Assessing Opportunities for Forest Landscape Restoration in Quang Tri, Vietnam

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Acronyms and Abbreviations

ADB	Asian Development Bank
ANR	Assisted Natural Regeneration
BAU	Business as Usual
BCI	Biodiversity Conservation Corridors Initiative
CIAT	International Centre for Tropical Agriculture
CO2	Carbon Dioxide
CPC	Commune People's Committee
DARD	Department of Agriculture and Rural Development (Quang Tri)
DONRE	Department of Natural Resources and Environment (Quang Tri)
EP	Enrichment Planting
ER	Extended Rotation
EU	European Union
FCPF	Forest Carbon Partnership Facility
FLEGT	Forest Law Enforcement, Governance and Trade
FLR	Forest Landscape Restoration
FMB	Forest Management Board
FSC	Forest Stewardship Council
GHG	Greenhouse Gas
GIS	Geographic Information Systems
Ha	Hectare(s), unit of area of 100 by 100 meters
IRR	Internal Rate of Return (i.e. the interest rate at which the net present value of all the cash flows from a project or investment equals zero)
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
KfW	KfW Development Bank
NGO	Non-Governmental Organisation
NPK	Nitrogen, Phosphorus, Potassium
NSI	Native Species Introduction
NTFPs	Non-Timber Forest Products
ODA	Official Development Assistance
REDD+	Reducing Emissions from Deforestation and Forest Degradation (REDD), plus the sustainable management of forest resources, and conservation and enhancement of forest carbon stocks
PES	Payment for Ecosystem Services
PRAP	Provincial REDD+ Action Plan
ROAM	Restoration Opportunities Assessment Methodology
ROI	Return on Investment (i.e. the amount of return on an investment relative to the investment's costs)
RUSLE	Revised Uniform Soil Loss Equation
SFE	State Forest Enterprise
SNV	SNV, Netherlands Development Organisation
SUF	Special-use forest
SWC	Soil and Water Conservation
tCO2e	Tonnes carbon dioxide equivalent
UN	United Nations
UNIQUE	UNIQUE forestry and land use GmbH
US	United States
US$	United States Dollar (1 US$ = 22,000 VND)
VND	Vietnamese Dong
VPA	Voluntary Partnership Agreement
WRI	World Resources Institute

Executive Summary

Forest Landscape Restoration (FLR) is the long-term process of regaining ecological functionality and enhancing human well-being across deforested or degraded forest landscapes. FLR has become widely recognised as an important means of restoring deforested and degraded land in ways that contribute to local and national economies, strengthen food and clean water supplies, safeguard biodiversity, and sequester significant amounts of carbon to mitigate the impact of climate change. The launch of the Bonn Challenge in 2011 was a milestone in an international effort to restore 150 million hectares by 2020 and 250 million hectares by 2030. This assessment is aimed at identifying FLR opportunities in Quang Tri Province, Vietnam.

Landscape challenges and goals

Located on the Demilitarized Zone, Quang Tri Province was devastated during the American War. Following the economic reforms initiated in the late 1980s, the province embraced forest restoration by planting fast growing eucalyptus and acacia species. Forest cover quickly increased from 98,000 hectares in 1989 to 235,000 hectares in 2016. However, forest quality is poor and plantations are almost entirely geared toward short rotation acacia for low-value wood chip. Meanwhile, natural forest has declined. The spatial analysis of the Forest Carbon Partnership Facility shows that between 2005 and 2015, Quang Tri lost 35,000 hectares of natural forest, which was offset by a 57,000 hectare increase in plantations, resulting in a net forest gain of 22,000 hectares.

The planned conversion of natural forest to plantations has been accelerated by rules that allow forest below a certain volume per hectare to be converted to plantation. Virtually all of Quang Tri's good quality natural forest is confined to two special-use forests (SUFs) or protected areas. Quang Tri also faces increased pressure on its forests from expanding agriculture. The expansion of cassava cultivation on steep slopes is of particular concern. The expected increase in droughts, intensive rainfall events, storms and pests/diseases in north-central Vietnam because of climate change further undermines the resilience of forest landscapes and forest-dependent communities.

In collaboration with Quang Tri Province, IUCN conducted a Restoration Opportunities Assessment Methodology (ROAM)[1] to map FLR opportunities. Provincial stakeholders defined three FLR goals: (1) increase forest biodiversity and quality; (2) enhance ecosystem services (including watershed protection, erosion prevention and habitats for biodiversity); and (3) improve livelihoods for local people to reduce incentives to encroach on the forest.

FLR options

Four FLR options were identified to help meet these goals: (1) enrichment planting and assisted natural regeneration (EP/ANR) in degraded natural forest, (2) extended rotation (ER) and (3) native species introduction (NSI) in plantations, and (4) soil and water conservation (SWC) in rainfed agriculture.

- *EP/ANR* are used to increase the density of desired tree species in degraded natural forests and the protection and preservation of natural tree seedlings in forested areas; these techniques improve forest quality and biodiversity, reduce erosion, improve water quality, and can provide an alternative source of income for farmers/landholders.
- *ER* is about converting short rotation acacia plantations into longer rotation plantations to reduce erosion by decreasing the time land is bare after harvesting; this reduces sedimentation and improves water quality, while increasing income from high value timber.
- *NSI* is used to transition monoculture acacia plantations to include native species for improved ecological outcomes; it contributes to the same goals as ER but has a stronger emphasis on biodiversity.
- *SWC* refers to measures to reduce soil loss from erosion and increase water retention in agricultural land, e.g., through fertiliser use, intercropping, and cross-slope barriers; these measures also contribute to higher yields for farmers.

These options increase the resilience of forest landscapes to climate change, while mitigating its impact by reducing emissions and enhancing carbon stocks.

[1] https://www.iucn.org/theme/forests/our-work/forest-landscape-restoration/restoration-opportunities-assessment-methodology-roam

FLR priority areas

FLR priority areas were identified using spatial analysis, which assessed areas in relation to three criteria: (1) forest quality and biodiversity; (2) water quality in key river basins; and (3) erosion risk on sloping land. The table shows a summary of the results.

The total area proposed for FLR is almost 54,000 hectares or 11% of the total area of the province (net of 1,100 hectares of overlap between selected areas).

Restoration area	FLR intervention	Land cover	Area (ha)	Total (ha)
SUF (poor quality sites)	• EP/ANR in degraded forest, with support of PES	• Poor evergreen forest • Bare land with trees	2,197 4,106	6,303
Biodiversity corridor (selected areas)	• EP/ANR of poor-quality forest and other selected (and to be converted) land	• Poor evergreen forest • Bare land with trees • Plantation • Agriculture (rainfed) • Transitional areas	1,383 2,365 497 2,753 2,881	9,879
Plantations upstream key river basins	• ER and/or NSI (and FSC)	• Acacia plantations held by large landholders	9,541	13,533
	• ER and/or NSI (and FSC)	• Family-held acacia plantations (> 10 ha)	1,332	
	• ER with support of FSC	• Family-held acacia plantations (3-10 ha)	2,660	
Agriculture (rainfed) at high risk of erosion	• SWC through fertiliser use, intercropping, and cross-slope barriers	• Agriculture (rainfed) at high erosion risk, especially cassava areas	24,975	24,975

Note: PES=Payment for Ecosystem Services; FSC=Forest Stewardship Council; 1,042 hectares of agriculture (rainfed) at high risk of erosion and 36 hectares of plantations (> 3 hectares) upstream key river basins are located within the biodiversity corridor

Natural forest quality was assessed based on forest type, maturity and substrate. For FLR purposes, “poor evergreen forest” and “bare land with regenerating trees” within SUFs were prioritised for EP/ANR since it will be easier to restore forests within protected areas. To reduce forest fragmentation and enhance biodiversity, a corridor is proposed to connect the two SUFs and allow wildlife to move between them.

Short rotation plantations frequently expose soil to erosion. To reduce soil loss and its impact on water quality through longer rotations, an assessment was made of plantation types in major upstream river basins; 16,674 hectares of acacia plantations were identified for ER. Family holdings of less than 3 hectares covering 3,141 hectares were excluded because ER is not economically feasible on such small holdings.

ER is recommended for all plantations larger than 3 hectares. NSI is recommended for plantations larger than 10 hectares as this requires a longer timeframe to break even financially. Given the growing demand for legal timber from Vietnam’s booming wooden furniture sector, sustainable forest management certification like FSC is relevant to all sizes of timber (but not wood chip) from plantations. The advantages of FSC certification may be particularly important for small, family-owned plantations.

The Revised Uniform Soil Loss Equation (RUSLE) was used to map areas at risk of soil erosion based on maximum rainfall, slope length and steepness, and erosion-susceptibility of land cover type. Based on this analysis, 27% of rainfed agriculture, almost 25,000 hectares, is at high risk of erosion and recommended for SWC. Most of this 27% is in mountainous areas in the west of the province, mostly in Huong Hoa District, the main cassava growing area. Another 11,600 hectares of transitional area with high erosion risk (especially in the south) were identified that show extensive signs of human use. Due to the dynamic and small-scale nature of agriculture (mainly swidden) in these areas, it is difficult to target them with specific interventions; they require further attention.

Benefits, costs and barriers

FLR options were assessed in terms of benefits, costs and barriers. EP/ANR are effective at restoring degraded natural forest and enhancing biodiversity. But their costs are high and vary greatly depending on the amount of labour required, with success depending strongly on follow-up and maintenance.

Alternatives were explored to transition short rotation acacia plantations. UNIQUE, a German consultancy, has developed two business models: for ER (11 years) and for NSI (long-term, with step-wise acacia replacement during the first 11 years). Both options are more profitable than short rotation acacia. However, high investments costs and longer payback periods limit their suitability to larger plantations. Unlike acacia for wood chip, value chains are currently not well developed for timber production, especially of high-value native species.

To address the impact of agriculture on soil erosion, several SWC measures were identified: fertiliser use, intercropping, and cross-slope barriers. While these were analysed for cassava, they are applicable to other crops. Use of fertiliser and intercropping (with black bean and groundnut) increase yields, improve water retention, and reduce soil loss. The application of fertiliser optimized for cassava allows for continuous cropping, and increased yields pay back the higher fertiliser cost within two years. Intercropping is financially attractive but labour intensive. Cross-slope barriers are particularly effective at preventing erosion on steep slopes but yield increases take longer to materialize.

These FLR options make the forest landscape and its communities more resilient to climate change by reducing the impact of storms, high-intensity rainfall, pests and diseases, especially when combined with measures that increase tree species diversity. They also contribute to the conservation of carbon stocks and increased carbon sequestration. On a per unit area basis, the highest potential gains are from natural forest regeneration. But in terms of total carbon sequestration over 25-30 years, the highest gains come from agricultural land because this covers a much larger area. This demonstrates the need for a landscape approach to FLR.

Enabling conditions

Four factors are considered critical for successful FLR: (1) motivation of key actors, (2) capacity and resources for implementation, (3) policy support and enforcement; and (4) access to markets and value chains.

In Vietnam, factors both support and impede FLR. For example, a high degree of tenure security allows farmers to invest in higher-value timber species. But the need to generate immediate income forces most farmers to rely on short rotation acacia for low-value wood chip. Similarly, logging bans often lead farmers to engage in “cut and run” logging rather than in sustainable harvesting of natural forest, which a series of pilot projects in Vietnam has shown to be profitable.

An issue in Quang Tri is the dominance of acacia, which has expanded across the province. This has resulted in the rapid increase in forest cover and rehabilitation of degraded lands. However, the large-scale monocultures that dominate the province are vulnerable to disease and declining quality, which is a growing economic risk. The almost exclusive focus on acacia has resulted in the forestry sector, from research to extension to marketing, becoming “acacia-ized”, which limits the scope for the province to move up the value chain by investing in ER and NSI. There is also a significant lack of technical capacity at the provincial level to support the availability of high-quality native tree species seedlings, sophisticated silviculture methods (beyond “plant and cut”), or FSC certification.

In the agricultural sector, the rapid expansion of cassava on steep slopes increases soil erosion and threatens natural forests. The International Centre for Tropical Agriculture (CIAT) has tested a range of SWC measures in Vietnam but smallholder adoption is low, partly because of the high labour requirements and uncertain yield increases. This is an area where government can play a key role by strictly protecting the remaining areas of natural forest and training farmers on sustainable intensification while improving access to inputs.

The key barriers to FLR are not only technical but also financial, policy, and institutional. Except for EP/ANR, all the proposed FLR options are profitable, albeit often over relatively long time periods and in most cases with high up-front costs, which may be unaffordable to farmers. This is where government can alleviate financial bottlenecks to enable the forestry sector to achieve its full potential.

A focus on forest quantity rather than quality remains a key policy and institutional barrier. Nationally, forest cover is rising but this is almost exclusively due to mono-culture plantations with very low biodiversity value. Shifting priority from quantity to quality would require reforms at the highest level of government. Under the revised 2017 Forestry Law all national sectoral plans will have to incorporate environmental protection, biodiversity conservation and climate change, providing an opportunity to accelerate FLR.

Conclusions and recommendations

Implementing FLR in the 54,000 hectares that this assessment has prioritised could significantly improve forest quality and rural livelihoods in Quang Tri, and increase their resilience to climate change. Successful FLR implementation will require improvements in knowledge, technical capacity, and incentives. Government needs to play a key role in transitioning to a forestry sector that is based on quality instead of quantity. The following recommendations are proposed:

- **New vision and policy**: Quang Tri, perhaps with neighbouring provinces, should prepare a FLR vision that adopts a landscape approach to ensure strict protection of the remaining natural forest, reorienting plantations to produce certified timber over longer rotations for the domestic and export markets, and transitioning from acacia monocultures into native species forests. This transition would take 20-30 years and would increase carbon stocks, soil and water conservation and biodiversity. Given the alignment with REDD+ objectives and the growing interest nationally in environmental quality and green growth, it is recommended that the provincial government puts in place a new policy framework on reforming its development strategies based on the recommendations of this ROAM assessment.
- **Innovative financing**: Quang Tri can reduce financial barriers to this forestry transition. It can work with the Vietnam Bank for Social Policies and other state funding programs to provide credit to households willing to invest in ER and NSI. This is likely to involve households with more than 3 hectares of forest in the case of ER and more than 10 hectares in the case of NSI. It can also improve the targeting and monitoring of PES to provide greater incentives to reduce deforestation and degradation, while piloting PES in areas that provide important ecosystem services but fall outside traditional forest management areas (e.g., for implementing cross-slope barriers in agricultural lands). In addition, the government could set up insurance schemes to reduce risks of ER and NSI, and/or encourage farmers to sustainably intensify rainfed crops, especially cassava. The government could facilitate negotiations along value chains whereby wood processors help farmers overcome technical and financial barriers to sustainable forest management while ensuring a stable supply of high-quality timber.
- **Improved extension**: Intercropping, cross-slope barriers, and other measures have been shown to reduce soil loss, maintain soil fertility, and increase yields. But uptake is low because of the misunderstandings over the costs and benefits. Quang Tri should organize visits to successful pilots in other provinces to encourage their adoption, particularly for cassava. Government assistance with the procurement of fertiliser tailored for cassava could be made conditional on farmers adopting these measures and stopping any further clearing of natural forest. Visits to successful pilots can also extend to sustainable plantation management. For households with less than 3 hectares, the province could help them secure group FSC certification. Given the focus on acacia, the province would need to help farmers source and care for native species as they move to higher-value timber production.

1. Introduction

The protection and restoration of forest landscapes is important to ensure food and water security and to improve livelihoods of forest communities and others who depend on the ecosystem services they provide. This has only become more urgent with climate change. Forest Landscape Restoration (FLR) has become widely recognised as an important means of restoring ecological integrity and generating local-to-global benefits by boosting livelihoods, economies, food and fuel production, and water security, while making landscapes and communities more resilient through climate change adaptation and mitigation. FLR focuses on restoring a whole landscape while delivering a range of benefits over time.[2] The 2011 launch of the Bonn Challenge was a milestone in this regard as an international platform to restore 150 million hectares globally by 2020 and 250 million hectares by 2030.[3] This study presents FLR opportunities in the province of Quang Tri in central Vietnam. The term "forest landscape" is new in Vietnam and is not recognized in legal or technical documents.

1.1 Need for FLR in Vietnam

Over the past 30 years, Vietnam has undergone a remarkable forest transition. Between the 1940s and the early 1990s it experienced a precipitous drop in forest cover, falling from 43% to 27% due to agricultural conversion and war.[4] Today, forest cover in Vietnam has recovered to its pre-1940s level and the country is no longer experiencing net deforestation.

The significant increase in forest cover since the 1990s has been achieved through a series of national FLR programs that have included replanting with fast growing exotic species. However, success has bred a new set of challenges related to continued loss of natural forest, declining biodiversity, and the massive expansion of monoculture plantations, all of which threaten critical ecosystem services and increase vulnerability to climate change.

New approaches are needed to improve the quality of Vietnam's forests. For example, native species can be introduced to transition acacia plantations into more diverse and resilient ecological systems. Longer plantation rotations can reduce erosion while increasing the value of wood. The protection of natural forests can be enhanced through better targeting and monitoring of Payment for Ecosystem Services (PES) schemes, and agricultural practices can be improved to increase productivity while preventing soil erosion and forest encroachment.

