UN-REDD
PROGRAMME

Inventory of Volume and Biomass Tree Allometric Equations for Central and South America

UN-REDD PROGRAMME

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The UN-REDD Programme, implemented by FAO, UNDP and UNEP, has two components: (i) assisting developing countries prepare and implement national REDD strategies and mechanisms; (ii) supporting the development of normative solutions and standardized approaches based on sound science for a REDD instrument linked with the UNFCCC. The programme helps empower countries to manage their REDD processes and will facilitate access to financial and technical assistance tailored to the specific needs of the countries.

The application of UNDP, UNEP and FAO rights-based and participatory approaches will also help ensure the rights of indigenous and forest-dwelling people are protected and the active involvement of local communities and relevant stakeholders and institutions in the design and implementation of REDD plans.

The programme is implemented through the UN Joint Programmes modalities, enabling rapid initiation of programme implementation and channeling of funds for REDD efforts, building on the in-country presence of UN agencies as a crucial support structure for countries. The UN-REDD Programme encourage coordinated and collaborative UN support to countries, thus maximizing efficiencies and effectiveness of the organizations' collective input, consistent with the "One UN" approach advocated by UN members.

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Photo credit:
Miguel Cifuentes. Biomass harvest in a Gmelina arborea plantation in Colombia.

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Contents

List of Figures

List of Tables

1. Introduction

Robust and transparent national systems for Measurement, Reporting and Verification (MRV) are necessary for REDD+ countries to properly assess any changes in fluxes of greenhouse gases due to the implementation of national actions designed to support international climate change efforts. A key element of any MRV system is the availability of methods and tools to accurately assess national volume, biomass and carbon stocks from trees and forested landscapes. Despite recent criticisms (Clark and Kellner 2012), a fundamental step in the calculation of these stocks, regardless of the techniques or scale, is the use of tree allometric equations. These are mathematical functions that relate variables that are hard to measure directly (i.e. the total dry mass of a standing tree) with other measurements that are easier to obtain (i.e. diameter at breast height, tree height, crown diameter, etc.).

The quality of the allometric equations being used will determine in large part the uncertainty associated with any landscape-scale estimate of biomass or carbon. In a study in Panama, for example, Chave *et al.* (2004) found the choice of allometric model was the most important source of error in biomass quantification; reaching up to 20 percent of the final estimate. Thus, to reduce uncertainty in biomass quantification, forestry personnel must be able to gain access to high quality, locally relevant equations.

Despite the large number of equations published in international journals worldwide, the choice of an appropriate one for a given location can become a challenge. First of all, technical personnel working in developing countries may have limited access to international journals, online resources and recent publications where allometric equations are usually described allometric equations are not always published in peer-reviewed journals and internationally distributed media. On the other hand, many equations constructed nationally through graduate and undergraduate research are not published internationally and lost in local library catalogs and bookshelves. Also, equations are not generally fully documented at the time of publication; background information on their construction and application is seldom explicitly and completely stated, making their choice and application dubious at best.

To complicate matters, the thousands of tree and plant species growing in tropical forests and landscapes make it impossible to have species-specific equations for all of them. Thus, ecosystem-wide or generalized equations must often be used; these tend to be constructed for the most common species growing in the most extensive ecosystems. When working in high-elevation, coastal ecosystems or with less common species the available options are fewer and calculations are made with generalized biome-scale equations. Thus, only a few more common equations are used although it is preferable to use site- and species-specific equations (Ketterings *et al.* 2001).

This document describes the results of a project aimed at compiling the largest possible number of allometric equations for 20 countries in Latin America and assembling them into a database structure that can be made available internationally. We describe the methods and sources used to compile relevant data. Then an analysis of the database structure is presented in such a way that current gaps in knowledge are identified. Finally, recommendations to improve allometric equation construction and reporting in the literature are outlined.

2. Objectives of the report

The main goal of this project was to compile, systematize and document all existing volume and biomass allometric equations for individual trees, sprouts and stands of 20 countries in Central (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama) and South America (Argentina, Brazil, Bolivia, Chile, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Surinam, Uruguay and Venezuela). Mexico was not considered in this analysis because recently inventoried by Birigazzi *et al.* (2013). In addition, wet set to identify gaps in current knowledge in the availability, construction and reporting of volume and biomass allometric equations. Based on that information, we also aimed to offer recommendations to improve allometric equation construction and reporting.

3. Data compilation

Volume and biomass allometric equations were compiled by obtaining all possible hard and soft copies of articles, reports and other documents containing such equations. We considered peer-reviewed manuscripts, technical reports, theses, dissertations and other grey literature. These documents were classified and organized into a bibliographic reference collection using EndNote software. All equations found within the available documents were then extracted and relevant information related to their application (geographic location; bioclimatic information; equation parameters, units and statistics) entered into an Excel database.

Search strategy and bibliography database

To locate relevant bibliography from where to extract the equations and their associated data we used the following four basic procedures: First, requests for relevant hard and soft copies of articles, reports and other documents were sent to over 325 research and academic institutions, individual researchers, forestry officials and several on-line distribution lists (Appendix 1). This effort also resulted in secondary contacts that were also queried. We also took advantage of IICA/CATIE's ORTON Library and its extensive network of technical contacts throughout Latin America and their access to academic databases to locate additional resources. Library personnel customized a strategy that included Boolean search strings and access to specialized resources[1]. Approximately 64 percent of all compiled resources were obtained through this method. Additional on-line searches using Google Scholar were also performed. Finally, close to 100 documents (22 percent of all resources) were provided directly by the FAO through their library services. Despite our best efforts may have not considered all published materials containing allometric equations. The expectation is to progressively add more resources as they become available.

Some of the international bibliography databases queried include Science Direct-Biological Sciences, Springer Link, Dissertation and Thesis-Proquest, Lan-Teeal, Cab-Direct-Biological Sciences. In addition, specific requests were made to SIDALC (Servicio de Información para América Latina y el Caribe – Latin America and the Caribbean Information Service), The National Agricultural Library and University of Idaho (United States of America). The José Figueres Ferrer Library (Instituto Tecnológico de Costa Rica - TEC), University of Costa Rica's Documentation and Library System, the Joaquín García Monge Library (Universidad Nacional – UNA), the Central Library (Distance Learning State University – UNED), the Organization for Tropical Studies' (OTS, Duke University) BINABITROP

[1] An example Boolean expression used to find relevant documents was: "((TS=(Biomass function* OR volume function* OR allometry* OR equation* OR phytomass* OR aboveground biomass* OR belowground* OR biomass* OR *carbon)))".

electronic services and EARTH University's W. Kellogg Library in Costa Rica also provided assistance in the search efforts.

The thousands of preliminary results obtained through the four approaches described were narrowed down to 454 documents from which relevant information could be obtained. More than half of all documents found (53 percent) were journal articles, followed by books (141) and theses (61). There is an approximately equal mix of graduate and undergraduate thesis (13 Ph.D., 20 M.Sc. and 28 undergraduate) in the compiled documents. The remaining 12 documents correspond to conference papers (9) or book sections (3). Bibliographic information was extracted from those documents, indexed and entered into an EndNote database.

Data compilation

We followed methods in Baldasso *et al.* (2012) for data entry. All equations found in the selected documents were extracted and entered into an electronic database. In addition, relevant information related to their application was also entered. This information includes data on the geographic location and bioclimatic variables of the area where the equations were constructed or applied, equation parameters and their units and common regression statistics. As in Henry *et al.* (2011), any given equation can be repeated in the database to the extent that it was used in more than one location, or that it represents a single tree species or one group of tree species in one location. Also, the same species can have different equations associated to it.

Each record in the Excel database was assigned a unique identifier. The scope of applicability of each equation is reported by describing the type of growth form (*e.g.* tree, liana, mangrove, etc.), ecosystem (*e.g.* forest, plantation) and the location for which it was derived. Locations were given a unique identifying code (Appendix 2). When the exact geographic coordinates of the study were not reported in the original source we obtained them through Google Earth based on the site's name or general location within a country. When it was not possible to locate a study site, we assigned it the general coordinates for the broader description of the site where the study was carried out: municipality, state or province, region within a country, or country.

We then used the geographic coordinates of each location to extract biome classification information from publically available spatially explicit datasets. We used the FAO's GeoNetwork[2] to download GIS layers of the FAO's Global Ecological Zones[3] (FAO 2001), Udvardy's ecoregions[4] (Udvardy 1975), World Wildlife Fund (WWF) global ecoregions[5] (WWF 2000), Bailey's global map of ecoregions[6] (Bailey 1989) and Holdridge life zones map[7] (Holdridge 1967). In addition, we used the New LocClim 1.11 software (FAO Local Climate Estimator[8]; FAO 2005) to obtain basic climatic variables for each of the study locations.

Allometric equations were transcribed from each reference. Their variable names and units were entered into the database, together with the range (maximum, minimum) of measurements for each variable. This is important because using an allometric equation outside of its range can produce considerable estimation errors. We also transcribed pertinent estimation statistics related to each equation (*e.g.* n, R^2, R-adj, RMSE, etc.), as well as the vegetation components of the trees or plants considered in the equation (*e.g.* branches, stem, roots, etc.; Figure 1).

