# Linking REDD+ with SFM

## A Case Study from the Fiji Islands

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### Nakavu demonstration area

The Nakavu demonstration area is located on Fiji's main island Viti Levu close to the village of Nakavu. The demonstration area is identical with the former Natural Forest Management Pilot Project (NFMPP) area where in the early 1990s a SFM concept for communally owned indigenous rainforests in Fiji was developed (Fiji-German Forestry Project (Fiji Forestry Department/Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ, now GIZ)))[1].

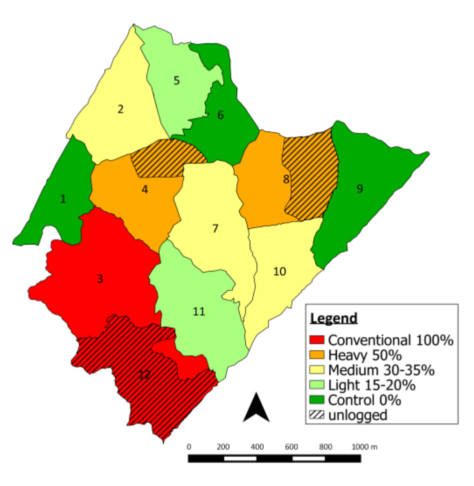


**Figure 1:** Subdivision and treatment of Nakavu demonstration area

The forest cover of the area is classified as mostly undisturbed indigenous dense mixed evergreen rainforest with an upper canopy at about 25 m height[2]. The area has a surface of around 309 ha and is subdivided into 12 compartments of 15-35 ha each (Fig. 1) where 5 different treatments (logging intensities) including unlogged control compartments[3] were applied about 20 years ago (Tab. 1). The first logging was carried out from 1992 to 1994. During the world exhibition in Hannover (2000) the SFM concept was introduced to an international public and in 2005 the FAO/APFC-Initiative "In Search of Excellence" distinguished it as special example for sustainable forest management[4].

**Table 1:** Treatments and corresponding removals of standing volume

| Logging Intensity | Removals (% of standing volume >=35 cm dbh) |
|---|---|
| unlogged | 0 |
| light (SFM) | 15-20 |
| medium (SFM) | 30-35 |
| heavy (SFM) | 50-60 |
| conventional | 80-90 |

### Objective

The objective of the actual demonstration activity in Nakavu is to develop technical parameters for the integration of SFM and REDD+. 20 years after different logging intensities are applied in different compartments the actual carbon stock shall be investigated. Based on the results the potential economic value regarding REDD+ compensation shall be compared with the potential wood increment and its commercial value after SFM treatment, conventional logging practice and full conservation.

### Methodology

To investigate the carbon storage 20 years after the first logging a carbon inventory was carried out. The plot design of the inventory is orientated to the Pacific MAR design[5]. 15 different carbon (sub-)pools were recorded (Tab. 2).

**Table 2:** Defined carbon pools and further subdivision of the carbon inventory

| Carbon Pool | Sub-Pool | Sub-Sub-Pool | Collected Data |
|---|---|---|---|
| Above-ground living biomass (AGL) | Trees and other woody plants (shrubs, climbers, bamboo, tree ferns) | dbh ≥ 35 cm | species, dbh |
| | | dbh 10-34 cm | species, dbh |
| | | dbh 0-9 cm (rounded) | dbh |
| | | saplings <1.3 m height | number, weight |
| | Non-wood vegetation (grass, ferns, herbs etc.) | | weight |
| Dead wood | Standing | dbh ≥ 35 cm | dbh |
| | | dbh 10-34 cm | dbh |
| | | dbh 0-9 cm (rounded) | dbh |
| | | saplings <1.3 m height | weight |
| | | Stumps | height, top diameter |
| | Lying | diameter ≥ 35 cm | diameter |
| | | diameter 10-34 cm | diameter |
| | | diameter 1-9 cm | weight |
| Litter | Fine woody debris, dead seedlings, leaves, humus etc. | | weight |
| Below-ground biomass (BGB) | not measured; estimation acc. to: shoot to root ration: 1 : 0.24 | | |
| Soil carbon | not measured | | |

While the big trees (≥ 35cm dbh) were recorded in a full enumeration all other pools were measured in a systematic sampling inventory design (Fig. 2). For all trees higher than 1.3 m the dbh and for all trees ≥ 10 cm dbh also the species name were recorded to use species-specific wood densities[6] for further calculation. While the lying deadwood < 10 cm diameter is included in the weight samples of the smaller plot the lying deadwood ≥ 10 cm is measured along the inventory line (line intersect method[7]). To transfer the measured data into volume, biomass and carbon own diameter to height models and Chave's formula[8] are used.

