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Nature-based Solutions (NbS) in Rural Development of Timor-Leste: An Opportunity for Strategic Integration

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ABSTRACT

Timor-Leste's rural development sectors face significant challenges, particularly those related to climate change. Many rural households depend heavily on agriculture and fisheries for their livelihoods, making them especially vulnerable to environmental disruptions. In response, stakeholders have begun promoting nature-based solutions (NbS) to enhance community resilience by delivering both social and economic benefits. NbS practices such as agroforestry, mangrove restoration, sustainable land management, and watershed protection offer practical approaches to improve livelihoods while strengthening ecosystems. For example, agroforestry can diversify income sources and improve soil health, while mangrove restoration protects coastal communities from storm surges and supports fisheries. From a rural tourism perspective, NbS can also include eco-tourism initiatives that promote conservation and generate income, such as community-led forest trails, birdwatching tours in protected areas, and restoration of cultural landscapes that attract visitors. These approaches foster environmental stewardship while supporting local economies. Despite their potential, NbS are not yet fully integrated into sector-specific strategies and plans. This gap limits institutionalization and reduces opportunities for collaboration among key actors. Achieving sustainable rural development in Timor-Leste requires the formulation and implementation of coherent strategies and action plans that address climate change and natural disasters. This paper explores the strategic opportunity to embed NbS into Timor-Leste's sectoral policies and plans. Through a literature review, it offers recommendations for mainstreaming NbS and identifies development finance and climate funding mechanisms that Timor-Leste could leverage to support the adoption and implementation of NbS in rural development.

Keywords: nature-based solutions, rural development, climate, agriculture, tourism, Timor-Leste

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1. Introduction

Timor-Leste is a small country with a total population of 1.34 million (INETL, 2023). According to the Timor-Leste Population and Housing Census 2022, of the total 1.34 million population, 71.4% live in rural areas, while 28.6% live in urban areas (INETL, 2023). The population growth rate in rural areas is faster than the urban areas, with 2.0 percent against 1.3 percent, respectively.

¡The high concentration of the population in rural areas makes the rural development sector a key to the country's development, as emphasized in Timor-Leste's Strategic Development Plan 2011-2030. Despite being a priority, Timor-Leste's rural development sectors face significant challenges, particularly those related to climate change. Many rural households depend heavily on agriculture and fisheries for their livelihoods, making them especially vulnerable to environmental disruptions (Word Bank, 2025). According to the World Risk Report 2025, which assesses the disaster risk for 193 countries worldwide, including Timor-Leste, indicates that Timor-Leste is a high-risk country (UNOCHA, 2025). In response, stakeholders have begun promoting nature-based solutions (NbS) to enhance community resilience by delivering both social and economic benefits in agriculture and tourism.

NbS practices—such as agroforestry, mangrove restoration, sustainable land management, and watershed protection—offer practical approaches to improve livelihoods while strengthening ecosystems. For example, agroforestry can diversify income sources and improve soil health, while mangrove restoration protects coastal communities from storm surges and supports fisheries.

From a rural tourism perspective, NbS can also include eco-tourism initiatives that promote conservation and generate income, such as community-led forest trails, birdwatching tours in protected areas, and restoration of cultural landscapes that attract visitors. Rehabilitating degraded lands into nature parks or community gardens not only enhances biodiversity but also creates attractive destinations for nature-based tourism. These approaches foster environmental stewardship while supporting local economies.

Despite their potential, NbS are not yet fully integrated into sector-specific strategies and plans. This gap limits institutionalization and reduces opportunities for collaboration among key actors. Achieving sustainable rural development in Timor-Leste requires the formulation and implementation of coherent strategies and action plans that address climate change and natural disasters.

This paper explores the strategic opportunity to embed NbS into Timor-Leste's sectoral policies and plans. Through a literature and implementation practices review, it offers recommendations for mainstreaming NbS and identifies development finance and climate funding mechanisms that

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Timor-Leste could leverage to support the adoption and implementation of NbS in rural development.

This paper begins with an introduction. The second section gives an overview of available studies and authors in area of NbS in the South-East Asia region and consequentially in Timor Leste. Following are methodology and results sections. The next section presents the existing NbS practices promoted in rural Timor-Leste, discusses the strategic opportunity for nature-based solution integration into Timor-Leste's sectoral policies and plans, and development finance and climate funding mechanisms opportunities. The concluding sections include the conclusion and implications, as well as limitations of the paper and potentials for future research.

2. Literature Review

This analysis draws on key research clusters to compare thematic focus, geographic coverage, and the core scholarly debates shaping NbS policy in the region. The concept of Nature-Based Solutions (NbS) defined by the IUCN as actions to protect, sustainably manage, and restore natural or modified ecosystems to address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits has gained significant traction in Southeast Asian scholarship. Research in this region is characterized by an urgent focus on climate change adaptation, disaster risk reduction, and the protection of biodiversity, often linking directly to the resilience of rural livelihoods.

