# Fiji National
# Forest Carbon Stock Assessment
## *Version 1*

Compiled by Carbon Partnership Ltd. for
SPC/GIZ Regional Programme -Coping with Climate Change in the Pacific Island Region and
the Fiji Forestry Department

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# Table of Contents


**EXECUTIVE SUMMARY .......... 4**
National Forest Carbon Stock Assessment .......... 4
Improving The Inventory .......... 6

**NATIONAL FOREST CARBON STOCK ESTIMATE .......... 9**
Background .......... 9
Methods .......... 10
Indigenous Forests .......... 10
Mahogany And Pine Plantations .......... 11
Results and Discussion .......... 16
Indigenous forests .......... 16
Mahogany And Pine Plantations .......... 16
Interpretation .......... 17
Improving the Inventory .......... 18
Data Ownership .......... 21
References .......... 22
Appendix 1 – Wood Density For Carbon Stocks Estimates in Indigenous Forests .......... 24

# Executive Summary

The Fiji National REDD+ Strategy Workshop was held during 25-26 November 2010 in Suva to advance the Fiji REDD+ Programme by:

- Providing an update on international policy, financing, and technical developments in REDD+
- Undertaking multi-stakeholder consultations for the preparation of the Fiji REDD+ Strategy.
- Advancing the national forest carbon stock assessment.

Immediately following this workshop further work was undertaken to advance the calculation of the national forest carbon stock assessment, and the preparation of a plan to improve forest carbon monitoring.

## NATIONAL FOREST CARBON STOCK ASSESSMENT

A detailed analysis was undertaken in collaboration with technical staff from the Department of Forestry to advance the national forest carbon stock assessment based on existing data sets. It was hoped that this process would be completed to a level able to stand up to international peer review. The outcome of this process was to get close to this goal but not to fulfil it completely due to anomalies in the existing data sets that prevented accurate closure for this first assessment. Recommendations were made for improving the data for this first carbon stock assessment, as well as for the design of the national forest carbon inventory to run as an element of the national forest inventory process.

Results are preliminary for indigenous forest and plantation forest data sets and indicate some anomalies that warrant further data improvement and analysis. In particular, tree height data in the survey datasets do not appear to be accurate. The problem will need to be clarified by means of targeted research if we are to obtain a reliable relationship between stem diameter and tree height. This is important due to the role that tree-height plays in the calculation of above ground live biomass and consequently carbon content.

Tables 1, 2 and 3 below provide the first iteration of the national forest carbon stock estimate for Fiji. Values are expressed as mean carbon stocks per hectare.

*Table 1. Carbon stock estimates (AGL and BG pools only) for plots in the National Forest Inventory (1991) and Permanent Sample Plots established in 2010.*

| | National Forest Inventory 1991 | | Permanent Sample Plots 2010 | |
|---|---|---|---|---|
| | tC/ha | $tCO_2e/ha$[1] | tC/ha | $tCO_2e/ha$ |
| Mean | 47.6 | 174.5 | 47.9 | 175.8 |
| SEM | 1.4 | 5.0 | 6.7 | 24.5 |
| CI (95%) | 2.7 | 9.9 | 13.6 | 49.9 |
| Range | 2.2 – 266.4 | 8.1 – 976.9 | 2.1 – 176 | 7.7 – 645.4 |
| No. of Plots | 529 | 529 | 33 | 33 |

*SEM = Standard Error of the Mean; CI = Confidence Interval*

*Table 2. Changes in carbon stock estimates (AGL + BG only) with stand age in Fijian mahogany and pine plantations.*

| Stand age years | Mahogany tC/ha | Mahogany $tCO_2e/ha$ | Pine tC/ha | Pine $tCO_2e/ha$ | Stand age years | Mahogany tC/ha | Mahogany $tCO_2e/ha$ | Pine tC/ha | Pine $tCO_2e/ha$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.4 | 1.5 | 9.9 | 36.3 | 26 | 126.0 | 461.9 | 282.7 | 1036.8 |
| 2 | 0.8 | 2.8 | 16.9 | 61.8 | 27 | 132.3 | 485.0 | 284.9 | 1044.7 |
| 3 | 1.3 | 4.7 | 26.4 | 96.8 | 28 | 138.2 | 506.8 | 286.7 | 1051.4 |
| 4 | 2.1 | 7.6 | 38.5 | 141.3 | 29 | 143.8 | 527.4 | 288.3 | 1057.1 |
| 5 | 3.2 | 11.9 | 53.0 | 194.4 | 30 | 149.1 | 546.7 | 289.6 | 1061.9 |
| 6 | 4.8 | 17.6 | 69.4 | 254.5 | 31 | 154.0 | 564.8 | 290.7 | 1066.0 |
| 7 | 6.9 | 25.3 | 87.1 | 319.4 | 32 | 158.6 | 581.7 | 291.6 | 1069.4 |
| 8 | 9.5 | 35.0 | 105.5 | 386.8 | 33 | 162.9 | 597.5 | 292.4 | 1072.4 |
| 9 | 12.8 | 47.0 | 124.0 | 454.7 | 34 | 166.9 | 612.1 | 293.1 | 1074.8 |
| 10 | 16.7 | 61.3 | 142.1 | 521.2 | 35 | 170.6 | 625.6 | 293.7 | 1076.9 |
| 11 | 21.3 | 78.0 | 159.5 | 584.8 | 36 | 174.0 | 638.1 | 294.2 | 1078.7 |
| 12 | 26.4 | 97.0 | 175.7 | 644.4 | 37 | 177.1 | 649.6 | 294.6 | 1080.2 |
| 13 | 32.2 | 118.1 | 190.7 | 699.4 | 38 | 180.0 | 660.2 | 294.9 | 1081.5 |
| 14 | 38.5 | 141.2 | 204.4 | 749.5 | 39 | 182.7 | 669.9 | 295.2 | 1082.5 |
| 15 | 45.2 | 165.9 | 216.7 | 794.5 | 40 | 185.1 | 678.9 | 295.5 | 1083.4 |
| 16 | 52.4 | 192.0 | 227.6 | 834.6 | 41 | 187.4 | 687.1 | 295.7 | 1084.2 |
| 17 | 59.8 | 219.1 | 237.2 | 869.9 | 42 | 189.4 | 694.6 | 295.8 | 1084.8 |
| 18 | 67.3 | 247.0 | 245.7 | 900.9 | 43 | 191.3 | 701.4 | 296.0 | 1085.4 |
| 19 | 75.0 | 275.2 | 253.0 | 927.9 | 44 | 193.0 | 707.7 | 296.1 | 1085.8 |
| 20 | 82.8 | 303.5 | 259.4 | 951.3 | 45 | 194.5 | 713.4 | 296.2 | 1086.2 |
| 21 | 90.4 | 331.6 | 264.9 | 971.6 | 46 | 196.0 | 718.6 | 296.3 | 1086.5 |
| 22 | 98.0 | 359.3 | 269.7 | 988.9 | 47 | 197.3 | 723.3 | 296.4 | 1086.8 |
| 23 | 105.4 | 386.3 | 273.8 | 1003.9 | 48 | 198.4 | 727.7 | 296.4 | 1087.0 |
| 24 | 112.5 | 412.5 | 277.2 | 1016.6 | 49 | 199.5 | 731.6 | 296.5 | 1087.2 |
| 25 | 119.4 | 437.8 | 280.2 | 1027.5 | 50 | 200.5 | 735.2 | 296.5 | 1087.4 |

[1] One tonne carbon = 3.667 tonnes $CO_2$ equivalent.

The mean carbon stock for indigenous forests amounts to 175 $tCO_2e$/ha. This figure is rather lower than would be expected and would need clarification by means of further refinement of forest inventory methods to enhance the accuracy of the forest carbon stock data set.

The carbon stock calculations for plantations are also based on data that present some anomalies that need to be clarified in order to increase confidence in carbon stock estimates. For example, the mean carbon stock per hectare for the pine forest resource is higher than expected and likely to be an overestimate.

In spite of these questions concerning data quality we conducted an estimate the national forest carbon stock based on these existing data. This is depicted in Table 3.

*Table 3. National Forest Carbon Stock Assessment*

| National Forest Carbon Stock Assessment | | | | | |
|---|---|---|---|---|---|
| | Total Land | Total Forest | Indigenous Forest | Plantation pine | Plantation mahogany |
| Area (1,000 ha) | 1,827 | 985 | 899 | 45 | 41 |
| $tCO_2e$/ha | | 195 | 175 | 613 | 350 |
| 1,000 $tCO_2e$ | | 192,270 | 157,325 | 27,590 | 14,355 |

The total carbon stock estimate for the national indigenous forest estate (on the basis of the current data set) is 157,325,000 $tCO_2e$.

