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FCPF
Room 403, 4th floor, 14 Thuy Khue Street Tha Ho District Hanoi Viet Nam
Tel +84 4 3728 6495 Fax +84 4 3728 6496
www.Viet Nam-redd.org

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1 Analysis of deforestation and forest degradation patterns in the REL and linkage to the proposed REDD+ intervention models

To link the REDD+ intervention with the drivers and ensure that GHG emission reduction estimates are fully consistent with section 4, 13 and section 8) initially an area wise assessment was carried out to assess the key sources of deforestation and deforest degradation. For this an analysis of the historical land use change matrices was carried out.

- For the quantification of the avoided deforestation and forest degradation, initially the RL land use change matrices in the natural forest land use classes - “evergreen broadleaves forest – high”, “evergreen broadleaves forest – medium” and “evergreen broadleaves forest – poor” as well as the deforestation of evergreen broadleaves forest - poor to non-forest land was analysed. In these land use classes, the majority of deforestation and forest degradation has occurred historically (see Table 1.1 below).

- Between 2000-2010, the total evergreen broadleaves forest degradation amounted to 272,826 ha. The degradation area equals to 15% of the total natural forest area in 2000 in the ER-P Accounting Area. The major driver of this forest degradation is attributable to illegal logging and illegal overexploitation of natural forest. Once the natural forest achieves a relative poor forest status (poor), there is a strong trend towards deforestation for agricultural land use (see below).

- Deforestation was 301,950 ha between the period 2000 - 2010. Deforestation in natural forest forests amounts to 184,996 ha while the remaining deforestation occurred on plantation or other forest land. Out of this natural forest deforestation area 163,029 ha 88% occurred in “evergreen broadleaves forest – poor” (or 54% of total deforestation occurred in this land use class).

- The major driver behind this change is at the first step natural forest degradation, followed by a conversion to agricultural land.

1.1 Historical forest degradation dynamics in natural forest

- The conversion of “evergreen broadleaves forest – rich” to “evergreen broadleaves forest – medium” area change between 2000 and 2005 was 48,684 ha and between 2005 – 2010, 17,593 ha were degraded (in total 66,277 ha or 24% of total forest degradation in the ER-P Accounting Area) (see also Table below 1.1 *“ER-Program areas compared to total areas and historical deforestation”*).

- The forest degradation dynamics form evergreen broadleaves forest - rich towards evergreen broadleaves forest - poor were significantly lower: Between 2000 and 2005, the area change amounted to only 8,267 ha and between 2005 – 2010 to only 12,454 ha. In total, this adds up to 20,721 ha or 8% of total forest degradation.

- The analysis of the evergreen broadleaves forest - medium land use class and transition towards evergreen broadleaves forest - poor land use class shows a forest degradation rate of 69,415 ha and 69,766 ha in 2000-2005 and 2005-2010, respectively. In total, this adds up to 139,181 ha or 51% of total forest degradation in the RL period.

- As a conclusion the conversion of evergreen natural forest towards the next lower forest quality class over the RL period is responsible for about 75% of total forest degradation which the REDD+ intervention models (1 and 2) will address.

1.2 Historical deforestation dynamics in natural forests

- The analysis of deforestation of the evergreen broadleaves forest - poor land use class towards non-forest land shows that 95,649 ha were deforested between 2000 – 2005, while 67,380 ha were deforested between 2005 - 2010. In total this add up to 163,029 ha over 10 years which is equivalent to 54% of total deforestation in the ER-P area or 88% of the total deforestation in the natural forest land use class (Table 1.1 below).

Table 1.1 ER-Program areas compared to total areas and historical deforestation and forest degradation areas

Total area in 2010 according to activity data report (Dien, 2016) (ha)		Key deforestation / forest degradation / enhancement land use change dynamic (2000-2010) (ha) (according to activity data report, Dien et al 2016		ER-P intervention to address drivers and enhance carbon stocks (ha)[1]		% of total land use class area (in 2010)
Evergreen broadleaves forest – rich	226,626 ha	Evergreen broadleaves forest – rich to medium (degradation)	-66,277 ha (24% of total degradation)	Model 1: Forest protection of existing natural forest through contracts	43,900 ha	19%
Evergreen broadleaves forest - medium	452,900 ha	Evergreen broadleaves forest - medium conversion to poor	-139,181 ha (51% of total forest degradation)	Model 2. Natural assisted regeneration of medium quality forest / avoiding degradation (no planting	43,055 ha	10%
Evergreen broadleaves forest - poor	1,315,598 ha	Natural forest - poor to bare land / agricultural land	-163,950 ha (54% of total deforestation)	Model 3. Natural regeneration and enrichment planting of poor natural forest	59,600 ha	4.5%
Plantation area	637,561 ha	Increase of plantation area from non-forest land	+376,659 ha (60% of total area, partly includes replanting of harvested areas)	Model 6,7: Transformation of Acacia plantation	48,665 ha	7.6%
Non-forest land	2,372,977 ha	Bare land / non-forest land	-97,125 ha	Models 4,5,8: Afforestation Reforestation with pure Acacia and mixed species and offsetting of infrastructure and development	29,710 ha	1.3%
Total	**5,144,508 ha**				**224,930 ha**	

[1] The REDD+ intervention models as well as the key underlying assumptions are presented and explained in detailed in the following sections.

2 Design, scale and underlying assumptions of the ER-P intervention models

2.1 Identification of intervention models

Based on the abovementioned analysis, representative 1 ha models for the reference level scenario and the REDD+ scenario were designed and compared. These models are presented in Table 2.1 below. The reference scenario is the baseline land use that would occur in the absence of the ER-Program; hence, the related models have been used for opportunity cost assessment only. For the financial and economic analyses, only the REDD+ scenario models were used.

Table 2.1 1-ha models of the ER-Program

Reference land use scenario	REDD+ activity	1-ha REDD+ scenario model	1-ha reference scenario model*
Reducing deforestation and forest degradation activities (Component 2)			
Evergreen broadleaf rich natural forest to agricultural land use	Protection and sustainable management of evergreen broadleaf forest - rich quality	*NTFP - REDD+ scenario* (protecting the forest and NTFP production/harvest) **(Model 1)**	*Illegal cutting & Firewood - Reference scenario* (degrading and final conversion to agriculture by year 15)
Evergreen broadleaf medium natural forest to agricultural land use	Protection and natural regeneration, no planting of evergreen broadleaf forest – medium quality	*Natural regeneration - REDD+ scenario* (protecting the forest, no planting, and limited harvest of wood/firewood) **(Model 2)**	*Illegal cutting & Firewood - Reference scenario* (degrading and final conversion to agriculture by year 10)
Evergreen broadleaf poor natural forest to agricultural land use	Protection and natural regeneration with enrichment planting of evergreen broadleaf forest – poor quality	*Natural regeneration - REDD+ scenario* (protecting the forest, enrichment planting, and limited harvest of wood/firewood) **(Model 3)**	*Illegal cutting & Firewood - Reference scenario* (degrading and final conversion to agriculture by year 5)
Enhancement of forest carbon stocks activities (Component 3)			
Plantation forest - Acacia short rotation (6 years)	Transformation of short rotation Acacia to long rotation (12 years)	*Acacia plantation 12 year rotation - REDD+ scenario* (Acacia plantation, rotation increased from 6 to 12 years) **(Model 6)**	*Acacia short rotation - 6 years - Reference scenario* (Acacia plantation, harvested in year 6)
Plantation forest - Acacia short rotation (6 years)	Transformation of short rotation Acacia to mixed native species long rotation (20 years)	*Transition: Acacia hybrid in year 4 to native species - REDD+ scenario* (Acacia plantation converted to mixed Acacia and native species in year 4) **(Model 7)**	*Acacia short rotation - 6 years - Reference scenario* (Acacia plantation, harvested in year 6)

