8 September 2016

Flora Monitoring Akumadan 2015

Form Ghana

Client

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Contents

1. Introduction

As part of Form Ghana's commitment to environmental sustainability, the development of the buffer zone vegetation is monitored every five years. Two indicators have been developed to measure biodiversity in the plantation:

- increase of buffer zone woody biomass stocks up to 350 m^3/ha with at least 2 m^3/ha/y
- tree species richness of the project area will remain equal or increase compared to the baseline situation

In order to verify these indicators, flora in buffer zones is measured by the Form Ghana monitoring team, assisted by a qualified botanist, and trained by Form international. The collected data are incorporated in the management plan and used in management decisions and implementation.

Buffer zone monitoring was done once before, in Asubima Forest Reserve (ASU FR), in 2010, by Noor de Laat, an intern for Form international. The current monitoring was performed by the Form Ghana monitoring team, assisted by a botanist from KNUST (Jonathan Dabo) and trained by Form international (Marthe Tollenaar).

2. Method

In order to compare the current state of the riparian zones of ASU to the state in 2010, data collection was kept largely the same as the method developed by Noor de Laat. Afrensu Brohuma Forest Reserve (AFR FR) was included in the monitoring; a number of PSPs was established in AFR.

2.1. Permanent Sample Plots

Noor de Laat created 21 Permanent Sample Plots (PSPs) in the buffer zones of Asubima FR in 2010, see map in Annex 1. Plots 7 and 13 were re-located because they were located in an indigenous planting area, which would interfere with the buffer zone data-set. Where relevant, the plots have been excluded from analyses to ensure optimal comparison with the 2010 data.

The plots were marked with a wooden pole in the centre, which had largely disappeared in 2015 due to termites and other pests. The plots were therefore re-marked with metal poles, like the ones used for the teak PSPs (figure 1), and mounted in the ground with cement. 9 new PSPs were created in the buffer zones of Afrensu Brohuma FR. These plots were marked with the same metal poles.

Figure 1. *Metal pole used for marking the PSPs.*

Each PSP consists of a main plot of 200m^2 (radius: 7.98m), with two nested subplots of 3x3m and 1x1m respectively (figure 2). This is different from the plot structure in 2010, where 5 sub-plots of 1m^2 were laid out randomly within the main plot, and no large sub-plot was included.

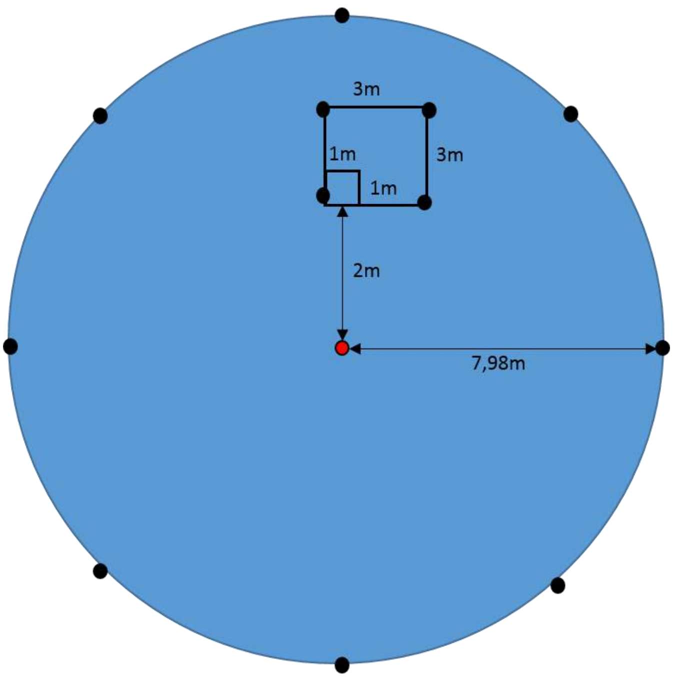


Figure 2. *Outline of a PSP buffer zone monitoring plot. Black dots are pegs that are places temporarily at the plot boundaries to demarcate the plot. The red dot is the permanent pole, indicating the location of the plot. The squares are the subplots.*

The main plots are created in the same way as the PSP monitoring of the teak plantation, with temporary pegs demarcating the outer plots boundaries. The 3x3m subplots were indicated temporarily with 4 pegs on the outer corners. The 1x1m plot was outlined by a 1x1m metal square.

To reach a plot, a cutlass was used to clear a path (figure 3). Damage to the buffer zones was kept to a minimum. Inside the plot, no cutlasses were used.

Figure 3. *Cutting a path to reach the next PSP.*

Noor de Laat measured 5 subplots per PSP, but this time the subplots were reduced to 2 (1 small, 1 big), because of time restraints. The position of both subplots within the main plot was standardized as follows, to prevent non-random selection of plot location: starting at 2m distance from the pole (2 big steps), in northern direction. The main plot was coded ‘0’, the large subplot (3x3m) was coded ‘1’ and the small subplot (1x1m) was coded ‘2’.

2.2. Monitoring parameters

In the main plot (200m^2), trees were measured with DBH > 5cm. The following parameters were recorded (figure 4):

- Tree species (scientific/local name)
- DBH (calliper)
- Height (estimates by botanist, using Raffia pole as reference)

- Distance to the middle of the plot (tape measure)
- Angle from the middle of the plot (compass, 8 bearings: N/S/E/W/NE/SE/NW/SW)
- Presence of standing and lying dead wood (estimate %)
- Inclination (Suunto clinometer)
- Bare soil without litter (estimate coverage in %)
- Photo from North to South

Figure 4. a) *Height estimations using a Raphia pole,* ***b)*** *DHB measurements using a calliper.*

In the large subplot (3x3m), all lianas, shrubs and trees with DBH < 5cm were measured. The following parameters were recorded:

- Species (scientific/local name)
- DBH (calliper)
- Height (estimate or tape measure, not relevant for lianas)

In the small subplot (1x1m), all shrubs, herbs, grasses and juveniles were measured. The following parameters were recorded:

- Species
- Height (estimate or tape measure)
- Cover in % per species (estimate, only if >15% of the subplot is covered with a certain species)

For further reference, see the monitoring field sheet in Annex 2.

A qualified botanist was hired to identify the species (figure 5). If a plant or tree could not be identified, a sample was bagged for determination at the site. In case of herbs and grasses, a full plant was bagged, including stem, leaves and, if possible, flowers/seeds. In case of trees or shrubs, part of a branch was selected that shows leaf composition and, if possible, flowers/seeds. The bag was labelled with the plot number, a letter (starting with A in each plot), and the subplot number (0: main plot; 1: large subplot; 2: small subplot). For example, the first unknown plant of PSP 2, found in the large subplot, should be labelled 2A1. The second unknown species, a tree species, should then be labelled 2B0. The letter on the bag was written on the field sheet, in the place of the species name. After identification, the corresponding species name was added to the digital sheet.