The total carbon stock estimate for the national pine forest estate (on the basis of the current data set) is 27,590,000 $tCO_2e$.

The total carbon stock estimate for the national mahogany forest estate (on the basis of the current data set) is 14,355,000 $tCO_2e$.

The total carbon stock estimate for the national forest estate (on the basis of the current data set) is 192,270,000 $tCO_2e$.

## IMPROVING THE INVENTORY

In order to improve data quality for subsequent iterations of the national forest carbon stock estimate, a number of improvements are needed in data gathering. Accordingly, we make the following recommendations:

1. That the measurement of tree height is discontinued on carbon inventory plots, and that tree height estimates are obtained using height:diameter relationships[2]. These should be

[2] The current practice is to measure the height of some stems on each plot, and use these data to estimate the height of the remaining stems.

species-specific for those species that make a significant contribution to the national carbon stock. For other species, height:diameter relationships based on the form of the tree crown would seem appropriate.

2. That the systematic sampling of wood density in Fijian tree species, targeting (but not limited to) species making a major contribution to the national carbon stock. This should include the development of:
    a. A protocol for collecting wood samples and determining their density
    b. Laboratory facilities for determining the density of wood samples
    c. A sample collection programme
    d. A wood density database
    e. Publication of a comprehensive set of wood density measurements for Fijian tree species.

3. That dead wood is routinely measured on the permanent sample plots that are used for carbon stock inventory in indigenous forests. This will require:
    a. A protocol for the measurement of dead wood on indigenous PSP plots, and the analysis of the measurements.
    b. A study of the rate at which carbon is lost from dead wood under the climatic conditions found in indigenous forests. This is required to establish what are termed decay rate modifiers for logs at different stages of decay.

4. That changes in dead wood with stand age are determined for the pine and mahogany plantations. This will require:
    a. A protocol for the measurement of dead wood on PSP plots in pine and mahogany plantations, and the analysis of the measurements.
    b. Development of carbon stock:stand age relationships for dead wood.
    c. A study of the rate at which carbon is lost from dead wood under the climatic conditions found in pine and mahogany plantations.

5. That country-specific data on carbon stocks in the litter pool are obtained for indigenous forests, and for pine and mahogany plantations.

6. That consideration be given to the development of a soil carbon model of the type used by New Zealand for UNFCCC and Kyoto Protocol reporting, to provide national estimates of carbon stock changes in Fiji soils. This would require:
    a. Extraction and collation of existing data that would be required to model carbon stock estimates. Many of these datasets were collected by New Zealand soil scientists during the 1960s and 1970s, and exist only in hardcopy form within New Zealand and Pacific institutions.
    b. That these data are assessed for their suitability for modelling soil carbon stocks.

7. That in the event that suitable data are available, a ‘New Zealand-style’ soil carbon model (Baisden et al 2006) is developed for Fiji. This model should not be limited to forests but extend across all land use classes.

8. That once all the plots on Viti Levu have been established, the PSP dataset is analysed to determine the number of plots that would be required to detect measurable changes in carbon stocks.

9. That consideration be given to ways in which permanent plot networks might be established in plantations other than pine and mahogany (e.g. teak) and mangrove forest types.

10. The development of a databank that incorporates all elements (data collection and analysis protocols, datasets etc) required for national carbon stock estimation in Fiji forests.

11. That once the components of the Fiji carbon inventory programme have been agreed, the programme should be formally documented in a published report, and externally peer reviewed.

# National Forest Carbon Stock Estimate

By Ian Payton and Sean Weaver, with assistance from Luke Delai, Paula Kamikamica, Samu Lagataki, Anjeshni Narayan, Timoci Sukulu, Ilimo Tulevu and Viliame Tupua.

In December 2010 the SPC/GIZ Pacific-German Regional Program on Adaptation to Climate Change in the Pacific Island Region (ACCPIR) undertook a national forest carbon stock estimation to enable Fiji to proceed to the IPCC Tier 2 in national forest carbon monitoring. This included capacity building of local counterparts as part of this process. The technical carbon inventory component required close collaboration with the Fiji Forestry Department and other relevant institutions. This Fiji Forest Carbon Inventory Report documents the outcome of national forest carbon stock estimation and presents recommendations on how to improve the national forest carbon inventory.

## BACKGROUND

Carbon stock estimation requires an understanding of the size of the area under consideration, and the average carbon stock per hectare for that area. The former is normally determined from maps, aerial photos or satellite images. The latter is typically obtained from plot-based measurements, although in some instances models may also be an option.

Inventories to determine whether forestry sector activities are GHG sources or sinks are required to take account of carbon stocks in five broad pools.

- Above-ground live – trees and shrubs
- Below ground – roots
- Dead wood – logs and fallen branches
- Litter – fine woody debris, dead leaves and humus
- Soil organic matter – carbon that has been incorporated into the mineral soil.

Carbon stocks are estimated from field measurements as follows:

- Above-ground live – diameter and height measurements are converted to biomass (and therefore carbon[3]) stocks using allometric relationships which may incorporate a species-specific density term. Shrub biomass is typically estimated from height and cover measurements. Density estimators derived from biomass harvests are used to convert the resulting volume to a mass.
- Below ground – estimated as a percentage of the above-ground live pool using values obtained from experimental studies.
- Dead wood – length and diameter measurements are used to obtain a volume which is converted to mass using a species-specific density factor and a decay-stage modifier.

[3] Woody biomass is c. 50% carbon.

- Litter – typically sampled using quadrat harvests.
- Soil organic matter – determined from a known volume of soil. Note that unlike woody biomass, soil carbon is not a set percentage of the volume or mass of the soil.

Datasets held by the Fiji Forestry Department, Fiji Hardwood Corporation Limited, and Fiji Pine Ltd enabled average per hectare carbon stock estimates to be calculated for the above-ground live (trees only) and below ground pools in indigenous forests and mahogany and pine plantations.

# METHODS

## Indigenous Forests

National inventories of indigenous forests in Fiji were undertaken in 1969, 1991 and 2006[4]. Data from the latter two inventories are available in electronic form. Both the 1991 and 2006 surveys used non-relocatable plots at randomly chosen locations to obtain a representative sample of forest communities on the six largest islands (Viti Levu, Vanua Levu, Taveuni, Kadavu, Gau, Koro, and Ovalau), which together constitute 95% of the land area of Fiji. Details of the inventory methods are available in the forestry field manuals for these surveys (Wakolo & Setje-Eilers 1991, Anon 2005). Some data are also available from the Permanent Sample Plot (PSP) network that is currently being established.

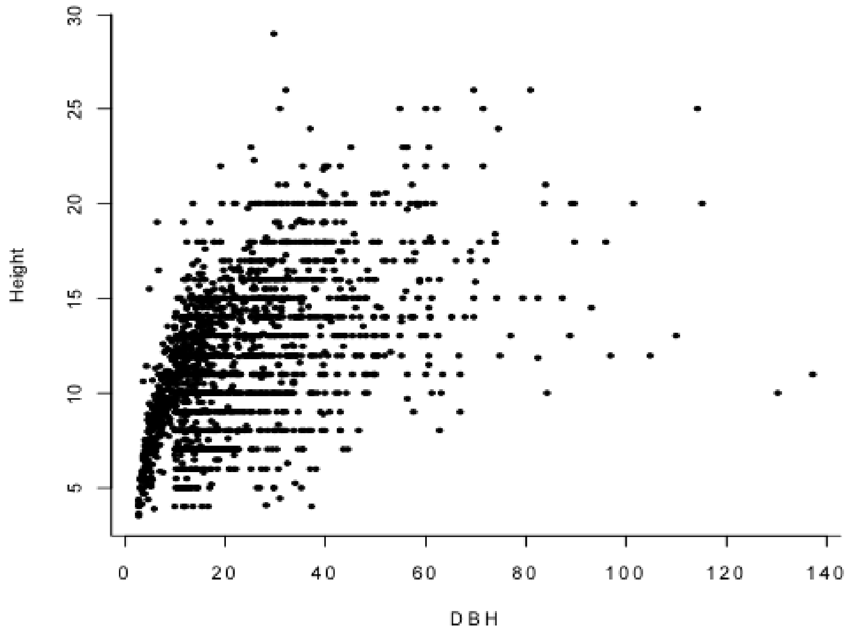
Stem diameter data are available for both the 1991 and 2006 inventories. Total height was measured on a selection of trees at each plot in 1991, but this measurement was replaced by merchantable height in 2006. Tree height measurements, which in 1991 were taken using a Bitterlich relascope, proved unreliable. Limited height data were however available from the PSP dataset and from an experimental plot.