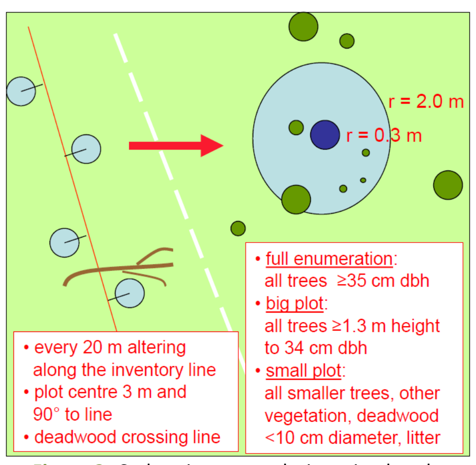


**Figure 2:** Carbon inventory design; circular plots and line intersect method

### Results

*Carbon Stock*

20 years after the first logging it turns out that in almost all treatments (exception: conventional logging) the biggest share of carbon is found in the trees ≥ 35 cm dbh (Fig. 4). The shares of all other carbon pools are very similar between the treatments. Due to the linear shoot to root ratio the share of below ground biomass is mainly influenced by the share of the big trees.

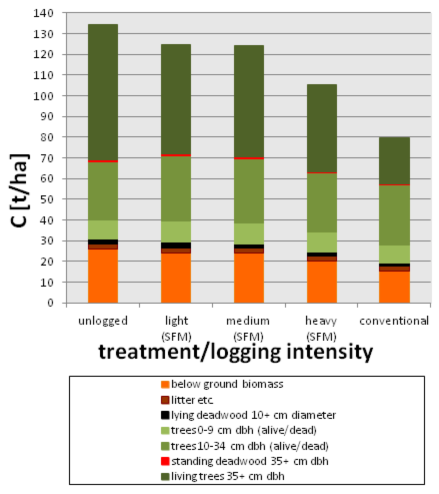


**Figure 3:** Carbon under different treatments 20 years after logging

Summing up the different carbon pools it gets obvious that most carbon (134.5 t/ha) is stored in the unlogged compartments. Light and medium treatments have both approx. 7 % less carbon storage (124.8 and 124.5 t/ha) and heavy treatment has approx. 22 % less (105.3 t/ha). Lowest carbon content is found in the conventionally logged compartments, bearing almost 41 % less carbon (79.5 t/ha) than the unlogged areas.

*Standardisation*

Due to the fact that 20 years ago there were differences between the compartments regarding standing volume, species composition etc. it is necessary to standardize the results to immediately comparable values. The standardisation was carried out in 3 steps:

1. Only the SFM treatment with the best performance shall be compared to the unlogged and the conventional logging treatment.
2. The carbon pools differ mainly regarding the trees ≥ 35 cm dbh and only slightly in other carbon pools. Therefore, the unlogged compartments are selected as a starting value and reduce by the target removal which is for medium logging 30 % and for conventional logging 80 % of the standing volume ≥ 35 cm dbh.
3. To the such reduced stocking the expected average increment[9] has to be added up to the mid of the felling cycle (10 years) which shall represent the average situation between two sustainability orientated harvesting operations in the same stand.

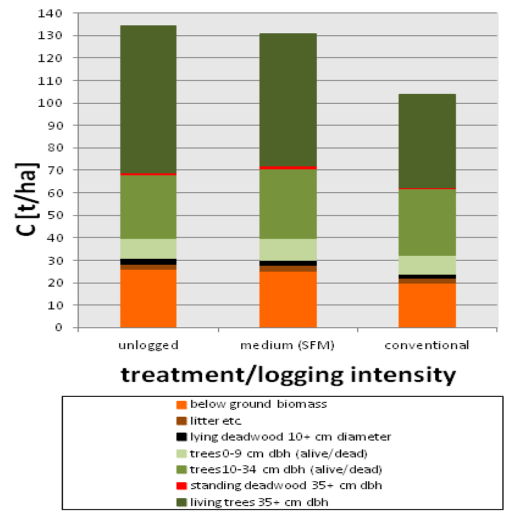


**Figure 4:** **Carbon under different treatments; simulation results for mid of felling cycle**

Looking at the standardized carbon pools it can be seen that medium logging has moved up by about 5 % to 131.1 t C/ha (Fig. 4). Conventional logging moved up by about 30 % to 103.7 t C/ha.