Achieving these goals will require a fundamental reorientation of forestry policy and management. In the words of a provincial researcher: *"The entire forestry sector, encompassing research, extension, nurseries, and marketing, has been 'acacia-ized'"*. To overcome this, forest managers need to develop new strategies, while farmers need the tools to implement more sustainable land management. Across the landscape, food and wood production must shift from maximizing quantity to increasing quality.

Both the market demand and international support are in place for such a shift. Wooden product markets across the world require timber that meets sustainable forest management standards and are willing to pay a premium price.[5] Agricultural export markets increasingly demand compliance with international standards.[6] Capitalizing on these opportunities will require Vietnam to pursue structural changes in the forest and agricultural sector.

1.2 Objective and set-up of the study

To address Quang Tri's FLR needs, IUCN worked with the Quang Tri Department of Agriculture and Rural Development (DARD), the Department of Natural Resources and Environment (DONRE), NGOs,[7] and farmer and community representatives to understand what they hoped to achieve through FLR.

Stakeholders identified three FLR goals: (1) increase forest biodiversity and quality; (2) enhance existing ecosystem services (watershed protection, prevention of erosion and habitats that support

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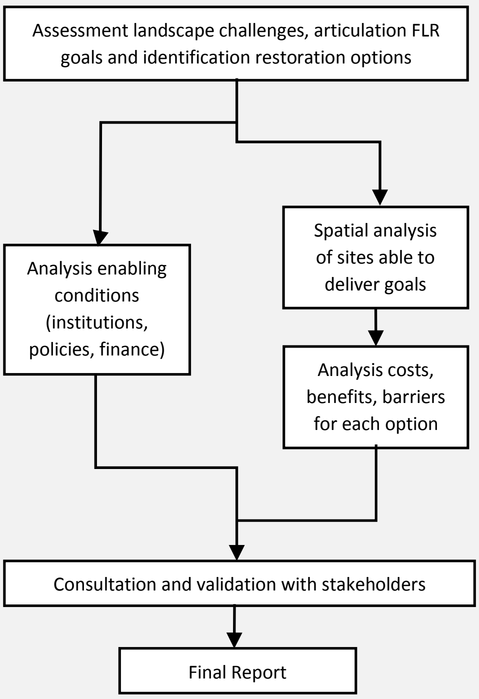
[2]IUCN and WRI (2014)
[3]http://www.bonnchallenge.org/content/challenge
[4]FAO (2009)
[5]Hoang, Hoshino and Hashimoto (2015)
[6]Giovannucci and Purcell (2008); see also http://www.fao.org/docrep/010/ag130e/AG130E00.htm
[7]WWF, Biodiversity Corridor Conservation Project and the Global Community Service Foundation (GCSF)

high levels of biodiversity); and (3) improve livelihoods for local people to reduce the incentives to encroach on the forest.

To meet these goals, a Restoration Opportunities Assessment Methodology (ROAM) was used (Box 1.1). ROAM has been used globally to chart pathways to improve ecosystem services and livelihoods and to enhance long-term sustainability of landscapes through a combination of stakeholder engagement, spatial analysis, assessment of restoration options, and analysis of enabling conditions.

BOX 1.1: RESTORATION OPPORTUNITIES ASSESSMENT METHODOLOGY (ROAM) IN QUANG TRI

ROAM is a methodology developed by the International Union for Conservation of Nature (IUCN) and the World Resources Institute (WRI) to identify conditions and information that can lead to improved landscape management. It embraces a participatory and iterative approach, involving stakeholders at key moments. The main components as applied in this study were:



- **Landscape challenges:** The team undertook a scoping study in July 2016 and met with government agencies at both the national and provincial level. In October 2016, an inception workshop was held in Quang Tri and Hanoi to identify FLR goals that stakeholders wanted to achieve and restoration models for investigation.
- **Spatial analysis:** Spatial analysis was employed to identify priority restoration areas. The analysis made use of datasets on land cover, forests, elevation, slope, watersheds, biodiversity areas, forest tenure, and climactic variables. These were used to identify FLR opportunities.
- **Restoration options:** Identified options were analysed in terms of costs, benefits and barriers. The team visited Quang Tri in May 2017 to undertake key informant interviews to inform this analysis.
- **Enabling conditions:** An assessment-tool (the WRI/IUCN Rapid Restoration Diagnostic) was used to identify institutional and policy challenges, and which was complemented with a financial analysis to assess funding sources.
- **Validation**: Findings and conclusions were validated in a workshop with relevant stakeholders in January 2018.

More information on ROAM can be found at: https://www.iucn.org/theme/forests/our-work/forest-landscape-restoration/restoration-opportunities-assessment-methodology-roam.

2. Landscape Challenges

Barriers to FLR were identified. This involved understanding developments in the forestry and agricultural sectors at the national and provincial levels and identifying interventions that are practical and cost-effective.

2.1. Quang Tri Province

Map 2.1: Quang Tri Province

Quang Tri Province is in north-central Vietnam (see Map 2.1). The total area is 4,772 km^2 and the population was 623,528 in 2016, with 71% of people living in rural areas. Most people are majority Kinh ethnicity with a small minority of ethnic groups (9%), including Van Kieu and Pa Ko. Average annual household income is 12.7 million dong (US$575).[8] Three-quarters of the province is dominated by mountains and hills; it has steep slope highlands, deep narrow valleys, and narrow coastal plains. Annual average temperature is 24°C and annual precipitation is about 2,500 mm. Quang Tri experiences a rainy season from June to December with tropical depressions and typhoons from September to November and a dry season from January to May. Variations in weather patterns are expected to increase because of climate change.[9]

Located on the Demilitarized Zone, Quang Tri was devastated by defoliation and bombing during the American War. Dense broadleaf evergreen and semi-deciduous forest grow naturally across the highlands but due to war damage and post-war deforestation, very little primary forest remains. Following the economic reforms initiated in the late 1980s, the province embraced forest restoration, planting fast growing species such as eucalyptus and acacia, which helped the province to increase its forest cover from 98,000 hectares in 1989 to more than 235,000 hectares in 2016. But forest quality is poor. Between 2005 and 2015, Quang Tri lost 35,000 hectares of natural forest, which was offset by a 57,000 hectares of plantation, resulting in a net forest gain of 22,000 hectares.[10] Quang Tri's remaining natural forests are secondary forests that have regenerated naturally and are predominately low timber volume.[11]

2.2. Forest composition and management

In Vietnam, forests are classified into three categories: special-use forest (SUF), protection forest and production forest, which vary in purpose, management, and access rights (see Table 2.1).

[8]North-central region has the highest rates of poverty per capita in the country: 29% of the 10.5 million population live below the national poverty line of US$1.90/day

[9]Information in this section is derived from http://www.quangtri.gov.vn/portal/pages/http--webthunghiemqt-quangtri-gov-vn-portal-Pages-.aspx, and Government Statistical Office, 2017

[10]MARD (2018)

[11]National government defines forest based on timber volume: very rich forest (> 300m^3/ha); rich forest (200-300 m^3/ha); medium forest (100-200 m^3/ha); poor forest (10-100 m^3/ha); very poor forest (< 10 m^3/ha) (Circular No. 34/2009/TT-BNNPTNT 10 June 2009 of MARD on criteria for forest defining and classification)

Table 2.1: Forest categories and characteristics in Vietnam (source: USAID 2016)

Type	Purpose	Management	Access rights for harvesting
SUF	Forest protection and biodiversity conservation	State management	People harvest Non-Timber Forest Products (NTFPs) in buffer zone; harvesting timber and NTFPs is outlawed in core zones
Protection forest	Protect ecosystem services, mitigate impacts of extreme events, avoid degradation	State and household management	No timber extraction allowed in natural forest, limited extraction allowed in plantation forest
Production forest	Commercial activities including rubber and acacia	State and household management	Exploitation/use must ensure maintenance of forest area, development of forest stock and quality, and comply with regulations

Table 2.2 shows the composition of forests in Quang Tri. The total area of forest and forest land is 346,000 hectares, of which 235,000 (68%) has actual forest. Forest includes 60,000 hectares of SUF (including two nature reserves: Dak Rong in the south and Bac Huong Ha in the northwest), 73,000 hectares of protection forest and 93,000 hectares of production forest. Of these, 143,000 hectares (61%) is natural forest and 91,000 hectares (39%) is plantation forest. While the two SUFs are almost entirely composed of natural forest, protection and production forests are a mix of natural and plantation forest. Large areas, especially in protection and production forest, have no forest cover. These are newly planted areas without canopy, surplus land (with and without naturally-regenerated trees), stony hills, land with agricultural crops, and other land.[12]

Table 2.2: Quang Tri forest composition (source: Quang Tri forest data 2016)

Forest category	Natural forest	Plantation forest	Non-forest	Total
SUF	59,052	1,065	8,777	68,894
Protection forest	50,517	22,156	26,837	99,511
Production forest	32,425	61,049	72,988	166,461
Outside categories	1,335	7,161	2,215	10,710
Total	**143,328**	**91,431**	**110,817**	**345,576**

Forest management authority is shared between the provincial government and farmers (see Figure 2.1). Forest protection and restoration are coordinated by DARD through the sub-Department of Forest Protection and the sub-Department of Forestry. Forest Management Boards (FMBs) manage about 100,000 hectares (44% of all forest); this is primarily natural forest in SUFs and protection forest. Commune People's Committees (CPCs) are responsible for almost 70,000 hectares (30% of the forested area), mostly production and some protection forest. These forests are intended for households and communities use but as of 2016 only 18% had been allocated to households, almost entirely poor-quality forest. State Forest Enterprises (SFEs) and other companies manage the remainder of the production forest (mostly plantations).

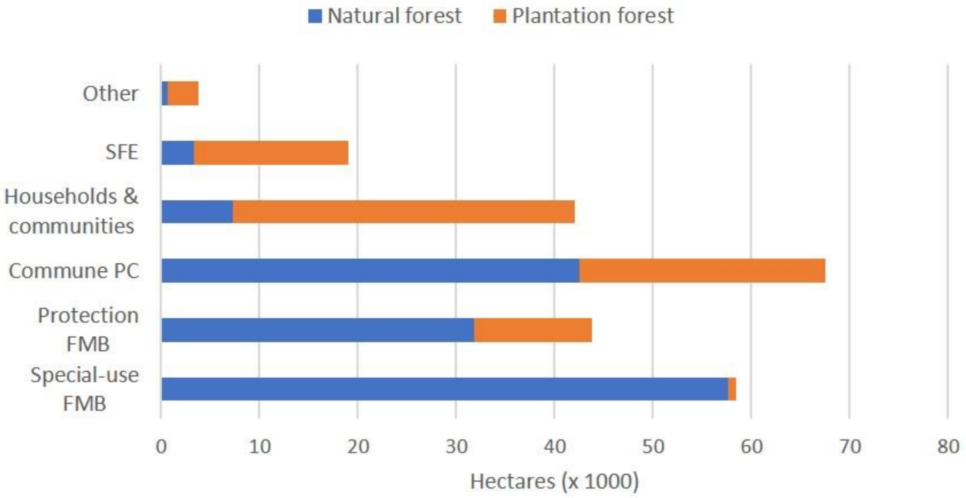


Figure 2.1: Forest management in Quang Tri (source: Quang Tri forest data 2016)

[12]Decision No.07/QD-UBND 4 January 2017 of Quang Tri Provincial People's Committee on approval for the forest inventory result in Quang Tri (refers to "Quang Tri forest data 2016", which is used for further reference)

2.3. Challenges in the plantation sector

To accelerate forest recovery in the 1990s, Vietnam planted fast-growing exotics such as eucalyptus, acacia and pine (*Pinus merkusii*) that could cope with the harsh, degraded environment. Farmers found these species economically attractive as they grew quickly, generated income as feedstock for pulp and were in strong demand.[13] Quang Tri's forest sector is currently dominated by acacia monocultures for wood chip under short rotations (see Table 2.3); 85,000 hectares (77%) of all plantations in 2016 were acacia monoculture, predominantly managed on rotations of 4-6 years.

Table 2.3: Tree species in plantations in Quang Tri (source: Quang Tri forest data 2016)

	Plantation forest	Newly planted	Total
Acacia	68,031	17,417	85,448
Rubber	7,436	121	7,557
Pine	6,429	45	6,474
Pine + Hopea + acacia	3,935		3,935
Pine + Mu oil tree	1,006		1,006
Mu oil tree	242	615	857
Pine + acacia	807		807
Acacia+ Hopea	628	74	702
Bollywood	293	304	597
Casuarina	547	5	552
Hopea + Pine + Mu oil tree	533		533
Other/no-data	1,544	996	2,540
Total	**91,431**	**19,577**	**111,008**

Note: Mu oil tree (*Vernicia montana*); Bollywood (*Litsea glutinosa*); Hopea (*Hopea odorata*); 69,159 out of 85,448 hectares (80.9%) of acacia monoculture is less than 6 years old.

Short rotations frequently expose the bare soil, which leads to soil erosion during heavy rainfall. This risk is particularly pronounced due to the greater frequency of high-intensity rainfall and the use of bulldozers for harvesting. Farmers often use clippings to grow their trees. Genetically uniform acacia monocultures are vulnerable to pests and diseases with growers in Quang Tri reporting increasing pest outbreaks. Monocultures are also less effective at protecting watersheds compared to native species.[14]

Plantation owners have not fully capitalised on Vietnam's booming wooden furniture sector; only 20% of Vietnam's wooden furniture is made from local wood.[15] Vietnam is therefore missing out on the opportunity to expand the its wooden furniture sector and reduce dependence on imported timber, particularly from "high-risk" countries that could jeopardise access to the EU and US markets.[16]

Even though sawn timber fetches over US$70/m^3 for acacia and US$165-360/m^3 for native species compared to US$30/m^3 for acacia wood chip,[17] wood chip is still preferred for its low risk and quick returns. The attractiveness of short rotation acacia is reinforced by the demand from wood chip factories, and because it does not require advanced silvicultural skills or much capital investment.[18] When farmers harvest their trees they sell their entire plot to a middle-man who pays a flat fee per hectare regardless of timber volume. There is therefore no incentive to shift to the longer rotations to produce timber-grade wood.

2.4. The relevance of agriculture

Agriculture is a key sector in Quang Tri, with 71% of people living in rural areas. Farmers mainly grow rice, rubber, and cassava, followed by coffee, groundnut, maize, banana, and some other crops and fruits (see Figure 2.2).[19] Rice accounts for almost half of the planted area; this includes spring paddy and autumn paddy, which largely overlap. The planted area for other annual and perennial crops was 54,000 hectares in 2015.

Figure 2.3 presents the planted area of major crops between 2010 and 2015. Whereas rice areas

[13] Amat et al. (2010); MARD (2016); eucalyptus was later replaced by acacia
[14] Ives (2010); Thulshrup (2014)
[15] Hoang, Hoshino, and Hashimoto (2015)
[16] USAID (2013)
[17] UNIQUE (2017)
[18] Silviculture is the practice of controlling establishment, growth, composition, health, and quality of forests to meet diverse needs and values
[19] Quang Tri Statistics Office (2016)

fluctuated slightly, rubber (+20.8%) and cassava cultivation (+30.4%) increased significantly.[20] Cassava, which is mainly exported as a food and industrial crop, earns about 22 million dong/hectare (US$1,000/hectare) per harvest at the farm gate. The surge in cassava production is mainly due to an increase in planted area (from 9,770 to 12,741 hectares) as average yields have remained stable at 16 tons/hectare. Cassava can grow on marginal land and tolerates drought and heat, which is especially important as farmers adapt to the impacts of climate change.[21]

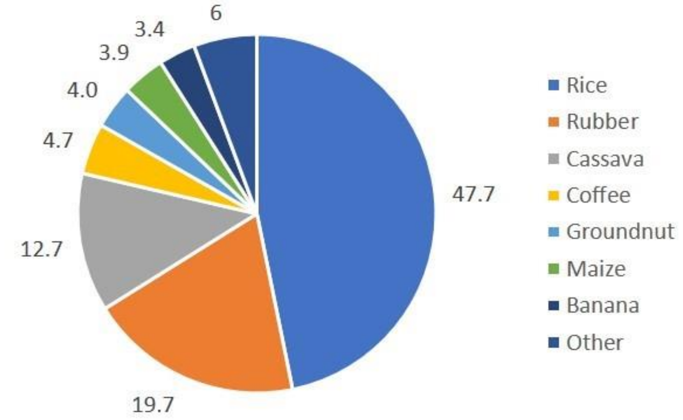


Figure 2.2: Planted area (x1000 ha) in 2015 in Quang Tri (source: Quang Tri Statistics Office, 2016)

The expansion of cassava is of concern. In the 2-3 months before the cassava canopy closes, the soil is exposed. With heavy rainfall and without soil conservation, soil washes downslope and accumulates in water reservoirs, irrigation channels and paddy fields. Cassava is also associated with forest clearing because it can be grown on steep slopes (where most of the remaining forest is found) and forest that has been logged and burned provides free fertiliser.