Wood density data are available for a range of commercially harvested timber species. These were grouped into four broad density classes (very light, light, medium and heavy). Local expert knowledge was used to allocate all tree species in the indigenous forest datasets to one of these classes. Where wood density was not available, tree species were allocated the average value for their density class. Wood densities ranged from 310 (Waciwaci, *Sterculia vitiensis*) to 850 (Caukuro, *Gymnostoma vitiense*) km/$m^3$. Density class averages were 340, 430, 535, and 735 kg/$m^3$ (Appendix 1).

Tree height (m) and diameter (cm) data from the PSP dataset (Figure 1) were used to derive a generalised height:diameter equation for indigenous forest species (Eq.1), and this was used to estimate the height of all stems for which height data were not available. The height:diameter equation, which includes species of widely differing forms, accounts for only 35% of the variability in the dataset. However, where sufficient data were available for individual species (e.g. Kaudamu, *Myristica castaneifolia*) height:diameter relationships accounted for upwards of 75% of the variability in the dataset.

[4] Plot measurements carried out between 2005 and 2007.

*Figure 1. Relationship between stem diameter (cm) and height (m) for tree species in Fiji's indigenous forests.*




$$\text{Height}_{\text{(Indigenous forest species)}} = 1.52 \times \text{DBH}^{0.31} \qquad \text{(Eq. 1)}$$

Above ground live (AGL) biomass was estimated for all stems using the allometric equation recommended by Chave et al. (2005) for moist tropical forests (Eq. 2), where D is the stem diameter at breast height (cm), H is the top height of the tree (m), and ρ is the density of the wood ($g/cm^3$).

$$AGL_{(est)} = \exp(-2.977 + \ln(\rho D^2 H)) = 0.0509 \times \rho D^2 H \qquad \text{(Eq. 2)}$$

Below ground (BG) biomass was estimated using the shoot:root ratio (1:0.24) recommended by Cairns et al. (1997) for tropical forests. Biomass (AGL + BG) estimates for each stem were summed by plot, expressed as tC/ha, and converted to a C-stock using a conversion factor of 0.50. Slope correction, which adjusts the on-ground plot area to a horizontal basis, was not required because plots had been established on a slope-corrected basis.

The carbon stock estimate is obtained by multiplying the area of indigenous forest (ha) by the average carbon stock (tC/ha) for that area.

## Mahogany And Pine Plantations

Equivalent datasets are not available for the pine (*Pinus caribaea* var. *hondurensis*) and mahogany (*Swietenia macrophylla*) plantations. For both species however PSP's have been established to assess growth rates and timber volumes[5]. Diameter and height data from these plots enable carbon

[5] We have not been able to locate the field data collection manuals used to establish and remeasure these plots, and have thus had to rely on the electronic record for the details of the inventory methods.

stocks to be estimated for the AGL and BG pools. When combined with stand age data, the resulting carbon stock:stand age curves can be used to estimate the average carbon stock (tC/ha) for each age class of trees. The carbon stock estimate for the total plantation estate is obtained by multiplying the area of each age class (ha) by the average carbon stock (tC/ha) for that area.

Diameter measurements are available for all stems in both the pine and mahogany datasets, and total height was measured on a selection of stems from each plot. Wood density data are available for both species.

Tree height (m) and stem diameter (cm) data for both mahogany (Figure 2) and pine (Figure 3), were used to derive height:diameter equations (Eqs. 3 & 4) for both species, and these equations were then used to estimate the height of all stems for which measured height data were not available.

$$Height_{(Mahogany)} = 2.58 \times DBH^{0.62} \quad \text{(Eq. 3)}$$

$$Height_{(Pine)} = 0.59 + 0.76 \times DBH \quad \text{(Eq. 4)}$$

The height:diameter equations account the majority of the variation in both the pine (73%) and the mahogany (92%) datasets. However, the presence of tree heights in excess of 40 metres in both datasets is a cause for concern, and suggests that the height of tall trees is being over-estimated.

*Figure 2. Relationship between stem diameter (cm) and height (m) for mahogany.*

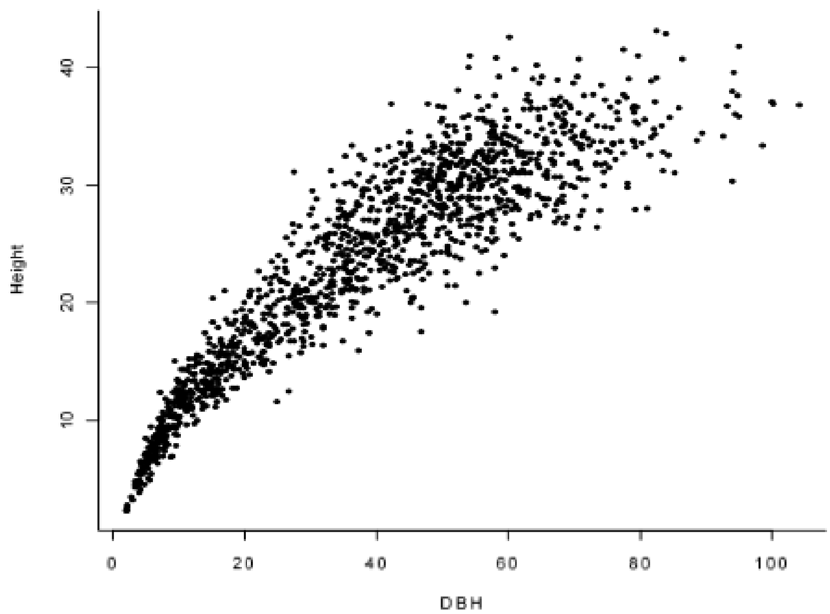
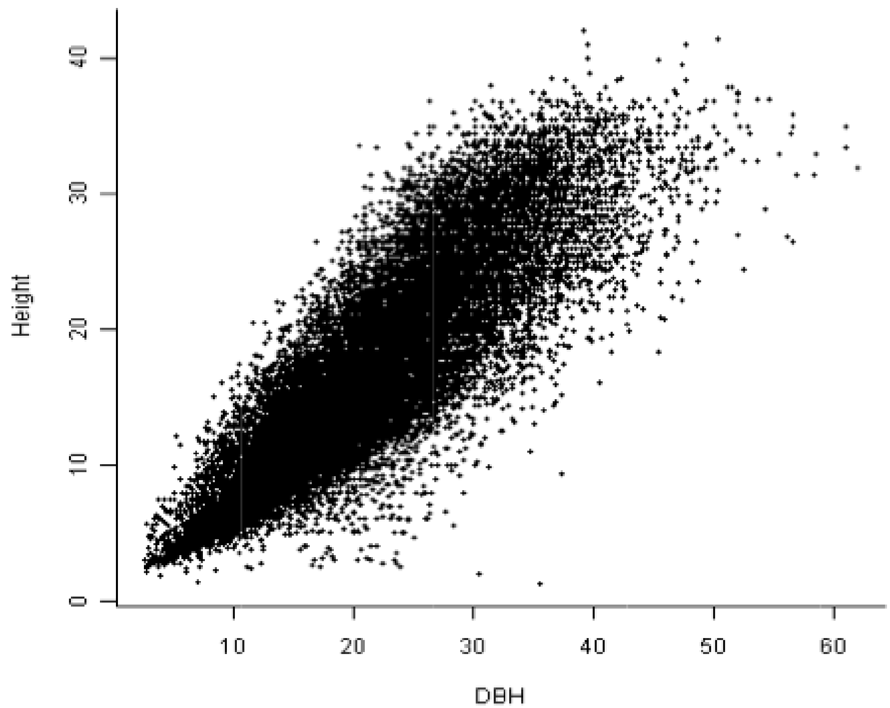


*Figure 3. Relationship between stem diameter (cm) and height (m) for pine.*




Above ground live (AGL) biomass for mahogany was estimated using the moist tropical allometry used for the indigenous forest calculations (Eq. 2). For pine, AGL biomass was initially estimated using a species-specific equation (Hairiah et al. 2001) derived from biomass estimates of Fijian plantation *Pinus caribaea* var. *hondurensis* (Claeson et al. 1984, Waterloo 1995). When this equation produced unrealistically high carbon stock values, we reanalysed the dataset using an allometric equation for moist tropical forests (Eq. 5) that does not require tree height measurements (Chave et al. 2005).

$$AGL_{(est)} = \rho \times \exp(-1.499 + 2.148\ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3) \qquad \text{(Eq. 5)}$$

where D is the stem diameter at breast height (cm) and ρ is the density of the wood ($g/cm^3$).

