Technical Report:

RESULTS OF FOREST CARBON ASSESSMENT AND MONITORING PROJECT SURINAME

Period 2010 -2011

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Suriname 2012

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List of acronyms

AGB	Aboveground Biomass
BBS	National Herbarium in Suriname
BGB	Belowground Biomass
C	Carbon
CBN	Capacity Building Fund for Forest and Nature Sector
CL	Coarse Litter
CO_2	Carbon dioxide
CELOS	Center for Agricultural Research in Suriname
CV	Coefficient of Variation
Dbh	Diameter at breast height
DOM	Dead Organic Matter
DW	Dead Wood
FAO	Food and Agriculture Organization
FL	Fine Litter
GHG	Greenhouse Gas
GPS	Global Positioning System
HFLD	High Forest Cover, Low Deforestation
IPCC	Intergovernmental Panel on Climate Change
Ministry RGB	Ministry of Physical Planning, Land and Forest Management
MRVs	Measurement, Reporting and Verification-system
PSP	Permanent Sample Plot
REDD+	Reduced Emissions from Deforestation and Degradation and the role of Conservation Sustainable Forest Management and the enhancement of Carbon Stocks
SBB	Foundation for Forest Management and Production Control
SOC	Soil Organic Carbon
SD	Standard Deviation
TBI	Tropenbos International
TCS	Total Carbon Stock
WWF	World Wildlife Fund

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Acknowledgements

Writing this foreword we are waiting for the train in the railway station in Vienna, Austria, where we are preparing the initiation of the national forest inventory for Suriname. As we are going towards this new adventure, we reminisce about the carbon adventures we had last year. There is not enough space in the foreword to tell all the exciting stories we have, but we would like to share at least some of the memorable experiences of the 'carbon group'.

We visited about twelve locations spread over the forest belt of Suriname, which we reached by car, by boat, by ATV and by foot. Every time our field team looked like a nomadic caravan on the move, characterized by plenty of emerging PVC-pipes, which gave us the appearance of a group of plumbers. Arriving at the destination, our first job was to assure a shelter for the night, using the raw materials provided by the surrounding forest. Those camps became our house for the time spent in the field, and our cook made it like a home for us preparing delicious food like the famous *power-soups*, the freshly made *bake*, and other special dishes. Sometimes our peace at the camp was roughly interrupted as for example the time at Kabo when a *mispel* tree fell down on the roof in the middle of the night terrifying the team; when one of the team members was looking for her belt in the dawn, and accidently grabbed a small Boa constructor instead or the morning the Mapanecreek overflowed her banks and turned our camp into a lake leaving us to think that this was the end of the world. Fortunately this was not the case and after one day our home was dry again.

The most important thing to remember about this year is the great collaboration we had between the team members. We learnt that everyone with his/hers own experiences could contribute to the team in any way possible. Hereby we would like to thank all the members of the field team for the great time we shared in the field, for the collaboration, sharing ideas, the jokes and the support. We would like to address a personal word to each one of you, because without you it would not have been possible to complete this project so successfully.

Also a word of thanks to the participating institutions: the Ministry of RGB, SBB, CELOS, BBS that supported us in different ways. We hope we can continue with this positive collaboration also in future projects. We are all working in the same forest, and we can achieve much more when we collaborate.

We would also like to thank the co-authors for their participation in the formulation of this report, a special word of thanks for Mr. Frits van Troon, who inspired us all with his extensive knowledge and *joy de vivre* during the tree spotters refreshment training and to the technical experts that shared their experience with us, particularly Mr. Christopher Baraloto, Mr. Olaf Bánki and Mr. Francis Putz for the scientifically questions and valuable input. We want to express our gratitude to the ngo's: WWF, Tropenbos International and CBN who provided the financial means for this project, Ms. Sandy Adriaenssens for the editing and Ms. Elly Tjon for the correction of language errors.

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Summary

Suriname is preparing to be included in a REDD+-mechanism and one of the steps to take is the establishment of a Measurement, Reporting and Verification system (MRVs). One of the activities towards the MRVs is the assessment of the emission factors, reason why the Ministry of RGB has written a three-year-project. Funding for the first year (November 2010-December 2011) was provided by different donor organizations, enabling capacity building of field personnel of the Ministry and its partner institutions (SBB, CELOS and BBS), while field measurements were carried out in 12 different locations in the forest of Suriname. The collected data provide an estimation of the forest carbon stock and its variations, and can be used to improve the proposed methodology.

The 12 locations were chosen in the more easily accessible parts of the forest, to maximize the opportunity to build capacity and to minimize transportation costs. All the plots were established in three main forest types: high dryland forest, marsh forest and low xerophytic forest. Because the soil sampling methodology was only applicable to dry soil conditions, no data about the swamp, peat and mangrove forests in the young coastal plain were collected.

At each location a transect was established, consisting of three permanent measurement plots of 0,5 ha (50m x 100 m), one kilometer apart from each other. Information about aboveground biomass (AGB) and standing dead wood was collected in these plots. For the trees, lianas and woody palms, the diameter at breast height (dbh) and/or heights were measured and the tree species were identified, which allowed us, by means of pantropic allometric equations to calculate their biomass storage. At a distance of 10 m from each corner of these plots, quadrats of 3 m by 3 m were laid out where the understory, coarse and fine litter were harvested and weighed, while soil samples were taken to a depth of 1 m to assess the Soil Organic Carbon (SOC) stock.

To assess the AGB, the biomass stored in trees, woody palms, lianas, and the understory vegetation was measured. Measuring the AGB stored in trees, woody palms and lianas directly, would include harvesting and determining their weight. As this would be labour-intensive and unpractical, the dbh was measured and the AGB was calculated based on its allometric relation with this dbh. Based on the data collected, AGB contains between 51,5 t/ha (low xerophytic forest) and 126,8 t/ha (high dryland forest) of carbon. Trees contributed the most to the AGB, in average 91%, whereby a relatively high variation was found. The contribution to the AGB of woody palms and lianas, is on an average 2% and 5% respectively. Nevertheless to optimize the protocol, for lianas a higher minimum diameter threshold of 5 cm is proposed. Harvesting the understory was very labour-intensive, while its contribution to the AGB was on average only 2%. Therefore it should be reconsidered whether measurement of understory vegetation has to be included in future measurement protocols.

The AGB found during this project is lower than the default values indicated by IPCC. In the IPCC-guidelines (2006), a default value for the AGB of 300 t/ha corresponding with a C-storage of 141 t/ha is given for tropical rainforest in North and South America. The values found are also lower than the values presented by Arets (2011) summarizing the results of different researches.

The assessment of belowground biomass (BGB) is time-consuming, and BGB is found to be strongly correlated with the AGB. To calculate the BGB based on the AGB, an allometric equation made by Cairns (1987) was used. AGB and BGB together contribute 70% on an average to the total carbon stock.

Dead organic matter (DOM) was assessed by measuring three components: standing dead wood with a diameter greater than or equal to 5 cm, coarse litter with a diameter greater than or equal to 2 cm and fine litter with a diameter smaller than 2 cm. In total, the contribution of this component to the total carbon stock varied between 9,2 t/ha (low xerophytic forest) and 19,5 t /ha (high dryland forest) corresponding with an average contribution of 9%. However, the coefficients of variation for coarse litter and standing dead wood are exceeding 100%, indicating a very variable spatial distribution of DOM. It is recommended to revise the methodology used to measure these components. The variation of coarse litter might decrease when we would measure it using a line intersect method. In addition, a diameter of 10 cm is recommended to distinguish between dead wood (standing and lying) and litter (IPCC, 2003).

Soil Organic Carbon (SOC) has been assessed to a depth of 1 meter. The layer of 0-30 cm is the most subjected to change while the contribution of the SOC in this upper soil layer to the total SOC varied between 55 and 93%. The total SOC in the 1 m profile varied on an average between 9,4 t/ha (white soils of the low xerophytic forest) and 48,9 t/ha (marsh forest). For future measurements it is acceptable to restrict the SOC measurements to the 0-30cm layer.

After adding up the different components, the total carbon stock found varies between 80,9 t/ha for the low xerophytic forest, 196,8 ± 34,4 t/ha for the marsh forest and 215,8 ± 5,2 t/ha for the high dryland forest (Assuming a 95%-confidence interval and a normal distribution of the data).

When Suriname continues with its national forest carbon assessment, it is important to evaluate the objectives (e.g. measuring biodiversity, timber stocks, carbon stock, carbon fluxes, forest dynamics). During this project permanent sample plots were used in order to make it possible to measure both the current carbon stock and future carbon fluxes (plot and tree demarcation). After analyzing the data, it turned out that the plot size of 0,5 ha seemed to be small to capture the variability of the forest and to monitor carbon fluxes and forest dynamics. Therefore, it is recommended that a more rapid inventory technique is applied for a national forest carbon assessment, with many small plots, covering larger areas. If both dynamic and static descriptors have to be assessed, a combination of both types of plots is recommended. Ideally, the field measurements could be used for the calibration of remote sensing data, enabling the mapping of the fine-scale variability of the forest on a regular basis. Finally, when planning a forest inventory, it is important to keep in mind the high travelling costs. The time spent in the field is therefore very valuable and should be optimized, for example by combining the measurement of the carbon stock with collection of data which could be used for other purposes.

Because of the difficulties experienced to identify the scientific tree species name, we decided to identify the trees up to the vernacular names, since the tree spotters are more familiar with these. We still have to find a practical solution to efficiently determine the scientific tree species name, which might be necessary for further inventories. Moreover, the group of tree spotters, who play a crucial rule in forest inventories, is very small and needs to be extended. Regular refreshment training is also required. Persons with botanical knowledge should be included in the inventory team. It is expected that BBS will play an important role in further capacity building.

The establishment of a MRVS is a challenge for Suriname. The forest is difficult to access and the existing capacity, especially human resource, is limited. A MRVS is a multidisciplinary system, involving a large group of field personnel and different experts e.g. foresters, soil specialists, remote sensing specialists, climate specialists, statisticians, and tree spotters. It is therefore essential that collaboration between all the institutions is maintained and improved, and that investment in capacity building is continued.

1 Introduction

As a High Forest cover, Low Deforestation (HFLD) country, Suriname can be included in a global carbon financing mechanism, such as REDD+. As a prerequisite for its inclusion in such a mechanism, a Measurement, Reporting and Verification system (MRVs) needs to be established. One of the steps towards such a system is the development of a methodology to assess forest carbon stock and capacity building to assess and periodically monitor this forest carbon stock. To achieve this, a three-year-project "*Capacity building for an efficient forest carbon stock assessment in Suriname*" was formulated. The first year was funded by WWF, TBI and CBN Suriname.

The project coordinator is the Ministry of Physical Planning, Land and Forest Management (Ministry of RGB), while the coordination of the fieldwork was carried out by the Foundation for Forest Management and Production Control (SBB). The Center for Agricultural Research in Suriname (CELOS) provided laboratory facilities and technical expertise. Personnel of all three organizations participated in the training and the field measurements. The training was given by the international consultant, Dr. Marijke van Kuijk of AidEnvironment, who delivered a similar training in Guyana (Alder & van Kuijk, 2009). The National Herbarium in Suriname (BBS) assisted in the plant identification and the training of the tree spotters involved in this project.

The project was initiated with a field training in November 2010, in the Tibiti region (concession of Suma Lumber Company N.V.), followed by a second training in February 2011 in the Mapane region (logged by E-Timberindustry Suriname). During these field trainings a group of employees from different Surinamese institutions was trained to measure forest carbon stocks. Subsequently from April 2011 to November 2011 field measurements were carried out by the group of trainees enabling them to refine their recently acquired skills and transfer their knowledge to a larger group of field workers, who received an on-the-job training. In July 2011 a short training in data processing was organized.

The results of the first project year are threefold: 1) a dataset was generated enabling the preliminary calculation of the forest carbon stock, 2) these data can be used for the improvement of the measurement protocol and 3) personnel was trained to carry out the measurements and do the calculations. In this report the results of the collected data of the first project year are presented.

Figure 1 The field team during the fieldwork and training

2 Study area

2.1 General information

Although data covering the whole country are needed, the measurements were limited to the forest belt, as it is easier to access (Figure 2). This was done to maximize the opportunity to build capacity, while minimizing the costs. The methodology provided needs to be adapted to allow measurements in forests with wet soil conditions e.g. peat or mangrove forests.

The collected data should be regarded as a preliminary data set, to be used as a basis to refine the methodology, including the sampling design and sampling intensity. No national sampling scheme or stratification was in place to determine the plot locations.

For the distribution of the plots over the country, three maps were used:

- Preliminary vegetation map (CELOS/Narena, 1998)
- Reconnaissance Soil map of Suriname (Dienst Bodemkartering, 1977)
- National Forest Cover map of Suriname (Ministry of RGB, 2010) (Figure 2).

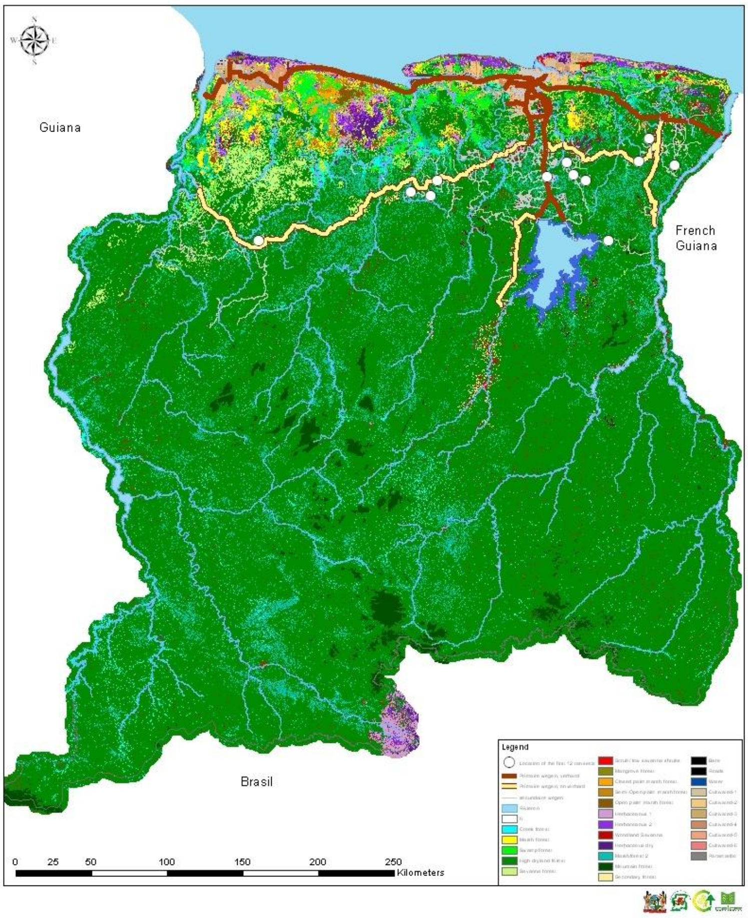

Figure 2 Location of the 12 transects, indicated by white dots, established for forest carbon stock measurement projected on the national forest cover map of Suriname (Ministry of RGB, 2010)

2.2 Description of the transect locations

At each location shown in Table 1, a transect was established. Each transect consists of three measurement plots as described in section 3.1.

Table 1 Location and measurement period of the different transects

Transect	Region	Measurement period
Transect 1	Tibiti	November 2010
Transect 2	Mapane	February 2011
Transect 3	Patamacca	April 2011
Transect 4	Mapane	May 2011
Transect 5	Mapane	May 2011
Transect 6	Kabo	June 2011
Transect 7	Kabo/Tibiti	June 2011
Transect 8	Mozeskreek	August 2011
Transect 9	East of the hydropower lake	August 2011
Transect 10	Java	September-October 2011
Transect 11	Pakira	October 2011
Transect 12	Marchallkreek	November 2011

2.3 Description of the measurement plots

A brief description was made and pictures were taken of all the 36 measurement plots. A comprehensive description of each measurement plot can be found in Annex 1, while the stand variables (e.g. basal area, vegetation height and average dbh) per measurement plot can be found in Annex 2.

It was difficult to allocate a single forest type to each plot, due to the high small-scale variability of the forest. The plots differed in the degree of disturbance, soil type, species composition and topography. In this report the classification of the plots is restricted to the dominant forest type as determined in the field (Table 2).

Table 2 Number of plots per forest type

Forest type	Number of plots
Marsh forest	6
Low xerophytic forest	1
High Dryland forest	29

On comparing the forest types in the field with the forest types shown on the National Forest Cover Map (Figure 2), we found that in 81% of the cases they matched (Annex 1). The deviations were mainly found in cases where the forest types differed from the “high dryland forest”. This information can be used as validation data for this recently developed map.

2.4 Tree species botanical and vernacular names

In each 0,5 hectare plot (Figure 4) trees with a diameter at breast height (dbh) greater than or equal to 5 cm were measured and for each tree, the vernacular tree name as indicated by the tree spotter was recorded. There is not always a clear link between the vernacular species name and the botanical species name (Annex 13). Some vernacular names correspond to multiple botanical species names and vice versa. To determine the botanical species name plant material (preferably fertile) has to be collected, dried and brought to the BBS for identification, what would substantially increase the costs. We preferred to focus, in this project, on the other measurements. The established plots have a permanent character, and can be easily traced back whenever it becomes necessary to determine the botanical species names.

In Table 3 the three dominant tree species per forest type and per dbh-class are shown. In Annex 3 this can be found for each measurement plot.

Table 3 The vernacular names of the three dominant tree species per forest type listed in order of predominance. The corresponding botanical names can be found in Annex 13

Forest type	Dominant species (trees dbh [5-20cm[)	Dominant species (trees dbh ≥ 20cm)
Marsh forest	1. Manbarklak, Hoogland, witte bast 2. Taya-udu, Geelbloemige 3. Boszuurzak, langbladige	1. Umabarklak 2. Walaba 3. Manbarklak, Hoogland, witte bast
Low xerophytic forest	1. Mangro, Sabana 2. Gawtri, Sabana 3. Fungu, Zwarte, Kleinbladige	1. Ijzerhart, Sabana 2. Mangro, Sabana 3. Fungu, Zwarte, Kleinbladige
High Dryland forest	1. Taya-udu, Geelbloemige 2. Manbarklak, Hoogland, witte bast 3. Umabarklak, hoogland	1. Walaba 2. Manbarklak, Hoogland, witte bast 3. Umabarklak

In the last part of the projects first year a tree spotter refreshment course was carried out in collaboration with BBS, CELOS, SBB and Mr. Frits van Troon, the most experienced field botanist of Suriname (Figure 3). During this course the tree spotters were taught how to describe trees, to recognize young trees in the field and to identify some of the major plant families.


Figure 3 Tree spotter's refreshment training

3 Methodology

The methodology to carry out these measurements was developed by AidEnvironment and the field manuals can be found in Annex 14 and 15. Throughout the project, and based on field experience small modifications were made in consultation with AidEnvironment and all the project partners. To guarantee the transparency of the protocol used for the different plots and to explain the decisions to change the protocol, the methodology and its modifications are reviewed again in this report.

Following the IPCC- guidelines of 2003 five carbon pools can be distinguished:

- Aboveground biomass (AGB)
- Belowground biomass (BGB)
- Dead wood (DW)
- Litter
- Soil Organic Carbon (SOC)

3.1 Sampling design

3.1.1 Permanent sample plot: shape and size

Within this project, it was agreed that the field measurements should allow the assessment of changes in the forest carbon stock. There are three approaches to measure changes in carbon stored in forests, each to be repeated with a time interval of 5-10 years (IPCC, 2003):

- The same sampling units are used on both censuses (permanent sampling units);
- Different, independent sets of sampling units are used on both censuses (temporary sampling units);
- Some sampling units can be replaced between censuses, while others remain the same (sampling with partial replacement).

When permanent sampling units are established, it is important that forest management is not influenced, as this may cause bias. Therefore logging companies active in the areas of the sample plots, were informed they did not have to adapt their management strategies, and to date some of the plots have already been logged.

Beside the temporal or permanent character one has to choose, setting up a forest inventory, also plot size and shape has to be discussed. After several technical meetings, a rectangular plot shape was chosen because of the familiarity of the fieldworkers in Suriname with this shape, and to allow easy integration in the international Rainfor-network. At each location a transect was established, consisting of three measurement plots, positioned in a straight line at least 1 km apart (Figure 4). The distance of 1 km was to ensure that the three different measurement plots were independent. This design is based on the assumption that the three measurement plots are repetitions within the same forest type. Data on trees, standing dead wood and lianas were collected in the measurement plots. Following the method described by Alder & Synnott (1992), each measurement plot was subdivided into 8 subplots of 25 by 25 meter. These dimensions were determined on the basis of the limited visibility in closed forest.

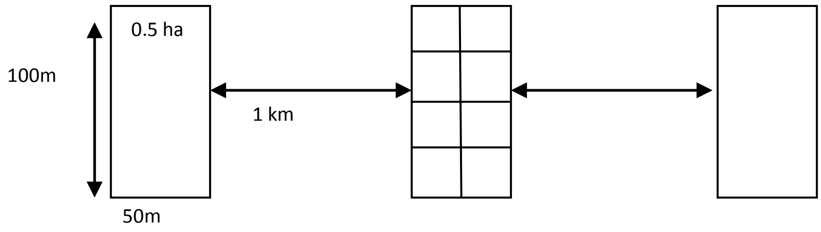

Figure 4 Design of the permanent sample plot

Figure 5 Establishing the permanent sample plot

3.1.2 3m x 3m-quadrats for destructive sampling

Ten meters away from each corner of a measurement plot, at an angle of 45 degrees, a 3 m x 3 m quadrat was laid out, where data on the understory, woody debris and fine litter was collected by destructive sampling (Figure 6). At the same locations the soil samples were taken, unless the soil was too disturbed after the destructive sampling or it was impossible to take soil samples due to the occurrence of stones in the soil. In those cases another location for soil sampling was chosen to a maximum distance of 50 m. In the case the location of the quadrat was not representative for the environment, the plot was moved with intervals of five meters.

Figure 6 Design of the 3m x 3m squares

3.1.3 Slope correction

Activity data on area of forest cover changes refer to a horizontal plane. In order to link the field data with the forest cover map or forest cover change data, a projection on a horizontal plane is needed. Where the slope is greater than 10% a slope correction has to be carried out, while slopes smaller than 10% are usually ignored (van Kuijk, 2011). For transects 1 to 7 the slope in the field was measured and the average slope was calculated, after which the surface area was corrected by following formula:

$L = Ls * \cos S$

where,

L	=	the true horizontal plot length
Ls	=	the standard length measured in the field along the slope
S	=	the slope in degrees
Cos	=	the cosine of the slope angle

Only one slope greater than 10% was found; this was at Transect 4, Plot 2, where the average slope found was 25%. The projected horizontal area of this plot is 0,47 ha.

For transects 8 to 12 the slope correction was done immediately in the field by assuring that the measurement tape was held in the horizontal plane (Figure 7.a). If the slope was too steep to measure the distance in a straight forward manner, it was measured by means of chaining (Klein & Bandari, 2004).

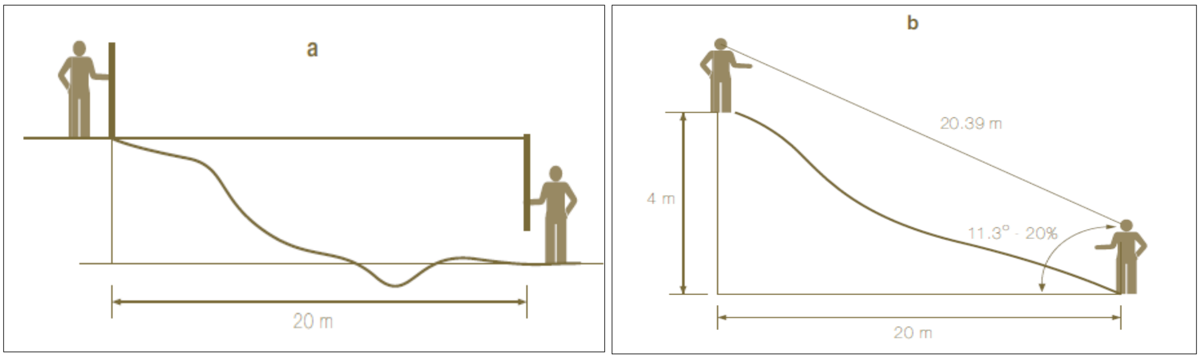

Figure 7 Slope correction by chaining (a) or with a slope measurement (b) (Source: Evaluacion forestal nacional de Equador- Manual de campo)

3.2 Measurements

3.2.1 Aboveground Biomass (AGB)

3.2.1.1 Trees

As recommended by Alder & Synott (1992), trees with a dbh ≥ 20 cm are measured within the whole measurement plot, while trees with a dbh between 5 and 20 cm were measured in two randomly selected subplots (25 m x 25 m each) with a total area of 0,125 ha. For all trees the dbh was measured with a diameter tape if possible. If this was impossible due to the occurrence of buttresses or an irregular tree trunk shape the diameter was estimated on two sides, perpendicular to each other, using a spring rule.

Figure 8 Measuring dbh

For each tree the vernacular tree species name of each tree was determined by a trained tree spotter. The vernacular names as shown on the list provided by the BBS (based on names used by van Troon F. and Comvalius L.) were used to allow uniformity and connect it with one or more name botanical name (Annex 13). Throughout the project this list was updated and improved.

The commercial height of trees with a dbh ≥ 20 cm was estimated and different tree scores were recorded to evaluate the stem form, forking, decay, logging damage and fire damage (Annex 14). This is not necessary for the carbon assessment, but the data might be useful for other purposes such as sustainable forest management.

To allow re-measurement, a unique tree number was assigned to each measured tree. This number was tagged on the tree with an aluminum label and painted on the tree bark (Figure 9). Also the tree measurement line was painted on the bark and a tree location map was made for each measurement plot.

Figure 9 Demarcation of measured trees. Each tree has a painted tree number, a measurement line, and an aluminium tag.

3.2.1.2 Woody palms

During the measurement in the first transect only the dbh of woody palms was recorded, but because the biomass stored in woody palms is more closely related to the height than to the dbh, only height should be measured (Pearson et al., 2005). From transect 2 onwards; the palm stem height from the ground level to the end of the stem was measured. From transect 2 to transect 7 the same dbh-limit used for trees was applied to decide whether to measure a woody palm or not. This dbh was sometimes difficult to measure, especially for *Astrocaryum sciophilum* (Bugrumaka) because of its thorny stem. From transect 8 onwards, woody palms were only measured in two randomly selected subplots (the same as for small trees with a dbh between 5 and 20 cm), if they had a woody stem at breast height (1,3m). If they did not have a woody stem at 1,3 m, they were regarded as understory vegetation and sampled destructively in the quadrats. Palm stem heights were measured using a clinometer or directly with a spring rule, if the palm stems were only a few meters tall. The measured woody palms were also tagged and mapped on the tree location map.

Figure 10 Measured pinapalms

3.2.1.3 Lianas

For transects 1 to 7, the number of lianas in each tree with a dbh ≥ 20 cm (Annex 14) were counted. Hereby no distinction in diameter-classes was made. To allow assessment of biomass stored in lianas, the lianas were measured from transects 8 to 12 in the two subplots where small trees were measured. For transect 8 all lianas with a dbh ≥ 1cm have been measured, but because of the limited contribution of the small lianas to the carbon stock and for cost efficiency, this threshold was increased to a dbh≥ 2 cm for transects 9 to 12. The measurement protocol used was based on the protocol developed by Gerwing et al. (2006) and Schnitzer et al. (2008). Besides the wide range of situations described in these protocols, some other situations were encountered in the field, which we resolved in the best possible manner.