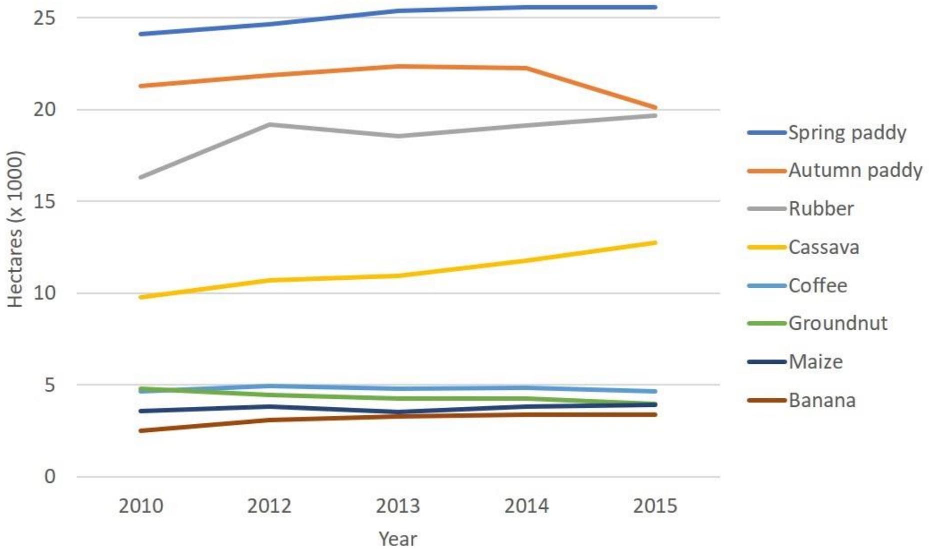


Figure 2.3: Planted area of key crops between 2010-2015 in Quang Tri (no-data for 2011) (source: Quang Tri Statistics Office, 2016)

2.5. Policy context

Vietnam has made significant commitments to forest restoration. Vietnam's Nationally Determined Contribution to the 2015 Paris Agreement includes a target of 45% forest cover by 2030.[22] In December 2014, the government banned logging of natural forests.[23] These commitments build on a series of national programs that have provided substantial funding for replanting, notably Program 327, launched in 1993, and it's successor, the Five Million Hectare Restoration Program (5MHRP), launched in 1998.

[20] Quang Tri Statistics Office (2016)
[21] CIAT (2011)
[22] Government of Vietnam (2015b)
[23] Decision 2242/QĐ-TTg 11 December 2014 of the Prime Minister on approving the scheme for strengthening the management of exploitation of timber of natural forest for the period 2014-2020

Vietnam has also set ambitious goals to improve forest quality. The Vietnam Forest Development Strategy 2006-2020 states that at least 30% of production forest should be certified by 2020 using international standards.[24] Vietnam has adopted policies to extend timber rotations to meet the demand from the wooden furniture industry. This includes increasing sawn log production from 30-40% to 50-60% of the total volume of timber harvested by 2020 while reducing the amount of wood used for wood chip to less than 40% by 2020.[25]

Over the last 30 years, rapid agricultural growth has transformed the rural economy. To maintain agricultural production under increasing climate risk, farmers need to adopt climate-smart practices. Creating an enabling environment for climate action in the agricultural sector is a priority but there is a conflict between the long-term benefits from climate-smart farming and the short-term benefits of current farming practices.[26]

Reforms in both the forest and agriculture sectors are included in the National REDD+ Action Plan that was approved by the Prime Minister in 2017.[27]

2.6. FLR in Quang Tri

Quang Tri aims to double its GDP per capita between 2015 and 2020 by increasing the profitability of the agricultural sector, protecting and developing its forests, improving land-use efficiency and combine forest plantations with livestock development.[28] FLR is considered important for realizing these goals.

Four FLR options were identified through consultation with stakeholders: (1) restoration of natural forest through enrichment planting (EP) and assisted natural regeneration (ANR); (2) extended acacia rotation (ER) in plantations (3) native species introduction (NSI) in plantations, and (4) soil and water conservation (SWC) in rainfed agriculture; options and contribution to FLR goals are presented in Table 2.4.

Table 2.4: FLR options and goals

Land use	FLR option	FLR goals
Natural forest	• *EP/ANR*: increase the density of desired tree species in (degraded) natural forests and protect and preserve natural tree seedlings in forested areas	• Improve forest quality and biodiversity • Reduce erosion of degraded forest • Improve water quality • Alternative source of income for farmers/landholders
Plantation	• *ER*: convert short rotation acacia plantations in to longer-rotation plantations to reduce erosion • *NSI*: transition monoculture acacia plantations to include native species to improve ecological outcomes	• Erosion control by reducing time land is bare after harvesting • Reduce sedimentation and improve water quality • Increase farmer incomes from high-value timber • Increase biodiversity through reintroduction of native species
Agriculture	• *SWC*: reduce soil loss as result of erosion and increase water retention through fertiliser use, intercropping, and cross-slope barriers	• Prevent erosion by conserving soil on farm land • Increase water retention and reduce runoff • Increase yields

By sequestering above- and below-ground carbon and protecting the soil, FLR can contribute to both climate change adaptation and mitigation. The conversion of grasslands and forests to cropland and the degradation of forests are responsible for about 20% of global greenhouse gas emissions. There is significant potential to increase carbon storage in soil and biomass through FLR.

[24]MARD (2007)

[25]Decision No.774/QĐ-BNN-TCLN 18 April 2014 on approval for the action plan to improve the productivity, quality and values of planted production forest in the period 2014-2020; Decision No. 5115/QĐ-BNN-TCLN 1 December 2014 on approval for options to manage wood chip in the period 2014-2020

[26]Nguyen et al. (2017)

[27]Decision 419/QĐ-TTg 5 April 2017 of the Prime Minister on Approval of the National Action Program on the Reduction of Greenhouse Gas Emissions through the reduction of Deforestation and Forest Degradation, Sustainable Management of Forest Resources, and Conservation and Enhancement of Forest Carbon Stocks (REDD+) by 2030

[28]Quang Tri Social-Economic Master Development Plan Towards 2020 available at: http://quyhoach.quangtri.gov.vn/index.php?language=vi&nv=news&op=Muc-tieu-phat-trien/MUC-TIEU-PHAT-TRIEN-8

3. Spatial Analysis

FLR opportunities were identified through spatial analysis that contribute to the three FLR goals.

3.1 Approach

Using data on land cover, river basins and forests (see Table 3.1), and in consultation with the provincial stakeholders, land areas were assessed based on three criteria: forest quality and biodiversity, water quality in key river basins, and erosion on sloping land. Priority areas were identified for three main land-use types: (1) natural forest, (2) plantations, and (3) agriculture.

Table 3.1: GIS datasets used to assess FLR opportunities in Quang Tri

Dataset	Input data	Method	Note
Land cover dataset	LANDSAT 8 images from 2016, OpenStreetMap and provincial forest dataset Google Maps aerial/satellite imagery used as reference to spot-check LANDSAT photography	Landsat used for initial land cover map (unsupervised classification), and specific water and paddy layers Forest cover derived from provincial dataset and spot-checked Settlement data digitised in OpenStreetMap Transitional areas are derived from forest dataset and spot-checked Remaining land assumed rainfed agriculture, but spot-checked against unsupervised classification and aerial imagery	Barren land includes sandy soil areas near the coast and unfertile areas in the interior of the province Grass cover is open area covered by grass, including utility corridors not used for agriculture and disturbed forest areas covered by grass Transitional areas refer to forested land undergoing change (recently cut/recently planted/swidden)
River basin dataset	ASTER DEM 30 m resolution (elevation model)	River basins were automatically defined using GRASS GIS watershed basin module; over 50 sub-basins were identified	River basins upstream from reservoirs and dams selected visually
Forest dataset	Provincial data on forest types as of 2016 Forest categories (special-use, protection and production forest) Forest owner, tenure length, and area size	MapInfo database imported into GRASS and rasterised over different variables to match land cover file at 30m resolution	Not all areas for special-use, protection and production forest currently have forest cover; these are governmental land (use) designations (*dat chua co rung*) and do not indicate current land cover

3.2 Land cover and forest categories

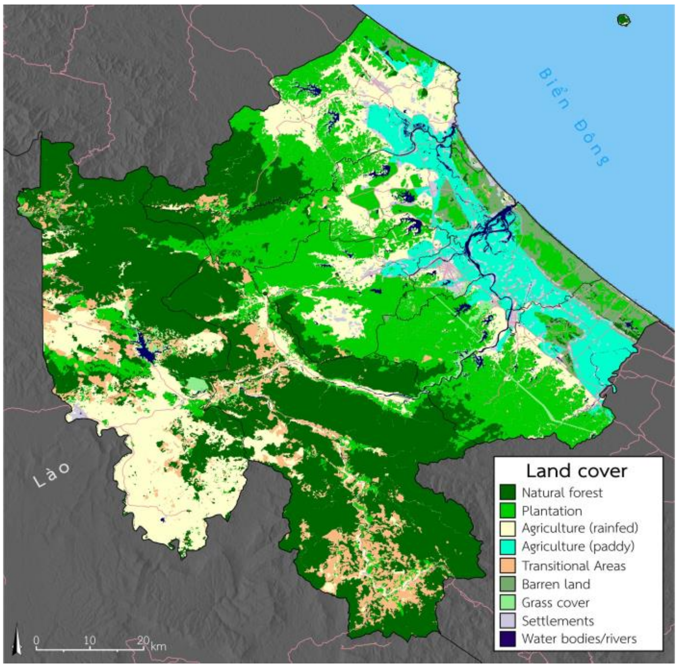
A 2016 land cover map was created with the following land cover types: natural forest, plantation, agriculture, transitional areas, barren land, grass cover, settlements, and water bodies/rivers; agricultural lands were divided between paddies and rainfed agriculture. Transitional areas are forests with clear signs of human activity, probably swidden and other forms of small-scale forest clearing (see Map 3.1).[29]

Quang Tri's land covers form distinct north-south bands. To the east are coastal forests on sandy soil that transition into rice paddies interspersed with settlements, and rainfed agriculture to the north. In the middle of the province, plantations stretch almost entirely from north to south. To the west, plantations eventually give way to natural forest followed by upland rainfed agriculture near the Lao border, with large areas of relatively flat agricultural land and steep forested hillsides mixed with swidden in transitional areas.

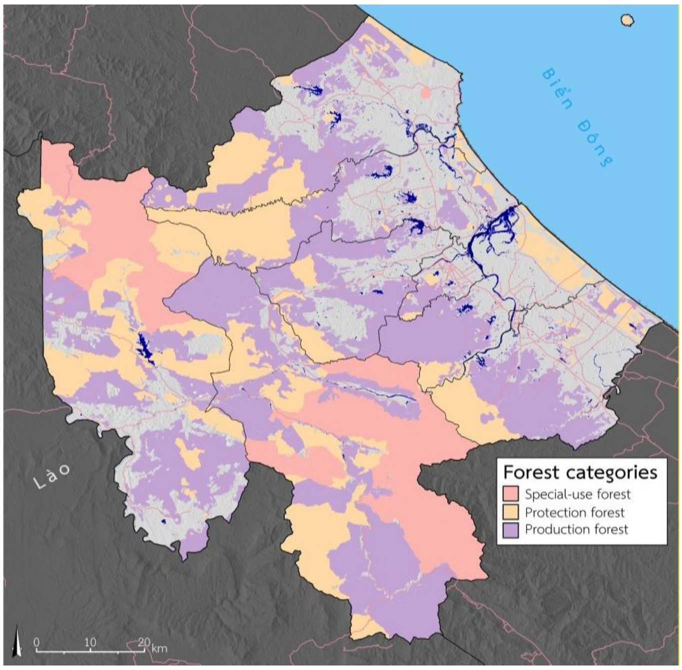
The area of each land cover type is presented in Table 3.2. There are two major differences with provincial data.

First, government data refer to 143,328 hectares of natural forest and 91,431 hectares of plantation forest (see Table 2.2). Differences with the land cover map are explained by forest types that are not considered forest by government: provincial data on forest land without forest refers to 25,000 hectares of bare land with regenerating trees and almost 20,000 hectares of recently planted areas without

[29]See Annex A for the government classification of forest types and how these types were used in the report



Map 3.1: 2016 land cover, Quang Tri



Map 3.2: Forest categories, Quang Tri

canopy. These categories were included in the land cover map as, respectively, natural forest (since the land with regenerating trees showed up as natural forest on satellite imagery) and as plantation.

Table 3.2: Land cover in Quang Tri

Land cover	Area (ha)
Natural forest	167,920
Plantation	114,524
Agriculture (rainfed)	91,008
Agriculture (paddy)	35,800
Transitional areas	28,460
Barren land	12,673
Grass cover	5,849
Settlements	10,119
Water bodies/rivers	7,276
Total	473,630

Second, the area of rainfed agriculture in the map (91,000 hectares) is much larger than the 54,000 hectares of cultivated area, excluding rice (Figure 2.2). Although the cultivated area is likely to be larger since not all crops are accounted for by the government data, the agricultural area also includes swidden in various stages of regeneration and small areas of grassland or barren land.

A second map used to identify FLR opportunities is forest categories. Map 3.2 shows how SUF is located in two nature reserves that mainly consist of natural forest. These reserves are surrounded by concentric zones of protection and production forest, which contain large areas of plantation as well as areas without forest cover.

The composition of the forest categories is given in Table 3.3.

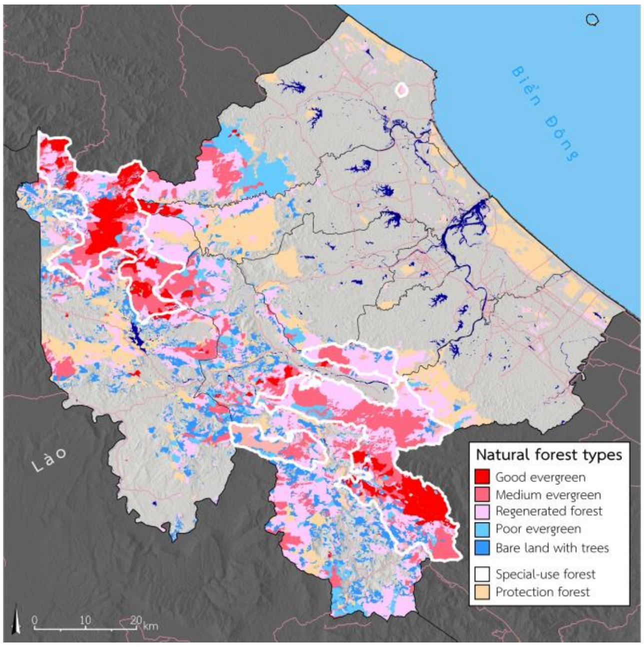
Table 3.3: Composition of forest categories based on land cover

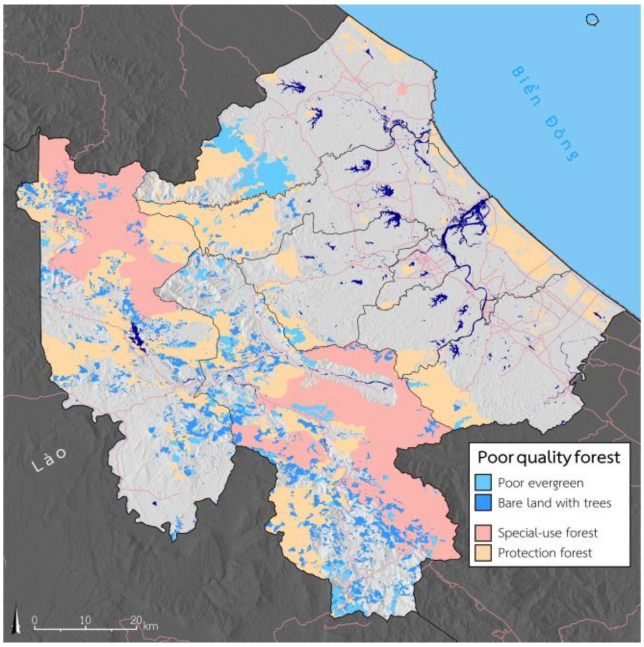
	SUF	Protection forest	Production forest	Outside categories	Total
Natural forest	63,017	58,154	45,323	1,426	167,920
Plantation	1,596	26,109	73,226	13,592	114,524
Agriculture (rainfed)	1,511	3,262	21,843	64,392	91,008
Agriculture (paddy)	3	331	402	35,064	35,800
Transitional areas	2,427	6,813	19,220	n/a	28,460
Barren land	104	3,810	2,155	6,604	12,673
Grass cover	164	476	2,785	2,425	5,849
Settlements	3	57	196	9,864	10,119
Water bodies/rivers	27	498	1,039	5,713	7,276
Total	**68,852**	**99,510**	**166,189**	**139,080**	**473,630**

Note: “transitional areas” are derived from forestry land; hence, no land outside forest categories has been classified as such

3.3 Forest quality and biodiversity

This section focuses on natural forests. Vietnam classifies natural forests as poor, medium or rich based on standing timber volume. But wood volume is not always a good indicator for forest quality in natural forests. Different natural forest types vary considerably in wood volume.[30] Volume also depends on the maturity of a forest. A young regenerating forest might have low volume but excellent growth potential and does not need any restoration support, whereas an old but over-exploited forest has higher remaining volume but will not be able to recover without assistance.[31] Hence, natural forest quality was assessed based on forest type, maturity, and substrate.[32]





Map 3.3: Natural forest types (left) and poor-quality forest (right)

Maps 3.3 shows different (secondary) natural forest types, including "bare land with regenerating trees". The map on the left shows the natural forest types along a gradient with good evergreen, medium evergreen and regenerated forest (good quality forest) in red and poor evergreen and bare land with regenerating trees (poor quality forest) in blue. The map on the right focuses on poor quality forest. Whereas good quality forest is concentrated in the two SUFs, poor quality forest is scattered but with a large concentration of poor evergreen in the central-north near plantation sites, which may point to recent deforestation. For FLR purposes, poor quality areas within SUFs are prioritised since it will be easier to protect them.[33]

The distribution of the main natural forest types is given in Table 3.4. These data are consistent with the government data on rich (good evergreen), medium (medium evergreen) and poor forest (regenerated forest and poor evergreen) (see Annex B).