Interaction between the NbS and rural development requires the sustainable management of natural resources and climate action. Rural development aims at balancing territorial development of rural economies and communities, which contributes to better management or rural-urban migrations. Promoting social inclusion, poverty reduction and economic development in rural areas are equally important to NbS and rural development approaches. The inclusion of people lays at the heart of NbS approach. Exclusion of marginalized communities, youth and indigenous people, those that have high interest to participate and decide in the processes, is significant obstacle, and institutions such as European Commission (European, 2025) are advocating for co-creating nature-based solutions with commonly excluded stakeholders (CES).

The academic landscape of NbS in Southeast Asia is primarily shaped by collaborations between regional universities (e.g., National University of Singapore, Institut Teknologi Bandung, Universiti Putra Malaysia) and global research hubs (e.g., Oxford's NbS Initiative, international NGOs, and development banks). This collaboration has produced distinct clusters of work focusing on different facets of the rural development challenges and can be broadly grouped by primary disciplinary lens or institutional base into several clusters: the Socio-Ecological and Global South Cluster; The Water, Urban-Rural Linkage Cluster; and The Climate Mitigation and Governance Cluster. Each of these explores various aspects of knowledge and development practices relevant to the contents and suggestions of this paper.

The Socio-Ecological and Global South Cluster: University of Oxford's Nature-based Solutions Initiative authors Woroniecki *et all* in their widely acknowledged and highly cited paper (Woroniecki et al., 2022). provided the foundational, globally relevant frameworks for assessing NbS. They stress the mandatory requirement for NbS to provide simultaneous human well-being and biodiversity benefits. This cluster serves as a crucial check on purely technocratic or carbon-focused approaches and is thus vital for comparing the social and equity outcomes of NbS. Authors argue that NBS are most relevant in the rural Global South due to high dependence on local ecosystems and a lack of financing for expensive, hard-engineered infrastructure. In terms of relevance to Southeast Asia and Timor-Leste, they caution against poorly designed NbS that fail to integrate local and traditional knowledge, a critique that resonates strongly with local governance challenges in countries like the Philippines and Indonesia.

The Water, Urban-Rural Linkage Cluster: in its reference point paper (Lechner et al., 2021). for this theme, authors Lechner *et all* from several universities in Indonesia, Malaysia, UK and Singapore often compare the implementation of NbS for water management and flood mitigation, particularly at the peri-urban and rural boundaries of rapidly expanding cities like Greater Bandung (Indonesia) and Greater Kuala Lumpur (Malaysia). Their research comparatively analyzes "grey" (engineered) versus "green" (natural) infrastructure, concluding that integrated hybrid solutions are often superior. The failure of urban flood control is often rooted in poor land-use planning in rural headwaters (e.g., deforestation, lack of landscape restoration). This shifts attention to the needs of building inland, upstream rural ecosystem integrity. Authors stress the unique challenge of urbanizing Southeast Asia, where rapid, often unregulated, development consumes rural lands, degrading the very ecosystems needed for city resilience. Recognizing the similar patterns in the context of development of Dili as Timor-Leste's capital and its interactions with other municipalities, this thinking cluster provides useful and relevant insights into the NbS challenges and possible ways to address them.

The Climate Mitigation and Governance Cluster: Authors Lian Pin Koh, Kelly Siman, Daniel A. Friess, Yiwen Zeng from Centre for Nature-based Climate Solutions (CNCS) at the National University of Singapore is influential in policy, focusing on Nature-based Climate Solutions (NbCS), a subset of NBS specifically aimed at climate targets. Their work provides quantitative assessments of regional carbon stocks, classifying them into Green Carbon (terrestrial forests, agriculture), Peatland Carbon (critical in Indonesia/Malaysia), and Blue Carbon (mangroves, seagrass). Their papers, such as the widely cited reports on "Nature-based Solutions for Climate Change Mitigation in the ASEAN Region (Siman, K., Friess, D.A., Huxham, M. et al, 2021) emphasize the commodification and governance of carbon sinks. Paper compares the mitigation potential across

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different ecosystems and highlights regulatory barriers. Critically, their focus is less on small-scale community development and more on high-level policy, finance, and large-scale, measurable interventions suitable for national climate commitments (NDCs). Authors provide scientific justification for large-scale rural land-use reform, often in collaboration with governments.

Scholarly comparisons in the region reveal a divergence in how NbS are applied across different rural livelihoods and ecosystems such as "Coastal livelihoods and risk reduction / NbS examples in rural Southeast Asia (mangrove restoration, coastal forest buffers, mussel/ oyster reefs); Agricultural systems & food Security/ NbS examples in rural SEA (agroforestry, paddy-Fish/ rice-lotus systems (e.g. Mekong Delta), sustainable peatland rewetting); Water resources & disaster risk/ NbS examples in rural SEA (watershed, reforestation, natural floodplains).

