FOREST CARBON ACCOUNTING SOFTWARE DEVELOPMENT REPORT

CASE STUDY USING MERANG PEAT SWAMP FOREST DATA, SUMATERA SELATAN

Fandi Susanto

Palembang, July 2011

Supported by :
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

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ABSTRACT

Forest carbon monitoring is one of the project components which deals with data collection, processing and analysis. To allow fast and accurate data processing, a data processing software had been developed. The software intended to provide forestry data input interfaces, processes the calculation and then output the calculation results into information. The software includes into the calculation additional data such as mass density and apply different carbon stock calculation formulas to different species. The software calculates tree distribution per DBH, tree distribution per plot, Importance Value Index, AGB Carbon Stock, DOM Carbon Stock, BGB Carbon Stock, Soil Carbon Stock and Total Carbon Stock.

1 INTRODUCTION

Forest carbon monitoring is one of the project components which deals with data collection, processing and analysis. A carbon inventory has been successfully conducted in the beginning of 2010. Huge amount of data about species, numbers and diameters have been collected on the field and have been digitized into Microsoft Access Database. However, mistakes occur very often when manual calculation is applied. Therefore, to allow fast and accurate data processing, a data processing software had been developed. The software processes collected forestry data into information. The information are AGB Carbon Stock, DOM Carbon Stock, Soil Carbon Stock and Importance Value Indices.

Although the software developed was able to provide fast and accurate calculation based on the raw data provided on Microsoft Access database, the software calculation accuracy could be improved by providing additional data such as wood mass density and by applying different carbon stock calculation formulas to different species

This software development project is intended to improve and revise the software developed on the previous project.

1.1 BRIEF EXPLANATION OF PREVIOUS PROJECT

Before the start of the previous project, the data was calculated using Microsoft Access and Microsoft Excel and therefore, to calculate the data, a person with a high level of understanding to the calculation is needed. Hence the software was developed to simplify, standarize and automate the calculation process.

Below is an image which represents the breadth of the software.

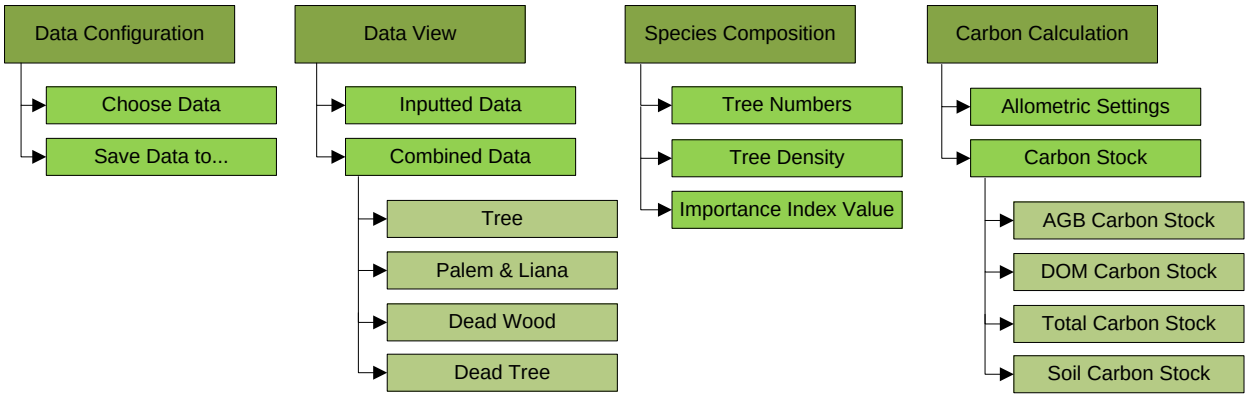


Figure 1-1 Previous Project Menu

The first menu group is the data configuration which contains two sub menus to configure the data to be used. The Data View menu group contains the menus to view the data in Microsoft Access file and the combined tree findings data which was distributed among some tables. The Species Composition menu group provided some tree species related data. The Carbon Calculation menu group provided Carbon Stock calculation which consists of AGB Carbon Stock, DOM Carbon Stock, Soil Carbon Stock and their total.

Since the tree findings data in the Microsoft Access file are separated into a number of table, the software uses Microsoft Access file as the raw data and moves the data into a MySQL database with the purpose to simplify the grouping and calculation process. The database structure of the databases can be observed below.

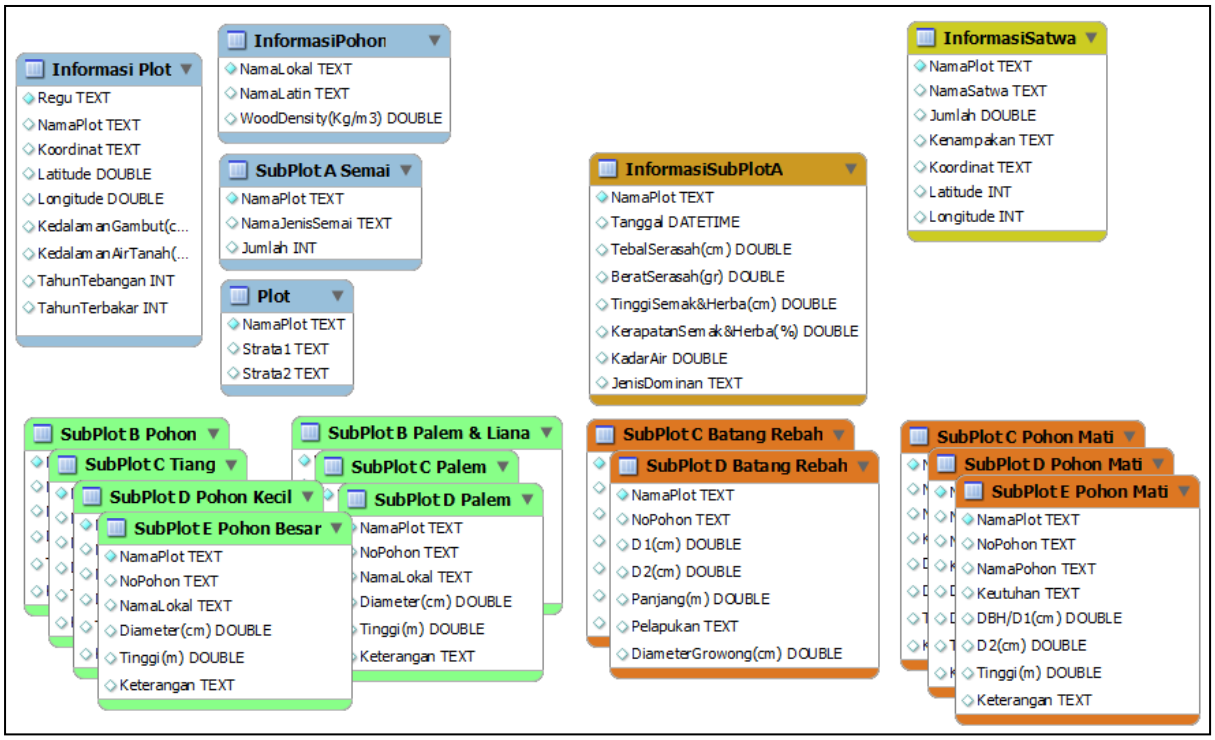


Figure 1-2 Previous Project Microsoft Access Data Structure

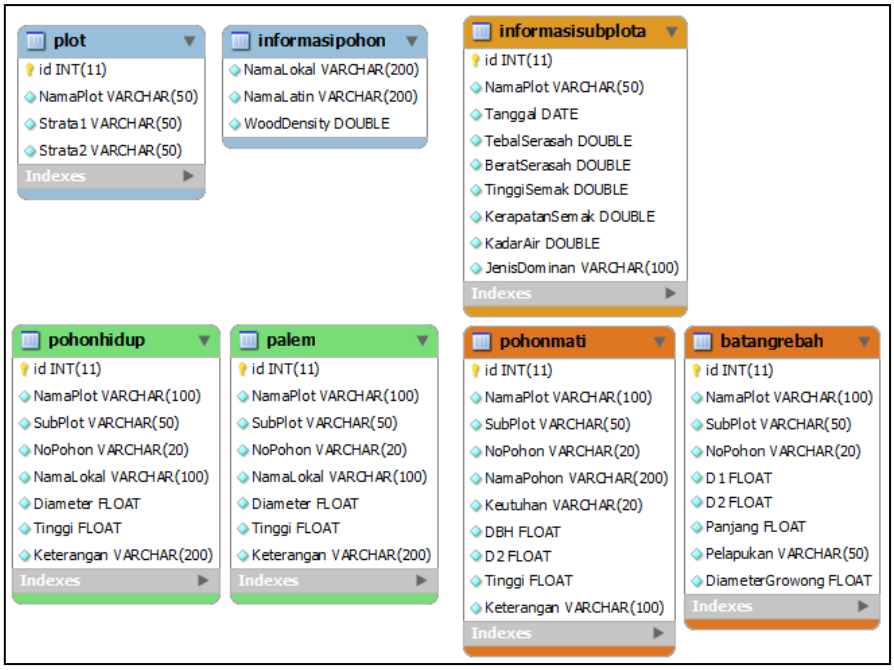


Figure 1-3 Previous Project MySQL Data Structure

The formulas used in the previous project were:

- AGB Carbon Stock: $C\ Kg/Tree = aD^b$
- DOM Carbon Stock:
  - Litter: $C\ Litter = \frac{Litter\ \ Weight}{1+\frac{Water\ \ Content}{100}}\ x\ \%Carbon$
  - Dead Tree: $C\ Kg/Tree = aD^b\ x\ correction\ factor$
  - Dead Wood: $C\ Kg/Tree = m\ x\ \ 15\%$, where:
    - $m = V\ x\ Mass\ density\ factor$
    - $V = \frac{1}{2}\pi r^2 p$
- Soil Carbon Stock: $C\ Soil\ /\ Ha = \frac{Volume\ \ x\ Mass\ \ Density}{Area}$
- Total Carbon Stock: AGB + DOM + Soil
- Importance Value Index:
  - $Density\ (D) = \frac{Species\ \ Tree\ \ Count}{Entire\ \ plot\ \ area}$
  - $Relative\ Density\ (DR) = \frac{Species\ \ Density}{Density\ \ sum\ \ of\ \ all\ \ species} x100\%$
  - $Frequency\ (F) = \frac{Number\ \ of\ subPlot\ \ where\ a\ species\ \ is\ found}{Sub\ \ plot\ \ count}$
  - $Relative\ Frequency\ (FR) = \frac{Species\ \ Frequency}{Frequency\ \ \ sum\ \ of\ \ all\ \ species} x100\%$
  - $Dominance\ (Do) = \frac{Sum\ \ of\ \ species\ \ basal\ \ area}{Entire\ \ plot\ \ area}$
  - $Relative\ Dominance\ (DoR) = \frac{Species\ \ dominance}{Total\ \ dominance\ \ \ of\ \ all\ \ species} x100\%$
  - $Importance\ Value\ Index = DR + FR + DoR$

2 OBJECTIVES

Based on meetings, several points to be developed or revised were concluded. Those are:

2.1 DATA INPUT

Previously, the data was inputted into Microsoft Access and then extracted into MySQL through the software. The new software was intended to do the data input and also output the calculation results.

2.2 REVISION OF THE CALCULATION METHODS.

Although previously the software developed was able to provide fast and accurate Carbon Stock calculation, the software calculation accuracy could be improved by including into the calculation additional data such as mass density and by applying different carbon stock calculation formulas to different species. This requirements triggered the needs for additional data table for the formulas and additional fields on related tables. The script for the carbon stock calculation also needs to be rewritten entirely which includes the calculation of AGB Carbon Stock, DOM Carbon Stock: Litter, Dead Wood, Dead Tree.

The formulas below will be used to calculate the trees' biomass carbon content. The trees' biomass is to be multiplied with a carbon fraction to find its carbon content.The SOM calculation also revised to include multiple layers to accommodate further possibilities.

1. AGB Carbon Stock: $f(DBH, WD)$ x % Carbon
2. BGB = f(AGB) x % Carbon
3. DOM Carbon Stock:
    a. Litter: $C\ Litter = \frac{Dry\ Weight\ Sample}{Fresh\ Weight\ Sample}\ x\ Fresh\ Weight\ Litter\ x\ \%Carbon$
    b. Dead Tree: $C\ Kg/Tree = f(DBH, WD)$ x % Carbon
    c. Dead Wood: $C\ \frac{Kg}{Tree} = m\ x\ \%\ Carbon$, where:
        i. $m = V\ x\ Mass\ density$
        ii. $V = \frac{1}{2}\pi {r_1}^2 l_1 - \frac{1}{2}\pi {r_2}^2 l_2$

        Where r_1 and l_1 are wood radius and length, while r_2 and l_2 are hollow radius and length.
4. Total Soil Carbon Stock for each layer:

$$C\ Soil\ = \left(\left(Volume - \frac{BGB}{Wood\ Density}\right)\ x\ Bulk\ Density\ x\ \%\ Carbon\right)$$

5. Soil Carbon Stock per ha: $C\ Soil/Ha = \frac{C\ Soil}{Area\ (ha)}$
6. Total Carbon Stock: AGB + DOM + Soil
   - % Carbon are variables which can be changed by user

2.3 ADDITIONAL CALCULATION.

The software also should include BGB Carbon Stock calculation (formula specified above), as it was also an important carbon pool. The software also added tree distribution per diameter range in the stand composition menu.

2.4 Database Structure Redesign.

While the previous software were able to calculate carbon stocks, but since the tables in the database structures above are not yet related, there are known error which could be triggered when there are no tree findings in a plot area. Each tables stands on their own when they should be related to each other. Therefore there is a need to design a new relational database structure to alleviate the known error and to improve computing and storage efficiency. Based on the calculation methods revision, there is also the need to add additional tables and fields to certain tables on the database to accommodate more accurate calculation.

2.5 The Species Composition Adaption.

There are no changes in tree distribution, tree density and Importance Value Index calculation. But since the database need to be restructured, these calculations need to adapt to the new database structure.

2.6 Backup and Restore Feature

To accommodate portability, this software needs to be able to backup its data and also restore its data to a previous state. This feature will also enable the software to store data from various carbon accounting projects and reload the data whenever required.

3 Hardware and Software Requirements

3.1 Hardware Requirements

This software was build on a system with Microsoft Windows 7, 2GB DDR3 Memory, Intel Core i5-460M Processor.

3.2 Software Requirements

This software needs Apache web server, MySQL database server and PHP scripting language which are bundled in Appserv 2.5.10. Optionally, users could use XAMPP which is quite similar to Appserv.

4 Analysis and Design

4.1 Identification of Needs

The Forest Carbon Accounting software need to be able to:

- Receive data input and provide data view the inputted data which consists of:
    - Plot Settings:
        - Stratification
        - Plots
        - Sub Plots
    - Species and Allometric Settings:
        - Equation Data
        - Species Data
        - Family Data
        - Conversion Factors

    - Biomass Data Input:
        - Living Tree
        - Dead Tree
        - Dead Wood
        - Palms and Liana
        - Seedlings and Litter
- Calculate and provide view of the stand composition:
    - Tree Distribution per DBH range
    - Tree Distribution per Plot
    - Tree Density
    - Importance Value Index
- Calculate and provide view of the carbon stock per carbon pool:
    - Above Ground Biomass (AGB) Carbon Stock
    - Dead Organic Matter (DOM) Carbon Stock
    - Below Ground Biomass (BGB) Carbon Stock
    - Soil Organic Matter (SOM) Carbon Stock
    - Total Carbon Stock

4.2 Graphical User Interface (GUI) Design

Following are the wireframe GUI Designs.