Figure 5. *Species identification by a qualified botanist.*

All plots were photographed for future reference.

2.3. Equipment

The following equipment was used for the field work by the Form Ghana monitoring team (figure 6):

- Metal PSP poles and mortar
- Calliper
- Clinometer
- Raffia pole
- Tape measure (10m or more)
- Compass
- Plastic bags
- Labels (paper or plastic) to put in plastic bags with plants
- GPS

- Cutlasses
- Camera
- Map with plots indicated
- Field sheets, notebook, checklists
- Pencil, eraser, permanent marker
- 1x1m square to indicate subplots
- First aid box
- Food/water
- Wellington boots, clothes with long sleeves
- Literature
- Photo camera

Figure 6. *Form Ghana monitoring team with field equipment.*

3. Results

A full list of plant species identified in the Permanent Sample Plots of Asubima and Afrensu Brohuma FR in 2015 is presented in Annex 3.

It cannot be assumed that the same population has been sampled in 2010 and 2015, since the pole marking the plot had disappeared in most of the plots, and the plots therefore changed location. In order to still make a relevant comparison in population characteristics, percentages have been indicated rather than individuals.

3.1. Tree Height and DBH

On average, trees were higher in Asubima FR in 2015 (9.2m) than in 2010 (3.5m), and had a larger DBH (15.6cm in 2015 and 13.7cm in 2010), see table 1. This indicates that the buffer zones develop into a more forest-like vegetation. The trees in Afrensu Brohuma FR were similar in size compared to the trees in Asubima FR, with a slightly lower DBH (6.9cm compared to 9.2cm in ASU).

York (*Broussonetia paperyfera*) was excluded from these analyses in order to make a fair comparison between the monitoring results in 2010 and 2015. In 2010, trees with DBH<5cm have been measured in the main plot (200m^2). In 2015, these trees were measured only in the large subplot (9m^2). Therefore, the trees with DBH<5cm found in 2010 have been multiplied with (9/200).

Table 1. *Average DBH and Height of trees in ASU and AFR in 2010 and 2015*

	Average DBH (cm)	Average Height (m)
ASU 2010	13.7	3.5
ASU 2015	15.6	9.2
AFR 2015	16.3	6.9

When comparing the distribution of the tree DBH in Asubima FR between 2010 and 2015, a very similar pattern is observed (figure 7).

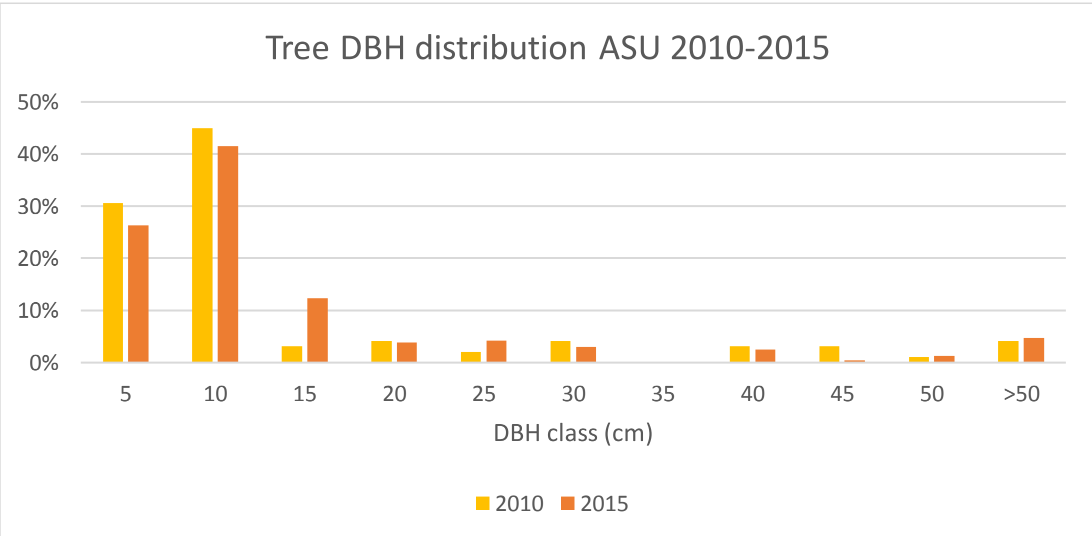


Figure 7. *Relative DBH distribution in ASU in 2010 and 2015.*

The trees in Afrensu Brohuma have a lower average DBH than in Asubima FR (table 1). The DBH distribution shows a peak in the lowest height class (0-5cm). Given the disturbed nature of the forest, this may suggest a composition of a relatively young forest with a number of big trees (figure 8).

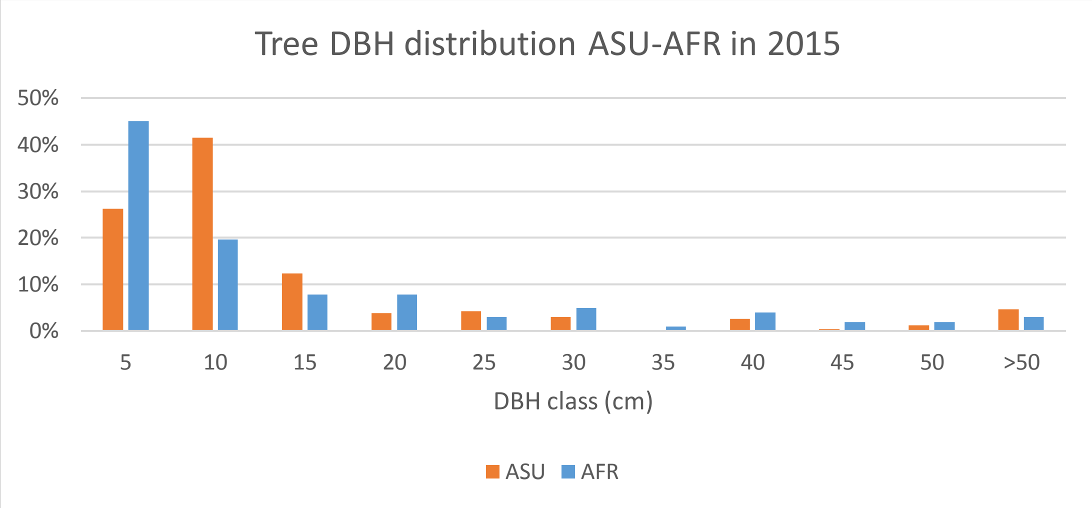


Figure 8. *Relative DBH distribution in ASU and AFR in 2015*

The height distribution has shifted from a peak in the lower classes (1 and 3) in 2010 to a more equally spread distribution with a minor peak around height class 5-6 (figure 9). This could indicate the maturing of the forest in the buffer zones, facilitated by reduced disturbance.