[2] http://www.fao.org/geonetwork/srv/en/main.home
[3] http://www.fao.org/geonetwork/srv/en/metadata.show?id=1255&currTab=simple
[4] http://www.fao.org/geonetwork/srv/en/metadata.show?id=1008&currTab=simple
[5] http://www.fao.org/geonetwork/srv/en/metadata.show?id=1009&currTab=simple
[6] http://www.fao.org/geonetwork/srv/en/metadata.show?id=1038&currTab=simple
[7] http://www.fao.org/geonetwork/srv/en/metadata.show?id=1006&currTab=simple
[8] Available for free download: http://www.juergen-grieser.de/downloads/ClimateInterpolation/ClimateInterpolation.htm

The genus and species for which the allometric equations were derived or applied to calculate volume or biomass were also entered into the database. Individual species were assigned a unique identification code (Appendix 3). We relied only on the original sources for the species identification and common names. To avoid bias or errors, we did not update taxonomic names to their current nomenclature but we checked spelling of species names using several on-line databases. Some sources only referred to the species by common names. In those cases, we made no attempt to assign a scientific name to the species given the considerable uncertainty involved in matching common names with their correct scientific names.

Finally, the bibliographic citation of each source was also entered into the database to facilitate later recovery of additional information pertaining to each equation. Quality control routines were run to ensure internal consistency in location names, species, variable names, units, mathematical expressions, etc. Additional checks were implemented to ensure all geographic locations were correct to the best of our knowledge.

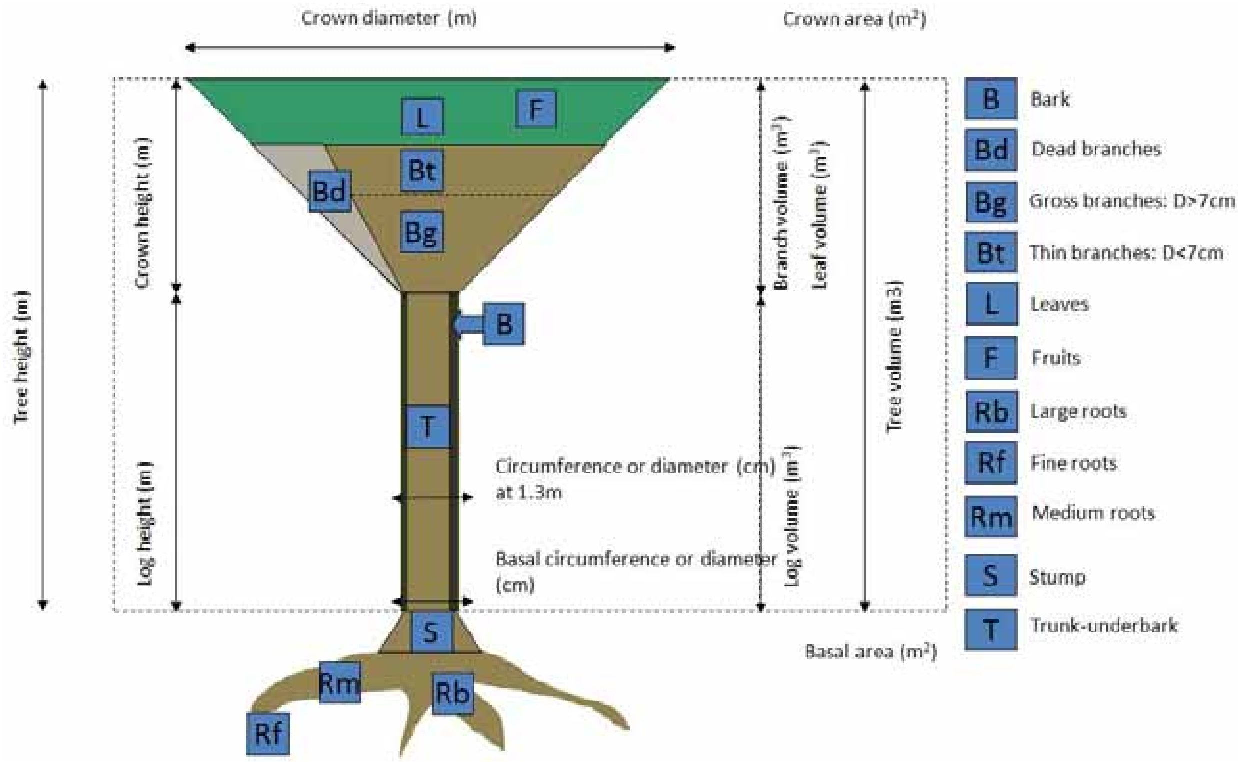

Figure 1. Representation of tree components considered in the descriptions of allometric equations for 20 Latin American countries. For a full description of tree components, see Baldasso *et al.* (2012). Figure taken from Henry *et al.* (2011).

4. Data description and structure

The database is composed of 84 variables, grouped into seven categories, as described in Birigazzi *et al.* (2013) and Baldasso *et al.* (2012). The database currently consists of 8 265 unique records extracted from 154 documents. A record corresponds to each instance a given equation was reportedly used at a given location or for a given tree species. Thus, the same equation can repeat itself in the database multiple times, but each instance corresponds to a unique combination of site and species.

The database currently consists of 1 237 unique equations. Almost 89 percent of those are for forest ecosystems. The remaining equations were derived for plantations (10 percent) and other ecosystems with varying degrees of tree cover (i.e. agroforestry and pastures). Tree equations represent close to 87 percent of all equations in the database. Equations for mangroves, palms and tree ferns are the least common; only 3 percent of records in the database correspond to these growth forms. Liana equations represent 10 percent of the total (Table 1).

Table 1. Ecosystems and plant forms for which volume, biomass and carbon allometric equations are available in Latin America.

Ecosystem	Population	Number of equations
Forest	Tree	949
	Liana	125
	Mangrove	35
	Palms	4
	Tree ferns	1
Plantation	Tree	128
Pasture	Tree	6
Agroforestry	Palms	1
	Tree	1

Source: this study.

Equations were found for 14 of the 20 countries in Latin America (Figure 2). We were unable to locate equations for Belize, Bolivia, El Salvador, Ecuador, Guyana, or Uruguay. This does not imply allometric equations have not been developed for those countries. In fact, only in El Salvador 3 independent experts stated there were no locally-derived equations[9]. In Ecuador, on the other hand, local UN-REDD and an FAO team are actively searching and compiling locally available equations. These can be added to this database at a later date.

There are forest equations available for the 14 countries represented in the database. Currently, the five countries with the most equations in the database (Figure 3) are Brazil (409), Colombia (253), Argentina (177), Chile (114) and Costa Rica (86). Together, they represent almost 75 percent of all equations. In contrast, approximately two thirds of all records currently in the database correspond to Brazil (46 percent), Colombia (19 percent) and Venezuela (11 percent). Plantation equations are available for Brazil, Chile, Colombia, Costa Rica, Nicaragua, Panama, Peru and Venezuela. We found agroforestry equations only for Colombia, Costa Rica and Nicaragua, most likely because of the prevalence of that type of ecosystems in those countries. A set of equations for trees in pasture ecosystems was only found for Costa Rica.

[9] Personal communications with Ángel Baltazar, Amilcar López (Ministry of Agriculture), Frank Sullivan Cardoza (GIZ).

Records span average annual temperature from 11 to 27.6 ºC. A total of 26 of Holdridge Life Zones (Holdridge, 1967) are included in the database (Table 2). We emphasize this biogeographic classification system because it is the most widely used in Latin America. Life zones range from very dry to rain forests and from tropical forests to polar tundra, covering a very wide range of precipitation and temperatures. Despite this apparent diversity in ecosystems the distribution of equations is highly skewed in the database; over 90 percent of all equations were constructed for 11 life zones and 95 percent of all equations for 15 of all life zones found in Latin America. The subtropical moist forest life zone has the most equations (477) among all life zones, while the tropical dry forest represents has 268. Close to 18 percent of all equations in the database were constructed for the subtropical wet and subtropical dry forests life zones.

Table 2. Number of volume and biomass equations available by Holdridge Life Zone for Latin America.

Holdridge Lize Zone	Number of equations	Percent
Subtropical moist forest	477	30.83
Tropical dry forest	268	17.32
Subtropical wet forest	150	9.70
Subtropical dry forest	135	8.73
Tropical moist forest	106	6.85
Warm temperate moist forest	74	4.78
Warm temperate dry forest	60	3.88
Cool temperate moist forest	59	3.81
Cool temperate wet forest	26	1.68
Boreal rain forest	25	1.62
Subtropical rain forest	23	1.49
Subtropical thorn steppe	21	1.36
Tropical very dry forest	20	1.29
Subtropical desert	18	1.16
Boreal wet forest	16	1.03
Tropical desert bush	13	0.84
Boreal moist forest	12	0.78
Cool temperate steppe	12	0.78
Warm temperate wet forest	10	0.65
Unclassified	8	0.52
Cool temperate rain forest	4	0.26
Warm temperate thorn steppe	3	0.19
Cool temperate desert bush	2	0.13
Polar desert	2	0.13
Cool temperate desert	1	0.06
Polar wet tundra	1	0.06
Warm temperate desert bush	1	0.06
Total	**1547**	**100.00**

Source: this study.

