MNYORORO WA THAMANI WA MAZAO YA MISITU

FORVAC

FORESTRY AND VALUE CHAINS DEVELOPMENT PROGRAMME

Impact of VLFRS and income from VLFRS on deforestation rates Based on satellite image-based monitoring of forest cover (deforestation) and greenhouse gas emissions determination in the FORVAC programme area

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Impact of VLFRS and income from VLFRS on deforestation rates
Based on satellite image-based monitoring of forest cover (deforestation) and greenhouse gas emissions determination in the FORVAC programme area

Presented to: **Forestry and Value Chain Development Programme (FORVAC)**

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Executive summary

The Forestry and Value Chains Development Programme (FORVAC) aims to strengthen Community Based Forest Management (CBFM) in Tanzania through supporting communities to generate more benefits from sustainable use. The premise underpinning this approach is that when forests are under community control and sustainable management, that maximising benefits from the forests will 'help the forest pay its way'. The expected impact of FORVAC states that on one hand the intention is to have 'Increased economic, social and environmental benefits from forests and woodlands (combined with) reduced deforestation'. This proposition runs at odds with conventional conservation approaches which generally aim to reduce deforestation by reducing use and dependence on the forests.

Therefore as part of FORVAC's impact assessment it is very important that FORVAC generates independent evidence to prove firstly whether community based management forests are more effective at reducing deforestation that other management types, and secondly to test the hypothesis that higher income from community managed forests, will lead to less deforestation. To do this a study was commissioned by Professors B.P. Mbilinyi & Zahabu of Sokoine University of Agriculture in Morogoro, who used satellite imagery from 2018 to 2023 to compare FORVAC supported community managed – Village Land Forest Reserves (VLFRs) with other comparable forest management types outside the VLFRs. They also compared deforestation rates across a range of VLFRs from low income to high income. They also calculated carbon loss rates outside VLFRs compared to those of VLFRs.

The key lessons that recommendations that emerged from the study and their implications include the following;

1) COMPARING DEFORESTATION IN COMMUNITY MANAGED FORESTS IN VLFR SITES WITH FORESTS IN OPEN LANDS AND UNDER TANZANIAN FOREST SERVICE (TFS) CONTROL (BETWEEN 2018 AND 2023). The overall deforestation rate in all VLFRS was around 2% during this period or around 0.5 % per year. The overall average deforestation rate in VLFR sites under FORVAC – were **in Lindi cluster** roughly 13 times lower than in open lands, and 12 times lower than TFS managed forest. **In Tanga cluster** the deforestation rates in VLFR sites under FORVAC were roughly 9 times lower than in open lands and 2.5 times lower than in TFS managed forest. In **Ruvuma Cluster** the VLFR sites had 5 times lower deforestation than open land and marginally lower deforestation that TFS forests. On average across all sites the deforestation rates were around 9 times lower in VLFRs compared to open land and around 7 times lower than TFS managed forests. Overall community managed VLFR forests perform better in terms of reduced deforestation than open land and TFS managed forests, so the recommendation would be to expand and strengthen VLFRs. However, there was considerable variation across sites – partly explained in point 2 below.

2) COMPARING DEFORESTATION RATES WITHIN COMMUNITY MANAGED VLFR SITES BETWEEN HIGH, MEDIUM AND LOW INCOME. Although VLFRs performed better than forests on open land and under TFS control in general, within the VLFRs there was a high variation in deforestation rates. The variation was strongly correlated to the income generated from sustainable timber production from the VLFRs. The higher the income,

the lower the deforestation, with the highest level of income sites recording extremely low rates of deforestation. This would seem to align with a premise of FORVAC that once the forest is under secure community tenure, increasing the income from the forest, increases the value of the forest and therefore incentivizes against forest clearance. Also it must be noted that with higher income there are more funds to cover patrolling and other protection activities. With the correlation clear, the recommendation to lower deforestation within VLFR is to focus on maximizing revenue from sustainable use, including sustainable timber use.

3) IMPACT OF COMMUNITY MANAGED VLFRS ON CARBON SEQUESTRATION. In line with the results highlighted under point 1 and 2 above, carbon sequestration is closely linked to rates of deforestation, so lower deforestation rates mean higher carbon sequestration. Community managed VLFRs have lower deforestation rates than non VLFR forests (both TFS and open land), however the difference is most pronounced when there is a significant income from sustainable timber harvesting, then the avoided deforestation is at its highest in VLFRs. This points to a scenario for optimum carbon sequestration of secure community tenure of the forests under VLFRs combined with maximizing revenues from sustainable timber harvesting. This results in the highest level of avoided forest loss, and therefore the highest level of carbon sequestration. As long as the timber harvesting is sustainable it will have minimal negative impact on the carbon capture ability of the forest, as felled trees will be replaced by regeneration that capture carbon as it grows, and substantive amounts of carbon extracted from the forest in the harvested timber will be locked up in timber products. Conversely from this correlation if timber harvesting in VLFRs is banned this will likely correlate with lowering the efficacy of VLFRs in terms of avoided deforestation and maximizing carbon sequestration. Based on the evidence carbon offsetting schemes operating in VLFRs should therefore support sustainable timber harvesting to maximize avoided forest loss and carbon sequestration capacity.