Barren land	Afforestation/Reforestation - Melia azedarach (8-year rotation)	*Melia azedarach - REDD+ scenario* (Melia plantation, harvested in year 8) **(Model 8)**	*Bare/Unforested land - Reference scenario* (land without vegetation cover, not under agriculture)
Barren land	Afforestation/Reforestation – Acacia long rotation (12 years)	*Acacia plantation 12 year rotation - REDD+ scenario* (Acacia plantation, harvested in year 12) **(Model 4)**	*Bare/Unforested land -* Reference scenario (land without vegetation cover, not under agriculture)
Barren land / Offsetting infrastructure	Afforestation/Reforestation - mixed Acacia and native species (50%:50%) (Also used as the basis for offsetting infrastructure and other development for roads and HPP)	*Restoration: planting 50% Acacia and 50 % native - REDD+ scenario* (mixed species plantation: 50-50 Acacia and native species, harvested in year 20) **(Model 5)**	*Bare/Unforested land –* (Does not assume the potential infrastructure, the cost and benefit of it)

*Used for opportunity cost assessment only.

- A financial analysis of the models is presented in the section 3.

2.2 Scale and implementation of the ER-P REDD+ intervention models

As deforestation and forest degradation is mainly concentrated in and around PFMBs, SUF MBs and SFCs, the ER-program intends to focus implementation of the ER-P on the level of these implementation units. The area assumptions are made per implementation entities, smallholder and households will participate in the program and an assumption is that about 10% of all assumed project area under PFMBs will be implemented by smallholders. For each province has an average number PFMBs[2], SUF MBs and SFCs and this was developed to scale land-based implementation activities for each province.

The ER-P includes two main investment targets: i) smallholders and ii) large forest owners, government forest MBs and SFCs (SFCs include private the sector). The ER-P processes for working with the smallholders follow on from the FSDP approach with funding and links already in place with the VBSP. The work with the MBs and SFC follows a combination of the tried and tested approach of a simple investment grant based approach (as used in the FSDP) to help the management entities to meet investment criteria, combined with links to access to funding through the VBSP - to facilitate the investment work with the SUFs and PFMBs and on specific issues with SFCs and the approach has been adopted to:

- Introduce a performance based approach which matches the overall CF approach to the ER-P;
- Streamlines the packaging and processing of the provincial budgets and helps implementation over a large and diverse area different stakeholders with largely un-quantified individual socio-economic and environmental settings;
- Facilitates the requirement to undertake detailed planning and capacity building exercise required in the PFMBs, SUF MBs and SFC for investments;

[2] Note that a PFMB is allowed to manage 30% of the total forest cover as production forest – so a number have invested in short term acacia plantations and can therefore act in a similar way to the SFCs for that 30% of their estate.

- Facilitates specific solutions to specific management issues – a flexible approach to help address hotspots of degradation/ deforestation;
- MBs are directly involved in detailed planning and have more ownership and are made more accountable;
- Capacity building can be tailored to the MBs' wishes and needs and helps them take ownership;
- Promotes an integrated approach between the MBs and local communities;
- Helps leverage public finance for PFMBs and helps promote equitisation/ and eventual private financing in the case of SFCs;
- Helps leverage public finance for PFMB and SUF MBs; and
- Facilitates and would be combined with the funding from the BSM and BSP for the SUFMBs; and The flexibility of funding in the process is a significant advantage as it can include front end funding and be supplemented by progressive top ups as funds are released from the CF[3].

The following Table 2.2 summarizes the proposed different forest intervention models for the three main forest entities and is the result of discussion on estimates from the six provinces. The design of the various intervention models has taken account of sample consultations and on-going technical assistance work with the various entities as part of the PRAP, work plantation transformation models funded by BMUB[4] (see also section 5) and the SESA as required for the ER-PD by the FCPF CF.

Table 2.2 REDD+ activities implemented in respective implementing entities

REDD+ activity	**Implementing entity**			
	PFMB	**SUF MB**	**SFC**	**Households/ cooperatives**
Reducing deforestation / Reducing forest degradation (Component 2)				
1. Protection and sustainable management	☑	☑	☑	☑
2. Protection and natural regeneration, no planting	☑	☑	☑	☑
3. Protection and natural regeneration with enrichment planting	☑	☑	☑	
Carbon stock enhancement activities (Component 3)				
4. Transformation of short rotation Acacia to long rotation (12 years)	☑		☑	☑
5. Transformation of short rotation Acacia to mixed native species long rotation (20 years)	☑		☑	
6. Afforestation/Reforestation - *Melia azedarach* (8 year rotation)	☑		☑	☑
7. Afforestation/Reforestation – Acacia long rotation (12 years)	☑		☑	

[3] The GOV has signalled a strong commitment to the VCF as an effective financing mechanism under MARD and integrated under the umbrella of the Vietnam Fund for Forests (VNFF). The VNFF will also cover funding for payments for environmental services, REDD+.
[4] International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)

REDD+ activity	Implementing entity			
	PFMB	SUF MB	SFC	Households/ cooperatives
8. Afforestation/Reforestation - mixed Acacia and native species (50%:50%)	☑		☑	

Key services available through the ER-P (and based on the FSDP) to facilitate smallholder plantations include inputs on nursery accreditation and improved seedling quality, improved silviculture and livelihoods training land survey, mapping, landscape and plantation design, Land use right certificate (LURC) processing, application and credit processes for VBSP loans, extension services, technical training, scientific research, nursery seedling production, ethnic minority development planning, internal PFSM, and pilots in FSC certification, collaborative management, three provinces with the ER-P region (Thanh Hoa, Nghe An and Thua Thien Hue) were part of the FSDP therefore it is envisaged that these processes and activities would still be familiar to the DARDs (which implemented the FSDP and would also be responsible for the ER-P).

The interventions model were scaled on each implementation unit for each province separately. In total, the six ER-P provinces include 47 PFMBs, 16 SFC and 14 SUF MBs. It is assumed that the majority of these entities will be part of the ER-P. The following tables present the key assumptions for the scaling of the ER-P interventions according to the implementation entities and province. The scaling and adoption of the model is envisioned to take place over a period of 5 years, while in year one no intervention are assumed to the required planning for the implementation.