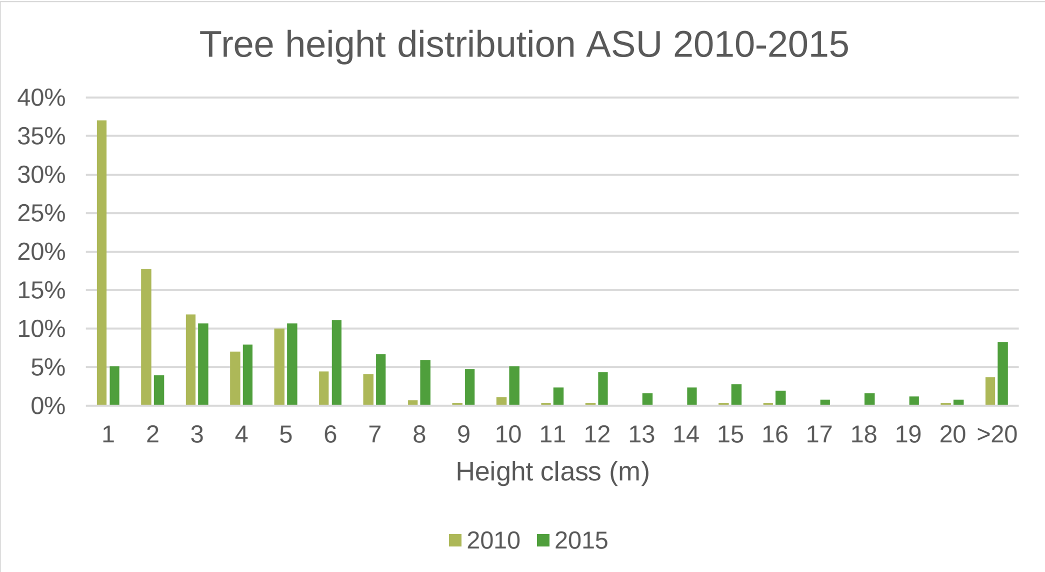


Figure 9. *Height distribution in ASU in 2010 and 2015.*

Distribution over height classes is similar in Asubima and Afrensu Brohuma FR (figure 10). The main difference is that the trees in Afrensu Brohuma show two peaks in height classes; the main one at the low height classes (2-3), and a smaller one at height classes 9-10, while in Asubima FR there is only one minor peak, at height class 5-6. The two peaks in Afrensu Brohuma could be caused by a rejuvenation of the forest, that has a number of high trees still standing, but has room for young trees to establish and develop. This is confirmed by the DBH distribution in Afrensu Brohuma FR (figure 8).

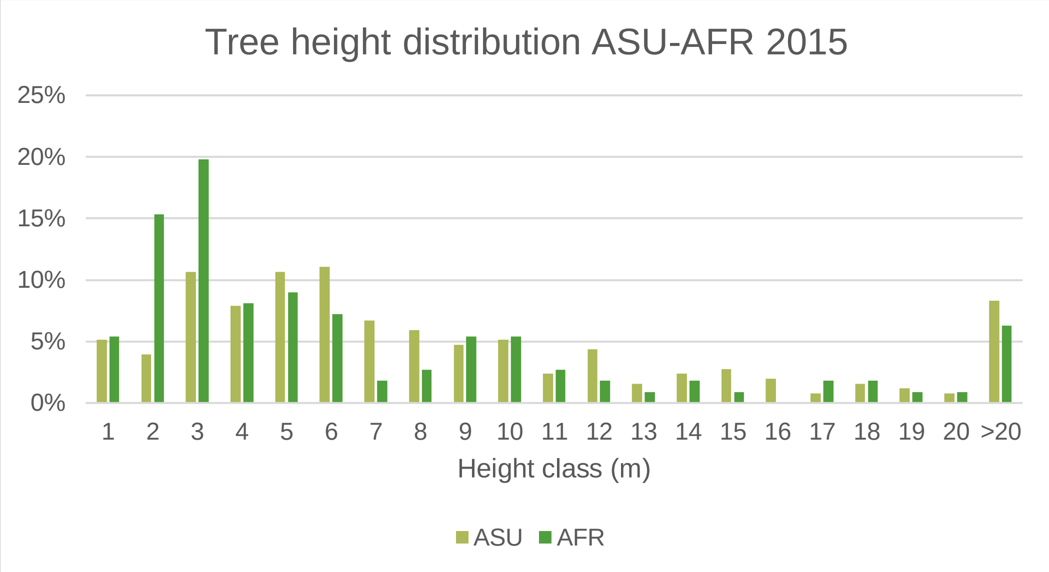


Figure 10. *Relative height distribution in ASU and AFR in 2015.*

3.2. Number of trees and tree species

The total number of trees (DBH =/> 5cm) in Asubima FR has increased with 72%; from 94 in 2010 to 162 in 2015 (excluding York) (table 2). The average tree density in Asubima now reaches 426 trees/ha. This is a strong indication for the recovery of the forest in the buffer zones.

Total number of tree species has also increased in Asubima, from 45 in 2010 to 53 in 2015 (18% increase). With plots 7 & 13 included, the total number of species is 57 in Asubima FR in 2015 (see also Annex 3).

Table 2. *Tree density and total number of species (exl York) in ASU.*

	2010	**2015**	**2015 incl. 7&13**
Total tree number	94	162	178
Trees/ha	247	426	424
Tree species	45	53	57

3.3. Tree volume and basal area

One of the indicators identified for measuring the development of the buffer zones is the increase of buffer zone woody biomass stocks up to 350 m^3/ha with at least 2 m^3/ha/y. In order to assess biomass, the specific gravity of each tree species should be known. This is not the case, so the wood volume was assessed instead, to compare standing tree stock of 2010 with standing tree stock in 2015.

The volume of the trees in the buffer zone was calculated using the bole formula for the trees that were >1.30m high. York was excluded from the analyses for two reasons: 1) York was not consistently recorded in 2010, and 2) York is an invasive species that does not qualify for this indicator.

In table 3, the calculated wood volume is presented per site, per year. From these numbers it can be concluded that tree volume has increased considerably since 2010. Average MAI was 20.8 m^3/ha/yr in Asubima over the 5 past years. The accuracy may be questioned since most of the plots have been moved slightly, due to the disappearing of the wooden poles. If we exclude the plots where the pole was not retrieved, we find an MAI of 11.7 m3/ha/yr.