*Simulation of economic and climate-related impacts*

Looking at the financial aspect of combining SFM with REED+ various simulations are performed. The first simulation show how landowner income from REDD+ payments and/or logging is effected when applying the different treatments (it is assumed that the net REDD+payments go directly to the landowners). The second simulation has a macro-economic perspective assuming that the market price for logs is its real value. This includes that also other stakeholders (loggers, sawmillers, hauliers etc.) profit directly from forest harvesting. The third simulation is climate-related by estimating the net $CO_2$ emissions under the compared treatments.

The following input parameters are used for calculations:

- Installment costs for a REDD+ regime are left out at that stage; only net values for REDD+ payments are used varying from 1 to 10 US$/t CO2/year;
- average royalty rates ranging from 10 to 100 F$/m³; the actual average rate is 30 F$/m³ [10];
- as landowner income from jobs in logging and SFM management the respective values from the first logging operation was extrapolated by the interest rates over the last 20 years[11];
- increment figures based on the recent investigations;
- average log price at sawmill entrance ranging from 50 to 500 F$/m³ ; the actual average price is 200 F$/m³ [10].

## References

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*Simulation results*

Simulations show that the difference in $CO_2$ content (values from Fig. 4 times 3.67 (conversion factor C:$CO_2$)) between the unlogged and the SFM treated compartments after standardization is 12 t/ha or 2.5 % while the difference to the conventional treatment is 113 t/ha or approx. 23 %.

Using net REDD+ payments varying from 1 to 10 US$/t $CO_2$ the total **REDD+ "value"** for SFM is in any case smaller than in unlogged forests (Fig. 5).

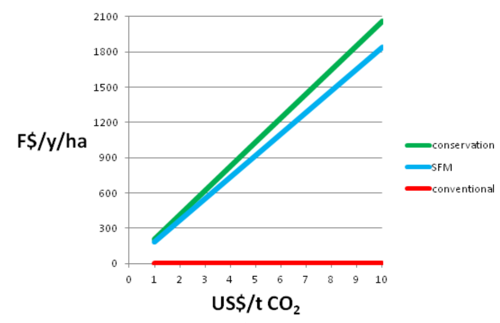


**Figure 5:** Optional REDD+ payments

Under the determined annual increment and varying average royalty rates the **forest owner** will have more income through sole REDD+ payments after conservation than from a combination of REDD+ and SFM only if the net REDD+ payments exceed a certain rate per t $CO_2$ (Fig. 6). At the actual average royalty rates the critical net payments is 2.81 US$ (approx. 5 F$) per year and t $CO_2$. If the net payment drops under this figure the SFM-REDD+ option seems to be superior.