Table 2.3 PFMB area under management per implementation entity after 8 years (ha)

PFMB models[5]	Thua Thien Hue	Quang Tri	Quang Binh	Ha Tinh	Nghe An	Thanh Hoa
1. Forest protection of existing natural forest through contracts	880	2,200	880	440	880	660
2. Natural assisted regeneration of medium quality forest / avoiding degradation (no planting)	800	1,320	660	880	880	660
3. Natural regeneration and enrichment planting of poor natural forest	1,200	1,200	1,200	1,200	1,200	1,200
4. Afforestation/Reforestation - Acacia long rotation model (12 years)	480	600	280	400	200	160
5. Afforestation/Reforestation - Acacia with mixed species (20 years) (50% native; 50% Acacia)	480	600	280	400	200	160
6. Transformation of Acacia short rotation to long-rotation (12 years)	540	1,100	400	880	400	480
7. Transformation of Acacia short rotation to long rotation mixed native species (20 years)	480	1,000	320	800	320	440
8. Afforestation/Reforestation - Melia azedarach (8-year rotation)	0	0	0	0	240	0

[5] Assume that 10% of the area is implemented by smallholders

Table 2.4 SUF MB area under management per implementation entity after 8 years (ha)

SUF MB models	Thua Thien Hue	Quang Tri	Quang Binh	Ha Tinh	Nghe An	Thanh Hoa
1. Forest protection of existing natural forest through contracts	440	1,120	720	120	280	600
2. Natural assisted regeneration of medium quality forest / avoiding degradation (no planting)	360	440	1,200	440	320	600
3. Natural regeneration and enrichment planting of poor natural forest	1,200	800	800	880	880	880

Table 2.5 SFC area under management per implementation entity after 8 years (ha)

SFC models	Thua Thien Hue	Quang Tri	Quang Binh	Ha Tinh	Nghe An	Thanh Hoa
1. Forest protection of existing natural forest through contracts	720	1,880	2,000	400	200	800
2. Natural assisted regeneration of medium quality forest / avoiding degradation (no planting)	600	720	3,200	1,600	200	800
3. Natural regeneration and enrichment planting of poor natural forest	600	600	880	1,200	720	800
4. Afforestation/Reforestation - Acacia long rotation model (12 years)	400	320	600	600	200	200
5. Afforestation/Reforestation - Acacia with mixed species (20 years) (50% native; 50% Acacia)	400	320	600	600	200	200
6. Transformation of Acacia short rotation to long-rotation (12 years)	480	1,240	520	320	680	480
7. Transformation of Acacia short rotation to long rotation mixed native species (20 years)	480	1,240	480	320	480	480
8. Afforestation/Reforestation - Melia azedarach (8-year rotation)	0	0	0	0	200	0

The following assumption are made for the start of implementation. It is assumed that some implementation entities can be mobilized relatively quickly, while the other start may start at a later stage. The table indicate the start of activities per province and per implementation entity which is then multiplied by the scale of the model as presented in Tables 2.2-2.5.

Table 2.6 Assumed rollout and participating implementation entities in the ER-Program

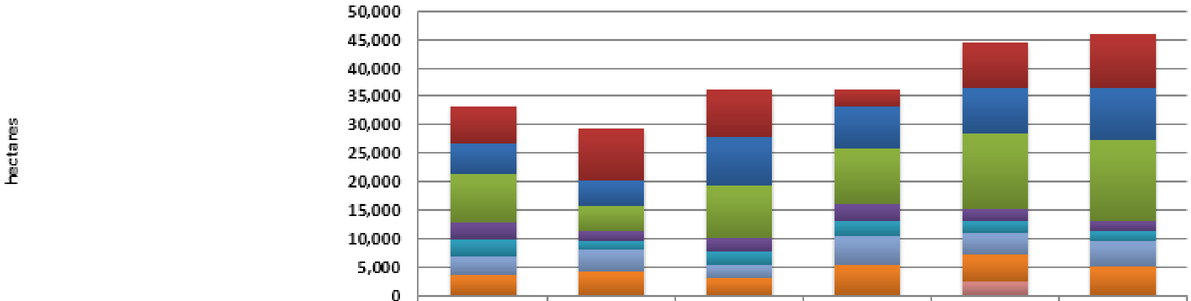
Timing	Year 1	Year 2	Year 3	Total 8 years
Protection Forest Management Board (PFMB)	**15**	**17**	**10**	**42**
Thua Thien Hue	2	2	1	**5**
Quang Tri	1	1		**2**
Quang Binh	3	3	2	**8**
Ha Tinh	3	3	1	**7**
Nghe An	3	4	3	**10**
Thanh Hoa	3	4	3	**10**
Special Forest Use Management Board (SUF MB)	**8**	**6**		**14**
Thua Thien Hue	1	1		**2**
Quang Tri	1	1		**2**
Quang Binh	1			**1**
Ha Tinh	1	1		**2**
Nghe An	2	1		**3**
Thanh Hoa	2	2		**4**
State Forest Company (SFC)	**9**	**4**		**13**
Thua Thien Hue	2	1		**3**
Quang Tri	1	1		**2**
Quang Binh	1			**1**
Ha Tinh	1			**1**
Nghe An	2	1		**3**
Thanh Hoa	2	1		**3**

- Based on the assumed rollout of the implementation entities (Table 2.6) and individual area estimates (Tables 2.3 – 2.5), the ER-P activities will cover a total area of 224,930 ha[6]. The area estimates are indicative and estimates and based on the data provided during the consultation processes with the provinces for the development to the PRAPs.

- The intervention area represents 8.1 % of the total forest area in the ER-P accounting area and 4.4 % of the ER-P accounting area.

[6] The target ER-P area of 224,930 ha represents approximately 4.4% of the total land area of the six target provinces and 8.1 % of total forest area in the NCC.

Figure 2.1 ER-P scale according to REDD+ intervention models (8 years)



	Thua Thien Hue	QuangTri	Quang Binh	Ha Tinh	Nghe An	Thanh Hoa
Model 1: Forest protection of existing natural forest through contracts	6,270	9,100	8,220	3,140	7,920	9,250
Model 2: Natural assisted regeneration of medium quality forest / avoiding degradation (no planting	5,480	4,340	8,525	7,430	8,030	9,250
Model 3: Natural regeneration and enrichment planting of poor natural forest	8,550	4,550	9,180	9,640	13,400	14,280
Model 4: Afforestation/Reforestation - Acacia long rotation model (12 years)	3,020	1,610	2,350	2,900	2,050	1,750
Model 5: Afforestation/Reforestation - Acacia with mixed species (20 years) (50% native; 50% Acacia)	3,020	1,610	2,350	2,900	2,050	1,750
Model 7: Transformation of Acacia short rotation to long rotation mixed native species (20 years	3,240	3,920	2,480	4,920	3,720	4,620
Model 6: Transformation of Acacia short rotation to long-rotation (12 years)	3,480	4,095	3,020	5,380	4,870	4,920
Model 8: Afforestation/Reforestation - Melia azedarach (8-year rotation)	0	0	0	0	2,350	0

2.2.1 Lessons learned for engaging SUF MBs, smallholders and SFCs

- The emphasis of the FSDP smallholder plantation component was on advocating a policy and market environment that supported investment in tree growing by smallholders, accelerating forest land allocation, and providing support to plantation and mixed forestry-agriculture crop establishment and management. A separate FSDP component supported SUFs through the Viet Nam Conservation Fund which due to the fragmented nature of the Viet Nam's SUF system required a mechanism that could deliver smaller and flexible support to a large number of SUFs supporting biodiversity of international importance. The KfW forest plantation projects included a community forest management CFM project approach, both projects generally worked with and build on work undertaken by the Forest Sector Support Program (FSSP) which closed in 2015.

- The FSDP models focused on Acacia plantations, the market forces operating at the time resulted inmost plantation production going to chipwood; however, a review of later FSDP work and further independent work concluded that carbon sequestration can be doubled by managing Acacia plantations for longer-rotation larger-diameter sawtimber[7]. Profits for Acacia sawtimber are also higher than for chipwood, with financial rates of return at 21% to 26%. While the evidence seems clear that longer-rotation timber can result in higher profits and increased carbon sequestration, producers have been reluctant to invest in the longer rotations, they also see increased risks to their investments from typhoons with the longer term approach. Providing the proper mix of incentives and mitigation of risks to

[7] Pistorius and Haupt (2016) found that in Vietnam the average short-rotation chipwood plantation sequestered an average of 60 tons of CO_2e ha^{-1} while the average long-rotation sawtimber plantation sequestered between 118 and 130 tons of CO_2e ha^{-1}. A standard 25 year performance period was applied for both models.

producers for investments in longer-rotation forestry will be a needed element of any program to encourage the adoption of the longer rotations.