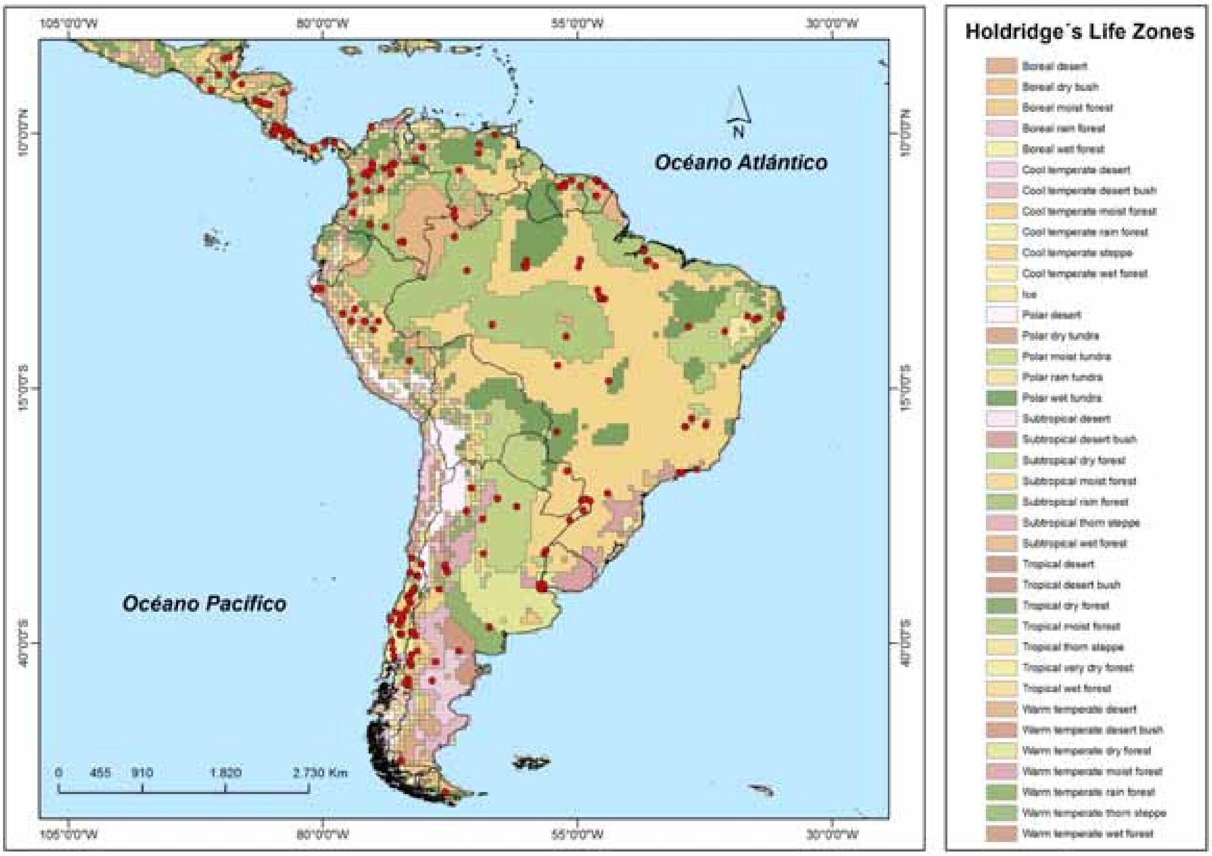

Figure 2. Location of study sites in Latin America showing the Life Zones where tree volume, biomass and carbon allometric equations have been constructed. Map by Freddy Argotty, CATIE, Costa Rica, with data from this study and the FAO's GeoNetwork10.

Before drawing further conclusions regarding the distribution of sample points within global biomes, we must recognize the global resolution of the biome classification data and the potential of misclassification because of this. The case of Manaus, Brazil, illustrates this point clearly. The Holdridge life zones map[11] used for this project classifies this site as "Tropical dry forest". However, it is more properly classified as a "moist forest", with average annual rainfall of over 2 000 mm, average temperature of 27 ºC and a dry season of only 4 months (Holdridge 1967, Carvalho *et al.* 1998, Gehring *et al.* 2004). Nevertheless, it is not always possible to properly describe the biome classification of a study site when little or no climatic information is provided in the original source. We recommend the use of downscaled or local (i.e. higher spatial resolution) biome classifications combined with elevation data to better pin-point bioclimatic conditions.

[10] http://www.fao.org/geonetwork/srv/en/main.home
[11] http://www.fao.org/geonetwork/srv/en/metadata.show?id=1006&currTab=simple

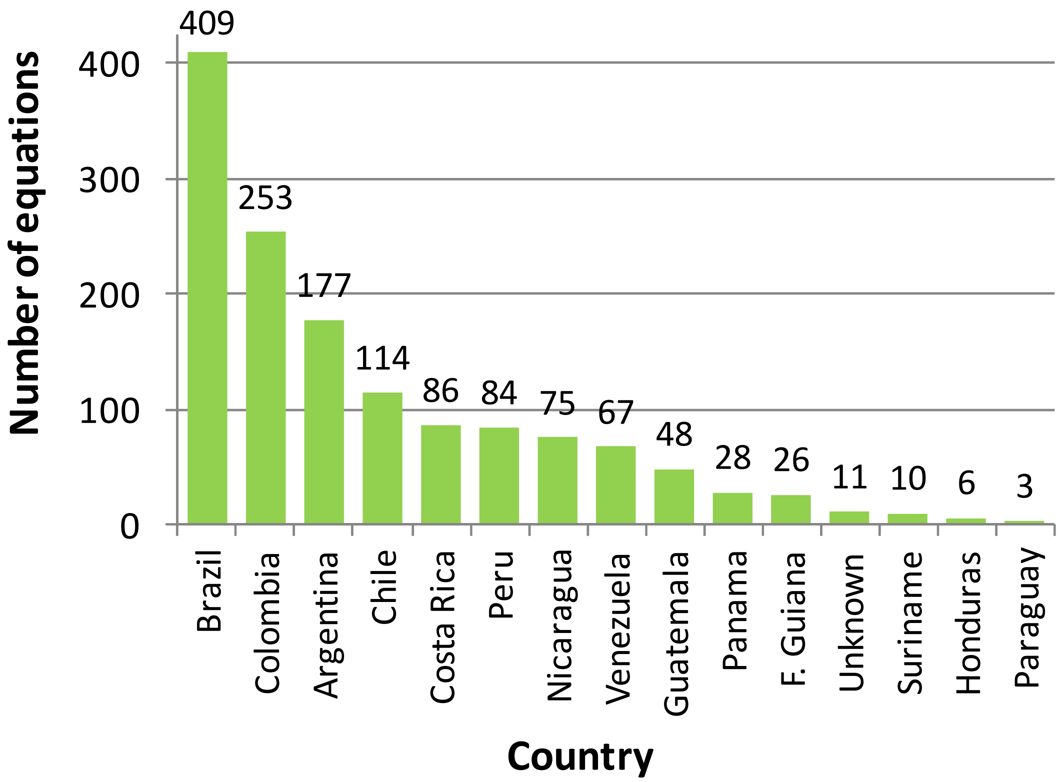

Figure 3. Number of allometric equation database records by Latin American country. Source: this study.

We found a consistently increasing trend in the number of studies published (Figure 4). Less than 10 references were available before 1970. Starting in the 1970's publishing of allometric equation show an increasing trend, reaching a rate of 6.5 documents published per year in the 1990's. The largest number of references (214 documents) where found to be published between 2000 and 2009. Since 2010 documents containing allometric equations are being published at a rate of 25 per year, slightly over the 21 per year in the previous decade. Only time will tell if this trend is sustained or if it decreases during the 2010's.

Approximately 40 percent of all equations those have their output log-transformed. The most common transformation (35 percent) was the natural logarithm transformation (Log base e), followed by the Log10 transformation (5 percent). Almost 10 percent of all equations have an exponential (e^x) component. From the remainder equations, 34 percent are square polynomials or include a squared term (X^2). Only 1.5 percent of the equations include a cubic (X^3) term.

We classified the output of the equations into 16 categories that include biomass, volume, carbon, height, bark and other dasonomic variables (see Table 3 for a summary of equation types). Equations to calculate biomass represent almost 70 percent of all equations in the database, followed by tree volume equations (23 percent). Together, the remaining output categories add up to less than 9 percent of the equations. Approximately 49 percent of all equations have 2 variables (X and Y) and 15 percent have 3 variables (X, Y, Z). Diameter at breast height (measured commonly at 1.30m height) is the most commonly used main variable; it is used in 79 percent out of the total 1237 equations. In two-variable equations, height is used 62 percent of the times as the second variable. Wood density is used 75 percent of the times when a third variable is included in the equations.

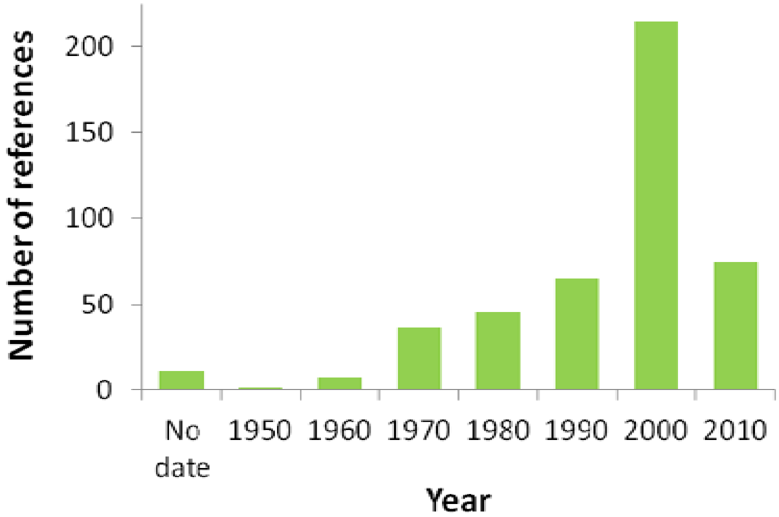

Figure 4. Number of documents containing allometric equations published as peer-reviewed manuscripts, technical reports, theses and other gray literature for 20 Latin American countries between 1950 and 2013. Source: this study.

There is a wide variation in the tree components considered by the equations. It is not always clear which tree components are included or not (*e.g.* the degree to which the stump of harvested tree is considered in the total biomass assessment, or exactly what size branches were harvested). In some cases where it was unclear what the difference might be between two components (e.g. "total tree height" and "height"). We tried to remain true to the original source to avoid introducing transcription errors into the database.