3.2.1.4 Understory

In each 3 m x 3 m quadrat the understory vegetation (all vegetation with a dbh < 5 cm) was harvested and the total fresh biomass weight was determined with a spring scale. Because of the difference in moisture content between woody and green biomass, these two components were kept apart. From transect 8 onwards the palms without a woody stem at 1,3 m height were weighed separately. From each component a subsample of ca. 400 g was taken and the moisture content was determined in the laboratory.

Figure 11 Harvesting, separation woody and green parts and weighing the understory vegetation

3.2.2 Belowground Biomass (BGB)

The method for measuring the AGB is simple and more or less established, while the measurement of BGB is much more complicated and time-consuming (Pearson et al., 2005). Consequently, this component was not measured, but was calculated using an equation based on the correlation between aboveground and belowground tree biomass (see section 3.3.3).

3.2.3 Dead Organic Matter (DOM)

3.2.3.1 Standing dead wood

All standing dead wood with a diameter ≥ 5 cm was measured in the whole 0,5 ha plot. The diameter and the height were measured for each standing dead wood and where possible the species name was recorded (Figure 12).

Figure 12 Measuring a tree stump

3.2.3.2 Coarse litter (CL)

Coarse woody debris and fallen dead wood were measured together as one component and were defined as “coarse litter” with a diameter ≥ 2 cm (Rainfor, 2009a). This component was harvested in all 3 m x 3 m quadrats. The wet biomass was weighed in the field using spring scales, and a subsample of ca. 400 g was sent to the laboratory to determine the moisture content.

3.2.3.3 Fine litter (FL)

Fine litter (litter with a diameter <2 cm) consisting of leaves, twigs and fruits was harvested in the quadrats, using four bicycle tires (with a diameter of 40 cm each). The wet biomass was weighed in the field with spring scales. As for the understory, CL and FL, a subsample of ca. 400 g was taken from each sample and sent to the laboratory to determine the moisture content.

Figure 13 Harvesting CL (left) and FL (right)

3.2.4 Soil Organic Carbon (SOC)

At each quadrat soil samples were taken to determine the SOC using Eijkelkamp, 100 cc-soil sampling rings. Considering the high spatial variation of SOC, two samples were taken for each sampling location and each layer, at distances of at least one meter. For transects 2-7 separate samples were taken for bulk density and SOC, while for transect 1 and transects 8 up to and including 12 both parameters were determined based on the same samples. For transects 1 to 7 the following layers were sampled: 0-5 cm, 5-10 cm, 10-20 cm, 20-30 cm, 30-60 cm and 60-100 cm. Based on the difficulties to collect two undisturbed samples between 0-5 cm and between 5-10 cm, from transect 8 onwards, only one sample was taken between 0 and 10 cm, while the other sampling depths remained the same.

Figure 14 Sampling SOC. From left to right: Digging a pit of 100 cm x 50 cm to a depth of 100cm - sampling at different depths- preparing the sampling rings for transport

3.2.5 Vegetation height

To improve the description of the measurement plots, tree height from a *representative* tree in each subplot was measured using a clinometer. A representative tree was described as the highest tree of the canopy layer. This was not always easy to determine. For those trees the total tree height and the bole height were measured. These eight tree height measurements carried out per plot were averaged to determine the average vegetation height of the plot (Annex 2).

3.3 Biomass calculations

3.3.1 Data quality

To allow uniform and efficient data processing, all data was inserted in a Microsoft Access Database created by the SBB. To guarantee the least possible errors the data was inserted in this database the first week after the field measurements, preferably by the same persons that had filled in the field forms. Before the data was processed all data was crosschecked with the field forms and errors were removed.

3.3.2 Aboveground tree biomass

To relate tree measurements to biomass, an allometric equation must be used. Even though the inclusion of wood density and tree height improves the accuracy significantly (Chave et al, 2005), pantropic equations based on dbh alone, have shown to be sufficiently accurate and are easier to apply since wood density data is not always available and tree height measurements are often time consuming. A comparison was done for Suriname by Arets et al. (2011) between a locally developed equation by Jonkers (1987) and two pantropic equations respectively developed by Chave et al. (2005) and Pearson et al. (2005) (the latter is an update of the equation developed by Brown (1997)). The results have shown that the locally developed equations significantly underestimated AGB, while no significant difference was found between the two pantropic equations. Because the vernacular name of the tree species was recorded during the field measurements, which is not always directly linked to the botanical species name, we experienced problems to use the species specific wood density in the equation of Chave et al. (2005). Therefore the allometric equation used in this study is:

$AGB\ (kg) = \exp(-2{,}289 + 2{,}649 * \ln(dbh) - 0{,}021 * \ln(dbh)^2)$ (dbh-range: 5- 148cm)

(source: Pearson et al. 2005, updated from Brown (1997) for moist forest)

It is recommended to verify the applicability of this and other equations in Suriname in the field for 2-3 large trees per specific location (Brown, 2002).

3.3.3 Belowground tree biomass

Belowground tree biomass is calculated based on the AGB by following equation:

$BGB\ (kg) = \exp(-1{,}0587 + 0{,}8836 * \ln AGB)$

(source: Cairns et al. 1997, which includes data by Ohler 1980 from CELOS)
This equation is based on the equation used for AGB (van Kuijk, 2011) and shown in section 3.3.2.

3.3.4 Woody palm biomass

For palms up to 11 m stem height we used a formula developed in Bolivia for motacu-palms *(Attalea speciosa),* a woody palm species (Pearson et al.,2005):

$AGB\ (kg) = 23{,}487 + 41{,}851*(\ln(height))^2$

For palms with a stem height greater than 11 m, the formula for pina (açai)- *(Euterpe oleracea)* and pataju-palms, both woody palm species (Pearson et al., 2005) was applied:

$AGB\ (kg) = 6{,}666+12{,}826*height^{0.5}*\ln(height)$ (height-range: 11-33m)

For transect 1, the tree height for palms was not measured, which made it impossible to calculate the biomass stored in palms. For reasons of uniformity between the different transects, palm biomass was only calculated for the subplots where all the palms have been measured.

It is highly recommended that the reliability of these equations in Suriname is verified in the field, as is commonly done for trees. Schmidt et al. (2011) developed several local allometric equations in Kabo and Mapane for palms. Because total palm height has been used to establish these equations, and we have only measured stem height, they are not applicable to the project data. For future measurements it is recommended to evaluate the use of these locally developed equations.

3.3.5 Liana biomass

To calculate the biomass stored in lianas, the equation developed by Schnitzer et al. (2006) was used:

$$AGB\ (kg) = \exp(-1{,}484 + 2{,}6557(\ln(dbh))$$

With dbh (cm) the diameter of the liana at 1,3 m from the roots. AGB is expessed in kg. This equation is valid for lianas with a maximum diameter of 23 cm.

3.3.6 Standing dead wood

To calculate the mass of standing dead wood the volume is calculated (assuming the standing dead wood to be cylindrically) and multiplied by the density of dead wood, assumed to be ca. 0,3 t/m^3 (van Kuijk, 2011).

3.3.7 Understory vegetation and litter

As recommended in van Kuijk (2011), biomass stored in these components for each quadrat will be calculated based on:

$$DM_{comp} = WM_{comp} * (1 - MC_{comp})$$

With DM= Dry mass; WM= Wet Mass; MC= Moisture content in %

Understory and coarse litter have been harvested in four 3m x 3m quadrats per plot. To calculate the dry weight of these components per hectare, DM_{comp} has to be divided by nine and multiplied by 10000 m^2. For fine litter, sampled within a smaller area, DM_{comp} has to be divided by 0,5 instead of nine. For each measurement plot the four samples collected for the measurement of the different components were averaged, where after the further analysis was done on a plot base.

3.3.8 Carbon content

To determine the C-content in the different carbon pools, the biomass is measured. To convert biomass to carbon the IPCC (2006) recommends to use a factor of 0,47, based on McGroddy et al. (2004). This implies:

$$Carbon\ (g) = Biomass\ (g) * 0{,}47$$

3.3.9 Soil Organic Carbon (SOC)

The organic matter content of the soil samples was determined in the laboratory by means of the the Walkey-Black method (1934), while we assumed the SOC content to be 58 % of the organic matter (Guo & Gifford 2002).

Bulk density is calculated per layer by dividing the dry weight of the sample (kg) (excluding particles > 2 mm) by the volume of the sampling ring (m^3). Since we took composite samples, the dry weight (of two samples) was divided by two times the sampling ring volume (van Kuijk, 2011).

SOC stocks will be calculated per sampled depth by using the following equation:

CSi = BDi * T * Ci

where,
CSi = SOC stock at depth i (kg/m^2)
BDi = the bulk density at depth i (kg/m^3)
T = the thickness of the sampled horizon (m)
Ci = the carbon fraction at depth i (g/g).
Summarizing the SOC stocks of the different horizons will give the total SOC stock (t/ha).

4 Results

4.1 Biomass

4.1.1 Trees

4.1.1.1 Trees with dbh [5-20 cm[

The AGB and BGB per plot stored in trees with a dbh between 5 and 20 cm is shown in Annex 4. In Table 4 a summary of the results is shown. The smallest number of trees (30) with a dbh between 5 and 20 cm corresponding to an AGB of 14,6 t/ha was found at a recently logged forest, where reduced impact logging was applied (T1,P2). The highest number of small trees (265), which corresponded to an AGB of 72,5 t/ha was found in a low xerophytic forest in the Mapane area (T2, P2). This forest type is different from the other forest types and was found in just one of the measurement plots (Table 2).

On an average 102 trees with a dbh between 5 and 20 cm were found in two subplots (corresponding to an average of 832 trees per ha), **contributing 20,5 t/ha to the total carbon stock** with **a standard deviation (SD) of 6,5 t/ha**. Measuring this component took 103 minutes on an average.

Table 4 Results of the arrhythmic mean (mean), minimum and maximum biomass calculations, the corresponding standard deviations (SD), the Coefficients of Variation (CV) and the time spent measuring trees with a dbh between 5 and 20 cm

	Mean	Minimum	Maximum	SD	CV
Number of trees per plot	102	30	265	40	38%
AGB (t/ha)	35,4	14,6	72,5	11,4	32%
BGB (t/ha)	8,1	3,7	15,3	2,3	28%
Total Carbon stock (t/ha)	20,5	8,6	41,2	6,5	32%
Time spent measuring component per subplot (minutes)	103	40	255	42,4	

Table 5 shows the contribution of the trees with dbh between 5 and 20 cm to the AGB and BGB for the different forest types. The contributions of these trees to the biomass stored in marsh and high dryland forest are the same, while for low xerophytic forest it is substantially higher.

Table 5 Contribution of trees with a dbh between 5 and 20 cm to the carbon stock per forest type. For the low xerophytic forest type only one plot was measured, therefore the SD and the CV cannot be calculated

Forest type	Mean AGB (t/ha)	SD	Mean BGB(t/ha)	SD	Mean TCS (t/ha)	SD	CV
Marsh forest	34,4	6,8	7,9	1,4	19,9	3,8	19%
Low xerophytic forest	72,4	-	15,3	-	41,2	-	-
High dryland forest	34,4	10,2	7,9	2,1	19,9	5,8	29%

4.1.1.2 Trees with dbh ≥ 20cm

Annex 5 gives detailed information about the AGB and BGB stored in trees with a dbh greater than or equal to 20 cm per measurement plot. A summary of the results is displayed in Table 6 and Table 7. The lowest number of trees with a dbh equal to or greater than 20 cm per plot (37) is found in the low xerophytic forest (T2, P2) which corresponds to an AGB of 33,6 t /ha , while the highest number of trees with a dbh equal to or greater than 20 cm per plot (129) was found in a high dryland forest (T11, P3) on undulating terrain. The highest AGB per ha of 456,3 t/ha was found in a high dryland forest (T8, P1), with only 91 trees, with five trees having a dbh greater than 95 cm. On an average, 94 trees with a dbh ≥ 20cm were found in the 0,5 ha plot, corresponding to an average of 188 trees per ha. These trees **contribute 114,2 t/ha to the total carbon stock** with a **SD of 38,5 t/ha**. Measuring this component took 37 minutes on an average.

Table 6 Results of the mean, minimum and maximum biomass calculations with the corresponding SD, CV and time spent measuring for trees with a dbh equal to or greater than 20cm

	Mean	Minimum	Maximum	SD	CV
Number of trees per plot	94	37	129	20	21%
AGB (t/ha)	204,9	33,6	456,3	70,3	34%
BGB (t/ha)	38,0	7,7	77,6	11,6	31%
Total Carbon stock (t/ha)	114,2	19,4	251,0	38,5	34%
Time spent measuring component per subplot(minutes)	37	12	106	15	

Table 7 shows the contribution of the "large" trees to the carbon stock per forest type. The contribution is the highest for high dryland forest and the lowest for low xerophytic forest. The CV is around 30%.

Table 7 Contribution of trees with a dbh greater than or equal to 20 cm to the carbon stock per forest type. Since only one plot was measured for the low xerophytic forest type, the SD and the CV cannot be calculated

Forest type	Mean AGB (t/ha)	SD	Mean BGB (t/ha)	SD	Mean TCS (t/ha)	SD	CV
Marsh forest	174,5	49,9	33,1	8,5	97,6	27,4	28%
Low xerophytic forest	33,6	-	7,7	-	19,4	-	-
High dryland forest	217,1	65,9	40,1	10,6	120,9	35,9	30%

4.1.1.3 All trees

4.1.1.3.1 General

The mean AGB stored in trees equal to or greater than 5 cm amounted to 239,8 t/ha with a SD of 66,8 t/ha (CV is 27%) (Table 8). Comparing these values with the values represented in the report of Arets et al. (2011) which brought together the results of different researches (e.g. research by Jonkers, Banki and Ter Steege, Ruyschaert and the FAO-inventory of the 70s), this value seems to be substantially lower than the values measured in the plots established by Jonkers (1987), by Banki (2011) and Ter Steege (2001) and by Ruysschaert who found average values greater than 300 t/ha for the AGB. This value is also lower than the default value of 300 t/ha for AGB in tropical forest in North and South America (IPCC, 2006). Only the results calculated based on the data of the large scale FAO-inventory data are in the same range.

Table 8 Results of the mean, minimum, maximum biomass calculations and the corresponding SD, CV and time spent measuring for all trees

	Mean	Minimum	Maximum	SD	CV
AGB (t/ha)	239,8	106,0	479,9	66,8	28%
BGB (t/ha)	43,8	21,3	81,2	10,7	24%
Total Carbon stock (t/ha)	133,3	60,0	263,7	36,4	27%
Time spent measuring component per plot(minutes)	502	-	-	-	-

Table 9 shows the average carbon stored in trees with a dbh greater than or equal to 5 cm per forest type. The CV is 25 % for marsh and high dryland forest. For high dryland forests the mean AGB stored in those trees is 250,8 t/ha.

Table 9 Contribution of all trees with a dbh greater than or equal to 5 cm to the carbon stock per forest type. Since only one plot was measured for the low xerophytic forest type, the SD and the CV cannot be calculated

Forest type	Mean AGB (t/ha)	SD	Mean BGB (t/ha)	SD	Mean TCS (t/ha)	SD	CV
Marsh forest	208,9	53,2	38,8	8,9	116,4	29,2	25%
Low xerophytic forest	106,0	-	21,4	-	59,9		-
High dryland forest	250,8	64,1	45,6	10,2	139,3	34,9	25%

4.1.1.3.2 Dbh distribution per forest type

The standard deviation of the abovementioned results is relatively high, which means a high variability of the spatial distribution of the tree biomass. Based on the field observations, large trees are scattered and they contribute substantially to the total AGB. To find out the relative contribution of the trees divided over the different dbh-classes to the AGB, the data were classified in three dbh-classes as used by Pearson et al. (2005). The results are shown in Table 10. The CV is very high for trees with a dbh greater than 50 cm (65% for marsh forest and 76% for high dryland forest).

Table 10 Mean, SD and proportional contribution of each dbh-class to the AGB per forest type

	[5-20cm[			[20-50cm[			≥50cm		
	Mean (t/ha)	SD	Prop (%)	Mean (t/ha)	SD	Prop (%)	Mean (t/ha)	SD	Prop (%)
Marsh forest	34,4	6,8	16	130,2	33,6	62	44,3	28,7	21
Low xerophytic forest	72,5	-	68	33,6	-	32	0	-	0
High dryland forest	34,1	10,1	14	127,6	30,9	51	89,1	67,9	36

In Figure 15 the mean contribution of each dbh-class with its standard errors (standard deviation divided by the square root of the sample size) are displayed.

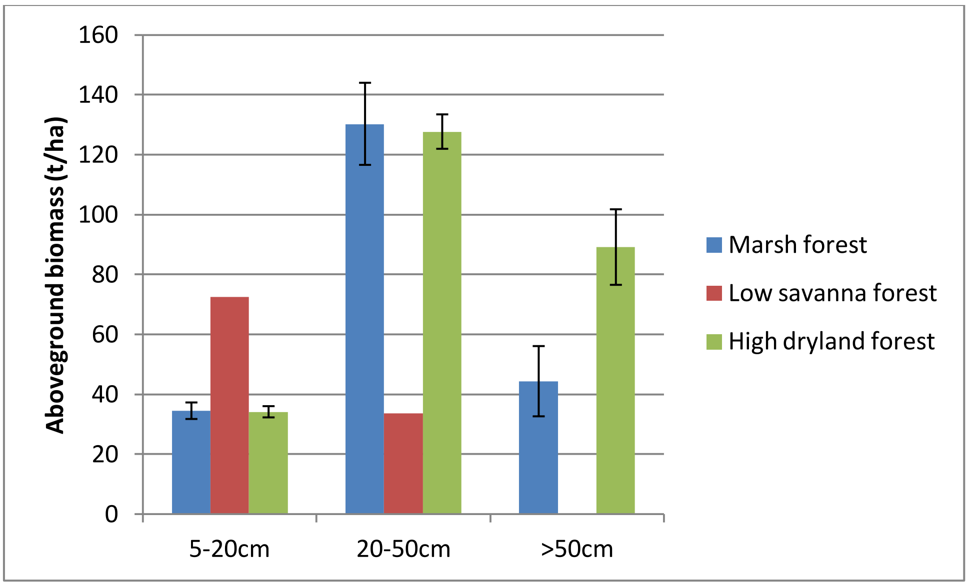

Figure 15 AGB per dbh-class per forest type with the errorbar indicating the standarderror (SE)

To find out the relation between the CV and the plot size, different plot sizes were simulated by combining different numbers of subplots (with an area of 25m x25m). This was done for all trees with a dbh greater than or equal to 20 cm on one hand and on the other hand respectively for the trees with a dbh between 20 and 50 cm and the trees with a dbh greater than 50 cm. The results are shown in Table 11. In Figure 16 the relation between plot size and CV is displayed. Based on the regression calculated, a plot size of 2,8 hectares would be necessary to achieve a CV of 10% of the AGB stored in trees with a dbh greater than 20 cm and 4 hectares for trees greater than 50 cm. This might suggest using a larger nest for trees with a dbh greater than 50 cm.

Table 11 CV for different plot sizes and dbh-classes. The different plot sizes were simulated by making all possible combinations of a different number the subplots of 25m x 25m measured within the 0,5 ha plots.

Sample size (ha)	CV		
	All trees dbh ≥20cm	Trees dbh: 20-50cm	Trees dbh≥50cm
0,0625 (25 m x 25 m)	60%	43%	149%
0,125 (50 m x 25 m)	47%	36%	113%
0,25 (50 m x 50 m)	38%	30%	92%
0,5 (50 m x 100 m)	34%	28%	83%

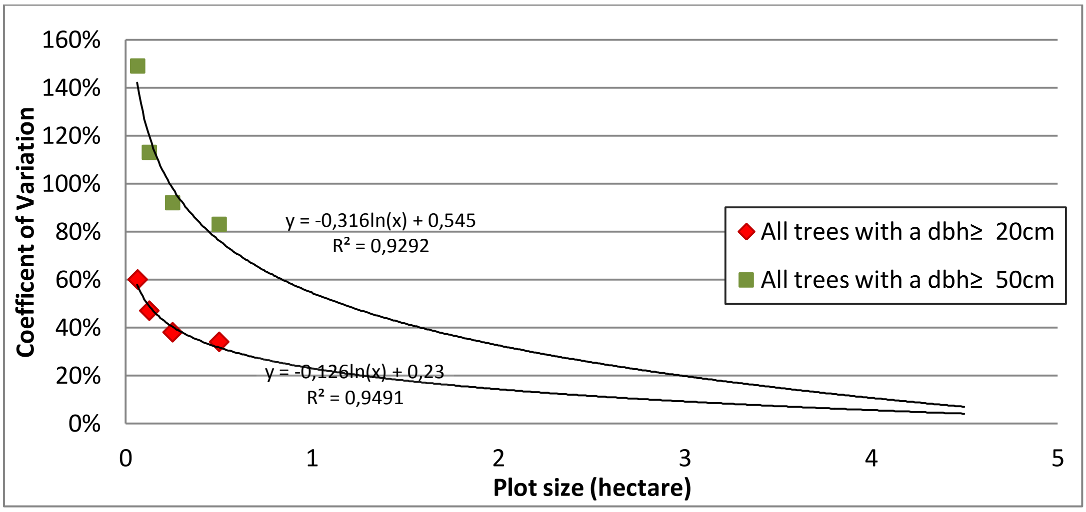

Figure 16 Variation of the CV for AGB for different plot sizes for trees with a dbh greater than or equal to 20 cm and trees with a dbh greater than or equal then 50 cm

4.1.1.3.3 Efficiency of time spent measuring trees

For each subplot the time needed to carry out the measurements was recorded. On an average 41% of the time needed to finish the measurements in the PSP was invested in the trees with a dbh between 5 and 20 cm, contributing only 15% to the total biomass stock in trees (Table 12). Investing more time in the measurement of large trees by measuring them in larger plots could not only decrease the overall CV (previous section), but would also lead to a more efficient time investment.

Table 12 Analysis of the efficiency of the plot design for the measurement of tree biomass

	Mean C-stock (t/ha)	SD	CV	Proportional contribution	Proportional amount of time
Trees with dbh 5-20cm	20,5	6,5	32%	15 %	41 %
Trees with dbh ≥20cm	114,2	38,5	34%	85%	59 %
Total	134,7	36,4			

4.1.2 Woody palms

Independent of forest type, a mean biomass stored in woody palms of 6,3 t/ha with a SD of 9,2 t/ha was found (CV=121%). After classification per forest type (Table 13), we see that the biomass stored in woody palms in marsh forest is less variable (CV= 46%) and contributes more to the AGB than in high dryland forest. No woody palms were found in the low xerophytic forest plot measured. Table 14 clearly shows the dominance of *Euterpe oleracea (*pinapalm) in marsh forest, while *Astrocaryum sciophilum* (bugrumaka) is the most common palm species in high dryland forest. Generally the biomass stored in woody palms contributes substantially to the total biomass and may therefore not be neglected.

The allometric equations presented in section 3.3.4 are developed for three specific species, of which only *Euterpe Oleracea* (pinapalm) is found in Suriname. The biomass and carbon stock for woody palms per measurement plot can be found in Annex 6.

Table 13 AGB and carbon stock for woody palms per forest type. Since only one plot was measured for the low xerophytic forest type, the SD and the CV cannot be calculated for this forest type

	Mean AGB (t/ha)	SD	Mean C (t/ ha)	SD	CV
Marsh forest	21,8	11,3	10,2	4,7	46%
Low xerophytic forest	0,0	-	0	-	-
High Dryland forest	3,0	3,6	1,4	1,7	121

Table 14 Proportional number of woody palms per species and per forest type

	Marsh forest	High Dryland forest
Pinapalm *(Euterpe oleracea)*	90%	1%
Bugrumaka *(Astrocaryum sciophilum)*	5%	57%
Maripa *(Atalea maripa)*	2%	2%
Kumbu *(Oenocarpus bacaba)*	1%	20%
Kaw-maka *(Bactris major)*	0%	2%
Ingiprasara *(Socratea exorrhiza)*	2%	4%
Nanaimaka *(Bactris spp.)*	2%	13%

4.1.3 Lianas

Lianas were only measured from transect 8 onwards. The results are shown in Table 15. The contribution to the AGB is relatively small and the variation considerable. The time spent per subplot in measuring lianas was on average approximately one hour. The biomass and carbon stored in lianas per measurement plot can be found in Annex 7.

Table 15 Mean AGB and C stored in lianas per forest type with the corresponding SD and CV. No lianas were measured when making the inventory of the low xerophytic forest plot (T2,P2)

Forest type	Mean AGB (t/ha)	SD	Mean C (t/ha)	SD	CV
Marsh forest	14,4	6,8	6,8	3,2	47%
High dryland forest	12,4	7,2	5,8	3,4	59%

In Table 16 the contribution of the lianas with a dbh between 2 and 5 cm and with a dbh greater than 5 cm were compared. In terms of number these are only 21% of the total number of lianas, but contribute 74% to the total AGB stored in lianas. The little contribution to the AGB and the high number of lianas between 2 and 5 cm might justify increasing the diameter limit to 5 cm in future protocols.

Table 16 Mean AGB stored in lianas per dbh-class and its corresponding SD and SC

	Mean AGB (t/ha)	SD	CV	Proportional number of lianas (%)
Dbh[2cm-5cm[	3,3	2,5	75%	79%
Dbh ≥5cm	9,6	5,7	59%	21%

4.1.4 Understory vegetation

In Annex 8 the C-storage in the understory per measurement plot is shown. The data from the four 3 m x 3 m quadrats linked to one measurement plot have been averaged. To calculate the time spent to harvest the understory, the total time spent to measure all the components was divided by the number of components (five) and multiplied by three (three components: palms, sapling green and sapling wood). Table 17 shows that the understory contributes on an average 3,1 t/ha to the total AGB, with a SD of 1,3 t/ha.

Table 17 Mean, minimum and maximum AGB and C stored in the understory vegetation with its corresponding SD, CV and time spent measuring this component

	Mean	Minimum	Maximum	SD	CV
AGB (t/ha)	3,1	0,9	6,2	1,3	42%
Total Carbon stock (t/ha)	1,4	0,4	2,9	0,6	42%
Time spent measuring component per plot (minutes)	43 x 4= 172	-	-	-	-

The data of the first seven transects indicated a high variation in the C-storage of the understory vegetation. Presumably this variation was caused by the abundance of palms in the understory (palms without a woody stem at 1,3 m height). Therefore palm leaves were kept apart from transect 8 onwards. Table 18 shows that this did not reduce the CV.

Table 18 Mean AGB per component of the understory for transects 8-12 and its corresponding SD and CV

Sample	Mean AGB (t/ha)	SD	CV
Palms	5,6	7,4	133%
Sapling green	0,8	0,3	44%
Sapling wood	4,4	2,9	65%

Table 19 shows the carbon stored in the understory vegetation for the different forest types. There are no significant differences between the different forest types.

Table 19 Mean AGB and C stored in the understory vegetation per forest type and its corresponding SD and CV

Forest type	Mean AGB (t/ha)	SD	Mean C (t/ha)	SD	CV
Marsh forest	3,5	1,7	1,7	0,8	47%
Low xerophytic forest	3,5	-	1,6	-	-
High dryland forest	3,0	1,2	1,4	0, 6	43%

4.1.5 Contribution of the different components to the AGB

Figure 17 shows the contribution of the different components to the total AGB. Trees are by far the most important contributing component.