1. INTRODUCTION

1.1 Background

The Forestry and Value Chains Development Programme (FORVAC) is a 6-year (7/2018-7/2024) Programme funded by the Governments of Tanzania and Finland. The implementing agency of the Programme is the Forest and Beekeeping Division (FBD) of the Ministry for Natural Resources and Tourism (MNRT), in close cooperation with Tanzania Forest Service (TFS) and the President's Office Regional Administration and Local Government (PO-RALG).

Forestry and Value Chains Development (FORVAC) aims to contribute to increasing economic, social, and environmental benefits from forests and woodlands while reducing deforestation. The expected outcome of FORVAC is "Sustainably managed forests and forest-based enterprises generating income for community members and revenue for community social services".

To achieve this outcome FORVAC Programme has supported the establishment of

Village Land Forest Reserves (VLFR) and related value chains development in three clusters of:

- Tanga cluster: Handeni and Kilindi districts in Tanga region, the district of Mpwapwa located in Dodoma region and the Suledo Forest Community in KIteto district in Manyara region);
- Lindi cluster: Liwale, Ruangwa and Nachingwea districts; and
- Ruvuma cluster (Namtumbo, Tunduru, Songea, Mbinga and Nyasa districts).

By the end of December 2022, FORVAC has supported the establishment of VLFRs and development of Forest Management Plans (FMPs) for 73 villages. FMP is an integral part of sustainable forest management. The FMPs describe how the forest should be managed taking into consideration their ecological and economic importance. It is the directive of both National Forest Policy of 1998 and Forest Act No. 14 of 2002 that all forest reserves should be managed based on an approved management plan.

Tanzania has a deforestation rate of 469,420 ha annually (URT 2017). One of the expected impacts of FORVAC is reduced deforestation. This pilot remote sensing study was designed to compare the development of forest cover between VLFRs, where FORVAC has been active, and other neighbouring forests to evaluate the impact of FORVAC interventions on deforestation.

1.2 Objective of the Assignment

The objective of the pilot is to evaluate if the activities of the FORVAC Programme have reduced the deforestation rate and greenhouse gas emissions in the VLFRs supported by FORVAC, and comparing them with government management forests and general land.

1.3 Expected deliverables.

The following are expected deliverables:

1) Demonstrating the change of the forested area/canopy cover in the VLFRs that FORVAC has supported by comparing and contrasting deforestation/canopy cover rates change with government/TFS forest reserves/district-managed forest reserves.
    - Calculation of the annual deforestation rate- including canopy reduction between 2018-2023;
    - Before and after images of the changes (forest cover and deforestation maps); and

- A report of the changes – comparing and contrasting community versus other types of management with simple and clear graphics to illustrate differences between forest management types

2) Determine the presumed reduced greenhouse gas emissions in the VLFRs compared to government and general land, again with simple graphics.

2. METHODOLOGY

To produce forest loss maps the study employed Google Earth Engine (GEE) and freely available JAXA/ALOS/PALSAR yearly mosaic collections for two chosen years (2018 and 2022) representing the desired analysis period.

Sentinel-2 data, with its high resolution and multiple spectral bands, was used to improve the accuracy of forest cover classification.

Training data, collected from high-resolution images such as Google Earth and Planet, was used to train a machine-learning classification model in GEE to distinguish between forests and non-forests.

The change detection and forest loss estimation were then determined based on the following steps.

1) Forest Thresholds were defined to identify forest pixels in both 2018 and 2023 PALSAR images based on backscatter coefficient values.
2) Change Ratio was calculated to identify areas where the radar backscatter has changed significantly, potentially indicating forest loss.
3) NDVI Threshold was calculated from Sentinel-2 data to exclude potential misclassification of wetlands as forest loss.
4) Area Calculations of forest loss and stable forest within the defined Area of Interest (AOI) were done in ArcGIS 10.8 software. The AOI included different VLFRs, TFS forest reserves, and open land in the selected clusters.

Carbon Emissions are estimated as a product of Activity Data and Emission Factors. In forest projects, this entail data on areas (activity data) and forest stocks (Emission Factors). The activity data generated from this study as summarized in Tabel 1 will be used.