- A wide range of potential stakeholders would be expected to be included for participation in the ER-P, including PFMBs SUFMBs, SFCs, communities and smallholders, each would need to have a tailored approach, including eligibility criteria and financing schemes appropriate to their situation developed and included the program.

- Building on and taking the example of the FSDP operation, it is expected that eligible producers would be able to take out loans for forestry plantations with the VBSP, which is funded through to 2036 and repay the loans at harvest time. This would ensure that the component would be largely self-financing and sustainable through a reimbursable funding mechanism. Technical assistance would be provided in ways compatible with current government policy on ODA.

- Similarly taking lessons from the FSDP conditions vary through the provinces and a basket of REDD+ intervention measures for a wide range of locations and different capacities is required for successful implementation, this would need to be coupled with funding from a number of sources (projects and government) and would need to be coupled with a simple, workable delivery mechanism with an accountable management system.

3 Financial and economic performance of the intervention models

3.1 Key underlying assumptions

- For each of the identified reference and REDD+ intervention model a cost and benefit analysis was carried out which serves as the basis for the assessment of the opportunity costs and the quantification of the operational budget and investments. The following section present the key assumption and results of this analysis.

- Each 1-ha land use model estimates the costs incurred and benefits in terms of revenues from sale of product. In addition for each 1-ha model GHG mitigation and employment generated in the reference and REDD+ scenarios is estimated. The following steps have been applied in constructing every 1-ha model:

  a) The costs of the activities and materials required to undertake the baseline land use activity (e.g., illegal cutting), and the REDD+ scenario land use activity (e.g., protection and harvest of wood products) were estimated based on local data/statistics, national cost norms, interviews, and published literature. All assumptions are presented in the Annex 1 separately.

  b) Benefits from products, e.g., wood/firewood, timber, etc. were estimated from expected yields, and prices obtained from the same data sources mentioned above. Benefits were annualized as per the estimated annual yields.

  c) Annual cash flows were then calculated as the difference between total annual costs and total annual benefits, i.e., b) minus a).

  d) All costs and benefit analyses were done for 25-year period due to the long time period forest-related benefits (products) would take to be realized.

  e) NPVs (at discount rate of 10%) and IRRs were estimated over a 25.

  f) Mitigation benefits were linked to the RL. Emission factor data is based on the RL data and from biomass accumulation rates based on biomass growth/yield data of the project *"business models for the restoration of short-rotation Acacia plantations in Vietnam"*[8], implemented by *UNIQUE forestry and land use, Climate Focus* and *IREN of Hue University*. For a detailed GHG mitigation assessment a separate summary report was prepared.

  g) Employment was estimated first in terms of annual labor days – by dividing the annual labor expenditure in a) above with daily labor cost – taken as 200,000 VND/day (USD 9.1/day) and a VND to USD exchange rate of VND 22,000 per 1

[8] This project is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) supports this initiative on the basis of a decision adopted by the German Bundestag.

USD; then converted to annual full-time job equivalent assuming 230 labor days in a year.

- The above steps were used to build all 1-ha models. The key results of the 1 ha models in the reference scenario and in the REDD+ scenario were calculated and used for the subsequent project cost and benefit analysis.

- The result in Table 3 below shows that all calculated REDD+ models are profitable. The natural forest REDD+ models range between USD 439 and 2,060 /ha over 25 years and an IRR between 14 and 27%.

- The newly established plantation models range between USD 3,009 and 3,297 /ha and IRR range of 17-27%. The plantation transformation models range between an NPV of 3,127 and 3,297, and IRRs between 17% and 21%.

Table 3.1 Key results for Reference scenario and REDD+ scenario and opportunity costs

Reference level	Average long-term carbon stock (tCO2/ha)	NPV 25 years (10% discount rate) USD	IRR 25 years	REDD+ scenario	Average long-term carbon stock (tCO2/ha)	NPV 25 years (10% discount rate) USD	IRR 25 years	Opportunity cost (USD/ha)[9]	Opportunity costs (USD/ tCO_2)
Evergreen broadleaf rich natural forest to agricultural land use	20	$4,795	N/A[10]	Sustainable management of evergreen broadleaf forest - rich	543.5[11]	$546	14%	-4,250	**-8**
Evergreen broadleaf medium natural forest to agricultural land use	20	$4,795	N/A	Natural regeneration of evergreen broadleaf forest – medium	543.5	$439	17%	-4,357	**-8**
Evergreen broadleaf poor natural forest to agricultural land use	20	$6,942	N/A	Natural regeneration of evergreen broadleaf forest – poor	543.5	$2,060	27%	-4,882	**-9**
Plantation forest - Acacia short rotation (6 years)	88	$358	12%	Convert short rotation to long rotation Acacia (12 years)	112	$3,127	21%	2,769	**115**
Plantation forest - Acacia short rotation (6 years)	88	$358	12%	Convert Acacia to mixed native species long rotation (20 years)	117	$4,914	18%	4,556	**158**
Barren land	0	$0		Plantation of Melia azedarach (8 year rotation)	112	$3,009	27%	3,009	**27**
Barren land	0	$0		Plantation of Acacia	117	$3,127	21%	3,127	**28**
Barren land (partly conversion to infrastructure and other development)	0	$0		Plantation of Acacia with mixed species	128	$3,297	17%	3,297	**28**

[9] Negative values indicates opportunity costs (foregone economic benefits), while positive values indicate net economic benefits from converting the reference land use towards REDD+ scenario land use.
[10] Cannot be calculated as the annual cashflows never turn negative.
[11] Based on Emission and removal factor data for North Central Costal Vietnam Report (Vu Tan Phuong, Vu Tien Dien), Version 20th April 2016

3.2 *Project economic analysis*

- The overall economic **expected rate of return (ERR)** over a period of 10 years amounts to **7 % and a NPV of USD -10.66 million. On the longer term (12 years) the project becomes profitable and achieves an ERR of 15.9% and a NPV of 30.9 million.**

- This is based on the aggregation of the 1-ha based models on the implementation entities (PFMB, SUF MB, SFC levels), the PRAPs scale and cross-cutting budgets for non-land-based activities and the ER-P administration costs. On the revenue side forest product sales and a carbon value at USD 5 /tCO_2 was assumed.

- For the carbon benefit calculation we assume an advance payment for generated emission reduction in year 1. **The advance payment is assumed at USD 7 million equivalent to 5% of the estimate 10 years emission reductions (ERs).** The 2nd payment in year 3 for ERs in years is assumed for the ERs generated in year 1-3. The 3rd payment in year 5 is assumed for the verified ERs in year 4-5, **minus the USD 7 million advance payment**. The 4th payment in year 8 (Year 2024 - end of the program) is assumed for ERs generated in year 6-8. The 5th payment in year 10 is assumed for ERs in year 10.

3.3 *Sensitivity analysis*

- The sensitivity analysis is concentrated on the impacts on ERR from changes in forest product prices and overall project costs. The ERR is sensitive to revenues and costs in the range of 10% – 20%. The sensitivity analysis is presented in Table 3.2 below.