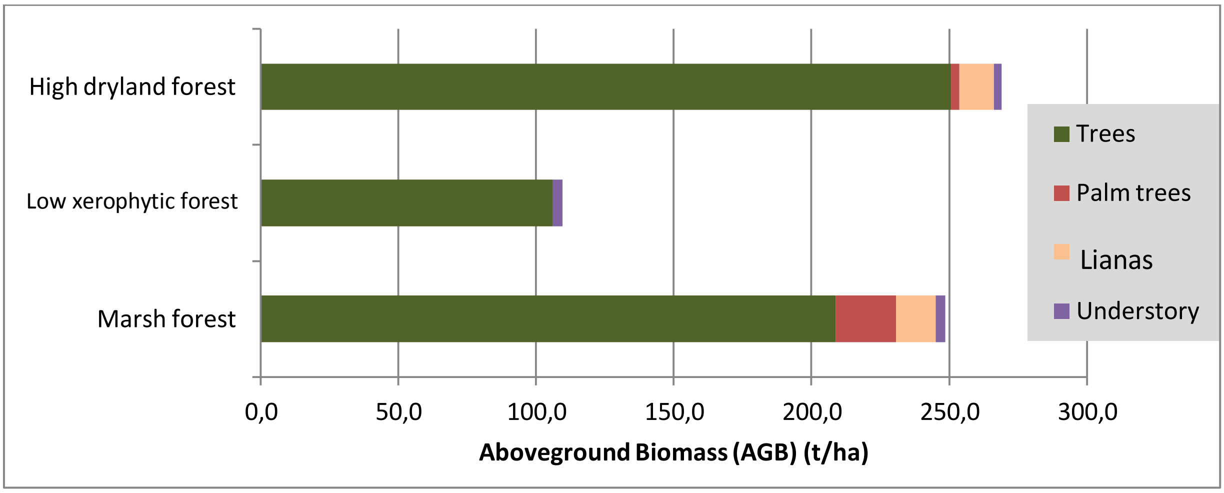

Figure 17 Contribution of the different components to the AGB

Table 20 shows the contribution of the components to the total biomass and the time involved to measure them for the different forest types. Even though trees (including palm trees) represent 94% of the total AGB, only 63% of the time spent to measure AGB is used to measure trees. Lianas contribute 5% to the total AGB while taking 15% of the measuring time and the understory vegetation contributes only 2% to the total AGB while taking 22% of the measuring time. For future measurements, it is recommended to use Tier 1 or 2 approaches to determine the carbon stock of the understory vegetation, measure only lianas greater than or equal to 5 cm and invest more time in measuring trees with a diameter equal to or greater than 20 cm.

Table 20 Relative contribution of each component to the AGB per forest type compared with the measuring time

	Trees	Woody Palms	Lianas	Understory
Marsh forest	85%	8%	5%	2%
Low xerophytic forest	97%	0%	-	3%
High dryland forest	92%	1%	5%	2%
Average	91%	2%	5%	2%
Time spent per plot (min)	502		120	172
Proportional time spent measuring the component	63%		15%	22%

4.2 Dead Organic Matter (DOM)

4.2.1 Standing Dead Wood (DW)

The contribution of the standing DW with a diameter greater than or equal to 5 cm to the carbon storage varies between a minimum of 0,5 t/ha and a maximum of 17,1 t/ha, with a mean of 2,9 t/ha and an almost equally sized SD (Table 21). This high variation can be explained by the large dead trees found in some plots, while in other plots only tree stumps were found. In Annex 9 the biomass and carbon stored in standing DW is shown per measurement plot.

Table 21 Mean, minimum and maximum dry matter of and C-storage in standing DW with its corresponding SD and CV

	Mean	Minimum	Maximum	SD	CV
Dry mass of standing DW (t/ha)	6,2	1,0	36,5	6,5	105%
Carbon stock (t/ha)	2,9	0,5	17,1	3,0	105%

When compared by forest type (Table 22) the amount of standing DW in a marsh forest seems considerably lower than in the other forest types. The variation of standing dead wood is very high for all forest types.

Table 22 Dry mass and C stored in standing DW per forest type with its corresponding SD and CV

Forest type	Mean dry mass (t/ha)	SD	Mean C (t/ha)	SD	CV
Marsh forest	3,9	3,4	1,8	1,6	89%
Low xerophytic forest	5,6		2,6		
High dryland forest	6,7	7,0	3,1	3,3	106%

The IPCC-guidelines (2003) define dead wood as all non-living woody biomass not contained in litter, either standing, lying on the ground or in the soil. To distinguish between dead wood and litter, a diameter of 10 cm or a country specific diameter can be used.

We measured lying DW in the component “Coarse Litter”, which had a different threshold (diameter 2 cm instead of 5 cm). For future measurements it is recommended to measure lying DW and standing DW using the same diameter threshold of 10 cm.

4.2.2 Coarse Litter (CL)

In Annex 10 the dry matter and C stored in CL is shown per measurement plot. As for the understory the amount of dry mass of CL has been averaged for the four quadrats per plot.

The contribution of CL to the C-storage varies between 0,5 t/ha and 69,5 t/ha, with a mean of 11,4 t/ha and a SD of 16,4 t/ha (Table 23), and also when analyzed per forest type the dry mass of CL has high SD and CV (Table 24). This can be explained by the variable spatial distribution of fallen trees. If there is a fallen tree in the 3 m x 3 m quadrat, the contribution can be 100 to 1000 times bigger than if there is not. This means the design of four quadrats per plot is not convenient. As explained in section 4.2.1, in future measurements, this component, as it is measured here, should be divided into fallen dead wood and litter. To address the spatial distribution of fallen dead wood, we could use the line intersect method suggested by Pearson et al. (2005), measuring length, diameter and indicating the density class for each log. This method should be evaluated and if found successful implemented.

Table 23 Mean, minimum and maximum dry mass and C stored in CL, its corresponding SD and CV and the time spent measuring this component

	Mean	Minimum	Maximum	SD	CV
Dry mass (t/ha)	24,2	1,1	148,0	34,8	144%
C- stock (t/ha)	11,4	0,5	69,5	16,4	144%
Time spent measuring component per subplot(minutes)	16,4 x 4	-	-	-	-

Table 24 Mean dry mass and C stored in CL per forest type and its corresponding SD and CV

Forest type	Mean dry mass (t/ha)	SD	Mean C (t/ha)	SD	CV
Marsh forest	14,5	22,8	6,8	10,7	157%
Low xerophytic forest	4,6	-	2,2	-	-
High dryland forest	26,9	37,2	12,7	17,5	138%

4.2.3 Fine Litter (FL)

The contribution of FL to the C-storage varies between 4,1 t/ha and 13,0 t/ha, with a mean of 7,6 t/ha and a SD of 2,2 t/ha (Table 25). Classified by forest type, the low xerophytic forest plot contained the highest FL-mass, but because only one plot was measured in this forest type, the SD cannot be calculated. Furthermore, the contribution of the FL-component is higher for high dryland forest than for marsh forest. This could be explained by the fast decomposition of litter in marsh forest. Considering this, the mean amount of litter for marsh forest is relatively high, which may be due to the fact that some of the plots classified as marsh forest were actually in the transition zone between marsh and high dryland forest. Some of the quadrats classified as marsh forests were in fact located in high dryland forest (Table 26).

For future measurements this component can be grouped with CL with a diameter smaller than 10 cm, and measured as one component “litter”.

Table 25 Mean, minimum and maximum dry mass and C stored in FL and its corresponding SD and CV

	Mean	Minimum	Maximum	SD	CV
Dry mass (t/ha)	7,6	4,1	13,0	2,2	28%
Carbon stock (t/ha)	3,6	1,9	6,1	1,0	28%
Time spent measuring component per subplot(minutes)	16,4 x 4	-	-	-	-

Table 26 Mean dry mass and C stored in FL per forest type and its corresponding SD and CV

Forest type	Mean dry mass (t/ha)	SD	Mean C (t/ha)	SD	CV
Marsh forest	6,8	1,8	3,2	0,8	25%
Low xerophytic forest	9,3	-	4,4	-	-
High dryland forest	7,8	2,2	3,6	1,1	31%

4.3 Soil Organic Carbon (SOC)

The contribution of the SOC stored in the layer 0-30 cm to the total carbon storage varies between 8,7 t/ha and 49,4 t/ha, with a mean of 26,2 t/ha and a SD of 6,7 t/ha (Table 27). The minimum was found in transect 2, plot 2, the low xerophytic forest in the Mapane area with white sand soils. The maximum was found in transect 3, plot 2, marsh forest, in the Patamacca region with loamy sand soils.

Table 27 Mean, minimum and maximum SOC-stock for a depth 0-30 cm

	Mean	Minimum	Maximum	SD	CV
Carbon stock (depth 0-30cm) (t/ha)	26,2	8,7	49,4	6,7	26%

Most carbon is stored in the upper 30 cm; this layer is generally subjected to change caused by disturbances (IPCC, 2003). Nevertheless because little data is available for carbon stock in Suriname, samples were taken to a depth of one meter. The results for the carbon stored in the different layers for the different forest types can be found in Table 28. It is clear that the lowest carbon stock can be found in the low xerophytic forest with white sand soils. The results for high dryland forest and marsh forest are comparable. During the classification of soil types by forest type, we assumed a strong relation between forest and soil types. In practice this was not always so due to small-scale variation of the terrain conditions.

Table 28 Mean SOC stocks for the different forest types to three different depths: 30cm, 60cm and 100 cm and their corresponding SD and CV

	Depth 30cm			Depth 60cm			Depth 100 cm		
	Mean (t/ha)	SD	CV	Mean (t/ha)	SD	CV	Mean (t/ha)	SD	CV
High dryland forest	25,8	6,0	23%	38,7	9,2	24%	47,0	12,1	26%
Low xerophytic forest	8,7	1,6	18%	9,4	2,5	26%	9,4	2,5	26%
Marshforest	30,4	12,3	40%	39,4	7,7	20%	48,9	12,6	26%

Figure 18 shows the relative contribution of the different layers to the SOC stored to a depth of 1 m. For all three forest types more than 50 % of the SOC is stored in the upper 30 cm layer in low xerophytic forest this percentage is even 93 %.

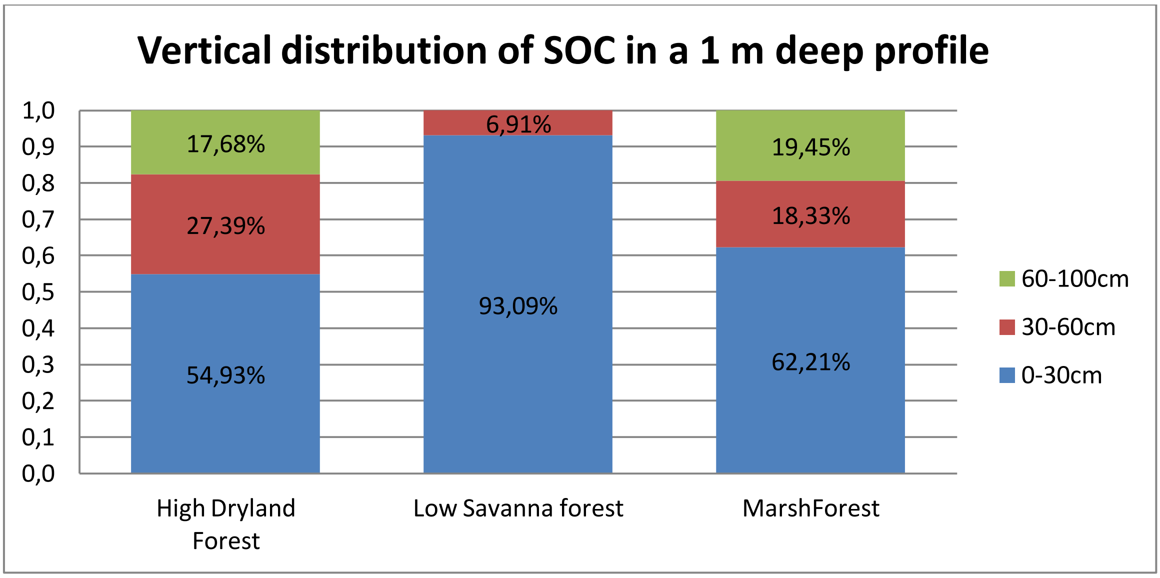

Figure 18 Vertical distribution of SOC in a 1 m deep profile for the different forest types

4.4 Total Carbon Stock (TCS)

After calculating all components separately, the TCS was determined (Table 29). Based on the amount of carbon stored in all measurement plots the mean TCS found is **189,2 t/ha**, with a **SD of 43,9 t/ha**. This corresponds to an average of 694 t/ha CO_2-equivalents. This is slightly higher than the carbon stock calculated for Suriname by Cedergren (2009), which used the FAO large scale inventory (De Milde, 1970) to calculate the AGB and default values to calculate all the other components (IPCC, 2006).

Table 29 Mean, SD, contribution and corresponding CO_2-equivalents of the Carbon stored in the different components measured in the field plots contributing to TCS. To calculate these results, no distinction has been made between the different forest types

Component	Mean (t/ha)	SD	Contribution	CO_2-equivalents (t/ha)
Biomass	145,1	37,1	77%	532
AGB	123,4	32,0	65%	452
Trees 5-20 cm	16,6	5,4	9%	61
Trees ≥ 20cm	96,3	33,0	51%	353
Woody palms	3,0	4,3	2%	11
Lianas	6,1	3,2	3%	22
Understory	1,4	0,6	1%	5
BGB	21,7	5,2	11%	79
Trees 5-20 cm	3,8	1,1	2%	14
Trees ≥ 20cm	17,9	5,5	9%	65
Dead organic matter	17,9	16,3	9%	66
Standing dead wood	2,9	3,0	2%	11
Coarse litter	11,4	16,4	6%	42
Fine litter	3,6	7,7	2%	13
Soil (0-30 cm)	26,2	6,7	14%	96
Total Carbon stock	189,2	43,9		**694**

Subsequently the results per forest type are shown in Table 30. High dryland forest contains the highest mean TCS of **215,8 t/ha** and a SD of **40,5**, corresponding to a CV of **18,7%**, marsh forest has a TCS of **196,8 t/ha** with a SD of **43,0** and a CV of **22%** and low xerophytic forest has a TCS of **80,9/ha**.

The contribution of **biomass** (AGB and BGB) is **69-77%** to the TCS, the **DOM** contributes **9-11%** and the **SOC** to a depth of 1m contributes **12-25%** to the TCS.

Assuming a normal distribution of the results, we could calculate 95%-confidence intervals indicating the reliability of the results. Because there was no statistical design in place choosing the plot locations, these results should be handled with care:

- Marsh forest: TCS is varying between 162,4 and 231,2 t/ha
- High dryland forest: TCS is varying between 201,1 and 211,5 t/ha
- Low xerophytic forest: TCS is 80,9 t/ha, and the variation cannot be calculated because we this was only one plot

Marsh forest has a larger confidence interval, because only six plots have been measured in this forest type while in high dryland forest 29 plots were assessed.

Table 30 Mean, SD and contribution of the total Carbon stock and the different components measured in the field plots contributing to this stock per forest type.

	High dryland forest			Marsh forest			Low xerophytic forest		
Component	Mean (t/ha)	SD	%of total	Mean (t/ha)	SD	%of total	Mean (t/ha)	SD	%of total
Biomass	**149,3**	**36,5**	**69%**	**136,1**	**28,6**	**69%**	**62,3**	**-**	**77%**
AGB	126,8	31,7	59%	116,9	24,4	59%	51,5	-	64%
Trees 5-20 cm	16,2	4,8	7%	16,2	3,2	8%	34,1	-	42%
Trees ≥ 20 cm	102	31	47%	82,0	23,4	42%	15,8	-	20%
Palm trees	1,4	1,7	1%	10,2	4,7	5%	0	-	0%
Lianas	5,8	3,4	3%	6,8	3,2	3%	NA	-	NA
Understory	1,4	0,6	1%	1,7	0,8	1%	1,6	-	2%
BGB	22,5	4,9	10%	19,3	4,3	10%	10,8	-	13%
Trees 5-20 cm	3,7	1,0	2%	3,7	0,6	2%	7,2	-	9%
Trees ≥ 20 cm	18,8	5,0	9%	15,5	4,0	8%	3,6	-	4%
Dead Organic Matter	**19,5**	**17,4**	**9%**	**11,8**	**9,9**	**6%**	**9,2**	**-**	**11%**
Standing dead wood	3,1	3,3	1%	1,8	1,6	1%	2,6	-	3%
Coarse litter	12,7	17,5	6%	6,8	10,7	3%	2,2	-	3%
Fine litter	3,7	1,0	2%	3,2	0,8	2%	4,4	-	5%
Soil (0-100 cm)	**47,0**	**4,6**	**22%**	**48,9**	**10,2**	**25%**	**9,4**	**-**	**12%**
Total Carbon stock	**215,8**	**40,5**		**196,8**	**43,0**		**80,9**	**-**	

4.5 General remarks about the efficiency of the plot design

To measure the carbon stored in the forest in the most efficient way, the time invested in each component should be proportional to its contribution to the TCS. Table 31 and Figure 19 show an overview of the contribution of the different components, while in Table 32 the time spent measuring these components is also indicated.

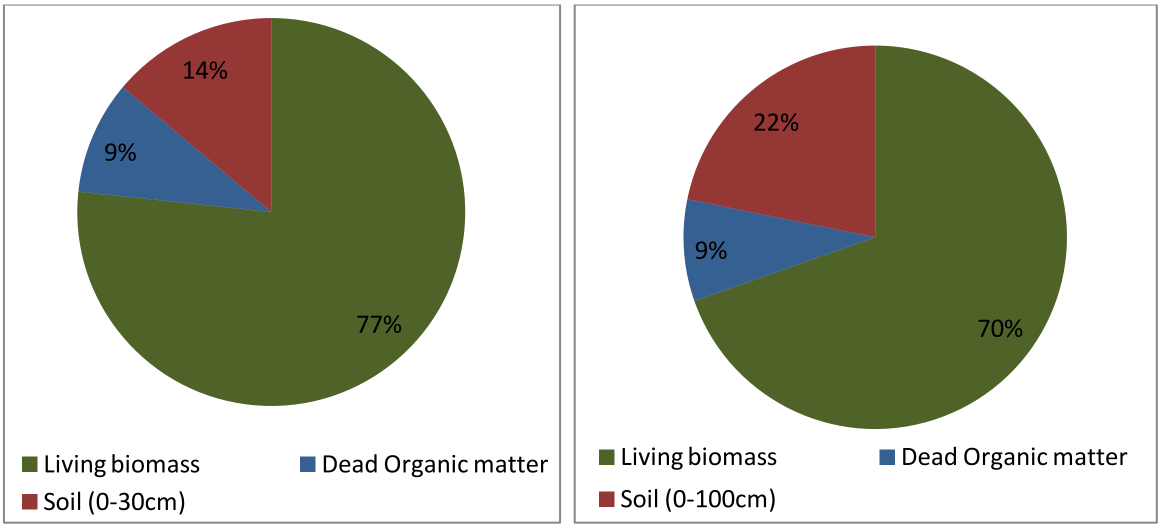

Figure 19 Relative contribution of each component to the TCS. The left figure taking into account a soil depth until 30 cm and the right figure the whole soil profile.

Comparing the time spent measuring the components with their contribution leads to the following conclusions:

- DOM: the time investment is in balance with its contribution to the TCS
- Biomass: its contribution of 70% to the TCS is slightly higher than the time spent measuring the component. Because biomass is also the component which is the most subjected to change, it would be good practice to invest more time in biomass measurements
- SOC: this component contributes slightly less than the time spent on the measurements. Therefore, and because the upper 30 cm are more subjected to change it might be recommendable to restrict the soil sampling to the this depth as required by the IPCC (2003).

Table 31 The contribution of each component and the proportional time spent to measure the components in the field

	Contribution	Time spent
Biomass (AGB +BGB)	70%	56% (794 minutes)
DOM	8%	9% (131 minuten)
SOC	22%	35% (492 minuten)

For further planning, it is important to consider the number of persons needed to carry out the different activities. On an average, it takes six days per measurement plot with a team of 5-6 persons. A team of this size needs roughly three weeks to finish one transect. Table 32 shows an optimal occupation of the field teams per activity.

Table 32 Optimal occupation of the field team per activity

Activity	**Optimal number of people needed**	**Average amount of time needed**
Plot and quadrat establishment	3	3 x 0,5 day
Plot measurements	5 (1 amongst them must be a tree spotter)	3 x 2 days
Liana measurements	2	3 x 0,5 day
Height measurements	2	3 x 0,5 day
Destructive sampling in quadrats	3-4	3 x 2 days
Soil sampling	3	3 x 2 days

5 Discussion and recommendations

5.1 Recommendation on efficient inventory design

5.1.1 Towards a national biomass monitoring system

In this project we have focused on the assessment of the carbon stocks in the forests of Suriname. If the land use (thus the land cover) changes, the carbon stocks will also change. This difference indicates the amount of carbon emissions or removals per unit area (*emission factors*). However, to carry out greenhouse gas inventories, not only the emission factors, but also data on the extent of areas subjected to deforestation, forestation or forest degradation (*activity data)* are needed (GOFC-GOLD, 2011). Ideally, a country should have a national system monitoring the spatial distribution of carbon on a regular basis, which would allow direct calculation of carbon removals and emissions caused by land cover changes.

To calculate the emission factors on a national scale, a national forest inventory should be carried out. This inventory would be more efficient if the national forest area could be stratified based on the spatial distribution of the carbon stocks. Unfortunately, spatial distribution of the carbon stored in the Amazon forest remains uncertain (Houghton, 2001). The distribution can be explained by large scale biomes on the one hand (Gibbs et al., 2007) and by fine-scale variability of disturbance, soil and hydrological conditions on the other hand (Laurance et al., 1999). A remote sensing technique that could capture the fine scale variability of the forest biomass for a specific time period could significantly reduce this uncertainty (Saatchi, 2011). The results of the application of airborne light detection and ranging (LiDAR) for an area of 4,3 million ha of lowland Amazon forest in the Department of Madre de Dios-Peru were very promising (Asner, 2010). In Suriname as well research has been started to develop a method for an efficient national forest inventory using aerial photographs. However, it will take time before spaceborne sensors that can provide regular biomass estimates on a desirable scale are operational, and even if these data become available, field measurements will still be required to calibrate the remote sensing data (Asner, 2010). Therefore the sampling design for the national forest inventory in Suriname is based on a systematic grid.

Because of the poor accessibility of the forests of Suriname, travel costs are a very important part of the expenses, making these field measurements very costly. Therefore, it is recommended to carry out a multipurpose inventory. This would allow for collection of data on commercial timber stock, biodiversity, socio-econonomic parameters, distribution of non timber forest products (NTFP's) besides forest carbon stock information.

5.1.2 Sampling design

In this study 36 permanent sample plots of 0,5 ha (50 m x 100 m), laid out in 12 transects of three plots were established across the forestry belt. This plot design was chosen analogous to the Rainfor plot network (Annex 15). Because the terrain characteristics (e.g. forest and soil type, topography and disturbance) between the plots within the transects differed as much as the terrain characteristics differed between transects, the three plots within each transect were treated as independent measurements.

We evaluated the relation between CV and plot size. As shown in Figure 13, the spatial distribution of large trees is captured better in larger plots (dbh ≥ 50 cm). This is an argument to increase the plot size for those trees. Nevertheless, the larger the plot size, the more time must be invested on each location and the fewer the number of plots that can be established. Therefore a combination could be made of large plots to measure dynamic descriptors, such as growth rate or carbon fluxes, and a rapid inventory system consisting of small plots covering large areas to obtain static descriptors (e.g. AGB, commercial timber stock, basal area) (Wagner, 2010).

If Suriname decides to continue the AGB assessments on a national scale, it is recommended to look at the plot design used during this project and evaluate the potential of the designs implemented in other networks in the Amazon region. Some of these designs are shown in Figure 20.

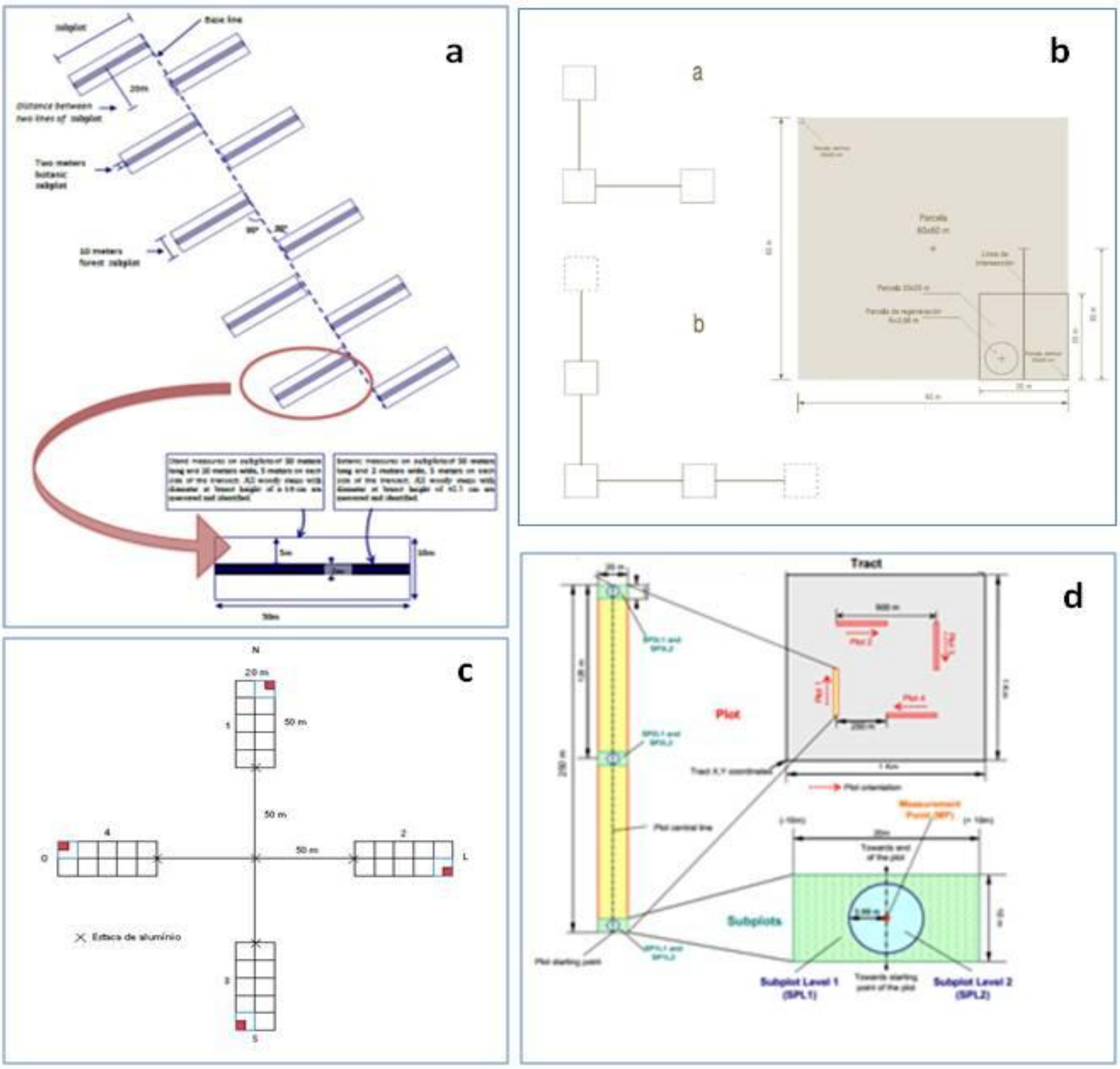

Figure 20 Different sampling designs used in Amazon countries: a) Modified Gentry plots with a total area of 0,5 ha (Baraloto, 2011), b) Sampling design used for the National Forest Inventory in Equador (Source: Evaluacion forestal nacional de Equador- Manual de campo), c) Sampling design used for the National Forest Inventory in Brazil (source: http://www.florestal.gov.br/) ; d) Sampling design used for National Forest Inventories as proposed by FAO (FAO, 2004)

The sampling design was evaluated on living biomass and other components. The results of C-storage in the components dead wood and coarse litter showed a CV greater than 100% (Table 23). This indicates that the sampling design for these components has to be modified. During this project, coarse litter was collected in four quadrats per plot. This did not allow us to capture the spatial distribution of coarse litter within the forest type where the plots were established. For future measurements it is recommended to use a different to assess coarse litter (or fallen deadwood). The line intersect design as described by Pearson et al. (2005) could offer a valid alternative.