Table 3.4: Natural forest types in relation to forest categories

	SUF	Protection forest	Production forest	Outside categories	Total
Good natural evergreen forest	13,929	2,015	729	32	16,705
Medium natural evergreen forest	20,796	10,145	7,118	22	38,082
Regenerated natural evergreen	22,139	29,696	19,914	1,156	72,905
Poor natural evergreen forest	2,197	8,713	4,558	53	15,521
Bare land with regenerating trees	4,106	7,708	13,242	0	25,056
Total	**63,167**	**58,277**	**45561**	**1263**	**168,269**

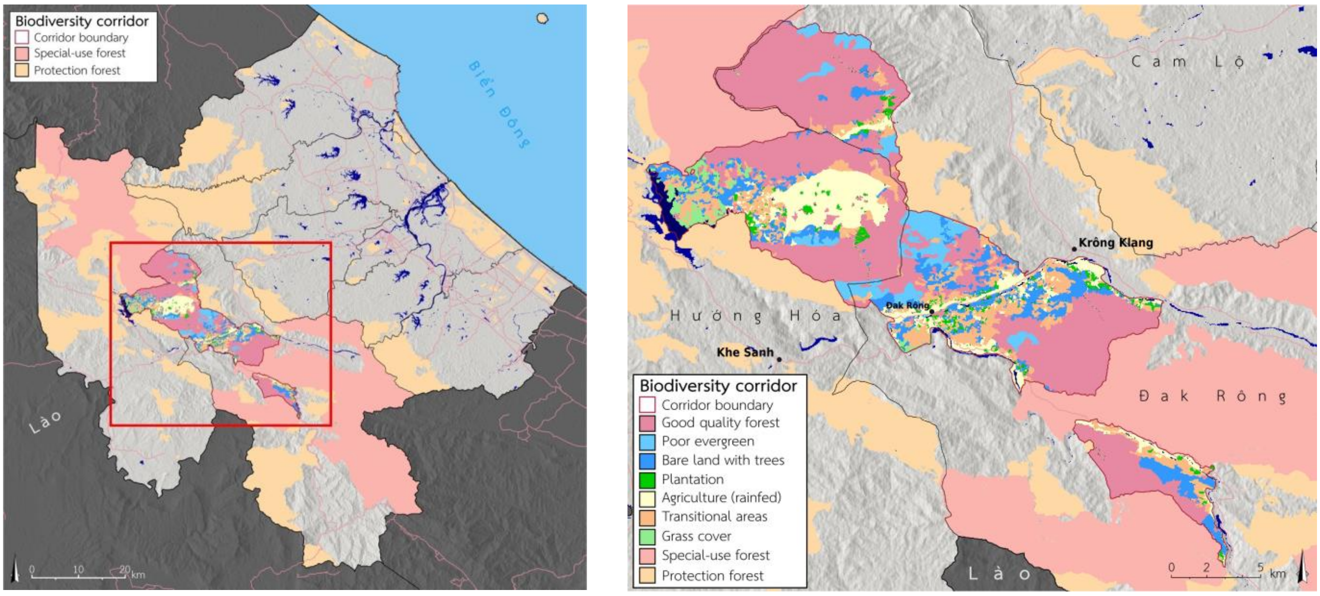
Note: 282 hectares of bamboo forest not included; data based on forest dataset

[30] Canopy closure and species composition (lack of pioneer trees, no climber infestation) would be more reliable as indicator for forest quality, but it is not possible to get this data for an entire province (KfW expert, pers. comm.)
[31] KfW expert, pers. comm.
[32] This is also not ideal since forest types are linked to fixed volume-based categories, making differentiation of quality within forest types impossible
[33] Poor quality forest types include areas on "rock hill" that are difficult to restore, but these areas are very small

However, in this case, we do not consider regenerated forest as "poor quality". Instead we include "bare land with regenerating trees" as poor-quality forest. The area of poor evergreen and bare land with regenerating trees inside SUFs identified as FLR priority is 6,303 hectares in total.

Restoring poor quality forest in SUFs is important but not sufficient. Quang Tri's natural forests are very fragmented. River valleys in the south-western part of the province have been largely converted to agriculture. FLR should protect forests that provide habitats for wildlife while replanting areas to connect isolated forest clumps. A biodiversity corridor between the two SUFs would allow species to move between them. This is in line with the goal of the ADB Biodiversity Conservation Corridors Initiative (BCI) in 2006-2011 to connect protected areas that are recognized as being the most important for endemic species conservation in north-central Vietnam.[34]

Map 3.4 shows the biodiversity corridor between the two SUFs. It is extended to include part of the SUF in the south, which has become disconnected over time. The border of the corridor is based on the BCI plan adapted to align with the SUF borders.



Map 3.4: Biodiversity corridor overview (left) and close-up (right)

The land cover of the biodiversity corridor is given in Table 3.5. The total area of the corridor is about 21,000 hectares of which more than half is good quality forest. Although the two SUFs are separated by a road, the connection could be improved by restoring 3,700 hectares of poor-quality forest (poor evergreen and bare land with regenerating trees) and converting 6,000 hectares of agricultural, transitional and plantation areas into natural forest. The area of grass cover is rather small and near the corridor edge and can be left as is.

Table 3.5: Biodiversity corridor

Land or forest type	Area (ha)
Good quality forest	11,051
Poor evergreen	1383
Bare land with trees	2365
Plantation	497
Agriculture (rainfed)	2,753
Transitional areas	2,881
Grass cover	461
Total	**21,391**

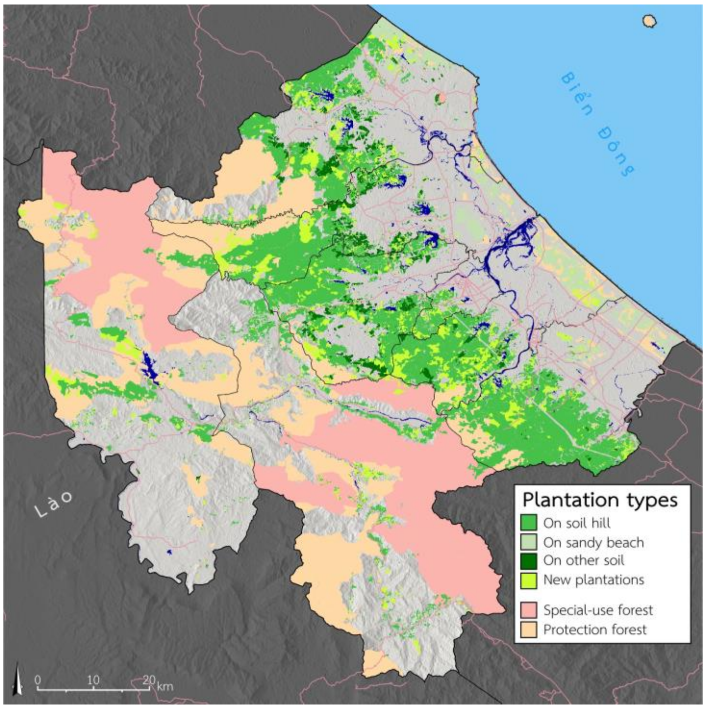
3.4 Water quality in key river basins

Water quality improvement was identified by stakeholders as a critical ecosystem service. Reservoir sedimentation is associated with erosion from plantations and agriculture. Since areas upstream of important reservoirs are dominated by plantations, the assessment focuses on plantations (see Chapter 4).

Map 3.5 shows the distribution of plantations in Quang Tri based on type.

Plantations are of four types: (1) on soil hill, (2) on sandy beach, (3) on other soil, and (4) new plantations. The distribution of plantation type by forest category is shown in the map and in Table 3.6.

[34]ADB Biodiversity Conservation Corridors Initiative (BCI) report 2006-2011



Map 3.5: Plantation types in Quang Tri

Plantations are mainly found on soil hill (75,000 hectares) across the province, with smaller areas on sandy beach along the coast (9,000 hectares), and on other soil (7,000 hectares). Plantations on soil hill and sandy breach are dominated by acacia with some pine, rubber, hopea, mu oil tree, and casuarina. Plantations on other soil types consist entirely of rubber. For new plantations, mainly on soil hill, acacia is even more dominant.

Table 3.6: Plantation types in relation to forest categories

	SUF	Protection Forest	Production Forest	Outside categories	Total
Planation forest on soil hill	982	17,193	51,098	5,272	74,546
Plantation forest sandy beach	0	4,740	2,814	1,832	9,386
Plantation forest on other soil	80	296	7,066	0	7,441
New plantations	554	4,446	12,390	2,202	19,593
Total	**1,616**	**26,675**	**73,368**	**9,306**	**110,966**

For FLR purposes, we are interested in acacia monocultures. Of the 111,000 hectares of plantation forest, 85,000 hectares (77%) are acacia monocultures (see Figure 2.3); almost 70,000 hectares of these are younger than 6 years, i.e., managed on short rotation cycles. Map 3.6 shows all acacia monocultures. Since the management of plantations and scope for FLR strongly depends on size of landholdings, these areas were further differentiated by area between large landholders (e.g., FMB, commune, or business) and family plantations varying in size (Map 3.6, on the left). In addition, river basins upstream of reservoirs were prioritized (Map 3.6, on the right).[35]

Table 3.7 shows the distribution of acacia monocultures by size class. The distribution of plantation by size class in key river basins is similar to the distribution in the whole province: about 60% of plantations are managed by large landholders and 40% by families. Of the family managed plantations, half are less than 3 hectares.

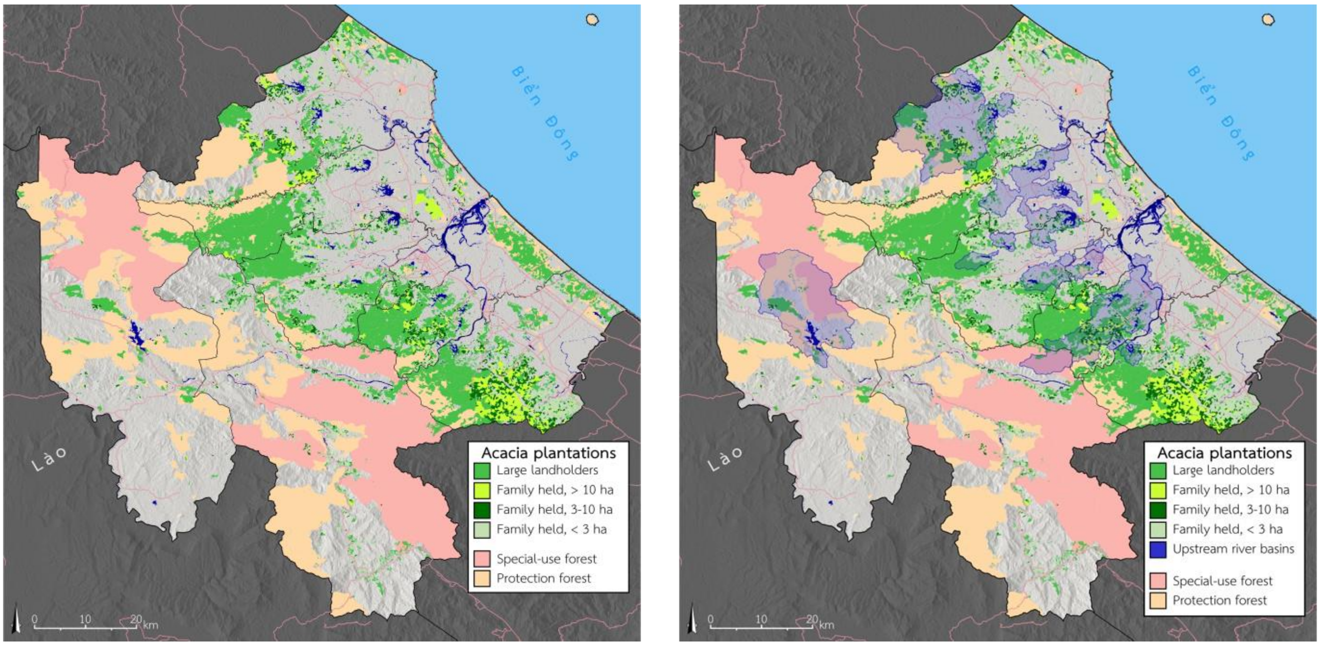
Table 3.7: Acacia monoculture per size class

	Province	River basins
Large landholders	51,269	9,541
Family > 10 ha	7,441	1,332
Family 3-10 ha	9,258	2,660
Family < 3 ha	16,747	3,141
Total	84,715	16,674

Note: river basins upstream key reservoirs and dams

A total of 16,674 hectares of planation in important river basins were identified for potential FLR, but roughly 3,141 hectares of family plantations smaller than 3 hectares were excluded since longer rotations are not considered economically feasible at such a small scale.[36] Whereas extended acacia rotations can be implemented on plantations larger than 3 hectares, the introduction of native species is only recommended for holdings of 10 hectares and larger since it requires a much longer timeframe to break even financially (see Chapter 4).

[35] A large basin upstream of a small reservoir in Dak Rong District was excluded because of the small area of plantations
[36] Pers. comm. with UNIQUE and consultations with provincial stakeholders



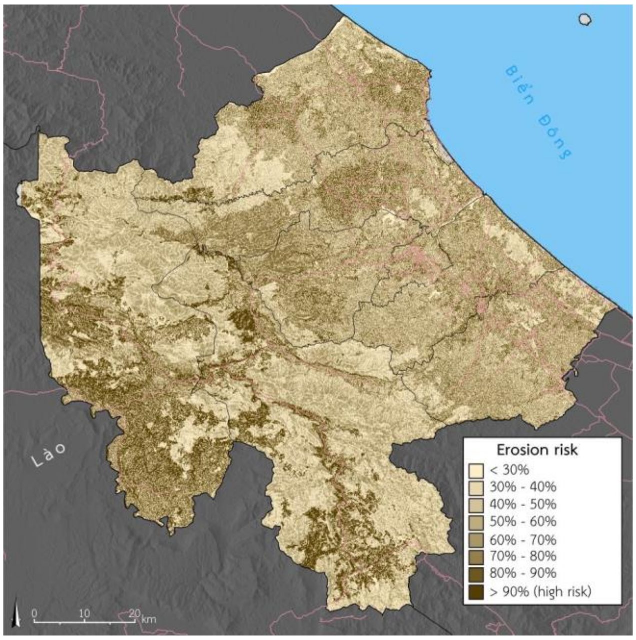
Map 3.6: Acacia (monoculture) plantations in Quang Tri Province (left) and upstream key river basins (right)

3.5 Erosion on sloping land

Erosion control was identified as a FLR priority. The Revised Uniform Soil Loss Equation (RUSLE) was used to map areas at risk. RUSLE uses maximum rainfall, slope length and steepness, and an estimation of erodibility of different land cover types to estimate erosion and works well with limited data.

Map 3.7 shows the erosion risk for the province. At first sight, the map is almost a negative of the land cover map, with low risk of erosion for areas that correspond to natural forest, slightly higher risks for areas that correspond to plantation forest, and high risk in areas of rainfed agriculture in the west of the province and transitional areas in the south.

The composition of erosion risk intervals in terms of land cover types is given in Table 3.8.



Map 3.7: Erosion risk profile for Quang Tri

The table shows the importance of rainfed agriculture as the land cover type most at risk of erosion, with more than half of the total area (25,000 hectares) in the highest category (which is equivalent to 27% of all rainfed agriculture). This is expected because RUSLE takes into account land use and agriculture is highly sensitive to erosion.[37] Transitional areas are also highly sensitive to erosion with almost 12,000 hectares in the highest risk category (which is equivalent to 40% of all transitional areas).