Table 1 Emission Factors

District	Management type	Forest_stable (ha)	Forest_loss (ha)
Handeni	TFS	19,846.50	728.69
	VLFR	15,495.91	447.08
	OL	438,458.28	89,836.62
Kilindi	TFS	24,779.56	2,517.38
	VLFR	1,073.33	1.54
	Out	454,811.53	71,239.21
Ruangwa	TFS	1,448.44	684.14
	VLFR	20,528.66	125.08
	Out	126,322.89	58,180.66
Liwale	TFS	95,934.16	2,850.93
	VLFR	195,717.10	2,916.87
	Out	1,322,622.45	69,108.52
Tunduru	TFS	299,153.52	19,179.91
	VFR	19,406.69	320.72
	Out	1,523,059.35	196,862.07
Songea	TFS	20,785.64	716.80
	VFR	15,899.59	684.39
	Out	1,092,178.67	132,488.62

Nachingwea	TFS	-	-
	VFR	36,225.49	613.85
	Out	425,830.57	110,248.91

Emission factors were taken from the most recent synthesis of NAFORMA data (Mauya *et al.* 2019). Forest in the FORVAC supported areas are categorised as Lowland, Woodland closed or Woodland open. Emission Factors for these forest types are shown in Table 2.

Table 2. Emission factors for lowland, woodland closed and woodland open.

Forest type	AGC (t C ha−**1**)	) BGC (t C ha−**1**)	DWC (t C ha−**1**)	Total
Lowland	43.7	10.9	3.4	58.0
Woodland closed	32.4	13.9	1.6	47.8
Woodland open	20.0	8.1	1,1	29.9

In this study, for the purpose of estimating GHG emissions an average situation of woodland closed will be assumed and its emission factors used. Basically, when determining the Emission factors, five Carbon pools are considered. These are aboveground biomass (AGB), belowground biomass (BGB), dead wood, litter, and soil Carbon. Litter has been ignored in woodland forests since there is wildfires that occur annually (URT, 2017). Soil carbon stock for closed woodland from Mauya *et al*. 2022 will be considered. The estimated amount was 35.19 ± 8.35 tC ha^{-1}.

3. RESULTS AND KEY FINDINGS

3.1 Comparing Forest Loss in the VLFRs, TFS Forest Reserves, and Open Land

A) **Lindi Cluster**

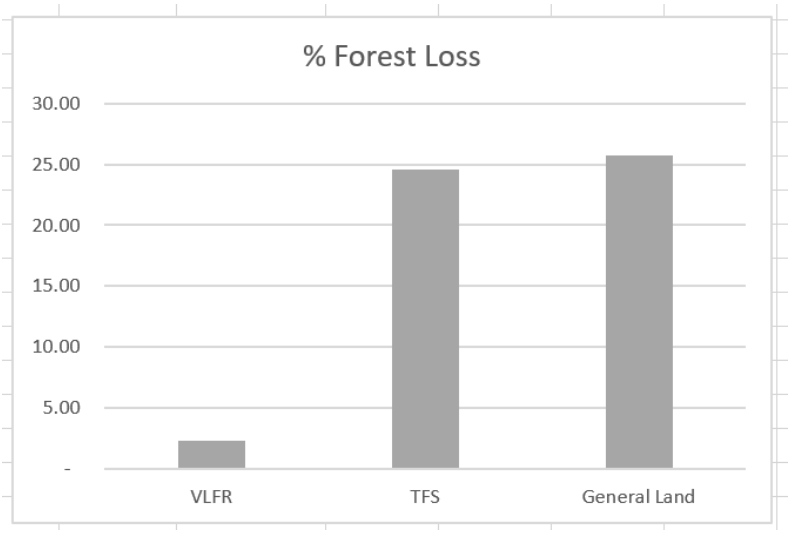


Table 3. Average forest loss in three forest management types in Lindi clusters

SNo.	Forest Management	Average Forest Loss (ha)
1	Forest Reserves under Village Land	96.2
2	Forest Reserves under TFS	883.8
3	Forest in General Land	79,179.4

Figure 1. shows the spatial distribution of forest cover and forest loss between 2018 and 2023 in the Lindi cluster: Liwale, Nachingwea, and Ruangwa districts.