Below ground (BG) biomass for both species was estimated using the shoot:root ratio (1:0.24) recommended by Cairns et al. (1997) for tropical forests.

Biomass estimates for each stem were summed by plot, expressed as tC/ha, and converted to C-stock using a conversion factor of 0.50. Slope correction was not required because for both species the PSPs had been established on a slope-corrected basis.

Relationships between carbon stock and stand age data were analysed using the nonlinear least squares procedure in the R statistical computing environment (ver. 2.11.1). Gompertz curves provided the best fit for both the mahogany (Figure 4) and the pine (Figure 5). datasets.

*Figure 4. Relationship between AGL carbon stock (t/ha) and stand age for mahogany.*

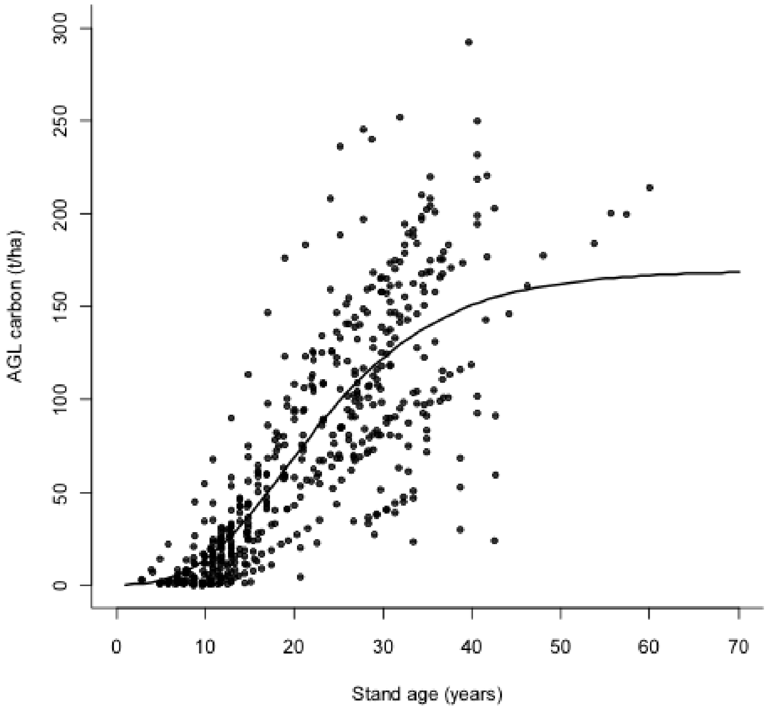
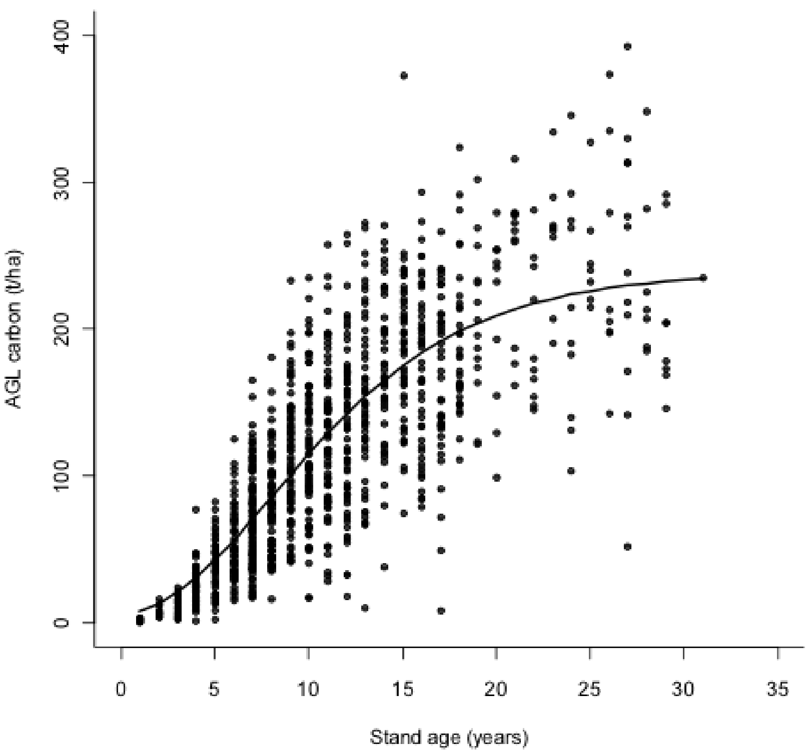



*Figure 5. Relationship between AGL carbon stock (t/ha) and stand age data for pine.*



The carbon stock:stand age curves (Eqs. 5 & 6) derived from these analyses were used to estimate average AGL carbon stocks for each age class of trees. These values were scaled to obtain an estimate of AGL +BG carbon stocks.

$$\text{AGL carbon}_{\text{(Mahogany)}} = 169.35 \times \exp(-6.88 \times \exp(-0.10 \times \text{age})) \quad \text{(Eq. 5)}$$

$$\text{AGL carbon}_{\text{(Pine)}} = 239.34 \times \exp(-4.03 \times \exp(-0.17 \times \text{age})) \quad \text{(Eq. 6)}$$

# RESULTS AND DISCUSSION

## Indigenous forests

Carbon stock estimates (AGL and BG pools only) of plots in the National Forest Inventory 1991, and the partially completed Permanent Sample Plot network are presented in Table 1. Mean values for both datasets are well below the 432 ± 92t$CO_2$e/ha reported from lowland tropical forests in the Sovi Basin (Green 2010), or the IPCC default value of 500t$CO_2$e/ha. Both datasets however include plots with carbon stock estimates on a par with old growth tropical forests. A cursory examination of the NFI dataset suggests that the configuration (5 × 0.04 ha subplots) of the plots may have resulted in large stems (which sequester the bulk of the carbon) being under sampled.

*Table 1. Carbon stock estimates (AGL and BG pools only) for plots in the National Forest Inventory (1991) and Permanent Sample Plots established in 2010.*

| | National Forest Inventory 1991 | | Permanent Sample Plots 2010 | |
|---|---|---|---|---|
| | tC/ha | t$CO_2$e/ha[6] | tC/ha | t$CO_2$e/ha |
| Mean | 47.6 | 174.5 | 47.9 | 175.8 |
| SEM | 1.4 | 5.0 | 6.7 | 24.5 |
| CI (95%) | 2.7 | 9.9 | 13.6 | 49.9 |
| Range | 2.2 – 266.4 | 8.1 – 976.9 | 2.1 – 176 | 7.7 – 645.4 |
| No. of Plots | 529 | 529 | 33 | 33 |

*SEM = Standard Error Margin; CI = Confidence Interval*

The explanation for the low mean carbon stock values on the PSP plots, which are the same shape and size as those used by Tuiwawa et al. (2006) to sample mature forest stands in the Sovi Basin, probably lies in their distribution. Many of the plots that have been established to date are located in the more degraded forests on the western side of Viti Levu, where carbon stock values can be expected to be lower. Assuming this is the case, the issue of lower than expected carbon stock values in indigenous forests will resolve itself when the PSP network is fully established.

## Mahogany And Pine Plantations

Carbon stock estimates (AGL and BG pools only) calculated from the mahogany and pine datasets are presented in Table 2. For mahogany, the estimates appear realistic despite the issues with height measurement. For pine, the estimates appear a little high. Comparable figures for unpruned radiata pine stands on high fertility sites New Zealand (Paul et al. 2008) are on average

[6] One tonne carbon = 3.667 tonnes $CO_2$ equivalent.

25% lower than those obtained from the Fiji Pine dataset. The reason for the higher than expected values isn't immediately obvious, and suggests a need to better understand the field data collection methods.