Table 3.2 Sensitivity analysis for ER-Program

Cases	NPV (USD) - 8 years	ERR - 8 years	NPV (USD) - 10 years	ERR - 10 years	NPV (USD) - 12 years	ERR - 12 years
Base case	**-47,695,311**	**-11.6%**	**-10,663,306**	**7.0%**	**30,943,925**	**15.9%**
Project cost (10% higher)	-47,001,843	-23%	-47,001,843	-3%	-11,199,978	8%
Project cost (20% higher)	25,675,232	1%	25,675,232	18%	73,087,827	25%
Project cost (10% lower)	-83,340,380	N/A	-83,340,380	-12%	-53,343,880	1%
Project costs (20% lower)	62,013,769	16%	62,013,769	30%	115,231,729	36%
Revenues (10% higher)	24,608,901	0%	24,608,901	17%	76,182,219	24%
Revenues (20% higher)	-45,935,512	-24%	-45,935,512	-4%	-14,294,370	7%
Revenues (10% lower)	59,881,108	11%	59,881,108	26%	121,420,514	32%
Revenues (20% lower)	-81,207,719	N/A	-81,207,719	-16%	-59,532,665	-3%

4 GHG emission reduction estimates of the intervention models

4.1 *Key underlying assumptions*

- The GHG emission reduction estimates were carried out according to the estimated scale of the ER-P.
- The GHG estimates assume a 13% reversal buffer as calculated in the Annex 1 Section 6, Table 6.1 and a 4% uncertainty buffer;
- GHG emission reductions are only quantified for the REDD+ investment areas (component 2 and 3), but not for the full Accounting Area of the ER-P. The cross-cutting province level investments (Component 1) and synergies with other governmental and donor related programs will most likely result in additional emission reductions;
- Only 85% of the ER-P investment are in natural forest is assumed to generate emission reduction, which reflect the effectiveness factor of the REDD+ interventions. The remaining 15% are conservatively excluded from calculations.
- For carbon stock plantation activities and areas related to reforestation, it is assumed that 90% of the plantation will survive and generate carbon stock enhancements;
- Carbon stock enhancement benefits adopt a long-term average carbon stock approach which takes into consideration the harvesting and respective reversal over time (Figure 4.1 below).

4.2 *Assumption for estimating emission reductions and carbon stock enhancement*

a) Emission reduction from reduced deforestation

- GHG emissions reduction from avoided deforestation are quantified based on the REDD+ intervention model 3 (Natural regeneration and enrichment planting of poor natural forest) which will prevent the conversion of the evergreen natural forest poor towards non-forest land use (agricultural land use). It is assumed that the target interventions for this model and the remaining will be based on a REDD+ needs assessment[12] which will identify the key deforestation hotspot areas, develop a management plan using the ER-P interventions.
- The estimates assumes that once the estimated intervention areas enter into the ER-P program GHG benefits due to avoidance of deforestation start to occur. This will result in avoiding emissions of 115.5 tCO_2/ha (carbon stock of evergreen natural forest – poor in RL). However, the GHG benefits of each effectively protected forest area are accounted

[12] For more details on the RNA see Annex1 Section 4.3 Process for working with PFMBs, SUFs MB and SFCs.

not immediately, but over a period of 5 years (115.5 tCO_2/5 years = 23.1 tCO_2/ha/yr), resulting in an annual emission factor of 23.1 tCO2/ha/yr over 5 years).

- In addition, due to the natural regeneration of the evergreen natural forest poor, aboveground and belowground biomass carbon stock enhancement benefits will occur. For this, we apply an annual growth emission factor of 3% of the total carbon stock of evergreen forest-poor, as used in the RL assessment. This is equivalent to 3.5 tCO_2/ha/yr.

- In the ER estimates it is assumed that 85% of the area subject to interventions will actually deliver results and will be effective, while 15% of the intervention area will not deliver results.

b) *Forest degradation reduction*

- GHG emission reduction from reduced forest degradation are assumed by the REDD+ intervention model 1 (Forest protection of existing natural forest) which prevents "evergreen broadleaves forest rich" to "Evergreen broadleaves forest medium" (degradation) (responsible for 24% of total historical forest degradation area).

- Reduction of emissions is calculated as the difference between the RL emissions factor (carbon stock) between evergreen forest rich and evergreen forest medium (543.5 – 264.9 = 278.6 tCO_2/ha. This emission reduction is assumed to occur over a period of 5 years, after the natural forest area enters into the ER-P implementation resulting an annual emission factor of 55.7 tCO_2/ha/yr over 5 years. In this model, carbon stock enhancement benefits are not accounted for as the forest is conservatively assumed at a high carbon equilibrium (undisturbed or minimally disturbed).

- In the second reduction of forest degradation model 2 (Natural regeneration of "evergreen natural forest – medium" which prevent forest degradation to "evergreen natural forest – poor" – responsible for 51% of total forest degradation area in RL) emission reductions benefits are quantified as the difference between the carbon stock evergreen natural medium and evergreen natural forest – poor (264.5 – 115.5 tCO_2/ha = 149 tCO_2/ha). The accounting of GHG benefits is distributed over a period of 5 year, same as under model 1 and 3 (29.8 tCO_2/ha/yr over 5 years).

- The historical data shows and justifies the assumption to use a five year conversion cycles from evergreen broadleaves forest land use classes rich, towards evergreen broadleaves forest - medium, and subsequently towards evergreen broadleaves forest - poor and subsequently conversion to non-forest land. Even though this land use change dynamic may differ from this described pattern and in some cases the transition may be faster or slower. However, for GHG benefit accounting this approach is conservative and avoid immediate accounting for GHG benefit from forest degradation and deforestation.

- For the quantification of the carbon stock enhancement benefits, the annual growth increment for this forest types is assumed for the RL assessment equivalent to 2.3% of the reported carbon stock. This converts to 6.1 tCO2/ha/year.

- For both models (1 and 2) the ER estimates are conservatively made assuming that 85% of the area subject to interventions will actually deliver results and will be effective, while the remaining 15% will no deliver emission reductions.

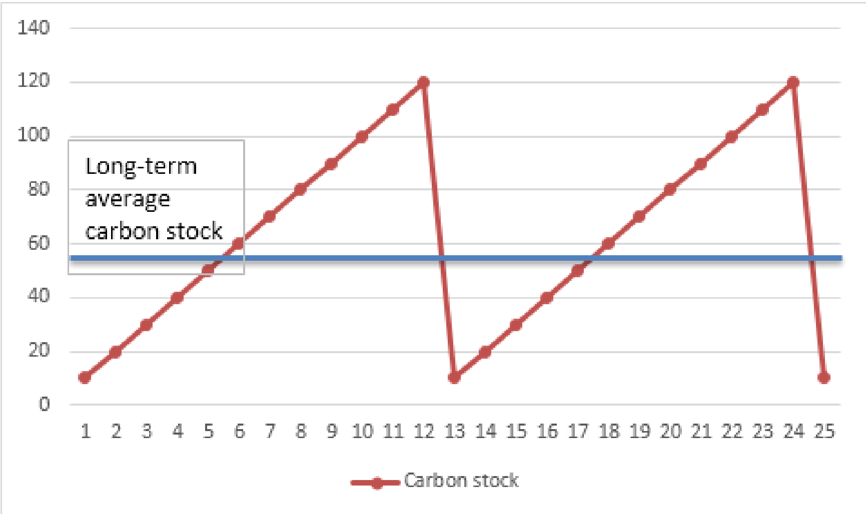
4.3 *Assumptions for estimating carbon stock enhancement benefits (reforestation and plantation restoration models)*

- Carbon stock enhancement models include Afforestation / Reforestation models to be implemented on bare land (Model 4,5,8) and restoration of existing short-rotation Acacia plantation (Model 6 and 7) towards a longer rotation period and mixed species.