Table 3. *Wood volume in ASU and AFR FR in 2010 and 2015*

Site	Year	Wood volume (m^3/ha)
ASU	2010	63.9
ASU	2015	168.0
AFR	2015	205.8 (83.0)

The volume of standing trees in the buffer zones of Afrensu Brohuma FR is relatively high compared to the volume in Asubima FR, with a difference of 37.8 m3/ha. This is likely caused by a big tree in plot 28 (DBH 223cm) that strongly affects the data. When this tree is taken out, the wood volume is reduced to 83.0m^3/ha.

We should note that accuracy of the height measurements cannot be guaranteed in dense vegetation. Heights were estimated in 2015, and measured using a Suunto clinometer in 2010, which may generate different results.

Since the accuracy of the wood volume is difficult to optimize, basal area is included as a parameter to compare forest cover over the years. The basal area per hectare has increased with 80% between 2010 (10.6m^2/ha) and 2015 (19.0m^2/ha) (table 4). This shows the development of forest cover in the buffer zones of ASU FR. This growth provides a more realistic indication of the volume growth than the calculations above.

Table 4. *Basal area.*

	ASU 2010	ASU 2015	AFR 2015
Basal Area	4.0	7.2	2.4
Basal Area/ha	10.6	19.0	13.4

3.4. Species-effort curve

A species-effort curve was created to present the cumulative number of recorded plant species as a function of the cumulative effort expended searching for them (number of plots recorded).

The first plot on the curve was determined by the highest amount of species recorded. The next plots on the curve are determined by the highest amount of 'new' species that were not yet included in the previous plot. If multiple plots had the same amount of 'new' species, the plot with the highest total amount of species was selected. If this too was equal for multiple plots, the lowest plot number was selected.

In figure 11 below, the species-effort curve is presented for all measured plots in 2015, in Asubima and Afrensu Brohuma FR. The curve shows a negative acceleration, and a flat line at the end. However, the trendline indicates that the asymptote (228, see formula) is not yet reached. This means that new species are likely to be found when more plots are added (146 found, 228 expected).

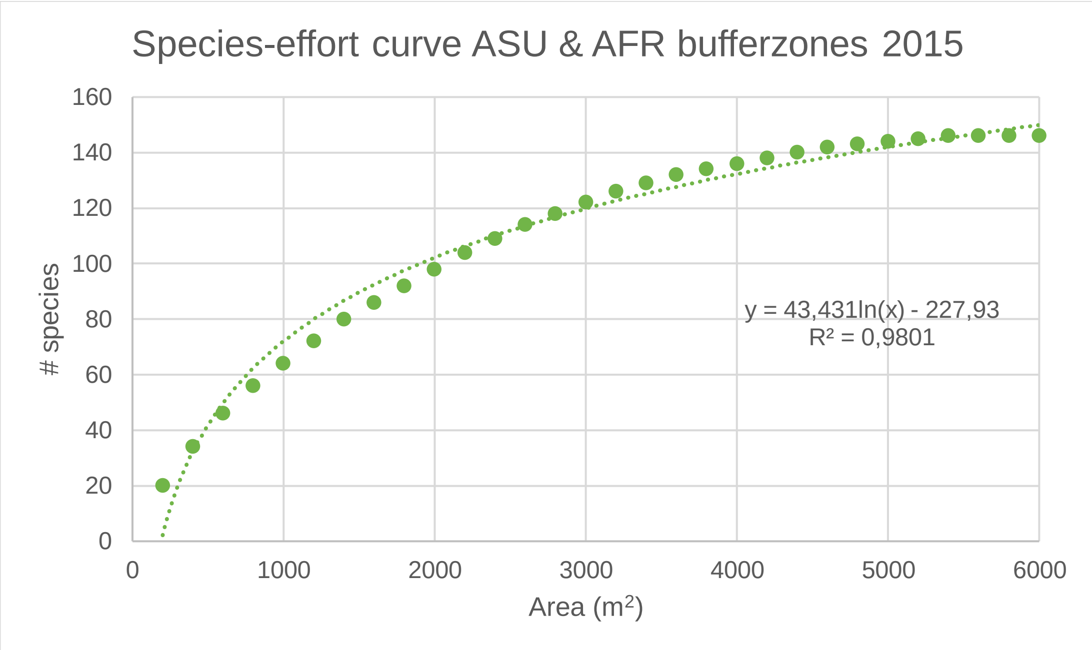


Figure 11. *Species-effort curve for all plots measured in 2015, in ASU and AFR.*

In order to compare the species-effort curve of 2015 to the curve of 2010, a separate curve is presented for Asubima Forest Reserve (figure 12). This curve shows a lower amount of total species (168) compared to the graph for both sites, indicating that there are different species expected to be present in both sites. Similar to the curve of both sites combined, the trendline for Asubima FR indicates that more species are likely to be found when increasing the amount of sample plots (115 found, 168 expected).

When comparing the species-effort curves of 2015 (figure 12) to the curve of 2010 (figure 13) it is remarkable to see that the expected amount of species has remained exactly the same (168). Slightly more species were found in 2010 in Asubima FR: 133, compared to 115 in 2015. This may be related to the reduction of small sample plots; in 2010, Noor de Laat sampled 5 subplots in each PSP and this was reduced to 1 small and 1 medium-sized subplot in 2015.