Stem and bark are the two components most commonly addressed by allometric equations; they are included in close to 80 percent of all records. Branches and leaves are included in 35 to 57 percent of the cases. Very few countries have root-specific equations: Brazil, Colombia, Costa Rica (see Cole and Ewel 2006; Pereira da Silva 2007 and Sierra *et al.* 2001 for examples). Because of the strenuous field effort, time and high costs involved in their quantification, thick and fine roots are only included in approximately 5 to 6 percent of the equations. However, medium-sized roots are included in less than 2 percent of the existing equations. This discrepancy may be due to the lack of clear definitions and thresholds used consistently across studies. Another reason for it may be the inadequate methodological descriptions in the original documents.

Table 3. Types of equations available to calculate biomass, volume and other dasometric variables in Latin America.

Type of output	Number of equations	Percentage
Biomass	852	68.71
Volume	282	22.74
Fresh biomass	35	2.82
Carbon	21	1.69
Bark	13	1.05
Leaf area	10	0.81
Height	10	0.81
Other	17	1.37

Source: this study.

By far, the least common tree component considered while constructing allometric equations are the fruits (considered in only 0.1 percent of all cases). From this fact, we may infer flowers are also underrepresented as tree biomass components. However, it can be argued they are a very small proportion of total tree biomass and that its presence depends on reproductive cycles which may be longer than a year. Thus, their inclusion in allometric equations may not be always advisable.

There are 94 plant families registered in the database, plus an "Unknown" family category. The Fabaceae and the "Unknown" family have over 300 equations each, followed by Pinaceae and Euphorbiaceae (186 and 103 equations each). Approximately 50 percent of all equations in the database were constructed for only 12 plant families (Figure 5) and 75 percent for 27 families (dat not shown).

There are 891 registered species names in the database, which also includes 174 species described only with their common name or represent a growth form (*e.g.* "conifers" or "tree ferns"; Appendix 3). There are also a large number of "unknown" species records. In fact, this category is the most common, with 82 percent of all records where a species name could not be assigned to a particular equation. The small proportion of fully identified records is consistent with results from inventories in high diversity tropical forests because of how difficult it is to reliably identify trees and other forest plants. In addition, we identified 70 groups of species for which allometric equations were derived.

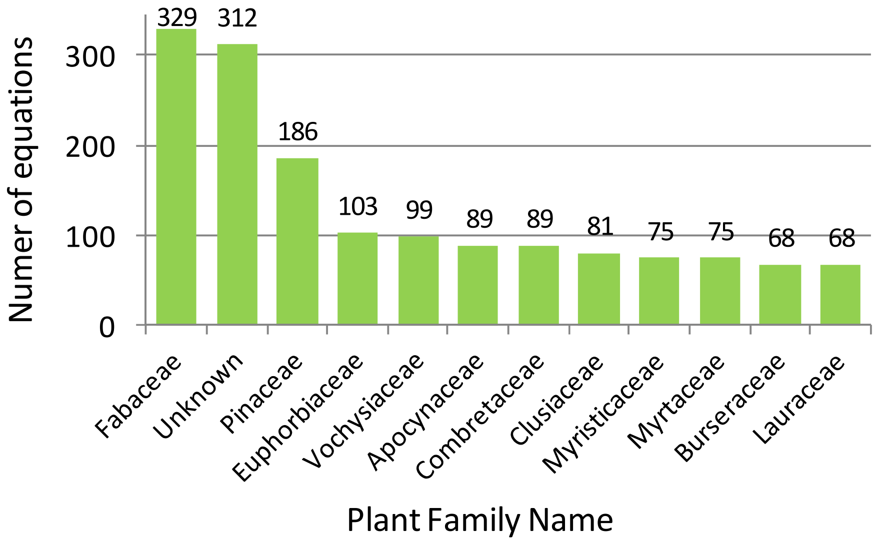

Figure 5. Plant families with the most volume and biomass equations developed in Latin America.The entire database includes 94 plant families. Source: this study.

There are an approximately equal number of volume and biomass equations for the species names in the database (512 and 528, respectively). The 10 genera with the greatest number of associated equations are *Pinus* (185), followed by *Inga* (96), *Vochysia* (83), *Aspidosperma* (80), *Terminalia* (72), *Protium* (59), *Cecropia* (56), *Eschweilera* (56), *Eucalyptus* (56) and *Ocotea* (55). There are 268 equations associated with unknown species (Table 4). This possibly reflects the widespread use of generalized equations across the region and suggest increased uncertainty in the estimates of volume and biomass (and, thus, carbon) being calculated.

Table 4. Genera with the greatest number of unique equations associated to them for calculating volume, biomass and carbon stocks in Latin America.

Genus	Number
unknown	268
Pinus	185
Inga	96
Vochysia	83
Aspidosperma	80
Terminalia	72
Protium	59
Cecropia	56
Eschweilera	56
Eucalyptus	56
Ocotea	55
Machaerium	50
Araucaria	47
Virola	46
Vismia	46
Mimosa	45
Rhizophora	41
Dialium	37
Dipteryx	37
Sclerolobium	37
Bellucia	35

Source: this study.

5. Gaps in assessing volume, biomass and carbon stocks in South and Central America

Available equations can be analyzed in light of IPCC Good Practice Guidelines (IPCC 2003), which in general terms outline that reporting should be complete, transparent, documented, consistent over time, comparable, assessed for uncertainties and subject to quality control and assurance. The database itself is built having those principles in mind. However, the quality of information contained in it can only be as good as the underlying data from the literature. Thus, our analysis and recommendations focus on the latter.

Completeness, transparency and documentation

There is good representation of countries in the database (Figure 1). For countries missing data from the database, additional efforts are needed to locate key local experts and records in each of those countries. In the case of Ecuador, the compilation of allometric equations by UN-REDD and an FAO team will be done later in 2013 and data can be directly incorporated into the database.

Despite our best efforts, it became apparent during this project that there are additional documents where allometric equations may be extracted from. However, recovering them completely may be a daunting task because there is no certain way of knowing the real extent of published materials, the format they are in, incomplete catalogs and lack of available personnel in local libraries and even archaic copyright regulations. In Colombia, for example, a university library is only allowed to share scanned copies of the first few pages of a document. A written authorization from the author of the document would be needed to release the full document. Many allometric equations are constructed as part of graduate or undergraduate students' research. Once they graduate it is nearly impossible to locate them to obtain the required "fair use" authorization. Further contacts with local researchers and libraries may be needed to fully document all available sources of allometric equations.

Non-compliance with minimum publishing and reporting standards is possibly the greatest weakness in allometric database reporting. Current database protocols use global geographic layers for classifying biomes and extracting climate data from study site coordinates. Because of the lower resolution of these datasets, it is possible to misclassify particular biomes. We also encountered instances where geographic limits do not match among layers, thus complicating consistent bioclimatic characterization. The obvious alternative would be to use bioclimatic data from the original sources or from local climate data and biome classifications layers. However, this type of information is not consistently reported in the literature, is seldom complete, or may not be available at all in some countries.

Lack of completeness is also apparent in other areas. For example, in some instances there is not enough information to properly identify the location of a study site. Only general directions may be given and no geographic coordinates provided to the reader. This complicates retrieving equations that may be applicable to a given region within a country. Having the name of the research site does not a guarantee its exact location either because the same name may be used in two or more regions of the same country.

A critical weakness we encountered was the lack of proper description of the tree components included in any given allometric equation. This is also related to the lack of uniform definitions of tree components and output from allometric equations. For example, a commonly used term in equation reporting is "total aboveground biomass" or "total biomass". However, this may or may not include leaves, dead branches and it seldom includes (0.01 percent of all records) fruits, or explicitly mentions whether the stump of the tree was included in the assessment or not. A potentially large amount biomass and carbon may thus be ignored in allometric equation development and we lack a reliable way of detecting and documenting where these errors might be originating. In general, researchers and publishing venues must become increasingly preoccupied with raising the quality and completeness of their reporting. An international set of "good practice" guidelines focused on allometric equations is needed to achieve this goal.

Problems with species identification that are common in many tropical forest inventories are also an identified weakness in the data we compiled. To avoid introducing further uncertainty and errors in the database, we remained true to the original sources when it came to plant taxonomy. However, we recognize that by doing this some species records and equations may be repeated or not properly indexed (i.e. the case of *Carapa guianensis* and its known synonym *Carapa nicaraguensis*, or the misclassification between *Rhizophora harrisonii* and *Rhizophora mangle*). At the core of this problem is the difficulty of correctly identifying species in the field. Any misidentification at that stage will propagate itself into the literature. Once there, it is all but impossible to correct. Thus, this problem should be corrected during early stages of research by using trained plant taxonomists or double-checking species identifications with local herbaria. In some cases, depositing collected specimens in those herbaria may be advisable.

The construction of allometric equations is currently biased towards trees in moist and wet forests. Other less common biomes such as dry and very dry forests, cloud forests and other high elevation ecosystems and coastal ecosystems (namely, mangroves), are greatly underrepresented in the available literature. In addition, research is highly biased towards above ground tree components. Currently, the only available large-scale tropical allometric equation available for roots is the one published by Cairns *et al.* (1997). This is understandable, given the considerable effort it takes to completely harvest the stump and complete root systems. However, additional efforts should be devoted to addressing this knowledge gap if we are to improve below ground biomass and carbon estimates.

Trees used in agroforestry systems or growing in silvopastoral systems are grossly under-represented in our sample; 0.6 percent of all records (8 equations). This may be due to the small number of species commonly growing in those systems. Similarly, the database contains equations for only 18 tree species (128 equations, Table 1) used in plantations. Although the number of tree species used in plantations is likely much higher in Latin America, especially considering the increasing promotion of native species for reforestation and landscape restoration, the ones included in the database are among the most common species used in large scale reforestation: *Acacia mangium*, *Eucalyptus* spp., *Gmelina arborea*, *Pinus caribaea*, *P. radiata* and *Tectona grandis*.