- For the quantification of the carbon stock enhancement we use average growth data from Viet Nam for respective species, based on conservative assumptions as further explained under each model.

- In order to account for the risk of reversals, and taking into account that plantation model will be subject to harvesting leading to reversals, a long-term average carbon stock approach is used to account for the long-term carbon stock enhancement benefits (Figure 4.1). The long-term average carbon stock is an average value over more than 20 years taking into consideration planting, thinning and harvesting and replanting over more than one rotation period. The calculations assume that after harvesting replanting of the models occur.

Figure 4.1 Carbon enhancement accounting approach for rotation forestry models (4-8)



4.3.1 *Plantation transformation models*

- For the quantification of the annual carbon stock enhancement benefits of existing plantations (Model 6 and 7) the average RL reported plantation carbon stock of 89 tCO_2/ha which is as a starting point for the calculations. The calculation are based on an in-depth feasibility assessment[13] of the growth performance of different plantation models in Viet Nam for Acacia and native species.

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[13] UNIQUE forestry and land use and Climate Focus, 2016: Development of Business Models to Address Drivers of Deforestation: *Phase II – Feasibility Study* - Restoration of short-rotation Acacia plantations with high value native tree species in Vietnam.
This project is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) supports this initiative on the basis of a decision adopted by the German Bundestag.

- A detailed description of the business model is provided in a separate section (XXX).

- For model 6 (Transformation of short rotation Acacia to long-rotation Acacia (12 years)) the average long-term carbon stock is calculated as 112 tCO_2/ha. Thus in the long-term benefit is 23 tCO_2/ha. Based on this long-term benefit an annual emissions factor is calculated as 23 tCO_2/10 yr = 2.3 tCO_2/ha/yr. This emission factor is used to account for the enhancement benefits of model 6) (For key input variables see Table 4.1 below).

- For model 7 (Short rotation Acacia transformation to long rotation mixed species (20 years)), average long-term carbon stock is calculated as the difference between 89 tCO_2/ha and a long-term average carbon stock (139 tCO_2/ha), equivalent to 50 tCO_2/ha/ 10 yr = 5.0 tCO_2/ha/year (Table 4.1 below).

Table 4.1 Transformation plantation models[14]

Parameter	Acacia long rotation	Acacia mixed species
Rotation length (Years)	12 years	Acacia 12 years and subsequently replaced by mixed Native species 20 years
Assumed management	Thinning in year 4 and 8	Acacia: Thinning in year 4 and 8 Native species: Thinning year 4 and 12
Average growth rate (MAI) (m³/ha/yr)	30 m³/ha/yr	Acacia: 30 m³/ha/yr Native species:16 m³/ha/year
Biomass Expansion Factor	1.3	1.3 for Acacia 1.5 for native species
Wood density (tdm / m³ fresh volume	0.47	0.47 for Acacia 0.6 for native species
Root to shoot ratio	0.2	0.2
Carbon fraction	0.47	0.47
Conversion factor C to CO2	44/12	44/12
Average long-term carbon stock (tCO2/ha)	112 tCO2/ha	139 tCO2/ha
Long term average accountable C enhancement benefit (tCO2/ha)	23 tCO2/ha	50 tCO2/ha

4.3.2 Reforestation models

- The reforestation models assume "bare land" as the starting point equivalent to a carbon stock of 0 tCO_2/ha.

[14] The calculations and data sources are based on an in-depth research of Acacia and native species in the frame of the International Climate Initiative (IKI) project ("Business models to address the drivers of deforestation"), supported by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and implemented by UNIQUE forestry and land use.

- For each model average growth rates are assumed, as presented in Table 4.2, including the key input values. C enhancement benefit are accounted for once the intervention enters the ER-P, e.g. if the model 5 starts in year 3 after ER-P implementation start C enhancement benefits are accounted for from year 3-10.

- For the Acacia and Melia plantation models (Model 4 and 8) we calculated an annual average carbon enhancement benefit of 11.2 tCO_2/ha/year and 11.6 respectively, equivalent to a maximum accountable carbon stock of 112 tCO_2/ha and 116 tCO_2/ha.

- For the Acacia and mixed species plantation model (Model 5), the long-term average carbon stock is higher, but growth rates are lower compared to pure Acacia and Melia. Therefore over a period of 10 years, an average annual carbon stock enhancement benefit of 11.7 tCO_2/ha/year is accounted for.

Table 4.2 Reforestation plantation models

Parameter	Acacia long-term model	Acacia with mixed species	Melia azedarach
Rotation length (Years)	12 years	Acacia 12 years and subsequently replaced by mixed Native species 20 years	8 years
Assumed management	Thinning in year 4 and 8	Acacia: Thinning in year 4 and 8 Native species: Thinning year 4 and 12	No thinning
Average growth rate (MAI) (m^3/ha/yr)	30 m^3/ha/yr	Acacia: 30 m^3/ha/yr Native species:16 m^3/ha/year	20 m^3/ha/yr
Biomass Expansion Factor	1.3	1.3 for Acacia 1.5 for native species	1.3
Wood density (tdm / m^3 fresh volume	0.47	0.47 for Acacia 0.6 for native species	0.5
Root to shoot ratio	0.2	0.2	0.2
Carbon fraction	0.47	0.47	0.47
Conversion factor C to CO2	44/12	44/12	44/12
Average long-term carbon stock	112 tCO2/ha	117 tCO2/ha	116 tCO2/ha

4.4 Estimation of GHG emissions reductions

- The target ER-P area of 224,930 ha represents 4.4% of the total land area of the six target provinces and 8.1% of total forest area in the north Central Region. Out of this area 86,955 ha are expected to be protected from further degradation and 59,600 ha subject to avoided deforestation activities. (Note 85% are accounted as GHG emissions reductions due the adopted effectiveness factor for planned REDD+ intervention in natural forests – see assumption for further explanation). See Table 4.3 below;

- In total, reduced forest degradation and reduced deforestation are estimated to reduce GHG emissions by 29.6% compared to the RL over 8 years (20.4 million tCO_2)[15];

- With respect to removals and carbon stock enhancement the ER-P would implement carbon stock enhancement activities on a total area of 78,375 ha which will result in total carbon stock enhancement benefits equivalent to 4.8 million tCO_2 over 8 years (6.1% of total RL removals excluding adjustment of 661 Program or 7.0% of total removals if 661 Program removals are taken into account);

- A detailed breakdown of the GHG emissions reduction and carbon stock enhancement estimates is provided below[16];

- Note that emission reduction and removals are quantified for the ER investment areas of 224,930 ha. This is a conservative approach and most likely there will be additional GHG benefits to the ER-P from the cross-cutting province level investments and other governmental and donor initiatives and programs. These estimates do not include a buffer of 13% and 4% uncertainty buffer, which are accounted in the overall GHG emissions estimates.

[15] All GHG emission reduction and carbon stock enhancement estimates are presented for a 10 year period in order to ensure comparability and consistency between the RL and the ER-P.
[16] Table calculation exclude the 661 Program removals RL adjustment and exclude reversal buffer deductions (13%) .