4.2.1 Main Frame and Menus

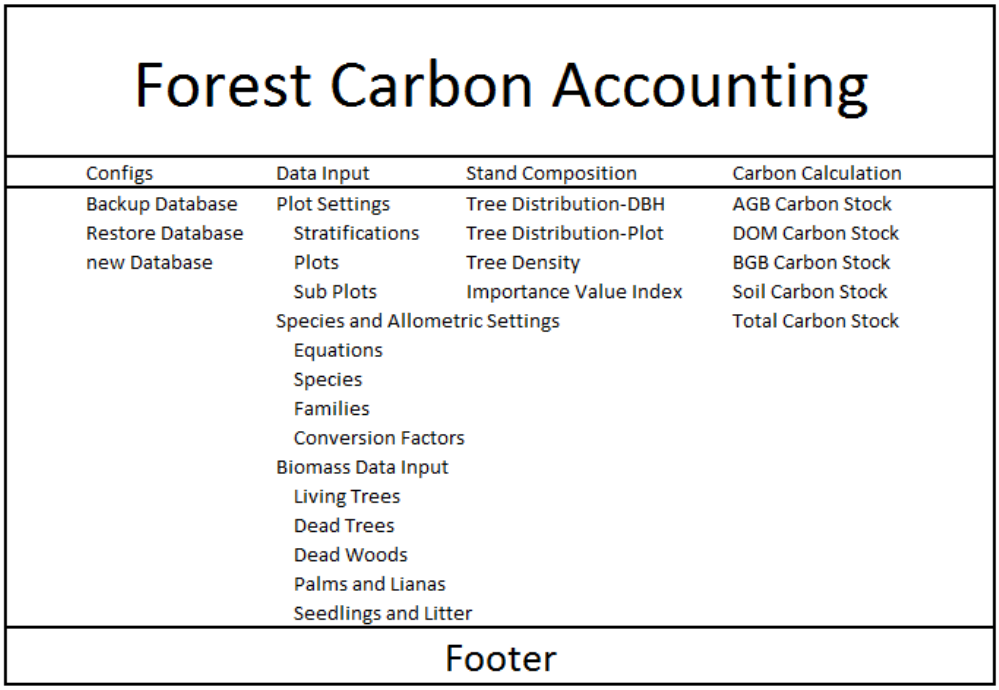


Figure 4-1 Main Menu wireframe design

4.2.2 Stratifications

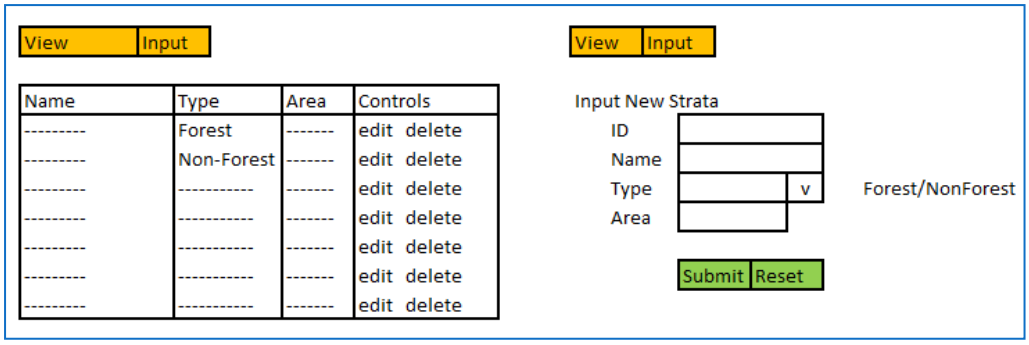


Figure 4-2 Stratifications wireframe design

4.2.3 *PLOTS*

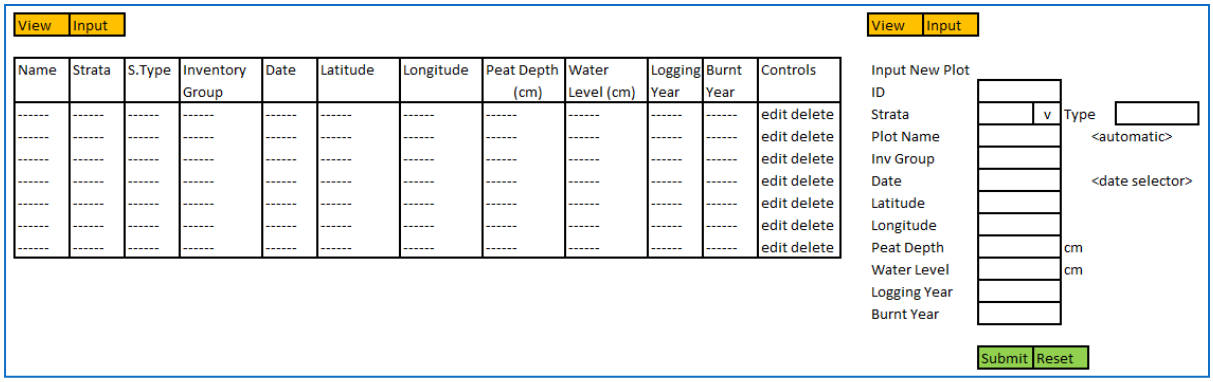


Figure 4-3 Plots wireframe design

4.2.4 *SUB PLOTS*

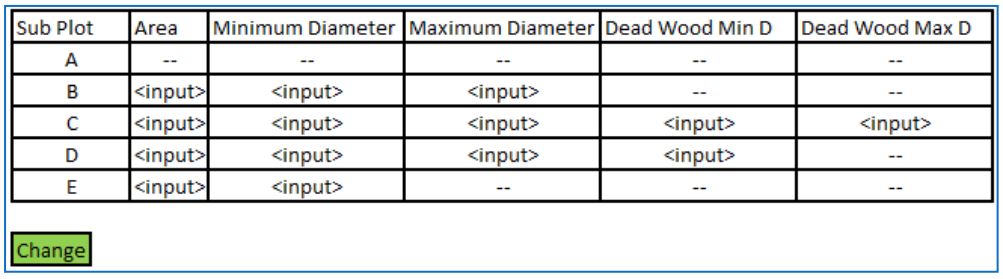


Figure 4-4 Sub Plots wireframe design

4.2.5 *EQUATIONS*

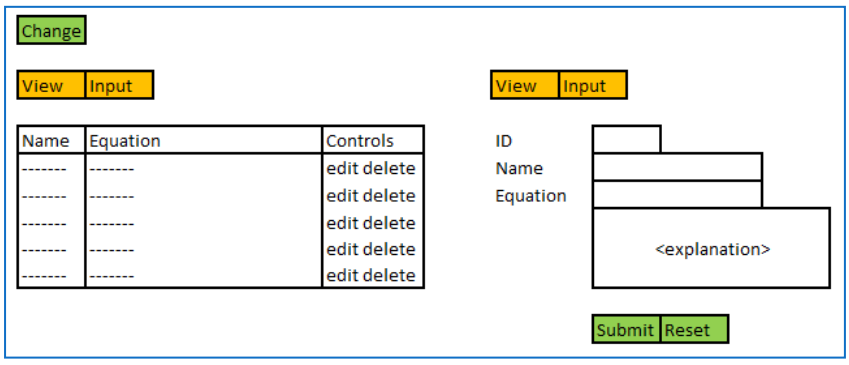


Figure 4-5 Equations wireframe design

4.2.6 *SPECIES*

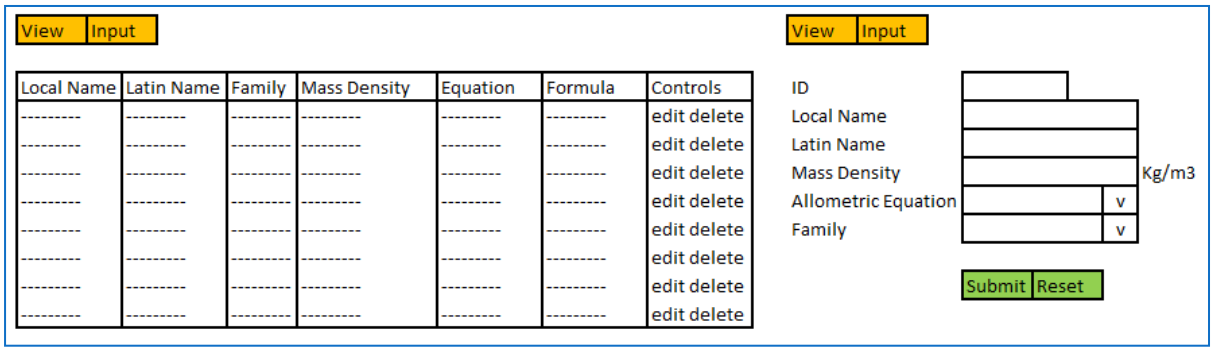


Figure 4-6 Species wireframe design

4.2.7 *FAMILIES*

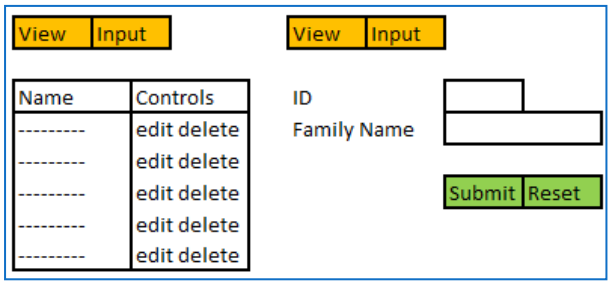


Figure 4-7 Families wireframe design

4.2.8 *CONVERSION FACTORS*

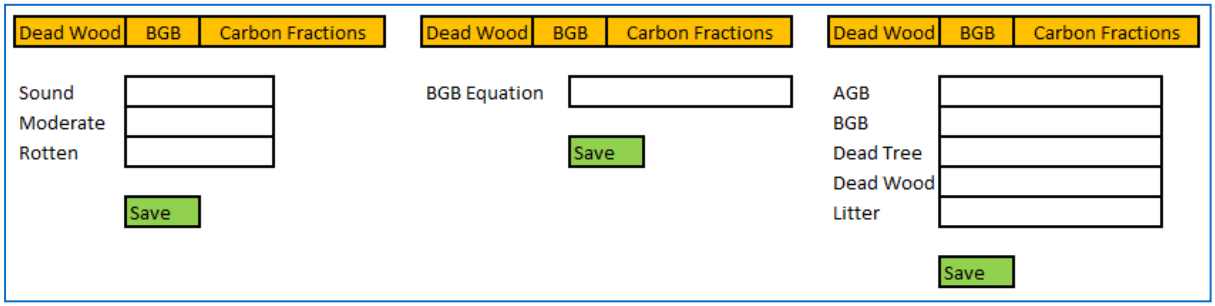


Figure 4-8 Conversion Factors wireframe design

4.2.9 *LIVING TREE*

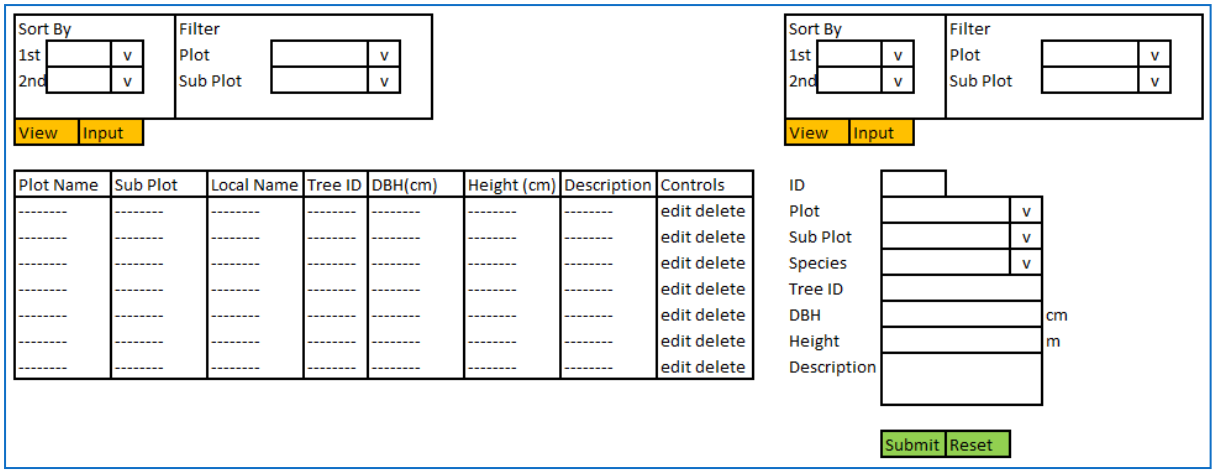


Figure 4-9 Living tree wireframe design

4.2.10 *Dead Tree*

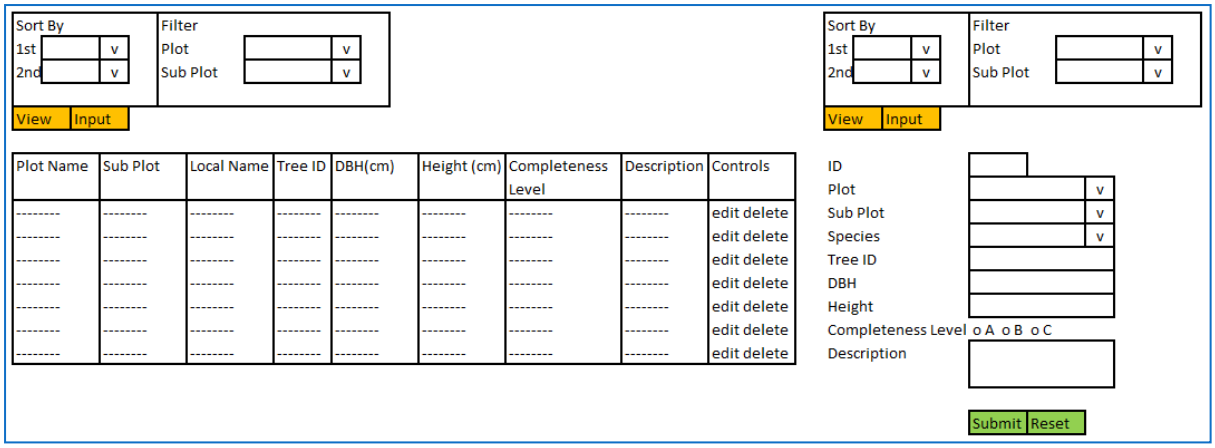


Figure 4-10 Dead tree wireframe design

4.2.11 *Dead Wood*

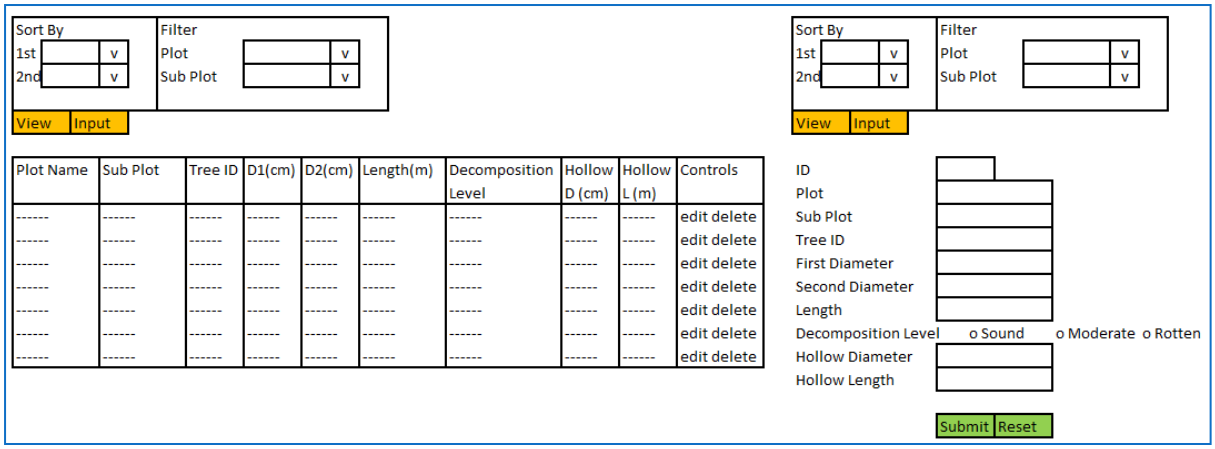


Figure 4-11 Dead Wood wireframe design

4.2.12 *Palms and Lianas*

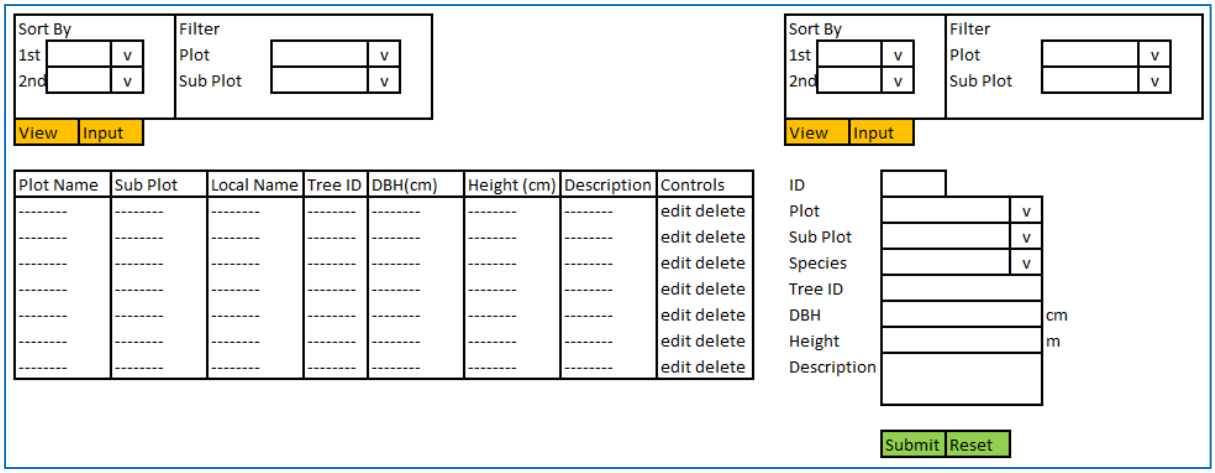


Figure 4-12 Palms and lianas wireframe design

4.2.13 *Seedlings and Litter*

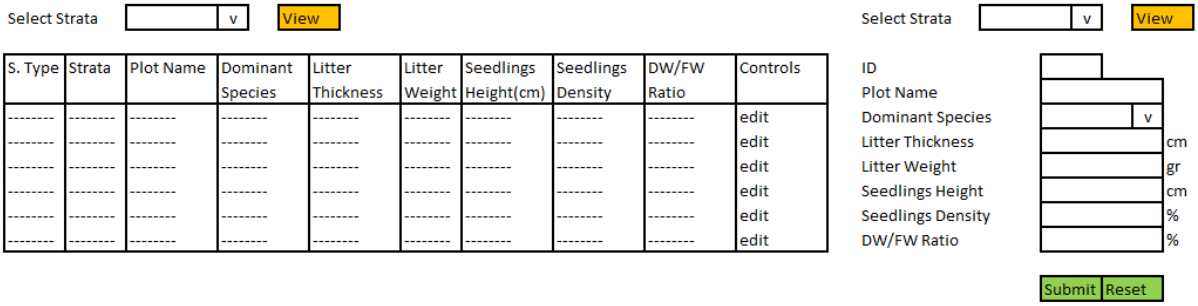


Figure 4-13 Seedlings and litter wireframe design

4.2.14 *AGB Carbon Stock*

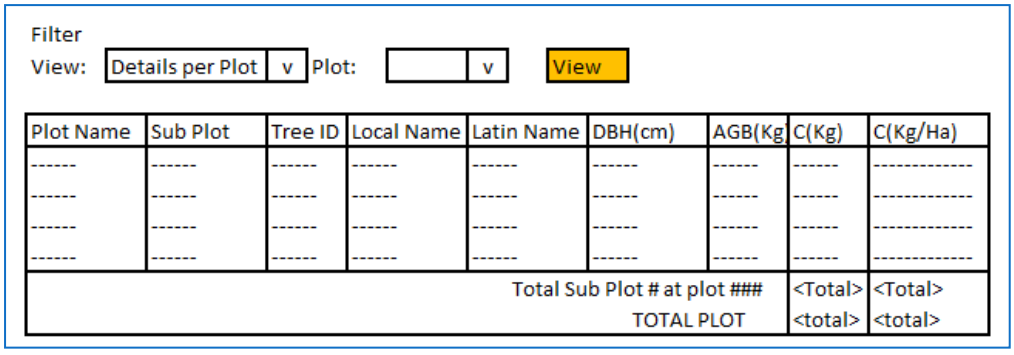


Figure 4-14 AGB Carbon details per plot wireframe design

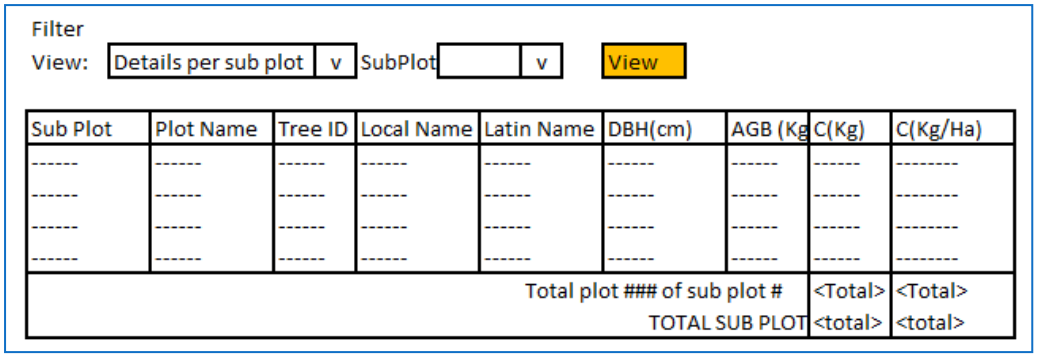


Figure 4-15 AGB Carbon details per sub plot wireframe design

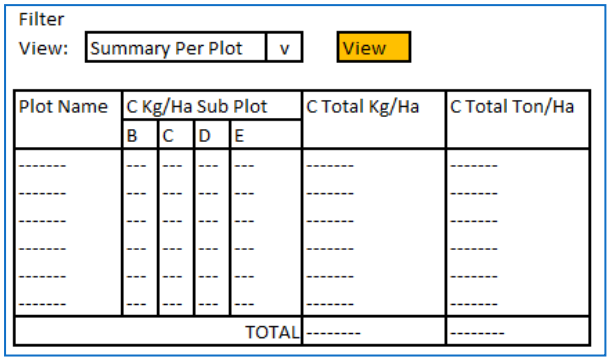


Figure 4-16 AGB summary per plot wireframe design

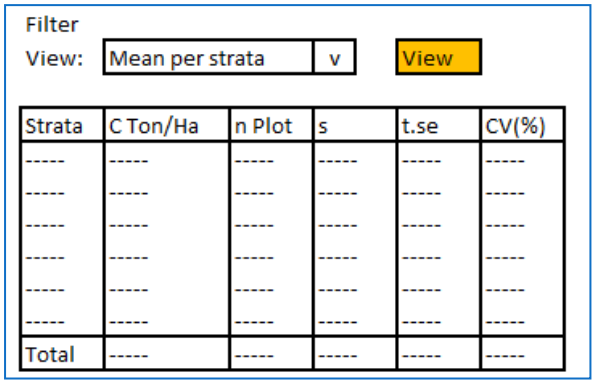


Figure 4-17 AGB mean per strata wireframe design

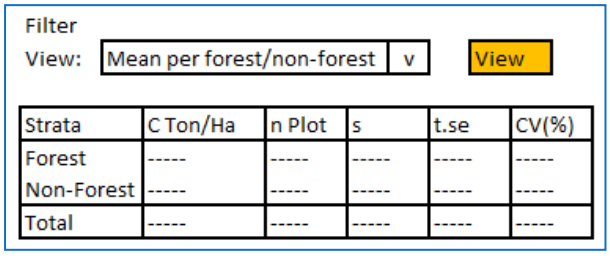


Figure 4-18 AGB mean per forest/non-forest wireframe design

4.2.15 DOM CARBON STOCK

4.2.15.1 Dead Tree

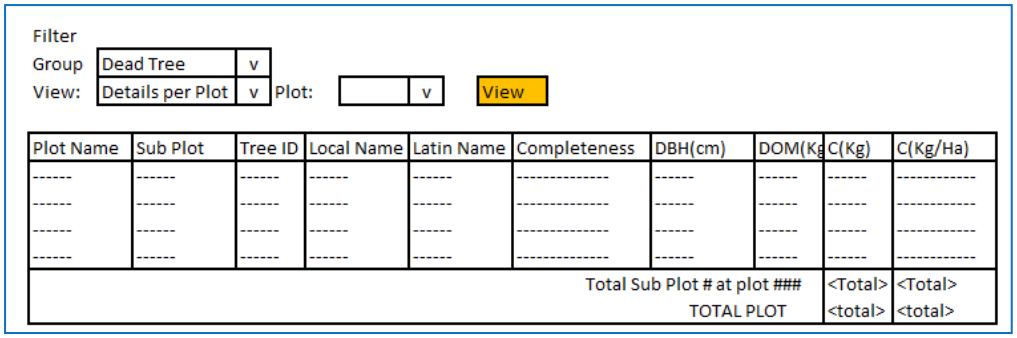


Figure 4-19 Dead tree details per plot wireframe design

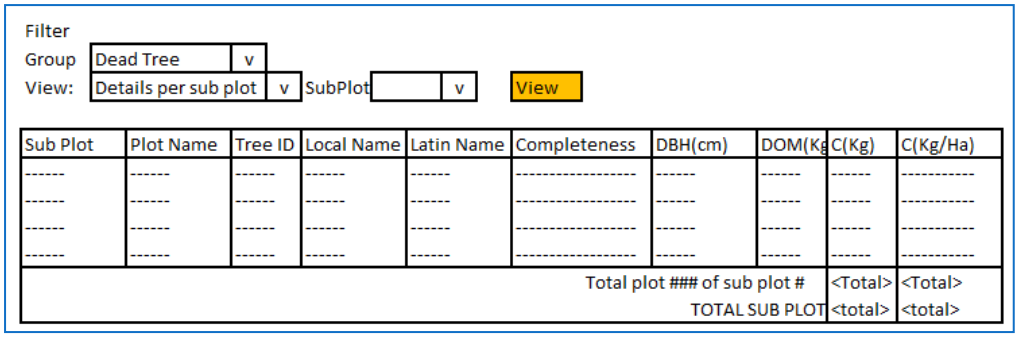


Figure 4-20 Dead tree details per sub plot wireframe design

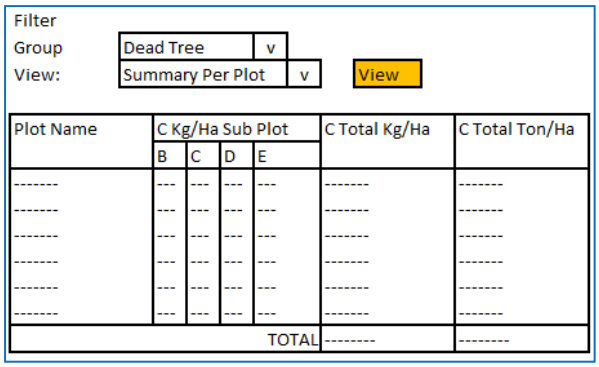


Figure 4-21 Dead tree summary per plot wireframe design

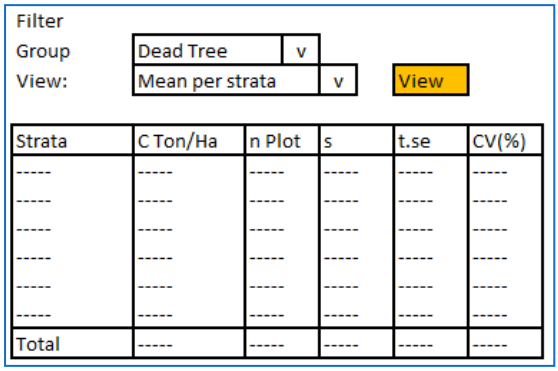


Figure 4-22 Dead tree mean per strata wireframe design

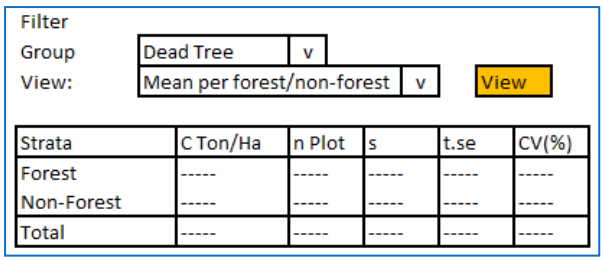


Figure 4-23 Dead tree mean per forest/non-forest wireframe design

4.2.15.2 Dead Wood

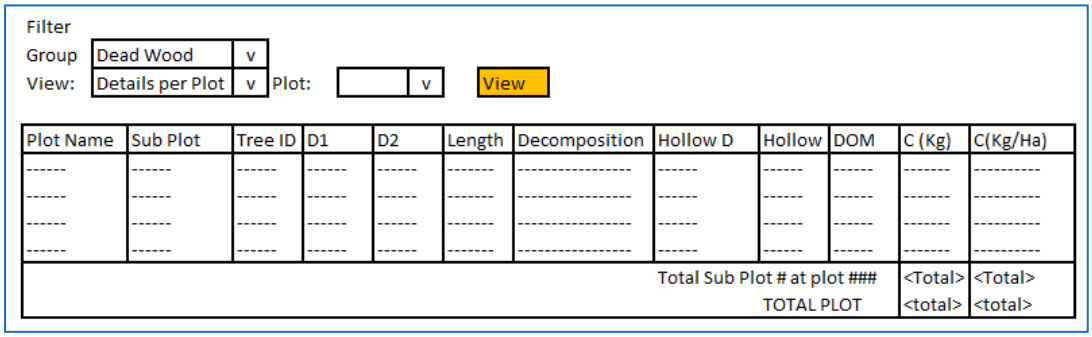


Figure 4-24 Dead wood details per plot wireframe design

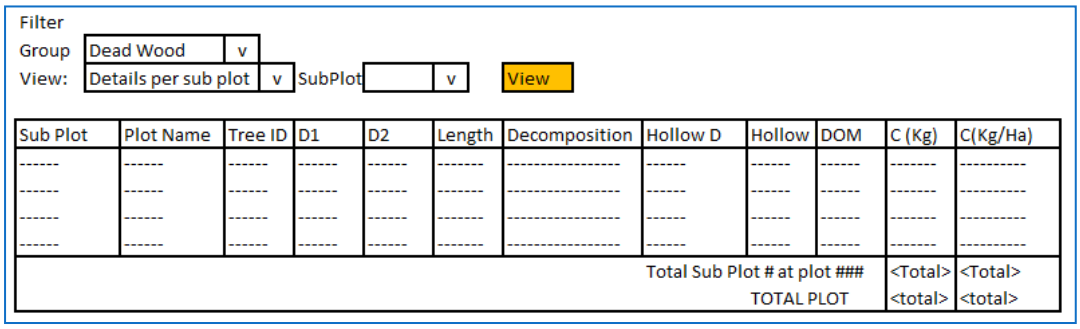


Figure 4-25 Dead wood details per sub plot wireframe design

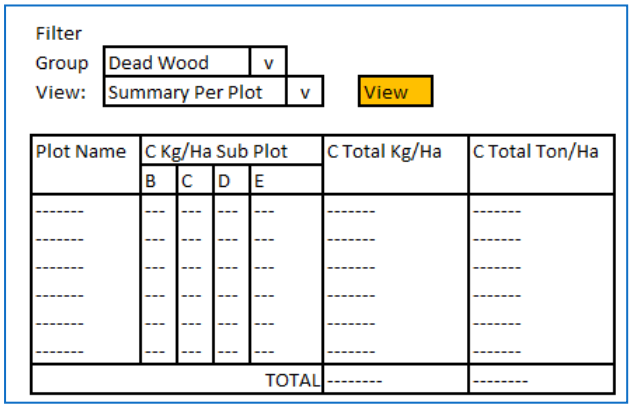


Figure 4-26 Dead wood summary per plot wireframe design

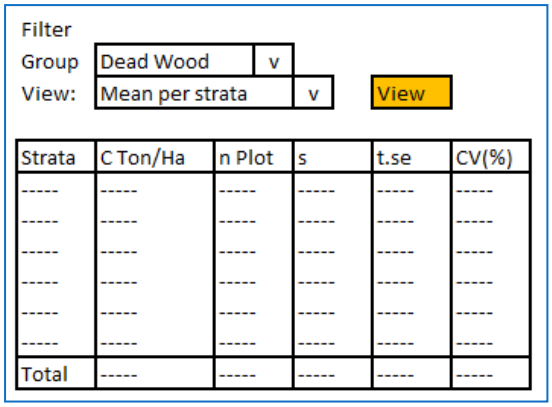


Figure 4-27 Dead wood mean per strata wireframe design

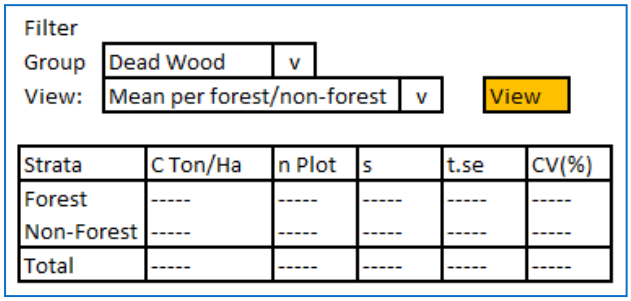


Figure 4-28 Dead wood mean per forest/non-forest wireframe design

4.2.15.3 Litter

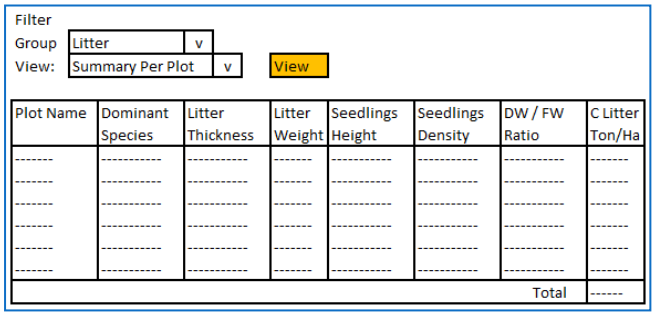


Figure 4-29 Litter summary per plot wireframe design

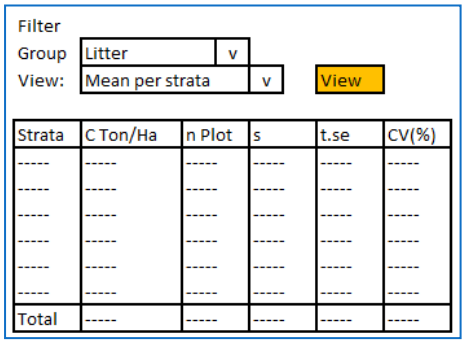


Figure 4-30 Litter mean per strata wireframe design

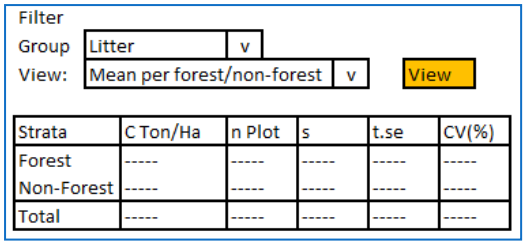


Figure 4-31 Litter mean per forest/non-forest wireframe design

4.2.16 BGB CARBON STOCK

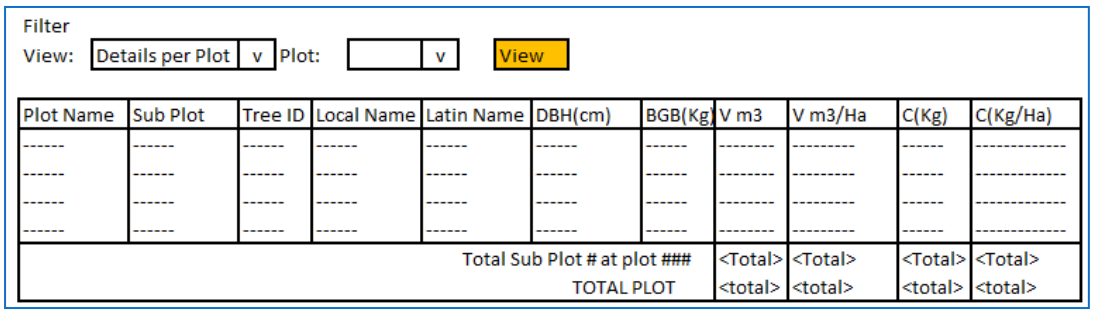


Figure 4-32 BGB Carbon details per plot wireframe design

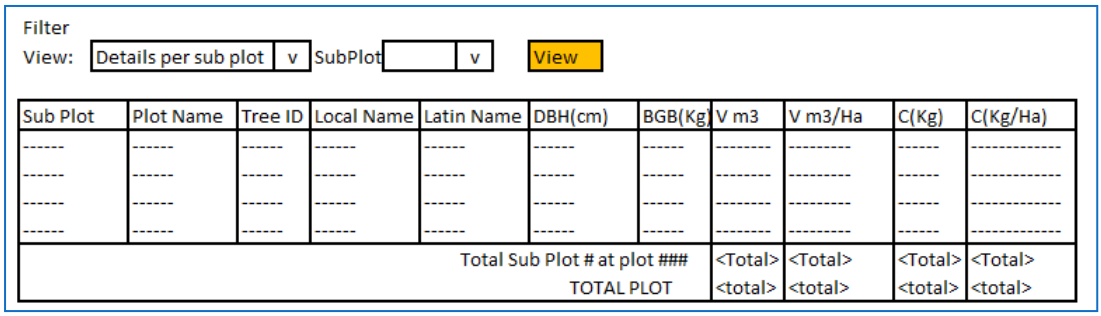


Figure 4-33 BGB Carbon details per sub plot wireframe design

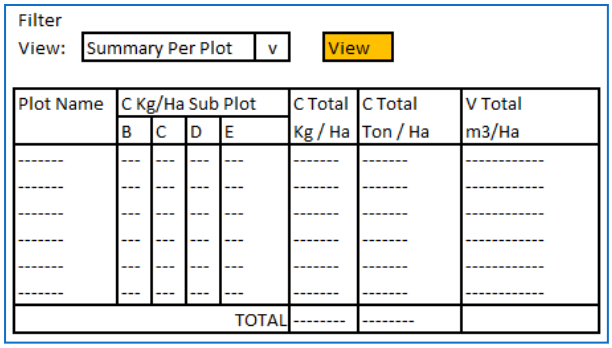


Figure 4-34 BGB Carbon summary per plot wireframe design

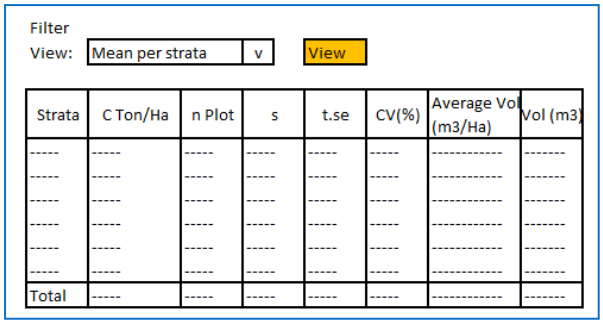


Figure 4-35 BGB Carbon mean per strata wireframe design

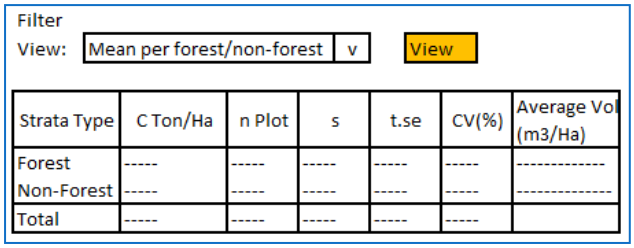


Figure 4-36 BGB mean per forest/non-forest wireframe design

4.2.17 Soil Carbon Stock

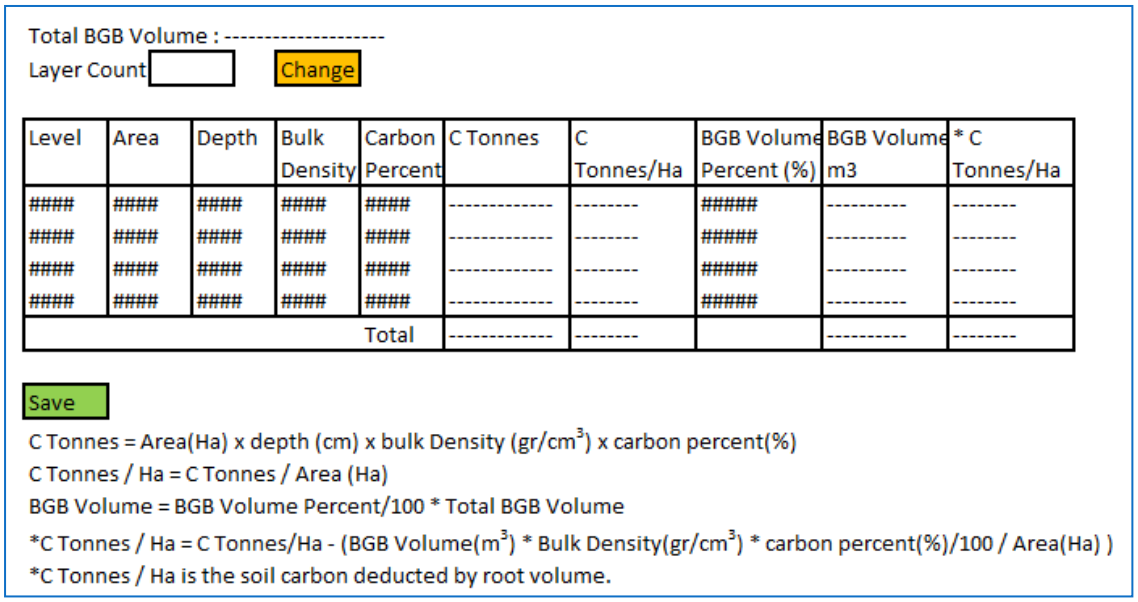


Figure 4-37 Soil carbon stock wireframe design

4.2.18 Total Carbon Stock

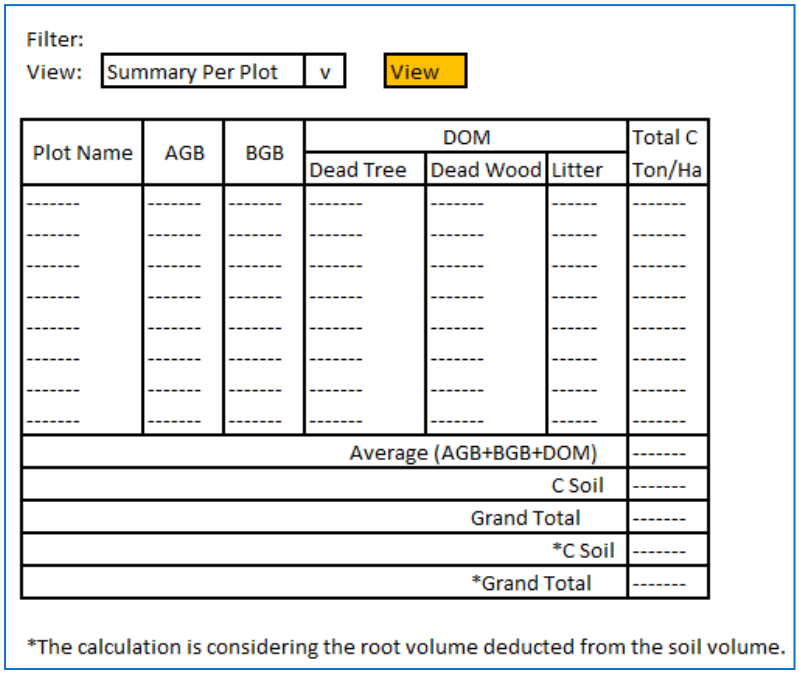


Figure 4-38 Total carbon stock per plot wireframe design

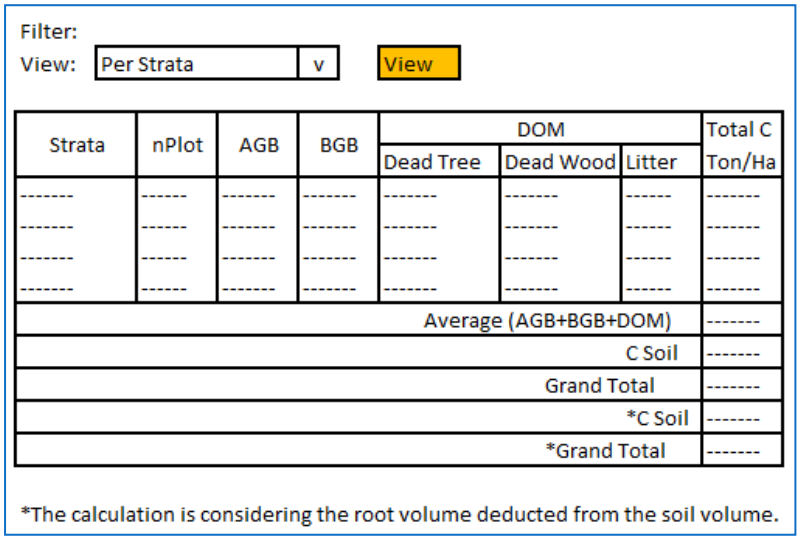


Figure 4-39 Total carbon stock per strata wireframe design

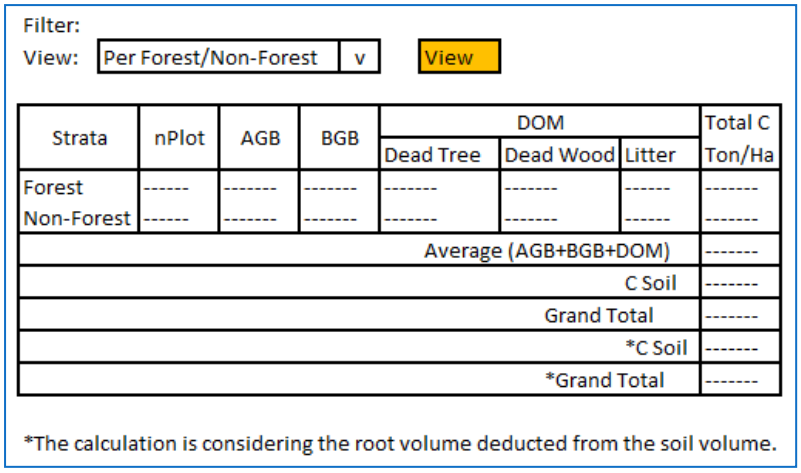


Figure 4-40 Total carbon stock per forest/non-forest wireframe design

4.2.19 BACKUP DATABASE

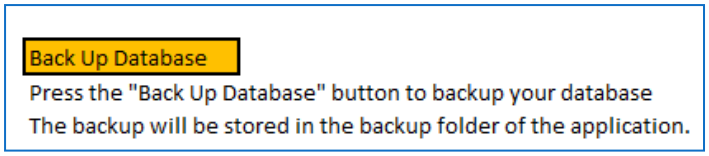


Figure 4-41 Back up database wireframe design

4.2.20 RESTORE DATABASE