Using the number of native tree species contained in the FAO's Forest Resources Assessment database (FAO 2006[12]), we determined there are species-specific allometric equations for an average 10 percent of species identified in the countries so far included in the database (Table 5). This proportion, however, varies wildly and depends in part on the number of native species identified in each country. Countries with less native species identified are more likely to have developed equations for a larger proportion of those species (Figure 6). In Brazil, for example, only 4 percent of the close to 8000 native species has an associated allometric equation. In contrast, in Argentina and Costa Rica, more than 20 percent of the approximately 120 to 240 native species identified have an associated allometric equation.

[12] Data table available for download at:
http://foris.fao.org/static/data/fra2005/global_tables/FRA_2005_Global_Tables_EN.xls

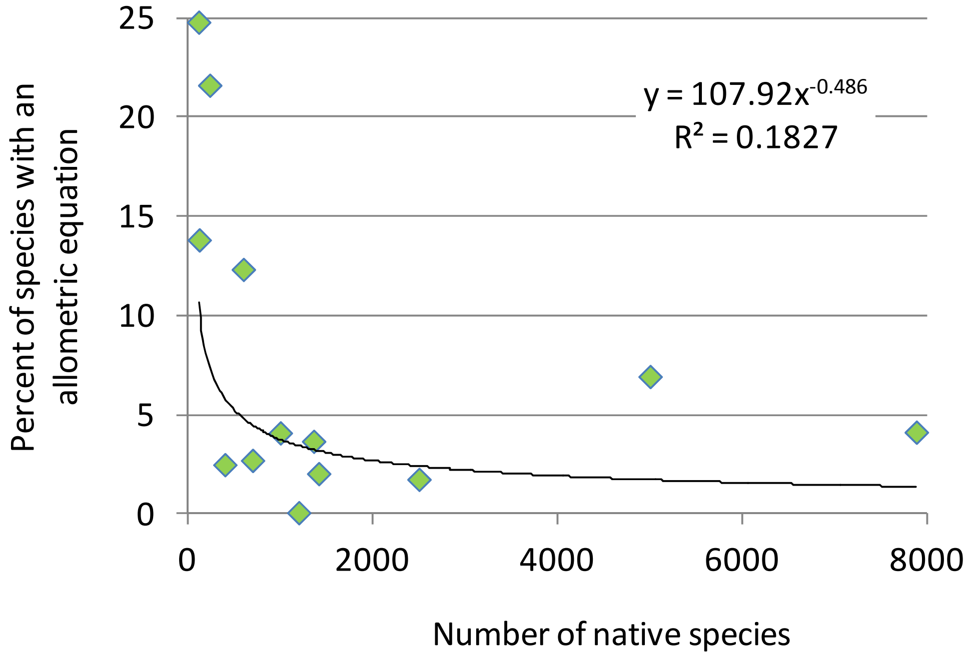

Figure 6. The proportion of tree species within a country for which allometric equations have been developed decreases with the total number of species identified. Data from this study and FAO (2006).

Given the high diversity of species in tropical forests and the logistical barriers to develop a large number of species-specific equations, it is difficult to determine what would be a sensible minimum target number of available species-specific equations for the Latin America. First of all, we would need better estimates of species richness. For example, while Condit *et al.* (2010) report 2300 tree species for Panama and Jiménez *et al.* (2002) report 2000 tree species for Costa Rica, FAO (2006) reports 1415 and 117. The use of "native" species by the FAO may only partly explain the difference. Information on growth patterns and plant functional traits may prove useful for grouping species into ecological groups with similar allometries. This could potentially reduce the number of allometric equations required to estimate large scale biomass and carbon stocks, while ensuring a broader representation of species.

In comparison, having a relatively large number of equations does not guarantee sufficient options for calculating volume and biomass stocks throughout Latin America. For mangrove ecosystems, for example, we identified 36 equations for only 4 mangrove tree species. However, those equations are representative of only 6 sites in 3 countries (Brazil, French Guiana and Nicaragua). Furthermore, the equations for French Guiana (Chave *et al.* 2005) are generic to any mangrove forest in the tropics. It is likely that biogeographic and phylogenetic differences among sites and species require us to use species and site-specific (or at least region-specific) equations. Although it may seem a relatively large number of equations available for just a handful of species, it may not be appropriate to assume that we have generated enough allometric equations to reliably quantify volume or biomass in mangrove ecosystems. An option to address problems with species over- or under-representation in allometric equations would be to pool species with similar growth habits (see Ortiz 1997 and Ortiz 2010).

Table 5. Number of tree species for which volume and biomass allometric equations are available in Latin America.

Country	Number of species	FRA (2006)	Percent of species
Argentina	51	236	21.6
Brazil	326	7880	4.1
Chile	17	123	13.8
Colombia	347	5000	6.9
Costa Rica	29	117	24.8
French Guiana	1	1200	0.1
Guatemala	19	700	2.7
Honduras	10	400	2.5
Nicaragua	41	1000	4.1
Panama	29	1415	2.0
Peru	44	2500	1.8
Suriname	74	600	12.3
Venezuela	50	1360	3.7

Source: this study, FAO (2006).

Quality control and assurance

Beyond the quality control and assurance (QA/QC) procedures in place for entering equations into the database, we must also be observant of these procedures in the actual sources of information as they affect the quality of the equations.

It is generally assumed that published materials are peer-reviewed and that all efforts have been made to accurately depict research procedures and results. However, this is not a failsafe method to ensure quality of scientific work or statistical procedures. We identified two main types of errors common in the literature. The first happens when equations are transcribed incorrectly or modified from the original source (compare equations from Frangi and Lugo (1985), Hughes *et al.* (1999) and Araujo *et al.* (1999) as cited by Návar (2009) for examples). The second type of errors arises when equations are attributed to the wrong source. For example, van Breugel *et al.* (2011) erroneously attribute the equation "-2.134+2.53*Ln(X)" to Brown *et al.* (1989), when the correct citation is Brown (1997).

These errors are further complicated because secondary citations are often used as if they were the primary source of equations, creating the illusion of many more equations being available. For example, equations Návar (2009) attributes to Montero and Kanninen (2005) are reproduced from Montero and Kanninen (2002). Keller *et al.* (2001) attribute an equation from Carvalho *et al.* (1998), but they in turn attribute the equation to Santos (1996). In this particular instance, we were unable to locate this last document so we were unable to verify if it was in fact the original source of the equation or if it also simply transcribed the equation from yet another document. In other cases, because of bad citations, it is impossible to track the original source and verify the equations contained therein. In Chave *et al.* (2001), for example, two equations are attributed respectively to Higuchi *et al.* (1998) and Araujo *et al.* (1999), but those equations cannot be found in the original sources, making their verification impossible. As a final example, the original source of an equation may not be properly recognized. In an article by Sierra *et al.* (2007) the equation for Aboveground tree biomass in secondary forests (D≥1 cm) "Ln(AB-T)= -2.232+2.422*Ln(D)" is reported as developed through that particular study, when the original source is Colorado (2001). In view of this evidence, we strongly recommend users of allometric equations to exhaust all available means to locate the original sources of any equations they might be using.

Any published allometric equation should have a large enough sample size and be sufficiently robust to produce output with high degree of certainty. Although there is no one rule to determine what the minimum sample size might be to construct robust allometric equations, statisticians commonly consider a sample size of 30 adequate to control for sample variation. If we apply this rule of thumb, we find over one third of all catalogued equations were constructed using small sample sizes. On the other hand, a similar proportion of equations have sample sizes larger than 100 harvested individuals. Although a large proportion of the equations seem to have a large enough sample size, we need to re-evaluate the robustness and applicability of those equations constructed from small sample sizes.

An additional element to improve the robustness of allometric equations would be the use of modern statistical methods. Generalized linear methods and other techniques now allow researchers to better control sources of variation and heteroscedasticity in fitting regression lines. Older publications, when these methods were not available may or may not fully control variation during regression, yielding less robust equations.

It is difficult to assess the robustness of allometric equations because validation outside the area where they were constructed is not generally done. The effort and cost involved in constructing allometric equations is not trivial, which may partly explain why validation is not common. However, due to phylogenetic variations among locales, it is entirely possible that populations of trees of the same species would have different allometries. Validation studies such as those carried out by Álvarez *et al.* (2011) and Álvarez *et al.* (2012) should be encouraged.

Finally, all efforts should be made to ensure wide distribution of available information. Beyond printed formats, the increasing use and availability of electronic media is recommended as a medium to distribute and exchange information on allometric equations.

6. Conclusions and recommendations

There is considerable and increasing attention in improving the availability and quality of allometric equations to calculate volume, biomass and carbon in Latin America. Although there seems to be an adequate geographic distribution in the equations catalogued through our efforts, the distribution of equations available per country is skewed, with most of the available equations constructed for a small number of countries and also biased towards trees in moist and wet forests. The lack of allometric equations in other less common biomes such as dry and very dry forests, cloud forests and other high elevation ecosystems and coastal ecosystems (namely, mangroves) needs to be addressed. In addition, increased attention should be devoted to constructing root allometric equations and properly include other relevant but often ignored tree components such as the stump.

For countries missing data from the database, additional efforts are needed to locate key local experts and records in each of those countries. Further contacts with local researchers and libraries are thus needed to fully document all available sources of allometric equations.

Given the high diversity of species in tropical forests, it is difficult to determine what would be a sensible minimum target number of available equations for the Latin America. Dominant species, or those more frequently used in restoration or reforestation should be prioritized. For other, less common, species allometric equations could be constructed based on similarities in growth patterns, ecological habits (light-loving species, shade-tolerant, etc.) or even functional traits. We recommend using trained plant taxonomists or double-checking species identifications with local herbaria to reduce the uncertainty in species identification and taxonomy.