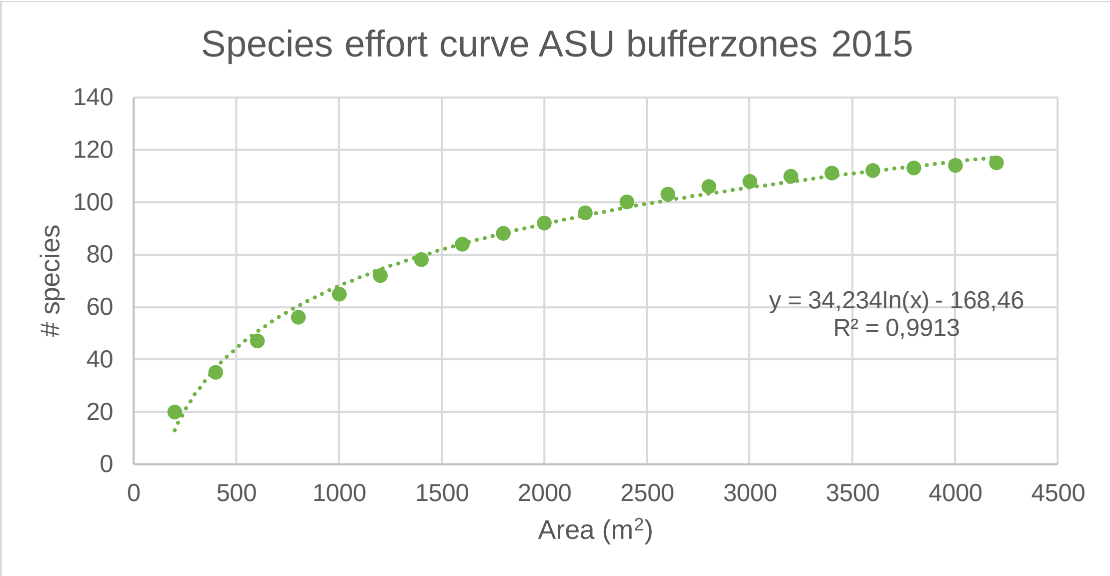


Figure 12. *Species-effort curve for Asubima FR in 2015.*

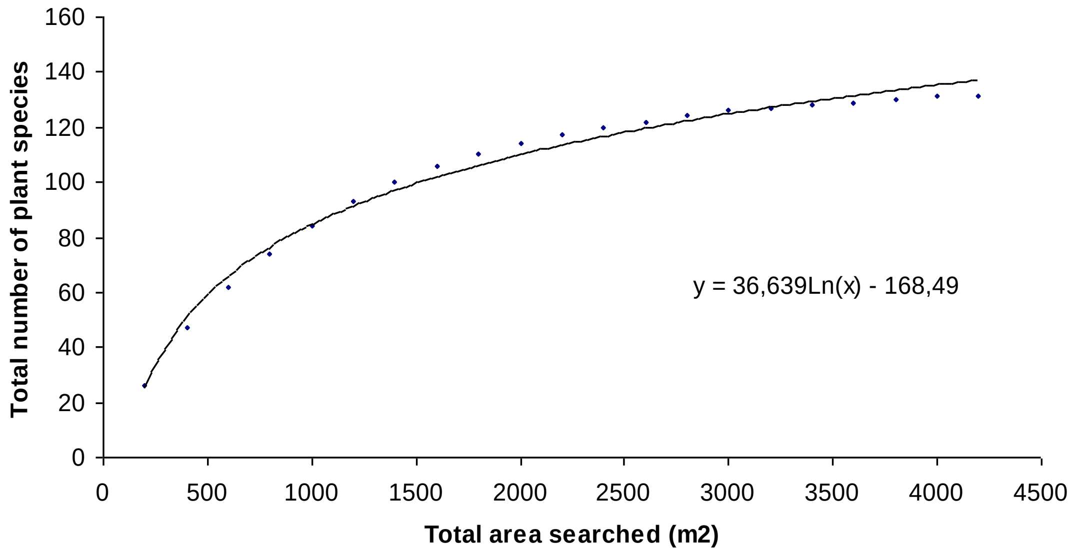


Figure 13. *Species-effort curve for Asubima FR in 2010.*

The species-effort curve for Afrensu Brohuma FR (figure 14) indicates that a lower amount of total species can be expected compared to Asubima FR (114). However, due to the limited number of samples taken in AFR, the curve is not yet flattening at maximum samples, indicating that the sample size was not high enough to accurately assess species richness in this forest reserve.

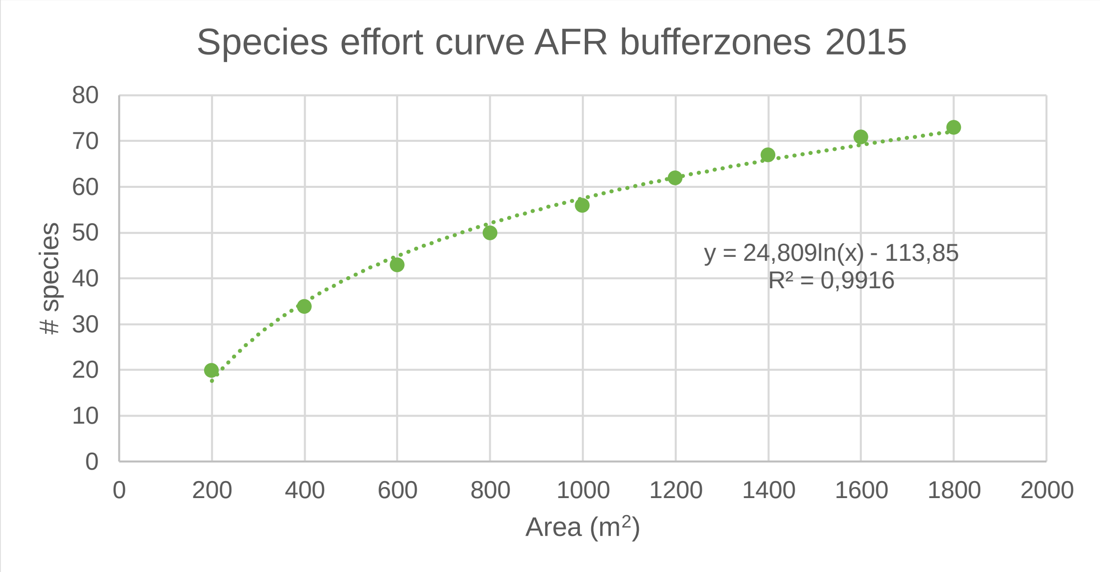


Figure 14. *Species-effort curve for Afrensu Brohuma FR in 2015.*

3.5. Biodiversity Index

Calculation of the Shannon-Wiener Index for biodiversity results in a very high biodiversity rating (3.7), for all plots measured in 2015. The index usually ranges 1.5 and 3.5, so this is an extremely high rating of the biodiversity in the bufferzones of Asubima and Afrensu Brohuma FR (figure 15). York was included in these analyses.

Figure 15. *Biodiversity in the buffer zones of ASU FR.*

3.6. Conservation status

3.6.1. IUCN and CITES

The status of all recorded plant species was checked for IUCN and CITES. In total, 5 tree species were classified as 'Vulnerable' on the IUCN Red List and one species was classified as ‘Low Risk/Least Concern’ (table 5). None of the species was listed on a CITES Appendix.