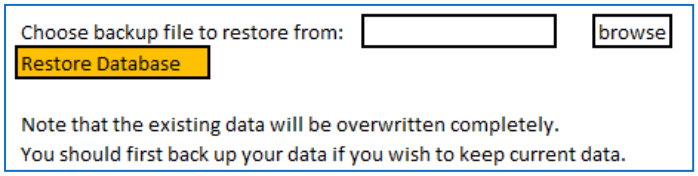


Figure 4-42 Restore database wireframe design

4.2.21 NEW DATABASE

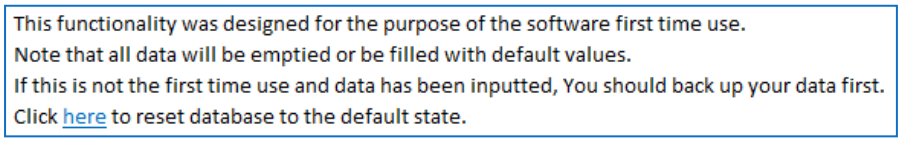


Figure 4-43 New database wireframe design

4.3 STRUCTURE OF TABLES

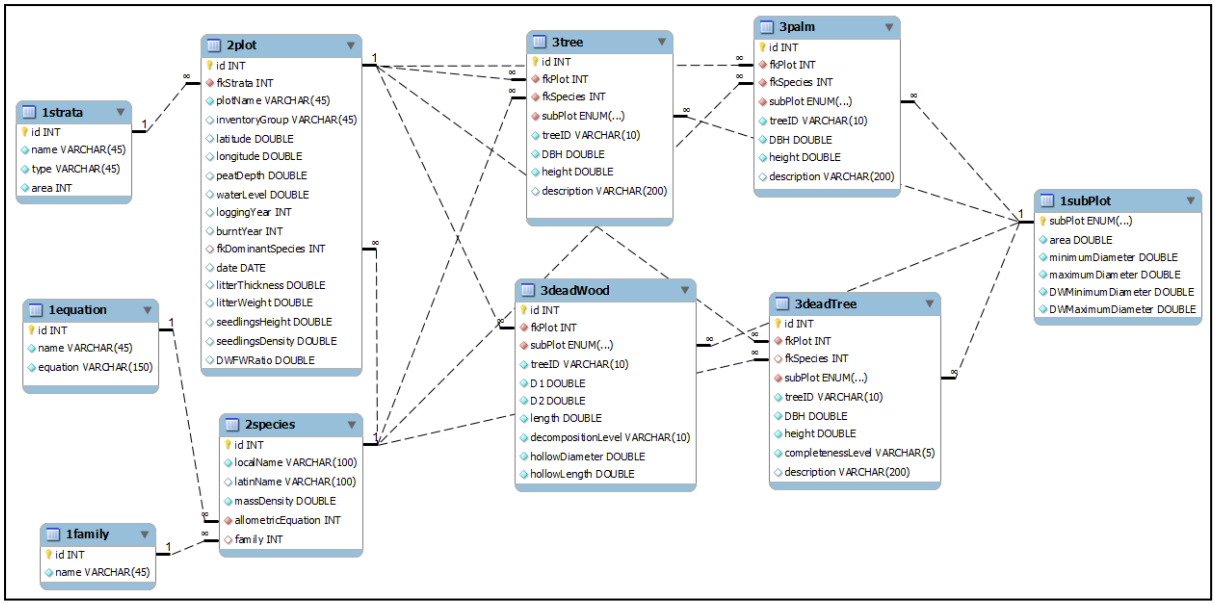


Figure 4-44 New database Structure of tables

5 RESULTS

Described below are the software developed on this project.

5.1 HOME

This is the starting point of the software. Users will see this page first when using the software. This page provides navigation and information about the software.

(Gambar dan penjelasan)

5.2 CONFIGS

This menu group contains software administration functionalities. Which includes database backup, database restoration and new database. These menu can used to save datas from different carbon inventory projects. Users can input trees data, back up the database, and then start a new carbon inventory projects by choosing new database and then back up the database. Users later can choose and restore the data they wish to view.

5.2.1 BACKUP DATABASE

This menu provides database backup functionality. Users can use this menu to back up their databases so that they could restore the database to previous state. The backup files will be saved in the backup folder of the application. The default name for the backup file will be: “backup <dd-MM-yyyy hh:mm:ss>.fsql”. Users later can manually rename the file to a more fitting name, for example: south sumatra forest 2011.fsql.

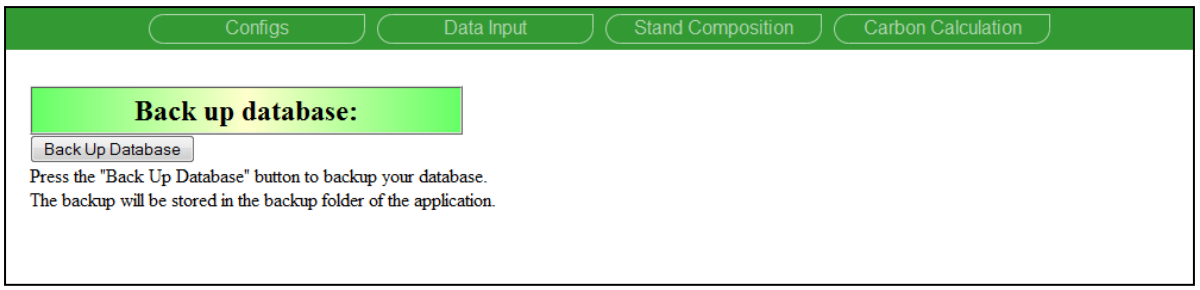


Figure 5-1 Database Backup Screenshot

5.2.2 RESTORE DATABASE

This menu provides database restoration functionality. Users can restore database to earlier condition. Users should use only the files generated by this software backup process. Users should not manually edit the contents of the backup files or use backup files generated by another software. Results are unpredictable for those actions. Note that the data prior to the restoration process will be lost. It is advised that users back up their database before using this menu.

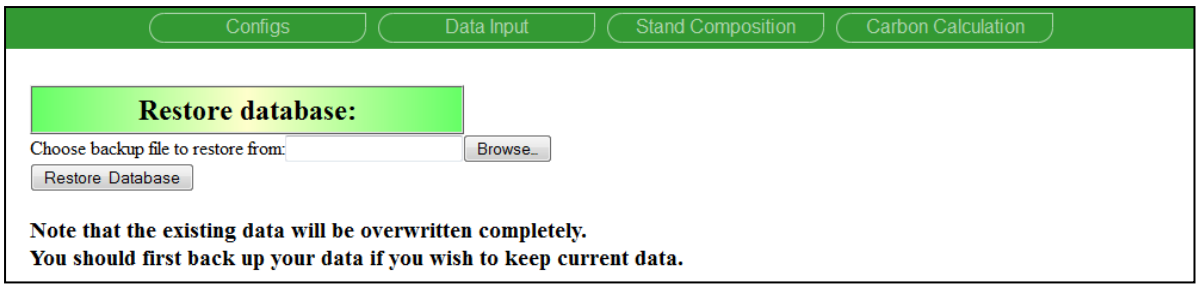


Figure 5-2 Database Restore Screenshot

5.2.3 NEW DATABASE

This menu provides new database functionality. If users need to clear the data and start a new carbon inventory project, user can use this menu to empty the database. The database will be emptied and some data such as equations and sub plots will be set into its default state. It is advised that users back up their database before using this menu except the first time use.

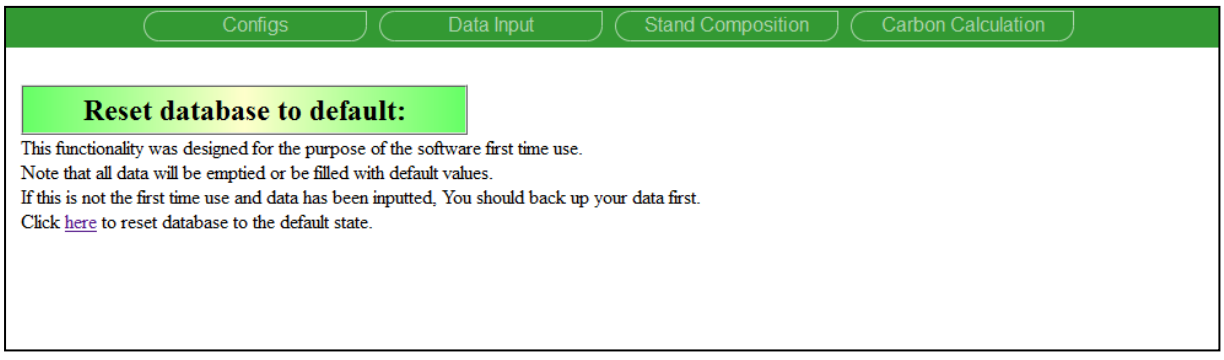


Figure 5-3 New Database Screenshot

5.3 DATA INPUT

This menu group contains data management functionalities. Users can manage raw data in the menu provided in this menu group. The menus in this menu group includes: stratas, plots, sub

plots, equations, species, families, conversion factors, living trees, dead trees, dead woods, palms and lianas, seedlings and litters. When inputting the data, if an the software detected an error in the values inputted, the values previously inputted will be lost. It is advised for the user to press the browser's back button to continue editting the values.

5.3.1 PLOT SETTINGS

This menu is separated further into Stratifications, Plots and Sub Plots menus. Before inputting trees data, users should first fill these data since these data will influence the trees data input.

The stratifications menu provides the funcitonality to input, view, edit and delete stratas. Note that strata name, type and area are required when inputting new stratas. The strata area has to be an integer, and the stratas names should be unique.

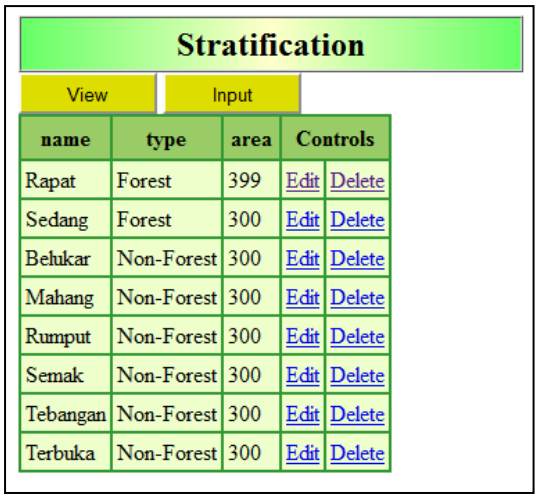


Figure 5-4 View Strata Screenshot

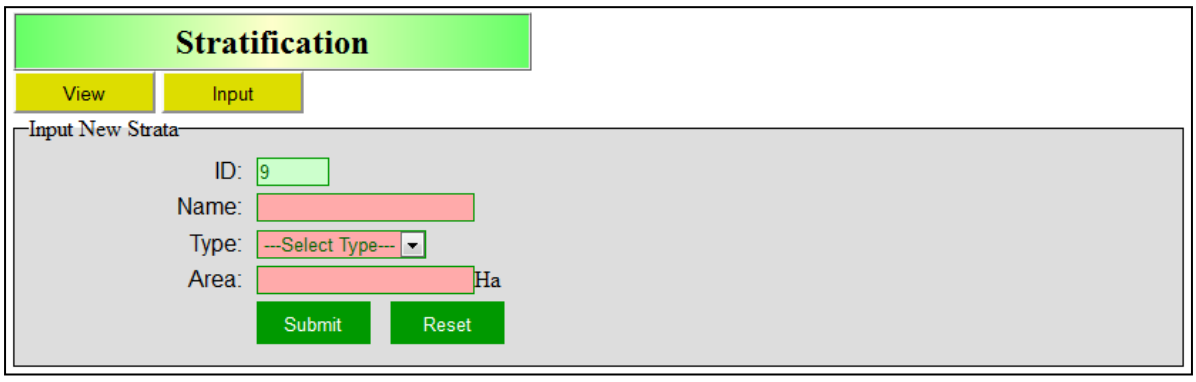
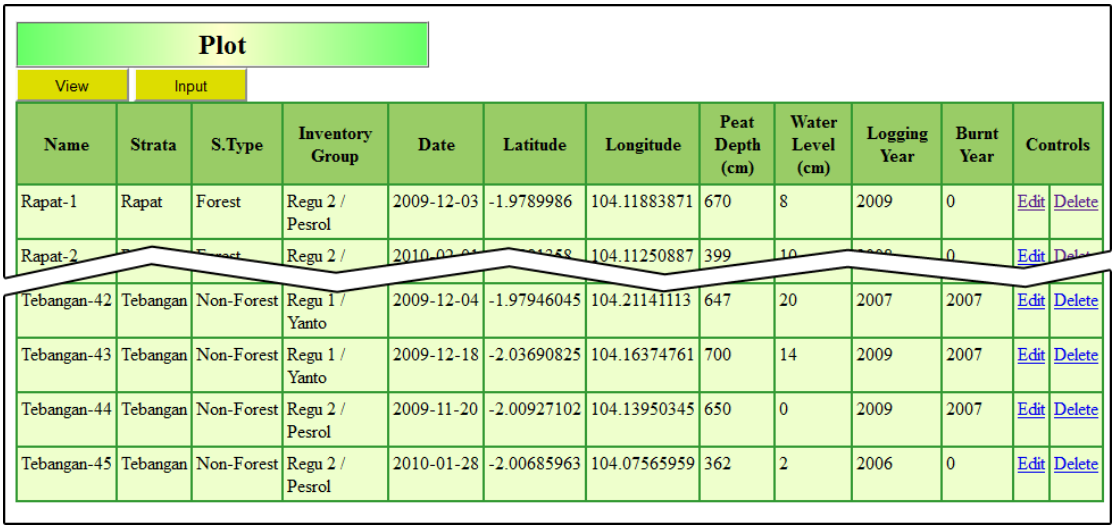


Figure 5-5 Input Strata Screenshot

The plots menu provides functionality to input, view, edit and delete plots. Plot names are automatically filled with "<strata name>-<plot ID>" when users select stratas for example, if the plot ID is 27 and the strata is "medang", the plot name will be medang-27. The rest of the fields are not compulsory. If not filled, inventory group will be empty, date will be filled with "0000-00-00" value, latitude, longitude, peat depth, water level, logging year and burnt year will be filled with 0. The latitude, longitude, peat depth, water level, logging year and burnt year can not accept non numeric values.