Non-compliance with minimum publishing and reporting standards is possibly the greatest weakness in allometric database reporting. A critical weakness we encountered was the lack of proper description of the tree components and definitions of terms that describe the output from an equation. In general, researchers and publishing venues must become increasingly preoccupied with raising the quality and completeness of their reporting. An international set of “good practice” guidelines focused on allometric equations is needed to achieve this goal. To minimize errors transcribing equations, all possible efforts should be made to locate the original document where they were first published. In addition, reviewers and editors should make sure equations have been transcribed correctly from their original sources before publishing.

A capacity building program may be needed to adequately complete the process of constructing and reporting allometric equations. Renewed attention should also be devoted to training technicians and researchers in sampling theory and statistical regression methods to properly deal with uneven variances and increase the robustness of future models. Validation studies such as those carried out by Álvarez *et al.* (2011) and Álvarez *et al.* (2012) should be encouraged.

Finally, all efforts should be made to ensure wide distribution of available information. Beyond printed formats, the increasing use and availability of electronic media is recommended as a medium to distribute and exchange information on allometric equations. The current database is, by nature, a work in progress. Thus, we encourage continued efforts to expand it and expand its use as a tool for quantifying terrestrial biomass and carbon stocks in Latin America.

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Appendix 2. List of location codes and names

Location Code	Location Name	Country
500	Cerro Guazu	Paraguay
502	Reserve near Lake Yojoa	Honduras
504	Cachipo, Managas	Venezuela
505	Manaus	Brazil
506	Northeastern Nicaragua	Nicaragua
507	National Forest Alejandro Von Humboldt, Pucalpa	Peru
509	Piste de Saint-Elie	French Guiana
510	Santiago del Estero	Argentina
511	Colchagua	Chile
512	La Suiza	Costa Rica
513	Uaxactun	Guatemala
514	Rio Chanchich	Guatemala
515	Sur	Chile
516	Patagonia	Argentina
517	Bariloche	Argentina
518	Region VI	Chile
519	Rio Negro	Argentina
520	Misiones	Argentina
521	Chubut	Argentina
522	Chile	Chile
525	Colombia	Colombia
526	Municipality of Serra Talhada	Brazil
527	Uverito Mongas	Venezuela
528	Caparino Barinas	Venezuela
530	San Martin	Peru
532	Para	Brazil
533	Barro Colorado	Panama
534	Brazil	Brazil
535	Sta Luz	Brazil
536	Northeast Brazil	Brazil
537	Sarapiqui	Costa Rica
539	San Ramon, Matagalpa	Nicaragua
540	Las Mesas de Moropotente	Nicaragua
541	Livingston	Guatemala
542	French Guiana	French Guiana
543	Venezuela	Venezuela
545	Rio de Janeiro	Brazil
546	La Selva Biological Station	Costa Rica
548	Nhecolandia	Brazil
549	Porce	Colombia
550	Parana	Brazil
551	Heredia	Costa Rica
552	Cauca	Colombia
553	Caqueta	Colombia
555	Flood Amazon	Colombia
556	Siquinala	Guatemala
557	District of Caroalina, Pernambuco	Brazil
558	Reserva natural de Cachalu, Santander	Colombia
559	Reserva natural Encenillo, Cundinamarca	Colombia
560	Reserva Forestal Serrania de San Lucas	Colombia

561	Minas Gerais	Brazil
562	Departamento de Piura	Peru
563	Araracuara Floodplain	Colombia
564	Cajamarca	Peru
565	Cajabamba	Peru
566	San Jose de Cusmapa	Nicaragua
567	San Pedro del potrero Grande	Nicaragua
568	Soutwest of Esteli	Nicaragua
569	Northwest of Leon	Nicaragua
570	Madriz	Nicaragua
571	Nueva Segovia	Nicaragua
572	Northern border with Honduras	Nicaragua
573	West border with Honduras	Nicaragua
574	Oriente Rio Macareli	Nicaragua
575	Quebrada los Terrerios	Nicaragua
576	Rio Arenal de Yauli	Nicaragua
577	Quebrada la America	Nicaragua
578	Rio Murra	Nicaragua
579	Rio Jicaro	Nicaragua
580	Tacana	Guatemala
581	San Jose Ojetenam	Guatemala
582	Cuilco	Guatemala
583	Tectitan	Guatemala
584	Northwestern Mato Grosso	Brazil
585	Southern Para	Brazil
586	Piura University Campus	Peru
587	Piura University Campus	Peru
595	Guatemala	Guatemala
596	Peru	Peru
597	Curvelo, Minas Gerais	Brazil
598	Araracuara White Sands	Colombia
599	Araracuara Old Terrace	Colombia
600	Carare Opon	Colombia
601	Rio Melcocho	Colombia
602	San Carlos de Rio Negro	Colombia
603	Capiro colinas	Colombia
604	Bajo Calima	Colombia
605	Piedecuesta, Santander	Colombia
606	Santa Helena	Colombia
607	Tona	Colombia
608	San Vicente	Colombia
609	Dry caribean	Colombia
610	Telteca Reserve	Argentina
611	Departamento de Cordoba	Colombia
612	Central Amazonia	Brazil
613	Petrolina	Brazil
614	Puntarenas	Costa Rica
615	Provincia Linares	Chile
616	Maule	Chile
617	Ñuble	Chile
618	Concepcion	Chile
619	Bio-Bio	Chile
620	Arauco	Chile
621	Malleco	Chile

622	Corregimiento de Solano	Colombia
623	Guapiles	Costa Rica
624	Tapajo´s National Park	Brazil
625	Serra do Mar State Park	Brazil
626	Serra da Bocaina National Park	Brazil
627	Salta	Argentina
628	Quindio	Colombia
629	Valle del Cauca	Colombia
630	Esparza	Costa Rica
631	Matiguas	Nicaragua
632	Aconcagua	Chile
633	Valparaiso	Chile
634	Santiago	Chile
635	O´Higgins	Chile
636	Colchagua	Chile
637	Curico	Chile
638	Talca	Chile
639	Valdivia	Chile
640	Osorno	Chile
641	Llanquigue	Chile
642	La Pantera	Mexico
643	Mato Grosso	Brazil
644	Tome Acu, Para	Brazil
645	Jari, Para	Brazil
646	Belem	Brazil
647	Rondonia	Brazil
648	Llanos secondary	Venezuela
649	Llanos old growth	Venezuela
650	Araracuara	Colombia
652	San Carlos	Venezuela
653	Cayenne	French Guiana
654	Sinnamary	French Guiana
655	Iracoubo	French Guiana
657	Kabo	Suriname
658	Yeguada	Panama
663	Apostoles	Argentina
664	Estacion Forestal. “Manuel Belgrano”(San Antonio)	Argentina
665	Lago Moquehue	Argentina
666	Monte Quemado	Argentina
667	Chaco	Argentina
668	Departamento Colon	Argentina
669	Departamento Concordia	Argentina
670	Departamento Federacion	Argentina
671	Parque Pereyra Iraola	Argentina
672	South edge of Lake General Vintter	Argentina
673	Cerro Colorado	Argentina
674	Rio Turbio	Argentina
675	Valle del Rio de Las Vueltas	Argentina
676	Cuartel Forestal Bombilla	Argentina
677	Ituzaingo	Argentina
678	Puerto Esperanza	Argentina
679	Departamento Iguazu	Argentina
680	Faldeos de las sierras del Aconquija (Famailla).	Argentina
681	San Carlos de Bariloche	Argentina

682	Corcovado	Argentina
683	Departamento de Alumine	Argentina
685	Caribbean region	Costa Rica
686	Caribbean region	Brazil
	Cocais	Brazil
687	Rio Doce	Brazil
688	Sabinopolis	Brazil
689	Santa Barbara	Brazil
690	Virginopolis	Brazil
692	Municipality of Sertania	Brazil
693	São Gabriel da Cachoeira	Brazil
694	Delta Bonaerense	Argentina
695	El Foyel	Argentina
696	El Coihue	Argentina
697	Cuesta de los Terneros	Argentina
698	Loma del Medio	Argentina
699	Las Golondrinas	Argentina
700	Cerro Radal	Argentina
701	Central Valley	Chile
703	Panama Canal Watershed	Panama
707	Fallawatra, Paramaribo	Suriname
708	Nassau, Paramaribo	Suriname
709	Kabalebo, Paramaribo	Suriname
710	Region Atlantica	Costa Rica
714	San Felipe	Colombia
715	Itamaraca, Pernambuco	Brazil
716	Several locations	unknown
	unknown	unknown
717	Igarape do Vinagre	Brazil
720	Illapel, Choapa	Chile
722	Comuna de Maria Pinto, Provincia Melipilla	Chile
725	Paragominas	Brazil
726	Central Valley, Dry sands, low fertilization treatment	Chile
727	Central Valley, Red clay, low fertilization treatment	Chile
728	Central Valley, Recent Volcanic, low fertilization treatment	Chile
729	Amazonas	Brazil
730	unknown	Panama
		unknown
731	Curua-Una	Brazil
732	Kilometer 41, Manaus	Brazil
733	unknown	Venezuela
734	Nouragues Research Station	French Guiana
735	San Carlos de Rio Negro	Venezuela
736	Cocha Cashu	Peru
737	Central Valley, Dry sands, medium & high fertilization treatment	Chile
738	Central Valley, Red clay, medium & high fertilization treatment	Chile
739	Central Valley, Recent Volcanic, medium fertilization treatment	Chile
740	Central Valley, Dry sands, low, medium & high fertilization	Chile
741	Central Valley, Red clay, low, medium & high fertilization treatment	Chile