5.1.3 Sampling scheme

Besides selecting the most efficient sampling design, we also need to find a statistically sound way to spread the measurement plots within the country. To increase the accuracy and precision and to reduce costs, it is recommended to stratify the country by its carbon stock (GOFC-GOLD, 2011). A research carried out on 74 0,5 ha plots, located in three habitat types in French Guyana and Peru showed a weak correlation between AGB and small scale soil or climate variables, while on the contrary, a strong correlation was found between AGB and stand variables and forest structure (Baraloto et al., 2011). Stratification of the forest should therefore be based on stand variables and forest structure, but as pointed out in section 4.6.1.1, we do not have the disposal of spaceborne sensors that can provide imagery with a sufficient spatial and temporal resolution to capture the fine scale variability of these stand variables or forest structure.

In Guyana, stratification is done based on the intensity of threat (pressure) of deforestation and forest degradation. Areas with a higher threat intensity have a higher sampling intensity than areas where the threat is low. (Source: Presentation given by Brown, S. & Pradeepkumar B., 9 November 2011). This method allows for efficient use of resources by focusing on the areas where emissions will take place and is probably sufficient when a country only focuses on carbon stock measurements for REDD-mechanisms. For a multipurpose national inventory, a random or systematic sampling approach is recommended. To reduce costs, we suggest that more plots are established in the more accessible parts of the country and fewer plots in the inaccessible parts. The precision and accuracy of the carbon estimates for the more intensely sampled parts of the country will also be higher which will allow a more detailed planning in this part of the country.

5.2 Identification of “key”-components

National GHG-inventories can be more efficiently conducted by focusing on the key-components in the field measurements. These are defined as the pools with the greatest carbon emissions (GOFC-GOLD, 2011). During this project, data on all components was collected, with the exception of BGB. These data were used to make a thorough evaluation of the contribution of the different components to the carbon storage in the forest types assessed. Based on this evaluation we formulated some recommendations regarding the components to be included in further measurements:

- The AGB stored in trees make by far the greatest contribution to the TCS (60%). Together with the BGB (which is calculated based on the AGB), it contributes to 70% of the total carbon stock. This component is also the most subjected to change. Table 31 shows that more time should be invested in the measurement of trees.
- Understory vegetation contributes very little to the TCS (1%), while measuring it is very labour-intensive and time-consuming. This component should not be included in future measurements.
- Measuring lianas takes proportionally more time than their contribution justifies. Moreover, the results show a high variability. In future measurements lianas could be measured in the whole plot, but starting at a diameter of 5cm.

- The SOC between 0-30 cm can be regarded as a key component. Although the SOC between 30 and 100 cm does contribute substantially to the total carbon stock in the soil (10-40% of the SOC between 0-100 cm), it is generally not exposed to anthropogenic disturbances (IPCC, 2003). Only in areas where mining activities take place the carbon contained in the latter will be released.
- Dead organic matter contributes about 8% to the TCS. Although the variability of its contribution is very high, it is relatively easy to measure. Therefore it is recommended to include DOM in future measurement protocols. Fine litter on the other hand is contributing little, while measurement is time-consuming. Fine litter should therefore not be included in the future measurements.

It is known that the key components can differ per forest type (GOFC-GOLD, 2011). Mangrove forests and the swamp forests in the coastal area were not included in this project, but for these forest types the various components can have a different contribution to the TCS.

5.3 Measurement protocol

Based on lessons learnt during this first project year, some modifications to the measurement protocol were formulated:

- Tree dbh's were estimated whenever the tree diameter was impossible to measure due to an irregular stem shape or the occurrence of buttresses. Nevertheless when it is necessary to measure tree growth in a permanent sample plot, it is recommended to determine this tree diameter more accurately. Tree climbing equipment, a ladder or optical equipment can be used to measure the dbh at a point above the buttresses
- Litter and dead wood should be distinguishable from each other. As pointed out in paragraph 4.2.1, DW (standing and lying) should have a diameter greater than 10 cm.
- Depending on the state of decomposition, dead wood can have different densities. Therefore it is recommended to classify the dead wood in three density classes: sound, intermediate and rotten.

5.4 Allometry and tree species identification

Throughout this project, the allometric equation developed by Brown (updated by Pearson, 2005) (Section 3.3.2) was used. The reliability of this equation should be tested by harvesting and weighing a minimum of 2-3 trees in each region (Brown, 2002).

Including tree height and wood density in the allometric equations usually improves the accuracy of the AGB (Chave et al., 2005). However, measuring tree height is a time consuming process because the top of tree is difficult to see through the often very dense canopy cover. Feldpausch et al. (2011) established an allometric equation to calculate height based on diameter, geographical location, precipitation and temperature. This research strongly recommends the inclusion of height in the allometric equation. For the Guiana shield, height could be calculated based on dbh using following equation:

$$\mathrm{Log}(H)= 0{,}6429 +0{,}5001*\log(D^*)+ 0{,}0120*A+0{,}0034*P_V-0{,}0449*S_D+0{,}0191*T_A$$

With H the tree height (m), D* the dbh (cm), A the basal area in m^2/ha, P_V the precipitation coefficient of variance, S_D number of months in the dry season, T_A the mean annual temperature.

Alternatively Baraloto et al. (2011) stated that tree height estimated by two independent trained persons, is as accurate as the estimations done using a laser finder.

For the assessment of the carbon stored in the forest it is not strictly necessary to know the botanical species name. As wood density has been found to be relatively constant within genera, it is thought that knowing the genus would already provide a fair estimate of the carbon stored in a forest. Although wood density measurements to calculate average local wood densities or classification of common tree names to wood density classes could be done, it is not clear what the effect of not knowing the exact botanical tree species names would have on the accuracy of biomass assessments.

The costs to carry out a forest inventory at a large scale and in remote areas are high. A forest inventory that includes establishing the exact botanical names of each tree species found, will need more financial input. But we do acknowledge that the proper identification of the tree species could allow us to use the data for multiple purposes, including a floristic diversity assessment, a conservation value assessment, and species distribution patterns across Suriname and the Guiana Shield. To achieve this we recommend following actions:

- Train more tree spotters, as the current pool of tree spotters is very small. When training tree spotters it is important to take different kinds of indigenous knowledge into account as well as that tree spotters come from different parts of Suriname including the remote southern parts.
- When conducting an inventory it is crucial to know from which tree (belonging to a certain species, genus or family) determination material should be collected. It may not be necessary to collect material from common and well-known tree species, but material from trees belonging to notoriously hard to identify genera and families should always be collected for verification purposes. Every inventory team should include a person with botanical knowledge, who can decide whether or not to collect determination material from a tree for further identification.
- To support the decision whether or not determination material should be collected, a protocol could be developed depending on the accuracy of the pre-identification of tree species in the field. Such a standard protocol has to be developed and established by a group of botanists and experienced tree spotters. In the past tree spotters have had the tradition of standardizing local tree names in connection to scientific species names. This tradition should be restored and become part of the process of developing a standardized protocol. The protocol should also include a standard form for tree descriptions, guidelines on the collection of the determination material and a field identification key, distinguishing between tree species that can be identified with certainty and trees species of which material must be collected for further identification. The original vouchers are stored at the Herbarium of Suriname and duplicates should be distributed to international herbaria for identification and verification purposes.
- Train people how to identify plant families not only in the field, but also from herbarium vouchers; how to collect plant material, describe trees, and identify tree species. The knowledge, technology and skills for these activities should be developed in a diverse group of motivated people, including tree spotters, foresters, biologists, students, etc. Courses on the Flora and plants occurring in the Guiana Shield, more specifically tree species in Suriname, should be organized on a regular basis. As part of these courses the knowledge

and skills of tree spotters, and other persons involved in national forest inventories could be tested and refreshed or upgraded on a regular basis. The results of these tests could be useful to improve the quality and accuracy of the standardized protocol (see above).

- A suggestion would be to establish a forum of tree spotters and botanists to improve the exchange of local and scientific botanical knowledge. This group can evaluate and update the standard protocol and the field determination key on a regular basis and further standardize the local tree species names that are used in Suriname (and perhaps beyond).
- The identification process of tree species determination material has to be standardized and discussed. The use of new technologies e.g. DNA-fingerprints and picture recognition should be evaluated. The capacity of the BBS has to be increased, because they can play an important role in this process. To facilitate the identification process, it is recommended to use the existing international networks. Individuals who have long demonstrated interest and dedication in the identification of the plants of Suriname should also be acknowledged and involved in this process.

It will take a while before an operational system to identify all the trees by their scientific/botanical names is established. Therefore a long term plan has to be formulated, with the short and long term objectives. Capacity building is crucial and because of the complexity of the problem an approach including all organizations and recognized individual specialists that can benefit from and contribute to this process is recommended.

6 Conclusion

This project was one of the first steps towards a Measurement, Reporting and Verification-system (MRVs). It allowed the key organizations to build capacity while a preliminary dataset on forest carbon stock was created. The results represented in this report can be used for the further development of an efficient methodology for a national forest inventory, which includes the assessment of forest carbon. It is recommendable to invest in a national forest monitoring plan to ensure a holistic approach of the different forest monitoring related projects and an optimal use of the scarce resources, in particular the human resource. The roadmap towards a MRV-system, based on a national REDD+-strategy could be a framework for such a plan.

Before continuing with field measurements, a national statistically sound sampling design needs to be developed. Discussion is needed if this design should cover the whole country with the same intensity or focus on areas which are prioritized in the REDD+-strategy (e.g. areas were human activities take place or are foreseen to take place). Furthermore we also have to agree on the temporal scale of this inventory. Will the plots be permanent and how often will they be remeasured? The data collected during this project provide valuable information we can use taking these decisions. It should be noted that some forest types in the young coastal plain (mangrove and swamp forest) have not been surveyed as yet. Due to their specific characteristics, it might be necessary to adapt the carbon stock assessment methodology for these forest types. Because of our limited experience with carbon assessments in humid forest types (in particular with soil sampling), more research on this topic might be needed.

To establish an operational MRV-system it is of necessary to increase the human resource capacity at all levels. There is a great lack of people who are able to manage and plan the MRV-system, specialists in the use of remote sensing for forest monitoring and data processing, tree spotters, botanists and field personnel. The human resource capacity needs have to be listed and a capacity building plan has to be made and carried out.

This project was an excellent example how successful the collaboration between different institutions can be. Sharing experience and knowledge between the team members contributed a considerable added value to the execution of this project. It is strongly recommended to use the experience acquired by the trained field personnel of different organizations in the further continuation of this project and consolidate long term collaboration.

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Annex 1: Description of the measurement plots

T	P	Forest type map	Forest type field	Disturbance	Topography	Vegetation Height (m)	Soil type
1	1	High dryland forest	High dryland forest	logging	Flat	33	Sandy loam
	2	High dryland forest	High dryland forest	logging	Flat	36	Loamy sand
	3	High dryland forest	High dryland forest	logging	Flat	28	Laterite
2	1	High dryland forest/ Marsh forest	High dryland forest	logging	Flat	29	Sandy clay
	2	scrub/low savanna shrubs	Low xerophytic forest	no	Flat	16	White sand
	3	High dryland forest	High xerophytic forest	logging	Flat	36	Sandy clay
3	1	High dryland forest	Marsh forest	logging	Flat	27	Brown sand
	2	High dryland forest	Marsh forest	logging	Flat	31	Loamy sand
	3	High dryland forest	High savanna forest	logging	Flat	32	Brown sand
4	1	High dryland forest	High dryland forest	logging	undulated	23	Brown sand
	2	High dryland forest	High dryland forest	no	undulated	20	
	3	High dryland forest	High dryland forest	no	undulated	18	Sandy loam
5	1	High dryland forest	High dryland forest	logging	undulated	26	Loam
	2	High dryland forest	High dryland forest	logging	flat	32	Loam
	3	High dryland forest	High dryland forest	logging	flat	35	Sandy loam
6	1	High dryland forest	High dryland forest	logging	flat	34	Loamy sand
	2	High dryland forest	High dryland forest	logging	flat	NA	Brown sand
	3	High dryland forest	High dryland forest	logging	flat	33	Brown sand
7	1	High dryland forest	High dryland forest	logging	flat	21	Loamy sand
	2	High dryland forest	High dryland forest	logging	undulated	31	Brown sand
	3	High dryland forest/ Marsh forest	High savanna forest	no	flat	25	White sand
8	1	High dryland forest	High dryland forest	no	undulated	31	Sandy loam
	2	High dryland forest	High dryland forest	no	undulated	31	Brown sand/ laterite
	3	High dryland forest	High dryland forest	no	undulated	29	Laterite
9	1	High dryland forest	High dryland forest	no	sloping	31	Sandy loam
	2	Marsh forest	Marsh forest	no	undulated	31	Sandy loam
	3	High dryland forest	High dryland forest	no	sloping	31	Sandy loam

T	P	Forest type map	Forest type field	Disturbance	Topography	Vegetation Height (m)	Soil type
10	**1**	High dryland forest	High dryland forest	logging	flat	24	Sand
	2	High dryland forest	High dryland forest	logging	sloping	31	Laterite
	3	Marsh forest	Marsh forest	no	flat	28	Loamy sand
11	**1**	High dryland forest	High dryland forest	no	Sloping	32	Laterite
	2	High dryland forest	High dryland forest	no	undulated	19	Laterite
	3	Marsh forest	High dryland forest	logging	sloping	29	Loam
12	**1**	Marsh forest/ high dryland forest	Marsh forest	logging	undulated	28	Loamy sand
	2	Marsh forest	Marsh forest	logging	undulated	25	Loam
	3	Marsh forest	High dryland forest	logging	undulated	26	Loam

Annex 2: Stand variables per measurement plot

Transect	Plot	Basal area (m2/ha)	Number of stems [5; 20cm[	Number of stems ≥20cm	Vegetation height	Mean dbh (cm)
1	**1**	18,6	560	136	33	13,6
	2	18,1	240	140	36	19,8
	3	18,2	424	134	28	16,6
2	**1**	28,0	1040	218	29	13,0
	2	17,4	2120	74	16	9,0
	3	31,3	640	194	36	16,1
3	**1**	23,1	664	208	27	14,8
	2	29,3	864	248	31	14,6
	3	25,4	928	208	32	13,2
4	**1**	24,1	864	172	23	13,5
	2	32,6	888	254	20	14,9
	3	26,2	888	200	18	13,5
5	**1**	24,3	880	166	26	13,3
	2	24,3	624	166	32	14,4
	3	19,5	528	168	35	14,8
6	**1**	26,3	752	156	34	14,4
	2	29,0	896	224	NA	14,0
	3	28,7	472	158	33	16,9
7	**1**	22,8	552	164	21	15,4
	2	23,8	1176	142	31	12,1
	3	21,8	896	178	25	12,8
8	**1**	36,1	544	182	31	16,7
	2	25,0	752	208	31	14,4
	3	21,7	656	150	29	13,7
9	**1**	28,6	824	212	31	14,4
	2	24,3	616	220	31	15,1
	3	27,2	536	214	31	16,5
10	**1**	20,1	840	192	24	12,7
	2	24,5	928	204	31	12,9
	3	21,4	896	212	28	12,3
11	**1**	29,3	1224	240	32	12,5
	2	29,3	1232	230	19	12,7
	3	31,1	1088	258	29	13,5
12	**1**	14,3	624	134	28	12,9
	2	25,9	1072	212	25	12,5
	3	20,4	616	198	26	14,0

Annex 3: Dominant species per measurement plot

Transect	Plot	Dominant species (dbh [5, 20cm[)	Dominant species (dbh ≥ 20cm)
1	1	Mispel, Pari-udu Pangapanga, gewone	Bebe, Bergi of Gandu Ingipipa, Grootbladige
	2	Pakiratiki Umabarklak	Babun, Hoogland Granbusi-papaya
	3	Sowtumeti Udu, liaan Umabarklak	Sali, Rode Babun, Hoogland
2	1	Melisali Brudu-Udu	Babun, Hoogland Kopi
	2	Mangro, Sabana Gawtri, Sabana	IJzerhart, Savanne- Mangro, Sabana
	3	Tingimoni, Rode bast, hoogbos Merkitiki	Tingimonisali, Gewone Ingipipa
3	1	Manbarklak, Hoogland (bergi?) witte bast? Srebebe	Umabarklak Manbarklak, Hoogland (bergi?) witte bast?
	2	Manbarklak, Hoogland (bergi?) witte bast? Taya-Udu, Geelbloemig	Umabarklak Krapa, Rode
	3	Taya-Udu, Geelbloemig Manbarklak, Hoogland (bergi?) witte bast?	Manbarklak, Hoogland (bergi?) witte bast? Swit'bonki, Rode bast
4	1	Tingimoni, Rode bast, hoogbos Taya-Udu, Geelbloemig	Granbusi-papaya, Drifinga Tingimoni, Rode bast, hoogbos
	2	Taya-Udu, Geelbloemig Tingimoni, Rode bast, hoogbos	Walaba Manbarklak, Hoogland (bergi?) witte bast?
	3	Taya-Udu, Geelbloemig Manbarklak, Hoogland (bergi?) witte bast?	Sali, Rode Pikinmisiki
5	1	Taya-Udu, Geelbloemig Tingimoni, Rode bast, hoogbos	Manbarklak, Hoogland (bergi?) witte bast? Gronfolu, Bergi
	2	Boskuswe, Rode en Gele Switbonki, Witte bast	Sali, Rode Switbonki, Rode bast
	3	Taya-Udu, Geelbloemig Sali, Rode	Sali, Rode Pikinmisiki
6	1	Pakiratiki Yakanta, Rode bast	Gronfolu, Bergi Bospapaya, Man-
	2	Gronfolu, Bergi Umabarklak, Hoogland (Bergi)	Gronfolu, Bergi Basralokus
	3	Pangapanga, gewone Boskuwe, Wilde/Wegboom	Walaba Foman

Transect	Plot	Dominant species (dbh [5, 20cm[)	Dominant species (dbh ≥ 20cm)
7	**1**	Pangapanga, gewone Pakiratiki	Walaba Gronfolu, Bergi
	2	Bospapaya, Uma- Bospapaya, Man-	Basralokus Boletri, Gewone
	3	Pisi, Kleinbladige zwarte /Grootbladige? Bosgujave, Gewone	Tete-udu, Witte bast Pisi, Kleinbladige zwarte /Grootbladige?
8	**1**	Yariyari, Langbladige Bosknepa, Gewone	Sali, Rode Bugubugu, Witte
	2	Manbarklak, bergi Boskoffie	Manbarklak, bergi Walaba
	3	Bugubugu, Witte Umabarklak, Hoogland (bergi)	Bugubugu, Witte Manbarklak, Hoogland (bergi?) witte bast?
9	**1**	Yariyari, Gewone Bebe, Bergi of Gandu	Kwepi, Harde Bast Foman
	2	Kreekboszuurzak, Grootbladige Walaba	Walaba Watra bebe
	3	Pakiratiki Kototiki	Umabarklak, Hoogland (bergi) Fungu, Witte
10	**1**	Taya-udu, Geelbloemige Gubaya	Umabarklak, Hoogland (bergi) Walaba
	2	Taya-udu, Geelbloemige Manbarklak, Hoogland (bergi?) witte bast?	Walaba Umabarklak
	3	Boszuurzak, langbladige Umabarklak	Umabarklak Walaba
11	**1**	Manbarklak, Hoogland (bergi?) witte bast? Taya-udu, Geelbloemige	Walaba Manbarklak, Hoogland (bergi?) witte bast?
	2	Taya-udu, Geelbloemige Manbarklak, Hoogland (bergi?) witte bast?	Walaba Manbarklak, Hoogland (bergi?) witte bast?
	3	Manbarklak, Hoogland (bergi?) witte bast? Taya-udu, Geelbloemige	Walaba Umabarklak, Hoogland (bergi)
12	**1**	Switbonki, Witte bast Doifisiri, Rode bast	Bospapaya, Man- Switbonki, Rode bast
	2	Taya-udu, Geelbloemige Pakiratiki	Umabarklak Hoepelhout
	3	Taya-udu, geelbloemige Pangapanga, gewone	Loto-udu Ayo-ayo

Annex 4: Biomass for trees with dbh [5,20cm[per measurement plot

Transect	Plot	# trees	AGB (t/ha)	BGB (t/ha)	AGC (t/ha)	BGC (t/ha)	TCS (t/ha)
1	1	70	22,7	5,5	10,7	2,6	13,2
1	2	30	14,6	3,7	6,9	1,7	8,6
1	3	53	27,1	6,4	12,7	3,0	15,7
2	1	130	41,0	9,2	19,3	4,3	23,6
2	2	265	72,5	15,3	34,1	7,2	41,2
2	3	80	30,9	7,2	14,5	3,4	17,9
3	1	83	33,3	7,7	15,7	3,6	19,3
3	2	107	45,1	10,0	21,2	4,7	25,9
3	3	116	35,8	8,2	16,8	3,9	20,7
4	1	108	40,3	9,1	19,0	4,3	23,2
4	2	111	44,2	9,9	20,8	4,6	25,4
4	3	111	38,3	8,7	18,0	4,1	22,1
5	1	110	42,9	9,6	20,2	4,5	24,7
5	2	78	24,5	5,9	11,5	2,8	14,3
5	3	66	22,8	5,5	10,7	2,6	13,3
6	1	94	38,0	8,6	17,9	4,1	21,9
6	2	112	38,5	8,7	18,1	4,1	22,2
6	3	59	18,7	4,6	8,8	2,2	11,0
7	1	69	26,6	6,3	12,5	3,0	15,5
7	2	147	54,4	11,9	25,6	5,6	31,1
7	3	112	40,7	9,2	19,1	4,3	23,4
8	1	68	23,5	5,7	11,1	2,7	13,7
8	2	94	40,9	9,2	19,2	4,3	23,6
8	3	82	29,6	6,9	13,9	3,3	17,1
9	1	103	37,8	8,6	17,8	4,0	21,8
9	2	77	26,9	6,4	12,6	3,0	15,6
9	3	67	25,5	6,1	12,0	2,9	14,9
10	1	105	35,0	8,0	16,4	3,8	20,2
10	2	116	32,4	7,5	15,2	3,5	18,8
10	3	112	30,0	7,0	14,1	3,3	17,4
11	1	153	47,5	10,5	22,3	4,9	27,3
11	2	154	53,1	11,6	25,0	5,5	30,4
11	3	136	46,5	10,3	21,9	4,8	26,7
12	1	78	31,7	7,3	14,9	3,5	18,3
12	2	134	39,7	9,0	18,6	4,2	22,9
12	3	77	23,1	5,6	10,9	2,6	13,5

Annex 5: Biomass for trees with dbh ≥20cm per measurement plot

Transect	Plot	# trees	AGB (t/ha)	BGB (t/ha)	AGC (t/ha)	BGC (t/ha)	TCS (t/ha)
1	1	68	165,4	31,7	77,7	14,9	92,6
1	2	70	177,9	33,8	83,6	15,9	99,5
1	3	67	146,9	28,5	69,1	13,4	82,5
2	1	109	220,7	40,9	103,7	19,2	122,9
2	2	37	33,6	7,7	15,8	3,6	19,4
2	3	97	318,7	56,5	149,8	26,6	176,3
3	1	104	182,2	34,5	85,6	16,2	101,8
3	2	124	229,7	42,3	108,0	19,9	127,8
3	3	104	199,0	37,3	93,5	17,5	111,1
4	1	86	183,1	34,6	86,0	16,3	102,3
4	2	127	286,4	51,4	134,6	24,2	158,8
4	3	100	211,6	39,4	99,5	18,5	118,0
5	1	83	185,7	35,1	87,3	16,5	103,8
5	2	83	238,2	43,7	112,0	20,5	132,5
5	3	84	165,8	31,7	77,9	14,9	92,8
6	1	78	231,5	42,6	108,8	20,0	128,8
6	2	112	242,9	44,5	114,2	20,9	135,1
6	3	79	319,6	56,7	150,2	26,6	176,9
7	1	82	200,2	37,5	94,1	17,6	111,7
7	2	71	153,4	29,6	72,1	13,9	86,0
7	3	89	148,6	28,8	69,8	13,5	83,4
8	1	91	456,3	77,6	214,5	36,5	251,0
8	2	104	198,3	37,2	93,2	17,5	110,7
8	3	75	203,1	38,0	95,4	17,8	113,3
9	1	106	240,1	44,0	112,9	20,7	133,5
9	2	110	204,6	38,2	96,2	18,0	114,1
9	3	107	260,9	47,4	122,6	22,3	144,9
10	1	96	134,8	26,4	63,3	12,4	75,8
10	2	102	190,4	35,9	89,5	16,8	106,3
10	3	106	155,3	30,0	73,0	14,1	87,1
11	1	120	213,2	39,6	100,2	18,6	118,9
11	2	115	201,3	37,7	94,6	17,7	112,3
11	3	129	237,6	43,6	111,7	20,5	132,2
12	1	67	86,0	17,8	40,4	8,3	48,8
12	2	106	189,1	35,6	88,9	16,8	105,6
12	3	99	163,4	31,3	76,8	14,7	91,5

Annex 6: C stored in woody palms per measurement plot

Transect	Plot	AGB (t/ha)	AGC (t/ha)
2	1	3,6	1,7
2	2	0,0	0,0
2	3	0,0	0,0
3	1	40,5	19,0
3	2	9,1	4,3
3	3	0,9	0,4
4	1	6,4	3,0
4	2	0,0	0,0
4	3	1,3	0,6
5	1	1,8	0,8
5	2	1,0	0,5
5	3	0,0	0,0
6	1	0,8	0,4
6	2	0,0	0,0
6	3	10,7	5,0
7	1	4,9	2,3
7	2	5,4	2,5
7	3	0,0	0,0
8	1	7,9	3,7
8	2	1,2	0,6
8	3	3,8	1,8
9	1	10,4	4,9
9	2	25,0	11,7
9	3	11,2	5,2
10	1	0,0	0,0
10	2	2,4	1,1
10	3	11,1	5,2
11	1	0,6	0,3
11	2	1,2	0,6
11	3	2,9	1,4
12	1	21,0	9,9
12	2	23,9	11,2
12	3	0,0	0,0