Plot

View Input

Name	Strata	S.Type	Inventory Group	Date	Latitude	Longitude	Peat Depth (cm)	Water Level (cm)	Logging Year	Burnt Year	Controls
Rapat-1	Rapat	Forest	Regu 2 / Pesrol	2009-12-03	-1.9789986	104.11883871	670	8	2009	0	Edit Delete
Rapat-2			Regu 2 /			104.11250887	399			0	Edit
Tebangan-42	Tebangan	Non-Forest	Regu 1 / Yanto	2009-12-04	-1.97946045	104.21141113	647	20	2007	2007	Edit Delete
Tebangan-43	Tebangan	Non-Forest	Regu 1 / Yanto	2009-12-18	-2.03690825	104.16374761	700	14	2009	2007	Edit Delete
Tebangan-44	Tebangan	Non-Forest	Regu 2 / Pesrol	2009-11-20	-2.00927102	104.13950345	650	0	2009	2007	Edit Delete
Tebangan-45	Tebangan	Non-Forest	Regu 2 / Pesrol	2010-01-28	-2.00685963	104.07565959	362	2	2006	0	Edit Delete

Figure 5-6 View Plot Screenshot

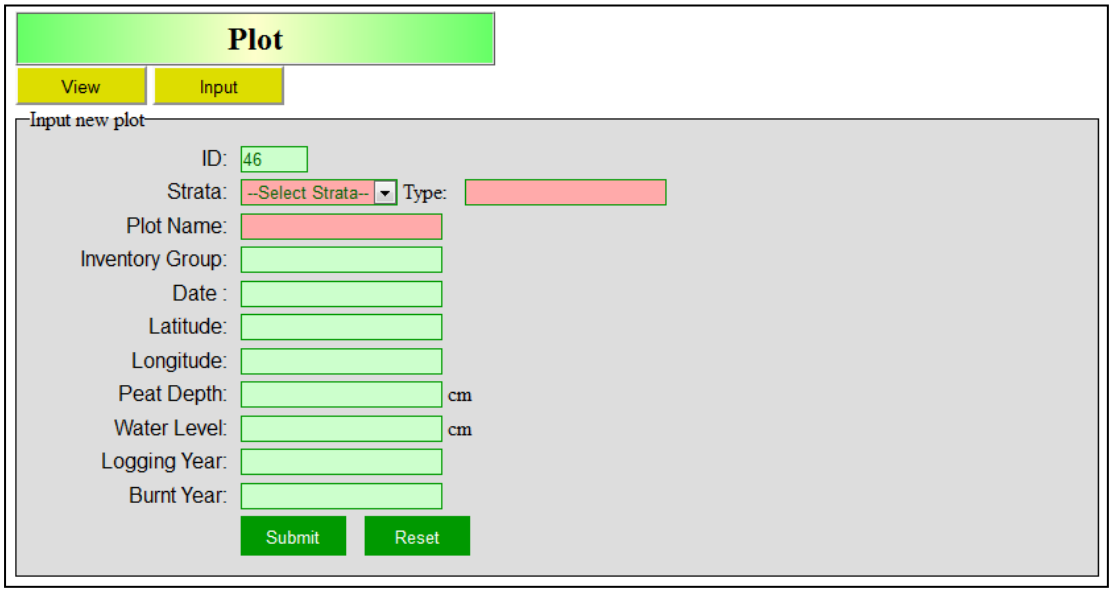


Figure 5-7 Input Plot Screenshot

The sub plots menu provides functionality to change the sub plots settings. Which includes sub plot area, minimum diameter, maximum diameter, dead wood minimum diameter and dead wood maximum diameter. The sub plots areas will be used in calculating the biomass and carbon stock, while the diameter ranges will be used as input restriction when inputting trees data. While the sub plot area could be changed any time, the minimum diameter, maximum diameter, dead wood minimum diameter and dead wood maximum diameter should not be changed after inputting trees data. For example if the minimum diameter for sub plot B is initially 5 cm and the maximum diameter initally is 10 cm, users can input trees data as sub plot B and specify 6 cm for its diameter. If after the trees data input, users change the minimum diameter for sub plot B into 10 cm and its maximum into 20cm, the 6 cm tree data will still exists and will be identified by the software as a sub plot B tree data.

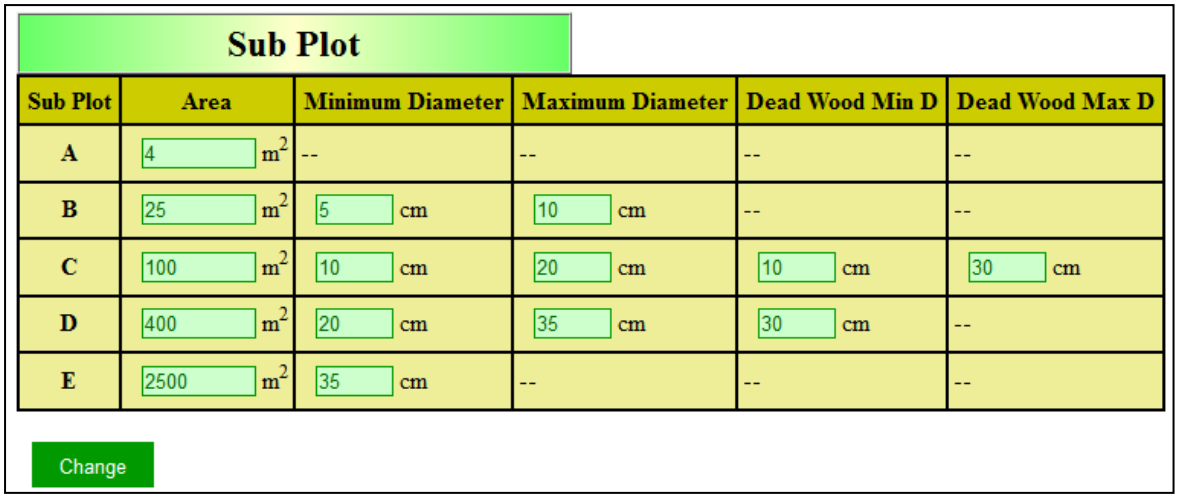


Figure 5-8 Sub Plots Screenshot

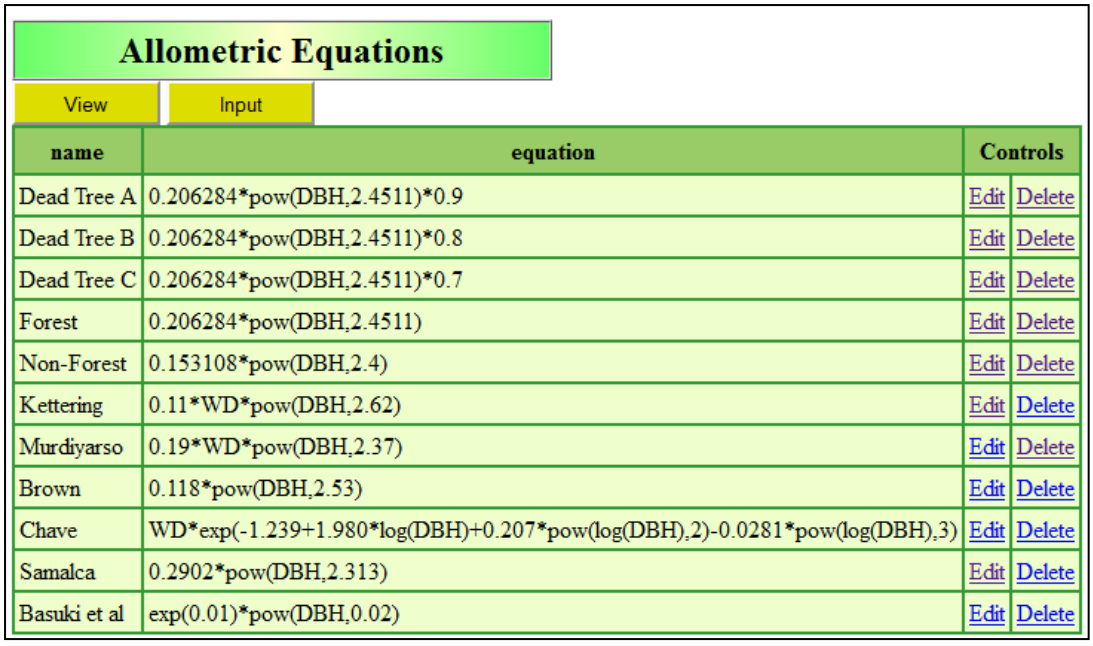
5.3.2 Species and Allometric Settings

This menu is separated further into Equations, Species, Families, Conversion Factors.

The equations menu provides functionality to manage the formulas for calculating trees biomass and carbon stock. Note that the formula used for calculating the trees biomass is determined by the trees species and their respective equation. When using the software for the first time, every species will be using the default "Forest" equation. Especially for dead trees, the equations used will be equations "Dead Tree A", "Dead Tree B", and "Dead Tree C" each for dead trees with completeness level "A", "B", and "C" respectively. Users can not delete or change the name of the "Dead Tree A", "Dead Tree B", "Dead Tree C", "Forest" and "Non-Forest" equations.

Users could use PHP mathematical functions for the equations. Those are pow for exponent, log for natural logarithm, log10 for base 10 logarithm, and exp to find the exponent of natural number e. Users should input the equation following common mathematical rules. Equation names should be unique.

When editting the equation, the software will check whether the equation contains WD variable. If it contains WD and some species with zero mass density (mass density is not specified) are using the equation, the software will reject the changes.

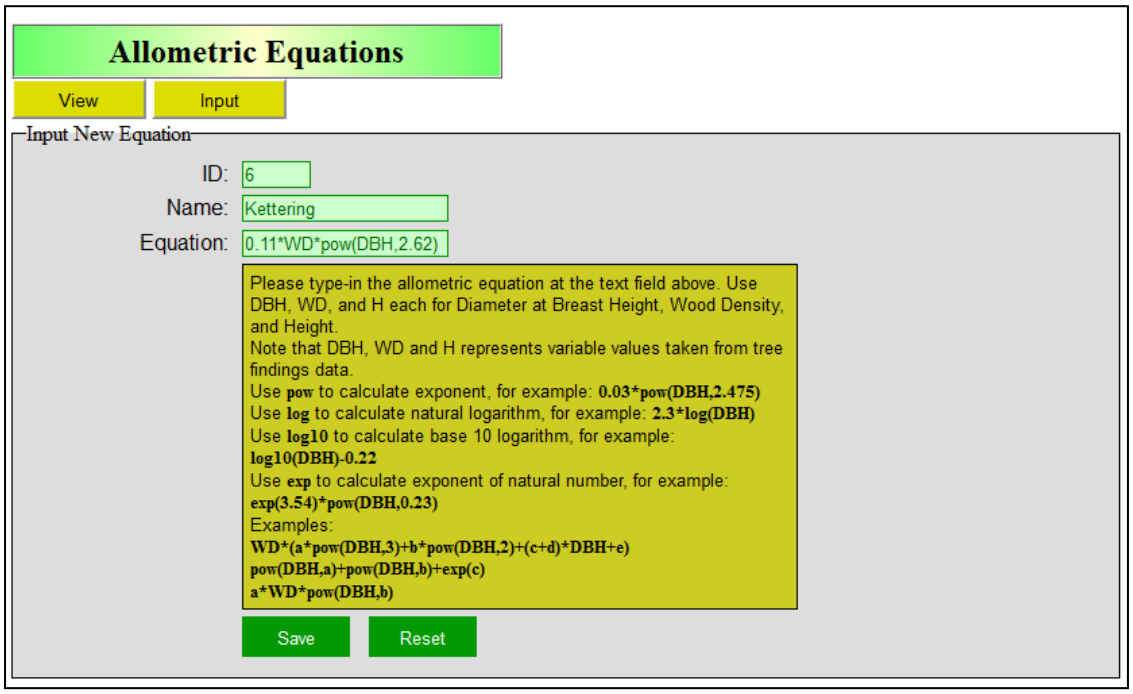


Allometric Equations

View | Input

name	equation	Controls	
Dead Tree A	0.206284*pow(DBH,2.4511)*0.9	Edit	Delete
Dead Tree B	0.206284*pow(DBH,2.4511)*0.8	Edit	Delete
Dead Tree C	0.206284*pow(DBH,2.4511)*0.7	Edit	Delete
Forest	0.206284*pow(DBH,2.4511)	Edit	Delete
Non-Forest	0.153108*pow(DBH,2.4)	Edit	Delete
Kettering	0.11*WD*pow(DBH,2.62)	Edit	Delete
Murdiyarso	0.19*WD*pow(DBH,2.37)	Edit	Delete
Brown	0.118*pow(DBH,2.53)	Edit	Delete
Chave	WD*exp(-1.239+1.980*log(DBH)+0.207*pow(log(DBH),2)-0.0281*pow(log(DBH),3)	Edit	Delete
Samalca	0.2902*pow(DBH,2.313)	Edit	Delete
Basuki et al	exp(0.01)*pow(DBH,0.02)	Edit	Delete

Figure 5-9 View Equations Screenshot



Allometric Equations

View | Input

Input New Equation

ID: 6

Name: Kettering

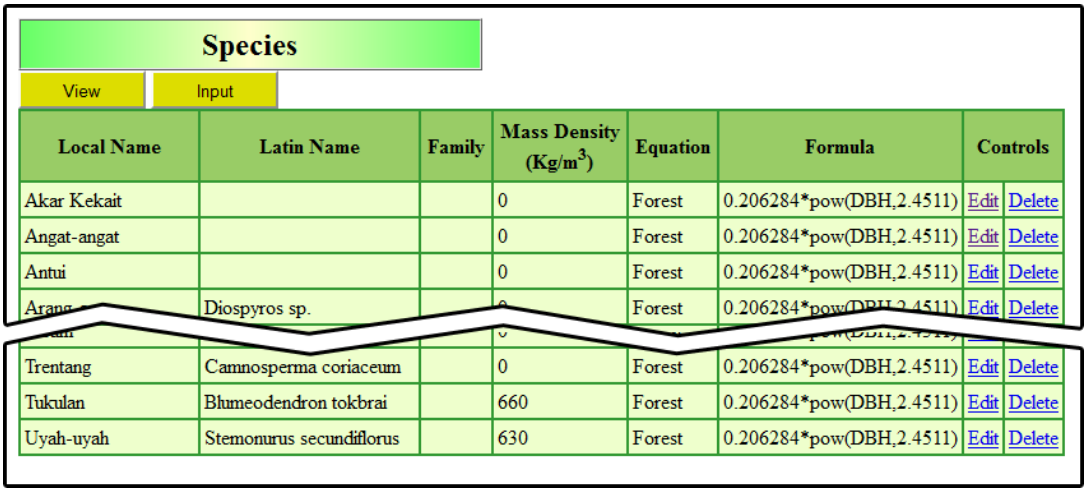
Equation: 0.11*WD*pow(DBH,2.62)

Please type-in the allometric equation at the text field above. Use DBH, WD, and H each for Diameter at Breast Height, Wood Density, and Height.
Note that DBH, WD and H represents variable values taken from tree findings data.
Use **pow** to calculate exponent, for example: **0.03*pow(DBH,2.475)**
Use **log** to calculate natural logarithm, for example: **2.3*log(DBH)**
Use **log10** to calculate base 10 logarithm, for example:
log10(DBH)-0.22
Use **exp** to calculate exponent of natural number, for example:
exp(3.54)*pow(DBH,0.23)
Examples:
WD*(a*pow(DBH,3)+b*pow(DBH,2)+(c+d)*DBH+e)
pow(DBH,a)+pow(DBH,b)+exp(c)
a*WD*pow(DBH,b)

Save | Reset

Figure 5-10 Input Equations Screenshot

The Species menu provides functionality to manage the trees species data. Users can view, input, edit and delete species data here. When inputting species, the species local name and its equation are compulsory. While its latin name, mass density and family are not. If the species equation contains WD variable, the species mass density must be specified and not zero. The species local name should be unique and its mass density also has to be a number.



Local Name	Latin Name	Family	Mass Density (Kg/m^3)	Equation	Formula	Controls	
Akar Kekait			0	Forest	0.206284*pow(DBH,2.4511)	Edit	Delete
Angat-angat			0	Forest	0.206284*pow(DBH,2.4511)	Edit	Delete
Antui			0	Forest	0.206284*pow(DBH,2.4511)	Edit	Delete
Arang	Diospyros sp.		0	Forest	0.206284*pow(DBH,2.4511)	Edit	Delete
Trentang	Camnosperma coriaceum		0	Forest	0.206284*pow(DBH,2.4511)	Edit	Delete
Tukulan	Blumeodendron tokbrai		660	Forest	0.206284*pow(DBH,2.4511)	Edit	Delete
Uyah-uyah	Stemonurus secundiflorus		630	Forest	0.206284*pow(DBH,2.4511)	Edit	Delete

Figure 5-11 View Species Screenshot

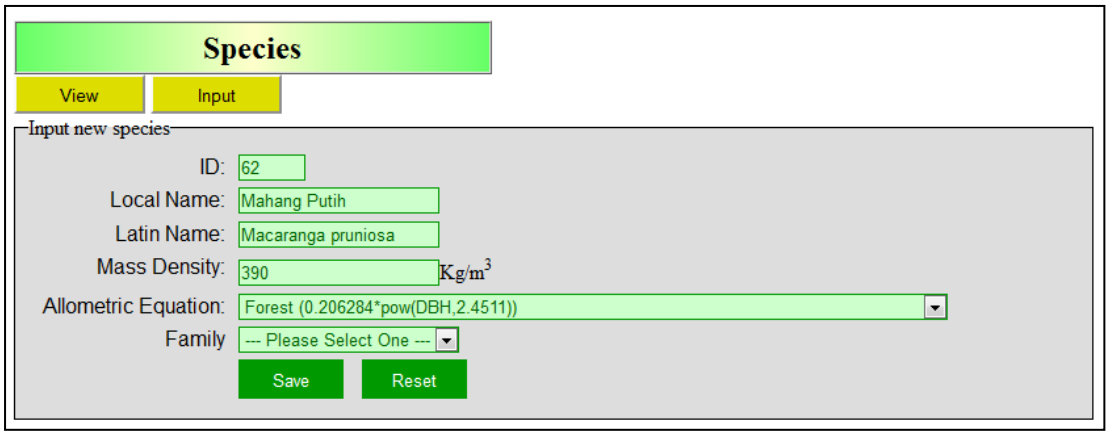


Figure 5-12 Input Species Screenshot

The families menu provides functionality to manage the families data. Users can view, input, edit and delete families here. Families name should be unique.

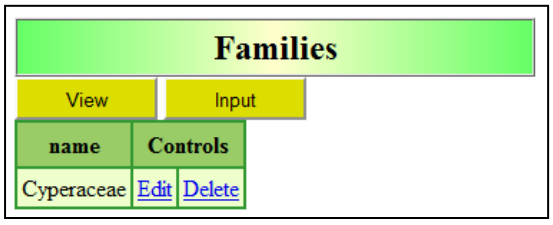


Figure 5-13 View Families Screenshot

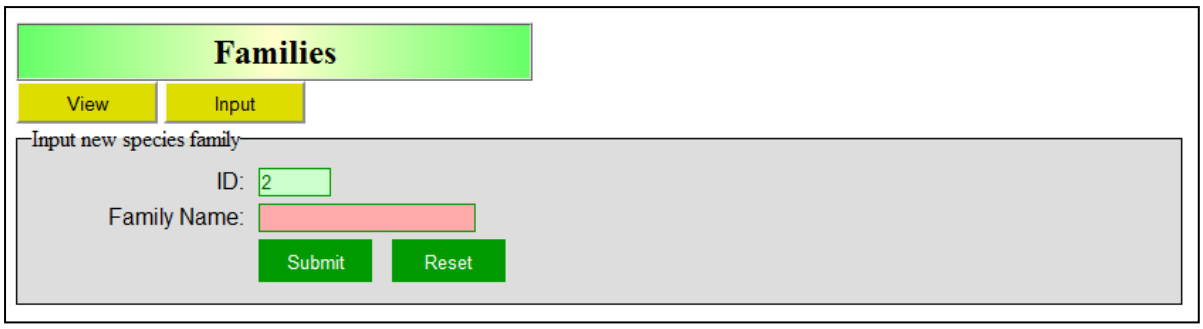


Figure 5-14 Input Families Screenshot

In the conversion factors menu, users can manage various constants which will be used when calculating biomass and carbon stocks. The dead wood constants group is used to deterimine the dead wood mass density based on its decomposition level.

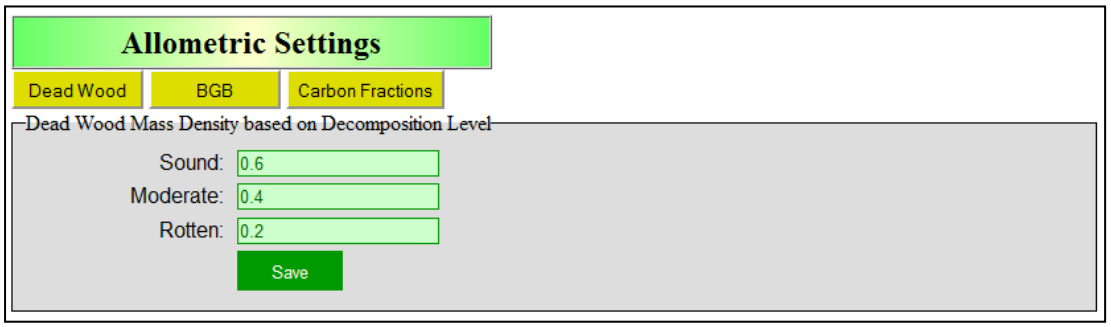


Figure 5-15 Dead Wood Conversion Factors Screenshot

The BGB group is used to deterimine the equation used for calculating BGB biomass. The BGB biomass equation is a function of AGB biomass and therefore must contain AGB variable.

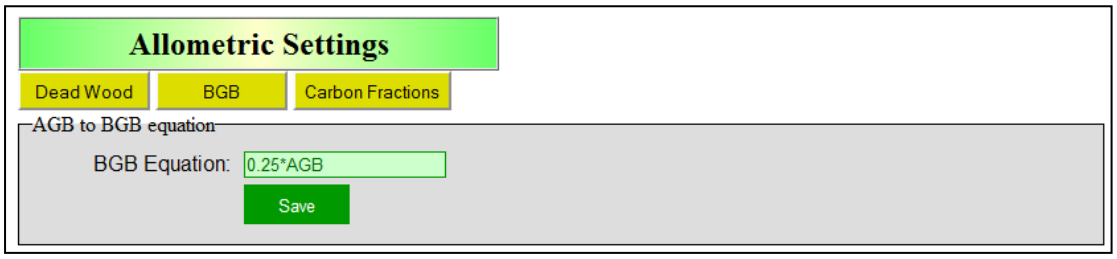


Figure 5-16 BGB Converstion Factors Screenshot

The Carbon Fractions Group contains the multiplication factor for calculating the trees carbon stock. Where the trees carbon stock is the trees biomass multiplied by the carbon fractions. The carbon fractions are divided into AGB, BGB, Dead Tree, Dead Wood, and Litter.

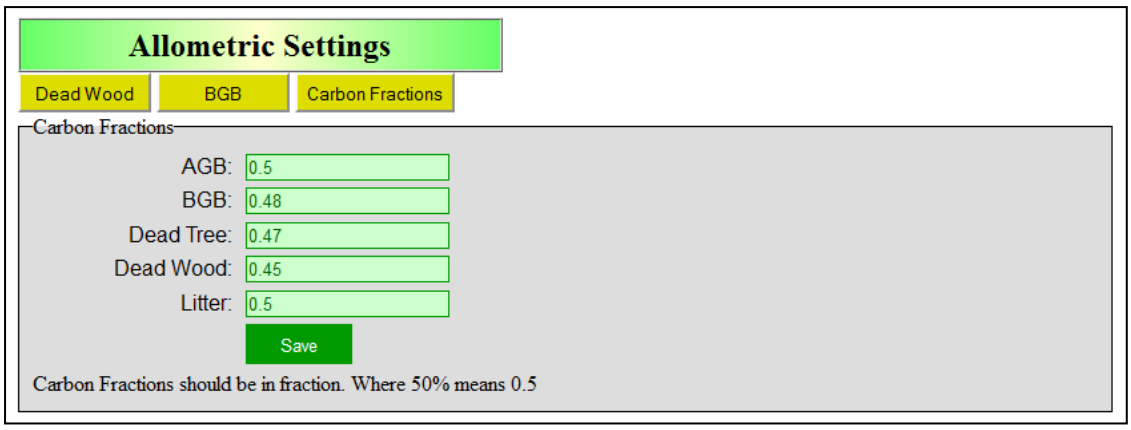


Figure 5-17 Carbon Fractions Conversion Factors Screenshot

5.3.3 BIOMASS DATA INPUT

The biomass data input is further separated into living trees, dead trees, dead woods, palms and lianas, and seedlings and litters. The menus provide the functionality to view, input, edit and delete trees data. Users can sort and filter the data view to fit the users needs. The users can also delete multiple trees data at once by ticking the desired trees data and clicking "delete selected" button.

The Living Trees menu is used to manage living trees data. When inputting living trees data, the plot, sub plot, species, treeID and DBH are compulsory. The tree ID should be unique in each plot. Users cannot input identical names for a tree in the same plot. While inputting the trees species, users can add new species by clicking the "new species" button. The trees DBH should be a number and between the range determined in the sub plots menu. The trees height should be a number.