*Table 2. Changes in carbon stock estimates (AGL + BG only) with stand age in Fijian mahogany and pine plantations.*

| Stand age | Mahogany | | Pine | | Stand age | Mahogany | | Pine | |
|---|---|---|---|---|---|---|---|---|---|
| years | tC/ha | $tCO_2e$/ha | tC/ha | $tCO_2e$/ha | years | tC/ha | $tCO_2e$/ha | tC/ha | $tCO_2e$/ha |
| 1 | 0.4 | 1.5 | 9.9 | 36.3 | 26 | 126.0 | 461.9 | 282.7 | 1036.8 |
| 2 | 0.8 | 2.8 | 16.9 | 61.8 | 27 | 132.3 | 485.0 | 284.9 | 1044.7 |
| 3 | 1.3 | 4.7 | 26.4 | 96.8 | 28 | 138.2 | 506.8 | 286.7 | 1051.4 |
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| 17 | 59.8 | 219.1 | 237.2 | 869.9 | 42 | 189.4 | 694.6 | 295.8 | 1084.8 |
| 18 | 67.3 | 247.0 | 245.7 | 900.9 | 43 | 191.3 | 701.4 | 296.0 | 1085.4 |
| 19 | 75.0 | 275.2 | 253.0 | 927.9 | 44 | 193.0 | 707.7 | 296.1 | 1085.8 |
| 20 | 82.8 | 303.5 | 259.4 | 951.3 | 45 | 194.5 | 713.4 | 296.2 | 1086.2 |
| 21 | 90.4 | 331.6 | 264.9 | 971.6 | 46 | 196.0 | 718.6 | 296.3 | 1086.5 |
| 22 | 98.0 | 359.3 | 269.7 | 988.9 | 47 | 197.3 | 723.3 | 296.4 | 1086.8 |
| 23 | 105.4 | 386.3 | 273.8 | 1003.9 | 48 | 198.4 | 727.7 | 296.4 | 1087.0 |
| 24 | 112.5 | 412.5 | 277.2 | 1016.6 | 49 | 199.5 | 731.6 | 296.5 | 1087.2 |
| 25 | 119.4 | 437.8 | 280.2 | 1027.5 | 50 | 200.5 | 735.2 | 296.5 | 1087.4 |

## INTERPRETATION

Results are preliminary for indigenous forest and plantation forest data sets and indicate some anomalies that warrant further data improvement and analysis. In particular, tree height data in the survey datasets do not appear to be accurate. The problem will need to be clarified by means of targeted research if we are to obtain a reliable relationship between stem diameter and tree height. This is important due to the role that tree-height plays in the calculation of above ground live biomass and consequently carbon content.

The mean carbon stock estimate for indigenous forests is 175 $tCO_2e/ha$. This figure is lower than would be expected and will need clarification by means of further research to enhance the accuracy of the forest carbon stock data set.

The carbon stock calculations for plantations are also based on data that present some anomalies that need to be clarified in order to increase confidence in carbon stock estimates. For example, the mean carbon stock per hectare for the pine forest resource is higher than expected and likely to be an overestimate.

In spite of these questions concerning data quality we conducted an estimate the national forest carbon stock based on these existing data. This is depicted in Table 3 and described further below.

*Table 3. National Forest Carbon Stock Assessment*

| National Forest Carbon Stock Assessment | | | | | |
|---|---|---|---|---|---|
| | Total Land | Total Forest | Indigenous Forest | Plantation pine | Plantation mahogany |
| Area (1,000 ha) | 1,827 | 985 | 899 | 45 | 41 |
| $tCO_2e/ha$ | | 195 | 175 | 613 | 350 |
| 1,000 $tCO_2e$ | | 192,270 | 157,325 | 27,590 | 14,355 |

The total carbon stock estimate for the national indigenous forest estate (on the basis of the current data set) is 157,325,000 $tCO_2e$.

The total carbon stock estimate for the national pine forest estate (on the basis of the current data set) is 27,590,000 $tCO_2e$.

The total carbon stock estimate for the national mahogany forest estate (on the basis of the current data set) is 14,355,000 $tCO_2e$.

The total carbon stock estimate for the national forest estate (on the basis of the current data set) is 192,270,000 $tCO_2e$.

## IMPROVING THE INVENTORY

The analysis of the current forest inventory datasets has identified a number of issues that will need to be addressed if they are to be used to provide robust carbon estimates for Fiji forests.

Biomass (and therefore carbon) stocks in trees are estimated from diameter, height and wood density measurements.

- Diameter measurements are a standard part of forest mensuration practice, and this type of data is normally collected to a high standard.

- Tree heights are more difficult to measure, and there is ample evidence in the current inventory data that the heights of tall trees are not being measured accurately. The main issues are the difficulty in seeing the tops of tall trees in closed forest stands, and a lack of suitable instruments to measure the height of tall trees.
- After diameter, wood density is the most important predictor of carbon stocks. Known densities for Fijian tree species range from 310 – 850 kg/m3. Wood density data are available for some commercially harvested species, but not for many species that make a significant contribution to the national forest carbon stocks.

We recommend:

1. The measurement of tree height is discontinued on carbon inventory plots, and that tree height estimates are obtained using height:diameter relationships[7]. These should be species-specific for those species that make a significant contribution to the national carbon stock. For other species, height:diameter relationships based on the form of the tree crown would seem appropriate.

2. The systematic sampling of wood density in Fijian tree species, targeting (but not limited to) species making a major contribution to the national carbon stock. This should include the development of:
    a. A protocol for collecting wood samples and determining their density
    b. Laboratory facilities for determining the density of wood samples
    c. A sample collection programme
    d. A wood density database
    e. Publication of a comprehensive set of wood density measurements for Fijian tree species.

The current Fiji national datasets enabled us to estimate carbon stocks two of the five broad pools specified in the IPCC Good Practice Guidance manual. These are above-ground live and below ground. It is not currently possible to provide national carbon stock estimates for the dead wood, litter and soil pools. Dead wood is an important contributor to carbon stocks, particularly after recent disturbance. Examples include forests that have been recently logged and those damaged by cyclones. Litter is generally a minor pool in tropical forests, but can take on greater importance at higher altitudes and in drier areas where rates of decay are lower. Soil carbon makes a major contribution to the total carbon stock, but tends to change only slowly except where there is a change in land use. Examples include a reduction in soil carbon when pasture is converted to forest, and a loss of carbon when previously uncultivated soils are brought into cultivation.

We recommend that:

[7] The current practice is to measure the height of some stems on each plot, and use these data to estimate the height of the remaining stems.

3. Dead wood is routinely measured on the permanent sample plots that are used for carbon stock inventory in indigenous forests. This will require:
    a. A protocol for the measurement of dead wood on indigenous PSP plots, and the analysis of the measurements.
    b. A study of the rate at which carbon is lost from dead wood under the climatic conditions found in indigenous forests. This is required to establish what are termed decay rate modifiers for logs at different stages of decay.

4. Changes in dead wood with stand age are determined for the pine and mahogany plantations. This will require:
    a. A protocol for the measurement of dead wood on PSP plots in pine and mahogany plantations, and the analysis of the measurements.
    b. Development of carbon stock:stand age relationships for dead wood.
    c. A study of the rate at which carbon is lost from dead wood under the climatic conditions found in pine and mahogany plantations.

5. Country-specific data on carbon stocks in the litter pool are obtained for indigenous forests, and for pine and mahogany plantations.

6. Consideration be given to the development of a soil carbon model of the type used by New Zealand for UNFCCC and Kyoto Protocol reporting, to provide national estimates of carbon stock changes in Fiji soils. This would require:
    a. Extraction and collation of existing data that would be required to model carbon stock estimates. Many of these datasets were collected by New Zealand soil scientists during the 1960s and 1970s, and exist only in hardcopy form within New Zealand and Pacific institutions.
    b. That these data are assessed for their suitability for modelling soil carbon stocks.

7. In the event that suitable data are available, a ‘New Zealand-style’ model (Baisden et al 2006) is developed for Fiji. This model should not be limited to forests but extend across all land use classes.

A comprehensive assessment of carbon stocks and carbon stock change needs to include all forest communities if it is to meet the IPCC requirement for completeness, and adequately address issues such as leakage. It also needs to be as accurate as possible within the limits of the resources that are available.

For indigenous forests, the PSP network that is currently being established will provide the data required for carbon stock calculations. For the above-ground live (AGL), below ground (BG), and dead wood (DW) pools this constitutes a Tier 1 (i.e. national inventory) approach. For the litter pool, we are recommending a country-specific data (Tier 2) rather than a national inventory (Tier 1) approach. The other issue associated with the PSP network is whether the number of plots proposed for the current network is adequate to obtain a robust estimate of carbon stock change. The usual way of determining this is to run a pilot trial, and analyse the variability in the data that are collected. In order to determine whether the size of the proposed plot network is adequate we recommend that:

8. Once all the plots on Viti Levu have been established, the PSP dataset is analysed to determine the number of plots that would be required to detect measurable changes in carbon stocks.