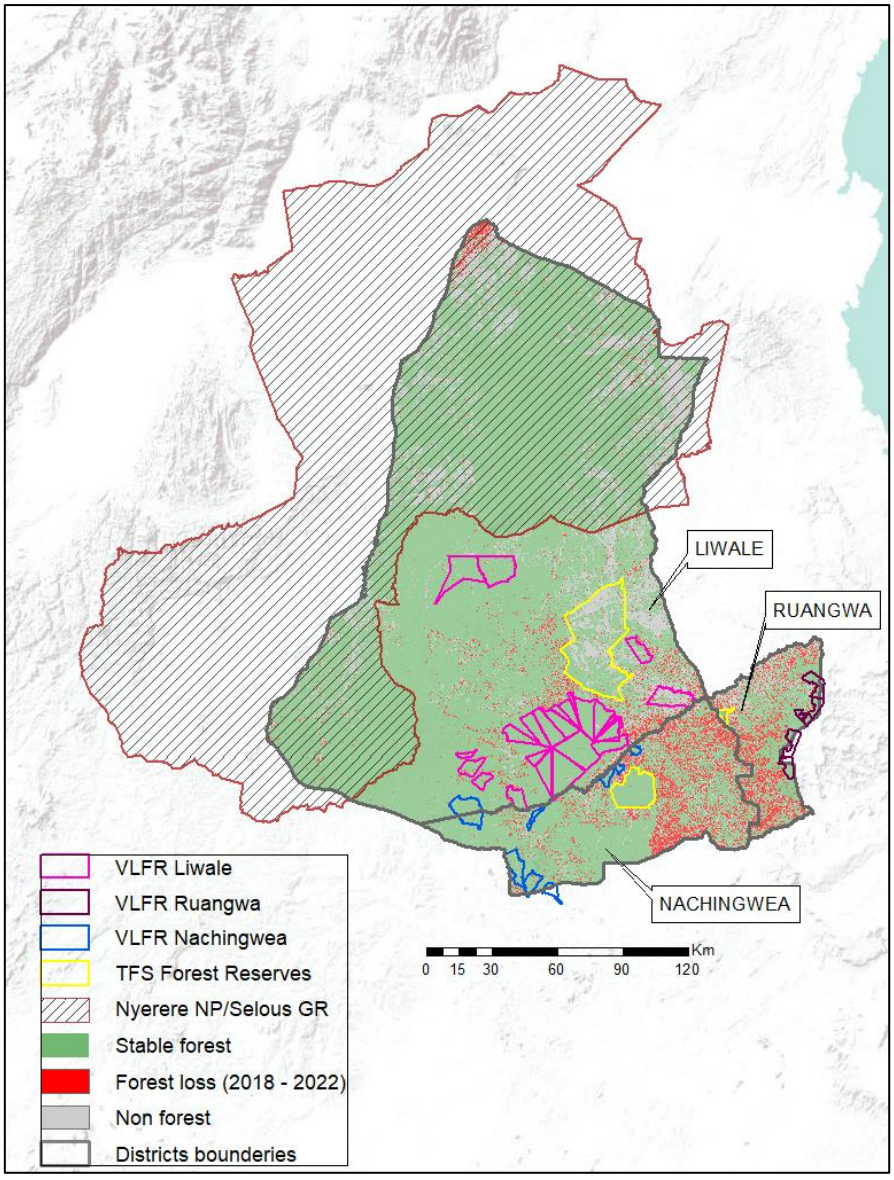


Figure *2*: Forest loss between 2018 and 2023 in Lindi cluster

Ruvuma Cluster

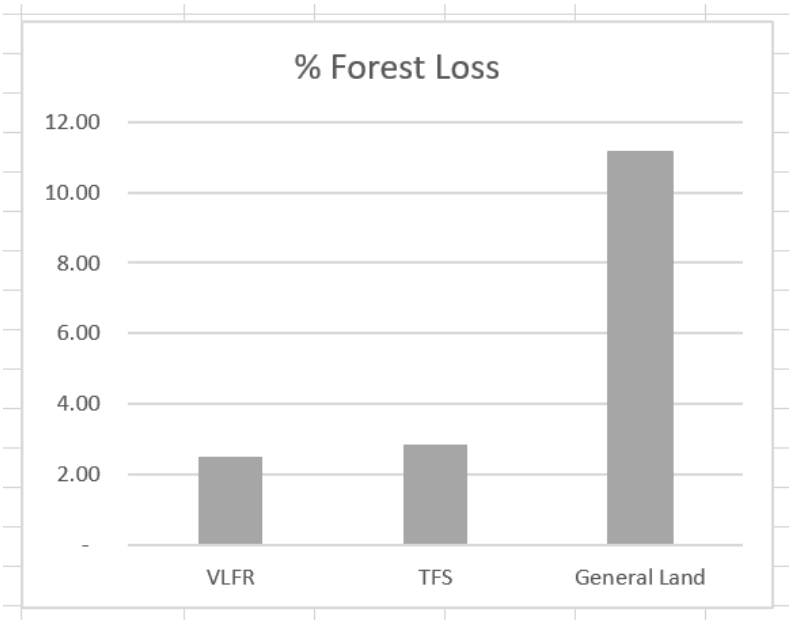


Table 4. Average forest loss in three forest management types in Ruvuma clusters

SNo.	Forest Management	Average Forest Loss (ha)
1	Forest Reserves under Village Land	117.2
2	Forest Reserves under TFS	864.0
3	Forest in General Land	110,736.2

Figure 3. shows the spatial distribution of forest cover and forest loss between 2018 and 2022 in the Ruvuma cluster: Songea, Namtumbo, and Tunduru districts. The cluster has a good proportion of VLFRs and TFS forest reserves, with 8 VLFRs and 13 TFS forest reserves.