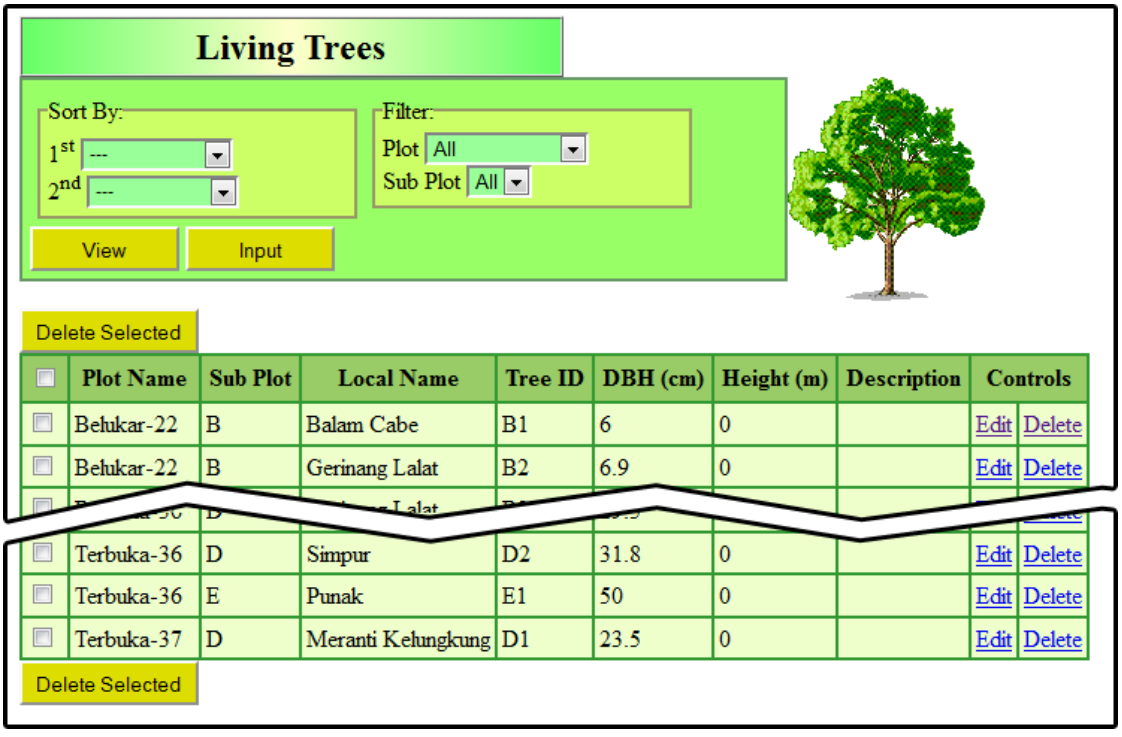


Figure 5-18 View Living Trees Screenshot

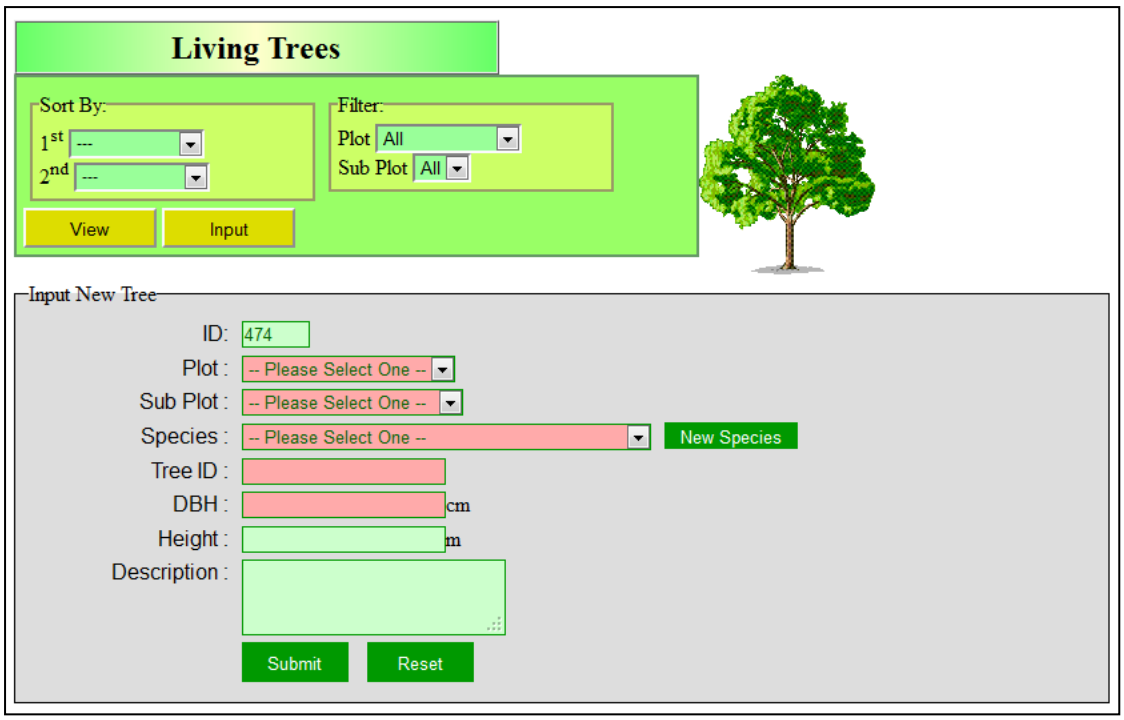


Figure 5-19 Input Living Trees Screenshot

The Dead Trees menu is used to manage dead trees data. Dead trees input follow rules similar to the rules when inputting living trees data, except the dead tree species data is not compulsory.

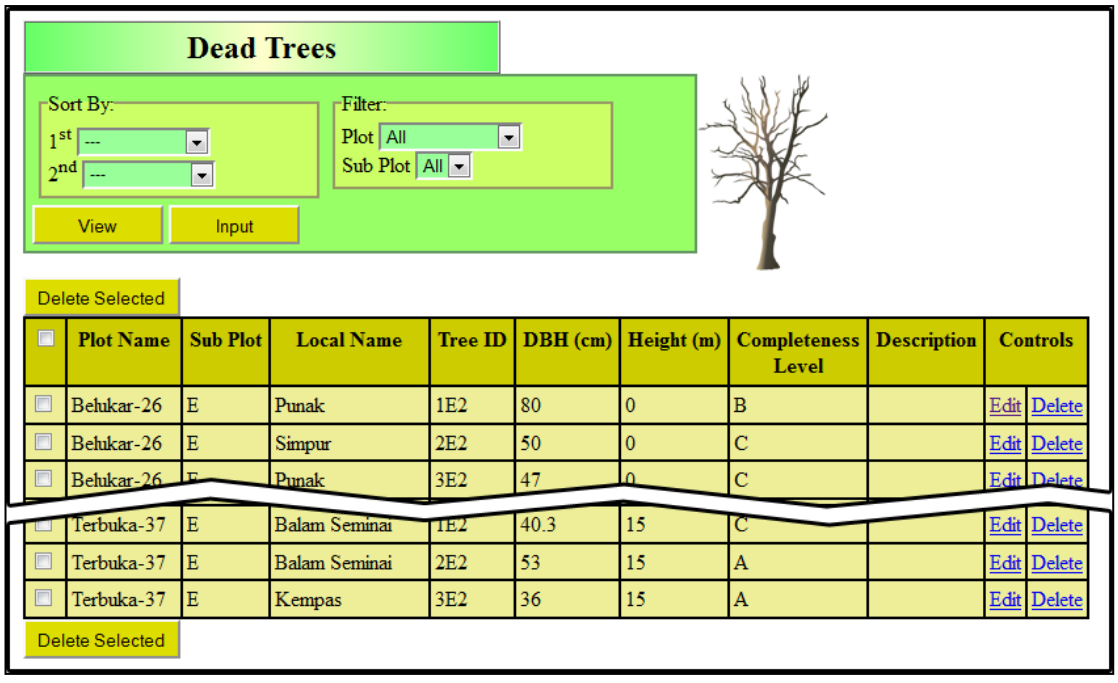
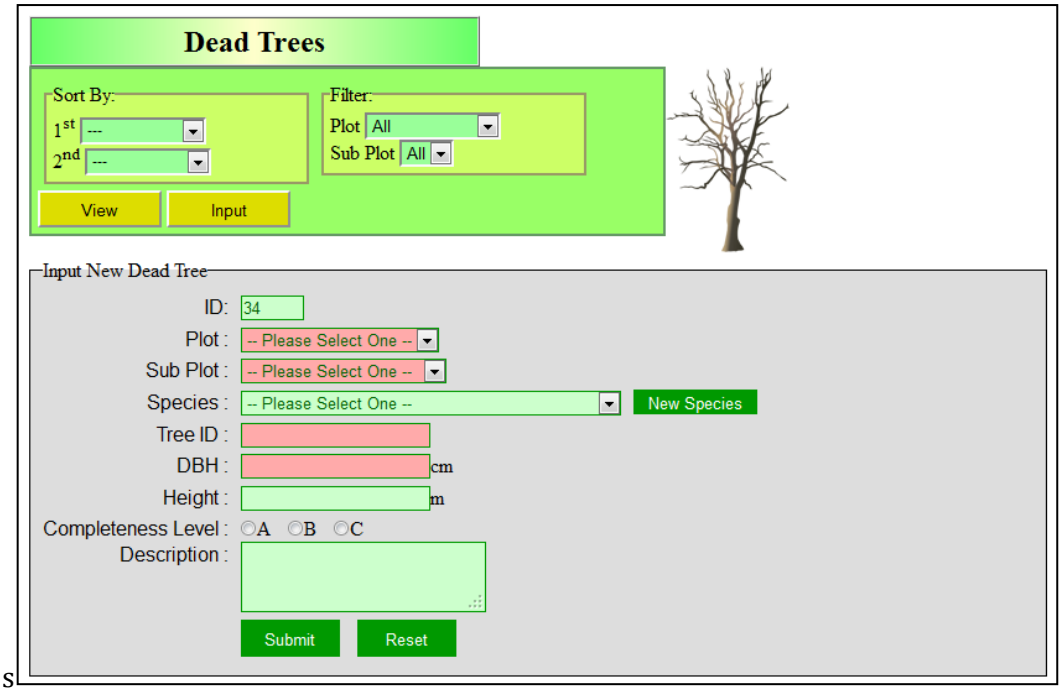


Figure 5-20 View Dead Trees Screenshot



S

Figure 5-21 Input Dead Trees Screenshot

The Dead Woods menu is used to manage dead woods data. Every fields in dead wood data is compulsory. The tree ID must be unique in each plot. The dead wood's 1st diameter, 2nd diameter, length, Hollow diameter and hollow length should be a number. The 2nd diameter and hollow diameter should be less than the 1st diameter, and the hollow length must be less than the dead wood's length.

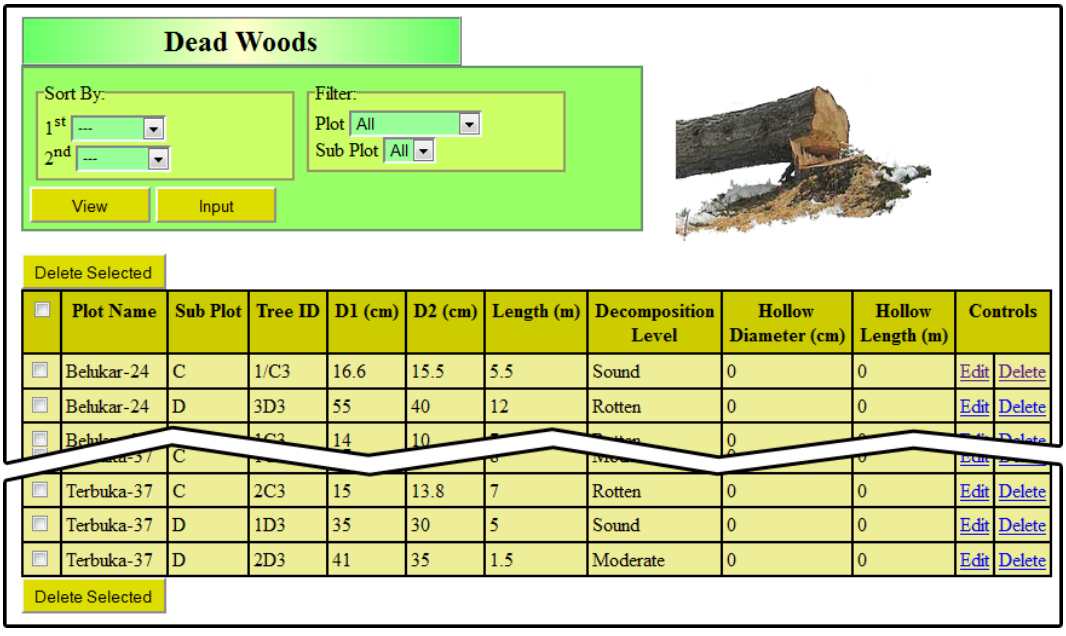


Figure 5-22 View Dead Wood Screenshot

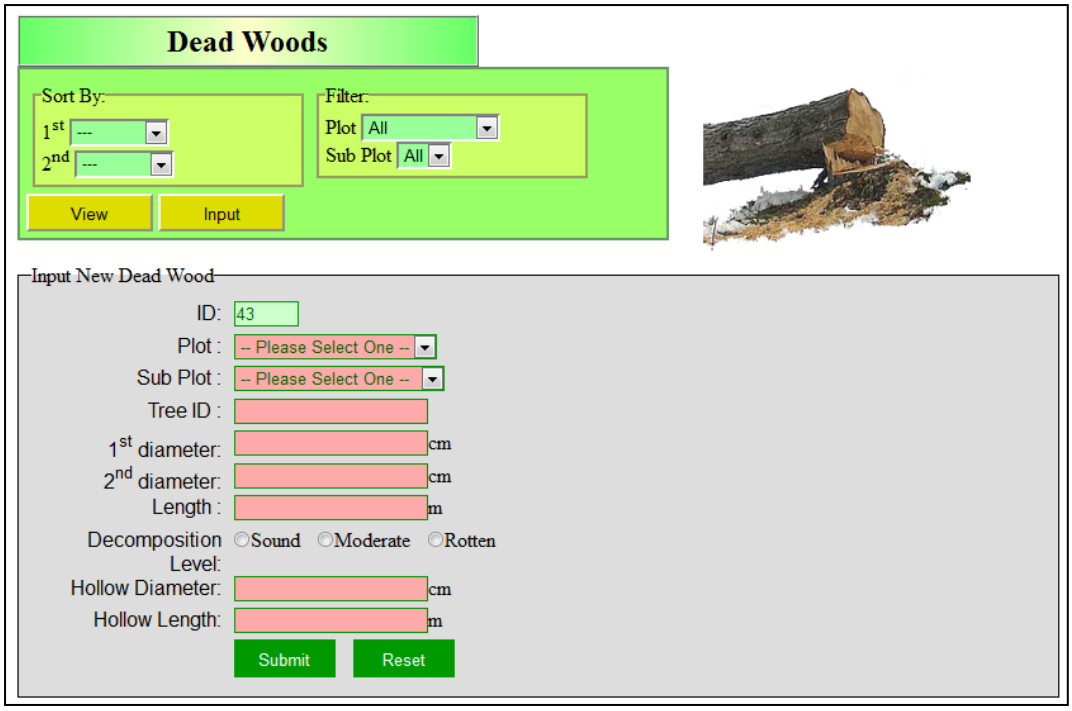


Figure 5-23 Input Dead Wood Screenshot

The Palms and Lianas menu is used to manage palms and lianas data. Palms and lianas input follow rules identical to the rules when inputting living trees data.

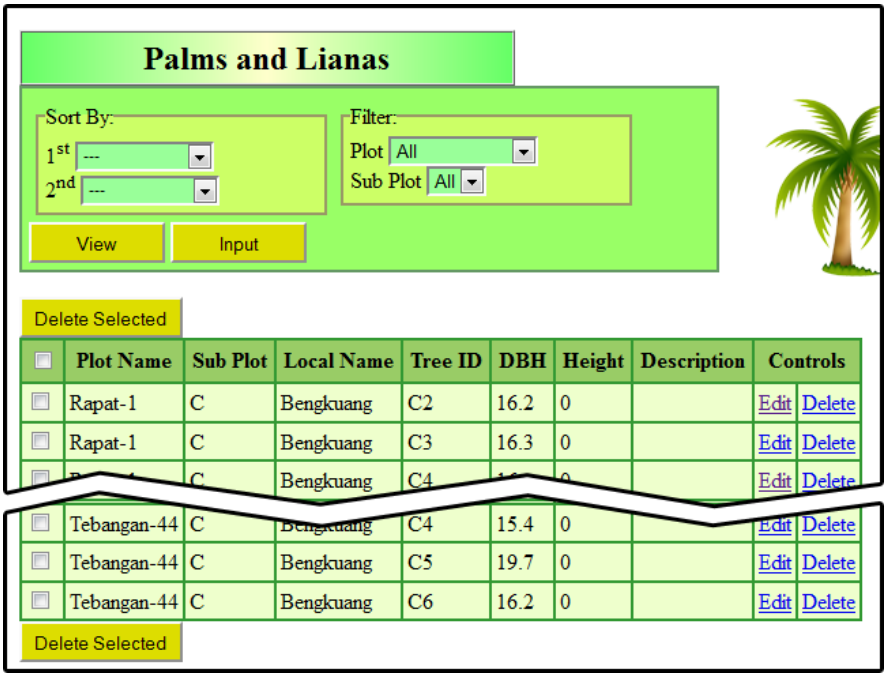


Figure 5-24 View Palms and Lianas Screenshot

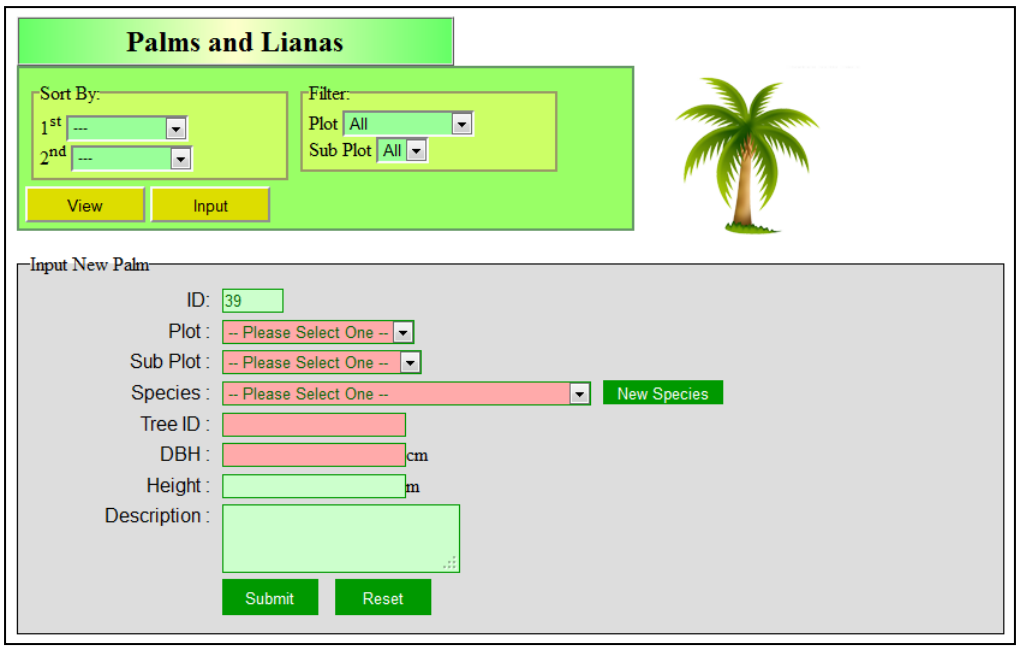
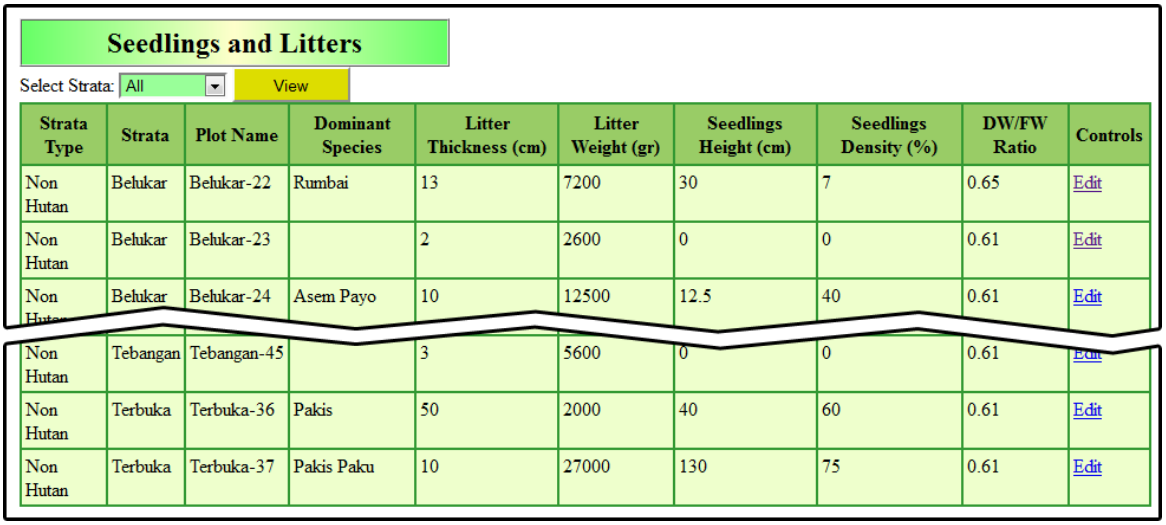


Figure 5-25 Input Palms and Lianas Screenshot

The seedlings and litters menu is used to manage the seedlings and litters data. The seedlings and litters data is specified per plot. There is exactly one seedlings and litters data for each plots. The seedlings and litters data can not be deleted. Users can only edit the data.



Seedlings and Litters

Select Strata: All View

Strata Type	Strata	Plot Name	Dominant Species	Litter Thickness (cm)	Litter Weight (gr)	Seedlings Height (cm)	Seedlings Density (%)	DW/FW Ratio	Controls
Non Hutan	Belukar	Belukar-22	Rumbai	13	7200	30	7	0.65	Edit
Non Hutan	Belukar	Belukar-23		2	2600	0	0	0.61	Edit
Non Hutan	Belukar	Belukar-24	Asem Payo	10	12500	12.5	40	0.61	Edit
Non Hutan	Tebangan	Tebangan-45		3	5600	0	0	0.61	Edit
Non Hutan	Terbuka	Terbuka-36	Pakis	50	2000	40	60	0.61	Edit
Non Hutan	Terbuka	Terbuka-37	Pakis Paku	10	27000	130	75	0.61	Edit

Figure 5-26 View Seedlings and Litters Screenshot

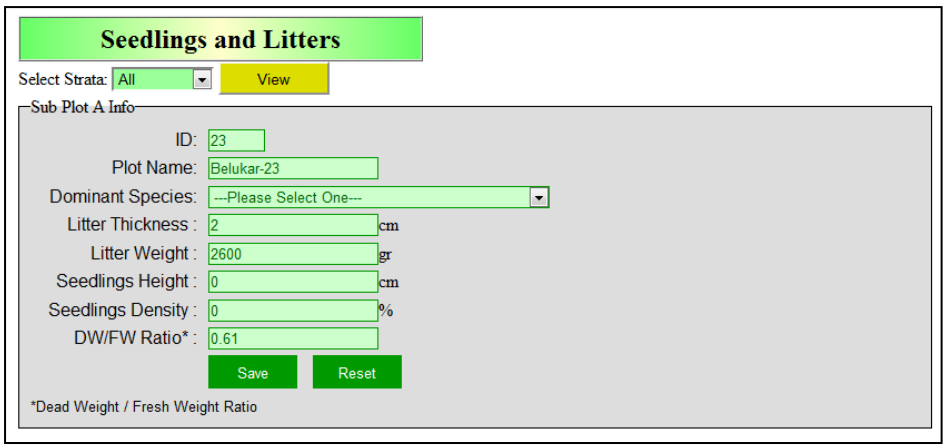


Figure 5-27 Edit Seedlings and Litters Screenshot

5.4 Stand Composition

The Stand Composition menu group consists of Tree distribution per DBH, tree distribution per plot, tree density and importance value index. These data represents the composition of tree species inside the plots specified. The composition calculation is done automatically by the software.

5.4.1 Tree Distribution per DBH

The Tree Distribution per DBH provides the view of tree count based on its species and DBH. Users can observe the trees DBH distribution aided by color ranges. The pink color represents trees count less than 3. The orange color represents trees count between 3 to 5. Yellow represents 6 to 8 trees count. Green represents 9 to 11 tree count. While blue represents 12 or more trees.

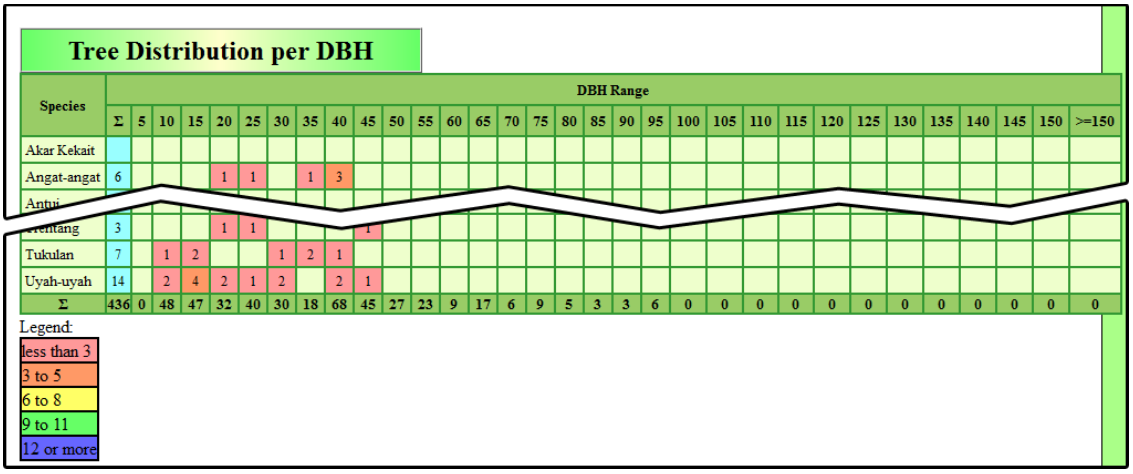


Figure 5-28 Tree Distribution per DBH Screenshot

5.4.2 Tree Distribution per Plot

The tree distribution per plot provides the view of tree count based on its plot and species. The view also provides color aid as in trees distribution per DBH.

