leading to many projects falling behind required schedules.• Afforestation investment projects are mostly Group C projects, according to the provisions of Government Decree No. 77/2015/ND-CP dated 10 September 2015 on medium-term and annual public investment plans. According to provisions, Group C projects have no more than three years to allocate capital and reach completion; while according to technical guidelines, effective coastal afforestation involves maintenance for four years after planting to ensure forest can become established. In addition, annual investment capital allocation plans for projects are often late, which affects the preparation of seedlings, planting seasons and progress. Consequently, some provinces (Soc Trang, Kien Giang) failed to comply with public investment plans on time, and had their capital recovered and not re-granted after three years of project implementation, or had to request an extension or transfer investment capital to the next year.

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Table 7. Continued

Challenge	Details
Institutional	<ul style="list-style-type: none"> Decree No. 120/2018/ND-CP amended and supplemented a number of articles in Decree No. 77/2015/ND-CP, thereby allowing “For projects under the Targeted Program for Sustainable Forestry Development: time to allocate capital to complete the project according to the silvicultural cycle”. However, after three years of implementation (2015–2017), many projects that had not completed the forest care period had their capital recovered and not re-granted, affecting the quality of planted forests. Investment projects in silviculture works with specific characteristics are often implemented in remote, isolated, disadvantaged areas, and forest land for the implementation of projects is mainly assigned or contracted to households for management and protection, and is combined with production in small, scattered areas. Therefore, only local people can implement afforestation and forest care effectively and save costs (because it is associated with the interests of households). However, according to current regulations, silvicultural investment projects must be tendered, which takes a long time and involves additional costs. This makes it difficult for contractors to implement projects on allocated or contracted land because they must have the consent of the people involved. Consequently, the implementation of silvicultural investment projects in some places has encountered many difficulties and has had to be reviewed and adjusted many times. Local governments have failed to handle illegal land encroachment in a timely manner to recover land for reforestation in accordance with plans.
Conversion to other land uses	<ul style="list-style-type: none"> Issues of changing land uses to other purposes in areas planned for coastal afforestation and encroachment on forest land for farming, fishing and other illegal activities remain complicated, and in some places are becoming increasingly difficult. Planning for coastal areas often fluctuates due to land-use needs for socioeconomic development, infrastructure construction projects, industrial development, seaports, electricity, tourism and resorts, and aquaculture, being allocated on forestry land. The conversion of forest land for resorts, energy generation and other activities in coastal areas remains complicated.
Technical	<ul style="list-style-type: none"> Incorrect site selection is a problem, with areas having inappropriate biophysical conditions being earmarked for afforestation. The technical capacity of contractors implementing the national programme on afforestation is weak, and surveys, designs, site preparation and seedling production are not closely adhered to. Scientific research and silvicultural technical guidelines have established initial planting requirements for restoring and protecting coastal forests. However, solutions to support wave breaks and prevent coastal erosion remain limited. Effective silvicultural models for responding to climate change have yet to be established for sites with difficult conditions, such as eroded coastlines, and arid, sandy and rocky areas. There are no guidelines for building organic product chain- or community forest management-based livelihood models to increase community earnings from forest protection and development, or effective solutions to prevent pests, diseases and damage to forests, especially mangroves. Although mangrove forests have been recognized as important regulators of greenhouse gases (GHGs), emission data on these important ecosystems through life cycle assessments remains limited (Järviö et al. 2017).

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Table 7. Continued

Challenge	Details
Climate change and biophysical	<ul style="list-style-type: none"> • Each year, coastal provinces are affected by frequent storms and tropical depressions, high tides, strong winds and sea-level rise, which cause erosion of estuarine shores. • Ba Ria Vung Tau and Binh Thuan provinces lost over 1,700 ha of mangroves due to heat and prolonged drought in 2020. • Some provinces have carried out land reclamation for many years, but have not been able to plant forests (Tien Giang); have had to change project location and design (Phu Yen, Quang Ninh); or even had to halt mangrove afforestation due to poor conditions and erosion (Bac Lieu, Thai Binh). • The afforestation situation is becoming increasingly difficult with alluvial ground being flooded with deep water; land becoming fallow from aquaculture or agricultural cultivation; land being used for salt production; and areas of nutrient-poor sandy soil becoming hot and dry with flying sand and exposed rock.
Pests	<ul style="list-style-type: none"> • Pests such as barnacles and crustaceans (Isopoda) are causing mangroves to die in Quang Ninh, Thai Binh, Ha Tinh and Binh Dinh provinces, while casuarina leafworms are doing the same in Quang Ninh, Thai Binh, Ha Tinh, Binh Dinh and Tra Vinh.
Pollution	<ul style="list-style-type: none"> • Environmental pollution from industrial parks or aquaculture areas, along with oil spills and widespread plastic waste hinder the growth and development of forest trees.
Financial	<ul style="list-style-type: none"> • Unit costs for mangrove reforestation and afforestation have increased significantly over time, while budget allocations from central to local governments are limited and not distributed in a timely manner. As a result, most provinces prioritize protecting existing mangrove areas rather than planting new ones. • Although there is significant foreign financial support for mangrove restoration, disbursement is slow and rates are low, with an ODA disbursement rate of only 18.7%. • The mobilization of capital from local budgets and from organizations, enterprises, individuals, etc. remains very low (5.1%) due to the difficult socioeconomic conditions of coastal communities. Meanwhile, forest protection and development projects have not been able to integrate capital for hunger eradication and poverty reduction to combine protection and development goals. • Due to economic pressures, people in coastal areas are encroaching illegally on sites planned for afforestation for aquaculture and fishing.