For the pine and mahogany plantations, the use of existing PSP datasets to estimate carbon stock:stand age relationships constitutes a Tier 2 approach (i.e. country-specific data rather than a national inventory).  A Tier 1 approach to carbon inventory in the plantation forests would require the establishment of a representative network of plots across the plantation estate, using the current plantation forest methodologies.

Two other forest types need to be considered. These are the teak plantations being established on Viti Levu, and the coastal mangrove forests. While neither currently constitute a significant proportion of the carbon stocks in Fiji's forests, it can be argued that both should be included in the national inventory for the sake of completeness, and because both are areas where significant changes in carbon stocks are occurring. We recommend that:

9. Consideration be given to ways in which permanent plot networks might be established in plantations other than pine and mahogany (e.g. teak), and mangrove forest types.

For inventory programmes to be successful in the long-term issues of quality control and data management (including data ownership and security) are paramount. Put another way, inventories are only as good as the methods and processes that are use to create and maintain them. Without formal attention to these issues most inventories do not survive the tenure of their creators. With this in mind we recommend:

10. The development of a databank that incorporates all elements (data collection and analysis protocols, datasets etc) required for national carbon stock estimation in Fiji forests.

Finally, we recommend that:

11. Once the components of the Fiji carbon inventory programme have been agreed, the programme should be formally documented in a published report, and externally peer reviewed.

## DATA OWNERSHIP

The datasets used in this report were sourced from the Fiji Forestry Department (indigenous forests), Fiji Hardwood Corporation (mahogany plantations), and Fiji Pine Ltd (pine plantations). They were supplied for the purpose of calculating a carbon estimate for Fiji forests. Ownership of the datasets remains with the originating organisations. Before the datasets are incorporated into a national carbon accounting database or otherwise disseminated, the owner organisations will need to agree to the terms and conditions under which this will happen.

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# APPENDIX 1 – WOOD DENSITY FOR CARBON STOCKS ESTIMATES IN INDIGENOUS FORESTS

| Local name | Botanical name | Density kg/m$^3$ |
|---|---|---|
| African tulip | Spathodea campanulata | 340 |
| Ai masi | Ficus fulvo-pilosa | 340 |
| Ai rorogi | Commelina diff usa | 340 |
| Ai susu | Symplocos leptophylla | 340 |
| Amunu | Dacrycarpus imbricatus | 450 |
| Asibolo | Podocarpus decipiens | 520 |
| Baka | Ficus obliqua | 430 |
| Baka ni viti | Ficus smithii | 430 |
| Bati tabua | Cyrtandra coleoides | 340 |
| Bati bona | Geniostoma spec. div. | 340 |
| Bau | Palaquium viti levuense | 535 |
| Bau sagali | Manilkara dissecta | 535 |
| Baubulu | Manilkara smithiana | 535 |
| Baudina | Burckella fi jiensis | 535 |
| Bauloa | Planchonella umbonata | 535 |
| Baumika | Burckella parvifl ora | 535 |
| Bausa | Planchonella grayana | 535 |
| Bausomi | Terminalia crebrifolia | 430 |
| Bauvudi | Palaquium porphyreum | 475 |
| Bawaki A | Burckella thurstonii | 340 |
| Bawaki B | Planchonella smithii | 430 |
| Belebele | Brackenridgea niti da | 340 |
| Beta beta | Cyrtandra jugalis | 340 |
| Bo | Viti cipremna viti levuensis | 340 |
| Bo (Nakavu) | Neuburgia alata | 340 |
| Boca | Manilkara viti ensis | 340 |
| Boiboi (Lidiyago) | Aglaia viti ensis var 1 | 340 |
| Boiboida levu | Geniostoma macrophyllum | 340 |
| Boloa | Neuburgia macrocarpa | 340 |
| Bonukiwabu | Casearia procera | 340 |
| Bua ni viqalau | Vavaea degeneri | 340 |
| Buabua | Fagraea gracilipes | 840 |
| Buabua dina | Fagraea berteroana | 840 |
| Buabua ni waitui | Guett arda speciosa | 535 |
| Bulei | Neuburgia corynocarpa | 340 |
| Bulei lailai | Alstonia montana | 340 |
| Bulewa | Pullea perryana | 340 |
| Bulu lailai | Garcinia viti ensis | 430 |
| Bulu m. A | Garcinia pseudogutti fera | 430 |
| Bulu wai | Garcinia sessilis | 430 |
| C(s)avuc(s)avu | Aglaia elegans | 340 |
| Cagoloqolo | Melicytus fasciger | 340 |
| Caukuro | Gymnostoma viti ense | 850 |
| Cawaru (Lidiyago) | Aglaia viti ensis var 2 | 340 |
| Cevua | Vavaea amicorum | 430 |
| Cevuga | Geanthus cevuga | 340 |
| Cicibi A | Cynometra insularis | 340 |
| Cicibi B | Maniltoa vesti ta | 340 |
| Covi (Sarosaro) | Planchonella viti ensis | 340 |
| Dabi | Xylocarpus granatum | 430 |
| Dabi legilegi | Xylocarpus moluccensis | 430 |
| Daiga | Pisonia umbellifera | 340 |
| Daka | Syzygium quadrangulatum | 340 |
| Dakua makadre | Agathis viti ensis | 450 |
| Dakua salusalu | Decussocarpus viti ensis | 370 |
| Dalovoci | Hernandia olivacea | 430 |
| Damabi A | Endiandra elaeocarpa | 430 |
| Damanu | Calophyllum viti ense | 500 |
| Damanu dilodilo | Calophyllum amblyphyllum | 500 |
| Damanu kula | Calophyllum neo-ebudicum | 500 |
| Damanu lailai A | Calophyllum cerasiferum | 500 |
| Damanu ni yaqaqa | Buchanania viti ensis | 430 |
| Danidani ni veikau | Polyscias multi juga | 340 |
| Dasia lailai | Tapeinosperma amplifl orum | 340 |
| Dasia levu | Tapeinosperma grande | 340 |