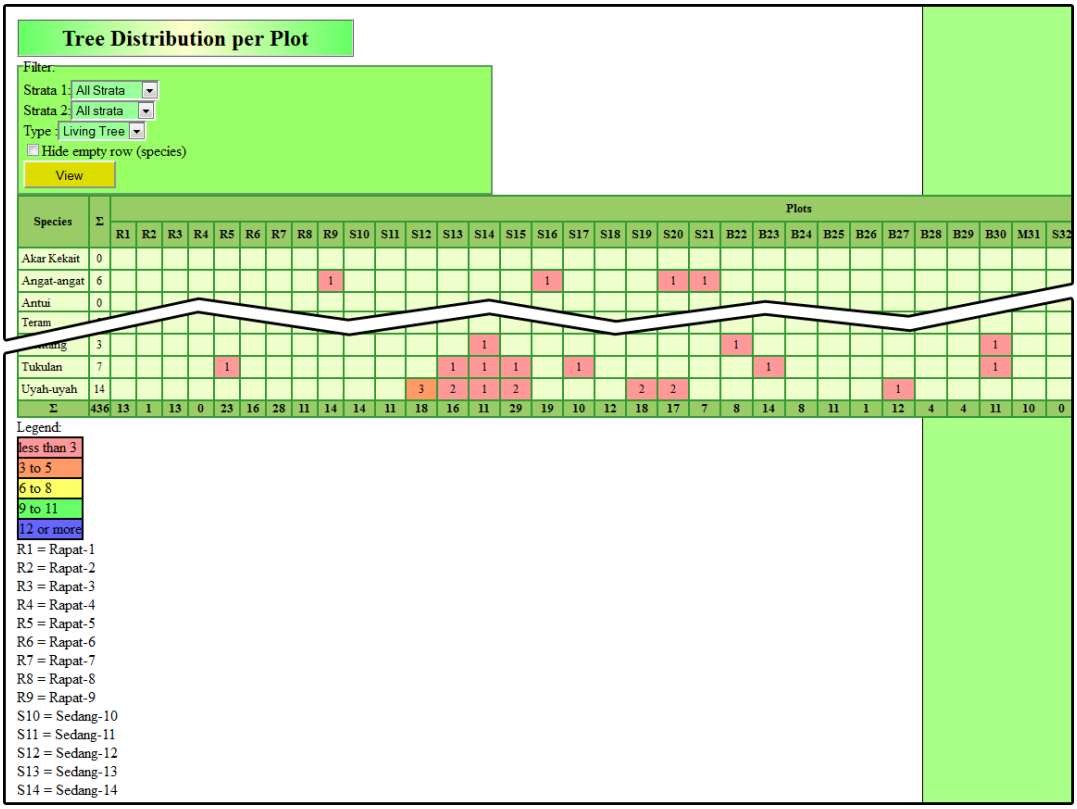
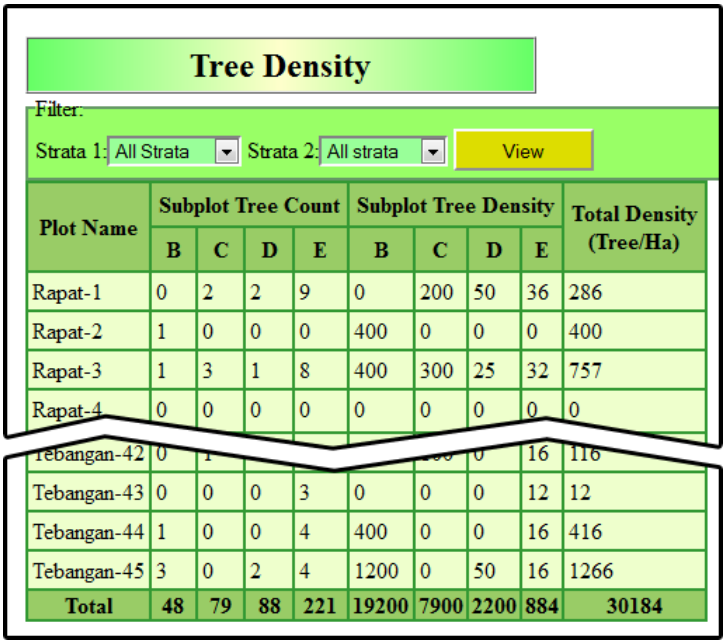


Figure 5-29 Tree Distribution per Plot Screenshot

5.4.3 TREE DENSITY

The tree density provides the view of tree densities per plot. The trees densities is calculated by the tree count per the subplot area (in Ha).

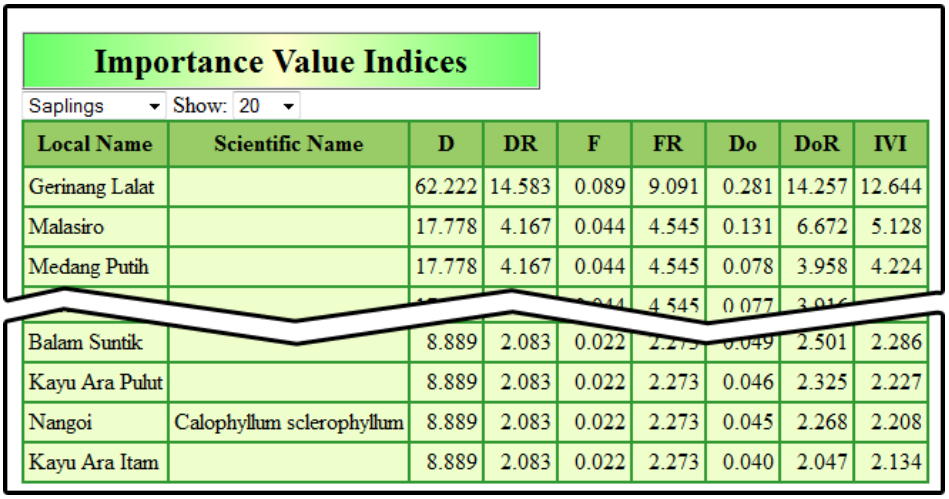


Plot Name	Subplot Tree Count				Subplot Tree Density				Total Density (Tree/Ha)
	B	C	D	E	B	C	D	E	
Rapat-1	0	2	2	9	0	200	50	36	286
Rapat-2	1	0	0	0	400	0	0	0	400
Rapat-3	1	3	1	8	400	300	25	32	757
Rapat-4	0	0	0	0	0	0	0	0	0
Tebangan-42	0	1					0	16	116
Tebangan-43	0	0	0	3	0	0	0	12	12
Tebangan-44	1	0	0	4	400	0	0	16	416
Tebangan-45	3	0	2	4	1200	0	50	16	1266
Total	**48**	**79**	**88**	**221**	**19200**	**7900**	**2200**	**884**	**30184**

Figure 5-30 Tree Density Screenshot

5.4.4 *Importance Value Index*

The importance value index provides the view of the importance value indices. Users can choose to view the IVI of all sub plots or only for saplings, poles, trees or large trees. Users can also choose to show the IVI for all species or just a limited number.



Importance Value Indices

Saplings Show: 20

Local Name	Scientific Name	D	DR	F	FR	Do	DoR	IVI
Gerinang Lalat		62.222	14.583	0.089	9.091	0.281	14.257	12.644
Malasiro		17.778	4.167	0.044	4.545	0.131	6.672	5.128
Medang Putih		17.778	4.167	0.044	4.545	0.078	3.958	4.224
					4.545	0.077		
Balam Suntik		8.889	2.083	0.022			2.501	2.286
Kayu Ara Pulut		8.889	2.083	0.022	2.273	0.046	2.325	2.227
Nangoi	Calophyllum sclerophyllum	8.889	2.083	0.022	2.273	0.045	2.268	2.208
Kayu Ara Itam		8.889	2.083	0.022	2.273	0.040	2.047	2.134

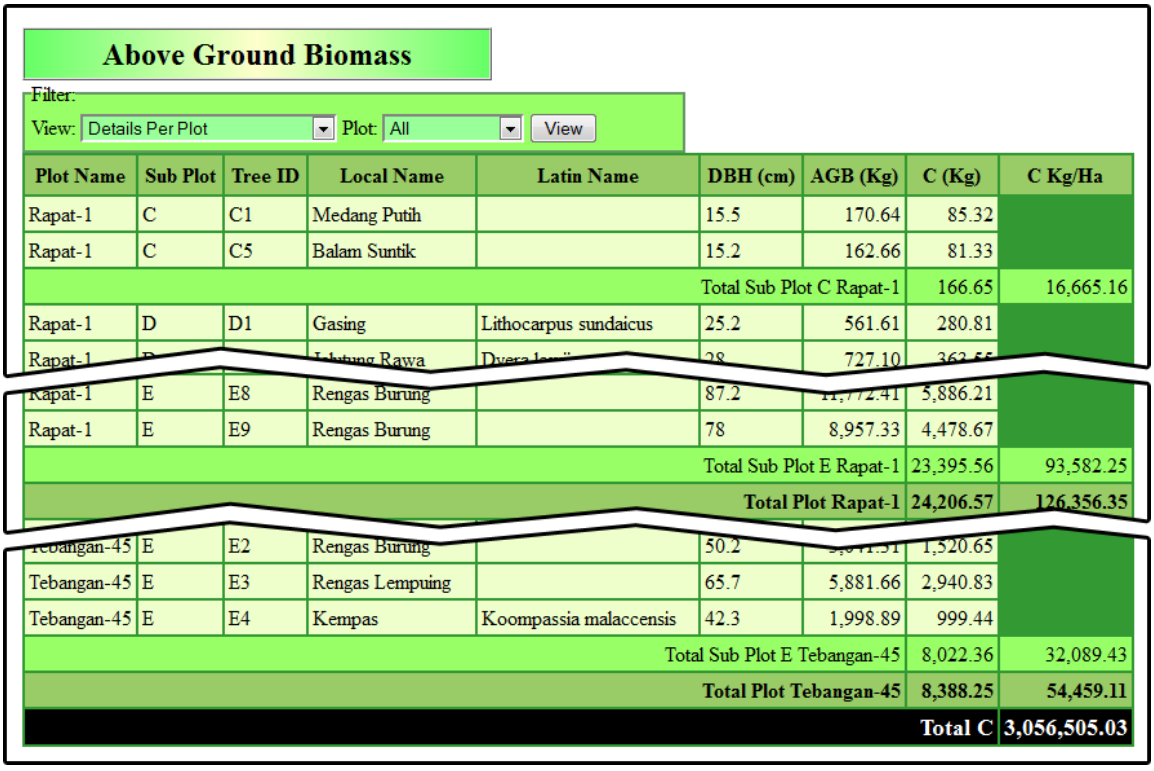
Figure 5-31 Importance Value Index Screenshot

5.5 Carbon Calculation

The carbon calculation menu group consists of AGB Carbon Stock, DOM Carbon Stock, BGB Carbon Stock, Soil Carbon Stock and Total Carbon Stock. The menus provide carbon stock calculation for each carbon pool.

5.5.1 *AGB Carbon Stock*

AGB carbon stock provides the calculation of Above Ground Biomass and its carbon stock. The AGB Carbon Stock is calculated using living trees data and their respective species and equations. There are 5 views for the carbon calculations: Details Per Plot, Details Per Sub Plot, Summary Per Plot, Mean Per Strata and Mean Per Forest/Non-Forest.

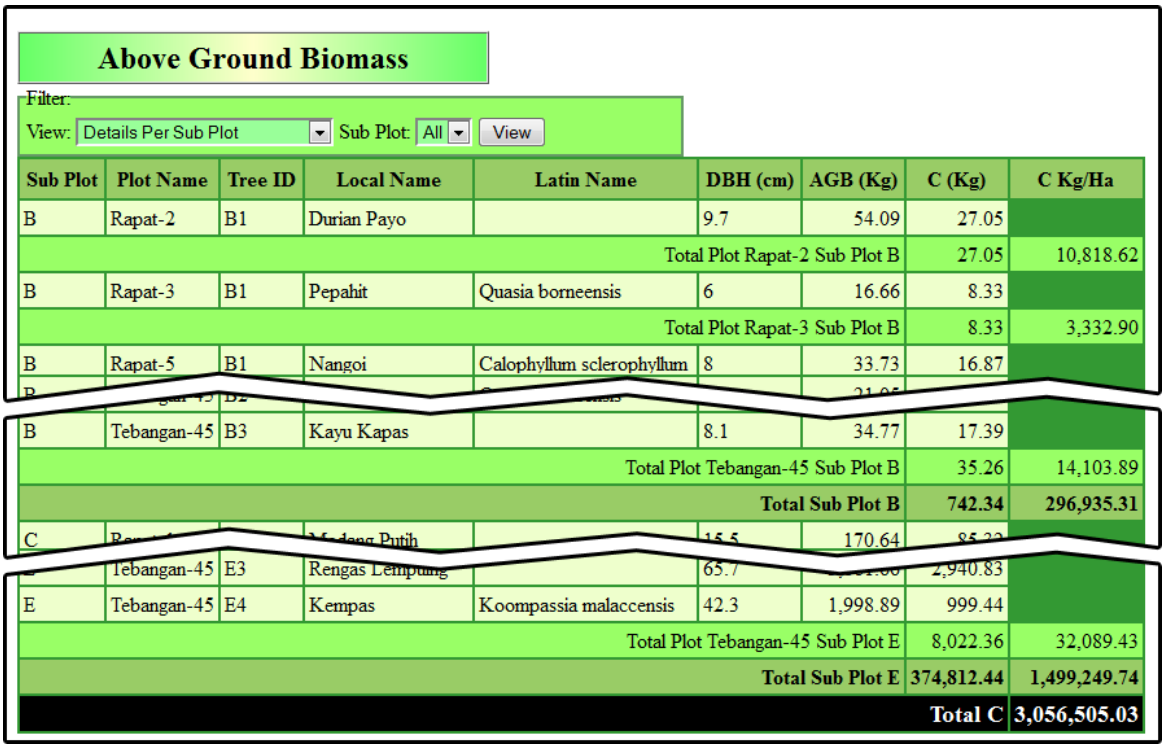


Above Ground Biomass

Filter:
View: Details Per Plot Plot: All View

Plot Name	Sub Plot	Tree ID	Local Name	Latin Name	DBH (cm)	AGB (Kg)	C (Kg)	C Kg/Ha
Rapat-1	C	C1	Medang Putih		15.5	170.64	85.32	
Rapat-1	C	C5	Balam Suntik		15.2	162.66	81.33	
						Total Sub Plot C Rapat-1	166.65	16,665.16
Rapat-1	D	D1	Gasing	Lithocarpus sundaicus	25.2	561.61	280.81	
Rapat-1			Lahung Rawa	Dyera lowii	28	727.10	363.55	
Rapat-1	E	E8	Rengas Burung		87.2	11,772.41	5,886.21	
Rapat-1	E	E9	Rengas Burung		78	8,957.33	4,478.67	
						Total Sub Plot E Rapat-1	23,395.56	93,582.25
						Total Plot Rapat-1	**24,206.57**	**126,356.35**
Tebangan-45	E	E2	Rengas Burung		50.2	3,041.31	1,520.65	
Tebangan-45	E	E3	Rengas Lempuing		65.7	5,881.66	2,940.83	
Tebangan-45	E	E4	Kempas	Koompassia malaccensis	42.3	1,998.89	999.44	
						Total Sub Plot E Tebangan-45	8,022.36	32,089.43
						Total Plot Tebangan-45	**8,388.25**	**54,459.11**
							Total C	**3,056,505.03**

Figure 5-32 AGB Details per Plot Screenshot

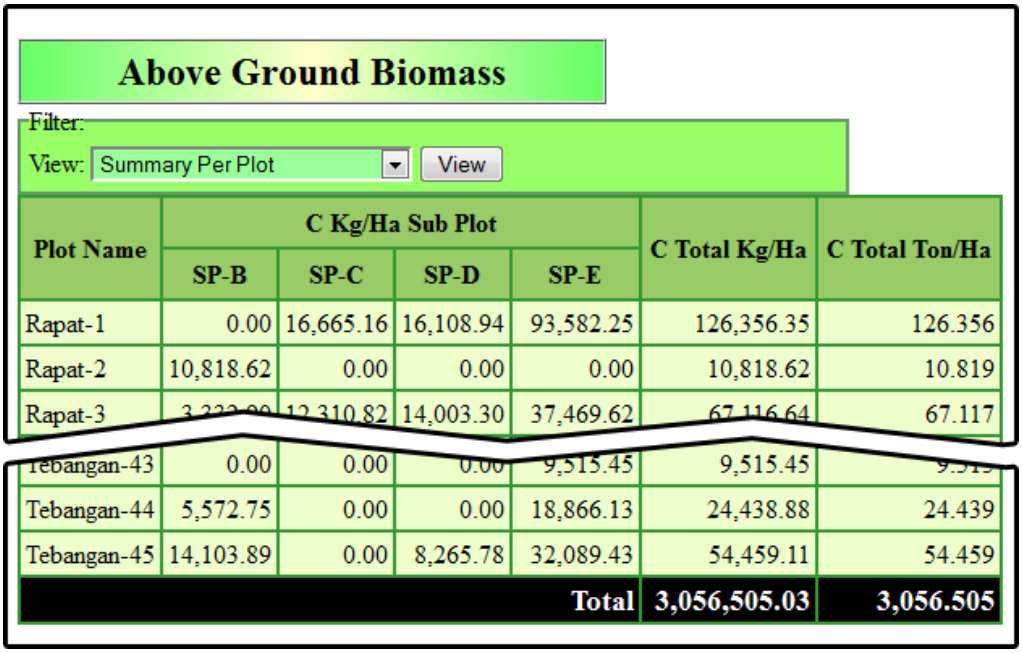


Above Ground Biomass

Filter:
View: Details Per Sub Plot Sub Plot: All View

Sub Plot	Plot Name	Tree ID	Local Name	Latin Name	DBH (cm)	AGB (Kg)	C (Kg)	C Kg/Ha
B	Rapat-2	B1	Durian Payo		9.7	54.09	27.05	
						Total Plot Rapat-2 Sub Plot B	27.05	10,818.62
B	Rapat-3	B1	Pepahit	Quasia borneensis	6	16.66	8.33	
						Total Plot Rapat-3 Sub Plot B	8.33	3,332.90
B	Rapat-5	B1	Nangoi	Calophyllum sclerophyllum	8	33.73	16.87	
B	Tebangan-45	B3	Kayu Kapas		8.1	34.77	17.39	
						Total Plot Tebangan-45 Sub Plot B	35.26	14,103.89
						Total Sub Plot B	**742.34**	**296,935.31**
C			Medang Putih		15.5	170.64	85.32	
	Tebangan-45	E3	Rengas Lempuing		65.7	5,881.66	2,940.83	
E	Tebangan-45	E4	Kempas	Koompassia malaccensis	42.3	1,998.89	999.44	
						Total Plot Tebangan-45 Sub Plot E	8,022.36	32,089.43
						Total Sub Plot E	**374,812.44**	**1,499,249.74**
							Total C	**3,056,505.03**

Figure 5-33 AGB Details per Sub Plot Screenshot

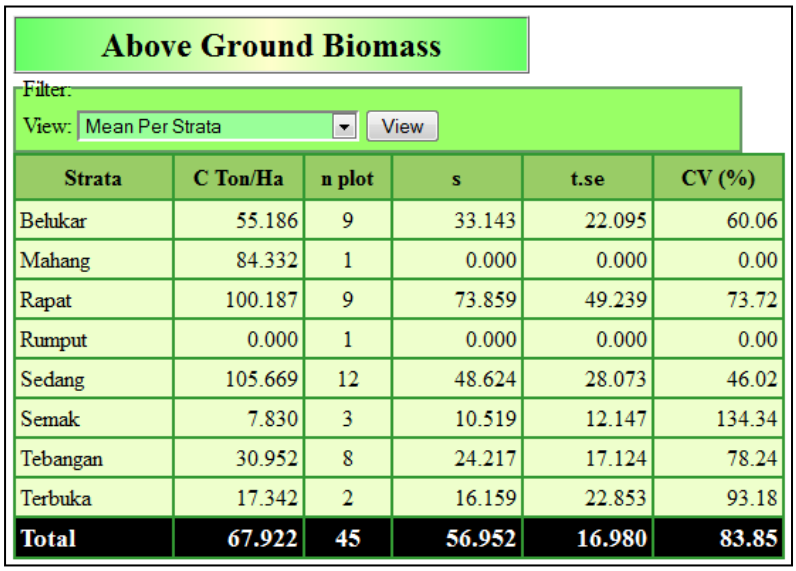


Above Ground Biomass

Filter:
View: Summary Per Plot View

Plot Name	C Kg/Ha Sub Plot				C Total Kg/Ha	C Total Ton/Ha
	SP-B	SP-C	SP-D	SP-E		
Rapat-1	0.00	16,665.16	16,108.94	93,582.25	126,356.35	126.356
Rapat-2	10,818.62	0.00	0.00	0.00	10,818.62	10.819
Rapat-3	3,333.00	12,310.82	14,003.30	37,469.62	67,116.64	67.117
Tebangan-43	0.00	0.00	0.00	9,515.45	9,515.45	9.515
Tebangan-44	5,572.75	0.00	0.00	18,866.13	24,438.88	24.439
Tebangan-45	14,103.89	0.00	8,265.78	32,089.43	54,459.11	54.459
				Total	3,056,505.03	3,056.505

Figure 5-34 AGB Summary per Plot Screenshot

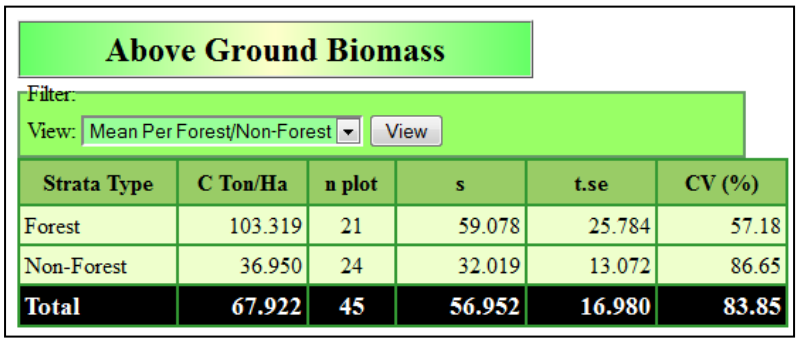


Above Ground Biomass

Filter:
View: Mean Per Strata View

Strata	C Ton/Ha	n plot	s	t.se	CV (%)
Belukar	55.186	9	33.143	22.095	60.06
Mahang	84.332	1	0.000	0.000	0.00
Rapat	100.187	9	73.859	49.239	73.72
Rumput	0.000	1	0.000	0.000	0.00
Sedang	105.669	12	48.624	28.073	46.02
Semak	7.830	3	10.519	12.147	134.34
Tebangan	30.952	8	24.217	17.124	78.24
Terbuka	17.342	2	16.159	22.853	93.18
Total	**67.922**	**45**	**56.952**	**16.980**	**83.85**

Figure 5-35 AGB Mean per Strata Screenshot



Above Ground Biomass

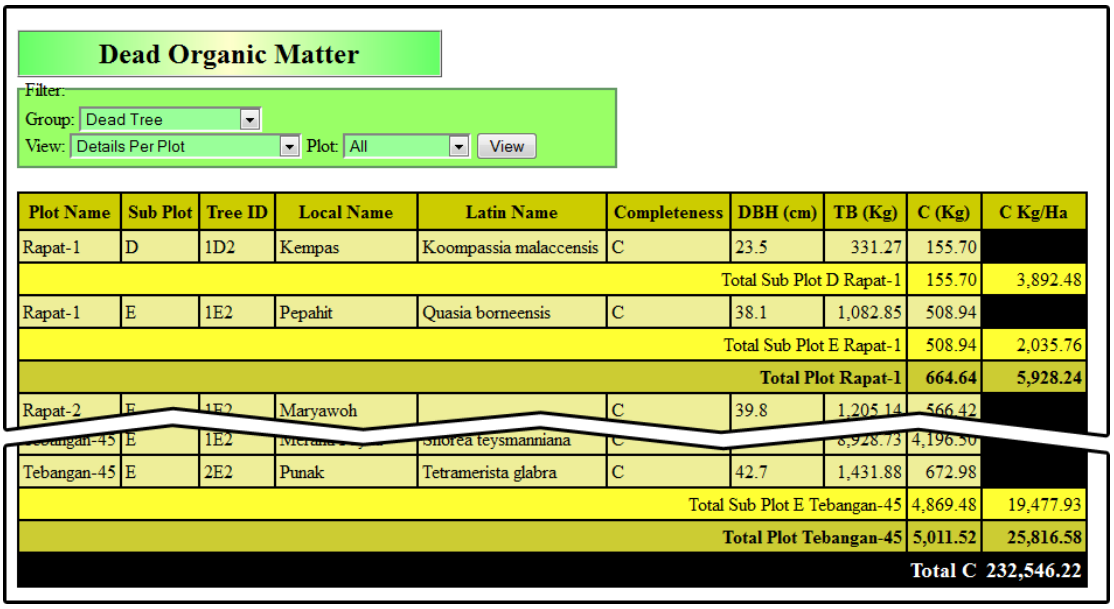
Filter:
View: Mean Per Forest/Non-Forest View

Strata Type	C Ton/Ha	n plot	s	t.se	CV (%)
Forest	103.319	21	59.078	25.784	57.18
Non-Forest	36.950	24	32.019	13.072	86.65
Total	**67.922**	**45**	**56.952**	**16.980**	**83.85**

Figure 5-36 AGB Forest/Non-Forest Screenshot

5.5.2 DOM CARBON STOCK

DOM Carbon Stock provides calculation of Death Organic Matter Biomass and its carbon stock. The DOM Carbon Stock uses three groups of data, which is Dead Trees, Dead Woods and Litter. Each group has five views for the carbon calculations: Details Per Plot, Details Per Sub Plot, Summary Per Plot, Mean Per Strata and Mean Per Forest/Non-Forest, except for Litter which has only three last views.