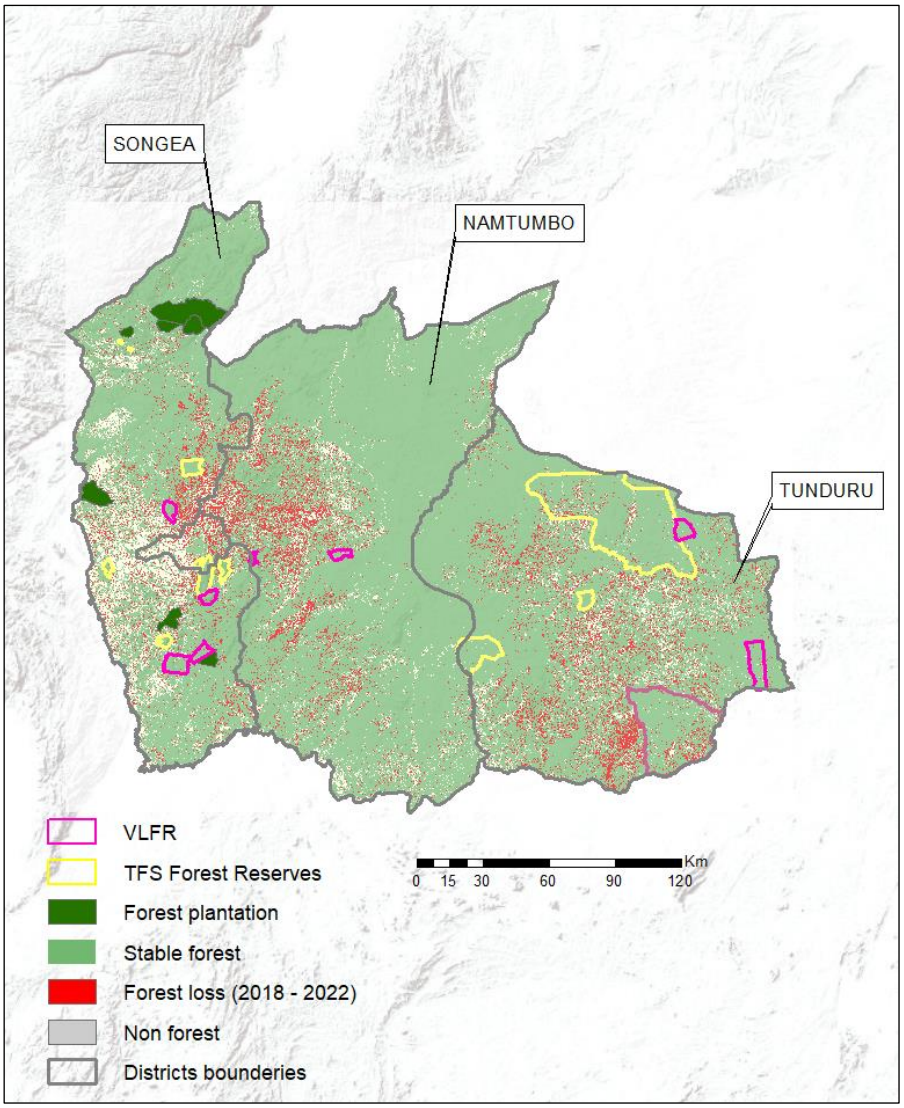


Figure 4: Forest loss between 2018 and 2022 in Ruvuma cluster

Tanga Cluster

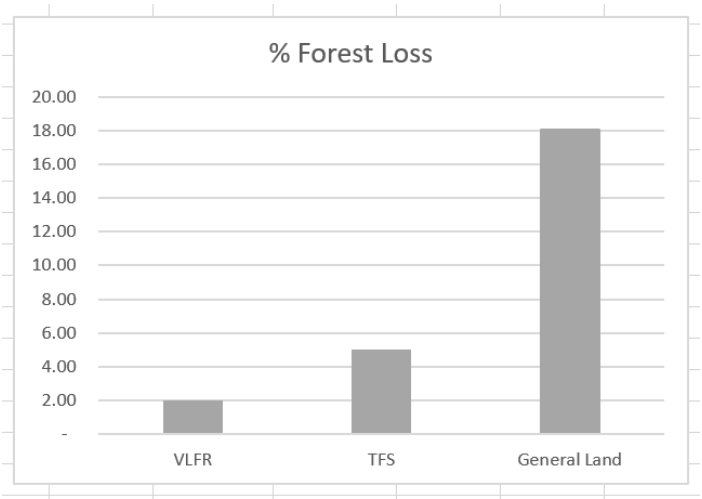


Table 5. Average forest loss in three forest management types in Tanga clusters

SNo.	Forest Management	Average Forest Loss (ha)
1	Forest Reserves under Village Land	112.2
2	Forest Reserves under TFS	190.9
3	Forest in General Land	80,537.9