[37]Paddy was identified as separate land cover group with low erosion coefficient (0.1-0.2); it did not appear on steep slopes; terraced rice can be grown in mountainous areas (Morgan, 2005)

Table 3.8: Erosion risk profile of Quang Tri

	< 30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	> 90%	No data	Total
Natural forest	37,370	41,864	40,885	35,348	10,316	498	280	1,070	289	167,920
Plantation	38,218	4,552	5,396	10,196	30,237	21756	1820	2,209	139	114,524
Agriculture (paddy)	15911	93	279	547	2,970	9,468	5,190	1,308	34	35,800
Agriculture (rainfed)	29,815	382	288	432	1,429	8,545	24,921	24,975	220	91,008
Transitional areas	5,197	4	10	25	175	2,052	9373	11,610	14	28,460
Barren land	5,643	71	56	58	108	926	2718	2,806	287	12,673
Grass cover	1,930	234	263	433	959	641	548	843		5,849
Settlements	4,312	41	62	180	928	2,934	1,445	218	0	10,119
Water bodies/rivers	3,377	37	34	51	135	434	971	2,234	3	7,276
Total	**141,773**	**47,276**	**47,273**	**47,270**	**47,257**	**47,254**	**47,267**	**47,274**	**986**	**473,630**

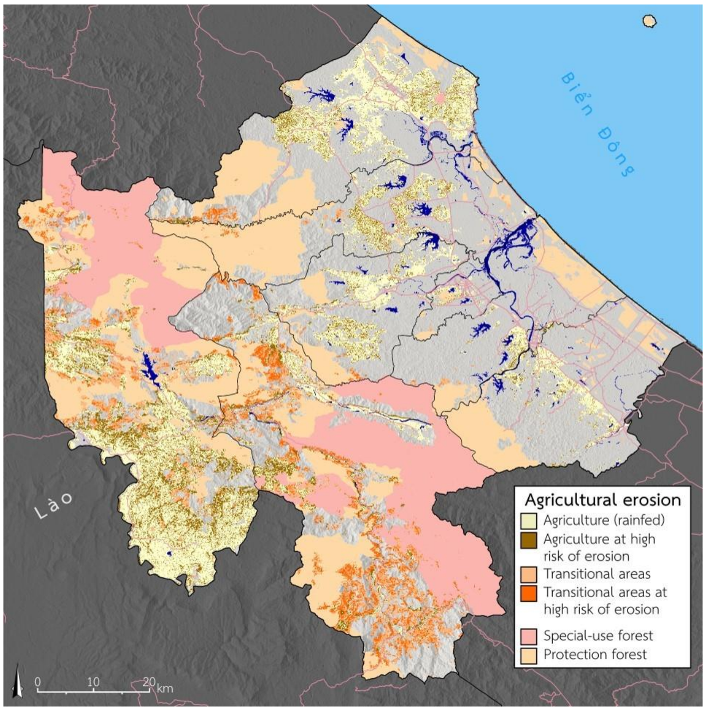
Note: "No data" refers to small areas near the coast and on Con Co Island that were not included

Table 3.9 shows the distribution of the two land cover types that are most at risk of erosion over different slope intervals. More than 40% of rainfed agriculture in the highest erosion risk category has a slope of more than 15%, beyond which cassava cultivation is officially discouraged.[38] For transitional areas this is more than half (50%); and even 80% in case of the highest risk category.

Table 3.9: Agriculture (rainfed) and transitional areas categorized according to slope

	Slope				No data	Total	Area > 15% of total
	< 3%	3-8%	8-15%	> 15%			
Agriculture (rainfed)	12,028	34,170	27,814	14,913	2,083	91,008	16%
Agriculture (rainfed), erosion risk >90%	519	4,030	9,935	10,432	59	24,975	42%
Transitional areas	758	4,275	8,470	14,863	94	28,460	52%
Transitional areas, erosion risk > 90%	30	301	1,735	9,541	4	11,610	82%

Map 3.8 only shows agricultural erosion. Most of the agricultural land and transitional areas are in the mountainous areas in the west and south of the province; almost 30,000 hectares are on slopes of more than 15%, highlighting the importance of soil and water conservation.



Map 3.8: Agricultural erosion and high-risk areas

High risk transitional areas are mainly located near the SUF in the south. These areas are mostly populated by ethnic minorities, who rely on swidden. Given the proximity to the SUF it is important to monitor these activities.

Table 3.10 shows agricultural data by district. It shows the area most at risk of erosion in relation to the total area for each district and the area of rainfed agriculture. Total planted area and areas of major crops are also shown. The data are consistent with erosion risk, being particularly high in Huong Hoa and Dak Rong Districts. When erosion risk area is compared with planted areas of key crops, erosion risk is most closely associated with cassava.

[38]Ketelsen et al. (2013); TCVN 8409:2010 of MARD on Agricultural production land evaluation instruction for land use planning uses following criteria for cassava cultivation on slopes: 3-8% highly suitable; < 3% and 8-15% moderately suitable, 15-25% marginally suitable; > 25% not suitable

Table 3.10: Agricultural data on area and erosion-risk per district compared to planted areas of crops

District	Total area	Agriculture (rainfed)	Erosion risk > 90%	Planted area	Rubber	Cassava	Coffee	Peanut	Maize	Banana
Huong Hoa	115,721	40,719	12,352	13,561	924	4,461	4,628	29	691	2,330
Dak Rong	121,936	10,352	4,518	4,890	35	1,940	48	477	1,522	460
Vinh Linh	63,678	18,008	3,225	12,172	6,582	1,394	-	1,483	549	76
Gio Linh	46,096	7,233	1,981	9,476	6,848	1,028	-	461	112	173
Cam Lo	34,312	7,894	1,580	7,139	4,146	1,508	-	608	275	201
Hai Lang	48,398	4,918	819	3,733	615	1,426	-	495	372	32
Trieu Phong	35,640	1,603	339	2,749	470	824	-	367	300	77
Dong Ha City	7,262	652	132	98	-	18	-	13	25	15
Quang Tri Town	565	90	26	364	55	142	-	20	99	18
Con Co	230	73	1	0	-	-	-	-	-	-
Total	473,838	91,542	24,973	54,176	19,674	12,741	4,675	3,952	3,945	3,382

Note: Crop data are based on Quang Tri statistical yearbook 2015; the planted area does not include rice; although data are generally consistent, planted area is some districts is larger than area of rainfed agriculture, which may refer to planted area on transitional areas, multiple crops grown on same area, or inaccuracies in data reporting

3.6 Priority restoration areas

Four FLR priority areas were identified based on the assessment criteria: forest biodiversity and quality, water quality in key river basins, and erosion on sloping land (see Map 3.9).

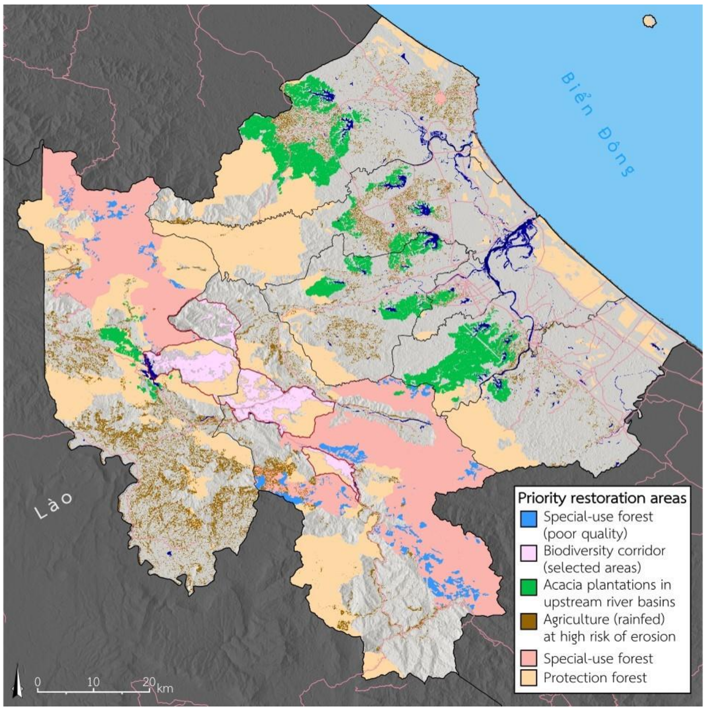
The main priority areas are:

1. Poor quality forest within SUFs.
2. Biodiversity corridor connecting SUFs.
3. Acacia monoculture plantations (> 3 hectares) upstream of key river basins.
4. Rainfed agriculture at high risk of erosion.

Priority FLR areas and options are described in Table 3.11.

Almost 10,000 hectares of natural forest was identified for restoration through EP/ANR: about 6,300 in SUF and 3,700 in the biodiversity corridor (which is about 6% of the total natural forest area). In addition, about 6,000 hectares of plantation, farm land and transitional areas in the biodiversity corridor were identified as land to be converted into natural forest with support of EP/ANR. Another 13,500 hectares of plantations in key river basins were identified for restoration through ER and NSI (which is 12% of all plantations). And 25,000 hectares of rainfed agriculture at high risk of erosion were selected for SWC (which is 27% of all rainfed agriculture).

The total area proposed for FLR is almost 54,000 hectares or 11% of the total area of the province.



Map 3.9: Priority restoration areas

Table 3.11: Priority FLR areas

Restoration area	FLR intervention	Land cover	Area (ha)	Total (ha)
SUF (poor quality sites)	• EP/ANR of degraded forest, with support of PES	• Poor evergreen forest • Bare land with trees	2,197 4,106	6,303
Biodiversity corridor (selected areas)	• EP/ANR of poor-quality forest and other selected (and to be converted) land	• Poor evergreen forest • Bare land with trees • Plantation • Agriculture (rainfed) • Transitional areas	1,383 2,365 497 2,753 2,881	9,879
Plantations upstream key river basins	• ER and/or NSI (and FSC) • ER and/or NSI (and FSC) • ER with support of FSC	• Acacia plantations held by large landholders • Family-held acacia plantations (> 10 ha) • Family-held acacia plantations (3-10 ha)	9,541 1,332 2,660	13,533
Agriculture (rainfed) at high risk of erosion	• SWC through fertiliser use, intercropping, and cross-slope barriers	• Agriculture (rainfed) at high erosion risk, especially cassava areas	24,975	24,975

Note: 1,042 hectares of agriculture (rainfed) at high risk of erosion and 36 hectares of plantations (> 3 hectares) upstream of key river basins are located within the biodiversity corridor

4. Restoration Options

Four FLR options were identified: (1) EP/ANR to restore degraded natural forest, (2) ER and (3) NSI to promote high value timber production through longer rotations in plantations, and (4) SWC to protect soils and enhance water retention in agricultural fields. This chapter describes the FLR options and analyses their benefits, costs and barriers.

4.1 Natural forest

Natural forests play an important role in protecting and enhancing biodiversity and providing ecosystem services such as preventing soil erosion and filtering rainwater. Natural forests can also be a source of food and NTFPs. The main methods to improve the forest quality are EP and ANR.

4.1.1 Enrichment planting and assisted natural regeneration

EP involves planting trees to supplement natural regeneration and to increase the diversity of tree species. ANR involves enhancing the establishment of secondary forest from degraded grassland and shrub vegetation by protecting and nurturing the mother trees. It aims to accelerate, rather than replace, natural successional processes by removing or reducing barriers to natural forest regeneration such as soil degradation, competition with weedy species, and recurring disturbances (e.g., fire, grazing, and wood harvesting)[39]. The type of intervention required depends on the quality of the forest. Where forests are present but degraded, ANR techniques can be sufficient. However, where the forest is severally degraded, EP is needed to support ANR.

To assess costs, the assessment drew on two projects in central Vietnam. These provided well documented data from geographically similar areas.

- In 2002, the Japan International Cooperation Agency (JICA) provided a loan to protect, restore, and establish new protection forests in Quang Tri using EP/ANR. As this study used both EP and ANR it was not possible to separate the costs of the two methods. The project supported 14 communes to protect the Thach Han irrigation systems. The project planted native species and acacia and used ANR techniques such as clearing weeds and lianas (vines). Initial planting cost was US$841/hectare in the first year and US$389/hectare to maintain the site over the next three years. After four years the trees were well established.
- SNV, the Netherlands Development Organisation ran an 11-year restoration project in Ha Tinh Province. It relied mainly on ANR using techniques such as clearing weeds and lianas and protecting growing plants. It also planted a small number of native species and tended soils around seedlings in years 1 and 11. The project funded patrols of the site in the intervening period. The initial intervention cost approximately US$299/hectare, while interventions in the last year cost US$128/hectare. Patrolling cost US$10/hectare/year.

Figure 4.1 shows costs per hectare. In the first project, which includes EP and ANR, costs were relatively high with significant upfront costs. Average costs were about US$300/hectare/year and were mainly used to pay for labour for enrichment planting. In the second project, which mainly focused on ANR, costs were lower and spread over a longer period. Cost averaged about US$50/hectare/year.

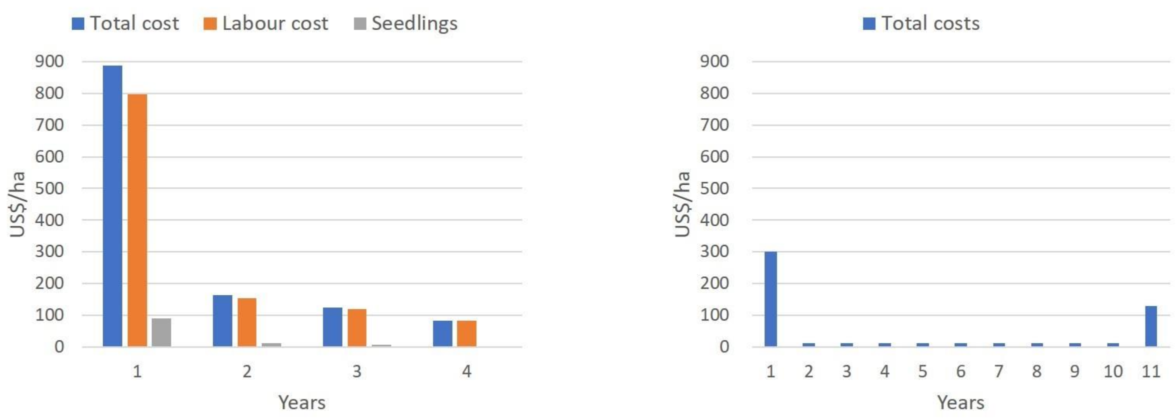


Figure 4.1: Cost of EP-ANR (4-year JICA project) (left) and ANR (11-year SNV project) (right)

[39] http://www.fao.org/forestry/anr/en/

4.1.2. Benefits and barriers

FLR provides benefits including erosion reduction, biodiversity protection and water retention. Labour required for EP and ANR can offer local people an alternative income source.

The key barrier for restoring natural forests is financial. While costs are upfront, the benefits are long-term, diffuse, and difficult to translate into monetary values. There may also be a lack of interest from local communities in forest protection. Households who have been contracted to take care of protection forest have reported lower financial benefits than neighbours who have been allocated land from production forest. The modest allowance provided to households to maintain protection forests is perceived as insufficient (see Box 4.1).[40]

There is continued pressure on natural forest from farmers in search of more land, whether for consumption or cash crop. The expansion of cassava is a particular risk due to its large area and tendency of farmers to use unsustainable cultivation methods (but see Section 4.3).[41]

Box 4.1: Protecting high value forest through the PES system[42]

Payment for Ecosystem Services (PES) can provide an important incentive for landholders to protect their land, particularly when they already have high quality forest. However, the scheme will only work when it provides a return that is comparable to alternative uses. Payments per hectare are small due to the broad targeting of land, making it difficult to dissuade farmers from converting forest-land.

Quang Tri was the first province in central Vietnam to implement PES. In 2015, the scheme covered 7,326 hectares of natural forest and 751 hectares of plantation forest for watershed protection. A fixed rate of 480,264 VND (US$21) per hectare was paid to 219 households for forest protection and enhancement, regardless of forest location, forest type being protected, or forest health. Disbursement of PES payments was significantly lower than the amount collected (3 billion VND or US$375,165). The government collects a flat fee from users of ecosystem services, such as hydro-electric companies, rather than fees based on improved outcomes.[43] This makes it difficult for those paying for ecosystem services to assess whether fees are being used effectively.[44]

Officials face difficulties in quantifying ecosystem service provision as defining watershed boundaries can be technically challenging, and they often opt for inclusivity, providing small payments to many. Officials are also hesitant to differentiate rates between households based on formulas, fearing community opposition. Finally, the monitoring system is inadequate, with farmers self-reporting their management of the forest. This is rarely validated by authorities, who lack the budget and resources to visit dispersed sites.

4.2 Plantations

Plantations dominant Quang Tri. Through government-led forest allocation programs starting in the early 1990s, many farmers have received small plots to grow trees. As the land was often highly degraded, farmers favored fast growing, hardy crops like acacia. These are predominantly grown as short rotation monocultures, with a negative impact on soil erosion, water quality, and biodiversity. The German consultancy UNIQUE forestry and land use (UNIQUE) has developed two business models with the University of Hue that could be used to transition short rotation acacia to higher-value forestry that delivers better environmental and, in the long run, economic outcomes.[45]

4.2.1. ER

A relatively easy option for improving acacia management is to move from short rotation wood chip production to longer-term timber production. Most farmers in Quang Tri grow acacia for 4-6 years before harvesting. Under a transition model, farmers grow acacia for rotations of 10 years or more and thin and prune at specific intervals (providing wood chip, small poles, and fuelwood). The longer growing period means that farmers can sell their wood for timber, which fetches a much higher price than wood chip. A comparison of projected annual and cumulative cash flow of short and extended acacia rotation is provided in Figure 4.2 for one cycle.