Annex 7: C stored in lianas per measurement plot

Transect	Plot	AGB (t/ha)	AGC (t/ha)
8	1	2,7	1,3
8	2	17,1	8,0
8	3	14,6	6,9
9	1	6,9	3,2
9	2	16,2	7,6
9	3	20,6	9,7
10	1	17,0	8,0
10	2	11,7	5,5
10	3	23,1	10,9
11	1	11,4	5,3
11	2	8,0	3,8
11	3	24,2	11,4
12	1	9,8	4,6
12	2	8,4	3,9
12	3	1,8	0,9

Annex 8: C stored in the understory per measurement plot

Transect	Plot	AGB (t/ha)	AGC (t/ha)
1	1	9,46	4,44
1	2	1,82	0,85
1	3	4,10	1,93
2	1	6,39	3,00
2	2	6,94	3,26
2	3	7,03	3,30
3	1	3,53	1,66
3	2	10,87	5,11
3	3	6,55	3,08
4	1	9,25	4,35
4	2	5,15	2,42
4	3	4,66	2,19
5	1	7,12	3,35
5	2	4,07	1,91
5	3	2,27	1,07
6	1	3,97	1,87
6	2	6,73	3,16
6	3	3,83	1,80
7	1	6,85	3,22
7	2	4,84	2,27
7	3	6,35	2,98
8	1	4,97	2,34
8	2	3,99	1,87
8	3	6,56	3,08
9	1	5,83	2,74
9	2	14,38	6,76
9	3	13,45	6,32
10	1	5,03	2,37
10	2	9,17	4,31
10	3	7,28	3,42
11	1	8,27	3,89
11	2	13,85	6,51
11	3	6,90	3,24
12	1	10,03	4,72
12	2	5,53	2,60
12	3	6,69	3,14

Annex 9: Dry weight and C stored in standing DW (diameter ≥ 5cm) per measurement plot

Transect	Plot	Dry weigh(t/ha)	C (t/ha)
1	1	18,5	8,7
1	2	8,3	3,9
1	3	36,5	17,1
2	1	9,4	4,4
2	2	5,6	2,6
2	3	2,8	1,3
3	1	3,7	1,7
3	2	9,6	4,5
3	3	5,5	2,6
4	1	2,5	1,2
4	2	2,5	1,2
4	3	9,8	4,6
5	1	3,4	1,6
5	2	3,7	1,7
5	3	3,2	1,5
6	1	7,6	3,6
6	2	11,3	5,3
6	3	2,7	1,2
7	1	10,1	4,8
7	2	3,6	1,7
7	3	3,8	1,8
8	1	11,6	5,4
8	2	2,2	1,0
8	3	9,9	4,7
9	1	5,0	2,3
9	2	1,5	0,7
9	3	4,1	1,9
10	1	1,7	0,8
10	2	3,2	1,5
10	3	6,0	2,8
11	1	4,3	2,0
11	2	2,7	1,3
11	3	2,3	1,1
12	1	1,4	0,7
12	2	1,0	0,5
12	3	1,6	0,7

Annex 10: Dry weight and C stored in CL per measurement plot

Transect	**Plot**	**Dry** weight **(t/ha)**	**C (t/ha)**
1	1	23,0	10,8
1	2	8,5	4,0
1	3	1,1	0,5
2	1	15,3	7,2
2	2	4,6	2,2
2	3	3,2	1,5
3	1	8,3	3,9
3	2	5,9	2,8
3	3	10,5	5,0
4	1	8,7	4,1
4	2	23,0	10,8
4	3	2,2	1,0
5	1	55,0	25,8
5	2	148,0	69,5
5	3	2,1	1,0
6	1	132,4	62,2
6	2	71,3	33,5
6	3	1,2	0,6
7	1	21,4	10,1
7	2	56,1	26,4
7	3	8,8	4,1
8	1	11,2	5,3
8	2	10,0	4,7
8	3	4,3	2,0
9	1	28,6	13,4
9	2	7,0	3,3
9	3	16,4	7,7
10	1	3,0	1,4
10	2	3,7	1,7
10	3	3,3	1,6
11	1	9,0	4,3
11	2	9,0	4,2
11	3	23,8	11,2
12	1	1,7	0,8
12	2	60,7	28,5
12	3	69,9	32,9

Annex 11: Dry weight and C stored in FL per measurement plot

Transect	Plot	Dry weight (t/ha)	C (t/ha)
1	1	13,0	6,1
1	2	10,8	5,1
1	3	6,7	3,1
2	1	5,7	2,7
2	2	9,3	4,4
2	3	8,5	4,0
3	1	8,0	3,7
3	2	8,6	4,0
3	3	7,7	3,6
4	1	12,3	5,8
4	2	7,4	3,5
4	3	6,6	3,1
5	1	6,5	3,1
5	2	8,3	3,9
5	3	5,1	2,4
6	1	6,7	3,1
6	2	7,4	3,5
6	3	9,4	4,4
7	1	5,9	2,8
7	2	9,1	4,3
7	3	8,7	4,1
8	1	4,9	2,3
8	2	11,2	5,3
8	3	5,8	2,7
9	1	8,1	3,8
9	2	8,0	3,8
9	3	8,2	3,8
10	1	5,3	2,5
10	2	6,5	3,1
10	3	4,1	1,9
11	1	7,2	3,4
11	2	11,4	5,3
11	3	5,3	2,5
12	1	7,0	3,3
12	2	5,2	2,4
12	3	5,3	2,5

Annex 12: Average SOC per measurement plot (depth 0-30cm)

Transect	Plot	SOC (t/ha)
1	1	22,2
1	2	21,3
1	3	25,3
2	1	24,9
2	2	8,7
2	3	27,9
3	1	35,2
3	2	49,4
3	3	33,1
4	1	25,6
4	2	29,9
4	3	32,7
5	1	25,6
5	2	31,8
5	3	26,9
6	1	24,2
6	2	33,9
6	3	19,4
7	1	32,8
7	2	23,0
7	3	14,3
8	1	22,6
8	2	24,3
8	3	27,3
9	1	23,6
9	2	21,1
9	3	23,8
10	1	27,4
10	3	26,9
11	1	30,8
11	2	23,9
11	3	21,7
12	1	28,7
12	2	24,4
12	3	23,9

Annex 13: Tree species list

Vernacular species name	Botanical species name	¨Plant family
Agrobigi, Grootbloemige	Parkia nitida (= Parkia oppositifolia)	Mimosaceae
Agrobigi, Kleinbloemige	Parkia ulei	Mimosaceae
Alanya-udu	Swartzia arborescens	Fabaceae
Alata-udu	Minquartia guianensis	Olacaceae
Amandelhout	Prunus myrtifolia	Rosaceae
Amotem	Emmotum sp.	Icacinaceae
Anawra, Hoogland	Couepia caryophylloides	Chrysobalanaceae
Anawra, Hoogland	Couepia guianensis (= Couepia versicolor)	Chrysobalanaceae
Anawra, Sabana-	Licania divaricata	Chrysobalanaceae
Anawra, Zwamp-	Licania heteromorpha	Chrysobalanaceae
Anawra, Zwarte	Licania canescens	Chrysobalanaceae
Apra-udu	Chrysophyllum argenteum	Sapotaceae
Apra-udu, Langbladige	Chrysophyllum mensalis (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Sapotaceae
Arumata, Rondbladige	Clathrotropis brachypetala	Fabaceae
Asawsafatu	Psychotria callithrix	Rubiaceae
Asisi-udu	Siparuna decipiens	Monimiaceae
Awara-udu	Jacaratia spinosa	Caricaceae
Awariston	Diospyros martinii	Ebenaceae
Ayari, Savanna / Monkimonki-boletri / Sabana-wana	Cybianthus punctatus (= Conomorpha magnoliifolia)	Myrsinaceae
Ayari, Savanne	Cybianthus fulvopulverulentus	Myrsinaceae
Ayari, Savanne	Cybianthus surinamensis (= Weigeltia surinamensis)	Myrsinaceae
Ayari, Zwamp	Stylogyne surinamensis	Myrsinaceae
Ayo-ayo	Hieronima alchorneoides (= Hieronima laxiflora)	Euphorbiaceae
Babun, Gele bast	Virola sp.	Myristicaceae
Babun, Hoogland	Virola michelii (= Virola melinonii)	Myristicaceae
Babun, Laagland	Virola surinamensis	Myristicaceae
Babun, Pintri-	Virola sebifera	Myristicaceae
Barmani	Catostemma fragrans	Bombacaceae
Basralokus	Dicorynia guianensis	Caesalpiniaceae
Batambali	Ecclinusa guianensis	Sapotaceae
Batbat	Ambelania acida	Apocynaceae
Bebe, Bergi of Gandu	Swartzia benthamiana	Fabaceae
Bebe, Hoogland-	Pterocarpus rohrii	Fabaceae
Bebe, Hoogland-	Pterocarpus santalinoides	Fabaceae
Bebe, Watra-	Pterocarpus officinalis	Fabaceae
Bergi Hevea	Micrandra elata ((naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht, mogelijk Micrandra brownsbergensis) (= Micrandra elata)	Euphorbiaceae
Bergi Manbebe	Ampelozizyphus amazonicus	Rhamnaceae
Bergibita	Geissospermum sericeum	Apocynaceae
Bitabon	Homalium guianense	Flacourtiaceae

Vernacular species name	Botanical species name	¨Plant family
Bita-udu	Ilex arimensis (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Aquifoliaceae
Bitawiwiri	Cestrum latifolium	Solanaceae
Blakaberi / Meri	Humiria balsamifera	Humiriaceae
Blaka-uma (boom)	Diospyros guianensis	Ebenaceae
Blaka-uma, Grootbladige	Diospyros lissocarpoides	Ebenaceae
Blaka-uma, Hoogbos	Diospyros capreifolia (= Diospyros melinonii)	Ebenaceae
Blaka-uma, Hoogland / Kleinbladige	Diospyros sp.	Ebenaceae
Blawkrala	Margaritaria nobilis	Euphorbiaceae
Bofrukasaba	Faramea multiflora	Rubiaceae
Bofrukasaba	Psychotria cuspidata (volgens S-lijst Olaf Banki: "not in Guianas")	Rubiaceae
Bofrukasaba	Psychotria poeppigiana	Rubiaceae
Bofru-siri	Abuta grandifolia	Menispermaceae
Bofru-udu, Witte bast	Sacoglottis cydonioides	Humiriaceae
Bofru-udu, Zwarte	Sacoglottis guianensis	Humiriaceae
Boletri	Manilkara bidentata	Sapotaceae
Boletri, Basra-	Manilkara huberi	Sapotaceae
Boletri, Savanne	Myrsine guianensis	Myrsinaceae
Bolomaka	Solanum stramoniifolium	Solanaceae
Bolomaka, Kleine	Solanum jamaicense	Solanaceae
Bonafousia	Malouetia tamaquarina	Apocynaceae
Bonafousia	Tabernaemontana heterophylla (wel in S-lijst, niet in V-lijst Olaf Banki)	Apocynaceae
Bonafousia Gummels, Geelbloemige PNR	Stemmadenia grandiflora	Apocynaceae
Bonafousia, Kleinbladige	Tabernaemontana attenuata (= Bonafousia attenuata) (wel in in S-lijst, niet in V-lijst Olaf Banki)	Apocynaceae
Bosamandel, Kleinbladige	Terminalia dichotoma	Combretaceae
Bosamandel, Savanne	Terminalia guyanensis	Combretaceae
Bosamandel, Zwamp	Terminalia amazonia	Combretaceae
Bosamandel, Zwamp	Terminalia lucida	Combretaceae
Bosamandel, Zwamp, Kleinbladige	Terminalia sp.	Combretaceae
Bosappel	Sapium brasiliensis (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Euphorbiaceae
Bosappel	Sarcaulus brasiliensis	Sapotaceae
Bosdruif	Heisteria cauliflora	Olacaceae
Bosgujave	Eugenia cowanii	Myrtaceae
Bosgujave	Eugenia cupulata	Myrtaceae
Bosgujave	Eugenia flavescens	Myrtaceae
Bosgujave	Marlierea schomburgkiana	Myrtaceae
Bosgujave	Eugenia coffeifolia	Myrtaceae
Bosgujave	Eugenia macrocalyx	Myrtaceae
Bosgujave, Bruinbladige	Calyptranthes fasciculata	Myrtaceae
Bosgujave, Grijze bast	Calycolpus revolutus	Myrtaceae
Bosgujave, Grootbladige	Calycolpus goetheanus	Myrtaceae
Bosgujave, Kleinbladige	Myrcia sylvatica	Myrtaceae
Boskalebas	Couroupita guianensis	Lecythidaceae
Boskalebas, Vierkante	Citharexylum spinosum	Verbenaceae

Vernacular species name	Botanical species name	¨Plant family
Boskasyu	Anacardium giganteum	Anacardiaceae
Boskasyu	Anacardium spruceanum	Anacardiaceae
Boskatoen	Eriotheca crassa	Bombacaceae
Boskatoen	Eriotheca globosa (= Bombax globosum)	Bombacaceae
Boskatoen, Kleinbladige	Bombacopsis nervosa	Bombacaceae
Boskatoen, Kleinbladige	Eriotheca surinamensis (= Bombax surinamensis)	Bombacaceae
Boskatoen, Savanne-	Pachira minor (= Rhodognaphalopsis minor)	Bombacaceae
Bosknepa	Pseudima frutescens	Sapindaceae
Bosknepa	Talisia guianensis	Sapindaceae
Bosknepa	Melicoccus pedicellaris (= Talisia pedicellaris)	Sapindaceae
Bosknepa, Eetbare	Talisia megaphylla	Sapindaceae
Bosknepa, Ruwe bast	Talisia sylvatica (= Talisia micrantha)	Sapindaceae
Boskoffie	Faramea guianensis	Rubiaceae
Boskoffie, Bergi	Guettarda acreana	Rubiaceae
Boskoffie, Kleinbladige	Faramea occidentalis	Rubiaceae
Boskoffie, Kleinbladige	Faramea quadricostata	Rubiaceae
Boskuswe, Rode en Gele	Sloanea trichosticha	Elaeocarpaceae
Boskuswe, Wilde / Wegboom	Aparisthmium cordatum	Euphorbiaceae
Bosmangro	Tovomita sp.	Clusiaceae
Bosmangro, Grootbladige	Tovomita choisyana	Clusiaceae
Bosmangro, Kleinbladige	Tovomita secunda	Clusiaceae
Bospapaya, Kleinbladige	Cecropia peltata (= Cecropia surinamensis)	Cecropiaceae
Bospapaya, Man-	Cecropia sciadophylla	Cecropiaceae
Bospapaya, Uma-	Cecropia obtusa	Cecropiaceae
Bostamarin	Elizabetha coccinea	Caesalpiniaceae
Bostamarin, Gevlamde- / Muserki	Zygia racemosa (= Marmaroxylon racemosum = Pithecellobium racemosum)	Mimosaceae
Bostamarin, Kleinbladige	Elizabetha paraensis	Caesalpiniaceae
Bostamarin, Kleinbladige	Hydrochorea corymbosa (= Pithecellobium corymbosa)	Mimosaceae
Bostamarinde, Rode bast / Kleinbladige	Elizabetha princeps	Caesalpiniaceae
Boszuurzak	Annona densicoma	Annonaceae
Boszuurzak, Kapuweri	Annona sericea	Annonaceae
Boszuurzak, Ritsbos	Annona montana	Annonaceae
Boyo-udu	Byrsonima aerugo	Malphigiaceae
Bradilifi	Coccoloba latifolia	Polygonaceae
Bradilifi	Coccoloba marginata	Polygonaceae
Bradilifi, Behaarde	Coccoloba mollis	Polygonaceae
Brudu-udu	Iryanthera lancifolia	Myristicaceae
Brudu-udu	Iryanthera sagotiana	Myristicaceae
Bruinhart	Vouacapoua americana	Caesalpiniaceae
Bugubugu, Witte	Swartzia schomburgkii	Fabaceae
Bugubugu, Zwarte	Swartzia remiger	Fabaceae
Busikakaw	Herrania kanukuensis	Sterculiaceae
Busi-mowmow	Pachira insignis	Bombacaceae
Coussapoa, Bruinnervige	Coussapoa angustifolia	Cecropiaceae
Coussapoa, Gladbladige	Coussapoa latifolia	Cecropiaceae

Vernacular species name	Botanical species name	¨Plant family
Coussapoa, Ruwbladige	Coussapoa asperifolia	Cecropiaceae
Crateva	Crateva tapia	Capparaceae
Cupania	Matayba laevigata	Sapindaceae
Cymbopetalum	Cymbopetalum brasiliense	Annonaceae
Daguston	Posoqueria latifolia	Rubiaceae
Daguston	Posoqueria longiflora	Rubiaceae
Daguston	Posoqueria trinitatis	Rubiaceae
Dakama, Coppename -	Dimorphandra pullei	Caesalpiniaceae
Dakama, Gewone	Dimorphandra conjugata	Caesalpiniaceae
Dakama, Roodbloemige	Dimorphandra polyandra (= D. hohenkerkii)	Caesalpiniaceae
Dede-udu	Capirona decorticans	Rubiaceae
Dede-udu	Capirona montana (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Rubiaceae
Demerara groenhart	Chlorocardium rodiei (= Ocotea rodiei)	Lauraceae
Doifisiri, Rode bast	Guarea sp.	Meliaceae
Doifisiri, Rode bast	Guarea guidonia = (Guarea guara)	Meliaceae
Doifisiri, Witte bast	Guarea grandifolia	Meliaceae
Doifisiri, Witte bast	Guarea pubescens (= Guarea davisii)	Meliaceae
Doifisiri, Zwarte bast	Guarea kunthiana	Meliaceae
Doifisiri, Zwarte bast / Witte bast	Guarea subsessilifolia (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Meliaceae
Donsedre	Cedrelinga cateniformis	Mimosaceae
Drieblad	Anthodiscus sp.	Caryocaraceae
Drypotes / Cassipourea	Cassipourea guianensis	Rhizophoraceae
Dukali	Brosimum parinarioides	Moraceae
Dukali, Kleinbladige	Brosimum lactescens	Moraceae
Dukali, Oranje bast	Brosimum sp.	Moraceae
Dukali, Rode bast	Clarisia racemosa	Moraceae
Dyadidya	Sclerolobium melinonii	Caesalpiniaceae
Dyedu, Mira-	Tachigali paniculata	Caesalpiniaceae
Dyedu, Rode, Grootbladige	Sclerolobium sp.	Caesalpiniaceae
Dyedu, Rode, Kleinbladige	Tachigali albiflora (= Sclerolobium albiflorum)	Caesalpiniaceae
Dyedu, Witte	Tachigali guianensis (= Sclerolobium guianense)	Caesalpiniaceae
Dyedu, Zwarte	Tachigali micropetala (= Sclerolobium micropetalum)	Caesalpiniaceae
Dyori-dyori of Kabbes, Wana-	Vataireopsis sp.	Fabaceae
Dyu-boletri, Hoogland	Pouteria sagotiana (= Eremoluma sagotiana)	Sapotaceae
Dyu-boletri, Sabana-	Pouteria trigonosperma	Sapotaceae
Erythoxylum	Erythroxylum macrophyllum	Erythroxylaceae
E-udu	Ouratea castaneifolia	Ochnaceae
E-udu	Ouratea guianensis	Ochnaceae
Fernandusia	Ferdinandusa rudgeoides	Rubiaceae
Ficus, Bruinbehaarde	Ficus sp.	Moraceae
Ficus, Diya	Ficus maxima	Moraceae
Ficus, Grootbladige	Ficus ernestiana (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Moraceae
Ficus, Kleinbladige	Ficus pertusa	Moraceae

Vernacular species name	Botanical species name	¨Plant family
Ficus, Kleinbladige	Ficus sp.	Moraceae
Fokofoko-udu	Apeiba albiflora (= Apeiba tibourbou)	Tiliaceae
Fokofoko-udu, Kleinbladige	Apeiba glabra	Tiliaceae
Foman	Chaetocarpus schomburgkianus	Euphorbiaceae
Fungu, Bongru	Licania robusta	Chrysobalanaceae
Fungu, Kleinbladige Rode	Hirtella bicornis	Chrysobalanaceae
Fungu, Kleinbladige Zwarte / Savanne hoogland	Licania leptostachya	Chrysobalanaceae
Fungu, Rode	Parinari rodolphii	Chrysobalanaceae
Fungu, Rode Grootbladige	Parinari campestris	Chrysobalanaceae
Fungu, Rode, Kleinbladige	Parinari excelsa	Chrysobalanaceae
Fungu, Ruwe bast, Savanna	Licania irwinii	Chrysobalanaceae
Fungu, Savanna	Licania incana	Chrysobalanaceae
Fungu, Savanne Hoogbos	Licania hypoleuca	Chrysobalanaceae
Fungu, Witte	Drypetes variabilis (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht wel Drypetes = Chaetocarpus (??)	Euphorbiaceae
Fungu, Zwarte	Licania octandra	Chrysobalanaceae
Fungu, Zwarte, Harde bast	Licania densiflora	Chrysobalanaceae
Fungu, Zwarte, Kleinbladige	Licania discolor	Chrysobalanaceae
Gagoe	Tabernaemontana laurifolia (V lijst Olaf: not in flora area)	Apocynaceae
Gagoe	Tabernaemontana lorifera (in S-lijst, niet in V lijst Olaf)	Apocynaceae
Gandu / Kakabruku	Swartzia panacoco (= Swartzia tomentosa)	Fabaceae / Caes
Gawtri, Barbakoeba	Matayba arborescens	Sapindaceae
Gawtri, Bruin behaarde	Cupania hirsuta	Sapindaceae
Gawtri, Hoogbos (zwarte)	Cupania scrobiculata	Sapindaceae
Gawtri, Kleinblad	Matayba peruviana (= Matayba oligandra)	Sapindaceae
Gawtri, Sabana	Matayba opaca	Sapindaceae
Geri-udu / Masala-udu	Pogonophora schomburgkiana	Euphorbiaceae
Gindya-udu	Buchenavia tetraphylla (= B. capitata)	Combretaceae
Gomhout	Sapium glandulosum (= Sapium aubletianum)	Euphorbiaceae
Gomhout, Langbladige	Sapium ciliatum	Euphorbiaceae
Granbusi Weti-udu	Thyrsodium guianense	Anacardiaceae
Granbusi-kuswe	Sloanea sp.	Elaeocarpaceae
Granbusi-papaya	Pourouma bicolor	Cecropiaceae
Granbusi-papaya	Pourouma melinonii	Cecropiaceae
Granbusi-papaya	Pourouma villosa	Cecropiaceae
Granbusi-papaya, Drifinga	Pourouma guianensis	Cecropiaceae
Granbusi-papaya, Fefifinga	Pourouma tomentosa	Cecropiaceae
Granbusi-papaya, Grootbladige	Pourouma mollis	Cecropiaceae
Granbusi-papaya, Kleinbladige	Pourouma minor	Cecropiaceae
Groenhart	Tabebuia serratifolia	Bignoniaceae
Groenhart, Man- / Kunatepi	Tabebuia sp.	Bignoniaceae
Gronfolu, Bergi	Qualea rosea	Vochysiaceae
Gronfolu, Hoogland	Ruizterania albiflora (= Qualea albiflora)	Vochysiaceae
Gronfolu, Laagland	Qualea coerulea	Vochysiaceae
Gubaya	Jacaranda copaia	Bignoniaceae
Gujave	Eugenia biflora	Myrtaceae

Vernacular species name	Botanical species name	¨Plant family
Gujave	Myrcia fallax	Myrtaceae
Gujave	Psidium guajavea	Myrtaceae
Gujave, Grootbladige	Calycorectes grandifolius	Myrtaceae
Gujave, Kreek	Psidium acutangulum	Myrtaceae
Gujave, Liba	Psidium striatulum	Myrtaceae
Gujave, Onbekende	Eugenia florida	Myrtaceae
Gujave, Onbekende	Marlierea umbraticola	Myrtaceae
Gujave, Onbekende	Elvasia elvasioides	Ochnaceae
Gujave, Rode bast	Myrcia amazonica	Myrtaceae
Gujave, Zwamp	Eugenia lambertiana	Myrtaceae
Gujave, Zwamp	Myrcia pyrifolia	Myrtaceae
Gujave, Zwamp	Eugenia sp.	Myrtaceae
Gujave, Zwamp Bruinbladige	Eugenia chrysophyllum	Myrtaceae
Hevea	Hevea pauciflora	Euphorbiaceae
Hevea, Bergi	Hevea guianensis	Euphorbiaceae
Hoepelhout	Copaifera duckei (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Caesalpiniaceae
Hoepelhout	Copaifera guyanensis	Caesalpiniaceae
Hoepelhout	Copaifera reticulata	Caesalpiniaceae
Hoepelhout, Kleinbladige	Copaifera tenuifolium (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Caesalpiniaceae
Hoepelhout, Kleinbladige	Copaifera epunctata	Caesalpiniaceae
Hukutiki	Bocageopsis multiflora	Annonaceae
IJzerhart	Bocoa prouacensis (= Swartzia prouacensis)	Caesalpiniaceae
IJzerhart	Bocoa tenuifolium (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Caesalpiniaceae
IJzerhart	Bocoa viridiflora	Caesalpiniaceae
IJzerhart, Paarse	Swartzia sp.	Fabaceae
IJzerhart, Rode	Swartzia sp.	Fabaceae
IJzerhart, Savanne-	Swartzia bannia	Fabaceae
Ilex	Ilex jenmanii	Aquifoliaceae
Ilex	Ilex martiniana	Aquifoliaceae
Ilex	Ilex ovalifolia	Aquifoliaceae
Inginoto / Paranoot	Bertholletia excelsa	Lecythidaceae
Ingipipa	Couratari oblongifolia	Lecythidaceae
Ingipipa	Couratari stellata	Lecythidaceae
Ingipipa, Grootbladige	Couratari guianensis (= Couratari pulchra)	Lecythidaceae
Ingipipa, Grootbladige	Couratari gloriosa	Lecythidaceae
Ingipipa, Kleinbladige	Couratari multiflora	Lecythidaceae
Jamun	Syzỉygium cumini	Myrtaceae
Jankrapa	Talisia mollis	Sapindaceae
Jankrapa, Kleinbladige	Toulicia sp.	Sapindaceae
Kabbes, Gele	Vatairea paraensis	Fabaceae
Kabbes, Gele	Vatairea guianensis	Fabaceae
Kabbes, Jong	Vataireopsis speciosa	Fabaceae
Kabbes, Maka Kleinbladig / Wana-kabbes	Hymenolobium petraeum	Fabaceae
Kabbes, Rode Kleinbladige	Andira sp.	Fabaceae
Kabbes, Rode, Hoogbos	Andira surinamensis	Fabaceae
Kabbes, Rode, Zwampbos	Andira coriacea	Fabaceae
Kabbes, Rode, Zwampbos	Andira inermis	Fabaceae