Source: Pham et al. 2022a

These findings are supported by other studies as discussed below.

Lack of understanding of mangrove carbon potential and conditions to fully enable mitigation potential: Mangrove carbon sequestration is not widely recognized as an option by local communities and many government agencies (Moudingo et al. 2020; Nguyen et al. 2023). Research and understanding on the potential of mangroves for offsetting emissions from other sectors, such as transportation and logistics – which are important for food systems in the Mekong Delta – are also overlooked by the region’s policymakers. Further, there is a need to closely examine the feasibility of forestry-based mitigation options such as mangrove restoration in the Mekong Delta region. For example, Pham et al. (2022a) found most provinces in the region having low and medium restoration potential due to their unfavourable conditions for mangrove restoration, including serious coastal erosion and coastal squeeze. Mangroves cannot accomplish their land-building and coastal protection roles under conditions of a failing sediment supply and prevailing erosion. Ignoring these overarching conditions implies that high expectations from mangroves in protecting and/or stabilizing the Mekong Delta shoreline, and eroding shorelines elsewhere, will meet with disappointment. False expectations include: a large and healthy mangrove fringe is sufficient to stabilize (eroding) shorelines; a reduction in the width of a large mangrove fringe to the benefit of other activities, such as shrimp-farming, is not deleterious to the shoreline position; and the effects of human-induced reductions in sediment

supply to the coast can be offset by a large belt of fringing mangroves (Besset et al. 2019). Furthermore, short-term economic gains are often prioritized as the total economic value of mangroves is not fully recognized, and mangroves are often the easiest places to convert to other land uses. Whether potential sites for mangrove restoration can actually become successful mangrove restoration sites is dependent on strong political commitment from provincial leaders (Pham et al. 2022a, c).

Mismatches in funding: Investment capital for coastal forest protection and development is still limited. For example, total investments mobilized for Project 120 and National Program 886 for 2016–2020 only met 65.6% of the plan and 32.4% of total approved capital, respectively. Although the government has developed numerous forest conservation programmes in the Mekong Delta, the financial packages provided for forest plantation cannot meet the actual need. Provincial leaders and forest owners in the Mekong Delta have said the government pays VND 15 million per hectare for forest owners to protect and conserve forests, but these payments are insufficient for performing the tasks necessary to do so (Hoang and Chanh 2012). Stakeholders in Kien Giang have pointed out that payments to perform such tasks would need to be doubled to incentivise local people to take part in forest conservation and restoration in the Mekong Delta. Further, despite there being multiple funding schemes for forest protection and development in the region, forest owners and provincial government agencies have difficulties accessing these schemes due to their complex procedures, the requirement to have high-counterpart funding, and the high initial investment necessary to meet their access criteria (Pham et al. 2019). Mangrove restoration is not cheap, and requires sufficient funding for planting trees, selecting appropriate species, planting in the right places, and monitoring and protecting newly planted trees (Pham et al. 2020a).

Trade-offs between conservation and development: Diversifying income sources and food production through forest aquaculture (shrimp-mangrove) is seen as an effective way to reduce the Mekong Delta's vulnerability to variable environmental conditions, pests and diseases (Chau et al. 2020). Numerous studies have pointed out challenges for mangrove protection and conservation being the income shrimp farming can generate, and poor land-use planning and forest land allocation (Tran et al. 2012; Tran et al. 2014; Pham et al. 2022b). Current shrimp farming systems are economically and ecologically risky, and may negatively influence the environment and the sustainability of local people's livelihoods (Tran et al. 2013; Truong et al. 2021). In the long run, certain challenges may become difficult to resolve if changes do not occur. These challenges include farmers' increasing resistance to forest ratio rules; increased encroachment; and a disparity in opinions between farmers and other stakeholders regarding the impacts of co-management models on communes (Starmans 2023). Despite large numbers of policies and projects being aimed at mangrove restoration, they have been impeded by weak political will to preserve and protect mangroves due to other land uses having higher opportunity costs; increasing pressure from industrial infrastructure development; and urbanization and aquaculture expansion leading to mangrove loss (Pham et al. 2020a). Even though current policies and land-use planning indicate production forests being areas with potential for mangrove restoration, stakeholders have felt such areas have low or no potential for restoration where aquaculture is taking place, as there are neither strong financial incentives nor sustainable livelihood models encouraging farmers to increase the area of forest in and around their shrimp ponds (Pham et al. 2020a).