[40] Pers. comm. with staff-member of Trieu Hai Protection FMB
[41] https://www.iucn.org/news/viet-nam/201607/forest-conservation-quang-tri-what-can-be-done
[42] See also CIFOR (2013)
[43] Pham et al. (2015)
[44] IUCN and the Natural Capital Project developed ROOT, a software tool to optimise trade-offs among different ecosystem services, which helps decision-makers to make restoration investments that benefit multiple landscape goals
[45] Information on the plantation models in this section is derived from UNIQUE (2017)

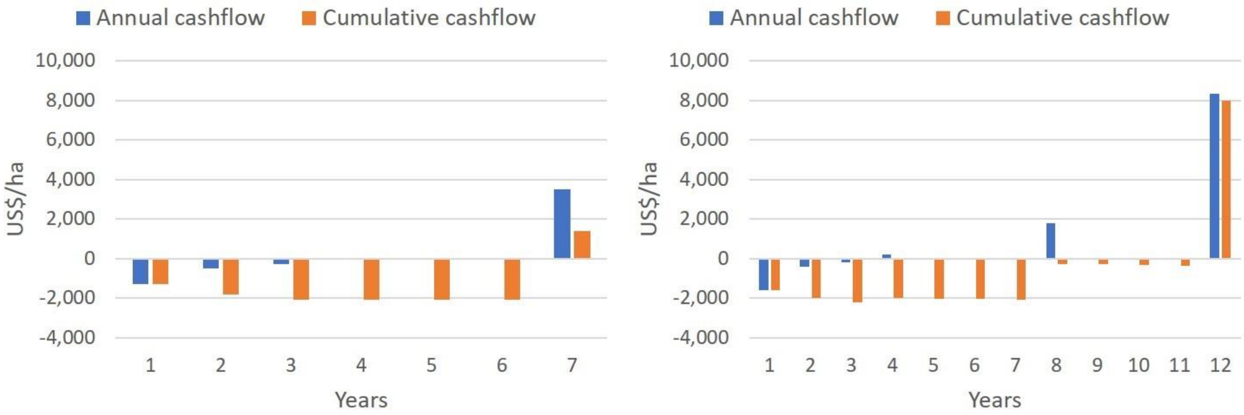


Figure 4.2: Cash flow projections for one cycle of short rotation acacia (left) and extended acacia rotation (right) (source: UNIQUE 2017)

Based on studies by UNIQUE, a baseline scenario of a 6-year (short rotation) acacia planted at high density of 1,667 trees/hectare without thinning and a clear-cut harvest in year 7 produced 122 m^3/hectare. Since there is no thinning, revenues come entirely in year 7, generating US$4,842/hectare based on a sale price of US$27/$m^3$ for wood chip and US$69/$m^3$ for sawn logs. The combined cash flows result in an Internal Rate of Return (IRR) of 15.8% over five rotations and 31 years.[46]

This can be compared to a model for acacia that extends the rotation to 11 years, allowing for increased production of larger diameter sawn logs. Assuming the same initial planting density, thinning takes place in years 4 and 8. A total of 205 m^3 is harvested. Intermediate revenues from thinning are US$354 and US$2,044/hectare, with US$9,868/hectare in year 12. The extended rotation model of acacia has an IRR of 19.1% over two rotations and 23 years.[47] Thus, lengthening the rotation of acacia is much more profitable. Higher profitability is mostly due to higher prices associated with larger trees, with 52% sold at US$69/$m^3$, 23% sold at US$74/m^3, while only 25% sold for wood chip prices of US$27/$m^3$.

4.2.2. NSI

A more fundamental intervention is to convert acacia plantations to native species. UNIQUE identified three species that are particularly appropriate for this part of Vietnam: Tarrietia (*Tarrietia javanica*),[48] Dipterocarp (*Dipterocarpus alatus*), and Hopea (*Hopea odorata*). These species were selected for their growth potential and high value timber. In addition, they are well accepted by forest owners and seedlings are available. These species are resistant to termites and other pests.[49] So far, this model has only been implemented at a small scale and has not been commercially demonstrated. The model requires that trees be planted in areas that are not storm prone and relatively well protected from natural disturbances.

The NSI model uses acacia as a nurse tree for native species to develop and grow. Farmers start opening strips in existing acacia stands to let in light and provide space for native species. UNIQUE recommends removing 12-m strips of acacia in a first thinning in a 6-year old plantation, which should provide sufficient income to cover transition costs and provide shade for the seedlings. This first harvest reduces the acacia volume by 50%, which is replaced by three lines of native species into each strip. Following the initial planting, farmers tend the native species by weeding in the first five years and pruning every six years. In year 11, farmers replace the remaining acacia with native species. By thinning over time, the farmer introduces multiple ages of trees into the stand, which allows older native trees to act as nurse trees to the newly planted native trees and staggers income over time. The projected cash flow from the native species model over 30 years is shown in Figure 4.3.

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[46] With planting in year 1, and harvesting in years 7, 13, 19, 25, and 31
[47] With planting in year 1, and harvesting in years 12 and 23
[48] The name *Tarrietia* is no longer used by Catalogue of Life, Kew and other; it has been replaced with name *Heritiera*
[49] Ives, M. (2010)

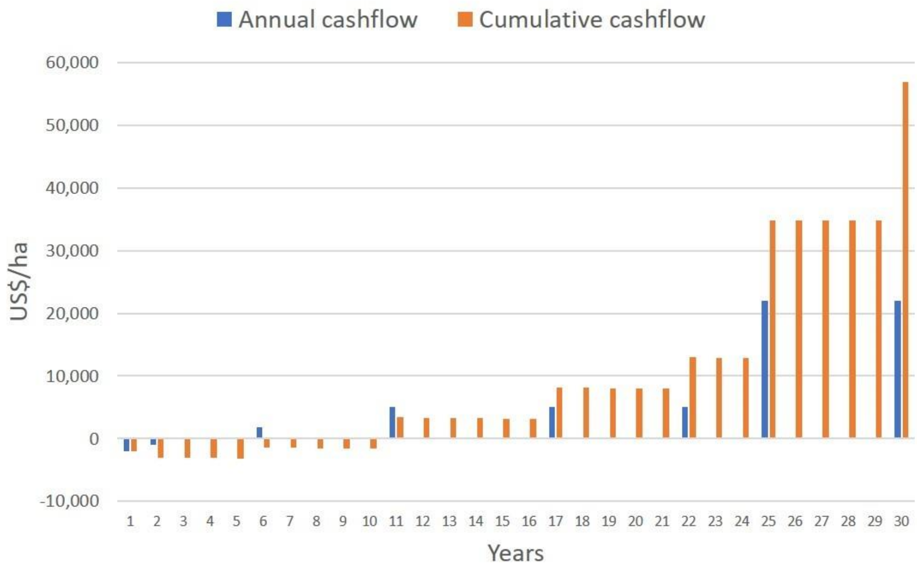

Figure 4.3: Cash flow projection native species introduced in acacia plantation (30 years) (source: Unique 2017)

Under good conditions and proper management, a total of 387 m^3/hectare of timber is harvested over 30 years. Initial establishment costs of the plantation are similar to the other models, but the NSI model has higher intermediate costs due to the replacement of acacia with native trees. Thinning results in significant revenues, but nearly 66% of the US$69,713 in revenues come from final harvests of the two native rotations. Transitioning to native species provides an IRR of 18.6% over 30 years. Thus, the introduction of native species is more profitable than short rotation acacia but less than extended rotation (total revenues are higher but delay in harvest results in a lower IRR). This model makes up for relatively low productivity by selling timber at much higher prices (US$165-360/$m^3$).

4.2.3. Benefits and barriers

ER would significantly increase the income that farmers receive from plantations as they can sell high quality wood for sawn timber rather than wood chip. Farmers can also diversify their market opportunities, expanding beyond pulp and paper and supplying the growing wood processing market (see Box 4.2). NSI also has a high return on investment, with farmers being able to sell native timber for significantly more than acacia.

ER also has environmental benefits. It reduces erosion by minimizing the amount of time a site is bare; frequency of tilling would also be reduced, preventing damage to soil fertility and structure.[50] ER allows soil nutrients to accumulate over time and support greater biodiversity. NSI would further enhance these benefits, improving biodiversity by returning plantations to a more natural state, introducing new seeds and providing habitat for a range of species while reducing pests and diseases.[51]

The most significant barrier for ER is that farmers need to wait much longer to recoup costs. Exposure to storms and natural disasters mean that farmers want to harvest as early as possible. They are particularly keen to avoid having to sell timber after storms, as the increased supply of wood means that markets are oversupplied, resulting in lower prices. To adopt these models, farmers need sufficient land and capital to cope with the longer break-even period and accept a higher level of risk.[52] This is particularly so in the case of NSI where farmers must wait up to 30 years before harvesting. For this reason, UNIQUE suggests that NSI is only viable for farmers with at least 10 hectares.

High quality timber needs careful harvest and transport as logs must withstand milling rather than being chipped. NSI would require a significant improvement in plantation management and silvicultural techniques. The UNIQUE model relies on timely interventions and will underperform if managers do not apply them, which implies additional training and technical assistance. Existing wood chip value chains dissuade farmers from investing time or energy in their plantations.

[50] Nambiar, Harwood, and Duc Kien (2015)
[51] Nghiem (2014)
[52] MARD (2016)

BOX 4.2: USING FSC CERTIFICATION TO CATALYSE CHANGE

Forest Stewardship Council (FSC) certification is a globally recognised program to promote sustainable forest management. To receive certification, farmers must comply with certain principles and standards. In return, farmers can sell timber into premium markets, which typically pay 15% more compared to unaccredited markets.[53] FSC also provides new knowledge and skills through training and certification visits. Establishing and maintaining certification involves significant costs. The initial audit fee to obtain FSC is about US$10,000 with additional annual audits of US$7,245. Landholders can organise themselves into one certification group to reduce costs, as the fees remain relatively constant regardless the size of the area being certified.

A pilot FSC project has been implemented in Quang Tri with the support of MARD and WWF (which funded the audit fees). By September 2010, FSC certificates were awarded to a group of 118 households for 316 hectares; this was the first smallholder group in Vietnam to receive certification. To help sell the FSC timber, WWF connected forest growers with local suppliers of IKEA. These companies initially paid a premium of 20-30% for FSC certified wood, although this reduced to 10-15% in 2014. The Quang Tri Forestry Department took over the project in July 2014, establishing the Association of Quang Tri Smallholder Forest Certification Group. By the end of 2015, the association had created 30 sub-associations in 51 villages in 5 districts and established a financing model for its operation.

Selling FSC certified timber can be time-consuming and complicated for farmers who must classify logs based on diameter, count number of wood logs in each category, apply FSC labels and maintain records. Monitoring to ensure compliance with FSC requirements is also complicated. However, if done well, FSC presents an opportunity to improve forest management practices and deliver significant economic benefits.

4.3 Agriculture

Agricultural land is very sensitive to erosion due to regular exposure to rain and wind. Cassava, one of the three primary crops in Quang Tri, is of special concern because it is often planted on sloping land, exacerbating soil loss. Cassava productivity in Quang Tri is 10-20 tons/hectare compared to an average of about 20 tons/hectare in Southeast Asia.[54] It is often grown on marginal, poor quality, land that is depleted in nutrients after a few seasons and left fallow for several years to recover. Farmers often plant cassava on forestland that has been cleared and burned. SWC has been identified as a suitable FLR strategy for agricultural land.

4.3.1. Soil and water conservation

SWC include measures that reduce soil erosion and increase water retention, such as no tillage, fertility management, mulching, rainwater harvesting, terracing, tree-planting (including agroforestry), intercropping and alley farming (cultivation of crops between rows of trees). These measures increase soil fertility and yield, thereby reducing the incentive to encroach into the natural forest. To address the negative impact of cassava cultivation, three options have been identified: fertiliser use, intercropping, and cross-slope barriers. These have been tested extensively in Southeast Asia, including in Vietnam.[55]

Fertiliser use. Continuous cultivation of cassava without application of fertilisers will result in decreasing yields and depletion of soil nutrients. Trials in Southeast Asia have shown that cassava root yield can be maintained for more than 25 crop cycles on the same land by applying mineral fertiliser and crop residue management (see Figure 4.4). Mineral fertiliser does not have a strong effect on erosion directly but does increase cassava yield and

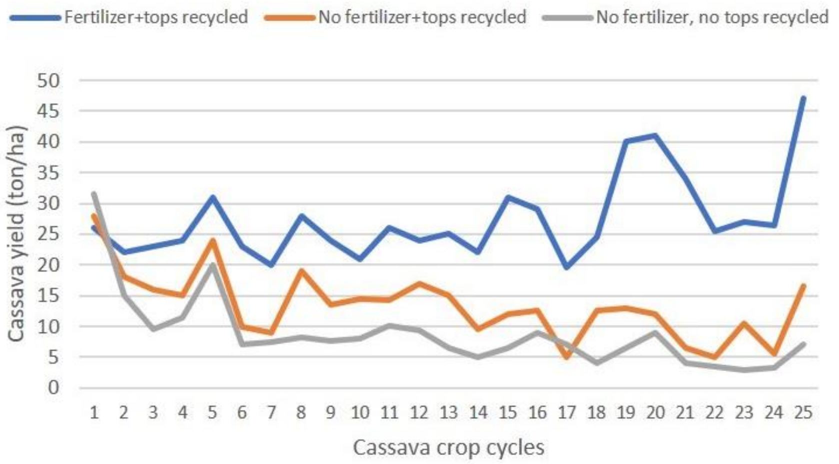

Figure 4.4: Effect of mineral fertiliser and crop-residue management on cassava root yield for 25 crop cycles, Thailand (source: CIAT, 2011)

[53]SNV REDD+ Program (2013)
[54]See http://www.fao.org/faostat/en/#data/QC (average increased from 18 tons/hectare in 2010 to 22 tons/hectare in 2016)
[55]CIAT (2011); FAO (2013)

leads to faster canopy closure. Organic matter will increase the soil's water and nutrient holding capacity and stimulate microbial activity.[56]

Balanced application of Nitrogen (N), Phosphorus (P) and Potassium (K) in rates of 2:1:2, added to organic manure for additional nutrients is most effective at increasing cassava yield, especially when using modern high-yielding varieties.[57] Farmers in a SNV-CIAT project on inclusive business models for cassava (IBC) in 2013-2015 tested an existing NPK (18:6:12) compost. Field trials in Quang Binh showed that fertilization increased cassava yield 50-110% compared to not fertilizing.[58] Return on investment based on prices for fertilisers and selling prices of fresh cassava roots varied from 110-300%, with the highest returns for highest rates of application, with the extra costs for fertilisers returned within a year.

Intercropping. Another measure that can reduce erosion, control weeds and improve the soil is intercropping. Generally, cassava can be mixed with acacia or intercropped with fast growing short-term crops, such as groundnut (peanut) and mung bean; however, maize, black bean (cowpea), soybean, winged bean, sorghum, cashew nut, fruit trees and vegetables can also be used. Mulching with crop residues or grass can also help to protect the soil from rain's direct impact, improving water infiltration and reducing erosion.[59]

Mixing cassava with acacia allows a second crop to be grown during the years when the land would otherwise be idle. During the early years of growth, cassava provides shade for acacia seedlings and holds the soil in place, but it cannot be grown in later years as it competes with acacia.[60] Although acacia may reduce cassava yield compared to cassava monoculture, the extra income from acacia could triple farmer income.[61] Farmers in Quang Tri have not adopted this model as they believe that cassava makes the soil acidic. This is probably incorrect as most soils for growing cassava in Southeast Asia are already classified as acid upland soil and there is no evidence of cassava increasing acidity. Excessive acidity can be addressed in many ways, most successfully by using liming agents.[62]

Cassava can also be alternated with short-term crops but SWC is most effective when both are planted at the same time. The impact of short-term crops on cassava yield is often small or even positive in case of leguminous plants. In a study supported by the ADB in Quang Ngai, Binh Dinh and Ninh Thuan Provinces, two main intercropping models were compared: cassava-groundnut and cassava-beans.[63]

Costs and income of the two models are presented in Figure 4.5. Net income from cassava intercropped with groundnut was US$2,918 (64.2 million VND) compared to US$1,728 (38 million VND) for cassava mixed with beans, and US$985 (21.7 million VND) for cassava monoculture (taking the average values of controls). While net income increased, costs did too. These findings are consistent with other studies of intercropping in Vietnam.[64]

Cross-slope barriers. Cross-slope barriers are another option for erosion control, particularly on steep sloping land. During an extensive program run by the Nippon Foundation and CIAT in 1993-2003, farmers in Thailand and Vietnam successfully applied hedgerows of grass, shrubs or leguminous trees along contour lines to increase infiltration of rainwater in the soil and to stop soil and nutrients washing away.[65] Hedgerows are typically planted 10-20 m apart, with closer spacing on steep slopes.[66]

Several SWC experiments were conducted in Vietnam,[67] some of which are presented in Figure 4.6. While intercropping cassava with groundnut reduces soil loss by 20% compared to cassava

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[56]CIAT (2011)
[57]Unpublished research suggests that most farmers in Vietnam use improved varieties, but farmers in Quang Tri might be using older varieties or varieties not ideally suited to the local conditions
[58]Duong Van Son, Nguyen Viet Hung and Keith Fahrney (2015)
[59]CIAT (2011); Delaquis et al. (2018)
[60]Pers. comm. with staff from CIAT in Hanoi
[61]Hoang Van Thang et al. (2015)
[62]Pers. comm. with staff from CIAT in Hanoi
[63]ASISOV (2012); cassava with groundnut produced 2.29 tons/hectare groundnut and 27.9 tons/hectare cassava, compared to 23.2 tons/hectare as monoculture; cassava with beans produced 1.08 tons/hectare beans and 25.7 tons/hectare cassava, compared to 23.5 tons/hectare as monoculture
[64]Howeler (2007); Duong Van Son, Nguyen Viet Hung, and Keith Fahrney (2015)
[65]CIAT (2011); Howeler (2007)
[66]See also: www.youtube.com/watch?v=FgK0M1u3v2o and www.youtube.com/watch?v=JyiMD6Q0fU8
[67]Howeler (2001)

monoculture, hedgerows are the most effective measures to reduce soil erosion. They reduced soil loss by 50%, while cassava yield increased by about 10%.