Appendix 3. List species codes

Species Code	Genus	Species	Species Name
500	Eriotheca	globosa	Eriotheca globosa
501	Bombax	munguuba	Bombax munguuba
502	Pachira	aquatica	Pachira aquatica
504	Ceiba	pentandra	Ceiba pentandra
505	Aspidosperma	polyneuron	Aspidosperma polyneuron
506	Pinus	caribaea	Pinus caribaea
508	Pinus	sp.	Pinus sp.
509	Eucalyptus	globulus	Eucalyptus globulus
510	Pinus	oocarpa	Pinus oocarpa
514	Spondias	mombin	Spondias mombin
515	Clarisia	racemosa	Clarisia racemosa
516	Brosimum	rubescens	Brosimum rubescens
517	Brosimum	uleanun	Brosimum uleanun
518	Swartzia	polyphylla	Swartzia polyphylla
520	Pterocarpus	vernalis	Pterocarpus vernalis
521	Virola	surinamensis	Virola surinamensis
522	Virola	pavonis	Virola pavonis
523	Iryanthera	laevis	Iryanthera laevis
525	Virola	flexuosa	Virola flexuosa
526	Copaifera	officinalis	Copaifera officinalis
529	Hura	crepitans	Hura crepitans
533	Hevea	sp.	Hevea sp.
534	Perebea	sp	Perebea sp
536	Perebea	chimicua	Perebea chimicua
537	Matisia	cordata	Matisia cordata
538	Matisia	bicolor	Matisia bicolor
548	Eschweilera	sp.	Eschweilera sp.
549	Eschweilera	timbuchensis	Eschweilera timbuchensis
550	Lecythis	peruviana	Lecythis peruviana
552	Eschweilera	equitoensis	Eschweilera equitoensis
553	Chorisia	insignis	Chorisia insignis
554	Ceiba	samauma	Ceiba samauma
557	Swietenia	macrophylla	Swietenia macrophylla
559	Cedrela	odorata	Cedrela odorata
560	Simaruba	amara	Simaruba amara
561	Cedrela	fissilis	Cedrela fissilis
562	Trichilia	sp.	Trichilia sp.
566	Guarea	trichilioides	Guarea trichilioides
567	Guarea	macrophylla	Guarea macrophylla
572	Myroxylon	balsamum	Myroxylon balsamum
574	Myroxylon	peruiferum	Myroxylon peruiferum
575	Pouteria	sp.	Pouteria sp.
576	Manilkara	bidentata	Manilkara bidentata
577	Aspidosperma	varguessi	Aspidosperma varguessi
578	Brosimum	alicastrum	Brosimum alicastrum
581	Virola	koschnyi	Virola koschnyi
582	Dialium	guianense	Dialium guianense
583	Pentaclethra	macroloba	Pentaclethra macroloba
584	Terminalia	oblonga	Terminalia oblonga
585	Tetragastris	panamensis	Tetragastris panamensis
586	Vochysia	ferruginea	Vochysia ferruginea

587	Vochysia	hondurensis	Vochysia hondurensis
588	Pterocarpus	hayessi	Pterocarpus hayessi
589	Dipteryx	oleifera	Dipteryx oleifera
590	Saccoglottis	trichogyna	Saccoglottis trichogyna
591	Mirandaceltis	monoica	Mirandaceltis monoica
592	Rhizophora	harrisonii	Rhizophora harrisonii
593	Bellucia	sp.	Bellucia sp.
594	Goupia	glabra	Goupia glabra
595	Laetia	procera	Laetia procera
596	Vismia	cayennensis	Vismia cayennensis
597	Vismia	japurensis	Vismia japurensis
598	Croton	matourensis	Croton matourensis
599	Cecropia	sciadophylla	Cecropia sciadophylla
600	unknown	unknown	Aguacatillo
601	Acacia	pennatula	Acacia pennatula
602	unknown	unknown	Coloradito
603	unknown	unknown	Hichoso
604	unknown	unknown	Maria
605	Psidium	guajava	Psidium guajava
607	Calophyllum	brasiliense	Calophyllum brasiliense
608	Cybistax	donnell-smithii	Cybistax donnell-smithii
609	Vochysia	guatemalensis	Vochysia guatemalensis
611	Pinus	maximoi	Pinus maximoi
612	Pinus	caribaea var. hondurensis	Pinus caribaea var. hondurensis
613	Coffea	sp.	Coffea sp.
614	Quercus	sp.	Quercus sp.
615	Buddleia	megalocephala	Buddleia megalocephala
616	Alnus	sp.	Alnus sp.
617	Eucalyptus	camaldulensis	Eucalyptus camaldulensis
618	Quercus	humboldtii	Quercus humboldtii
619	Weinmannia	tomentosa	Weinmannia tomentosa
620	Bejaria	resinosa	Bejaria resinosa
621	Cavendishia	cordifolia	Cavendishia cordifolia
622	Clethra	fimbriata	Clethra fimbriata
623	Diplostephium	rosmarinifolium	Diplostephium rosmarinifolium
624	Drymis	granatensis	Drymis granatensis
625	Hesperomeles	goudotiana	Hesperomeles goudotiana
626	Macleanea	rupestris	Macleanea rupestris
627	Myrsine	dependens	Myrsine dependens
628	Vallea	stipularis	Vallea stipularis
629	Viola	macrocarpa	Viola macrocarpa
630	Compsoneura	rigidifolia	Compsoneura rigidifolia
631	Clusia	cruciata	Clusia cruciata
632	Faramea	flavicans	Faramea flavicans
633	Blakea	granatensis	Blakea granatensis
634	Clusia	shomburgkiana	Clusia shomburgkiana
635	Billia	rosea	Billia rosea
636	Aniba	cinnamomiflora	Aniba cinnamomiflora
637	Sterigmapetalum	tachirensis	Sterigmapetalum tachirensis
639	Alfaroa	colombiana	Alfaroa colombiana
640	Eucaliptus	microcorys	Eucaliptus microcorys
641	Prosopis	pallida	Prosopis pallida
642	Pinus	insigne	Pinus insigne
644	Virola	sebifera	Virola sebifera

646	Carapa	nicaraguensis	Carapa nicaraguensis
649	Hymenaea	courbaril	Hymenaea courbaril
650	Terminalia	amazonia	Terminalia amazonia
653	Symphonia	globulifera	Symphonia globulifera
654	Vatairea	lundellii	Vatairea lundellii
655	Hyeronima	alchorneoides	Hyeronima alchorneoides
656	Brosimum	costaricanum	Brosimum costaricanum
658	Pithecellobium	arboreum	Pithecellobium arboreum
659	Astronium	graveolens	Astronium graveolens
661	unknown	unknown	All other species
662	Pinus	pseudostrobus	Pinus pseudostrobus
663	unknown	unknown	Roble
664	unknown	unknown	Roble amarillo
665	unknown	unknown	Roble negro
666	unknown	unknown	Roble encino
667	unknown	unknown	Guayavillo
671	Lonchocarpus	castilloi	Lonchocarpus castilloi
672	Lysiloma	sp.	Lysiloma sp.
676	Machaerium	hoehneanum	Machaerium hoehneanum
677	Machaerium	madeirensis	Machaerium madeirensis
678	Machaerium	castaneiflorum	Machaerium castaneiflorum
679	Machaerium	caudatum	Machaerium caudatum
680	Machaerium	ferox	Machaerium ferox
682	Machaerium	amplum	Machaerium amplum
683	Virola	melinonii	Virola melinonii
684	Clitoria	leptostachya	Clitoria leptostachya
685	Dicorynia	guianensis	Dicorynia guianensis
686	Manikara	bidentata	Manikara bidentata
687	Vouacapoua	americana	Vouacapoua americana
688	Rourea	cuspidata	Rourea cuspidata
689	Davilla	rugosa	Davilla rugosa
690	Securidaca	rivinaefolia	Securidaca rivinaefolia
691	Memora	adenophera	Memora adenophera
692	Pseudoconnarus	rhynchosioides	Pseudoconnarus rhynchosioides
693	Leucocalantha	aromatica	Leucocalantha aromatica
694	Strychnos	subcordata	Strychnos subcordata
695	Oenocarpus	bataua	Oenocarpus bataua
696	Quillaza	saponaria	Quillaza saponaria
697	Peumus	boldus	Peumus boldus
698	Acacia	saligna	Acacia saligna
700	Pinus	radiata	Pinus radiata
701	Pinus	ponderosa	Pinus ponderosa
702	Austrocedrus	chilensis	Austrocedrus chilensis
703	Araucaria	angustifolia	Araucaria angustifolia
710	Azadirachta	indica	Azadirachta indica
713	Gmelina	arborea	Gmelina arborea
716	Eucalyptus	urophylla	Eucalyptus urophylla
719	Tectona	grandis	Tectona grandis
720	Aspidosperma	pyrifolium	Aspidosperma pyrifolium
721	Croton	sonderianus	Croton sonderianus
722	Jatropha	mollissima	Jatropha mollissima
723	Caesalpinia	pyramidalis	Caesalpinia pyramidalis
724	Maytenus	rigida	Maytenus rigida
725	Mimosa	hostilis	Mimosa hostilis