The most consistent comparative finding is that the implementation of NbS in rural Southeast Asia is hampered by governance issues, different from the global North. The authors Morita and Matsumoto provide a direct comparison of these barriers such as policy coherence, financing, social equity and land rights (Morita and Matsumoto, 2021). NbS is slowly but surely becomes great potential in building healthy communities, from simply advocating the concept to implementation of the approach. The work of Lian Pin Koh and Centre for Nature-based Climate Solutions (CNCS) at the National University of Singapore shows the immense mitigation potential tied to rural ecosystems (peatlands, forests), while *The Water, Urban-Rural Linkage* group highlights the adaptation urgency of maintaining rural function for urban benefit. Seddon argues that the success of these solutions hinges on overcoming entrenched, cross-sectoral, and socio-legal barriers unique to the region.

3. Research Methodology

After defining the above problem, the aim of the review paper is to explore the strategic possibilities of including NbS in sectoral policies and plans. A search of available relevant literature was carried out, as well as an overview and appropriate analysis of available experiences. Research includes review of available databases (aggregate with full text), secondary data from existing domestic and international professional and statistical publications in the field of management, strategic management, NbS, rural development. The analysis of the collected tertiary and secondary data showed the experiences, attitudes, circumstances and problems faced by professionals in the defined area of data collection sequence: tertiary – secondary.

Qualitative methods will be used in the analysis of the research including historical method applies analysis, synthesis, induction and deduction over a certain period of time. Documentary analysis and case analysis were also used. Comparison will be analyzed to determine good practices available for the transfer of TL but also the limitations that TL has in the implementation of NbS. The following methods were used: historical method, narrative analysis (conceptual apparatus and understanding of concepts), comparative and documentary analysis, content analysis, case study method.

4. Result and Discussion

Achieving sustainable rural development in Timor-Leste requires the formulation and implementation of coherent strategies and action plans that address climate change and natural disasters. One of the main obstacles to this relates to the lack of integration of NbS into the sector specific strategies and plans.

This paper explores the strategic opportunity to embed NbS into Timor-Leste's sectoral policies and plans. Through a review of literature as well as the implementation practices, paper contributes to prospective improved institutionalized approach to NbS integration through offered recommendations for mainstreaming NbS.

Also, paper opens potential collaboration avenues between key actors which can increase the prospect of increased development finance and climate funding availability. These could support the adoption and implementation of NbS in rural development, leading to improved living conditions for population living in the area, improved livelihood options, while protecting nature and ensuring the environmental, social and economic sustainability of the interventions (rural development, agriculture, tourism, disaster risk reduction etc.).

4.1. Nature-based Solutions Concept and Its Application

The Nature-based solutions concept was first mentioned in 2008 in a World Bank report (Hickey et al., 2010). There are more than 20 various definitions of the nature-based solutions (NbS) concept (Sowińska and Gracia, 2022). For example, the European Commission defines NbS as ''solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience (European, 2025). The International Union for Conservation of Nature (IUCN) defines NbS as "actions to address societal challenges through the protection, sustainable management and restoration of ecosystems, benefiting both biodiversity and human well-being (IUCN, 2025). The United Nations Environment Programme (UNEP) defines NbS as actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature (UNEP, 2023).

The IUCN definition is the commonly agreed, one but the most frequently used and often referred to in the scientific literature is the definition adopted by the United Nations Environment Assembly (UNEA) of UNEP on 2 March 2022 (UNEP, 2025). Despite the differences in the concept definitions, they all have in common that NbS works with nature, for nature and for humans (Norden, 2022).

NbS targets key challenges such as climate change, disaster risk reduction, food and water security, biodiversity loss, and human health, and is vital to sustainable

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development. NbS can deliver positive outcomes alongside their intended outcomes, addressing urban heat island effects by stabilizing warming and cooling temperatures, improving agricultural productivity and food security through building terraces to control soil erosion, or by restoring wetlands. Additional benefits brought by NbS can include improved natural habitat for wildlife, enhanced water and air quality, and improved socio-cultural and economic conditions of communities.

The NbS has now gained rapid traction in the public and private sectors and have been promoted as a key tool for solving diverse environmental and societal problems. Also, it directly contributes to reduction of risks of weather and climate related or men-made disasters, as it builds the resilience of communities and countries. Increasing number of international organizations, NGOs, and private sector institutions are implementing new nature-based programs or NbS elements, often integrated into the development programs in rural development, agriculture, tourism, water management, disaster risk reduction etc.

4.2. Nature-based Solution and Rural Development in Timor-Leste

In response to the challenge of climate change in Timor-Leste's rural development sector, various stakeholders (UN, UNDP, World Fish, DFAT, ACIAR, USAID, World Bank, ADB, JICA, GIZ etc.) have begun promoting NbS to enhance community resilience by delivering both social and economic benefits. The promotion of relevant NbS practices in the agriculture, livestock, fisheries, and forestry sectors is well-documented in the Timor-Leste Ministry of Agriculture's Compendium Climate Resilient Agriculture Technologies and Practices. Beside these programs, some local NGOs (Permatil, Raebia etc.) and CBOs are implemented many important NbS activities (Norden, 2022).