Table 5. *List of tree species on IUCN Red List.*

Family	**Species**	**Common name**	**AFR**	**ASU**	**IUCN red List status**
Fabaceae (Papilionoideae)	*Pterocarpus santalinoides*	Mututi		2	Low Risk / Least Concern
Malvaceae (Sterculiaceae)	*Nesogordonia papaverifera*	Kotibe	1		Vulnerable
Meliaceae	*Entandrophragma cylindricum*	Sapele		1	Vulnerable
Meliaceae	*Khaya anthotheca*	African Mahogany	7	2	Vulnerable
Rubiaceae	*Coffea togoensis*	Coffee	1		Vulnerable
Rubiaceae	*Hallea/Mytragyna ledermannii*		1	1	Vulnerable

The species identified in ASU and AFR with an IUCN conservation status (table 5) are all forest species (table 6). Major threats include over-exploitation and habitat loss. This emphasizes the relevance of the protection of the buffer zone vegetation, and the efforts made by Form Ghana to restore these areas to natural forest.

Table 6. *Habitat description of species with conservation status, and their major threats.*

Species	**Habitat***	**Major threats***
Pterocarpus santalinoides	Mixed deciduous forest and flooded savannah on lake and lagoon sides, riverbanks. River banks, usually on sandy and moist soils, at elevations up to 500 metres.[1]	
Nesogordonia papaverifera	A timber species, which grows in dense stands, commonly in areas where savannah has been replaced by forest. Regeneration is good in disturbed forest	Genetic impoverishment is reported in outlying parts of the species' range. Exploitation is moderate. Sometimes large individuals are left after logging.
Entandrophragma cylindricum	This species is scattered in semi-deciduous forests. In comparison with other species of *Entandrophragma*, this species can occur in drier	Exploited heavily throughout its range. Genetic erosion caused by the large-scale depletion of mature

[1] http://tropical.theferns.info/viewtropical.php?id=Pterocarpus+santalinoides

	habitats, including abandoned fields, but it does not respond well to burning.	individuals from populations has taken place in some countries
Coffea togoensis	Dry forest.	Dry forests have suffered the most serious losses of all the forest types in this area. They continue to decline because of fire, felling and agricultural expansion.
Mytragyna ledermannii	A gregarious forest species restricted to swampy areas, rivers and also coastal regions. Regeneration is good in wet areas. It is able to reproduce vegetatively.	Overexploitation of the general-purpose timber and habitat degradation in large parts of its range are causing population declines.

* Derived from www.IUCNredlist.org unless otherwise specified.

3.6.2. Genetic Heat Index/STAR rating

In Ghana, a special system has been developed to assess conservation priority of tree species. Each species has been assigned to a Star category based on its rarity in Ghana and internationally, with subsidiary consideration of the ecology and taxonomy of the species (Hawthorne & Abu-Juam, 1995[2]). Table 7 presents the Star rated species identified in Asubima and Afrensu Brohuma FR in 2015.

In total, 12 species were identified in Afrensu Brohuma FR that were rated in the Pink category or above, and 22 in Asubima FR.

Table 7. *Observations of STAR-rated species in ASU and AFR in 2015.*

Star	Comment[3]	Species	AFR	ASU
Gold	Fairly rare internationally and/or locally. Ghana has some inescapable responsibility for maintaining these species.	*Maranthes aubrevillei*	3	5
Scarlet	Common, but under serious pressure from heavy exploitation. Exploitation needs to be curtailed if usage is to be	*Entandrophragma cylindricum*		1
		Khaya anthotheca	7	2

[2] Hawthorne & Abu-Juam, 1995. *Forest Protection in Ghana*, IUCN Forest Conservation Program.
[3] As stated in Hawthorne & Abu-Juam, 1995

	sustainable. Protection on all scales vital.			
Red	Common, but under pressure from exploitation. Need careful control and some tree by tree and area protection.	*Afzelia bella*		2
		Amphimas pterocarpoides		1
		Antiaris toxicaria	5	4
		Canarium schweinfurthii		1
		Ceiba pentandra		7
		Daniellia ogea		1
		Distemonanthus benthamianus		1
		Hallea ledermannii	1	1
		Mansonia altissima	1	
		Piptadeniastrum africanum		1
		Terminalia superba		1
Pink	Common and moderately exploited. Also non-abundant species of high potential value.	*Albizia zygia*	1	16
		Bombax buonopozense	1	3
		Celtis mildbraedii	1	2
		Holoptelea grandis		1
		Morus mesozygia		2
		Nesogordonia papaverifera	1	
		Petersianthus macrocarpus		1
		Ricinodendron heudelotii	4	8
		Sterculia oblonga	1	
		Sterculia rhinopetala	1	1
		Strombosia glaucescens		1

Each Star category has been assigned a ‘weight’ that indicates the relative value of each category in building up a standard spot conservation score. This score is referred to as the Genetic Heat Index (GHI) and calculated for Asubima and Afrensu Brohuma FR based on collected monitoring data of 2010 and 2015 (table 8). For the sake of comparison, only the main plots have been included in the analyses, since the sub-plots had changed in composition between 2010 and 2015.

The GHI has increased in Asubima FR; from 48 in 2010 to 68 in 2015. Note that this index indicates relevance for conservation purposes only. The number of species found that are of no particular conservation concern decrease the GHI value.

Table 8. *Genetic Heat Index calculated for ASU and AFR in 2010 and 2015. Only main plots (Plot code: 0) were included in the analyses.*

	2010	**2015**
ASU	48	68
AFR		68

All values are within the 'Slightly Warm' range classified by Hawthorne & Abu-Juam (1995) (table 9). This is in line with the GHI values found in Afrensu Brohuma in 1974 (GHI: 41) and 1990 (GHI: 70) (Hawthorne & Abu-Juam, 1995).

Table 9. *Genetic Heat Index categories and ranges.*

GHI Category	GHI range
Cool	0-24
Tepid	25-49
Slightly warm	50-99
Very warm	100-149
Fairly hot	150-199
Very hot	200+

4. Conclusions

- The forest in the buffer zones of Asubima FR has shown development over the past 5 years to a more mature forest, with larger average height and DBH.

- The buffer zones in Afrensu Brohuma show typical characteristics of a disturbed forest that is now rejuvenating, with a large number of small trees and a small number of large, mature trees.

- A number of species identified in the buffer zones is classified as 'vulnerable' by the IUCN Red List: *Nesogordonia papaverifera, Entandrophragma cylindricum, Khaya anthotheca, Coffea togoensis, Hallea ledermannii.*

- The Genetic Heat Index of Asubima FR has increased since 2010, emphasizing the need for conservation of the buffer zones.