Unfavourable policy environment for sustainable forest management: To date, authors have highlighted challenges being ineffective investment policies for forest development (Ly 2020); inconsistent policies and guidelines causing confusion for local authorities and weak coordination between government agencies (Minh Tan 2023); limited investment for research and forest inventory leading to challenges in informing appropriate and timely decisions; and a lack of understanding and appreciation of biodiversity (Minh Tan 2023). The fact that central budget allocations to Mekong provinces are unstable and fluctuate from year to year also makes it difficult for Mekong provinces to develop long-term development plans. Consequently, these provinces carry out forest protection activities based on what financial resources they have rather than what needs to be done and prioritized to deliver beneficial environmental and social outcomes. Sustainable forest management and forest certification

could provide significant benefits to forest owners and the forestry industry. However, the majority of requirements for securing certification can be overwhelming for forest owners (Huu Viet 2012). Vietnam does not have principles, criteria and procedures for sustainable forest management as yet. At present, sustainable forest management is only being implemented on a pilot basis and requires support from foreign projects, and human resources for performing sustainable forest management remain weak. To achieve certification, forest owners must develop sustainable forest management plans following 10 principles set out by the Forest Stewardship Council (FSC). However, most forest owners are still confused about implementing these principles. A requirement for sustainable forest management is the forest owner's land being granted a land-use right certificate, which many forestry companies are currently unable to do as the necessary investment and assessment costs are too high (Huu Viet 2012).

Participation of local people in forest protection and restoration: Conflicts over land between local forest owners and forest protection boards, and between aquaculture production and forest protection interests will remain widespread in the Mekong Delta region when local people are not involved in decision making on forest protection and restoration schemes (UAE International Development 2010; Pham et al. 2019) or climate change policies in general (Dechen et al. 2021). Current mitigation strategies implemented by local governments, including those involving planting and protecting forests, are focused on households, particularly those with land, and fail to take into account their likely exclusion of the landless and female poor (UAE International Development 2010). The poor and indigenous groups have no access to forestry land, and consequently cannot benefit from any government programmes or support (UAE International Development 2010).

7 Conclusions

Food production systems in the Mekong Delta region rely on healthy forest ecosystems. Forests can also contribute to low-emission food systems through their potential to remove and sequester carbon and provide food security, particularly for vulnerable groups including women and poor landless households.

While provincial authorities, international organizations, the private sector and forest owners have developed and implemented numerous forestry-based mitigation options in the Mekong Delta, their policies have often overlooked potential contributions to food systems. Moreover, policies and practices initiated by such actors have also been impeded by drivers of deforestation and forest degradation rooted in political prioritization of economic development; weak coordination between different sectors and actors; unclear tenure systems; mismatches between funding required and available resources; and limited inclusion of vulnerable groups, including the poor, landless and women.

Future food system policies in the Mekong Delta region need to consider well-established scientific evidence and local knowledge in forestry-based mitigation, particularly mangrove restoration. Macro policy changes, particularly in addressing drivers of deforestation, need to be coupled with cross-sectoral collaboration and inclusive governance to enable effective, efficient and equitable low-emission food systems.

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This report was developed based on a literature review of existing laws and policies, and reports on forestry stakeholders, forestry-based mitigation options and their linkages to food systems in the Mekong Delta in Vietnam. The report shows that despite forests playing a vital role in providing food security, this is often overlooked by policymakers and current national and provincial policies. Only a limited number of studies have explored this linkage across the 13 provinces of the Mekong Delta region. This highlights the need for future research to address the knowledge gap to ensure better low-emission food systems in the region. While the Government of Vietnam has acknowledged the important roles forests play in its Nationally Determined Contribution (NDC), and has developed forestry-based mitigation options, the area of forest in the Mekong Delta region has fallen over the last 20 years. Although forestry-based mitigation options are now being supported and co-funded by a wide range of actors, including forest owners, government agencies, international organizations, donors and private sector parties, their outcomes have been ineffective due to unclear tenure, conflicts of interest and weak coordination between different actors. Most Mekong Delta provinces have developed plans to address these challenges, but doing so will require macro policy changes and political commitment to protect mangroves, which do not always fall within the sphere of influence of provincial governments. Forestry-based mitigation options have direct impacts on the earnings and food consumption of the poor, women and Indigenous Peoples in the Mekong Delta. However, these vulnerable groups are rarely involved in decision making over policies and practices. They also have difficulties participating in and benefitting from government, international, private and public-private partnership programmes as they are landless or live on contested areas of land. Ensuring forestry-based mitigation options can contribute to low-emission food systems but will require cross-sectoral approaches, participatory decision-making processes and evidence-based analyses for determining viable options. Social inclusion and social safeguards will be essential for ensuring forestry-based mitigation and future low-emission food systems leave no one behind and do not result in social marginalization of vulnerable groups.