The preferred grass/shrub type for hedgerows varied between locations. Farmers in northern Vietnam preferred *Tephrosia candida* because it grows well in the cooler climate and as a leguminous species is expected to improve soil quality. Farmers in southern Vietnam preferred *Paspalum atratum* because it provides feed for cattle and buffaloes. Other types of hedgerows, like pineapple, *Flemingia macrophylla* (a woody shrub) and leguminous tree species such as *Leucaenia leucocephala* and *Gliricidia sepium* were also effective in reducing erosion but were seldom adopted. This indicates that farmers select those practices that fit best into their farming practices and are most suitable for their own conditions.[68]

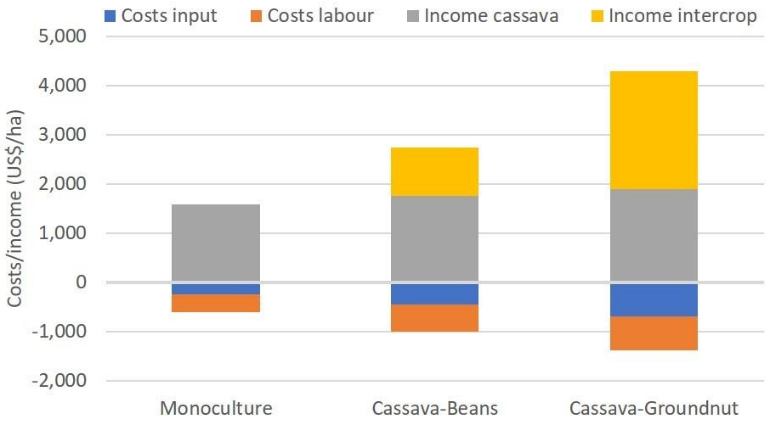

Figure 4.5: Costs and income of cassava intercropping in Vietnam

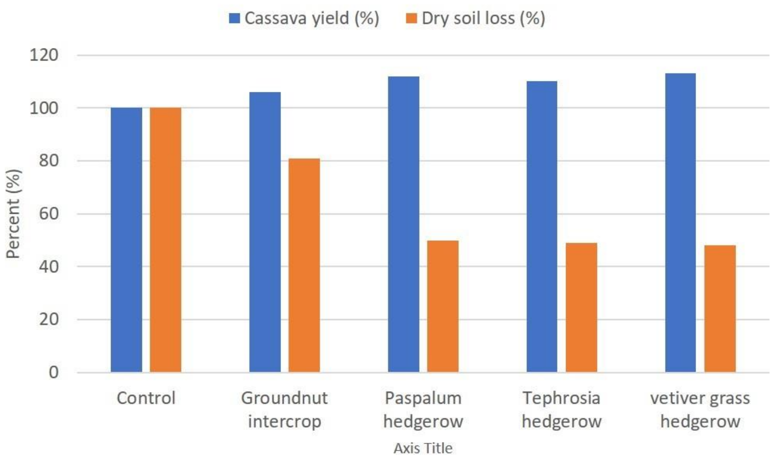

Figure 4.6: Effect of soil conservation practices on cassava yield and dry soil loss (fertiliser application standardised)

4.3.2. Benefits and barriers

Targeted use of organic and inorganic fertiliser with improved cassava varieties is a relatively straightforward measure that can significantly improve soil fertility and increase yield. An important benefit is that early fertilization causes faster canopy closure, thereby reducing erosion. While shortage of healthy and good quality planting material is a concern,[69] fertiliser use largely depends on the economic status of the farmers.[70] Farmers tend to reserve fertilisers for paddy since cassava can grow

[68]CIAT (2011)
[69]Aye, Fahrney, and Lefroy (2015)
[70]Some farmers do not apply fertiliser on cassava, even when provided for free; this will require demonstrations to show the impact and ROI

without application. There is also a lack of appropriate fertilisers, with most fertilisers available on the market adapted to rice.[71]

Intercropping allows farmers to harvest a second crop for increased income and food security while helping protect soil from rainfall impact. However, intercropping may also (but not always) decrease the yield of the main crop and requires considerable extra labour for planting, harvesting, and post-harvest handing, as well as money for seeds or seedlings. This makes intercropping less suitable for small-scale farmers who do not have access to capital and may be more risk averse, or to those who cultivate parcels far from their dwellings.

Cross-slope barriers are most effective in reducing soil loss on steep slopes. Farmers have adopted hedgerows when provided with training and free grass seeds and/or cuttings. Even though hedgerows reduce the area for cassava, many farmers in long-term trails reported higher yields, with the terraces keeping the soil uncompacted, making it easier for cassava roots to develop and to uproot. However, some farmers stopped using hedgerows after direct support ended. Farmers needed to continuously maintain and re-establish hedgerows destroyed during harvesting, by fire during the fallow period or by livestock. Moreover, despite the apparent success of hedgerows on soil conservation, the effect on cassava yield can be modest, especially in the first few years.[72]

4.4 Climate change adaptation and mitigation

The north-central coast region of Vietnam experiences frequent tropical depressions or typhoons. It also experiences extreme rainfall (or droughts), which are expected to become more frequent due to climate change. Impacts of droughts, storms, intensive rainfall, pests and diseases could be substantial. Table 4.1 gives an overview of how FLR options help to address these impacts.

Table 4.1: FLR options and climate change adaptation

FLR option	Climate change adaptation
EP/ANR	• Restoration of degraded forests improves water infiltration/retention capacity and makes them more resilient in times of drought while preventing erosion and landslides
ER	• Extended acacia rotation limits soil erosion by reducing the time the soil is bare and exposed to rain and wind and limits the impact of frequent ploughing; longer rotation could however increase the risk of income loss due to storm and fire damage
NSI	• Native species are adapted to the local climate and more tolerant to weather changes; a diversity of native species further reduces risk of loss, particularly from pests and diseases
SWC	• Fertiliser use, intercropping and cross-slope barriers improve water infiltration and water retention, while protecting the soil against the impact of intensive rain events; cassava tolerates drought, heat and poor soil, which can help farmers adapt to climate change

The impacts of climate change on the forest landscape are strongly reduced through measures that make them more resilient to droughts, intensive rain events, pest and diseases. However, some of these measures may have unintended effects. Restoring open (degraded) forest landscapes may make natural forest more vulnerable to forest fires, while longer rotations in plantations may increase the risk of income loss due to storms, pests and diseases. These risks are strongly reduced when measures are included that enhance biodiversity, for example through EP in natural forests and NSI in plantations.

FLR can also contribute to climate change mitigation by reducing emissions and sequestering carbon in soil and biomass.

Natural forests can be significant carbon sinks. Estimated baseline carbon stock for poor forests is 71 tonnes carbon dioxide equivalent per hectare (tCO2e).[73] Using 20-year projections, SNV calculated that natural forest, if protected, would increase the amount of carbon sequestered to 136 tCO2e/hectare through natural regeneration, and to 168 tCO2e/hectare through ANR (see Figure 4.7, left).[74]

Longer rotation plantations can also provide carbon benefits. Over 30 years, UNIQUE estimated that a plantation managed for wood chip accumulated 65 tCO2e/hectare. But this increases to 114

[71] Pers. comm. with staff from CIAT in Hanoi
[72] Howeler (2007)
[73] MARD (2016)
[74] SNV (2013)

tCO2e/hectare if plantations transitioned to ER and 146 tCO2e/hectare for NSI. However, the amount sequestered may differ depending on the quality of the specific site, plant material used, and other factors (see Figure 4.7, right).[75]

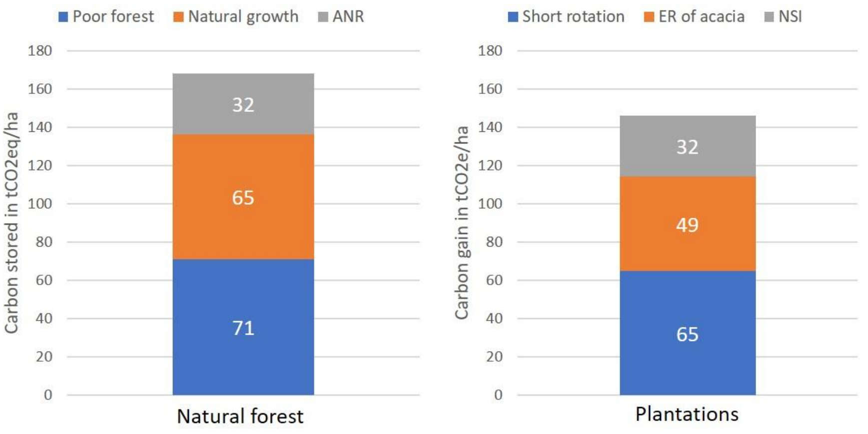

Figure 4.7: Long-term projections of carbon sequestered by different FLR options in natural forest (left) and plantations (right)

The impact of SWC on carbon storage in agricultural land has long been neglected. Since most crops are harvested on an annual basis, the net carbon benefit may seem negligible, but an increase in soil fertility and microbial activity, and hence soil organic matter, can have a significant impact on soil carbon storage. Most of the carbon sequestered in soil takes place in the first 20-30 years. To capitalize on this potential, appropriate measures need to be identified based on synergies between carbon storage while minimizing trade-offs with food security and livelihoods.

Based on a global study by the World Bank, Figure 4.8 compares the amount of carbon sequestered annually by various SWC measures. The figure shows that intercropping and alley farming deliver high levels of carbon sequestration and increased profitability (top right quadrant). The inclusion of trees, improved fallow and establishing cross slope barriers in the lower right quadrant have high mitigation potentials and are modestly profitable. While reducing land available for cultivation in the short run, they can lead to overall increase in productivity and resilience in the long run. Judicious application of fertiliser increases crop yield and profitability but impact on carbon storage is limited (top left quadrant). Manure contributes more to carbon storage but is less profitable than inorganic fertiliser because of the labour costs involved.

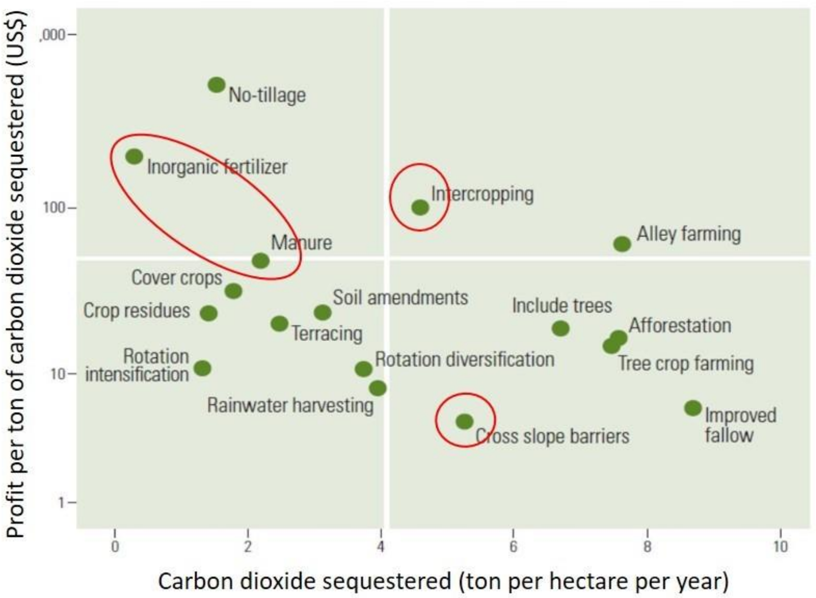

Figure 4.8: Trade-offs between profitability and carbon sequestration of SWC measures (source: World Bank 2012)[76]

[75] UNIQUE (2017)

[76] Climate benefits were measured by the net rate of carbon stored adjusted for emissions associated with technologies

4.5 A comparison of options

The main benefits, costs and barriers for various FLR options are summarised in Table 4.2. The table also provides an indication of the overall implementation costs and carbon-benefits if the FLR options are applied across all the priority areas (see Table 3.10).

Table 4.2: Benefits/costs, barriers and implications of FLR options

FLR option	Benefit/costs[77]	Barriers
EP/ANR	• Costs vary greatly (US$50-300/ha) depending on degree of degradation and intervention required • Better water infiltration/retention capacity; reduced risk of erosion/landslides • Carbon gain: +97 tCO2e/ha (vs. poor-forest); +32 tCO2e/ha (vs. natural regeneration) • Significantly increases biodiversity	• Costs of implementation • Maintenance and follow-up • Low incentive for landowners
ER	• IRR: 19.1% (vs. 15.8% BAU) (over 23 years; 2 rotations) • Reduced time that land is bare and exposed to intensive rain events and wind • Carbon gain: +49 tCO2e/ha (vs. BAU)	• Delayed income; limited technical capacity • Requires land/capital • Value chains adapted to short rotation
NSI	• IRR: 18.6% (vs. 15.8% BAU) (over 30 years) • Native species more tolerant to climatic change; diversity reduces impact of storms, pests/diseases • Carbon gain: +81 tCO2e/ha (vs. BAU) • Increases biodiversity by introducing new tree species into the landscape and providing habitat for broader range of species compared to acacia	• Delayed income; limited technical capacity • Requires land/capital • Value chains not currently in place
SWC	• Fertiliser use increases cassava yield by 50-110%; pays back in 1-2 years • Intercropping cassava can double or triple profits; costs also increase. • Cross-slope barriers reduce soil loss by 50%; yield impact modest • Increased water infiltration and water retention capacity and protection of soil; cassava tolerates drought, heat and poor soil • Carbon storage varies from 1 to 6 tCO2e/ha/year	• Limited access to appropriate fertiliser/improved cassava varieties • Intercropping requires labour and capital • Cross-slope barriers labour intensive; benefits long-term

Note: IRR=Internal Rate of Return; BAU=Business as usual.

Although costs of EP/ANR are based on data from only two models, they give an idea of the total cost when applied at scale. Restoration of degraded sites in the SUF (6,000 hectares) and identified areas in the biodiversity corridor (10,000 hectare) could cost as much as US$0.8-4.8 million (based on US$50-300/hectare). This does not include any compensation costs for converting plantations, farm land and transitional areas back into natural forest. PES will not be able to cover those costs based on US$21/hectare, but carbon credits could possibly provide additional financial support. Carbon gains of restoring degraded sites in SUF will only contribute 30 tCO2e/hectare compared to natural growth under protected conditions but restoring the biodiversity corridor may deliver 100 tCO2e/hectare. This provides a total carbon benefit of 1,080,000 tCO2e.

The plantation models are in principle self-financing but have high start-up costs and may need some financial assistance. To calculate carbon gains through ER and NSI, the average carbon gain of both

[77]Economic benefits were based on published data and surveys with farmers and landholders. Economic returns were not calculated for EP/ANR as these activities do not provide direct income to farmers or landholders.

models (65 tCO_2e/ha) was used, leading to a carbon gain of 877,500 tCO_2e when applied at scale (based on 13,500 hectares of acacia plantation upstream reservoirs).

SWC measures are largely self-financing but may require the supply of fertiliser to incentive farmers. Although the contribution of fertiliser, intercropping and cross slope barriers appears modest at 1-6 tCO_2e/hectare/year, the total contribution can be substantial. Based on 1.5 tCO_2e/hectare/year over 30 years (see Section 4.4) and a restoration area of 25,000 hectares, the total amount of carbon sequestered could reach 1,125,000 tCO_2e, more than that of restoring natural forest or plantations.