| Dava | Astronidium conferti fl orum | 340 |
| Dava levu | Astronidium robustum | 340 |
| Davo | Macaranga graeff eana | 340 |
| Davo levu | Macaranga magna | 340 |
| Dawa | Pommeti a pinnata | 340 |
| Deqedeqe | Psychotria amoena | 340 |
| Dilo | Calophyllum inophyllum | 430 |
| Diridamu | Adenanthera pavonina | 340 |
| Diriniu | Cryptocarya constricta | 340 |
| Dodolala | Anti rhea smithii | 340 |
| Dogo | Bruguiera gymnorhiza | 535 |
| Dogo ni vanua | Timonius affi nis | 340 |
| Dogodogo | Ochrosia viti ensis | 430 |
| Doi | Alphitonia zizyphoides | 500 |
| Doi ni vosa | Rapanea myricifolia | 340 |
| Doida | Cleistocalyx myrtoides | 340 |
| Doidamu | Alphitonia franguloides | 500 |
| Doko ni sau | Alangium viti ense | 430 |
| Dovula | Elaeocarpus subcapitatus | 340 |
| Drala | Erythrina fusca | 340 |
| Drala segai | Erythrina variegata | 340 |
| Drau(toka)tolu | Melicope cucullata | 340 |
| Drausasa A | Guioa rhoifolia | 430 |
| Drausasa B | Guioa chrysea | 430 |
| Drega B | Gardenia spec. div. | 340 |
| Dregadrega | Arytera brackenridgei | 340 |
| Drou | Parasponia andersonii | 340 |
| Droudrou | Trema cannabina | 340 |
| Droutolu | Melicope spec. div. | 340 |
| Droutolu | Melicope spec.div | 340 |
| Drove | Zingiber zerumbet | 340 |
| Dulewa | Xylopia pacifi ca | 430 |
| Duruka | Saccharum edule | 340 |
| Duva | Pitt osporum arborescens | 340 |
| Duvu | Medusanthera viti ensis | 340 |
| Duvula | Masti xiodendron robustum | 430 |
| Evuevu | Hernandia nymphaeifolia | 340 |
| Gadoa | Macaranga harveyana | 340 |
| Gasau | Miscanthus fl oridus | 340 |
| Guava | Psidium guajava | 340 |
| Ivi | Inocarpus fagifer | 340 |
| Iviivi | Cryptocarya hornei | 340 |
| Iviloa | Melochia viti ensis | 340 |
| Jale ni veikau | Gardenia storckii | 340 |
| Kabi | Elaeocarpus kambi | 340 |
| Kabi lailai | Elaeocarpus lepidus | 340 |
| Kabi Nadarivatu | Elaeocarpus degeneriana | 340 |
| Kabi namosi | Elaeocarpus milnei | 340 |
| Kabi tabadamu | Elaeocarpus viti ensis | 340 |
| Kai sou | Polyalthia viti ensis | 340 |
| Kaiga | Allophyllus ti moriensis | 340 |
| Kaivatu | Veitchia viti ensis | 340 |
| Kalabuci | Acalypha spec. div. | 340 |
| Kalabuci ni veikau | Acalypha insulana | 340 |
| Kali | Aglaia archboldiana | 340 |
| Kalini Macou | Cryptocarya spec. div. | 340 |
| Kaloni | Cinnamomum leptopus | 340 |
| Karaua, Karava | Cryptocarya fusca | 340 |
| Katakata | Spiraeanthemum katakata | 340 |
| Kau | Burckella richii | 340 |
| Kau ni yalewa | Sophora tomentosa | 340 |
| Kauceuti | Turrillia viti ensis | 535 |
| Kauceuti levu | Turrillia ferruginea | 535 |
| Kaudamu | Myristi ca castaneifolia | 490 |
| Kaudamu lailai | Myristi ca chartacea | 490 |
| Kaudamu levu | Myristi ca grandifolia | 490 |
| Kaudamu male | Myristi ca gillespieana | 490 |
| Kaukaro | Semecarpus viti ensis | 430 |
| Kaukauloa | Diospyros spec. div. | 430 |
| Kaunicina A | Canarium harveyi var 1 | 540 |
| Kaunicina daliga | Canarium harveyi var 2 | 540 |
| Kaunigai | Haplolobus fl oribundus | 540 |
| Kaunisiga | Canarium vanikoroense | 540 |
| Kautoa | Dysoxylum hornei | 430 |
| Kauvula | Endospermum macrophyllum | 400 |
| Kauvula Bua | Endospermum robbieanum | 400 |
| Kavika damu | Syzygium malaccense | 430 |
| Kavika gaga | Syzygium brackenridgei | 340 |
| Kavika gaga lailai | Syzygium conferti fl orum | 340 |
| Kavika ni yalu | Syzygium oblongifolium | 340 |
| Kedra ivi | Heriti era litt oralis | 340 |
| Kesa | Elaeocarpus pyriformis | 340 |
| Koka | Bischofi a javanica | 620 |
| Kuasi | Podocarpus neriifolius | 430 |
| Kuasi balavu | Podocarpus degeneri | 520 |
| Kuasi lailai | Podocarpus affi nis | 520 |
| Kuluva | Dillenia bifl ora | 430 |
| Kuluva ni toda | Tapeinosperma capitatum | 340 |
| Kutu | Baccaurea seemannii | 340 |
| Laubu | Garcinia myrti fl ora | 650 |
| Lauci | Aleurites moluccana | 340 |
| Lidi | Litsea spec. div. | 340 |
| Lidi seti | Litsea viti ana | 340 |
| Lidiyaqo | Aglaia gracilis | 340 |
| Lilidi | Litsea pickeringii | 340 |
| Lolo | Ficus viti ensis | 340 |
| Lolo tagane | Ficus theophrastoides | 340 |
| Losilosi | Ficus barclayana | 340 |
| Lutulutu | Meryta tenuifolia | 340 |
| Lutulutu siliwa | Syzygium gracilipes | 340 |
| Ma | Pterocymbium oceanicum | 340 |
| Macou | Cinnamomum spec. div. | 340 |
| Macou lailai | Cinnamomum pallidum | 340 |
| Macou levu | Cinnamomum fi ti anum | 340 |
| Mahogany | Swietenia macrophylla | 490 |
| Makamakadora | Cyrtandra anthropophagorum | 340 |
| Makita | Atuna racemosa | 340 |
| Makita leka | Atuna ellipti ca | 340 |
| Mako loa | Trichospermum calyculatum | 340 |
| Mako vatu | Trichospermum richii | 340 |
| Makosoi B | Cananga odorata | 340 |
| Makosoi B | Richella monosperma | 340 |
| Makosoi ni veikau | Cyathocalyx insularis | 340 |
| Mala | Dysoxylum quercifolium | 430 |
| Malamala | Dysoxylum lenti cellare | 430 |
| Malawaso | Cryptocarya parinarioides | 340 |
| Male ni via | Claoxylon viti ensis | 340 |
| Male waqa | Myristi ca macrantha | 490 |
| Maletawa | Dysoxylum gillespieanum | 340 |
| Mama | Macaranga seemannii | 340 |
| Mamakara | Kleihovia hospita | 340 |
| Mana i vanua | Excoecaria acuminata | 340 |
| Manawi | Koelreuteria elegans | 340 |
| Manawi (Totowiwi) | Rhus simarubifolia | 340 |
| Manui | Pleiogynium ti moriense | 430 |
| Maqo ni veikau | Buchanania att enuata | 430 |
| Marasa | Storckiella viti ensis | 430 |
| Masa B | Alectryon grandifolius | 340 |
| Masamasa | Elatt ostachys falcata | 340 |