The Compendium provides an overview of climate-smart agriculture technologies and practices to achieve sustainable agricultural development for food security in a changing climate and to build the resilience of agriculture-dependent communities. The promoted Nbs practices include reforestation, agroforestry, conservation agriculture, mangrove restoration, carbon farming, watershed management, and organic farming. Despite their promotion in Timor-Leste, these NbS practices are often limited to project activities and not yet systematically implemented or mainstreamed into national sectoral programs (GoTL, 2021). To ensure that these practices are mainstreamed into national agriculture programs, they first need to be integrated into sectoral policies and plans. This will lay a strong foundation to mobilize both national and international resources for programming and hence, pave the way for the implementation. Timor-Leste's Ministry of Agriculture, Livestock, Fisheries and Forestry's preliminary findings of the mapping of development partners' programs/projects reveal current promotion of NbS practices in rural development sectors. Mapping of Development Partners' activities of NbS practices (please see Appendix 1).

4.3. Strategic Opportunity for NbS Integration into Timor-Leste's Sectoral Policies and Plans

Despite their potential, NbS are not yet fully integrated into sector-specific strategies and plans. This gap limits institutionalization and reduces opportunities for collaboration among key actors. Achieving sustainable rural development in Timor-Leste requires the formulation and implementation of coherent strategies and action plans that address climate change and natural disasters.

Ideally, a unified rural development national strategy is crucial to ensure coherent strategies and action plans that address climate change and natural disaster challenges with NbS mainstreaming. The Timor-Leste Strategic Development Plan 2011-2030 set a target to develop a National Planning Framework by 2015, guiding the acceleration of rural development while protecting Timor-Leste's biodiversity and natural environment (GoTL, 2011). Progress evaluation report suggests that this target appears not to have been achieved yet, and it calls for reconsideration and reformulation (GoTL, 2021).

Considering this, it is highly recommended to develop a unified rural development strategy with NbS mainstreaming in accordance with the IUCN Global Standard for Nature-based Solutions. This offers advantages which will be further elaborated in the coming paragraphs. Developing a unified rural development strategy could be a long endeavor.

Alternatively, the immediate steps could start with the NbS integration could start with the existing sectoral strategies and plans. These could include: Timor-Leste's Agriculture Policy and Strategic Framework; Timor-Leste's Coffee Sector Development Plan 2019-2030; Timor-Leste's National Aquaculture Development Strategy 2012-2030; Timor-Leste's National Forest Policy; Policy and Strategy Forestry and Watershed Subsector; and National Disaster Risk Management Policy 2008. The NbS integration could be done by conducting a rigorous assessment to identify opportunities to integrate or further strengthen the integration of NbS into the above sectoral policies and plans.

Timor-Leste is now in the process of finalizing its Blue Economy Policy and Action Plan. This move is considered by the 9th Constitutional Government as a paradigm shift in Timor-Leste's economic development model. The Blue Economy Policy aims to ensure the sustainable use of marine resources, improve the living conditions of coastal populations, and protect ecosystems with job creation, poverty reduction, and mitigating the impacts of climate change as its central objectives (GoTL, 2025). As per IUCN, the aims of the Blue Economy Policy align with the NbS objectives. Considering this and given that the policy is still in the public consultation phase and not finalized yet, there could be an opportunity for NbS integration into the policy.

Another opportunity for NbS integration is through the incoming National Biodiversity Strategy and Action Plan (NBSAP). The main objective of the NBSAP is to ensure that biodiversity is conserved and wisely used by all sectors, providing food security and contributing to poverty eradication and improved quality of life. The former expired

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NBSAP covered the period from 2011 to 2020, and a new NBSAP is required.

To ensure the effective NbS mainstreaming into the existing relevant sectoral policies and plans, the Blue Economy Policy, new NBSAP, and their successful operationalization, it is highly recommended that the integration of NbS into these policies and plans is in line with the IUCN Global Standard for Nature-based Solutions. The standard aims to ensure the application of the NbS approach is credible, and its uptake is tracked and measured for adaptive management so that its contributions can inspire others (IUCN, 2020). This aligns particularly with Timor-Leste's intention to project the Blue Economy on the international stage and promote Timor-Leste's image and sustainable development abroad.

The utilization of this standard will ensure that the design and execution quality are accounted for, and the results can be tracked and linked to global goals as well as research narratives. Using this standard would ensure that the NbS, integrated into the policies and plans, is based on a common understanding of its interpretation and a shared vision for sustainable development of Timor-Leste.