5. Enabling Conditions

To assess whether key success factors are in place in Quang Tri to implement FLR at scale, this chapter examines institutional and policy arrangements that help or hinder FLR interventions, as well as financing options.

5.1 Institutional and policy conditions

Four factors are identified as critical for FLR: (1) the motivation of key actors; (2) the capacity and resources for implementation; (3) policy support and enforcement; and (4) access to markets and value chains. These factors are summarised in Table 5.1.

Table 5.1: Key success factors for FLR in Quang Tri (facilitating: green, constraining: red, neutral: yellow)

Condition	Current situation	Status
Motivation	• Security of forest tenure allows farmers and landholders to invest in FLR (e.g., ER, NSI, and SWC)	green
	• Farmers face difficulties getting loans; government can play key role, as shown by the Vietnam Bank for Social Policies in boosting rural credit	yellow
	• Logging bans (including harvesting regenerated trees) serve as disincentive for sustainable forest management and native species recovery	red
	• PES can encourage FLR, but payments are low and fixed regardless of performance, reducing farmer incentives to protect forests	red
Implementation	• Proven FLR models exist, several have strong income generating potential; benefits of longer rotations and agricultural options are well understood	green
	• Farmers have basic skills but need technical assistance with longer rotations and sustainable agriculture; skepticism about feasibility of NSI models	yellow
	• EP and ANR often fail because of the inadequacy of post-planting care and maintenance	red
	• Costs and low availability of good planting material/native species seedlings and appropriate fertilisers limit FLR options	red
Policy and enforcement	• Provincial REDD+ Action Plan (PRAP) includes specific measures to curb deforestation and degradation, and promote sustainable forest management	green
	• Laws and institutions are well developed but rules are often not enforced because perpetrators are seen as poor and deserving	yellow
	• Growing emphasis on sustainability and forest conservation (Vietnam is a pioneer in REDD+, FLEGT),[78] but national policies focused on quantity	yellow
Markets and value chains	• International demand for legal timber and heavy dependence on imports are driving the expansion of FSC-certified timber	green
	• Smallholder FSC has been implemented in several provinces, in some cases with financing provided by the timber processor	green
	• As cassava factories can source from any region there is no market incentive to promote more sustainable practices	red

5.1.1. Motivation of key actors

The proposed FLR options provide ways to improve forest quality and farm land. Agricultural technologies such as soil fertility management and mixed cropping, and the UNIQUE plantation models, offer farmers an opportunity to increase incomes while reducing environmental impacts.

However, banks and insurance companies provide limited support to small-scale farmers or for long-term investments as their loans require quick pay-back and carry high interest rates. This means that commercial finance is unlikely to provide the capital required to finance these transitions. Given the public benefits, government should play a catalytic role by providing affordable finance linked to specific FLR interventions. The national government has already issued several decrees establishing programs to finance longer rotations in plantations.[79] These programs are underfunded but in principle are a mechanism to accelerate the transition to longer rotations, especially for smallholders.

[78]EU's Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan aims to reduce illegal logging by strengthening sustainable and legal forest management, improving governance, and promoting trade in legally produced timber

[79]For more information on these programs, see UNIQUE (2017)

The management and ownership of natural forest has undergone substantial changes in recent years. In some protection forests, farmers have been granted use rights. But these use rights are very restricted and include a ban on clearing natural forest, which may result in “cut and run” logging rather than in sustainable harvesting of natural forest, which a series of pilot projects have shown to be profitable.

PES and certification schemes like FSC are intended to improve farmer forest management. But PES payments are too low to justify protecting the forest. In practice, PES payments are treated as a welfare payment paid irrespective of performance. A better designed PES scheme that targets degraded areas could provide a stronger incentive to protect natural forests. This would require significantly improved performance monitoring.

5.1.2. Capacity and resources for implementation

The proposed FLR options are tried and tested. The UNIQUE plantation models draw on existing farmer experience growing acacia. There are also well-documented cases of farmers introducing native species in plantations in neighbouring provinces.[80] The government can capitalise on this experience by providing silvicultural training to farmers to implement these new models with the eventual goal of achieving forest certification. NSI will require changes in farmers’ perceptions, with many farmers expressing skepticism about the feasibility of the business model. Demonstration plots can help convince them.

The government provides funding for EP/ANR in protection and special used forest: 3 million VND/ha/six years for ANR; 1.6 million VND/ha/year in the first three years and 600,000 VND/ha/year in subsequent three years for EP.[81] But their performance needs to be improved. In Vietnam, there has been a high rate of mortality due to inadequate post-planting care and follow-up.[82] This can be addressed by creating platforms that allow lessons learned to be shared, combined with better monitoring of restoration efforts. PES could be used to pay for more intensive farmer-led monitoring.

Growing cassava makes land vulnerable to erosion and encourages forest encroachment, but it is also an opportunity. Cassava is tolerant to heat and drought, can grow on poor soils, and requires minimal skills. Current low productivity indicates scope for yield increases but most farmers are unaware of how to do so. The environmental benefits of SWC are unlikely to motivate changes in farming practices. But farmers may be willing implement new practices if they are confident that these will increase yield and income.

Government can encourage farmer investments in SWC by organizing farmer-to-farmer exchanges and delivering improved extension. It is difficult, however, for farmers to access high quality planting material/seedlings and inputs.

5.1.3. Policy support and enforcement

Quang Tri has shown a strong commitment to forest protection. It was one of the first provinces to implement PES and to support FSC certification. It is also a pioneer province for REDD+, which was introduced through the FCPF-funded REDD+ Readiness Project in 2013. As part of this project, the provincial REDD+ Action Plan (PRAP) was developed for 2016-2020.[83] The plan includes specific measures to reduce deforestation and degradation, as well as suggestions how to conserve and enhance carbon stocks and sustainable forest management.

Nevertheless, there are several areas that need improvement. The government often struggles to enforce forestry regulations, leading to violations, deliberate misinterpretation of harvesting limits and illegal conversion.[84] Even when resources allow, the government is often unwilling to fine farmers for clearing the forest as the farmers are poor and unable to pay. Since there is no meaningful deterrent, forest clearing for cassava continues. By helping farmers increase cassava yields on their existing

[80] UNIQIUE (2016)
[81] Prime Minister Decision 889/QD-TTg 16 June 2017 on approval for the target program on sustainable forestry development in the period 2016-2020 and Decision 38/2016/QD-TTg 14 September 2019 on promulgating a number of policies on forest protection and development, and support for investment in infrastructure construction and assignment of public-utility tasks to agricultural and forestry companies
[82] Consultations in Quang Tri Province
[83] Quang Tri PRAP, version March 2017
[84] USAID (2013)

plots, the government will be in a stronger position to negotiate a complete ban on natural forest clearing.

Moreover, despite growing emphasis on sustainability and forest conservation, national forest policy is strongly focused on quantity. The revised Forestry Law in 2017 is an opportunity to shift the focus to forest quality. Under the revised law, all national sectoral plans will be required to take account of environmental protection, biodiversity conservation and climate change.[85]

5.1.4. Access to markets and value chains

The government aims to increase wooden furniture exports to US$8 billion by 2020 and to certify 5,000 km^2 of plantation forest. There is a growing emphasis on transitioning the forest sector to a more sustainable footing through REDD+ and the recently signed Voluntary Partnership Agreement (VPA), a bilateral trade agreement with the EU aimed at reducing illegal logging. As the demand for FSC-certified timber grows, Vietnam's wooden furniture processors are trying to secure their supply by investing in FSC certified plantations. This presents a major opportunity for Quang Tri to shift to longer rotation plantations.

Underpinning the dominance of short rotation acacia is a well-established value chain for wood chip, supported by middlemen who buy from multiple farmers at a fixed price regardless of quality, and by government support for mills via tax advantages and subsidies. To encourage higher value plantations, these subsidies should be redirected to strengthen value chains for timber and native species. Increasing the area of FSC-certified plantation will require farmers to contribute technically and financially. The government can reduce this burden by encouraging smallholders to secure group FSC certification.

5.2. Financing options

Quang Tri's forestry sector receives significant national and international support and there are opportunities to finance FLR options identified in this assessment (see Figure 5.1).

EP/ANR	ER/NSI	SWC
• Government target program on sustainable forestry development in the period 2016-2020 and Decision 38/2016/QD-TTg • Donor programs to restore lands • Sale of carbon credits • Access to REDD+ funding • Expanded funding through improved PES system to capture carbon benefits	• Government grants for transition costs, training, demonstration • Establishment of insurance schemes to reduce risk • Targeted loans to spread costs of transition over time • Private sector partnerships to meet certification costs • Fit native species into large scale plantation investment strategies	• International and national grants as part of Climate Smart Agriculture initiatives • Small targeted loans for inputs (seeds, fertiliser, etc.). • Government funding for training and demonstration • Advance payment by companies to support reliable supply (with government support)

Figure 5.1: Summary of financing options for restoration

Carbon markets could play an important role, particularly in the management of natural forests. While these markets currently suffer low prices and high volatility, the 2015 Paris Agreement could reinvigorate carbon trading as countries use forest carbon offsets to meet their national targets. However, maximizing access to carbon markets will require significant improvements in Vietnam's capacity to monitor emissions reductions. Carbon, and particularly REDD+ funding could play a key role in financing EP/ANR. Similarly, the PES system can be expanded to incentivise carbon benefits. Climate-smart agriculture could help fund agricultural transitions, particularly the sustainable intensification of cassava.

While the forest and agricultural sectors will continue to depend heavily on public funding, there are opportunities to diversify. Under the right conditions, private sector investment can play an important role. For example, the costs of certification could be met through partnerships with wood processing companies, particularly those that exports to the EU, US, and other environmentally sensitive markets.

[85]Forestry Law. National Assembly No.:/2017/QH14 (unofficial translation)

Unlike small family-owned plantations, large plantation owners should be able to finance ER and NSI without external assistance.

The government could facilitate smallholder transition to longer rotations by putting in place insurance schemes against damage by fires, storms, or other natural disasters or by providing loans to cover immediate family expenses that would otherwise be paid for through short-term rotation.

PES is currently implemented in river basins upstream of large hydropower reservoirs. Within these basins, the funds could be targeted on priority areas identified by this assessment rather than being distributed equally among all families. Coupled with improved performance monitoring, higher payments could also be used to incentivise and help pay for sustainable cassava intensification.

6. Conclusions and Recommendations

Implementing FLR in the 54,000 hectares that this assessment has prioritized could significantly improve forest quality and rural livelihoods in Quang Tri, while making forest dependent communities more resilient to climate change. EP/ANR will improve forest quality within SUFs and by connecting SUFs provide corridors for wildlife movements; ER plantations will reduce soil erosion and produce high-value timber; NSI that replaces acacia monocultures is profitable over 20 years; and fertiliser use, intercropping, and cross-slope barriers will improve water infiltration, reduce erosion and increase cassava yields.

Successful FLR implementation will require improvements in knowledge, technical capacity, and incentives. The government has a key role to play in helping transition from forest quantity to quality by engaging business and supporting new timber value chains, strictly protecting the remaining natural forest, assisting farmers to achieve group certification, insuring farmers against natural disasters, and using PES to finance sustainable cassava intensification.

The following recommendations are made:

1. **New vision and policy**: Given the alignment with REDD+ and the growing interest nationally in environmental quality and green growth, it is recommended that Quang Tri develops a new forestry vision and policy that includes the following key objectives:

   - Strict protection of the remaining natural forest
   - Reorient plantations to produce certified timber over longer rotations
   - Transition large plantations from acacia monocultures into native species forests

This transition would take 20-30 years and would increase carbon stocks, soil and water conservation and biodiversity.

2. **Innovative financing**: Quang Tri can reduce financial barriers for restoration in several ways:

   - Work with the Vietnam Bank for Social Policies and other state funding programs to provide credit to households willing to invest in ER plantation and NSI. This should focus on households with more than 3 hectares of forest in the case of ER and more than 10 hectares in the case of NSI.
   - Improve the targeting and monitoring of PES to provide sufficient incentives to avoid deforestation and degradation; PES could also be piloted in areas that provide important ecosystem services but fall outside traditional forest management areas (e.g., for cross-slope barriers in agricultural lands).
   - Set-up insurance schemes to help farmers reduce the risk of ER and NSI, and/or encourage farmers to sustainably intensify rainfed crops, especially cassava (e.g., through intercropping)
   - Facilitate communication along value chains to create institutional arrangements whereby wood processors assist farmers overcome technical and financial barriers to achieve sustainable forest management certification while ensuring a stable and high-quality supply of timber.

3. **Improved extension**: Intercropping and cross-slope barriers and other measures, have been shown to reduce soil loss and erosion, maintain soil fertility, and increase yields. However, uptake is low, often because of the misunderstandings over costs and benefits and ways to overcome barriers. Therefore, Quang Tri should consider the following policies:

   - Develop pilot sites and organise visits to successful pilots in other provinces to encourage their adoption and sustainable intensification, particularly of cassava and ER plantation management.
   - Assist farmers to procure fertiliser suitable for cassava; this could be made conditional on farmers adopting these measures and stopping any further clearing of natural forest.
   - Help famers with less than 3 hectares of land secure group forest certification (and other scale-dependent benefits), possibly in cooperation with wood processing companies.
   - Ensure that forest restoration projects are well documented and that lessons from projects are effectively shared to ensure that restoration becomes more effective over time.

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Annex A: Classification of forest types in Vietnam

Code	Government classification of forest type	Classification as used in report
A.	**Primary forest**	(not in Quang Tri Province)
B.	**Secondary forest**	
I	Evergreen and semi-deciduous forest	
TXG	Good Natural Evergreen Forest	Good evergreen (forest)
TXB	Medium Natural Evergreen/semi-deciduous Forest on Soil Hill	Medium evergreen (forest)
TXN	Poor Natural Evergreen Forest (on Soil Hill)	Poor evergreen (forest) (TXN+TXDN)
TXDN	Poor Natural Evergreen Forest on Rock Hill	
TXP	Regenerated Natural Evergreen Forest (on Soil Hill)	Regenerated forest (TXP+TXDP)
TXDP	Regenerated Natural Evergreen Forest on Rock Hill	
II	**Deciduous forest**	(not in Quang Tri Province)
III	**Coniferous forest**	(not in Quang Tri Province)
IV	**Mixed broad-leaf/coniferous forest**	(not in Quang Tri Province)
V	**Rock-hill forest**	(not in Quang Tri Province)
VI	**Inundated forest**	(not in Quang Tri Province)
VII	**Bamboo forest**	Negligible
TNK	Other bamboo forest	
VIII	**Mixed bamboo forest**	Negligible
HG1	Mixed bamboo-tree forest on soil hill	
HG2	Mixed bamboo-tree forest on rock hill	
IX	**Palm forest**	(not in Quang Tri Province)
X	**Plantation forest (species, age and origin)**	
RTC	Forest plantation on sandy beach	Plantation on sandy beach
RTG	Forest plantation on soil hill	Plantation on soil hill
RTK	Forest plantation on other soil	Plantation on other soil
RTM	Mangrove plantation	Negligible
RTTN	Bamboo plantation on soil hill	Negligible
XI	**None-forested land that is planned for forestry purposes**	
11.1	***Already planted but not forest yet***	
DTR	New plantation on soil hill	New plantations (DTR+DTRC)
DTRC	New plantation on sandy beach	
DTRM	New plantation on salty/brackish soils	Negligible
11.2	***Bared land with scrubs***	
DT1	Bared soil hill	Transitional areas (DT1+DT1D)
DT1D	Bared rock hills	
BC1	Sandy beach	Barren land
BC2	Sandy beach with scattered vegetation	Barren land/Plantations
11.3	***Bared land with regenerated trees***	
DT2	Soil hill with regenerated trees	Bare land with (regenerating) trees
DT2D	Rock hill with regenerated trees	(DT2+DT2D) (included as natural forest)
11.4	***Bared land with regenerated agricultural crops***	(not in Quang Tri Province)
11.5	***Other land***	Diverse

Annex B: Government forest classification based on density in Quang Tri

Forest type	Natural forest (total)		Special-use forest		Protection forest		Production forest		Outside categories	
	Ha	(%)	Ha	(%)	Ha	(%)	Ha	(%)	Ha	(%)
Rich	16,679	(11.7)	13,913	(23.6)	2,003	(4.0)	731	(2.3)	32	(2.5)
Medium	38,022	(26.6)	20,783	(35.2)	10,110	(20.1)	7,107	(22.0)	22	(1.7)
Poor	88,201	(61.7)	24,323	(41.2)	38,207	(75.8)	24,484	(75.8)	1187	(93.5)
Very poor	145	(0.1)	0	(0)	117	(0.2)	0	(0)	28	(2.3)
Total	143,047	(100)	59,019	(100)	50,437	(100)	32,32	(100)	1270	(100)

Note: Very rich forest: timber volume >300m^3/ha; Rich forest: timber volume 200-300 m^3/ha; Medium forest: timber volume 100-200 m^3/ha; Poor forest: timber volume 10-100 m^3/ha; Very poor forest; timber volume <10 m^3/ha

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