Figure 5. shows the spatial distribution of forest cover and forest loss between 2018 and 2022 in the Tanga cluster: Handeni and Kilindi districts. The cluster is dominated by TFS forest reserves, with 17 TFS forest reserves and 4 VLFRs.

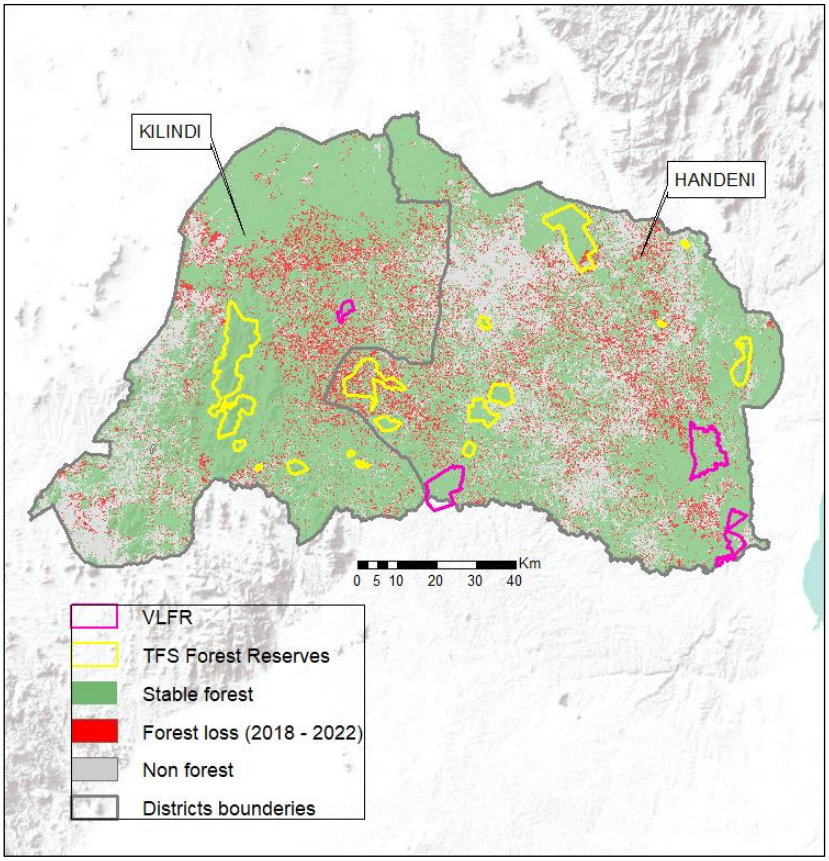


Figure 6: Forest loss between 2018 and 2022 in Tanga cluster

Analysis: What the findings reveal on comparison between deforestation rates.