Vernacular species name	**Botanical species name**	**¨Plant family**
Kabbes, Zwamp- Zwarte / Watragrin	Acosmium nitens (= Sweetia nitens)	Fabaceae
Kabbes, Zwarte	Diplotropis purpurea	Fabaceae
Kaiman-udu = Pinto-kopi	Laetia procera	Flacourtiaceae
Kaiman-udu, Gele vrucht	Flacourtia sp.	Flacourtiaceae
Kaiman-udu, Grootbladige	Flacourtia sp.	Flacourtiaceae
Kaiman-udu, Kapuweri	Banara guianensis	Flacourtiaceae
Kaiman-udu, Kleinbladige	Casearia arborea	Flacourtiaceae
Kaiman-udu, Kleine soort	Casearia pitumba	Flacourtiaceae
Kaiman-udu, Platte vrucht	Flacourtia sp.	Flacourtiaceae
Kaiman-udu, Rode vrucht	Flacourtia sp.	Flacourtiaceae
Kalebashout	Citharexylum macrophyllum	Verbenaceae
Kalebashout	Vitex sp.	Verbenaceae
Kalebashout	Vitex stahelii	Verbenaceae
Kalebashout, Vierkante	Vitex compressa	Verbenaceae
Kanambuli	Simaba guianensis	Simaroubaceae
Kanambuli / Noyanyanyan	Simaba orinocensis (= Simaba multiflora)	Simaroubaceae
Kandra-udu	Palicourea longiflora	Rubiaceae
Kaneelhart	Kubitzkia mezii	Lauraceae
Kaneelhart	Licaria cannella	Lauraceae
Kankantri	Ceiba pentandra	Bombacaceae
Kankan-udu	Apeiba petoumo (= Apeiba echinata)	Tiliaceae
Kankan-udu	Apeiba schomburgkii	Tiliaceae
Kankan-udu, Kleinbladige	Apeiba sp.	Tiliaceae
Kapuwatiki	Bonafousia siphilitica (= Tabernaemontana tetrastachya) (in S-lijst, niet in V-lijst Olaf)	Apocynaceae
Kapuweri pisi	Ocotea floribunda (= Ocotea wachenheimii)	Lauraceae
Kasaba-udu	Schefflera decaphylla (= Scheffleria paraënsis)	Araliaceae
Katun-udu	Lueheopsis rugosa	Tiliaceae
Katun-udu	Lueheopsis rosea (= L. flavescens)	Tiliaceae
Kaw-udu	Bagassa guianensis (= Bagassa tiliaefolia)	Moraceae
Kersi, Adoyakers	Campomanesia aromatica	Myrtaceae
Kersi, Sabana	Eugenia punicifolia	Myrtaceae
Kersi, Sekrepatu	Eugenia patrisii	Myrtaceae
Kimboto	Pradosia surinamensis	Sapotaceae
Kimboto, Bergi / Zwarte Yamboka	Pouteria glomer~~ul~~ata	Sapotaceae
Kimboto, Hoogland	Pradosia ptychandra (= Pouteria ptychandra = Neopometia ptychandra)	Sapotaceae
Kimboto, Hoogland / Laurierkers	Chrysophyllum pomiferum (= Achrouteria pomifera)	Sapotaceae
Kokobe-switbonki	Zygia latifolia (= Zygia cauliflora)	Mimosaceae
Kokriki	Ormosia paraensis	Fabaceae
Kokriki, Grootbladige	Ormosia sp.	Fabaceae
Kokriki, Hoogbos	Ormosia coccinea	Fabaceae
Kokriki, Hoogbos	Ormosia coutinhoi	Fabaceae
Kokriki, Kleinbladige	Ormosia melanocarpa	Fabaceae
Kokriki, Savanne	Ormosia costulata	Fabaceae
Konkoni-udu, Hoogland	Gustavia hexapetala	Lecythidaceae
Konkoni-udu, Laagland / Watramamabobi	Gustavia a~~n~~ugusta	Lecythidaceae

Vernacular species name	Botanical species name	¨Plant family
Kopi	Goupia glabra	Celastraceae
Kopkopi	Trema micrantha	Ulmaceae
Kototiki	Mabea piriri	Euphorbiaceae
Krapa, Rode	Carapa guianensis	Meliaceae
Krapa, Witte	Carapa procera	Meliaceae
Kreekboszuurzak, Grootbladige	Anaxagorea dolichocarpa	Annonaceae
Kreekboszuurzak, Kleinbladige	Anaxagorea acuminata	Annonaceae
Kromantikopi	Aspidosperma helstoneii	Apocynaceae
Kromantikopi	Aspidosperma cruentum	Apocynaceae
Kromantikopi, Kleinbladige	Aspidosperma megalocarpon	Apocynaceae
Kromantikopi, Kleinbladige, Gewone	Agonandra silvatica	Opiliaceae
Kromoko	Eugenia feijoi	Myrtaceae
Kromoko	Eugenia tapacumensis	Myrtaceae
Kromoko, Hoogland	Eugenia wullschlaegeliana	Myrtaceae
Krubara	Pentaclethra macroloba	Mimosaceae
Kunatepi	Platymiscium trinitatis	Fabaceae
Kunatepi	Platymiscium ulei	Fabaceae
Kurali / Kurahara	Calophyllum brasiliense	Clusiaceae
Kurali / Kurahara	Calophyllum longifolium	Clusiaceae
Kusa	Micropholis sp.	Sapotaceae
Kwaku	Marlierea montana	Myrtaceae
Kwari, Apra	Vochysia densiflora	Vochysiaceae
Kwari, Gewone / Dukali, Gewone	Vochysia surinamensis	Vochysiaceae
Kwari, Guyaba-	Qualea dinizii	Vochysiaceae
Kwari, Mawsi- / Singri-kwari / Feli-kwari	Erisma uncinatum	Vochysiaceae
Kwari, Wana-	Vochysia tomentosa	Vochysiaceae
Kwari, Watra-	Vochysia tetraphylla	Vochysiaceae
Kwari, Wiswis-	Vochysia guianensis	Vochysiaceae
Kwasiba	Pouteria cuspidata (= Pouteria gonggrijpii = Pouteria dura = Neoxythece robusta)	Sapotaceae
Kwasibita	Quassia amara	Simaroubaceae
Kwaskwasi-udu	Ampelocera edentula	Ulmaceae
Kwatabobi	Chrysophyllum cuneifolium (= Ecclinusa cuneifolia)	Sapotaceae
Kwatakama	Parkia pendula	Mimosaceae
Kwatapatu	Lecythis zabucajo (= Lecythis davisii)	Lecythidaceae
Kwateri	Eschweilera decolorans	Lecythidaceae
Kwepi	Licania laxiflora	Chrysobalanaceae
Kwepi	Hirtella macrosepala	Chrysobalanaceae
Kwepi, Behaarde	Hirtella paniculata	Chrysobalanaceae
Kwepi, Behaarde / Smalbladige / Kleinbladige Rode / Sabana-	Hirtella racemosa (= Hirtella strigulosa)	Chrysobalanaceae
Kwepi, Behaarde smalbladige	Hirtella hispidula	Chrysobalanaceae
Kwepi, Grootbladige	Hirtella silicea	Chrysobalanaceae
Kwepi, Grootbladige Rode	Licania longistyla	Chrysobalanaceae
Kwepi, Grootbladige Rode	Couepia sp.	Chrysobalanaceae
Kwepi, Grootbladige Rode	Licania jimenezii	Chrysobalanaceae
Kwepi, Harde Bast	Licania majuscula (=Licania hostmanii)	Chrysobalanaceae
Kwepi, Harde Bast, Savanne	Couepia cognata	Chrysobalanaceae
Kwepi, Kleinbladige Rode	Exellodendron barbatum	Chrysobalanaceae

Vernacular species name	**Botanical species name**	**¨Plant family**
Kwepi, Rode Bast	Hirtella glandulosa	Chrysobalanaceae
Kwepi, Savanne	Couepia parillo	Chrysobalanaceae
Kwepi, Zwamp	Licania apetala	Chrysobalanaceae
Kwepi, Zwarte	Licania micrantha	Chrysobalanaceae
Laksiri	Caraipa densifolia	Clusiaceae
Laksiri, Hoogland	Stryphnodendron polystachyum	Mimosaceae
Laurierkers	Pouteria coriacea	Sapotaceae
Laurierkers	Pouteria cladantha	Sapotaceae
Leletiki	Rinorea brevipes	Violaceae
Leletiki	Rinorea falcata	Violaceae
Leletiki	Rinorea macrocarpa	Violaceae
Letterhout	Brosimum americana (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Moraceae
Letterhout	Helicostylis pedunculata	Moraceae
Letterhout	Brosimum guianense (= Piratinera guianensis = P.velutina = P.scabridula)	Moraceae
Lika-udu	Antonia ovata	Loganiaceae
Lika-udu, Rode bast	Styrax glabratus	Styracaceae
Loksi, Pingo Rode Lokus	Hymenaea oblongifolia (volgens V-lijst Olaf Banki: "to be expected in Suriname")	Caesalpiniaceae
Loksi, Rode	Hymenaea courbaril	Caesalpiniaceae
Lontukasi	Byrsonima coriacea	Malpighiaceae
Lontukasi	Byrsonima stipulacea	Malpighiaceae
Lontukasi	Spachea elaegans	Malpighiaceae
Lontukasi, Geelbloemige Sabana-	Byrsonima crassifolia	Malpighiaceae
Lontukasi, Paarsbloemige	Byrsonima laevigata (= Byrsonima observa)	Malpighiaceae
Loto-udu	Miconia longifolia	Melastomataceae
Makagrin	Tabebuia capitata	Bignoniaceae
Makakabbes	Albizia subdimidiata (= Pithecellobium multiflorum)	Mimosaceae
Makakrapa	Talisia esculenta	Sapindaceae
Makakrapa	Talisia squarrosa	Sapindaceae
Makaraima	Humiria sp.	Humiriaceae
Makakabbes / Wormbast	Hymenolobium flavum	Fabaceae
Makraka, Hoogland	Dialium guianense (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Fabaceae
Malasi-udu	Brunfelsia guianensis	Solanaceae
Manaritiki	Rinorea pubiflora (= Rinorea passoura)	Violaceae
Manari-udu	Panopsis sessilifolia	Proteaceae
Manbarklak	Eschweilera subglandulosa	Lecythidaceae
Manbarklak, Hoogland	Eschweilera pedicellata (= Eschweilera longipes)	Lecythidaceae
Manbarklak, Hoogland witte bast	Eschweilera coriacea (= Eschweilera odora)	Lecythidaceae
Manbarklak, Hoogland, Rode bast	Eschweilera sp.	Lecythidaceae
Manbebe, Hoogland, Bergi	Alchorneopsis floribunda (= A. trimera)	Euphorbiaceae
Mangandu, Bergi	Swartzia sp.	Fabaceae
Mangro	Rhizophora mangle	Rhizophoraceae
Mangro, Sabana	Clusia fockeana	Clusiaceae
Mangro, Sabana	Clusia nemorosa	Clusiaceae
Mangro, Sabana	Clusia panapanari	Clusiaceae
Mani	Moronobea coccinea	Clusiaceae

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Mankrapa / Jankrapa, Grootbladige	Simaba cedron	Simaroubaceae
Manletter	Pseudolmedia laevis	Moraceae
Manletter, Grootbladige	Maquira sclerophylla	Moraceae
Manletter, Grootbladige	Helicostylis tomentosa	Moraceae
Manletter, Grootbladige	Perebea guianensis	Moraceae
Manletter, Kleinbladige	Maquira sp.	Moraceae
Manletterhout	Maquira guianensis	Moraceae
Manpikapika	Ephedranthus guianensis	Annonaceae
Mansali	Croton hostmannii	Euphorbiaceae
Mapa, Kleinbladige	Parahancornia fasciculata (= Parahancornia amapa)	Apocynaceae
Mapa, Sokosoko-	Macoubea guianensis	Apocynaceae
Mapa, Witte	Himatanthus articulatus	Apocynaceae
Marmeldoos, Behaarde blad / Eetbare Marmeldoos	Duroia eriopila	Rubiaceae
Marmeldoos, Gladbladige	Amaioua corymbosa	Rubiaceae
Marmeldoos, Grootbladige	Duroia aquatica	Rubiaceae
Marmeldoos, Grootbladige, Gladde bast	Amaioua guianensis	Rubiaceae
Marmeldoos, Lang gladbladige	Duroia longiflora	Rubiaceae
Marmeldoos, soort	Duroia merumensis	Rubiaceae
Mataki	Symphonia globulifera	Clusiaceae
Mata-udu	Sabicea oblongifolia	Rubiaceae
Melisali	Trichilia euneura	Meliaceae
Melisali	Trichilia schomburgkii	Meliaceae
Melisali, Witte bast	Trichilia pallida	Meliaceae
Melisali, Witte bast	Trichilia sp.	Meliaceae
Merkitiki	Tabernaemontana undulata (= Bonafousia undulata) (wel in S-lijst, niet in V-lijst Olaf)	Apocynaceae
Mira-udu	Triplaris weigeltiana (= Triplaris surinamensis)	Polygonaceae
Mispel	Loreya mespiloides	Melastomataceae
Mispel	Myriaspora egensis	Melastomataceae
Mispel, Boom	Miconia poeppigii = (Miconia surinamensis)	Melastomataceae
Mispel, bruinbladige	Miconia francavillana	Melastomataceae
Mispel, Eetbare	Bellucida grossularioides	Melastomataceae
Mispel, gewimperde	Miconia ciliata	Melastomataceae
Mispel, Kanker-	Henriettea multiflora	Melastomataceae
Mispel, Kleine	Leandra solenifera	Melastomataceae
Mispel, Mira-	Tococa guianensis	Melastomataceae
Mispel, Pari-udu	Henriettea spec.	Melastomataceae
Mispel, smalbladige	Miconia chrysophylla	Melastomataceae
Mope	Spondias mombin	Anacardiaceae
Mope fransman	Ximenia americana	Olacaceae
Mora	Mora excelsa	Caesalpiniaceae
Morabukeya	Mora gonggrijpii	Caesalpiniaceae
Morokobita	Jacaranda obtusifolia (= Jacaranda rhombifolia)	Bignoniaceae
Morototo	Schefflera morototonii (= Didymopanax morototonii)	Araliaceae
Neku-udu	Alexa wachenheimii	Fabaceae

Vernacular species name	Botanical species name	¨Plant family
Neku-udu	Lonchocarpus heptaphyllus (= Lonchocarpus latifolius)	Fabaceae
Neku-udu	Poecilanthe hostmannii	Fabaceae
Nyamsi-udu	Ilex guianensis	Aquifoliaceae
Okerhout	Sterculia exelsa (volgens S-lijst Olaf Baki: niet in de Guianas)	Sterculiaceae
Okerhout	Sterculia pruriëns	Sterculiaceae
Oli-udu	Trymatococcus amazonicus (= Trymatococcus paraensis)	Moraceae
Pagamea	Psychotria mapourioides	Rubiaceae
Pakiratiki	Roucheria sp.	Hugoniaceae
Pakiratiki	Tapura guianensis	Dichapetalaceae
Pakuli, Geelhart	Platonia insignis	Clusiaceae
Pakuli, Hoogland, Grootbladig	Rheedia benthamiana	Clusiaceae
Pakuli, Hoogland, Grootbladig	Rheedia macrophylla	Clusiaceae
Pakuli, Hoogland, Kleinbladig / Swampu / Sabana	Rheedia madruno (= Rheedia acuminata= Rheedia kappleri)	Clusiaceae
PAKULI, Zwamp Coesewijne		
Pangapanga	Palicourea guianensis	Rubiaceae
Pangapanga, Kleine	Coussarea paniculata	Rubiaceae
Pangapanga, zwamp	Palicourea crocea	Rubiaceae
Panta, Hoogland	Conceveiba guianensis	Euphorbiaceae
Panta, Liba-	Tabebuia fluviatilis (= Tabebuia aquatilis)	Bignoniaceae
Panta, Zwamp-	Tabebuia insignis	Bignoniaceae
Parelhout, Witte	Aspidosperma marcgravianum	Apocynaceae
Parelhout, Witte of gele bast /Kromantikopi	Aspidosperma album	Apocynaceae
Parelhout, Zwarte, Grootbladige	Aspidosperma oblongum	Apocynaceae
Parelhout, Zwarte, Kleinbladige	Aspidispema excelsum	Apocynaceae
Pata(ku)wana / Botro-udu	Chaunochiton kappleri	Olacaceae
Patakuwana	Gordonia fruticosa (= Laplacea fruticosa)	Theaceae
Pedreku	Xylopia discreta	Annonaceae
Pedreku	Xylopia sericea	Annonaceae
Pedreku / Pedrekupisi	Xylopia aromatica	Annonaceae
Pedreku, Langbladige	Xylopia cayennenis (= Xylopia longifolia)	Annonaceae
Pedrekupisi	Xylopia surinamensis	Annonaceae
Pedrekupisi, Rode	Xylopia amazonica	Annonaceae
Pedrekupisi, Witte	Xylopia nitida	Annonaceae
Pepre-udu	Pera bicolor	Euphorbiaceae
Pera	Couma guianensis	Apocynaceae
Peritiki	Heisteria densifrons	Olacaceae
Pikapika	Oxandra asbeckii	Annonaceae
Pikinmisiki	Pseudopiptadenia suaveolens (Piptadenia suaveolens = Newtonia suaveolens)	Mimosaceae
Pikintiki	Maprounea amazonica (= Maprounea guianensis)	Euphorbiaceae
Pinja, Man, grootbladige	Vismia japurensis	Hypericaceae
Pinto lokus zwarte	Talisia microphylla	Sapindaceae
Pinto lokus zwarte	Talisia hemidasya	Sapindaceae
Pinto-boletri	Micropholis mensalis	Sapotaceae
Pinto-boletri	Pouteria eugeniifolia	Sapotaceae
Pinto-boletri	Pouteria gonggrijpii	Sapotaceae

Vernacular species name	Botanical species name	¨Plant family
Pinto-boletri	Pouteria reticulata	Sapotaceae
Pinto-boletri, Zwarte	Pouteria sp.	Sapotaceae
Pintolokus, Witte = Bosmahoni	Martiodendron parviflorum (= Martiusia parviflora)	Caesalpiniaceae
Pinya	Vismia latifolia	Hypericaceae
Pinya, Grootblad / Kleinblad	Vismia sessilifolia	Hypericaceae
Pinya, Man-	Vismia macrophylla (= Vismia angusta)	Hypericaceae
Pinya, Uma	Vismia guianensis	Hypericaceae
Pinya, Zwamp	Vismia cayennensis	Hypericaceae
Pisi	Aiouea laevis	Lauraceae
Pisi	Ocotea canaliculata	Lauraceae
Pisi	Ocotea cernua	Lauraceae
Pisi	Ocotea endlicheriopsis	Lauraceae
Pisi	Ocotea neesiana	Lauraceae
Pisi (waikara)	Aniba taubertiana	Lauraceae
Pisi (waikara)	Endlicheria multiflora	Lauraceae
Pisi (waikara)	Aniba williamsii	Lauraceae
Pisi, Bamba-	Ocotea cymbarum (= Ocotea barcellensis)	Lauraceae
Pisi, Bronsbladige	Endlicheria bracteolata	Lauraceae
Pisi, Gele	Aniba kappleri	Lauraceae
Pisi, Grootbladige Zwarte	Rhodostemonodaphne praeclara (= Nectandra grandis)	Lauraceae
Pisi, Kaneel-	Aniba megaphylla	Lauraceae
Pisi, Kaneel-	Licaria guianensis	Lauraceae
Pisi, Kaneel, Grootbladig	Licaria vernicosa	Lauraceae
Pisi, Kleinbladige zwarte /Grootbladige?	Ocotea glomerata	Lauraceae
Pisi, Kras-	Ocotea puberula	Lauraceae
Pisi, Langbladige zwarte	Rhodostemonodaphne kunthiana (= Nectandra kunthiana)	Lauraceae
Pisi, onbekend	Mezilaurus itauba	Lauraceae
Pisi, Papaya	Ocotea oblonga	Lauraceae
Pisi, Sabana-	Ocotea schomburkgiana	Lauraceae
Pisi, Waikara	Aniba hostmanniana	Lauraceae
Pisi, Wana-	Ocotea splendens (= Ocotea globifera)	Lauraceae
Pisi, Witte	Ocotea petalanthera	Lauraceae
Pisi, Zilver- / Yoroyoro-pisi	Ocotea guianensis	Lauraceae
Pisi, Zwarte Langbladige	Nectandra globosa (= Nectandra pisi)	Lauraceae
Posentri	Hura crepitans	Euphorbiaceae
Powisipepre	Myrcia splendens	Myrtaceae
Powisitere	Rhabdodendron amazonicum	Rhabdodendraceae
Prasara-udu	Guapira cuspidata	Nyctaginaceae
Prasara-udu	Guapira eggersiana	Nyctaginaceae
Prasara-udu	Neea floribunda	Nyctaginaceae
Prasara-udu	Pisonia sp.	Nyctaginaceae
Prasara-udu, Kleinbladige	Guapira salicifolia	Nyctaginaceae
Prasara-udu, Kleinbladige	Neea ovalifolia	Nyctaginaceae
Prasara-udu, Kleinbladige	Guapira sp.	Nyctaginaceae
Pritiyari	Zanthoxylum pentandrum (= Fagara pentandra)	Rutaceae
Pritiyari, Witte	Zanthoxylum flavum (= Fagara flavum)	Rutaceae

Vernacular species name	**Botanical species name**	**¨Plant family**
Prityari	Zanthoxylum rhoifolium (= Fagara pentandra)	Rutaceae
Prityari, Zwarte	Lacmellea aculeata	Apocynaceae
Prityari, Zwarte	Zanthoxylum sp.	Rutaceae
Prokoni, Rode	Inga alba	Mimosaceae
Prokoni, Witte	Inga leiocalycina	Mimosaceae
Pruim, Zwamp-	Chrysobalanus icaco	Chrysobalanaceae
Puperhart, Alastan / Purperhart, Man-	Peltogyne paniculata (= P. pubescens)	Caesalpiniaceae
Purperhart	Peltogyne venosa	Caesalpiniaceae
Rafrunyanyan	Sloanea guianensis	Elaeocarpaceae
Rafrunyanyan	Sloanea parviflora	Elaeocarpaceae
Rafrunyanyan	Sloanea eichleri	Elaeocarpaceae
Rafrunyanyan, Grootbladige	Sloanea robusta	Elaeocarpaceae
Rafrunyanyan, Grootbladige	Sloanea rufa	Elaeocarpaceae
Rafrunyanyan, Grootbloemige	Sloanea grandiflora	Elaeocarpaceae
Rafrunyanyan, Kleinbladige	Sloanea garckeana	Elaeocarpaceae
Rafrunyanyan, Kleinbladige	Sloanea sp.	Elaeocarpaceae
Rafrunyanyan, Midden(lang)blad	Sloanea sp.	Elaeocarpaceae
Rafrunyayan, Grootblad(ige)	Sloanea brevipes	Elaeocarpaceae
Randia (boom)	Randia sp.	Rubiaceae
Redi-udu (no stipulae)	Calyptranthes speciosa	Myrtaceae
Redi-udu met stipulae	Quiina obovata (= Quiina oblanceolata)	Quiinaceae
Redi-udu, Grootbladige	Lacunaria jenmani	Quiinaceae
Redi-udu, Kleinbladige	Lacunaria crenata (= Quiina crenata)	Quiinaceae
Riemhout, Witte, Wetilo-udu	Micropholis guyanensis var. guyanensis	Sapotaceae
Riemhout, Zwarte /Blakalo-udu	Micropholis guyanensis var. commixta	Sapotaceae
Riemhout, Zwarte grootbladige	Pouteria engleri	Sapotaceae
Riemhout, Zwarte lang blad	Pouteria brachyandra	Sapotaceae
Rozenhout	Aniba parviflora	Lauraceae
Rozenhout, Echte	Aniba rosaeodora (= Aniba duckei)	Lauraceae
Rozenhout, Man-	Aniba panurensis (= Aniba mas)	Lauraceae
Ryania	Ryania sp.	Flacourtiaceae
Sabana Dyedu	Sclerolobium sp.	Caesalpiniaceae
Sabicea	Sabicea glabrescens	Rubiaceae
Sali, Rode	Tetragastris altissima	Burseraceae
Sali, Witte	Tetragastris sp.	Burseraceae
Santi-udu	Licania ovalifolia	Chrysobalanaceae
Satijnhout	Brosium rubescens (= B. paraënse)	Moraceae
Savanna-zuurzak	Annona sp.	Annonaceae
Savannekers	Myrcia guianensis	Myrtaceae
Sawarinoto	Caryocar nuciferum	Caryocaraceae
Sedre, Ceder	Cedrela odorata	Meliaceae
Sergeantskloot / Sponshout	Licania macrophylla	Chrysobalanaceae
Sinya-udu	Chimarrhis turbinata	Rubiaceae
Slangenhout, Hoogland en Gewone	Loxopterygium sagotii	Anacardiaceae
Sopo-udu	Abarema jupunba (= Pithecellobium jupunba)	Mimosaceae

Vernacular species name	Botanical species name	¨Plant family
Sopo-udu, Gladde bast	Caryocar glabrum	Caryocaraceae
Sopo-udu, Ruwe bast	Caryocar microcarpum	Caryocaraceae
Sorosali	Trichilia surinamensis	Meliaceae
Sorosali	Trichilia micrantha (= Trichilia roraimana)	Meliaceae
Sorosali	Trichilia quadrijuga	Meliaceae
Sowtumeti-udu	Maytenus myrsinoides	Celastraceae
Sowtumeti-udu, Dikke bast	Maytenus sp.	Celastraceae
Spikri maka, pranasi	Chomelia tenuiflora (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Rubiaceae
Spikri-udu	Mouriri collocarpa	Melastomataceae
Spikri-udu	Mouriri sagotiana	Melastomataceae
Spikri-udu	Mouriri sideroxylon	Melastomataceae
Spikri-udu	Mouriri crassifolia	Melastomataceae
Spikri-udu drasbos	Mouriri grandiflora (= Mouriri princeps)	Melastomataceae
Spikri-udu hoogbos	Mouriri nigra	Melastomataceae
Spikri-udu kreekbos	Mouriri sp.	Melastomataceae
Spikri-udu zwamp	Mouriri acutiflora	Melastomataceae
Srebebe	Iryanthera hostmanni	Myristicaceae
Sumaruba	Simarouba amara (= Quassia simarouba)	Simaroubaceae
Swit'anini	Chrysophyllum sanguinolentum	Sapotaceae
Switbonki	Inga acreana	Mimosaceae
Switbonki	Inga cinnamomea	Mimosaceae
Switbonki	Inga capitata	Mimosaceae
Switbonki	Inga auristellae	Mimosaceae
Switbonki	Inga graciliflora	Mimosaceae
Switbonki	Inga splendens	Mimosaceae
Switbonki	Inga thibaudiana	Mimosaceae
Switbonki with stipulae	Inga stipularis	Mimosaceae
Switbonki, Behaarde	Inga ingoides	Mimosaceae
Switbonki, Behaarde	Inga pilosula	Mimosaceae
Switbonki, gevleugelde bladas	Inga umbellifera	Mimosaceae
Switbonki, Grootbladige	Inga rubiginosa	Mimosaceae
Switbonki, Kapuweri	Inga disticha	Mimosaceae
Switbonki, Kleinbladige	Inga heterophylla	Mimosaceae
Switbonki, Langbladige / kleinbladige?	Inga lateriflora	Mimosaceae
Switbonki, Muserki	Inga bourgonii	Mimosaceae
Switbonki, Rode bast	Inga pezizifera	Mimosaceae
Switbonki, Rode bast / lianenpeul??	Inga marginata (= Inga semialata)	Mimosaceae
Switbonki, Tamarin	Inga sp.	Mimosaceae
Switbonki, Witte bast	Inga alata	Mimosaceae
Switbonki, Witte bast	Inga acrocephala	Mimosaceae
Switi lemki	Triphasia trifolia	Rutaceae
Tabakabron	Croton matourensis	Euphorbiaceae
Tabakabron, Liba	Croton cuneatus	Euphorbiaceae
Tafrabon	Cordia fallax	Boraginaceae
Tafrabon	Lepidocordia punctata	Boraginaceae
Tafrabon, Hoogland	Cordia sagotii	Boraginaceae
Tafrabon, Knopo-, Mira-	Cordia nodosa	Boraginaceae
Tafrabon, Laagland	Cordia tetrandra	Boraginaceae