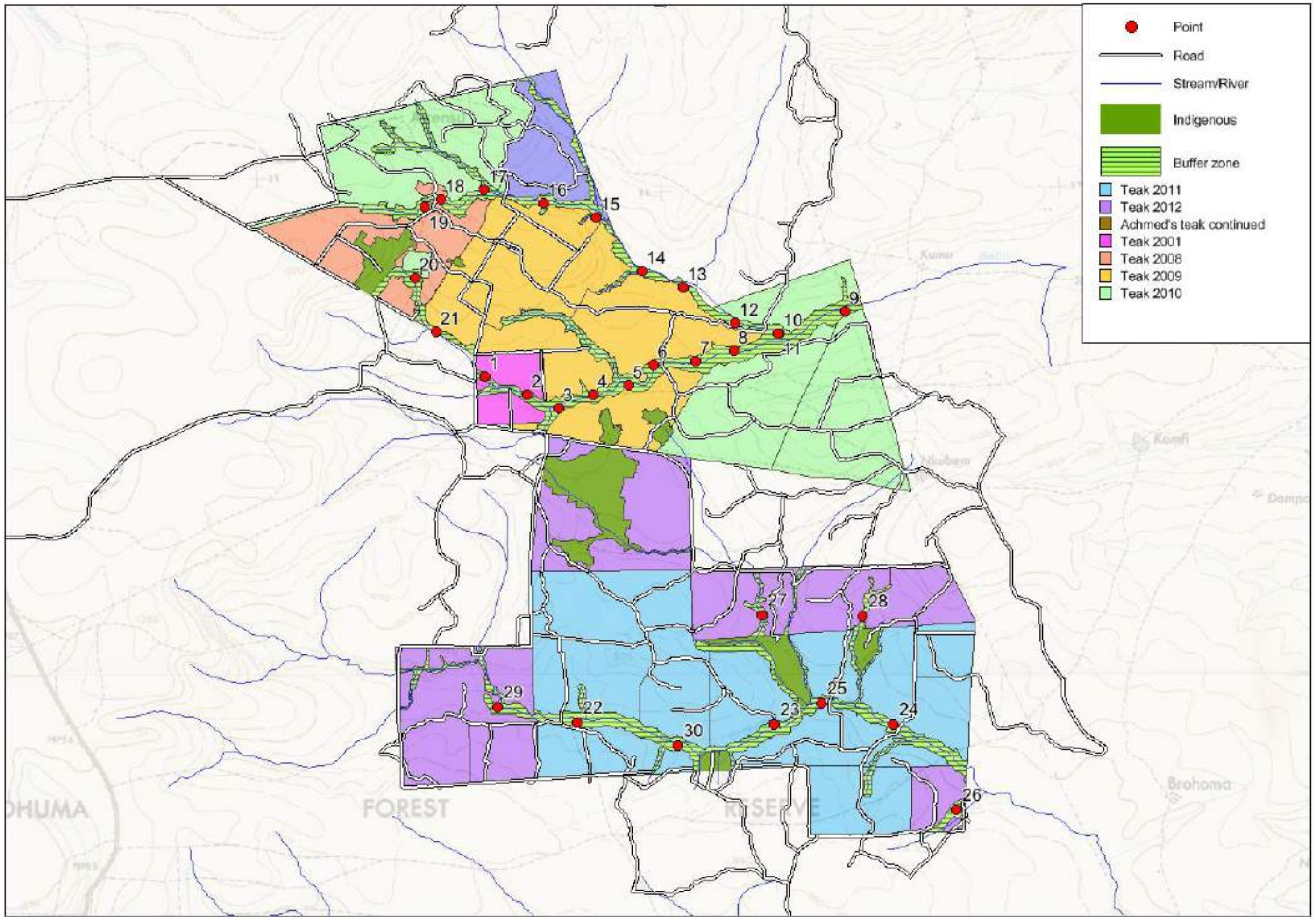
5. Recommendations

- From personal communication with Frans Bongers it was concluded that the plot design in 2015, with 5 1x1m subplots, gives a better indication of grasses and herbs. One subplot is insufficient for that purpose, according to Mr. Bongers. However, considering the fact that the new plot design was implemented in both forest reserves, we would recommend to maintain the current design to facilitate easy comparison with the 2015 dataset.

- Mr. Bongers indicated that historic data exists on the vegetation in Asubima and Afrensu Brohuma FR, collected by Hawthorne on sample plots located in the project area. It would be interesting to retrieve those data and make a comparison with our own data to assess whether the buffer zones develop towards their historic, pre-degraded state. However, this is a considerable effort that would preferably be done by a student/intern.

- For consistency, we would recommend to hire the same botanist (Mr. Jonathan Dabo) for the next monitoring exercise in 2020, if he is still available then. It became evident that different botanists identify species differently, causing inconsistencies in the data, that make it difficult to compare data over the years.

Annex 1. Map of monitoring plots



Annex 2. Monitoring Field Sheet

Buffer zone PSP Monitoring - Field Sheet

Subplot 1 (herbs, grasses, shrubs, juveniles)

Species	Cover (%)	Height (cm)

General

Plot number	
Date	
Time	
Team members	
Plot radius	7.98m
Pole present	Y / N
GPS coordinates	X:
GPS coordinates	Y:

Main plot (coverage)

Inclination	
Bare soil cover (%)	
Canopy cover (%)	
Dead wood cover (%)	

Subplot 2 (shrubs & lianas >5cm DBH)

Tree Nr.	Shrub/liana species	Height (m)	DBH1 (cm)	DBH2 (cm)	Remark
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					

Main plot (trees >1.3m high)

Tree Nr.	Tree species	Tree height (m)	DBH1 (cm)	DBH2 (cm)	Distance to center (m)	Angle to center (°)	Remark
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Annex 3. Species list of ASU and AFR Forest Reserves

Family	Species	Life form*	AFR	ASU	Total
Acanthaceae	*Asystasia gangentica*	H		1	1
Anacardiaceae	*Lannea welwitschii*	T		1	1
	Pseudospondias microcarpa	T	2	9	11
Annonaceae	*Cleistopholis patens*	T	5	16	21
	Monodora tenuifolia	T		1	1
	Uvaria ovata	S		1	1
Apocynaceae	*Alstonia boonei*	T	1	3	4
	Cryptolepis triangularis	L		4	4
	Funtumia elastica	T	3		3
	Holarrhena floribunda	T	1	1	2
	Motandra guineensis	L	2	1	3
	Rauvolfia vomitoria	T		3	3
	Secamone afzelii	L	1	1	2
	Strophanthus preussii	L		1	1
	Voacanga africana	T		2	2
Araceae	*Anchomanes difformis*	H	1	4	5
	Culcasia scandens	L		1	1
Arecaceae	*Elaeis guineensis*	T		1	1
	Raphia hookeri	T	4	6	10
Asteraceae	*Chromolaena odorata*	S	2	2	4
Bignoniaceae	*Markhamia lutea*	T		4	4
	Newbouldia laevis	T	1	9	10
	Spathodea campanulata	T		1	1
Burseraceae	*Canarium schweinfurthii*	T		1	1
Celastraceae	*Hippocratea vignei*	L	1		1
	Salacia africana	L		1	1
Chrysobalanaceae	*Maranthes aubrevillei*	T	3	5	8
Combretaceae	*Combretum mildbraedii*	L		1	1
	Combretum paniculatum	L		2	2
	Combretum zenkeri	L	1		1
	Terminalia superba	T		1	1
Commelinaceae	*Aneilema beniensis*	H	1		1
	Commelina benghalensis	H		1	1
	Commelina erecta	H		1	1
Ebenaceae	*Diospyrus ferrea*	T		1	1
Euphorbiaceae	*Alchornea cordifolia*	T		5	5
	Discoglypremna caloneura	T	1		1
	Mallotus oppositifolius	S		7	7
	Mareya micrantha	T	1		1