In the absence of a unified rural development strategy in Timor-Leste, the Green Economy could be considered as an alternative overarching strategy, which would represent another paradigm shift in Timor-Leste's economic development model towards a more sustainable and resilient economy after the paradigm shift to the Blue Economy. A Green Economy could address climate-related issues in the economy of Timor-Leste, including work on a policy framework for sustainable and green solutions in the economy and the promotion of practices that contribute to a green economy within the private and public sectors.

With this alternative, the integration of green policies and NbS solutions in the rural development sector could be done through a combination of integration into strategies, policy adoption, rules enforcement, and incentives for green investments. These could include: Greening value chains and market systems; Incentivizing energy production from renewable sources; Promoting climate-smart solutions in rural development (agriculture, tourism, water management, and disaster risk reduction/DRR) – with DRR solutions possibly contributing to water harvest and use in agriculture; Energy-efficient building construction to save on climatization costs; and Capacity-building of government institutions, civil society, and the private sector. The Green economy/and corresponding NbS and climate change mitigation and adaptation interventions in various sectors could include

4.4. Agriculture and Food Security

NbS practices, such as agroforestry, mangrove restoration, sustainable land management, and watershed protection offer practical approaches to improve livelihoods while strengthening ecosystems. For example, agroforestry can diversify income sources and improve soil health, while mangrove restoration protects coastal communities from storm surges and supports fisheries. Supporting iinterventions could include:

a) Promoting nutrition-sensitive, climate-smart water-efficient, and soil-protecting methods (vertical farming gardens, hydroponics, aquaponics, fishponds, integrated farming) - built and operated by using locally available materials (bamboo, leaves, organic waste)
b) Development and greening of value chains and market systems
c) Focus on organic agricultural production and incentivizing organic certification
d) Production and promotion of organic fertilizers
e) Protection of soil and water from chemicals and chemical-based pesticides
f) Demonstration plots and model integrated farms establishment
g) Soil desalinization techniques
h) Resilient seeds and crops promotion
i) Sloping agricultural land technology (SALT)
j) Green skills capacity-building of extension services, advisors, and farmers in climate-smart technologies
k) Low and high tunnels establishment with drip irrigation to increase the efficiency of water use
l) Mechanization and transport solutions improvements and information and technology (IT) solutions for reduced carbon footprint
m) Support for women and youth entrepreneurship in NbS
n) Support to laboratories to improve animal and food safety and animal feed production support
o) Conservation and Climate-smart agriculture
p) Improvements of energy efficiency in food processing and packaging
q) Mechanization and transport solutions improvements
r) Agriculture sector knowledge management.

4.5. Tourism

From a rural tourism perspective, NbS can also include eco-tourism initiatives that promote conservation and generate income, such as community-led forest trails, birdwatching tours in protected areas, and restoration of cultural landscapes that attract visitors. Rehabilitating degraded lands into nature parks or community gardens not only enhances biodiversity but also creates attractive destinations for nature-based tourism. These approaches foster environmental stewardship while supporting local economies.

Rural tourism development and promotion of environment-friendly tourist packages include the promotion of outdoor tourism packages, energy efficiency in air-conditioning of tourist facilities, and developing nature-based tourism programs with a strong focus on sustainable management and nature protection. Possible interventions include:

a) Designate areas for tourism development in line with the protection of nature requirements
b) Build recognition in line with IUCN protection statuses
c) Avoid overcrowding of the most popular micro destinations - carrying capacity assessment and alignment with the lives of the local population (not to

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disturb their social and economic activities or endanger their livelihoods)

d) Promote/prioritize a community-based tourism approach while developing nature-based micro destinations; and
e) Incentivize the use of traditional fishing methods and integrate them into the tourism offer.

4.6. Rural Infrastructure

On the infrastructure front, the rural development infrastructure improvement and adjustment could be done in line with the NbS and DRR. Hybrid infrastructure solutions strategically integrating both conventional "grey" (engineered, human-made) and "green" (natural or nature-based) components to deliver essential services, such as water management, transportation, or energy, should be prioritized. This could include water harvest and preservation for multi-sectoral purposes (agriculture, water, health, sanitation and hygiene, tourism, DRR), and spatial planning of the areas with the highest potential for the rural development sector, along with the targeted strategic investments in infrastructure, programs, and projects (in target sectors in selected areas).

4.7. Development Finance and Climate Funding Mechanisms

To execute the systemic integration of NbS into existing sectoral policies and plans, the Blue Economy Policy, and the new NBSAP (and potentially the Green Economy programs), it is recommended that Timor-Leste seek funding support from the Green Climate Fund and Global Environment Facility.

The systemic integration of NbS into existing sectoral policies and plans, the Blue Economy Policy, and the new NBSAP will diversify options to finance the implementation beyond the country's General State Budget. This will facilitate access to climate finance, such as Green Climate Fund, Adaptation Fund, Global Environment Facility, Least Developed Countries Fund, Special Climate Change Fund, Capacity-building Initiative for Transparency Trust Fund etc.