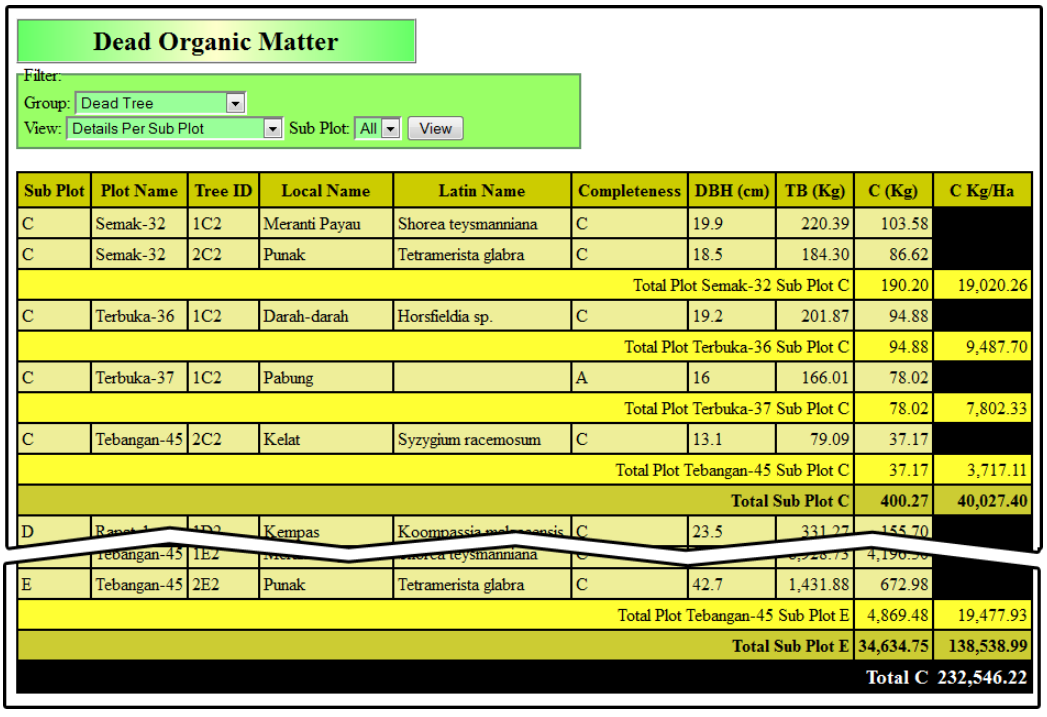


Dead Organic Matter

Filter:
Group: Dead Tree
View: Details Per Plot Plot: All View

Plot Name	Sub Plot	Tree ID	Local Name	Latin Name	Completeness	DBH (cm)	TB (Kg)	C (Kg)	C Kg/Ha
Rapat-1	D	1D2	Kempas	Koompassia malaccensis	C	23.5	331.27	155.70	
							Total Sub Plot D Rapat-1	155.70	3,892.48
Rapat-1	E	1E2	Pepahit	Quasia borneensis	C	38.1	1,082.85	508.94	
							Total Sub Plot E Rapat-1	508.94	2,035.76
							Total Plot Rapat-1	**664.64**	**5,928.24**
Rapat-2	E	1E2	Maryawoh		C	39.8	1,205.14	566.42	
Tebangan-45	E	1E2	Meranti Payau	Shorea teysmanniana	C		8,928.73	4,196.50	
Tebangan-45	E	2E2	Punak	Tetramerista glabra	C	42.7	1,431.88	672.98	
							Total Sub Plot E Tebangan-45	4,869.48	19,477.93
							Total Plot Tebangan-45	**5,011.52**	**25,816.58**
								Total C	**232,546.22**

Figure 5-37 DOM Dead Tree Details per Plot Screenshot

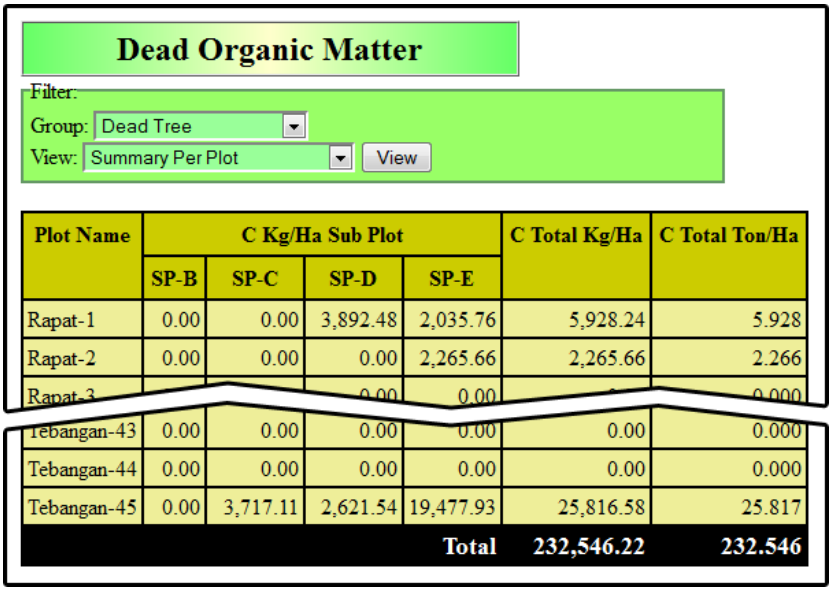


Dead Organic Matter

Filter:
Group: Dead Tree
View: Details Per Sub Plot Sub Plot: All View

Sub Plot	Plot Name	Tree ID	Local Name	Latin Name	Completeness	DBH (cm)	TB (Kg)	C (Kg)	C Kg/Ha
C	Semak-32	1C2	Meranti Payau	Shorea teysmanniana	C	19.9	220.39	103.58	
C	Semak-32	2C2	Punak	Tetramerista glabra	C	18.5	184.30	86.62	
							Total Plot Semak-32 Sub Plot C	190.20	19,020.26
C	Terbuka-36	1C2	Darah-darah	Horsfieldia sp.	C	19.2	201.87	94.88	
							Total Plot Terbuka-36 Sub Plot C	94.88	9,487.70
C	Terbuka-37	1C2	Pabung		A	16	166.01	78.02	
							Total Plot Terbuka-37 Sub Plot C	78.02	7,802.33
C	Tebangan-45	2C2	Kelat	Syzygium racemosum	C	13.1	79.09	37.17	
							Total Plot Tebangan-45 Sub Plot C	37.17	3,717.11
							Total Sub Plot C	**400.27**	**40,027.40**
D	Rapat-1	1D2	Kempas	Koompassia malaccensis	C	23.5	331.27	155.70	
	Tebangan-45	1E2	Meranti Payau	Shorea teysmanniana	C		8,928.73	4,196.50	
E	Tebangan-45	2E2	Punak	Tetramerista glabra	C	42.7	1,431.88	672.98	
							Total Plot Tebangan-45 Sub Plot E	4,869.48	19,477.93
							Total Sub Plot E	**34,634.75**	**138,538.99**
								Total C	**232,546.22**

Figure 5-38 DOM Dead Tree Details per Sub Plot Screenshot

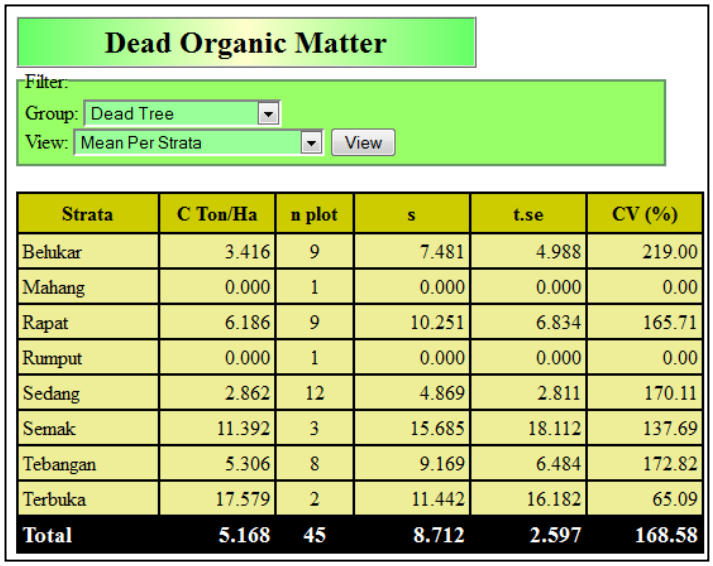


Dead Organic Matter

Filter:
Group: Dead Tree
View: Summary Per Plot View

Plot Name	C Kg/Ha Sub Plot				C Total Kg/Ha	C Total Ton/Ha
	SP-B	SP-C	SP-D	SP-E		
Rapat-1	0.00	0.00	3,892.48	2,035.76	5,928.24	5.928
Rapat-2	0.00	0.00	0.00	2,265.66	2,265.66	2.266
Rapat-3			0.00	0.00		0.000
Tebangan-43	0.00	0.00	0.00	0.00	0.00	0.000
Tebangan-44	0.00	0.00	0.00	0.00	0.00	0.000
Tebangan-45	0.00	3,717.11	2,621.54	19,477.93	25,816.58	25.817
				Total	232,546.22	232.546

Figure 5-39 DOM Dead Tree Summary per Plot Screenshot

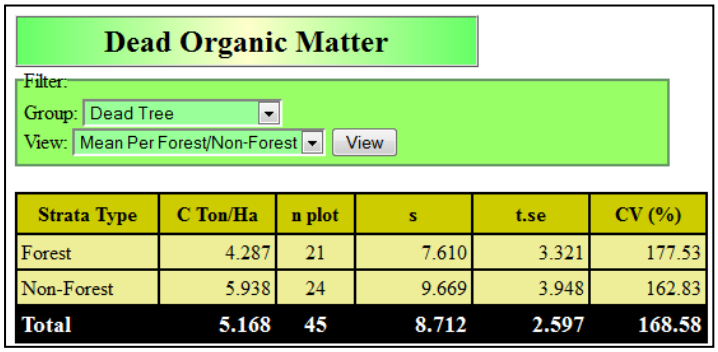


Dead Organic Matter

Filter:
Group: Dead Tree
View: Mean Per Strata View

Strata	C Ton/Ha	n plot	s	t.se	CV (%)
Belukar	3.416	9	7.481	4.988	219.00
Mahang	0.000	1	0.000	0.000	0.00
Rapat	6.186	9	10.251	6.834	165.71
Rumput	0.000	1	0.000	0.000	0.00
Sedang	2.862	12	4.869	2.811	170.11
Semak	11.392	3	15.685	18.112	137.69
Tebangan	5.306	8	9.169	6.484	172.82
Terbuka	17.579	2	11.442	16.182	65.09
Total	**5.168**	**45**	**8.712**	**2.597**	**168.58**

Figure 5-40 DOM Dead Tree Mean per Strata Screenshot

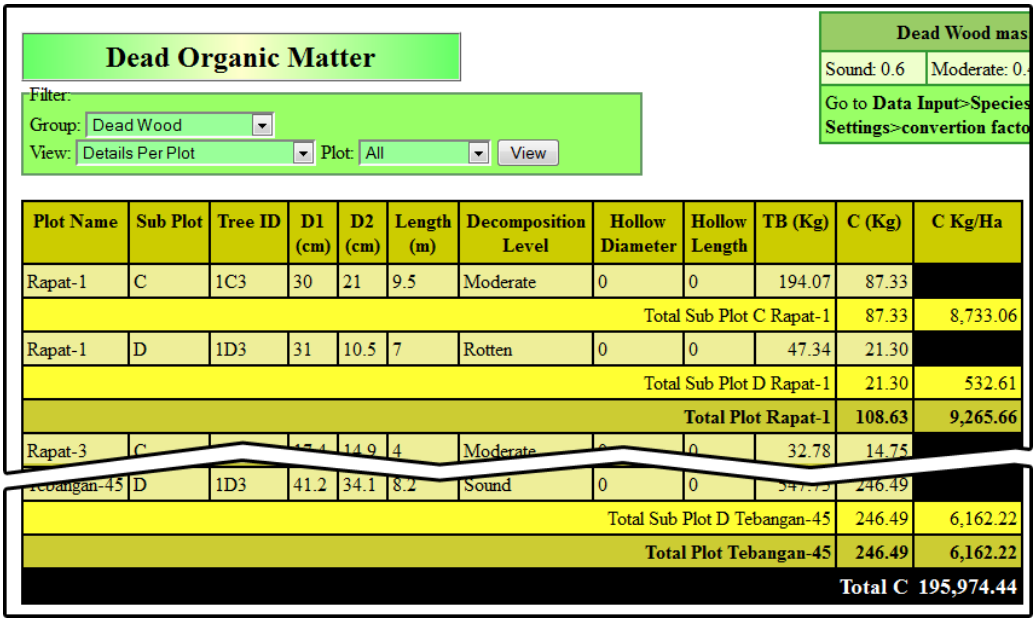


Dead Organic Matter

Filter:
Group: Dead Tree
View: Mean Per Forest/Non-Forest View

Strata Type	C Ton/Ha	n plot	s	t.se	CV (%)
Forest	4.287	21	7.610	3.321	177.53
Non-Forest	5.938	24	9.669	3.948	162.83
Total	**5.168**	**45**	**8.712**	**2.597**	**168.58**

Figure 5-41 DOM Dead Tree Mean Per Forest/Non Forest Screenshot



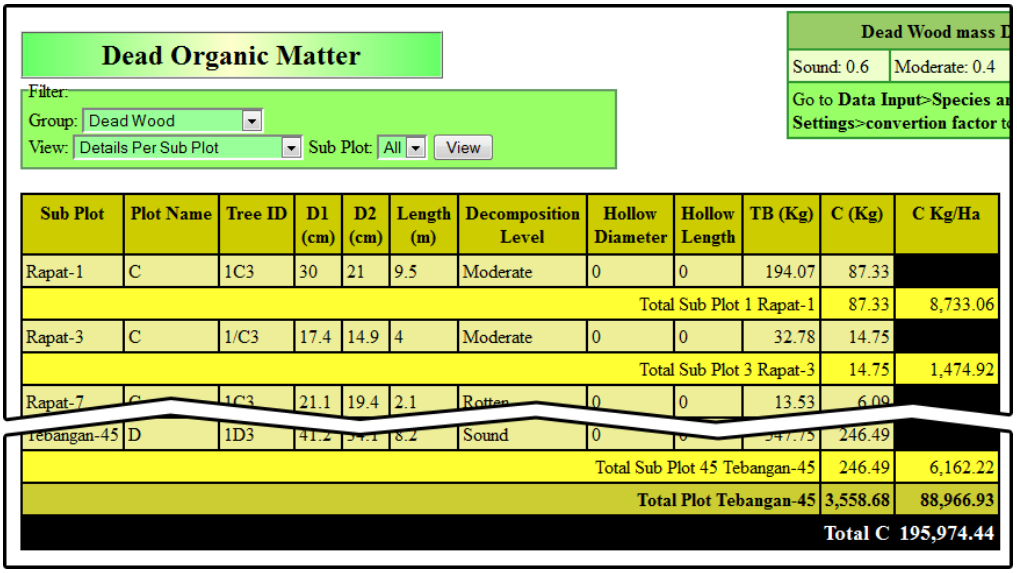
Dead Organic Matter

Filter:
Group: Dead Wood
View: Details Per Plot Plot: All View

Dead Wood mas
Sound: 0.6 Moderate: 0.
Go to **Data Input>Species Settings>convertion facto**

Plot Name	Sub Plot	Tree ID	D1 (cm)	D2 (cm)	Length (m)	Decomposition Level	Hollow Diameter	Hollow Length	TB (Kg)	C (Kg)	C Kg/Ha
Rapat-1	C	1C3	30	21	9.5	Moderate	0	0	194.07	87.33	
									Total Sub Plot C Rapat-1	87.33	8,733.06
Rapat-1	D	1D3	31	10.5	7	Rotten	0	0	47.34	21.30	
									Total Sub Plot D Rapat-1	21.30	532.61
									Total Plot Rapat-1	**108.63**	**9,265.66**
Rapat-3	C		17.4	14.9	4	Moderate	0	0	32.78	14.75	
Tebangan-45	D	1D3	41.2	34.1	8.2	Sound	0	0	347.75	246.49	
									Total Sub Plot D Tebangan-45	246.49	6,162.22
									Total Plot Tebangan-45	**246.49**	**6,162.22**
										Total C	**195,974.44**

Figure 5-42 DOM Dead Wood Details Per Plot Screenshot



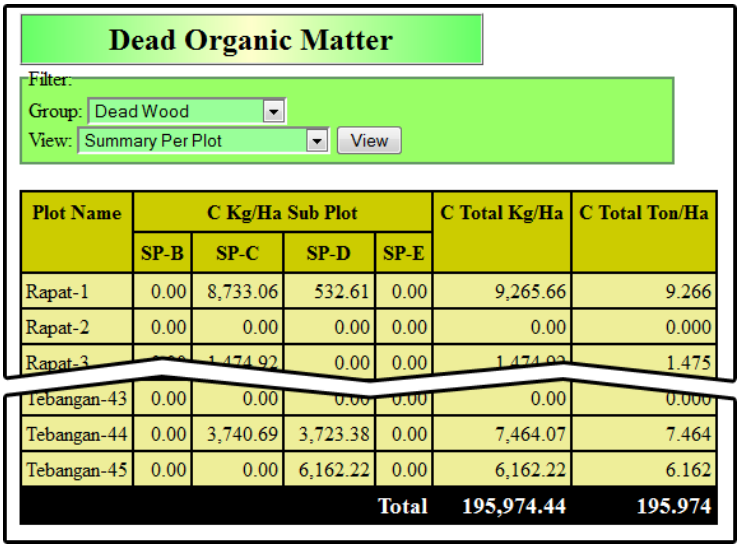
Dead Organic Matter

Filter:
Group: Dead Wood
View: Details Per Sub Plot Sub Plot: All View

Dead Wood mass D
Sound: 0.6 Moderate: 0.4
Go to **Data Input>Species an Settings>convertion factor t**

Sub Plot	Plot Name	Tree ID	D1 (cm)	D2 (cm)	Length (m)	Decomposition Level	Hollow Diameter	Hollow Length	TB (Kg)	C (Kg)	C Kg/Ha
Rapat-1	C	1C3	30	21	9.5	Moderate	0	0	194.07	87.33	
									Total Sub Plot 1 Rapat-1	87.33	8,733.06
Rapat-3	C	1/C3	17.4	14.9	4	Moderate	0	0	32.78	14.75	
									Total Sub Plot 3 Rapat-3	14.75	1,474.92
Rapat-7	C	1C3	21.1	19.4	2.1	Rotten	0	0	13.53	6.09	
Tebangan-45	D	1D3	41.2	34.1	8.2	Sound	0	0	347.75	246.49	
									Total Sub Plot 45 Tebangan-45	246.49	6,162.22
									Total Plot Tebangan-45	**3,558.68**	**88,966.93**
										Total C	**195,974.44**

Figure 5-43 DOM Dead Wood Details per Sub Plot Screenshot

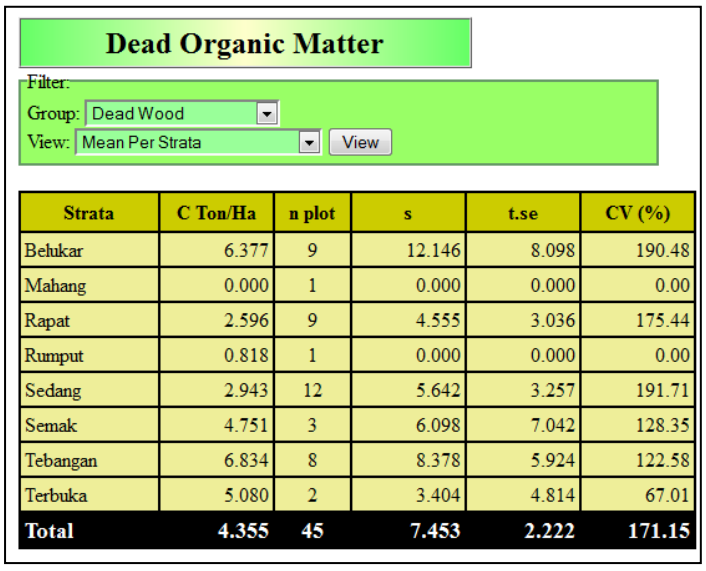


Dead Organic Matter

Filter:
Group: Dead Wood
View: Summary Per Plot View

Plot Name	C Kg/Ha Sub Plot				C Total Kg/Ha	C Total Ton/Ha
	SP-B	SP-C	SP-D	SP-E		
Rapat-1	0.00	8,733.06	532.61	0.00	9,265.66	9.266
Rapat-2	0.00	0.00	0.00	0.00	0.00	0.000
Rapat-3		1,474.92	0.00	0.00	1,474.92	1.475
Tebangan-43	0.00	0.00	0.00	0.00	0.00	0.000
Tebangan-44	0.00	3,740.69	3,723.38	0.00	7,464.07	7.464
Tebangan-45	0.00	0.00	6,162.22	0.00	6,162.22	6.162
				Total	195,974.44	195.974

Figure 5-44 DOM Dead Wood Summary per Plot Screenshot

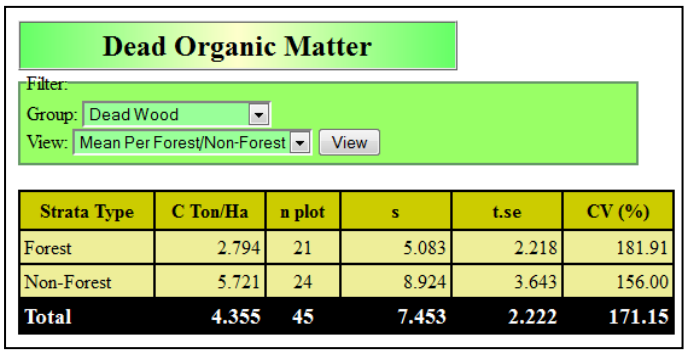


Dead Organic Matter

Filter:
Group: Dead Wood
View: Mean Per Strata View

Strata	C Ton/Ha	n plot	s	t.se	CV (%)
Belukar	6.377	9	12.146	8.098	190.48
Mahang	0.000	1	0.000	0.000	0.00
Rapat	2.596	9	4.555	3.036	175.44
Rumput	0.818	1	0.000	0.000	0.00
Sedang	2.943	12	5.642	3.257	191.71
Semak	4.751	3	6.098	7.042	128.35
Tebangan	6.834	8	8.378	5.924	122.58
Terbuka	5.080	2	3.404	4.814	67.01
Total	**4.355**	**45**	**7.453**	**2.222**	**171.15**

Figure 5-45 DOM Dead Wood Mean per Strata Screenshot

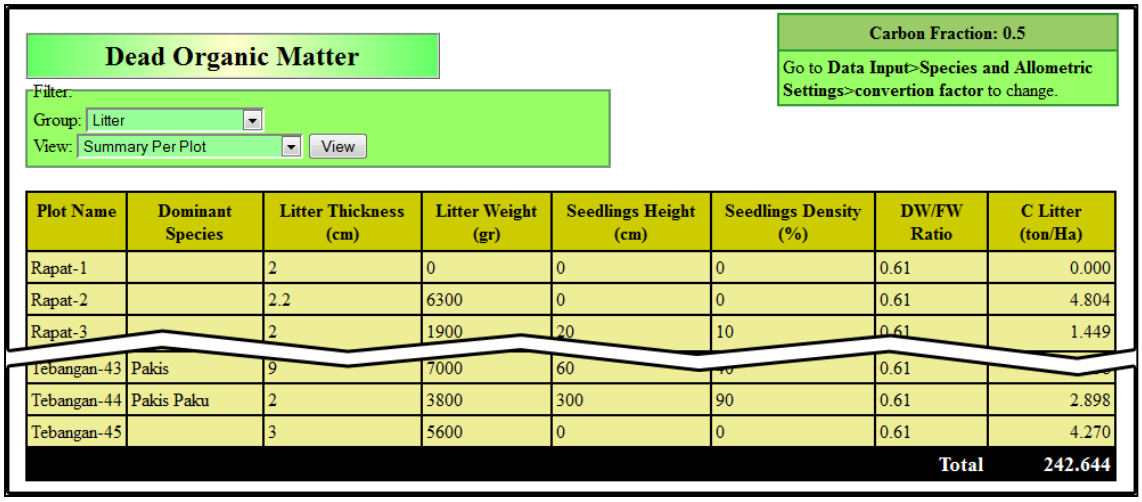


Dead Organic Matter

Filter:
Group: Dead Wood
View: Mean Per Forest/Non-Forest View

Strata Type	C Ton/Ha	n plot	s	t.se	CV (%)
Forest	2.794	21	5.083	2.218	181.91
Non-Forest	5.721	24	8.924	3.643	156.00
Total	**4.355**	**45**	**7.453**	**2.222**	**171.15**

Figure 5-46 DOM Dead Wood Mean per Forest/Non Forest Screenshot



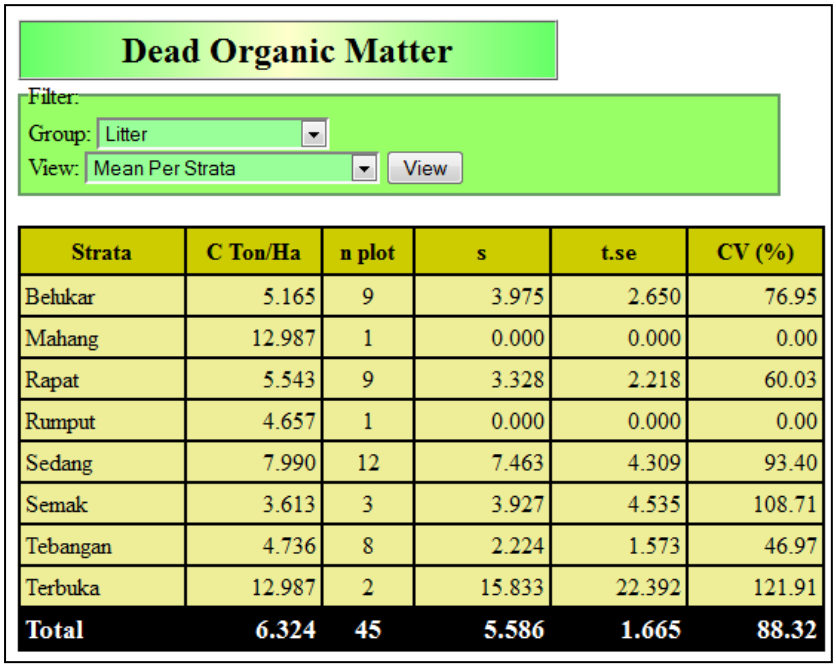
Dead Organic Matter

Filter:
Group: Litter
View: Summary Per Plot View

Carbon Fraction: 0.5
Go to **Data Input>Species and Allometric Settings>convertion factor** to change.