	Margaritaria discoidea	T		2	2
	Ricinodendron heudelotii	T	4	8	12
Fabaceae (Caesalpinioideae)	*Afzelia bella*	T		2	2
	Bussea occidentalis	T	1	2	3
	Daniellia ogea	T		1	1
	Daniellia oliveri	T		1	1
	Distemonanthus benthamianus	T		1	1
	Griffonia simplicifolia	L	3	21	24
	Hymenostegia afzelii	T	5		5
Fabaceae (Mimosoideae)	*Albizia adianthifolia*	T		5	5
	Albizia lebbeck	T		19	19
	Albizia zygia	T	1	16	17
	Piptadeniastrum africanum	T		1	1
Fabaceae (Papilionoideae)	*Abrus precatorius*	L	1		1
	Amphimas pterocarpoides	T		1	1
	Baphia nitida	T	7	1	8
	Centrosema pubescens	L		2	2
	Dalbergia hostilis	L	1	2	3
	Millettia barteri	L	1	1	2
	Millettia rhodantha	T	3		3
	Millettia zechiana	T	2	3	5
	Pterocarpus santalinoides	T		2	2
Gleicheniaceae	*Dicranopteris linearis*	H	2		2
Lamiaceae	*Tectona grandis*	T		3	3
	Vitex ferruginea	T	1	1	2
Lecythidaceae	*Petersianthus macrocarpus*	T		1	1
Malvaceae (Sterculiaceae)	*Nesogordonia papaverifera*	T	1		1
Malvaceae (Bombacaceae)	*Bombax buonopozense*	T	1	3	4
	Ceiba pentandra	T		7	7
Malvaceae (Sterculiaceae)	*Cola caricifolia*	T	1	2	3
	Cola gigantea	T	1	1	2
	Cola millenii	T	1		1
	Mansonia altissima	T	1		1
	Sterculia oblongata	T	1		1
	Sterculia rhinopetala	T	1	1	2
	Sterculia tragacantha	T	2	12	14
Malvaceae (Tilliaceae)	*Christiana africana*	T		1	1
	Desplatsia dewevrei	T		1	1

	Glyphaea brevis	T		1	1
Marantaceae	*Hypselodelphys poggeana*	L		5	5
	Marantochloa purpurea	H	1	3	4
Meliaceae	*Carapa procera*	T		6	6
	Entandrophragma cylindricum	T		1	1
	Khaya anthotheca	T	7	2	9
	Trichilia monadelpha	T		2	2
	Trichilia prieuriana	T	7	8	15
	Trichilia tessmannii	T	1		1
Moraceae	*Antiaris toxicaria*	T	5	4	9
	Broussonetia paperyfera	T	67	155	222
	Dorstenia kameruniana	S	1		1
	Ficus exasperata	T		5	5
	Ficus sur	T		3	3
	Ficus varifolia	T	1	2	3
	Ficus vogeliana	T	1	9	10
	Morus mesozygia	T		2	2
	Myrianthus arboreus	T		2	2
	Trilepsium madagascariense	T	1		1
Olacaceae	*Olax subscorpioidea*	T	1	8	9
	Strombosia glaucescens	T		1	1
Pandaceae	*Microdesmis puberula*	T	5	3	8
Passifloraceae	*Adenia cissampeloides*	L		1	1
Phyllanthaceae	*Bridelia grandis*	T		1	1
Poaceae	*Acroceras zizanoides*	G	2		2
	Imperata cylindrica	G		1	1
	Leptaspis urceolata	G	1		1
	Olyra latifolia	S		3	3
	Oplismenus burmannii	G		1	1
	Pennisetum purpureum	G		9	9
	Sorghum arundinaceum	G	1	1	2
Rubiaceae	*Aidia genipiflora*	T	3	1	4
	Coffea togoensis	T	1		1
	Hallea ledermannii	T	1	1	2
	Morinda morindoides	L	1		1
	Mussaenda elegans	L		1	1
	Rothmannia longiflora	T	1	3	4
	Rothmannia whitfieldii	T	1		1
	Tricalysia pallens	L	1	2	3
Sapindaceae	*Blighia sapida*	T	1		1
	Blighia unijugata	T		1	1
	Deinbollia cuneifolia	T		1	1
	Lecaniodiscus cupanioides	T	3	3	6
	Paullinia pinnata	L		5	5

Sapotaceae	*Malacantha alnifolia*	T	1		1
Smilacaceae	*Smilax kraussiana*	L		1	1
Solanaceae	*Lycopersicon esculatum*	C		2	2
Thelypteridaceae	*Cyclosorus afer*	F		1	1
Ulmaceae	*Celtis mildbraedii*	T	1	2	3
	Holoptelea grandis	T		1	1
	Trema orientalis	T		2	2
Urticaceae	*Musanga cecropioides*	T	1		1
Verbenaceae	*Clerodendron cephalanthum*	L		1	1
Violaceae	*Rinorea angustifolia*	T	8	8	16
	Rinorea oblongifolia	T	2		2
	Rinorea yaundensis	T	3	1	4
Zingiberaceae	*Aframomum stanfieldii*	H	4	9	13
Unknown	*Ataenidia conferta*	L		1	1
	Chytranthus carneus	L		2	2
	Cyathula prostrata	H		2	2
	Landolphia dulcis	L		1	1
	Leptodermis micrantha	L		1	1
	Sclerodendron capitatum	L	2		2
	Sp. 2015.1	T		1	1
	Sp. 2015.G1	G	1		1
	Sp. 2015.L1	L		1	1
	Sp. 2015.T1	T	1		1
		Total	**212**	**517**	**729**

*H=Herb, L=Liana, T=Tree, R=Rattan, S=Shrub, F=Fern, C=Crop www.forminternational.nl