Vernacular species name	**Botanical species name**	**¨Plant family**
Tafrabon, Laagland	Cordia sercicalyx	Boraginaceae
Takina	Brosimum acutifolium	Moraceae
Tamarin, Hoogbos	Pithecellobium sp.	Mimosaceae
Tamarin, Zwamp	Pithecellobium sp.	Mimosaceae
Tamarin-prokoni	Enterolobium schomburgkii	Mimosaceae
Tamarin-prokoni	Balizia pedicellaris (= Pithecellobium pedicellaris, Macrosamanea pedicellaris)	Mimosaceae
Tamarin-prokoni	Hydrochorea gonggrijpii	Mimosaceae
Tapuripa	Genipa americana	Rubiaceae
Tapuripa, Bergi-	Pouteria speciosa	Sapotaceae
Taya udu	Amphirrhox longifolia	Violaceae
Taya udu	Paypayrola longifolia	Violaceae
Taya-udu	Paypayrola sp.	Violaceae
Taya-udu, Geelbloemige	Sagotia racemosa	Euphorbiaceae
Taya-udu, Geelbloemige	Paypayrola guianensis.	Violaceae
Taya-udu, Grootbladlige	Paypayrola sp.	Violaceae
Taya-udu, Kleinbladige	Paypayrola sp.	Violaceae
Taya-udu, Langbladige	Paypayrola sp.	Violaceae
Taya-udu, Roodbloemige	Paypayrola sp.	Violaceae
Taya-udu, Roodbloemige	Sagotia sp.	Euphorbiaceae
Taya-udu, Witbloemige	Rinorea sp.	Violaceae
Taya-udu, Zwarte	Pausandra martinii	Euphorbiaceae
Tete-udu, Gele bast	Lecythis poiteaui = (Eschweilera poiteaui)	Lecythidaceae
Tete-udu, Rode bast	Eschweilera sp.	Lecythidaceae
Tete-udu, Witte bast	Eschweilera simiorum	Lecythidaceae
Tete-udu, Witte bast / Snekibita	Lecythis chartacea (=Eschweilera charteacea)	Lecythidaceae
Tingimoni	Protium crassipetalum	Burseraceae
Tingimoni	Protium decandrum	Burseraceae
Tingimoni / Aluwa pisi	Trattinnickia demerarae	Burseraceae
Tingimoni / Aluwa pisi	Trattinnickia rhoifolia	Burseraceae
Tingimoni onbekende	Protium glabrescens	Burseraceae
Tingimoni, Ayawa / Aluwa pisi	Trattenickia burserifolia	Burseraceae
Tingimoni, Getande-	Crepidospermum rhoifolium (= Hemicrepidospermum rhoifolium)	Burseraceae
Tingimoni, Grootbladige	Protium robustum	Burseraceae
Tingimoni, Grootbladige	Protium tenuifolium (= Protium neglectum)	Burseraceae
Tingimoni, Harde bast	Protium sagotianum	Burseraceae
Tingimoni, hoogbos	Protium guianense (Protium hostmannii)	Burseraceae
Tingimoni, Rode bast, hoogbos	Protium polybotryum	Burseraceae
Tingimoni, Sabana	Protium heptaphyllum	Burseraceae
Tingimoni, Savanna	Protium aracouchini	Burseraceae
Tingimonisali	Tetragastris panamensis	Burseraceae
Tingimonisali hoogbos savanne	Tetragastris tenuifolium ((naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht, wel Protium tenuifoium)	Burseraceae
Tingimonisali, Hoogbos savanne	Tetragastris hostmannii	Burseraceae
Tjintjin udu	Cinchona cf microcarpa (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Rubiaceae
Tonka	Dipteryx odorata	Fabaceae
Tonka	Dipteryx punctata	Fabaceae

Vernacular species name	**Botanical species name**	**¨Plant family**
Umabarklak	Eschweilera congestiflora	Lecythidaceae
Umabarklak, Bergi-, Gele bast	Lecythis idatimon (= Eschweilera amara)	Lecythidaceae
Umabarklak, Dwerg-	Corythophora labriculata	Lecythidaceae
Umabarklak, Hoogland (bergi)	Lecythis corrugata (= Eschweilera corrugata)	Lecythidaceae
Uma-udu	Casearia javitensis	Flacourtiaceae
Uma-udu, Kleinbladige	Casearia commersoniana	Flacourtiaceae
Walaba	Eperua falcata	Caesalpiniaceae
Walaba	Eperua schomburgkiana	Caesalpiniaceae
Walaba, Kleinbladige / Babunwalaba	Eperua grandiflora	Caesalpiniaceae
Walaba, Oever-	Eperua rubiginosa	Caesalpiniaceae
Walatapa	Macrolobium angustifolium	Caesalpiniaceae
Wana	Sextonia rubra (= Ocotea rubra)	Lauraceae
Watra bebe soort	Paloue guianensis (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Fabaceae
Watrabiri	Crudia glaberrima	Caesalpiniaceae
Watrabiri, Hoogland	Macrolobium sp.	Caesalpiniaceae
Watrakakaw	Pachira aquatica (= Bombax aquaticum)	Bombacaceae
Wetilo-Abi	Lecythis pisonis (=Eschweilera pisonis) (naam komt niet voor in V&S-lijsten Olaf Banki - Utrecht)	Lecythidaceae
Weti-udu / Jamaica siri	Tapirira guianensis	Anacardiaceae
Wit riemhout/ Lo-udu	Micropholis venulosa	Sapotaceae
Yakanta, Gele bast	Hebepetalum humiriifolium (wel in S-lijst, niet in V-lijst Olaf Banki)	Hugoniaceae
Yakanta, Gele bast	Por~~o~~aqueiba guianensis	Icacinaceae
Yakanta, Rode bast	Dendrobangia boliviana	Icacinaceae
Yakanta, Witte bast	Discophora guianensis	Icacinaceae
Yamboka, Rode / Jan Snijder	Pouteria guianensis	Sapotaceae
Yamboka, Rode / Jan Snijder	Pouteria hispida	Sapotaceae
Yamboka, Zwarte / Dyu-boletri	Pouteria melanopoda	Sapotaceae
Yarakopi	Siparuna surinamensis	Monimiaceae
Yarakopi	Siparuna guianensis	Monimiaceae
Yarakopi, Grootbladige	Siparuna sp.	Monimiaceae
Yarakopi, Man-	Siparuna cuspidata	Monimiaceae
Yariyari	Duguetia neglecta	Annonaceae
Yariyari	Fusaea longifolia	Annonaceae
Yariyari	Unonopsis guatterioides	Annonaceae
Yariyari	Unonopsis glaucopetala	Annonaceae
Yariyari, Avanavero	Duguetia pycnastera	Annonaceae
Yariyari, Gele bast	Duguetia calycina	Annonaceae
Yariyari, Gele bast	Duguetia surinamensis	Annonaceae
Yariyari, Gele bast	Duguetia yeshidan	Annonaceae
Yariyari, Langbladige	Unonopsis sp.	Annonaceae
Yariyari, Witblad	Duguetia inconspicua	Annonaceae
Zwampzuurzak	Annona glabra	Annonaceae

Annex 14: Measurement protocol for the permanent plots

Opzetten van permanente sample plots voor biomassa monitoring

Het monitoren van bosdynamiek is essentieel om de effecten van bosactiviteiten te meten, om klimaatseffecten te bepalen en om beleid hierop te baseren. Om biomassa en veranderingen in bossen betrouwbaar te monitoren zijn permanente sample plots (PSPs) nodig. Hierin wordt de bosdynamiek herhaaldelijk gemeten (bijv. met tijdsintervallen van 5 jaar). Dit document beschrijft hoe PSPs opgezet en gemeten dienen te worden voor het verzamelen van data die gebruikt kunnen worden voor bovengenoemde doelen, met een focus op een eventueel toekomstig REDD+-programma. Uit de data kan een carbon stock worden berekend.

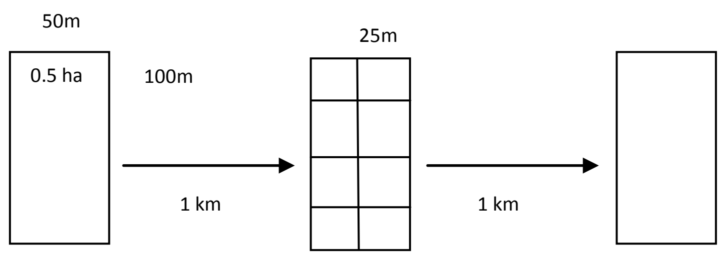
KAPPEN, HAKKEN OF ANDERSZINS VERNIELEN VAN BIOMASSA IN DE PLOTS IS NIET TOEGESTAAN

Dit geldt alleen voor de veldmedewerkers die de plot opzetten en niet voor de concessiehouder die later bomen wil omzagen. De plots worden opgezet om biomassa te monitoren zodat carbon stock bepaald kan worden. Hakt men biomassa weg tijdens het opzetten en meten, dan hakt men koolstof weg en verstoort men tevens de natuurlijke dynamiek van het bos omdat meestal zaailingen en jongen bomen worden weggehakt. Vegetatie die het werk ernstig hindert, mag wel worden verwijderd.

Plot design

Er zijn verschillende designs mogelijk. In Suriname wordt een design aangehouden die veel overeenkomsten vertoond met die van RAINFOR (Amazon Forest Inventory Network).

Er worden op elke locatie 3 deelplots opgezet van elk 0.5 ha. Samen vormen zij de PSP van een locatie (1.5 ha), ook wel een transect genoemd. Elke deelplot ligt 1 km verwijderd van de vorige (gemeten aan de linkeronderhoek) om variatie in vegetatie en bodem te kunnen meten. De afmetingen zijn 50 x 100 m, onderverdeeld in subplots van 25 x 25 m. Dit formaat is geschikt om bosdynamiek te meten.



In het gehele deelplot (5000 m^2) worden bomen van 20 cm in dbh en groter gemeten. In 2 willekeurig gekozen subplots per deelplot (1250 m^2 per deelplot) worden ook bomen tussen 5 en 20 cm gemeten.

Het handigst is om eerst de basislijn (linksonder naar rechtsonder) uit te zetten en vervolgens daarop de gehele middellijn. Vanuit de middellijn kan men naar links en rechts lijnen uitzetten. Vervolgens meet men vanuit linksboven en rechtsboven naar linksonder en rechtsonder toe, om te controleren of alle subplots 25 bij 25 m zijn. In een dicht bos kan men met meerdere tussenpaaltjes met flagging tape werken.

Aantal plots en locatie

De plots moeten elk bostype, bodemtype en combinaties daarvan bedekken. Er zullen meer plots opgezet moeten worden in gebieden met veel verstoring maar men kan er wat minder opzetten in rustige gebieden met weinig/geen verstoring. Stratificatie kan gedaan worden met de forest cover map, aangevuld met andere bronnen.

Bij voorkeur vallen alle deelplots in hetzelfde bostype, maar waar dit niet mogelijk is, zou in ieder geval het gehele deelplot binnen 1 bostype moeten vallen.

Voor alle plots geldt dat de monitoring ervan een volledig, realistisch en betrouwbaar beeld moet geven van de biomassa en bosdynamiek in Suriname. Plots moeten daarom net zo behandeld worden als andere delen van het bos. Dus als een plot in een concessie ligt en de concessiehouder wil bomen kappen, dan mag dat. Ook als een plot verdwijnt door mijnbouw, dan is dat geen probleem voor de metingen. Dit geeft een realistische biomassa verandering weer.

Plot data

Van elke plot wordt genoteerd in welk bostype en op welk bodemtype zij liggen. Hiervoor worden standaard classificaties gebruikt zoals die bekend zijn in Suriname (de classificatie van Lindeman wordt gehanteerd). Eveneens wordt een algemene beschrijving van het terrein opgenomen in termen van hoogte boven zeeniveau, helling, natheid, type en mate van verstoring, etc.

De helling kan men bepalen door op een stok een flagging tape te hangen, op ooghoogte van de persoon die de meting gaat verrichten. Iemand anders gaat verderop staan met de stok op de grond en de meter noteert de hoogte van de flagging tape in procenten (met de clinometer). Meet altijd omhoog. Je noteert dan altijd een positief getal.

Plot markering

De plots dienen een grondoppervlakte te hebben van 1.5 ha. Dit betekent dat wanneer men op een helling werkt, de plot dusdanig wordt opgezet zodat er de afmetingen correct zijn als zij op een horizontaal vlak zouden worden geprojecteerd.

Transect en plotnummering

Drie deelplots bij elkaar noemt met een transect. Elk transect krijgt een uniek nummer, beginnend bij 1. Het meest noordelijk deelplot krijgt nummer 1. Als plots op een west-oost lijn zijn gepositioneerd dan krijgt het meest westelijke deelplot nummer 1. Het middelste deelplot is 2, gevolgd door 3.

Elke deelplot is verdeeld in 8 subplots. De subplots krijgen een kolomletter en een nummer, zoals hieronder aangegeven:

Deelplot 1:

A4	B4
A3	B3
A2	B2
A1	B1

Plot geo-referencing

Van elke linkeronderhoek hoek van elke deelplot worden de coördinaten genoteerd mbv GPS. Als een dik kronendak een meting verhindert, loopt men naar de dichtstbijzijnde open plek voor een meting. Vervolgens wordt de afstand en de richting tot de linkeronderhoek van het deelplot gemeten en genoteerd.

De linkeronderhoeken van elke deelplot worden voor vertrek naar het veld bepaald. In het veld wordt de exacte locatie opgezocht mbv GPS. Als de hoek op een plek valt waar moeilijk te meten is, bijv. in een riviertje, of een steil rotsenblok, of een opgevallen boom, dan verhuist men de plothoek enigszins. Ook als er een grote boom precies op de hoek staat mag men de hoek iets verplaatsen. Het is niet erg als de LOH's van de 3 deelplots niet exact op 1 km afstand van elkaar liggen. Ligt de LOH op een regenererend stuk bos, bijv op een oude sleepweg, en hoort dit bij het bostype omdat er gekapt is in het verleden, dan verplaats je de LOH niet. De LOH kan niet op een log landing geplaatst worden aangezien dit niet geclassificeerd wordt als bos.

<u>Hoek bepalen en lijnen uitzetten</u>

Zodra de linkeronderhoek gevonden is markeert men deze met een PVC buis van ongeveer 1.5 m lengte met rood geverfde top (30-40 cm). De buis moet stevig in de grond worden bevestigd. De buis moet worden gemarkeerd met het transect nummer (Tx) en het deelplotnummer (DP 1,2 of 3). Vervolgens schrijft men LOH op de buis (linker onder hoek). De opschriften moeten met een goede zwarte watervaste marker van voldoende formaat worden geschreven.

Op de andere 3 hoekpunten zet men ook buizen in de grond met een rode top en een opschrift zoals hierboven beschreven is. In plaats van LOH noteert men LBH (linker boven hoek), RBH (rechter boven hoek) of ROH (rechter onder hoek). Subplots markeert men met dunnere PVC buizen. Elke buis in de linkeronderhoek van een subplot krijgt het subplotnummer (dus de LOH buis van elk deelplot bevat ook het subplotnummer). De subplotbuizen aan de rechterkant van de deelplot krijgen geen nummer. Eventueel kan met alle buizen voorzien van aluminium labels, voor het geval de verf/stift eraf gaat.

Omdat het grondoppervlakte van elke deelplot precies 0,5 ha moet zijn, moet er in geval van helling gecorrigeerd worden. Dit kan heel eenvoudig in het veld gebeuren door ervoor te zorgen dat de meetband altijd precies horizontaal gehouden wordt. Indien dit niet mogelijk is over de gehele lengte van 25m kan in kleinere stukken gemeten worden. Hierbij is het wel noodzakelijk dat het begin en eindpunt van elke meting precies samenvallen.

Markeren en meten van grote levende bomen

<u>Soortidentificatie</u>

De boomsoorten zouden idealiter een wetenschappelijke naam moeten krijgen tot op soortniveau. Bij gebrek aan kennis hiervan noteert men de lokale naam *zo volledig en eenduidig mogelijk*. Gebruik eenduidige spelling zoals die beschreven zijn in lijsten van het herbarium. Als men een naam niet weet, noteert met een '?' en verzamelt men bladmateriaal en maakt men foto's voor identificatie in het herbarium. Als men meerdere onbekende individuen tegenkomt van eenzelfde soort dan noteert men dit maar er wordt maar 1 monster meegenomen.

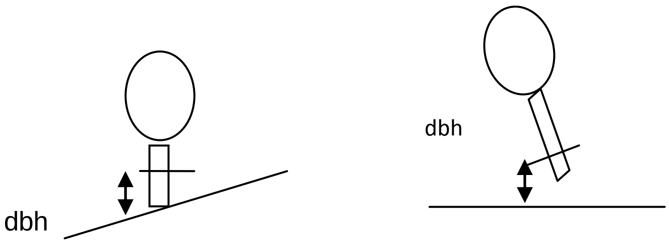
<u>Markeren en meten van grote bomen</u>

In het gehele deelplot worden alle bomen van 20 cm en groter gelabeld en gemeten. Begin in de linkeronderhoek van elke subplot met nummer 1 en nummer door in de volgende subplots wanneer een subplot af is. Je werkt van A1 naar A4 en dan terug van B4 naar B1.

Wanneer een boom deels buiten de plots lijkt te vallen kijkt men naar de stam op grondhoogte. Staat deze voor meer dan de helft in de plot dan telt hij mee. Zo niet, dan telt hij niet mee. Is het echt niet te zien, tel dan oneven nummers niet mee, even nummers wel.

Bomen worden gemeten op 1.3 m langs de stam. Er kunnen stokken van 1.3 m gebruikt worden ter verificatie. dbh wordt genoteerd. Als een boom een plankwortel heeft, meet dan 0.5m boven de plankwortel. Bevindt dit punt zich te hoog, dan moet men een schatting maken van de diameter. Voor het meten moet altijd losse schors worden verwijderd. Schattingen maken doet met aan 2 kanten, waarvan vervolgens het gemiddelde genoteerd wordt op het formulier. Ook als een boom fluted is, of wanneer het anderszins niet mogelijk is om op dbh te meten, maakt men een schatting (altijd aan 2 kanten!). Noteer op het formulier dat het een schatting is en de reden waarom.

Bomen op een helling worden gemeten aan de lage zijde van de helling. Bomen die scheef staan worden gemeten aan die kant die het dichts bij de grond zit.



Daar waar men diameter meet, wordt een klein streepje met krijt gezet (*maar maak geen incisie met een machete*). De tape wordt over het krijt geplaatst tijdens het meten. Vervolgens wordt er een band geverfd (met rode olieverf) over de plaatst waar is gemeten (dus over het krijt). Een aluminium (of calvan) label wordt met een spijker bevestigd 30 cm boven de dbh. De spijker slaat men omhoog de stam in. Het nummer wordt ook op de boom geverfd, boven het meetpunt. Binnen een subplot markeert men alle bomen aan dezelfde kant. In aangrenzende subplots markeert men aan een andere kant zodat later te zien is waar de scheiding tussen subplots loopt.

Als een boom gevorkt is beneden 1.3 m dan kan het gezien worden als 2 bomen. Beide bomen worden dan gemeten en gelabeld. Als de boom vorkt boven 1.3 m dan is het 1 boom.

Als er zich vergroeiingen of takken bevinden op het meetpunt, meet dan net erboven. Noteer het meetpunt op het formulier. Noteer ook waarom er afwijkend gemeten is.

Boomkwaliteit

Het opnemen van de boomkwaliteit is in principe niet nodig voor het berekenen van koolstof maar het geeft wel extra informatie over de bomen in de plots. Het sample plot formulier bevat een aantal kolommen waar verschillende aspecten van de boomkwaliteit ingevuld kunnen worden. Het gaat om het volgende (terminologie is in het Engels om internationale standaarden aan te kunnen houden): *stem straightness, forking, decay, crown health, logging damage, fire damage*. Pas deze scores niet toe op dode bomen. De verschillende aspecten worden op onderstaande manier gescoord:

<u>Stem straightness</u>: (1) 100% of length straight up to the point of crown break; (2) more than half of stem straight, rest with sweep or curvature; (3) approximately half of stem with sweep or curvature; (4) largely malformed, less than half of bole straight; (5) No straight sections to the bole at all.

<u>Forking</u>: (1) There is no forking below the crown; (2) forking occurs above 4 m (3) Forking occurs between dbh and 4 m (4) Forking occurs below dbh (measure as 2 trees) (5) Forking occurs from ground level (measure as 2 trees)

<u>Decay:</u> (1) There is no evidence of decay; (2) The stem sounds hollow, but no external decay; (3) There is some external evidence of decay at the base or upper part of the stem; (4) Extensive external evidence of decay and fungal fruiting bodies; (5) Whole stem severely decayed, tree may be partially broken, largely moribund, but with some green foliage or epicormic growth.

<u>Crown Health</u> (1) Crown green and healthy, with no sign of dieback; (2) Limited dieback on a few branches; (3) About half of the crown appears healthy (4) Extensive evidence of dead branches in the crown, less than half is healthy OR crown was (partly) destroyed but new branches are growing (5) Crown appears entirely dead.

Logging damage (1) No sign of logging damage; (2) Minor bark or crown damage; (3) More extensive damage, whole branches broken in crown, or areas of bark stripped off over lengths of 1-2 m on stem; (4) Severe logging damage, half crown broken, buttresses and base of tree severely damaged, bark stripped off over lengths of more than 2 m; (5) Crown completely broken, or with few minor branches intact.

Fire damage (1) No fire damage; (2) Light charring on bark on lower 2 m of bole; (3) Heavy charring extending more than 2 m up bole, burnt wood exposed at base of tree. (4) Base of tree severely burnt, charring up whole of tree into the crown; (5) Extensive burning of wood (not just bark) on bole and branches.

Markeren en meten van kleine levende bomen

Zodra men klaar is met het meten van de grote bomen in een subplot, begint men met het meten van kleine bomen (tussen 5 en 20 cm in diameter) in 2 subplots in totaal per deelplot. De meetprocedures en het markeren zijn gelijk aan die van de grote bomen, alleen hoeft er niks over de kwaliteit genoteerd te worden. Als de boom erg smal is kan het nummer vertikaal geverfd worden ipv horizontaal.

De nummering van de kleine bomen begint volgend op het laatste nummer van de grote bomen in het betreffende subplot. Na het meten van de kleine bomen nummert men weer door met de grote bomen in het volgende subplot.

Als na afronding van het deelplot blijkt dat een boom is gemist, dan krijgt deze een 3 voor het nummer van de dichtstbijzijnde andere boom. Dus heeft de dichtstbijzijnde boom nummer 65, dan krijgt de gemiste boom nummer 365 (of een 4 of hoger als er al honderden bomen gemeten zijn).

Kaart van levende bomen

Na of tijdens het meten van grote en kleine bomen wordt er per subplot een kaartje getekend met de locaties van alle bomen.

Dode bomen

Tijdens het meten van bomen in een subplot, dient men dode bomen van 5 cm dikte of meer te meten. dbh wordt gemeten waar mogelijk. De hoogte wordt geschat. Is de boom afgebroken, meet dan tot waar de afbraak van de stam meer dan 50% beslaat. Als de stomp lager is dan 1.3 m, meet dan de diameter op de helft van de hoogte van de stomp. Bomen die lager hangen dan 45˚ worden beschouwd als dood hout wat op de grond ligt (zie manual over het verzamelen van necromass en bodem). Dode bomen krijgen geen nummer of label en worden apart genoteerd op het formulier. Markeer de stomp na het meten om dubbel meten te voorkomen.

Wanneer een stronk spruiten heeft worden deze spruiten gemeten als ze een dbh groter hebben dan de onderdbh van het subplot dat gemeten wordt. Aangezien de stronk zelf zal verrotten wordt deze, hoewel ze niet echt dood is; toch als staand dood hout opgenomen.

Gekapte bomen

Gekapte boomstronken dienen op naam gebracht te worden en ze worden gemeten op diameter en hoogte.

Palmen

Van palmen wordt ook de naam genoteerd, en de stamhoogte (van de grond tot waar de kroon ontspringt). Als men niet de stamlengte kan meten, moet er een schatting gemaakt worden. Bij houtige palmen die wel een stam maken, noteert men tevens de diameter op dbh. Palmen worden gemeten als zij >20 (alle subplots) of >5 cm dik (in 2 subplots) zijn. Noteer een P op het veldformulier bij in de kolom ‘remarks’. Als er geen ruimte is om stamhoogte in te vullen, vul dat dan verderop op de betreffende regel in. Als de lengte van de stam kleiner is dan 1,3m neem je hem niet mee in de PSP, maar wordt hij meegenomen in de kwadranten.

In het geval van bugrumaka, of palmen met eenzelfde groeiwijze, worden de individuen met een stam (met bladschedes of niet) op 1.30m hoogte meegenomen in de metingen. In dit geval kan je er vanuit gaan dat de stam op 1.30m groter is dan 5cm. Vormt de palm geen stam op 1.30m, dus als hij nog kleiner is, neem hem dan niet mee.

Lianen en andere klimmende planten

Klimmende planten en vooral lianen, slingeren van boven naar beneden door het kronendak maar hebben een beginpunt ergens op de grond (waar zij wortelen). In de PSP worden tijdens het meten van de grote bomen en staand dood hout, ook de klimmende planten meegenomen. Van elke klimmer wordt op 1.3 m boven de wortels de diameter gemeten (met een caliper indien dbh kleiner dan 5cm, met een diametermeetband voor dbh vanaf 5cm, op 1.3 m gemeten *langs* de liaan). Neem hierbij elke klimmende stam mee die onafhankelijk in de plot in de grond geworteld is, ook al is het 1 individu die meerdere keren wortelt. Meet alleen de klimmers groter dan 2 cm in diameter. Als het een platte liaan betreft, meet dan twee keer de diameter: een keer aan de smalle kant en een keer aan de brede kant, en middel de diameters. Als de stam niet-houtig is of geen liaan is, noteer dit dan op het formulier. De lianen hoeven niet permanent gemarkeerd te worden (wel tijdelijk om dubbelmetingen te voorkomen).

Onderstaand plaatje verduidelijkt de metingen:

Source: Gerwing et al (2006); Schnitzer et al (2008)

(A) Measure the diameter of all lianas (>2 cm) 130 cm from the main rooting point at the soil surface.

(B) Measure twining lianas 130 cm from the rooting point, along the stem of the liana.

(C) If lianas branch below 130 cm (but >40 cm from the roots), measure 20 cm below the branching point.

(D) If lianas loop to the ground and root before ascending into the canopy, ignore the loop and measure 130 cm from the last substantial (cannot be easily dislodged) rooting point along the stem that ascends into the canopy.