Table 4.3 GHG emissions reduction and C enhancement benefits & relation to RL emissions and removals

Deforestaiton / Forest degradation driver	REDD+ activity	Targeted area (ha)	Percentage of total remaining land use class in ER-P accounting area (%)	Effectiveness factor survival rates for GHG ERs (%)	ER category: Emissison reduction (ER) / Carbon stock enhancment (C+)	Total ERs (8 years) (tCO2)	Total ERs (10 years) (tCO2)	% of 10yr RL GHG emissions	% of 10yr RL GHG removals
Evergreen broadleaves forest rich to Evergreen broadleaves forest – rich to medium (degradation) due to illegal logging and overexploitation	Model 1: Forest protection of existing natural forest	43,900	19.4%	85%	ER	9,768,886	10,395,959	15.1%	0.0%
Evergreen broadleaves forest - medium conversion to Evergreen broadleaves forest - poor due to illegal looging and overexplitation	Model 2. Natural assisted regeneration of medium quality forest / avoiding degradation (no planting	43,055	9.5%	85%	ER	5,140,174	5,467,554	7.9%	0.0%
					C+	1,170,149	1,616,095	0.0%	2.1%
Evergreen broadleaves forest - poor conversion to bare land for illegal agricultural land conversion	Model 3. Natural regeneration and enrichment planting of poor natural forest	59,600	4.5%	85%	ER	5,494,069	5,851,230	8.5%	0.0%
					C+	916,149	1,267,223	0.0%	1.6%
Plantation area remains plantation area - Enhancement activitiy for production and reversal risk reduction and reversal risks	Model 6: Transformation of Acacia plantation to long Acacia rotation	25,765	4.0%	100%	C+	311,282	430,435	0.0%	0.6%
Plantation area remains plantation area - Enhancment activity - Enhancement activitiy for production and reversal risk reduction and reversal risks	Model 7: Transformation of Acacia plantation to long rotation mixed species	22,900	3.6%	100%	C+	599,820	829,306	0.0%	1.1%
Non-forest land - Enhancment activitiy	Models 4: Afforestation Reforestation with pure Acacia	13,680	0.6%	90%	C+	722,413	998,194	0.0%	1.3%
Non-forest land - enhancment activitiy to compensate for planned infrastrucutre development	Models 5: Afforestation Reforestation with pure Acacia and mixed species and offsetting of infrastructure and development	13,680	0.6%	90%	C+	751,876	1,038,904	0.0%	1.3%
Non-forest land - Enhancment activitiy	Models 8: Afforestation Reforestation with Melia	2,350	0.1%	90%	C+	126,179	175,069	0.0%	0.2%
Total		**224,930**				**25,000,997**	**28,069,969**	**31.6%**	**8.1%**

5 Business models and feasibility for Acacia plantation restoration / transformation[17]

5.1 Background

Since the 1990's Viet Nam's forest cover has increased impressively, then only 27.2% of the land was covered with forest, many of which were severely degraded. In 2015 the forested area once more covered 42% of the country (about 14 million ha) as a result of massive reforestation activities (e.g. the 5 million ha 661 program which ended in 2010). However, for the most part this increase was achieved mainly with short-rotation plantations. In the target region of the ER-Program, the plantation area in the production forest amounts to more than 650,000 ha. A large share of this is covered with Acacia and this area is still growing. Acacia hybrid and *Acacia mangium and a. auriculiformis*, are the dominant tree species in these plantations, and has enabled this success story of reforesting barren lands and rehabilitating severely degraded soils, i.e. helped through its nitrogen-fixing property. In addition it provided a quick, though low-return, business model based on a reliable supply chain for woodchip production by state forest companies, communities and small holders. Acacia is, compared to other species, a relatively short-term investment as it can be harvested for pulpwood and wood chips after 3 to 7 years, and for timber after 9 to 15 years. Currently, over 10 million m^3 is harvested annually from Acacia plantations[18]. A large share of the production is processed as woodchips, although Acacia for sawn timber enjoying high demand from the export-oriented (garden) furniture industry, which has to currently import approximately 80% of the logs required for production (Phuc & Canby 2011 [19]).

Despite higher revenues for timber compared to wood chips, many forest owners are reluctant to increase the rotation length, for three key reasons:

- Many forest owners still depend on the income to cover their living costs and salaries; shifting to longer rotations (and other species) results in significant liquidity gaps. This holds true for private landholders but also for State Forest Companies and Forest protection Management Boards which must cover the expenses for labour of forest workers and replanting.
- The risk for storm damage (monsoon and typhoons), root diseases (due to the common and cheap practice of using shoots), pests and increases significantly, especially for the predominantly used Acacia hybrid in its current form. With this and increasing labour costs the low profitability and economic performance of this land use further decreases.
- A significant lack of technical capacities needed to manage the transition from the very simple Acacia model to more sophisticated silvicultural management approaches – starting from nurseries for appropriate high-quality seedlings of Acacia and high-value native tree species, to planting, infrastructure for large-dimension timber, timely treatments (thinning, weeding and pruning) to proper harvesting.

Without questioning the merits of Acacia for Viet Nam´s successful forest transition, the above-described challenges and concerns associated with the abundance and expansion of

[17] Eduard Merger and Dr. Till Pistorius (UNIQUE forestry and land use) UNIQUE forestry and land use.
[18] Exact harvesting values are unknown due to great variation in small-holder reporting (Nambiar et al. 2014)
[19] Phuc and Canby (2011): Phuc, X. and K. Canby. 2011. Baseline Study 3, Vietnam: Overview of Forest Governance and Trade. Forest Trends FLEGT Asia Regional Programme. Washington DC, USA: Forest Trends.

Acacia monocultures in Viet Nam provide good arguments for initiating the next major step – restoring the short-rotation plantations and enhancing the low economic and environmental quality of Viet Nam's production and protection forests.

The proposed transition (described in the next section) addresses three key aspects. Firstly, their low economic performance does little to support the overarching policy objective for the forestry sector in Viet Nam: to contribute to rural development and poverty alleviation (in the context of the widening income gap between urban and rural areas). Secondly, the resilience of Acacia plantations is low and needs to be improved through suitable management measures to address climatic risks. Last but not least, current Acacia plantation management leaves much room to enhance the delivery of ecosystem services, provided they are enriched with native tree species and managed sustainably – this concerns in particular the potential of carbon sequestration in the context of REDD+ (Pistorius, 2015)[20].

Today, the economic and environmental performance of short-rotation Acacia plantations in Viet Nam is low, and with significantly increasing prices for labour, it is prone to further decrease in the future. Thus, it is a declared policy objective of Viet Nam to shift towards sustainable and economically more attractive business models in production forests. Improved forest production schemes and corresponding value chains will increase the profitability of the sector in the long term, and also generate options for improving the livelihood of communities and smallholders through respective out-grower schemes

5.2 Business models and feasibility for Acacia plantation restoration

Pilot example business models[21], that if adopted by the private sector SFCs, smallholders of the ER-P region, were developed to promote sustainable forest management and focus on two main activities – with the simultaneous objectives of contributing significantly to mitigation in the context of REDD+, enhancing the economic performance and taping potentials for up-scaling:

- Increasing the rotation length to make it suitable for sawn log production; and
- The stepwise introduction of marketable high-value native species in existing Acacia plantations.