Plot Name	Dominant Species	Litter Thickness (cm)	Litter Weight (gr)	Seedlings Height (cm)	Seedlings Density (%)	DW/FW Ratio	C Litter (ton/Ha)
Rapat-1		2	0	0	0	0.61	0.000
Rapat-2		2.2	6300	0	0	0.61	4.804
Rapat-3		2	1900	20	10	0.61	1.449
Tebangan-43	Pakis	9	7000	60	70	0.61	7.[illegible]
Tebangan-44	Pakis Paku	2	3800	300	90	0.61	2.898
Tebangan-45		3	5600	0	0	0.61	4.270
						Total	242.644

Figure 5-47 DOM Litter Summary per Plot Screenshot

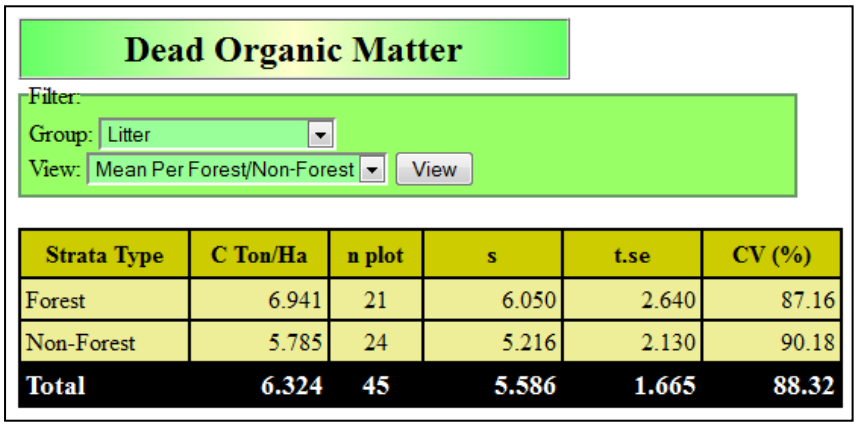


Dead Organic Matter

Filter:
Group: Litter
View: Mean Per Strata View

Strata	C Ton/Ha	n plot	s	t.se	CV (%)
Belukar	5.165	9	3.975	2.650	76.95
Mahang	12.987	1	0.000	0.000	0.00
Rapat	5.543	9	3.328	2.218	60.03
Rumput	4.657	1	0.000	0.000	0.00
Sedang	7.990	12	7.463	4.309	93.40
Semak	3.613	3	3.927	4.535	108.71
Tebangan	4.736	8	2.224	1.573	46.97
Terbuka	12.987	2	15.833	22.392	121.91
Total	**6.324**	**45**	**5.586**	**1.665**	**88.32**

Figure 5-48 DOM Litter Mean per Strata Screenshot



Dead Organic Matter

Filter:
Group: Litter
View: Mean Per Forest/Non-Forest View

Strata Type	C Ton/Ha	n plot	s	t.se	CV (%)
Forest	6.941	21	6.050	2.640	87.16
Non-Forest	5.785	24	5.216	2.130	90.18
Total	**6.324**	**45**	**5.586**	**1.665**	**88.32**

Figure 5-49 DOM Litter Mean per Forest/Non Forest Screenshot

5.5.3 BGB CARBON STOCK

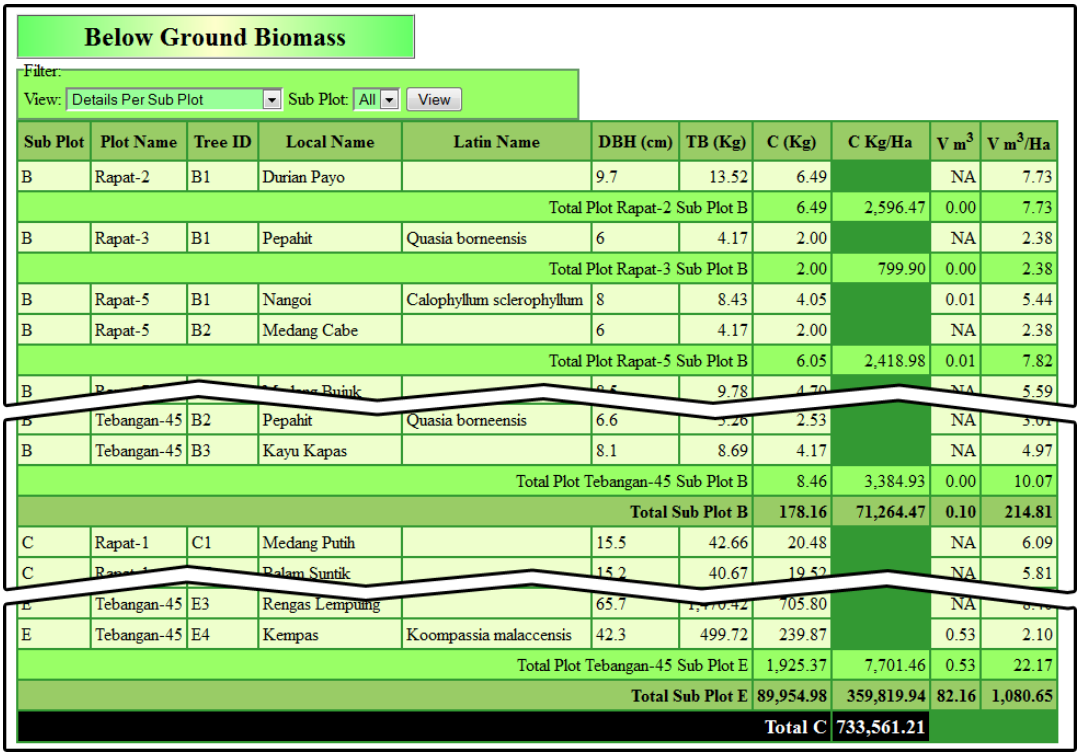
BGB Carbon Stock provides calculation of Below Ground Biomass, its carbon stock and its volume. The BGB Carbon Stock uses living trees data, calculate their AGB, and convert them into BGB using the equation set in the Conversion Factors menu. The BGB Volume is the tree's BGB divided by its mass density. If the tree's mass density is not specified, the volume is displayed as NA in the view. Even though the volume is not displayed, when calculating Volume / Ha, the software used default mass density which is 700Kg/M^3.

Below Ground Biomass

Filter:
View: Details Per Plot Plot: All View

Plot Name	Sub Plot	Tree ID	Local Name	Latin Name	DBH (cm)	TB (Kg)	C (Kg)	C Kg/Ha	V m^3	V m^3/Ha
Rapat-1	C	C1	Medang Putih		15.5	42.66	20.48		NA	6.09
Rapat-1	C	C5	Balam Suntik		15.2	40.67	19.52		NA	5.81
						Total Sub Plot C Rapat-1	40.00	3,999.64	0.00	11.90
Rapat-1	D	D1	Gasing	Lithocarpus sundaicus	25.2	140.40	67.39		NA	5.01
Rapat-1	D	D2	Jelutung Rawa	Dyera lowii	28	181.78	87.25		0.50	12.62
						Total Sub Plot D Rapat-1	154.65	3,866.15	0.50	17.64
Rapat-1	E	E1	Rengas Burung		71.4	1,803.04	865.46		NA	10.30
Rapat-1	E	E2	Pabung		40.5	449.20	215.62		NA	2.57
Rapat-1	E	E3	Jelutung Rawa	Dyera lowii	44.4	562.74	270.11		1.56	6.25
Rapat-1	E	E4	Gasing	Lithocarpus sundaicus	41	462.91	222.20		NA	2.65
Rapat-1	E	E5	Rengas Burung		78.1	2,246.38	1,078.26		NA	12.84
Rapat-1	E	E6	Beringin	Ficus benjamina	42.7	511.38	245.46		0.98	3.93
Rapat-1	E	E7	Darah-darah	Horsfieldia sp.	41.6	479.70	230.25		NA	2.74
Rapat-1	E	E8	Rengas Burung		87.2	2,943.10	1,412.69		NA	16.82
Rapat-1	E	E9	Rengas Burung		78	2,239.33	1,074.88		NA	12.80
						Total Sub Plot E Rapat-1	5,614.93	22,459.74	2.55	70.89
						Total Plot Rapat-1	**5,809.58**	**30,325.52**	**3.05**	**100.43**
Tebangan-45	E	E3	Rengas Bemplang		65.7	1,705.42	705.80		NA	
Tebangan-45	E	E4	Kempas	Koompassia malaccensis	42.3	499.72	239.87		0.53	2.10
						Total Sub Plot E Tebangan-45	1,925.37	7,701.46	0.53	22.17
						Total Plot Tebangan-45	**2,013.18**	**13,070.19**	**0.66**	**38.68**
							Total C	**733,561.21**		

Figure 5-50 BGB Details per Plot Screenshot

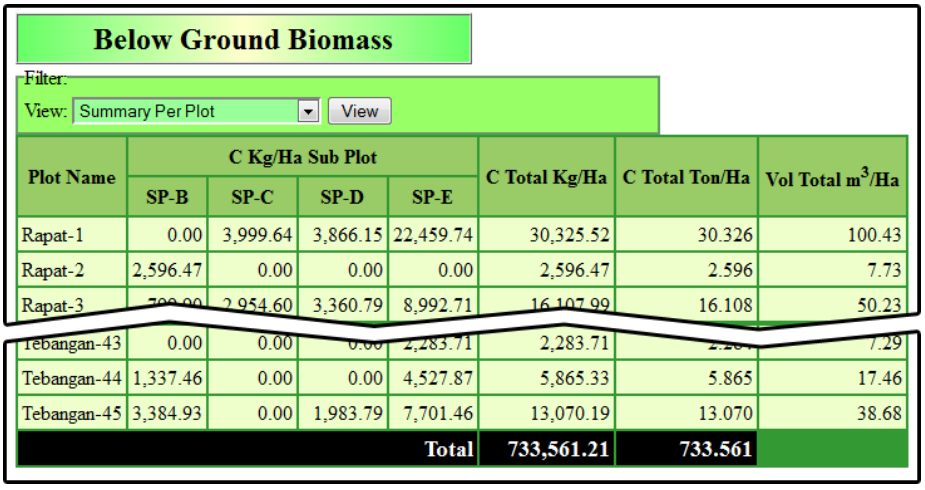


Below Ground Biomass

Filter:
View: Details Per Sub Plot Sub Plot: All View

Sub Plot	Plot Name	Tree ID	Local Name	Latin Name	DBH (cm)	TB (Kg)	C (Kg)	C Kg/Ha	V m^3	V m^3/Ha
B	Rapat-2	B1	Durian Payo		9.7	13.52	6.49		NA	7.73
						Total Plot Rapat-2 Sub Plot B	6.49	2,596.47	0.00	7.73
B	Rapat-3	B1	Pepahit	Quasia borneensis	6	4.17	2.00		NA	2.38
						Total Plot Rapat-3 Sub Plot B	2.00	799.90	0.00	2.38
B	Rapat-5	B1	Nangoi	Calophyllum sclerophyllum	8	8.43	4.05		0.01	5.44
B	Rapat-5	B2	Medang Cabe		6	4.17	2.00		NA	2.38
						Total Plot Rapat-5 Sub Plot B	6.05	2,418.98	0.01	7.82
B	[illegible]		[illegible]		[illegible]	9.78	[illegible]		NA	5.59
B	Tebangan-45	B2	Pepahit	Quasia borneensis	6.6	[illegible]	2.53		NA	[illegible]
B	Tebangan-45	B3	Kayu Kapas		8.1	8.69	4.17		NA	4.97
						Total Plot Tebangan-45 Sub Plot B	8.46	3,384.93	0.00	10.07
						Total Sub Plot B	**178.16**	**71,264.47**	**0.10**	**214.81**
C	Rapat-1	C1	Medang Putih		15.5	42.66	20.48		NA	6.09
C	[illegible]		Balam Suntik		15.2	40.67	19.52		NA	5.81
E	Tebangan-45	E3	Rengas Lemputing		65.7	[illegible]	705.80		NA	[illegible]
E	Tebangan-45	E4	Kempas	Koompassia malaccensis	42.3	499.72	239.87		0.53	2.10
						Total Plot Tebangan-45 Sub Plot E	1,925.37	7,701.46	0.53	22.17
						Total Sub Plot E	**89,954.98**	**359,819.94**	**82.16**	**1,080.65**
						Total C	**733,561.21**			

Figure 5-51 BGB Details per Sub Plot Screenshot

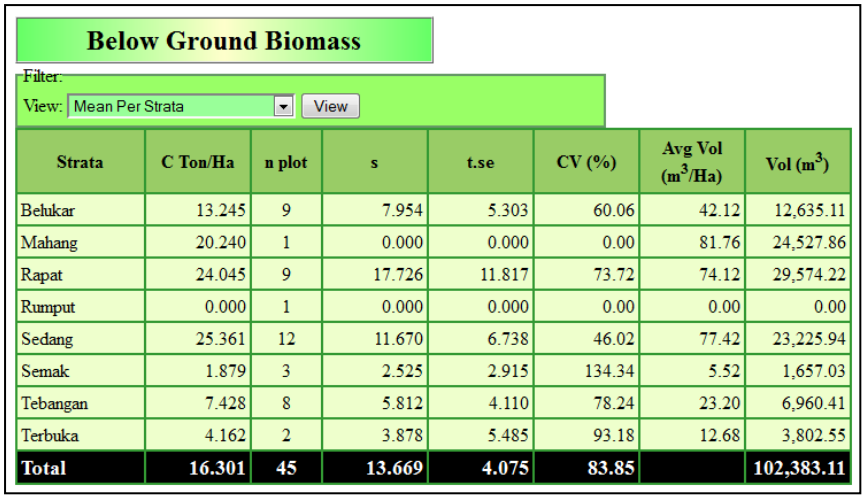


Below Ground Biomass

Filter:
View: Summary Per Plot View

Plot Name	C Kg/Ha Sub Plot				C Total Kg/Ha	C Total Ton/Ha	Vol Total m^3/Ha
	SP-B	SP-C	SP-D	SP-E			
Rapat-1	0.00	3,999.64	3,866.15	22,459.74	30,325.52	30.326	100.43
Rapat-2	2,596.47	0.00	0.00	0.00	2,596.47	2.596	7.73
Rapat-3	[illegible]	2,954.60	3,360.79	8,992.71	16,107.99	16.108	50.23
[illegible]	0.00	0.00	[illegible]	[illegible]	2,283.71	[illegible]	7.29
Tebangan-44	1,337.46	0.00	0.00	4,527.87	5,865.33	5.865	17.46
Tebangan-45	3,384.93	0.00	1,983.79	7,701.46	13,070.19	13.070	38.68
				Total	**733,561.21**	**733.561**	

Figure 5-52 BGB Summary per Plot Screenshot

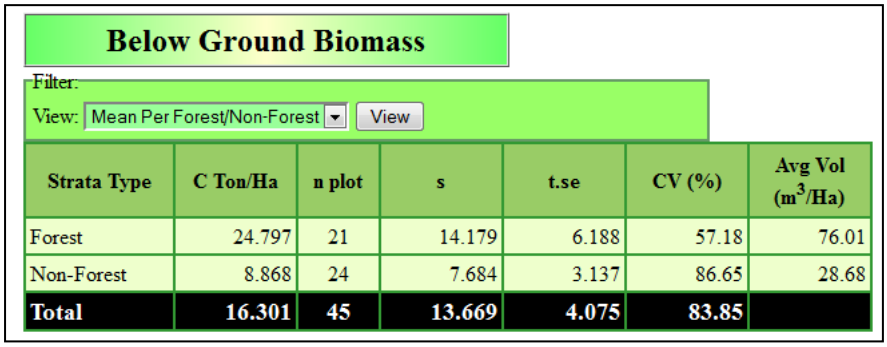


Below Ground Biomass

Filter:
View: Mean Per Strata View

Strata	C Ton/Ha	n plot	s	t.se	CV (%)	Avg Vol (m^3/Ha)	Vol (m^3)
Belukar	13.245	9	7.954	5.303	60.06	42.12	12,635.11
Mahang	20.240	1	0.000	0.000	0.00	81.76	24,527.86
Rapat	24.045	9	17.726	11.817	73.72	74.12	29,574.22
Rumput	0.000	1	0.000	0.000	0.00	0.00	0.00
Sedang	25.361	12	11.670	6.738	46.02	77.42	23,225.94
Semak	1.879	3	2.525	2.915	134.34	5.52	1,657.03
Tebangan	7.428	8	5.812	4.110	78.24	23.20	6,960.41
Terbuka	4.162	2	3.878	5.485	93.18	12.68	3,802.55
Total	**16.301**	**45**	**13.669**	**4.075**	**83.85**		**102,383.11**

Figure 5-53 BGB Mean per Strata Screenshot



Below Ground Biomass

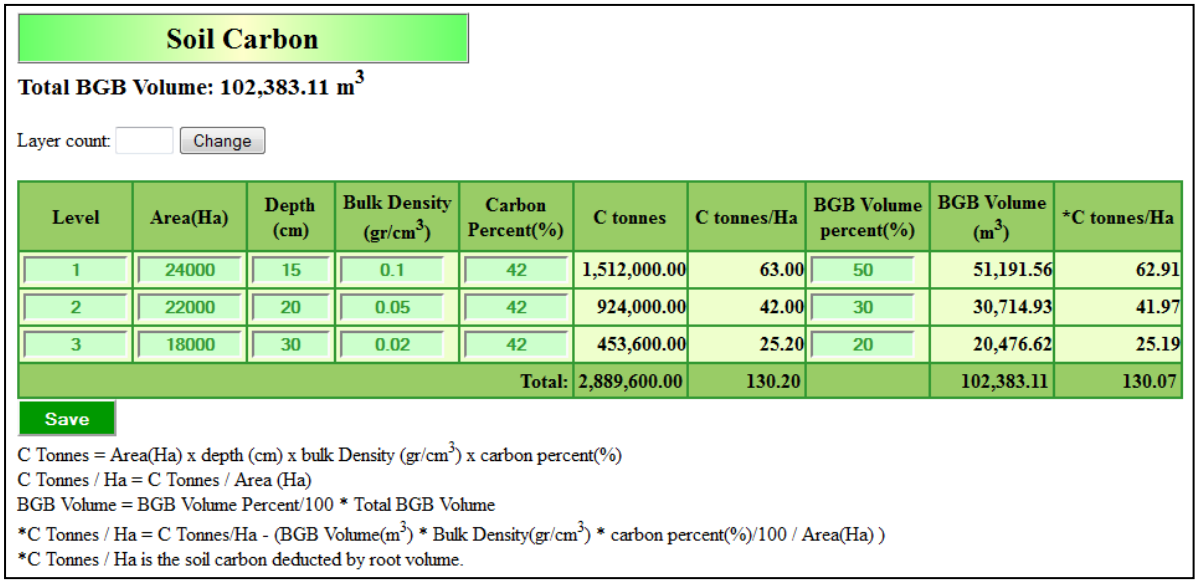
Filter:
View: Mean Per Forest/Non-Forest View

Strata Type	C Ton/Ha	n plot	s	t.se	CV (%)	Avg Vol (m^3/Ha)
Forest	24.797	21	14.179	6.188	57.18	76.01
Non-Forest	8.868	24	7.684	3.137	86.65	28.68
Total	**16.301**	**45**	**13.669**	**4.075**	**83.85**	

Figure 5-54 BGB Mean per Forest/Non Forest Screenshot

5.5.4 Soil Carbon Stock

The Soil Carbon menu provides the interface to calculate Soil Carbon Stock. Users can change the layer count for the soil and set the variables for each soil layer.



Soil Carbon

Total BGB Volume: 102,383.11 m^3

Layer count: Change

Level	Area(Ha)	Depth (cm)	Bulk Density (gr/cm^3)	Carbon Percent(%)	C tonnes	C tonnes/Ha	BGB Volume percent(%)	BGB Volume (m^3)	*C tonnes/Ha
1	24000	15	0.1	42	1,512,000.00	63.00	50	51,191.56	62.91
2	22000	20	0.05	42	924,000.00	42.00	30	30,714.93	41.97
3	18000	30	0.02	42	453,600.00	25.20	20	20,476.62	25.19
				Total:	2,889,600.00	130.20		102,383.11	130.07

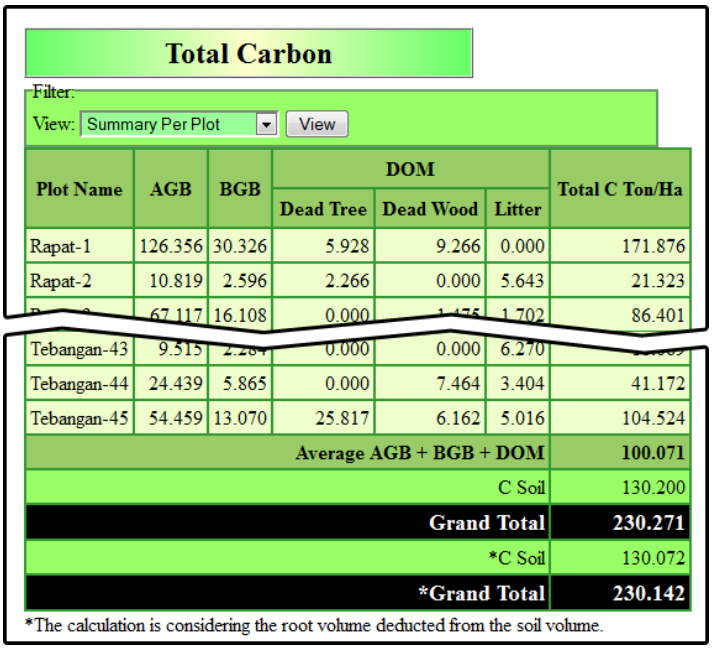
Save

C Tonnes = Area(Ha) x depth (cm) x bulk Density (gr/cm^3) x carbon percent(%)
C Tonnes / Ha = C Tonnes / Area (Ha)
BGB Volume = BGB Volume Percent/100 * Total BGB Volume
*C Tonnes / Ha = C Tonnes/Ha - (BGB Volume(m^3) * Bulk Density(gr/cm^3) * carbon percent(%)/100 / Area(Ha))
*C Tonnes / Ha is the soil carbon deducted by root volume.

Figure 5-55 Soil Carbon Stock Screenshot

5.5.5 *Total Carbon Stock*

The The Total Carbon Stock Menu provides the calculation summary of all the other carbon stock calculation. The Total Carbon Stock summarizes the AGB, DOM, BGB and Soil carbon stock altogether. There are three view choices: Summar Per Plot, Per Strata and Per Forest/Non-Forest.



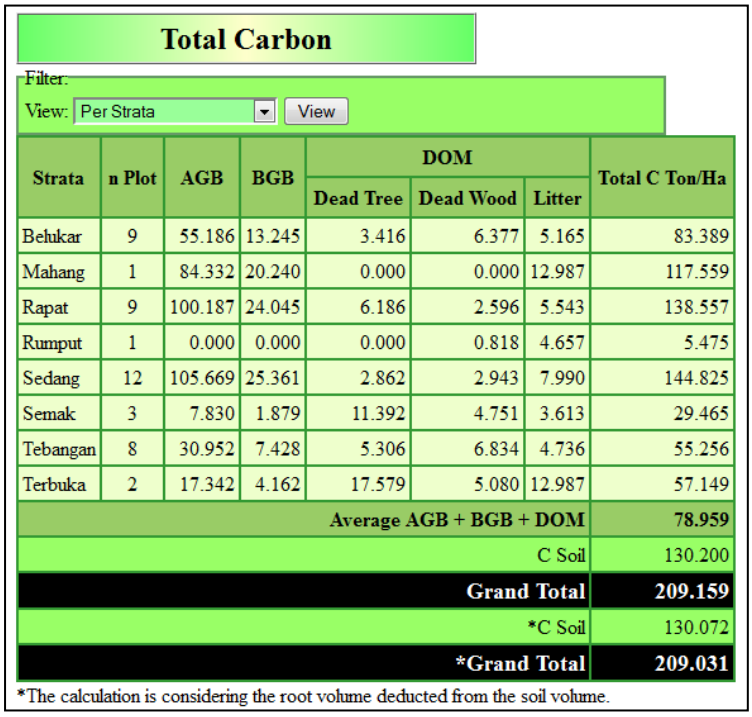
Total Carbon

Filter:
View: Summary Per Plot View

Plot Name	AGB	BGB	DOM			Total C Ton/Ha
			Dead Tree	Dead Wood	Litter	
Rapat-1	126.356	30.326	5.928	9.266	0.000	171.876
Rapat-2	10.819	2.596	2.266	0.000	5.643	21.323
[illegible]	67.117	16.108	0.000	[illegible]	1.702	86.401
Tebangan-43	9.515	[illegible]	0.000	0.000	6.270	[illegible]
Tebangan-44	24.439	5.865	0.000	7.464	3.404	41.172
Tebangan-45	54.459	13.070	25.817	6.162	5.016	104.524
					Average AGB + BGB + DOM	**100.071**
					C Soil	130.200
					Grand Total	**230.271**
					*C Soil	130.072
					***Grand Total**	**230.142**

*The calculation is considering the root volume deducted from the soil volume.

Figure 5-56 Total Carbon Stock per Plot Screenshot



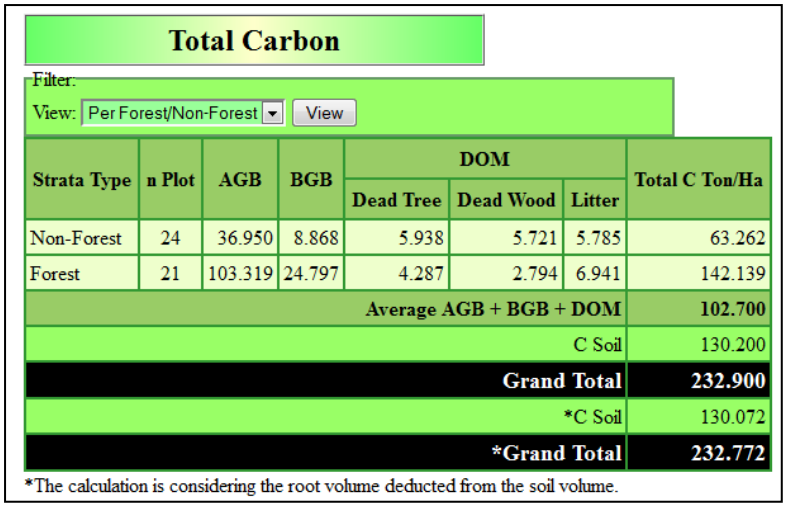
Total Carbon

Filter:
View: Per Strata View

Strata	n Plot	AGB	BGB	DOM			Total C Ton/Ha
				Dead Tree	Dead Wood	Litter	
Belukar	9	55.186	13.245	3.416	6.377	5.165	83.389
Mahang	1	84.332	20.240	0.000	0.000	12.987	117.559
Rapat	9	100.187	24.045	6.186	2.596	5.543	138.557
Rumput	1	0.000	0.000	0.000	0.818	4.657	5.475
Sedang	12	105.669	25.361	2.862	2.943	7.990	144.825
Semak	3	7.830	1.879	11.392	4.751	3.613	29.465
Tebangan	8	30.952	7.428	5.306	6.834	4.736	55.256
Terbuka	2	17.342	4.162	17.579	5.080	12.987	57.149
						Average AGB + BGB + DOM	**78.959**
						C Soil	130.200
						Grand Total	**209.159**
						*C Soil	130.072
						***Grand Total**	**209.031**

*The calculation is considering the root volume deducted from the soil volume.

Figure 5-57 Total Carbon Stock per Strata Screenshot



Total Carbon

Filter:

View: Per Forest/Non-Forest View

Strata Type	n Plot	AGB	BGB	DOM			Total C Ton/Ha
				Dead Tree	Dead Wood	Litter	
Non-Forest	24	36.950	8.868	5.938	5.721	5.785	63.262
Forest	21	103.319	24.797	4.287	2.794	6.941	142.139
						Average AGB + BGB + DOM	102.700
						C Soil	130.200
						Grand Total	232.900
						*C Soil	130.072
						*Grand Total	232.772

*The calculation is considering the root volume deducted from the soil volume.

Figure 5-58 Total Carbon Stock per Forest/Non Forest Screenshot