The development finance options mentioned above are more appropriate and are crucial for Timor-Leste, considering that the Petroleum Fund, which has been the main source of funding for development over the past decades, is projected to deplete by 2036. If there is no new alternative revenue before the Fund is depleted, significant consequences for government expenditure and the broader economy will arise. The government will not have sufficient revenues to carry out its most basic functions, such as paying salaries to public sector workers, providing social security payments to the elderly, continuing payments to veterans, and paying back loans (GoTL, MoF, 2025). Consequently, financing rural development will become extremely difficult, affecting the rural sector development progress and further exacerbating the existing vulnerability of the rural development and its sectors.

Another option for funding is support from donors/development partners. Timor-Leste Foreign Aid Policy calls on development partners to align their activities with Timor-Leste's Strategic Development Plan 2011-2030, as well as the sectoral policies and plans. Under the Foreign Aid Policy, rural development, agriculture, and tourism are highlighted under the economic development pillar, while water and sanitation are highlighted under the infrastructure development pillar of Strategic development plan as a priority area for development partners' support (European Commission, 2025). The systemic integration of NbS into existing sectoral policies and plans, the Blue Economy Policy, and the new NBSAP will contribute to mobilizing the financial support for the implementation.

5. Conclusion and Implication

Promoted NbS practices in the rural development sector in Timor-Leste were discussed, while exploring the opportunities for NbS mainstreaming into Timor-Leste's sectoral policies and plans.

This paper has offered recommendations for mainstreaming integration of nature-based solutions into Timor-Leste's sectoral policies and plans. In the absence of a unified rural development strategy in Timor-Leste and considering that developing such a strategy may be a long journey, the recommended immediate step is to commence mainstreaming the NbS into the existing sectoral strategies and plans, while aligning it with the IUCN Global Standard for Nature-based Solutions. The draft of Timor-Leste's Blue Economy Policy and the new NBSAP are also recommended to adopt the systemic integration of NbS. If a rural development strategy is not pursued by Timor-Leste, a green economy policy with NbS systemic integration complying with the IUCN Global Standard for Nature-based Solutions is recommended as an alternative.

The paper has identified sources of funding for systemic integration of NbS into policies and plans. Given the projected depletion of Timor-Leste's development finance in less than a decade from now, climate finance, along with official development assistance, is considered more appropriate for the implementation.

This paper provides a unique contribution to understanding the opportunity for NbS integration into policy in a developing country, in which its rural development faces enormous challenges, such as climate change. NbS is powerful to address developmental challenges. Therefore, its potential to support Timor-Leste's sustainable and resilient developmental progress should not be underestimated.

6. Limitation and Future Research

Lack of comprehensive data focused on NbS practices and implementation (including current and available financing) in Timor-Leste limited the scope and depth of the research and possibly impacted the applicability of recommendations.

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APPENDIX A - Table 1: Mapping of Development Partners' activities of NbS practices

Program/project title (Start/End date) Donor agency/donor country Implementing agency	Areas of intervention/key activities	Climate change integration
Toward Sustainable and Conversion-Free Aquaculture in Southeast Asia Apr 2024 – Sep 2028 Global Environment Facility (GEF) ADB in cooperation with the General Directorate of Fisheries, Ministry of Agriculture, Livestock, Fisheries and Forestry	The technical assistance will support (i) development of the national seaweed aquaculture strategy; (ii) farmers adopt sustainable techniques for seaweed aquaculture for increased production and capture of nutrients from the ocean; (iii) farmer groups and traders to be trained to improve market linkages; and (iv) development of knowledge products.	The program aims to increase climate change mitigation and resiliency of communities.
TOMAK (To'os ba Moris Di'ak or Farming for Prosperity) Jun 2016 – May 2026 Australia Implemented by Adam Smith International	Improve food security and nutrition, and resilient agriculture-based livelihoods that are productive and profitable. TOMAK promotes legumes, red rice, orange-fleshed sweet potato, shallots, green leafy vegetables, pigs, and chickens.	TOMAK promotes four key Climate-Smart Agriculture (CSA) practices in target communities to strengthen the resilience of agriculture-based livelihoods against climate shocks. These practices include: Sloping Agricultural Land Technology (SALT); Water Management; Composting; Agroforestry. The nurseries produce a variety of seedlings tailored to specific purposes: **Nutrition**: Dragon fruit, **Animal Feed**: Leucaena taramba, Indigofera, **Water Spring Conservation**: Walnut, Saria, Mahogany, **Biodiversity**: Vanilla These CSA practices are integrated into Farmer Field Schools, where agricultural extension workers promote good agricultural practices and build local capacity.
Market Development Facility (MDF) Phase 2 Jul 2012 – Jun 2027 Australia - Implemented by Palladium	Partner with the private sector to introduce business models that increase farmer incomes and create jobs. Key markets include: agricultural inputs, early-stage export commodities (e.g., seaweed, cocoa), chicken, coffee, and pigs.	-Research and analysis - Improving farmer resilience to climate shocks in target market systems (e.g., improving coffee drying, increasing access to more resilient seeds, and coffee farm rehabilitation)
Agricultural Innovations for Communities - Intensified and Diverse Farming Systems for Timor-Leste (AI-Com 2) Nov 2022 – Oct 2027 ACIAR - Australia Implemented by University of Western AU	Expand the use of biochar by training. Define the mechanisms that make Biochar such a useful fertilizer. Research new Conservation Agriculture cropping options with farmers. Understand how and why farmers are adopting CA plus. Assist in developing elite sandalwood populations.	All systems are tested for climate change scenarios, using crop modelling APSIM
TRACC Jun 2022 – Dec 2025 Australia, Implemented by Catholic Relief Services	Agroforestry	The project is applying agroforestry to target food security and reduce carbon emissions.
"Fish Innovation" - Innovating fish-based livelihoods in the community economies of Timor-Leste and Solomon Islands (FIS/2019/124) Sep 2021 – Dec 2025 ACIAR - Australia Implemented by WorldFish	1. Improve understanding of opportunities to improve post-harvest fish distribution patterns and practices. 2. Evaluate past coastal livelihood development programs to inform better future investment.	The project indirectly addresses climate change through research on post-harvest fish distribution to recognize the role of 'informal' mobile fish traders, such as those using motorbikes, which have low carbon emissions; deliver training and