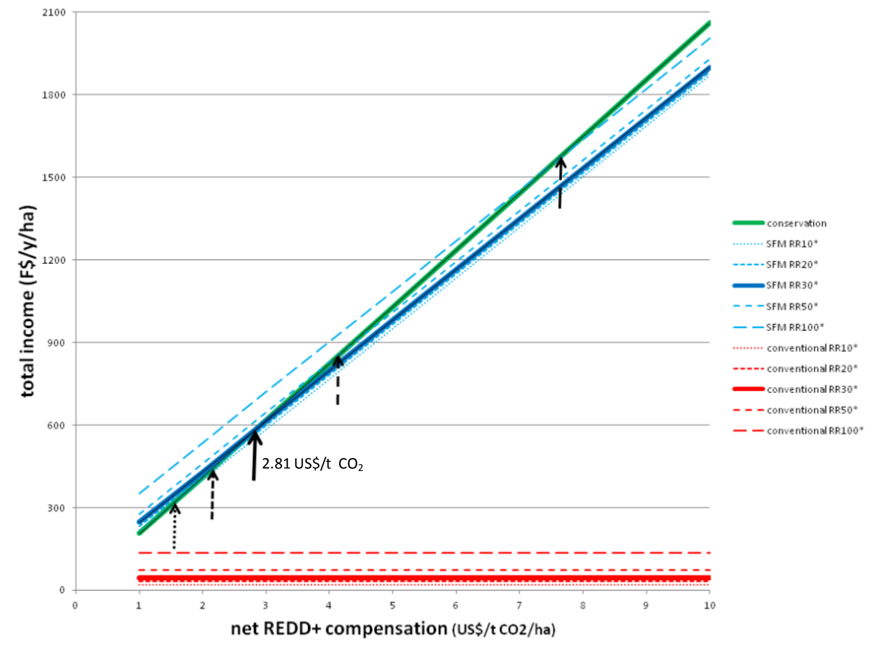


**Figure 6:** Landowner income depending on average royalty rate (* 10 to 100 F$/m³) and REDD+ $CO_2$ compensation rate

Looking from a **macro-economic perspective** and varying average log prices (50-500 F$/m³) in most cases significantly higher value are generated from the SFM-REDD+ option than by sole REDD+ compensation after forest conservation (Fig. 7). Only if the actual roundwood prices (200F$/m³) would drop by more than 25 % the pure REDD+ option could be superior.

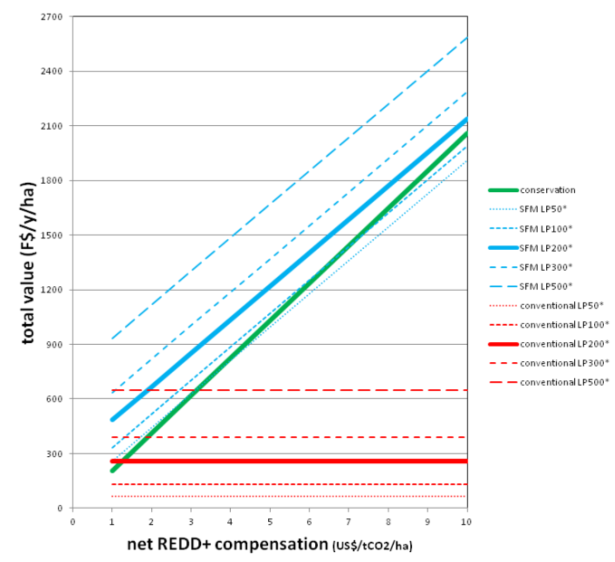


**Figure 7:** Macro-economic value depending on average log price (*50 to 500 F$/m³) and $CO_2$ compensation rate

Under a **climate-related perspective** the SFM-REDD+ option avoids any net emission of $CO_2$ if 20 years after logging at least 1/3rd of the removed wood is still existing or was used in the meantime to replace fossil energy (Fig. 8). If the share would increase (e.g. more durable good, more energetic use of waste wood) a net sink of carbon could be the consequence after implementing SFM.

Under all of the investigated perspectives the conventional way of logging shows the poorest performance in comparison to SFM or forest conservation in combination with REDD+ payments.

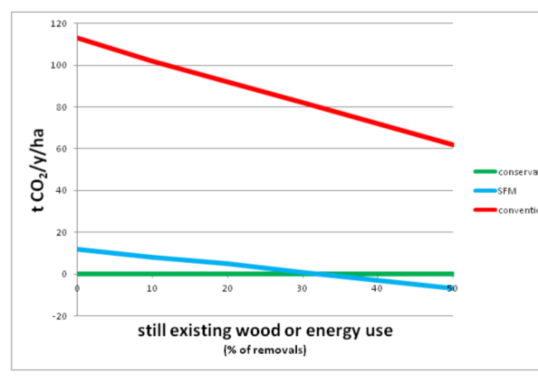


**Figure 8:** $CO_2$ net emission (t/ha)

### Conclusions

Analysis of the carbon-related data in the Nakavu demonstration area gives a first insight into the carbon stock 20 years after applying different logging and management regimes in tropical rainforests in Fiji. Even if the analyses are not fully finished yet the results provide some good orientation on the relation of the carbon balance of SFM-orientated treatments and conventional logging in comparison to unlogged forests. It seems that under certain but realistic frame conditions a combination of SFM and REDD+ leads to more advantages for the involved stakeholders than conventional logging or total forest conservation with REDD+ compensation.