Through these activities, the existing short-rotation Acacia business model can be successively replaced by new silvicultural and forest management approaches focused on producing high-value timber for sawn logs. These activities are expected to help to significantly increase the profitability of SFCs and PFMBs with production forests and provide a future resource base of legally produced timber for the export-oriented furniture industry.

Following a site-species-market approach that matches the technical and market feasibility of the model, the program identified three native species, namely *Tarrietia javanica, Dipterocarpus alatus*, and *Hopea odorata* that are particularly promising for an economically profitable forest restoration in a relative short amount of time (20 yr. rotation). The selected species all have a very good growth potential, are adapted to the biophysical conditions in

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[20] Pistorius, T. (2015): The Impacts of International REDD+ Finance – Vietnam Case Study, http://www.climateandlandusealliance.org/en/Impacts_of_International_REDD_Finance/

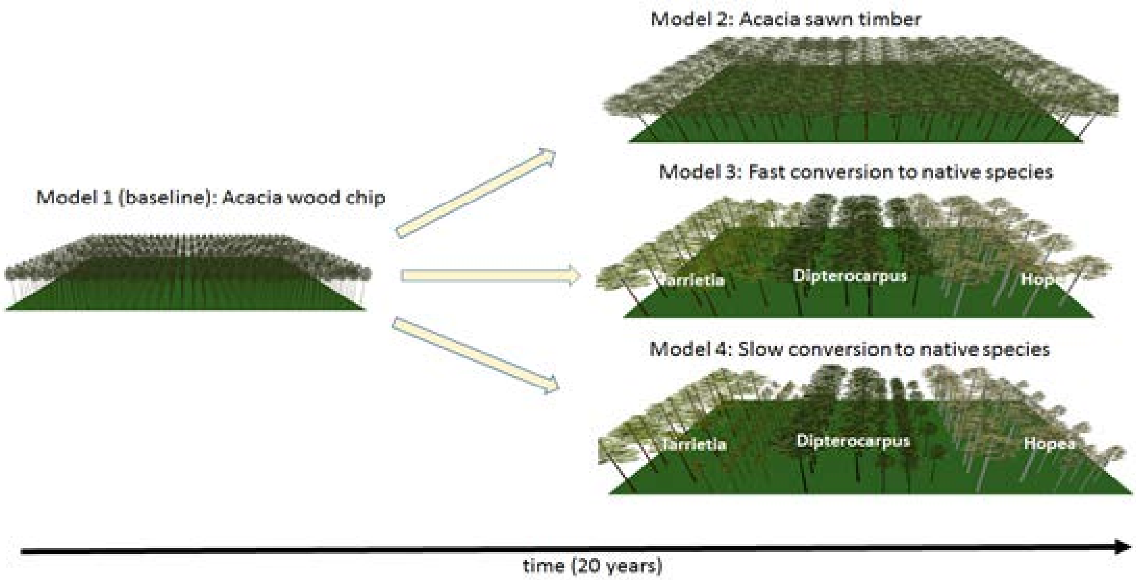
[21] The business models were developed in the frame of the program "business models for the restoration of short-rotation Acacia plantations in Viet Nam" (financed by the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) supports this initiative on the basis of a decision adopted by the German Bundestag) implemented by UNIQUE forestry and land use, Climate Focus and IREN of Hue University.

North-Central Viet Nam, and produce good quality, marketable timber. Furthermore, there have been preliminary activities focusing on planting and managing these species, and thus there are experiences that can provide key lessons learned and important insight for planting (e.g. conditions) and plantation management.

The program initially developed and calculated the reference model – the most common plantation model in North-Central Viet Nam: Acacia hybrid for chipwood production in 6-year-rotation periods without any silvicultural management (Model, “Acacia 6 years wood chip”) and an approximate average carbon stock of 60 tCO2/h[22]a over one rotation period. Taking into account the specific requirements of different native species, the program developed different transition models (all on a 1-ha-scale, for comparison), with a special focus on the silvicultural aspects. Below three illustrative transition models are presented, noting that there is a range of other possibilities and that the location of implementation determines which species and which silvicultural approach is appropriate:

- Model 6: Acacia sawlog production in 12 year rotations; and
- Model 7 (fast conversion of Acacia): Transition of model 1 Acacia to mixed native species in year 4 and 6.

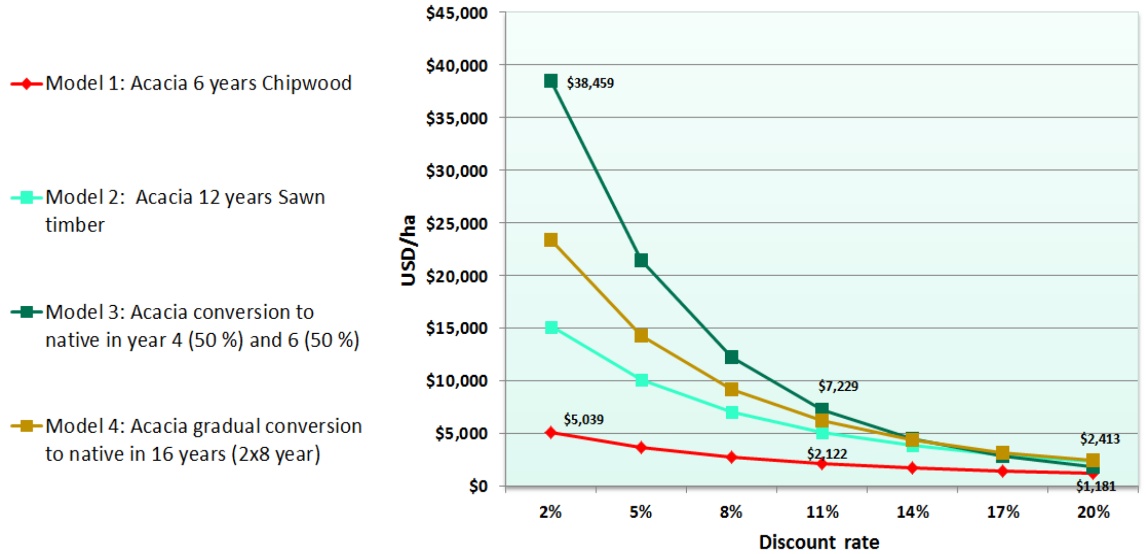
Figure 5.1 Short-rotation Acacia transition models



Comparing the models for a consistent period of 25 years and calculating the internal rate of return (IRR) and net present value (NPV) for each model at different discount rate, the models shows that the transition models are significantly more profitable compared to the current six year rotation period of Acacia, even if the applied discount rate is below 20%.

[22] For GHG emissions reduction calculations we apply a carbon stock value of 89 tCO2/ha, in order to maintain overall consistency with the RL accounting approach. Thus ER estimates are conservative.

Figure 5.2 NPV and financial performance of the models at different discount rates



However, the key challenges of implementing these models are investments into these new species planting and adopting new management technologies as well as foregoing short-term profits overcoming the liquidity gap (Figure 4). In order to manage this transition PFMBs and SFC will either require either external investments or balance sheet investments, e.g. from Acacia income – depending on the financial situation of the PFMB and SFC, provincial budget lines and other sources of finance. Another key challenge is the existing incentive system of SFC and PFMB leaders which are appointed for 5 or 10 yrs. Since it the transition period is marked by high investments and the profits start materializing after 10 years there are few incentives for them to promote the transition

Figure 5.3 Modelled cumulative cashflow/ ha Yr 3-25