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	3. Increase skills in good fish handling to improve the safety of fish and other aquatic foods. 4. Build the capacity of national and municipality fisheries officers to improve fisheries extension services to support community-led development.	develop training materials on fish handling and processing to improve fish quality and preservation options, to strengthen resilience during periods of variable fish catches and reduce waste and loss. Final project reflections and recommendations will also consider climate change implications.

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Program/project title (Start/End date) Donor agency/donor country Implementing agency	Areas of intervention/key activities	Climate change integration
Disaster Ready Project Jul 2022 – Dec 2026 Australia, Implemented by ChildFund Timor-Leste	Farmer Field School	The DRP project team has trained the farmer group on how the community can adapt to climate change through farmer field school training.
Enhanced Agroforestry for Resilient Timorese Households (EARTH) Jan 2025 – Feb 2030 European Union Implemented by World Vision Timor Leste and Fundacao Carbon Offset Timor (FCOTI)	Establish Agroforestry Committees; Develop landscape-level agroforestry plans with target sucos; Verify land tenure; Legal transfer of carbon rights with benefit sharing; Support and establish tree nurseries; Climate Smart Agriculture; Business plans for women-led agroforestry; Market system strengthening and private sector partnerships.	The implementation of sustainable agroforestry activities will enhance the environment's resilience to disasters and climate change, in turn creating social resilience for communities.
Implementation of Participatory Land Use Planning with Climate change vulnerability and Enhancement of Local Government Capacity in Target villages in the Laclos Watershed for the first contract Period Feb 2024 – Apr 2029 Green Climate Fund (GCF) Implemented by Plan International Timor-Leste	1. Meeting to introduce PLUP with CCVA at the municipal and the post-administrative level; 2. Introduction of PLUP at the target village; 3. Formulation of a working group; 4. Exposure visit (a study tour to one of the villages where the CBNRM Mechanism is in place); 5. Present land use mapping with hazard mapping and vulnerability matrix assessment; 6. Future land use planning with impact and solution analyses; 7. Identification of effective agriculture and forestry extension services/ micro programs; 8. Review of traditional/customary rules in the past; 9. Discussion on draft village regulations; 10. Review of draft village regulations; 11. Consultation meetings with each aldeia xii. Agreement of the local governments with the village regulation; 12. Tara Bandu ceremony	**The project integrates climate change considerations by integrating climate risk analysis and adaptation planning into community land use planning, through:** 1. Climate Change Vulnerability Assessment (CCVA), which conducts participatory CCVA to identify the natural resource vulnerabilities, climate-related hazards, and exposure levels within the community, to inform adaptive land use planning and resilience-building measures 2. Enhance local capacity building on how to use natural resources management in a sustainable manner and promote land use practices that mitigate climate risks and support long-term environmental sustainability
IkanAdapt: Strengthening the adaptive capacity and resilience of fisheries and aquaculture-dependent livelihoods in Timor-Leste (GEF part) - FSP (FSP) Apr 2022 – May 2028 Global Environment Facility (GEF) Implemented by FAO	Water catchment restoration, climate-smart aquaculture, Wetland conservation planning, Improved information from gleaning, locally managed marine areas, business skills training, Fisheries co-management training, adaptation seaweed farming, safety at sea, fisher app development.	The project is expected to enable fisheries and aquaculture stakeholders in Timor-Leste to adapt to climate change and manage biodiversity conservation through reducing vulnerabilities, piloting and adopting new practices and technologies, and sharing information and knowledge
The Project for Community-Based Landscape Management for Enhanced Climate Resilience and Reduction of Deforestation in Critical Watershed Aug 2022 – Jul 2029 Green Climate Fund (GCF); Japan; Government of Timor-Leste; Implemented by JICA	Addressing climate risks by disseminating and upscaling the community-based natural resource management (CBNRM) mechanism in 4 watersheds: Comoro, Laclo, Caraulun and Tafara (PLUP/CCVA and Micro Program).	This project aims to address the climate risk issue through implementing a CBNRM mechanism
The Project for Promotion of Sustainable Coastal Fisheries for Blue Economy Jun 2025 – Jun 2028 Japan, Implemented by JICA	Improve the capacity for DG-FAARM's project management through the pilot project activities; Improve the capacity for increasing productivity of coastal fisheries in the target areas; Improve the capacity for sales promotion of fish and fishery products in the target areas	This project includes the collection of catch information that could contribute to analyzing the influence on variable catch patterns by climate change.