| Local name | Botanical name | Density kg/m$^3$ |
|---|---|---|
| Masimasi | Ficus storckii | 340 |
| Masiratu | Degeneria viti ensis | 350 |
| Mavida | Erythrospermum acuminati ssimum | 340 |
| Mavota | Gonystylus punctatus | 570 |
| Mavu | Macaranga spec. div. | 340 |
| Mavu ni Tonga | Anti aris toxicaria | 340 |
| Mediri tabua | Cyrtandra spec. div. | 340 |
| Meme | Drypetes viti ensis | 340 |
| Midra | Baccaurea seemannii | 340 |
| Midri | Elaeocarpus graeff ei | 340 |
| Mimila | Saurauia rubicunda | 340 |
| Mocelolo | Polyalthia amygdalina | 340 |
| Mocemoce (Raintree) | Samanea saman | 460 |
| Moivi | Kingiodendron platycarpum | 760 |
| Moivi lailai | Maniltoa minor | 760 |
| Moivi levu | Maniltoa grandifl ora | 760 |
| Molaca | Homalium viti ense | 340 |
| Molau | Glochidion seemannii | 340 |
| Moli Madarini | Citrus reti culata | 340 |
| Mudari | Litsea magnifolia | 340 |
| Namo | Endiandra monti cola | 340 |
| Namoliwawa | Cyathocalyx suaveolens | 340 |
| Nici | Grewia viti ensis | 340 |
| Niuniu | Veitchia spec. div. | 340 |
| Nokonisau | Psydrax odorata | 340 |
| Nokonoko | Casuarina equiseti folia | 535 |
| Nunu | Ficus pritchardii | 430 |
| Nuqa | Citronella viti ensis | 340 |
| Nuqanuqa | Decaspermum viti ense | 340 |
| Okeoke | Readea membranaceae | 340 |
| Ola | Cyclophyllum barbatum | 340 |
| Qaigai | Cordyline terminalis | 340 |
| Qaiqai | Elaeocarpus storckii | 340 |
| Qanuya | Calamus viti ensis | 340 |
| Qeleqai | Endiandra luteola | 340 |
| Qiliyaqo | Aglaia axillaris | 340 |
| Qumu | Acacia richii | 690 |
| Rauba | Garcinia adinantha | 340 |
| Raubalabu | Memecylon viti ense | 340 |
| Rewa | Cerbera manghas | 340 |
| Rogi | Heriti era ornithocephala | 680 |
| Rosawa | Gmelina viti ensis | 540 |
| Rote | Macaranga secunda | 340 |
| Sa | Parinari insularum | 650 |
| Sacau | Palaquium hornei | 700 |
| Sagali | Lumnitzera litt orea | 340 |
| Sakisakivuto | Homalium laurifolium | 340 |
| Salato | Dendrocnide harveyi | 340 |
| Salato baubau | Dendrocnide viti ensis | 340 |
| Sama | Commersonia bartramia | 340 |
| Sarosaro A | Planchonella garberi | 770 |
| Sasaqilu | Micromelium minutum | 340 |
| Sasawira | Dysoxylum richii | 490 |
| Saula | Astronidium saulae | 340 |
| Sawailau | Sapindus viti ensis | 340 |
| Se ni caucau | Taeniophyllum fasciola | 340 |
| Sekula | Metrosideros collina var3 | 340 |
| Semalo | Melochia degeneriana | 340 |
| Sevua A | Vavaea harveyi | 340 |
| Sila ni koro | Ophiorrhiza laxa | 340 |
| Sinamoni | Cinnamomum camphora | 340 |
| Sinu gaga | Excoecaria agallocha | 340 |
| Sinu mati avi | Wirkstroemia foeti da | 340 |
| Sinu ni veikau | Ixora pelagica | 340 |
| Sisisi | Gironniera celti difolia | 340 |
| Siti | Grewia crenata | 340 |
| Siti dromodromo | Microcos viti ensis | 340 |
| Sivia | Elaeocarpus chelonimorphus | 340 |
| Soga | Metroxylon viti ensis | 340 |
| Sole | Scheffl era seemanniana | 340 |
| Sole dina | Plerandra pickeringii | 340 |
| Sole gau | Plerandra viti ensis | 340 |
| Sole lailai | Plerandra insolita | 340 |
| Sole lewa | Scheffl era viti ensis | 340 |
| Sorovulu | Dysoxylum aliquantulum | 340 |
| Sorua | Alstonia viti ensis var 1 | 340 |
| Sorua lailai | Alstonia pacifi ca | 340 |
| Sorua veimama | Alstonia viti ensis var 2 | 340 |
| Soso ni ura | Dolicholobium lati folium | 340 |
| Soso ni ura damudamu | Dolicholobium macgregorii | 340 |
| Sukau | Gnetum gnemon | 340 |
| Tabulina | Psychotria conferti loba | 340 |
| Tadalo | Pagiantha thurstonii | 340 |
| Tadano | Omalanthus nutans | 340 |
| Tadili | Celti s viti ensis | 340 |
| Tadiriri | Pitt osporum spec. div. | 340 |
| Tadruka | Flacourti a viti ensis | 340 |
| Tagitagi | Dacrydium nausoriense | 340 |
| Talatalabia | Tarenna seemanniana | 340 |
| Tarawau | Dysoxylum seemannii | 430 |
| Tarawau | Dracontomelon viti ense | 430 |
| Tarawau tagane | Dysoxylum tenuifl orum | 430 |
| Tatagia | Acacia simplex | 340 |
| Tava A | Astronidium storckii | 340 |
| Tava B | Astronidium victoriae | 340 |
| Tavesau | Syzygium curvistylum | 340 |
| Taviti lau | Macaranga viti ensis | 340 |
| Tavola ni veikau | Terminalia viti ensis | 430 |
| Tavoloa | Terminalia catappa | 430 |
| Tavoloa ni waitui | Terminalia litoralis | 430 |
| Tawatawa | Aglaia greenwoodii | 340 |
| Tebateba | Masti xiodendron fl avidum | 340 |
| Tiri selala | Rhizophora x selala | 340 |
| Tiri tabua | Rhizophora stylosa | 535 |
| Tiri vanua | Crossostylis seemannii | 535 |
| Tiri wai | Rhizophora samoensis | 535 |
| Tivi A | Terminalia pterocarpa | 480 |
| Tivi loa | Terminalia capitanea | 480 |
| Tivi losi | Terminalia strigillosa | 480 |
| Tivi vula | Terminalia spec. unid. | 480 |
| Tomanu | Emmenosperma micropetalum | 430 |
| Totowiwi | Zanthoxylum gillespieanum | 430 |
| Totowiwi | Pleiogynium hapalum | 430 |
| Tovau | Berrya pacifi ca | 340 |
| Ulala | Syzygium corynocarpum | 340 |
| Unknown | Weinmannia viti ensis | 340 |
| Unknown | Elaeocarpus gillespieanus | 340 |
| Usi | Dodonea viscosa | 340 |
| Uto | Arthocarpus alti lis | 340 |
| Uto ni Idia, Jak Fruit | Artocarpus integra | 340 |
| Uvi | Dioscorea alata | 340 |
| Vacea | Neonauclea forsteri | 430 |
| Vaivai | Mimosaceae spec. div. | 480 |
| Vaivai ni vavalaqi | Albizia saman | 480 |
| Vaivai ni veikau A | Serianthes melanesica | 480 |
| Vaivai ni veikau B | Serianthes viti ensis | 480 |
| Vaivai ni wai | Parkia parrii | 480 |
| Vakacare davui | Tarenna sambucina | 340 |
| Vakaceredavui | Claoxylon fallax | 340 |
| Vaoko | Neiosperma oppositi folium | 340 |
| Vasa damu | Euphorbia fi djiana | 340 |
| Vasa ni veikau | Amaroria soulameoides | 340 |
| Vau ceva | Firmiama diversifolia | 340 |
| Vaudraunisiga | Diospyros gillespiei | 340 |
| Vauvau ni vavalagi | Gossypium hirsutum var. taltense | 340 |
| Vesi | Intsia bijuga | 740 |
| Vesivesiwai | Homalium pallidum | 430 |
| Vesiwai | Pongamia pinnata | 430 |
| Vetau | Mammea odorata | 340 |
| Voivoi, Balawa | Pandanus spec. div. | 340 |
| Vono | Alyxia spec.div | 340 |
| Vota | Geissois spec. div. | 340 |
| Vovo | Tremenia weinmanniifolia | 340 |
| Vuga tagane | Metrosideros collina var1 | 760 |
| Vuga yalewa | Metrosideros collina var2 | 760 |
| Vure B | Geissois superba | 340 |
| Vure C | Geissois imthurnii | 340 |
| Vure D | Geissois sti pularis | 340 |
| Vurutumoko | Litsea mellifera | 340 |
| Vusavusa | Cupaniopsis viti ensis | 340 |
| Vutu | Barringtonia asiati ca | 480 |
| Vutu dina | Barringtonia seaturae | 480 |
| Vutu kana | Barringtonia edulis | 480 |
| Vutu wai | Barringtonia racemosa | 480 |
| Vutuvutu | Discocalyx fusca | 340 |
| Vuvudi | Polyalthia habrotricha | 340 |
| Wa bosucu | Micania micrantha | 340 |
| Wa denimana | Dalbergia candenatendis | 340 |
| Wa duva | Deris trifoliata | 340 |
| Wa lai, Ai cibi | Entada phaseolides | 340 |
| Wa lutumalagi | Cassytha fi liformis | 340 |
| Wa rusi | Smilax viti ensis | 340 |
| Wa vereverelagi | Cuscula campestris | 340 |
| Wa vuti | Ipomoea indica | 340 |
| Waciwaci | Sterculia viti ensis | 310 |
| Wailoaloa | Elaeocarpus cassinoides | 340 |
| Wainidra | Cyrtandra anthropophagorum | 340 |
| Warokamici | Dysoxylum myriandrum | 340 |
| Waulo levu | Flagellaria gigantea | 340 |
| Wi | Spondias dulcis | 340 |
| Wiriwiri | Gyrocarpus americanus | 340 |
| Yabia | Tacca leontopetaloides | 340 |
| Yaka | Dacrydium nidulum | 520 |
| Yamo | Maniltoa fl oribunda | 340 |
| Yaqoyaqona | Piper aduncum | 340 |
| Yaro | Premna serrati folia | 340 |
| Yasi dina | Santalum yasi | 430 |
| Yasidravu | Syzygium fi jiense | 430 |
| Yasidravu lailai | Syzygium eff usum | 430 |
| Yasikavika | Syzygium leucanthum | 430 |
| Yasileba | Syzygium grayi | 430 |
| Yasiloa | Cleistocalyx ellipti cus | 535 |
| Yasimoli | Cleistocalyx decussatus | 535 |
| Yasiwai | Syzygium seemannianum | 430 |
| Yasiyasi A | Cleistocalyx eugenioides | 760 |
| Yasiyasi damudamu | Syzygium purpureum | 690 |
| Yasiyasi draudrau | Piliocalyx concinnus | 690 |
| Yasiyasi nadarivatu | Syzygium nandarivatense | 690 |
| Yasiyasi naivici | Syzygium amicorum | 690 |
| Yasiyasi niqa | Syzygium nidie | 690 |
| Yawe (Sarosaro) | Planchonella pyrulifera | 770 |
| Yawe korobaba | Planchonella sessilis | 770 |
| Yemane | Gmelina arborea | 340 |