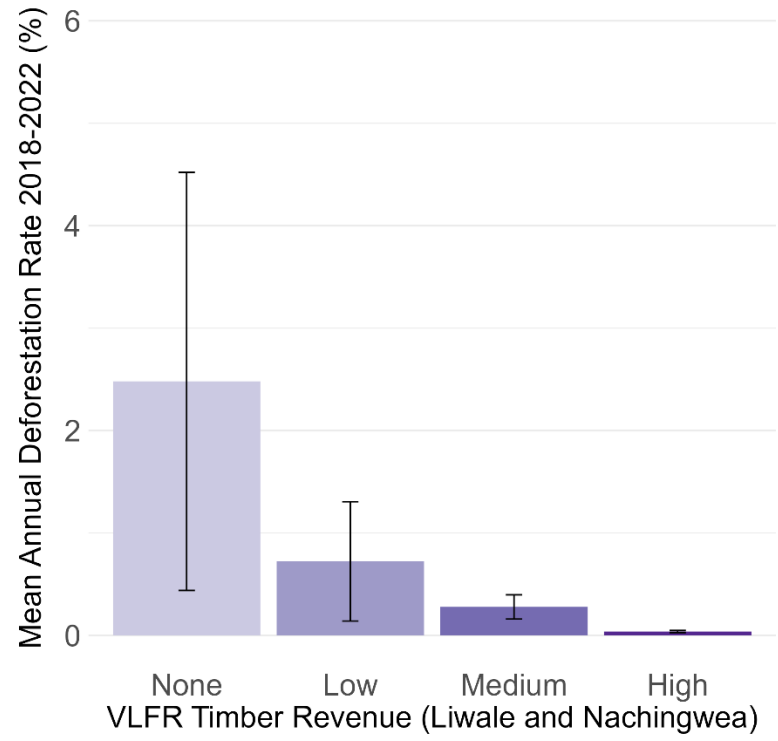
The overall deforestation rate in all VLFRS was around 2% during this period or around 0.5 % per year. The overall average deforestation rate in VLFR sites under FORVAC – were **in Lindi cluster** roughly 13 times lower than in open lands, and 12 times lower than TFS managed forest. **In Tanga cluster** the deforestation rates in VLFR sites under FORVAC were roughly 9 times lower than in open lands and 2.5 times lower than in TFS managed forest. In **Ruvuma Cluster** the VLFR sites had 5 times lower deforestation than open land and marginally lower deforestation that TFS forests. On average across all sites the deforestation rates were around 9 times lower in VLFRs compared to open land and around 7 times lower than TFS managed forests. Overall community managed VLFR forests perform better in terms of reduced deforestation than open land and TFS managed forests, so the recommendation would be to expand and strengthen VLFRs.

3.2 Comparing income from VLFRs versus deforestation rates.

Outside two districts in Lindi, Liwale and Nachingwea, the number of sites with harvesting timber and income were so few, it was not possible to have a significant sample of sites where deforestation rates could be compared between those with higher income and lower income within a similar locality. Therefore, the study looking at income versus deforestation rates focussed on districts where there was a statistically significant sample size of VLFR sites with different levels of income, Liwale and Nachingwea.

The income data was provided by MCDI/FORVAC field team/DFOs and the income bands were categorized as the following:

None
Low < 50 mil Tanzanian Shillings (TZS)
Medium = 50-200 mil TZS
High > 200 mil TZS



*Data from Mbilinyi and Zahabu, 2024

Figure 7: Comparing deforestation rates and income from the VLFRs combined for Liwale and Nachingwea.

Analysis: What Does the data mean?

The variation of deforestation rates within VLFRs was strongly correlated to the income generated from sustainable timber production from the VLFRs. The higher the income, the lower the deforestation, with the highest level of income sites recording extremely low rates of deforestation. This would seem to align with a premise of FORVAC that once the forest is under secure community tenure, increasing the income from the forest, increases the value of the forest and therefore incentivizes against forest clearance. Also it must be noted that with higher income there are more funds to cover patrolling and other protection activities. Overall this evidence suggests that monetary incentive is a significant motivator of community participation in forest conservation. With the correlation clear, the recommendation to lower deforestation within VLFR is to focus on maximizing revenue from sustainable use, including sustainable timber use.

3.3 Emission estimates

Using the Activity data from Table X and Emission Factors from Table 1, the emission estimates are shown in Table 2. As it was the case for deforestation Open Land within the villages has higher emissions well above 90% in all the districts followed by TFS forests with

exception of Liwale and Songea district where TFS forests are of similar condition with the VLFR under the FORVAC programme Table 4.