(E) If lianas loop to the ground and root (as in D), but the loops have branches that ascend to the canopy, measure each rooted ascending stem of the individual separately and use the multiple stem datasheet.

(F) If lianas have aerial roots >80 cm from the ultimate rooting point of the prostrate stem, measure 50 cm above highest rooted aerial root.

(G) If lianas branch <40 cm from the rooting point, measure each branch of the individual separately at 130 cm above the main rooting point and use the multiple stem datasheet.

(H) Ignore branches <1 cm diameter and measure the principal stem 130 cm from the roots.

(I) Exclude lianas that branch below 130 cm from the roots if none of the stems are >2 cm diameter 130 from the roots.

(J) If a liana branches within 40 cm of the roots, measure each stem (>2 cm) 130 cm from the rooting point. Note that they are branches of a single individual and tag them as multiple stems (see below).

(K) Measure each resprout or branch (>2 cm) 130 cm from the roots of each distinct rooting point.

(L) Exclude“ground-to-ground’’ lianas, those that do not ascend toward the canopy, but rather loop from one rooting spot to another or that are prostrate on the soil without any resprouts or branches, even if they are >2 cm diameter.

(M) Include ‘‘ground-to-ground’’ lianas if they have a resprout or branch, even if the branch is <2 cm diameter. If the branch is <2 cm, measure the principal stem 130 cm from the roots, ignoring the branch. If the branch is >2 cm and within 130 cm of the roots, the point of measurement should be on the ascending branch.

(N) Exclude lianas growing prostrate along the soil if they do not have a stem >2 cm ascending towards the canopy.

(O) Exclude multiple branches that originate within 130 from the main roots if they are smaller than 2 cm in diameter.

(P) Measure 50 cm above the last aerial root if that root is >80 cm from the final rooting location of the stem before the stem ascends to the canopy.

(Q) If the stem is anomalous and not uniform below 130 cm from the roots, measure stem 20 cm above the point where it becomes uniform. If there is no uniform area within reach, measure the stem 130 cm from the roots.

(R) If the stem is flat and wide, include the liana if the mean of its wide and narrow axes is >2 cm.

Hoogtemetingen van de vegetatie (dikte vh kronendak)

In elk subplot wordt een grote boom geselecteerd die representatief is voor de vegetatiehoogte en de dikte van het kronendak. Deze 8 bomen per deelplot worden gemeten op hoogte tot de top van de kroon, mbv een clinometer of een ander soortgelijk instrument. Hoogtemetingen moeten worden gedaan op voldoende afstand zodat een hoek bereikt wordt van 45˚ (100%) of minder. Als de top of bodem van de boom niet goed zichtbaar is, dan moet men een andere meetlocatie zoeken. Zo ook voor de bodem van de boom, of met een extra persoon werken die naast de boom staan met flagging tape op 2m. De hoogte tot de eerste kroontak wordt ook genoteerd. Welke bomen gebruikt zijn voor de hoogtemeting moet genoteerd worden op het formulier. Achteraf moet na berekening van de hoogte nog 2m worden opgeteld.

Deze meting is in principe niet noodzakelijk voor het berekenen van een koolstofgehalte, echter het geeft wel meer informatie over de vegetatie wat kan helpen bij het verklaren van groeipatronen.

Data entry

Na terugkomst uit het veld moeten alle data zo snel mogelijk worden ingevoerd in de computer (Excel of Access file). Ontbrekende data of onduidelijke data moeten worden opgelost.

Data van 1 transect komen in 1 file terecht, met verschillende datasheets. Alle files van 1 transect komen in 1 map terecht die de nummer en naam van het transect draagt (bijv T1- Suma Lumber).

Hermeten

Op dit moment heeft de IPCC nog niet bepaald hoe vaak plots hermeten dienen te worden. Voorlopig kan men uitgaan van een tijdsinterval van 5 jaar. De plots dienen hermeten te worden op ongeveer hetzelfde moment in het jaar als wanneer ze opgezet worden om meetbias te voorkomen.

Van elke boom wordt opnieuw de diameter gemeten op exact dezelfde plek als de vorige keer (rode ring). Het kan zijn dat plankwortels zijn gegroeid tot het meetpunt. In dat geval meet men de oude diameter maar zet men tevens een nieuw punt voor diameter metingen tot daar waar de plankwortel nog niet gegroeid is. De volgende meting vindt plaats op de nieuwe ring.

Er zullen ook bomen te vinden zijn die gemist zijn tijdens de eerste meting. Meet deze en label ze. De groei wordt bepaald adhv andere gegevens (bijv. wetenschappelijk onderzoek). Bomen die tijdens de voorgaande meting niet groot genoeg waren maar nu wel, worden gelabeld en gemeten. Vanaf dat moment worden zij gemonitord.

Referenties

Deze veldhandleiding is gebaseerd op het rapport '*Proposals for a National Forest Biomass Monitoring System in Guyana'* (Alder & Van Kuijk 2009), waarin de volgende referenties zijn gebruikt:

- Alder, D. & Synnott, T.J. 1992 Permanent sample plot techniques for mixed tropical forests. Oxford Forestry Institute, Department of Plant Sciences, University of Oxford, Tropical Forestry Paper 25, 124 pp.
- Alder, D. 1997 Report on a consultancy to the Quintana Roo Forest Management Project. Consultancy Report, 45 pp.
- Brown, S. 1997 Estimating biomass and biomass change of tropical forests: A primer. FAO Forestry Paper 134, 27 pp.
- GOFC-GOLD 2008 Reducing greenhouse gas emissions from deforestation and degradation in developing countries: a sourcebook of methods and procedures for monitoring, measuring and reporting. GOFC-GOLD Report version COP13-2. 108 pp.
- IPCC 2006 Guidelines for National Greenhouse Gas Inventories: Volume 4 - Agriculture, Forestry and Other Land Use. http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html
- Kangas, A. & Maltamo, M. 2006 Forest Inventory: Methodology and Applications. Springer, 363 pp.
- Lowe, R.G. 1992 Volume increment of natural moist tropical forest in Nigeria. EC/Nigeria High Forest Monitoring Plots Project, Federal Department of Forestry, Ibadan, Nigeria. Consultancy Report, 106 pp.
- Merger, E. 2008 Forestry Carbon Standards 2008 - A comparison of the leading standards in the voluntary carbon market and the state of climate forestation projects. A Carbon Positive publication. 72 pp. http://www.carbonpositive.net/
- Pöyry 2008 Supporting Forest Law Enforcement Using Remote Sensing and Information Systems. Consultancy Report 38A09905 10-Jun-08 revision 4, 55 pp.

- Ravindranath, N.H., Ostwald, M. 2008 Carbon Inventory Methods: Handbook for Greenhouse Gas Inventory, Carbon Mitigation and Roundwood Production Projects. Springer, Netherlands. 308 pp.
- Ter Steege, H. 2001 Biomass estimates for forests in Guyana and their use in carbon offsets. Iwokrama Research Report 2001-01, 43 pp.
- VCS 2007 Guidance for Agriculture, Forestry and Other Land Use Projects. Voluntary Carbon Standard. http://www.v-c-s.org.
- Winrock 2008 Efficient biomass measurements and sampling strategies: Lessons learned from the field. Workshop on Designing IPCC Compliant National Biomass Inventories for REDD, Santa Cruz, Bolivia, 27 pp.

No.	**Description**	**Quantity**
1	GPS	2
2	AA Batteries	4 pairs
3	Compass	2
4	Clinometer	2
5	50 m Tape/Chain 100 m tape	2 2
6	Diameter Tape	2
7	PVC Pipes per plot location (For demarcating Plot Boundaries) • 12 (1,5 m length, 5 cm diameter) • 33 (1,5 m length, 2 cm diameter)	12 + 33 + some extra
8	Paint (RED oil based)	4 gals. (cans)
9	Paint Brush 6mm of 8mm	4
10	Aluminum Tags	2 boxes (total 1000)
11	Nails (3''roofing nails)	5 kg
12	Hammer	2
13	Flagging Tape/ Ribbon (preferably pink)	2 rolls
14	Cutlass	2
15	Cutlass File	2
16	Notebook(write-in-rain)	2
17	Pens, Pencils, Markers	4 each
18	Clipboard	3
19	Printed Field Forms	10
20	Plastic Folders	10
21	First Aid Kit	1
22	Snake Bite Kit	1
23	Pencil Sharpener	5
24	chalk	Box
25	Gloves	4 pairs
26	A4 Envelopes	50
27	rope	Min. 2x 25m
28	Digital camera	1 (plus batteries, card)

Equipment needed for 1 plot location, for 1 team

Annex 15: Measurement protocol for the 3mx3m quadrats

Dood hout, zaailingen en bodemmonsters

Naast de permanente plots worden er tijdelijke plots uitgelegd waarin destructief de koolstofvoorraad wordt gemeten. De tijdelijke plots heten quadrats.

Quadrat locatie en design

Per deelplot worden er 4 quadrats uitgelegd, 10 m vanaf elke hoek, zoals afgebeeld in de figuur hieronder. Elke quadrat is 3 bij 3 m.

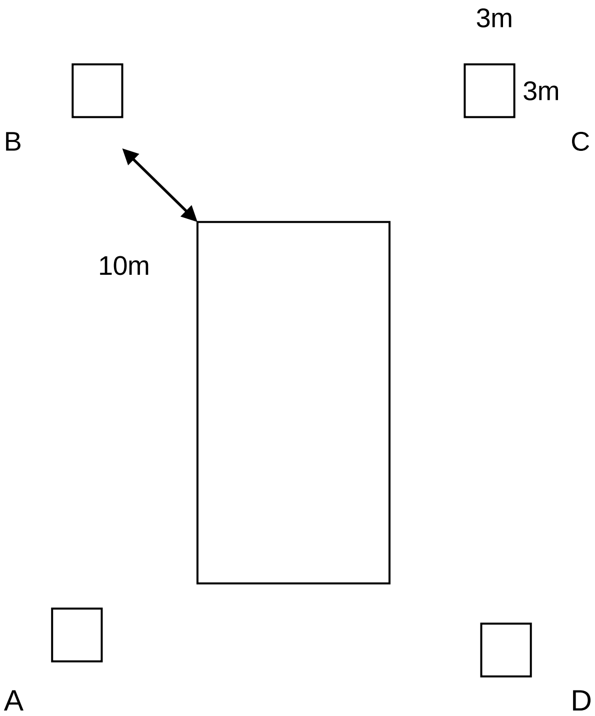


Fig 1 Locatie van de quadrats (niet op schaal)

De quadrats worden genummerd van A tot D, waarbij de meest ZW quadrat de letter A krijgt, en met de klok mee B, C en D. Het volledige quadrat nummer zal dan zijn: TxDPxQx (T= transect, DP= deelplot, Q=quadrat).

De quadrats liggen buiten de PSPs omdat zij destructief worden gemeten. Als zij binnen de PSP zouden liggen dan zouden zij de dynamiek binnen de plot beïnvloeden. De quadrats zijn tijdelijke plots en worden niet hermeten. Als de quadrats toevallig op locaties liggen die moeilijk meetbaar zijn, zoals in een rivier, dan kunnen ze enkele meters verschoven worden op dezelfde lijn, met een vaste afstand (per 5 meter). Als zij op een oude sleepweg vallen, dan mag je ze niet verschuiven aangezien een regenererende sleepweg bij het bostype hoort. De richting mag ook systematisch aangepast worden, maar let erop dat er niet bewust een 'mooie' plek wordt uitgekozen. De quadrant is dan niet meer random gekozen, wat statische analyses moeilijk maakt.

De quadrats zijn 3 bij 3 m. De hoeken en lijnen worden tijdelijk aangeduid met houten paaltjes en touwen. Er mag nog niet worden gelopen in de quadrats tijdens het afzetten. Figuur 2 laat de quadrat in detail zien.

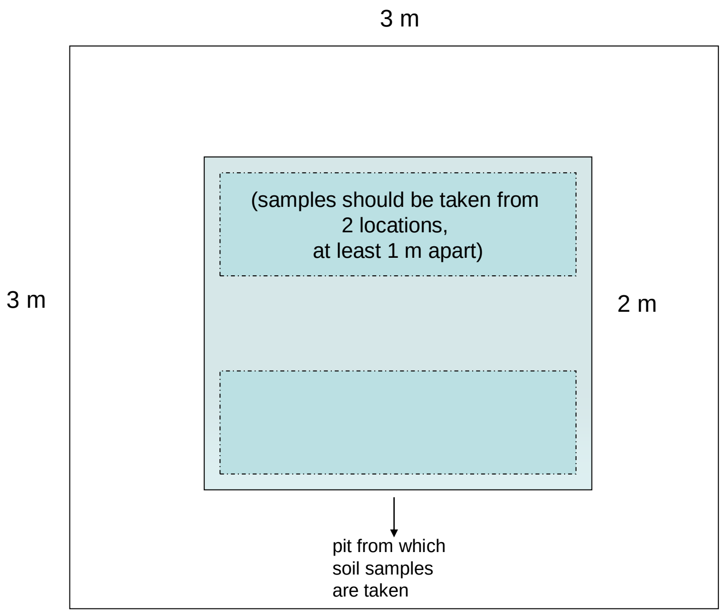


Fig 2 Quadrat design

Destructieve metingen

Beschermende kleding, zoals handschoenen en rubber laarzen, worden aangeraden tijdens dit type werk.

Er betreedt maar 1 persoon de quadrat en die zet zo min mogelijk stappen in het gebied om minimale verstoring te garanderen.

Het destructieve oogsten van kleine planten en dood hout wordt als volgt gedaan:

Kruidachtigen, zaailingen en kleine planten (<5 cm): Deze worden afgeknipt op de bodem en gescheiden in niet-houtig (blad en petiolen) en houtig materiaal. Elk monster wordt apart gewogen en het gewicht wordt genoteerd. Er wordt een subsample genomen van het materiaal zoals verderop beschreven. Kleine lianen (<2cm) die om planten heen geslingerd zitten mogen worden meegenomen. Sample codes: SG (sapling green) en SW (sapling wood). Palmen moeten apart gehouden worden en apart gemonsterd worden.

Grof strooisel (houten delen > 2 cm in diameter): Deze worden verzameld voor zover zij binnen de grenzen van het quadrat liggen. Boomstammen die deels in de quadrat liggen worden doorgezaagd op de exacte grens. Kleinere stukken worden ook afgezaagd of afgeknipt op de grens. Alle materiaal wordt gewogen en vervolgens wordt een subsample genomen. Staand dood hout wordt niet meegenomen (dit wordt al opgemeten tijdens de inventarisatie van de PSPs). Hout wat in de lucht 'hangt' wordt gezien als liggend op de grond, en wordt dus meegnomen. Sample code: CL (coarse litter).

Fijn strooisel en ander klein organisch materiaal: Vier fietsbanden van eenzelfde afmeting (40 cm in doorsnee) worden op de grond gelegd op een random wijze. Fijn strooisel wordt verwijderd binnen de fietsbanden en verzameld als 1 sample. Hiervan wordt een subsample genomen. Sample code: FL (fine litter). Als de quadrant teveel verstoord is door het eerdere werk, gooi de fietsbanden dan ergens buiten het quadrant neer (random).

Paddenstoelen kan men meenemen als biomassa. Ze kunnen bij sapling green worden geplaatst als ze vanuit de grond groeien of bij dood hout als ze daarop groeien.

Als een plant op de lijn staat dan wordt hij meegenomen als de basis van de stam voor meer dan de helft in de plot staat. Anders niet. Als een plant dood materiaal heeft en het zit nog vast, dan wordt het bij SG en SW ingedeeld. Valt het op de grond, dan is het strooisel.

Natte samples worden gewogen in rijstzakken waarvan het gewicht ook telkens genoteerd moet worden,en daarna worden de subsamples verzameld in plastic zakken. Een plakkend label wordt bevestigd onderaan op de plastic zak. Labels moeten geschreven worden met potlood, in het kamp, alvorens men naar het veld gaat. Het label bevat het quadratnummer TxDPxQx met de toevoeging SG, SW, CL of FL. Schrijf aub duidelijk. De zakken worden gesloten mbv een tywrap of ijzerdraad.

Het is onvermijdelijk dat de samples een aantal dagen in het veld bewaard moeten worden voordat zij naar het lab kunnen worden gebracht. Om te voorkomen dat schimmel zich vestigt op de monsters, moeten de zakken in de zon gezet worden, geopend, zodat vocht eruit kan. ’s Avonds moeten de zakken weer gesloten worden anders nemen de monsters weer vocht op. De monsters moeten goed worden bescherm tegen omvallen, wind en regen.

Veel zakken moeten vanuit het veld naar de kamp vervoerd worden en van het kamp naar de stad. Hou hier rekening mee.

Sub-sampling procedure (niet voor bodemmonsters)

Alle biomassa monsters worden in zijn geheel gewogen. Het vochtgehalte van de monsters kan sterk verschillen, daarom rekenen we altijd met drooggewichten. Alle grote monsters worden gesubsampled. Het subsample is minimaal 400 gram, en wordt naar het lab gebracht om te drogen en weer te wegen. Hierdoor kan men een natgewicht-drooggewicht ratio bepalen en zo berekenen hoeveel drooggewicht er in het veld aanwezig was op afgebakende oppervlaktes. Dit wordt geïllustreerd in figuur 3.

--- In het veld meet men het gewicht van de subsample-zak met label, alvorens het subsample erin te doen. Gewicht van zak en label worden telkens vermeld op het formulier maar pas in Excel van het totaalgewicht afgetrokken om rekenfouten in het veld te voorkomen. Het subsample moet min. 400 g zijn, zonder zak en label meegeteld. ---

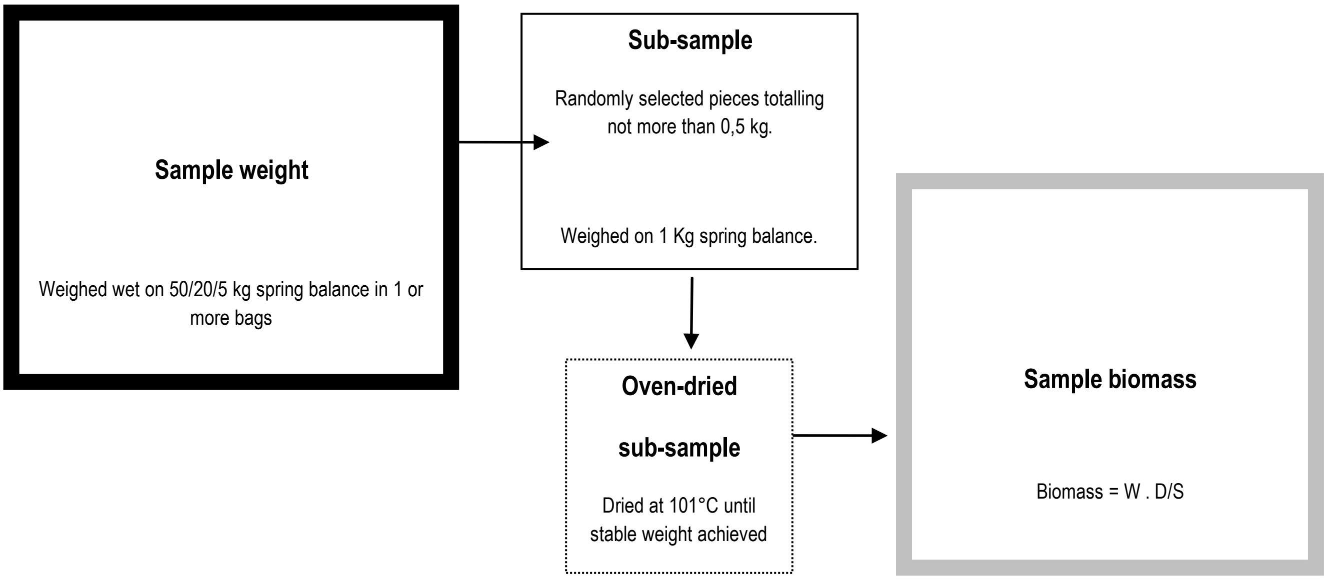


Fig 3 (Sub) sampling, drogen en omrekenen

De procedure zelf is niet ingewikkeld. De meeste fouten worden gemaakt door onduidelijk schrijven, foutieve labels en incomplete formulieren.

Bodemmonsters

De bodem bevat veel koolstof. Het is daarom belangrijk dat hier goed en nauwkeurig monsters van worden genomen. De methode is gebaseerd op internationale richtlijnen.

De methode bestaat uit het monsteren tot minimaal 30 cm diep op 2 plaatsen, het mixen van de monsters en analyse als 1 monster. Omdat er niet veel bekend is over koolstof in Surinaamse bodems, kan men ervoor kiezen wat dieper monsters te nemen, bijv. tot 1 m. De volgende bodemlagen worden dan bemonsterd: 0-10, 10-20, 20-30, 30-60 and 60-100 cm.

In het bodemlab van CELOS wordt organisch materiaal bepaald met de Walkley-Black methode (1934). Dit resulteert in een percentage aan organisch materiaal waarvan 58% koolstof is (Guo & Gifford 2002). *Note:* ISRIC gebruikt een conversiefactor van 0.5 (50%) (Van Reeuwijk 2002).

Er wordt een grote kuil gegraven waarin op tegenoverliggende zijden monsters worden genomen per horizont (min 1 m afstand). De 2 monsters per horizont worden in ringen bewaard. Pas in het lab worden de monsters gemixt alvorens geanalyseerd te worden.

Bodemmonsters worden genomen met speciale ringen (Eijkelkamp, 100 cc) die de grond in gedraaid of geduwd worden (zonder te wiebelen) tot dat de top van de ring ca 2cm dieper komt te zitten dan de bodemoppervlakte. De ringen worden dan voorzichtig uitgegraven. Als er verstoring plaatsvindt aan het monster in de ring bij het uitgraven, moet er opnieuw worden bemonsterd. De ring moet geheel gevuld zijn met grond. Grond die niet exact in de ring valt wordt weg gesneden en wortels worden afgeknipt. Ook als hier verstoring plaats vindt, moet er opnieuw een monster worden genomen.

Op de labels dient duidelijk geschreven te worden. De labels moeten het quadratnummer bevatten en de diepte waaruit het monster komt (bijv. TxDPxQx 5-10). De ringen worden op een koele plaats bewaard in het kamp (bijv in een gegraven kuil, die goed afgedekt is).

Als het langs de ene zijde van de kuil wel lukt om van 60-100 een bodemmonster te nemen, maar langs de andere zijde niet; dan wordt het monster van deze laag niet meegenomen. Het is belangrijk dat in ieder geval tot en met de laag 20-30 cm samengestelde bodemmonsters worden genomen. Is het monsteren in de bovenste laag niet mogelijk, maar wel in de onderliggende lagen, neem dan monsters in de onderliggende lagen zodat er in ieder geval van elk profiel minstens 3 monsters worden genomen van aaneengesloten horizonten. Besteed niet te lang aan het zoeken van een goede locatie (max 1 uur). Je mag rondom het deelplot zoeken zolang je niet in een ander bostype of bodemtype terecht komt.

De monsters moeten zo snel mogelijk naar het bodemlab gebracht worden, uiterlijk 2 dagen na het verzamelen van de monsters. Het lab bepaald het gewicht van de monsters (excl. steentjes van > 2 mm) en het gehalte aan organisch materiaal.

Rekenprocedures (bodemmonsters)

Bulk density wordt berekend per horizont (laag) door het drooggewicht van het monster (zonder steentjes) te delen door 2 keer het ringvolume (elk monster bestaat uit 2 gevulde ringen). Het volume moet gecorrigeerd worden voor het volume aan steentjes. De dichtheid wordt bepaald in kg m^{-3}.

Absolute koolstof gehalte wordt voor elke diepte berekend door de volgende vergelijking:

$$CS_i = BD_i * T * C_i$$

waarin CS_i de koolstofvoorraad is op diepte i (kg m^{-2}), BD_i de bulk density op diepte i (kg m^{-3}), T de dikte van de bemonsterde laag (m) en C_i de koolstoffractie op diepte i (kg kg^{-1}). Als je de koolstofvoorraden optelt voor alle horizonten, kom je tot de totale koolstofvoorraad (Total Carbon Stock TCS in t/ha).

Als men de eerste dataset analyseert (van 12 quadranten per plotlocatie) kan men bepalen of er voldoende monsters genomen zijn voor dat bodemtype op die locatie. Hierin wordt de variatie in data meegenomen en een minimum nivo aan nauwkeurigheid. Dit rekenproces staat beschreven in FORDA & JICA (2005) en is gebaseerd op Boone et al (1999).

Biomassa laboratorium

De bodemmonsters worden verwerkt en geanalyseerd door CELOS. De andere monsters worden verwerkt in het drooglab op het kantoor van de FCU. Alle monsters die in plastic zakken zitten moeten zo snel mogelijk in papieren zakken worden gedaan alvorens ze in de oven gezet worden. Het label moet ook verplaatst worden. Omdat de lijm vaak oplost door de hitte van de oven, is het beter het label vast te nieten of met een paperclip te bevestigen aan de papieren zak. Als het monster te groot is voor 1 zak moeten meerdere zakken worden gebruikt, maar bevestig alle zakken van 1 monster goed aan elkaar. Zorg dat het hele monster en elk monster in een papieren zak terecht komt. Voorkom omvallen in de oven.

Biomassa monsters worden gedroogd in de oven volgens IPCC procedures. Hout, blad en strooisel moeten gedroogd worden bij 101°-103°C totdat ze een constant gewicht bereiken. Hogere temperaturen zijn niet geoorloofd vanwege het verlies van volatiele organische verbindingen. Lagere temperaturen zijn niet geschikt om het monster volledig te drogen. Drogen kan enkele dagen duren. Een monster wordt als droog beschouwd als het gewicht niet meer veranderd (dit moet men dus testen en bijhouden van enkele monsters). Nadat het monster droog is, wordt het drooggewicht gemeten en genoteerd op de veldformulieren (dit is tevens om te controleren of elk monster uit het veld in het lab is gekomen). Daarna worden monsters bewaard in papieren zakken in droge condities totdat de data-analyse gedaan is en volledig in orde is.

Note: monsters moeten binnen een half uur nadat zij uit de oven komen gewogen worden anders nemen zij weer vocht op uit de lucht.

Data entry

Voor dood hout worden alle data verzameld in Excel spreadsheets. De files komen in de map van het desbetreffende transect terecht, dus bij de data van de PSPs. Bodemdata komen in een aparte file terecht in dezelfde map.

Referenties

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Equipment needed for 1 plot location for 1 team

1.	Soil Rings	4
2.	knives	2
3.	Trowel	2
4.	Scraper	2
5.	Ruler (1m)	2
6.	Shovel	2
7.	Spade	2
8.	Large buckets	6
9.	Soil Bags	100
10.	Garbage Bags	100
11.	Shears	3
12.	Rice bags	10
13.	Scissors	2
14.	Cutlass	2
15.	Labels	200
16.	Tie-Wraps	as many as bags
17.	Diameter Tape/Measuring Tape	1 each
18.	Compass	2
19.	GPS + Coordinates + Map	2 sets (plus batteries)
20.	Spring scales	5 (50 kg, 20 kg, 5 kg, 1 kg, 300 g)
21.	Data Sheets	20
22.	Pencils	4
23.	Gloves	4 pairs
24.	Write in Rain Note Book	1
25.	Clipboard	1
26.	hammer	2
27.	similar bicycle tires (40 cm Φ)	4
28.	rope	10 m