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Program/project title (Start/End date) Donor agency/donor country Implementing agency	**Areas of intervention/key activities**	**Climate change integration**
Coffee and Agroforestry Livelihood Improvement Project Sep 2020 – Oct 2026 Japan Implemented by ADB	The project has three outputs: (i) more productive coffee and agroforestry production systems established; (ii) coffee quality and market linkages improved; and (iii) sector management and coordination improved.	Climate-friendly agroforestry techniques are being introduced under the project. The project interventions improve the climate resilience of the farmers by diversifying their income sources and improving food security.
Rural Resilience and Livelihood Improvement Sector Project Dec 2024 – Jan 2031 Japan Implemented by ADB	The project has three outputs: (i) institutional and organizational capacity of farmer groups, communities, and government strengthened; (ii) Rural water-related infrastructure strengthened; and (iii) livelihood and economic diversification for climate resilience developed.	The project promotes climate change adaptation and improves climate resilience of rural communities by strengthening capacities for climate resilient water and agricultural management, developing water harvesting and flood protection infrastructure.
Project on the Agricultural Value Chain Improvement through Farmers' Participation in Timor-Leste Sep 2021 – Dec 2026 KOICA Implemented by Project Management & Consulting - Yonsei University and World Canaan Farmer's Movement (WCM) Organization.	1. Agricultural Infrastructure 2. Agricultural Production Capacity 3. Agricultural Marketing Capacity	The HADALA Project, introducing terrace farming in the Municipality of Aileu, as an integrated climate change strategy, is to enhance food security and build community resilience against the adverse impacts of climate change. The activity will contribute to: * Combating Soil Erosion and Landslides * Improving Water Management and Conservation * Promoting Sustainable Agricultural Practices * Increasing Food Production and Livelihood Security * Empowering Local Communities
Crop Diversification in Timor-Leste; Raising Incomes through Sustainable Export Agriculture (RISE) Jan 2025 – Dec 2025 New Zealand Implemented by CCT/NCBA	The RISE activity is intended to consolidate coffee gains by further extending rehabilitation practices, improving the quality and processing of cocoa for export to the high-value international market, and increasing the volume of spice crops, particularly vanilla.	The Activity is designated as a climate change adaptation initiative to build resilience, enhance food security, and ensure sustainable livelihoods for rural communities in the face of unpredictable and extreme weather patterns
Aquaculture Development in Timor-Leste (PADTL-Phase 2) Apr 2020 – Jun 2026 New Zealand Implemented by WorldFish	The second phase expands on the number and geographic range of tilapia farmers; continue providing a (reduced) level of technical backstopping and training to the MAF hatchery in Gleno; establish new public/private partnership hatcheries in different parts of the country to ensure farmers can access fingerlings for their ponds; improve access to fish food; improve market connections for fish sales; and promote fish consumption as a high nutrition food, particularly for children.	The Activity aims to improve the environmental performance of Aquaculture and promote adaptation to climate change.
Projeto Quinta Portugal Jan 2016 – Dec 2028 Camões, Instituto da Cooperação e da Língua, IP / Portugal Implemented by Camões, Instituto da Cooperação e da Língua, IP	Areas of intervention: Training, demonstration, and field research on coffee and agroforestry systems; Farmers and Agriculture Technicians training; Farmers' Assistance/ rural extension.	Program activities are designed and implemented with a focus on environmental sustainability and integrating practices that will help farmers cope with climate change effects, allowing them to take advantage of climate change and not be so affected by climate change's negative impacts.
Farmer Field Business School (FFBS) Oct 2022 – Jun 2026 Sall Family Foundation Implemented by CARE in Timor-Leste	Providing training to farmer groups and connecting farmers with access to markets.	FFBS programs empower farmers by providing education and training, enabling them to make better-informed decisions about their farming practices and adapt to changing conditions.