Table 3. Emission estimates between 2018 and 2022

		Forest_stable (ha)	**Forest_loss (ha)**	AGC (t C ha−**1**)	) BGC (t C ha−**1**)	DWC (t C ha−**1**)	Total	**%age**
Handeni	TFS	19,846.50	728.69	23,609.47	10,128.75	1,165.90	34,831.25	0.8
	VLFR	15,495.91	447.08	14,485.40	6,214.42	715.33	21,370.44	0.5
	OL	438,458.28	89,836.62	2,910,706.42	1,248,728.99	143,738.59	4,294,190.33	98.7
			91,012.39			**Total**	**4,350,392.02**	**100**
Kilindi	TFS	24,779.56	2,517.38	81,563.06	34,991.56	4,027.81	120,330.69	3.4
	VLFR	1,073.33	1.54	49.96	21.43	2.47	73.70	0.0
	OL	454,811.53	71,239.21	2,308,150.40	990,225.02	113,982.74	3,405,234.24	96.6
						Total	**3,525,638.63**	**100**
Ruangwa	TFS	1,448.44	684.14	22,166.04	9,509.51	1,094.62	32,701.75	1.2
	VLFR	20,528.66	125.08	4,052.52	1,738.58	200.12	5,978.71	0.2
	OL	126,322.89	58,180.66	1,885,053.45	808,711.20	93,089.06	2,781,035.65	98.6
						Total	**2,819,716.12**	**100**
Liwale	TFS	95,934.16	2,850.93	92,370.21	39,627.96	4,561.49	136,274.56	3.8
	VLFR	195,717.10	2,916.87	94,506.65	40,544.52	4,667.00	139,426.48	3.9
	OL	1,322,622.45	69,108.52	2,239,115.95	960,608.39	110,573.63	3,303,387.11	92.3
						Total	**3,579,088.15**	**100**
Tunduru	TFS	299,153.52	19,179.91	621,429.00	266,600.71	30,687.85	916,799.57	8.9
	VFR	19,406.69	320.72	10,391.23	4,457.97	513.15	15,330.27	0.1
	OL	1,523,059.35	196,862.07	6,378,330.98	2,736,382.74	314,979.31	9,410,006.82	91.0
						Total	**10,342,136.66**	**100**
Songea	TFS	20,785.64	716.80	23,224.20	9,963.47	1,146.87	34,262.86	0.5
	VFR	15,899.59	684.39	22,174.23	9,513.02	1,095.02	32,713.83	0.5
	OL	1,092,178.67	132,488.62	4,292,631.21	1,841,591.79	211,981.79	6,332,955.92	99.0
						Total	**6,399,932.62**	**100**
Nachingwea	TFS	-	-	-	-	-	-	0.0
	VFR	36,225.49	613.85	19,888.89	8,532.58	982.17	29,342.24	0.6
	OL	425,830.57	110,248.91	3,572,064.64	1,532,459.83	176,398.25	5,269,897.83	99.4
						Total	**5,299,240.07**	**100**

Where: OL = Open Land, VFR = Village Land Forest Reserve and TFS = Tanzania Forest Service Reserve

Analysis: What do the figures mean?

In line with the results highlighted under 3.1 and 3.2, carbon sequestration is closely linked to rates of deforestation, so lower deforestation rates mean higher carbon sequestration. Open Land within the villages has higher emissions well above 90% in all the districts followed by TFS forests, then the best performing forests in terms of carbon sequestration were VLFRs, particularly the VLFRs with the highest income from timber harvesting. Community managed VLFRs have lower deforestation rates than non VLFR forests (both TFS and open land), however the difference is most pronounced when there is a significant income from sustainable timber harvesting, then the avoided deforestation is at its highest in VLFRs. This points to a scenario for optimum carbon sequestration of secure community tenure of the forests under

VLFRs combined with maximizing revenues from sustainable timber harvesting. This results in the highest level of avoided forest loss, and therefore the highest level of carbon sequestration. As long as the timber harvesting is sustainable it will have minimal negative impact on the carbon capture ability of the forest, as felled trees will be replaced by regeneration that capture carbon as it grows, and substantive amounts of carbon extracted from the forest in the harvested timber will be locked up in timber products. Conversely from this correlation if timber harvesting in VLFRs is banned this will likely correlate with lowering the efficacy of VLFRs in terms of avoided deforestation and maximizing carbon sequestration. Based on the evidence carbon offsetting schemes operating in VLFRs should therefore support sustainable timber harvesting to maximize avoided forest loss and carbon sequestration capacity.

4. CONCLUSIONS

Based on the findings from this study, the following conclusions can be drawn:

1) Forest under community tenure and management – the VLFRs perform much better than open land and better than TFS controlled forest in terms of having lower deforestation rates,
2) There was a strong correlation between high income from sustainable timber harvesting and low deforestation in VLFRs, suggesting a causal link, with direct forest income incentivizing forest maintenance and protection.
3) Linked to points 1 and 2 VLFRs are performing better that particularly open land but also most TFS forest when it comes to carbon sequestration, however the highest level of avoided deforestation and therefore carbon sequestration occurs in VLFR forests with the highest level of income from sustainable timber harvesting.

In summary, devolving control of natural forests to community tenure and management under VLFRs is an effective strategy for forest conservation, and this approach is significantly more effective in reducing deforestation when coupled with support for sustainable timber harvesting generating a high income directly from the VLFR. The recommendation would be to scales up VLFRs but also to promote more income generation based on sustainable use and adding value from existing and new VLFRs. Although slightly counterintuitive, supporting sustainable use of the VLFRs, including timber use. clearly incentivizes forest maintenance against the biggest threat to the forests, forest clearance. The evidence strongly suggests that the 'use it or lose' it approach promoted by FORVAC in VLFRs has high efficacy and these findings show that economic use of the forest which is popular amongst communities, conservation and carbon capture objectives go hand in hand within VLFRs. Stopping or banning use in VLFRs especially of timber would be counterproductive to conservation and carbon capture objectives

5. References

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