726	Anadenanthera	macrocarpa	Anadenanthera macrocarpa
727	Myracrodruon	urundeuva	Myracrodruon urundeuva
728	Schopsis	glabra	Schopsis glabra
729	Cereus	jamacaru	Cereus jamacaru
734	Dipteryx	panamensis	Dipteryx panamensis
738	Ocotea	glomerata	Ocotea glomerata
739	Ocotea	petalanthera	Ocotea petalanthera
741	Inga	punctata	Inga punctata
742	Inga	tonduzzi	Inga tonduzzi
743	Cordia	alliodora	Cordia alliodora
744	Cecropia	sp.	Cecropia sp.
745	Vismia	guianensis	Vismia guianensis
746	Avicennia	schaueriana	Avicennia schaueriana
747	Rhizophora	mangle	Rhizophora mangle
748	Laguncularia	racemosa	Laguncularia racemosa
749	Clusia	hilariana	Clusia hilariana
752	Euterpe	oleracea	Euterpe oleracea
754	Diptychandra	aurantiaca	Diptychandra aurantiaca
755	Protium	heptaphyllum	Protium heptaphyllum
756	Magonia	pubescens	Magonia pubescens
757	Terminalia	argentea	Terminalia argentea
758	Licania	minutiflora	Licania minutiflora
759	Pinus	taeda	Pinus taeda
760	Acacia	mangium	Acacia mangium
761	Bactris	gasipaes	Bactris gasipaes
762	Coffea	arabica	Coffea arabica
765	Acosmium	sp.	Acosmium sp.
766	Astronium	fraxinifolium	Astronium fraxinifolium
767	Byrsonima	coccolobifolia	Byrsonima coccolobifolia
768	Curatella	americana	Curatella americana
769	Eriotheca	gracilipes	Eriotheca gracilipes
770	Erythroxylum	suberosum	Erythroxylum suberosum
771	Lafoensia	pacari	Lafoensia pacari
772	Piptocarpha	rotundifolia	Piptocarpha rotundifolia
773	Plathymenia	reticulata	Plathymenia reticulata
774	Pouteria	torta	Pouteria torta
775	Pterodon	emarginatus	Pterodon emarginatus
776	Qualea	grandiflora	Qualea grandiflora
777	Qualea	parviflora	Qualea parviflora
778	Sclerolobium	sp.	Sclerolobium sp.
779	Solanum	sp.	Solanum sp.
781	Inga	sp.	Inga sp.
782	Pseudolmedia	laevigata	Pseudolmedia laevigata
783	unknown	unknown	Broadleaf species
784	Tapirira	guianensis	Tapirira guianensis
785	unknown	unknown	General forest equation
786	Dussia	sp.	Dussia sp.
787	Prosopis	flexuosa	Prosopis flexuosa
788	Virola	sp.	Virola sp.
789	unknown	unknown	unknown unknown
790	unknown	unknown	Aguasco
791	unknown	unknown	Cacho
792	Cedrelinga	catenaeformis	Cedrelinga catenaeformis
794	Olmediaperebea	sp.	Olmediaperebea sp.

795	Guarea	sp.	Guarea sp.
796	Erisma	sp.	Erisma sp.
798	Sterculia	rugosa	Sterculia rugosa
801	Qualea	sp.	Qualea sp.
802	unknown	unknown	Balato
803	unknown	unknown	Bollo puerco
804	Apeiba	sp.	Apeiba sp.
805	unknown	unknown	Diablo
807	unknown	unknown	Mantequilla
808	unknown	unknown	Mochilero
809	unknown	unknown	Mollejo
810	unknown	unknown	Palo arco
811	Capirona	sp.	Capirona sp.
813	Nectandra	sp.	Nectandra sp.
814	Protium	sagotianum	Protium sagotianum
815	Iryanthera	juruensis	Iryanthera juruensis
816	unknown	unknown	Cacao
817	unknown	unknown	Nabueno
818	unknown	unknown	Lacre
819	unknown	unknown	Totumo
820	unknown	unknown	Vara santa
821	unknown	unknown	Cenizo
822	Inga	coruscans	Inga coruscans
823	Carapa	guianensis	Carapa guianensis
825	Stryphnodendron	microstachyum	Stryphnodendron microstachyum
826	Bauhinia	alata	Bauhinia alata
827	Bauhinia	guianensis	Bauhinia guianensis
828	Acacia	multipinnata	Acacia multipinnata
829	Mimosa	guilandinae	Mimosa guilandinae
830	Mimosa	spruceana	Mimosa spruceana
831	Senna	tapajozensis	Senna tapajozensis
832	Memora	moringifolia	Memora moringifolia
833	Pleonotoma	jasminifolia	Pleonotoma jasminifolia
834	Derris	negrensis	Derris negrensis
835	Derris	amazonica	Derris amazonica
836	Amburana	cearensis	Amburana cearensis
839	Cariniana	pyriformis	Cariniana pyriformis
841	Pouteria	pedicellosa	Pouteria pedicellosa
843	Clathrotropis	brachypetala	Clathrotropis brachypetala
844	Ormosia	paraensis	Ormosia paraensis
849	Xylopia aff	emarginata	Xylopia aff emarginata
850	Caryocar	amygdaliferum	Caryocar amygdaliferum
852	Brosimun	potabile	Brosimun potabile
853	Gustavia	brasilensis	Gustavia brasilensis
854	Calophyllum	mariae	Calophyllum mariae
855	Basiloxylon	excelsum	Basiloxylon excelsum
856	Jacaranda	copaia	Jacaranda copaia
857	Xylopia	sp.	Xylopia sp.
858	Guatteria	sp.	Guatteria sp.
859	Hyeronima	sp.	Hyeronima sp.
861	Dacryodes	colombiana	Dacryodes colombiana
862	Humiriastrum	colombianum	Humiriastrum colombianum
863	Hymenea	courbaril	Hymenea courbaril
864	Protium	neglectum	Protium neglectum

865	Copaifera	canime	Copaifera canime
868	Aspidosperma	megalocarpum	Aspidosperma megalocarpum
869	Prioria	copaifera	Prioria copaifera
871	Bombacopsis	quinata	Bombacopsis quinata
872	Couratari	guianensis	Couratari guianensis
874	Lecithys	sp.	Lecithys sp.
875	Aniba	perutilis	Aniba perutilis
876	Podocarpus	sp.	Podocarpus sp.
877	Centrolobium	paraense	Centrolobium paraense
878	Tabebuia	guayacan	Tabebuia guayacan
879	Piptadenia	rigida	Piptadenia rigida
880	Vataireopsis	spp.	Vataireopsis spp.
882	Couma	macrocarpa	Couma macrocarpa
884	Cespedecia	macrophylla	Cespedecia macrophylla
885	Coumarouma	sp.	Coumarouma sp.
886	unknown	unknown	Balsamo
887	Hyeronima	chocoensis	Hyeronima chocoensis
888	unknown	unknown	Cariseco
889	Huberodendron	patinoi	Huberodendron patinoi
890	unknown	unknown	Cartageno
892	Pourouma	apiculata	Pourouma apiculata
894	unknown	unknown	Cope
895	Apeiba	aspera	Apeiba aspera
896	Matayba	trianae	Matayba trianae
897	Guazuma	ulmifolia	Guazuma ulmifolia
899	Bursera	simaruba	Bursera simaruba
900	Guopia	sp.	Guopia sp.
901	unknown	unknown	Laureles
903	unknown	unknown	Mangle
904	unknown	unknown	Nispero
905	Enterolobium	sp.	Enterolobium sp.
906	Peltogyne	pubescens	Peltogyne pubescens
907	Brosimum	utile	Brosimum utile
908	Sterculia	caribaea	Sterculia caribaea
910	Sterculia	sp.	Sterculia sp.
911	unknown	unknown	Azafran
912	Ochroma	lagopus	Ochroma lagopus
913	unknown	unknown	Caballo muerto
914	Xilosma	sp.	Xilosma sp.
915	Crudia	sp.	Crudia sp.
916	Aspidosperma	curranii	Aspidosperma curranii
918	unknown	unknown	Guasca dulce
919	Terminalia	sp.	Terminalia sp.
920	Ficus	sp.	Ficus sp.
922	Rheedia	sp.	Rheedia sp.
923	Luehea	seemannii	Luehea seemannii
924	Iryanthera	ulei	Iryanthera ulei
925	Didymopanax	morototoni	Didymopanax morototoni
927	Crescentia	cujeta	Crescentia cujeta
929	unknown	unknown	Abinge
930	unknown	unknown	Abraza palo
931	unknown	unknown	Abrojo
932	Bixa	orellana	Bixa orellana
934	unknown	unknown	Aguachento

935	unknown	unknown	Algondoncillo
936	unknown	unknown	Almanegra
937	unknown	unknown	Amanzamoso
938	unknown	unknown	Amarrabollo
939	Annona	sp.	Annona sp.
940	unknown	unknown	Arara
941	unknown	unknown	Ardeverde
942	unknown	unknown	Ariza
943	unknown	unknown	Arracacho
944	Myrcia	sp.	Myrcia sp.
945	Himatanthus	articulata	Himatanthus articulata
946	unknown	unknown	Azulejo
947	unknown	unknown	Babaternero
948	unknown	unknown	Bastimento
949	Ryania	speciosa var. chocoensis	Ryania speciosa var. chocoensis
950	unknown	unknown	Borrajo
951	unknown	unknown	Botoncillo
952	unknown	unknown	Cabildo
953	unknown	unknown	Cabofosforo
954	unknown	unknown	Cabohacha
955	unknown	unknown	Cacao de indio
956	unknown	unknown	Cacaona
957	Parkia	pendula	Parkia pendula
958	unknown	unknown	Cachohierro
959	unknown	unknown	Cadillo
960	unknown	unknown	Cafeto
961	unknown	unknown	Calientamano
962	Sterculia	apetala	Sterculia apetala
963	unknown	unknown	Cambomba
964	unknown	unknown	Cañafistulo
965	unknown	unknown	Caracolito
966	Vismia	sp.	Vismia sp.
967	unknown	unknown	Carbon
968	unknown	unknown	Cargador
969	unknown	unknown	Carnegallina
970	unknown	unknown	Cascarillo
971	unknown	unknown	Caimito
972	unknown	unknown	Castaño
973	unknown	unknown	Caucho
974	unknown	unknown	Caunce
975	Simaba	cedron	Simaba cedron
976	Trichanthera	sp.	Trichanthera sp.
977	unknown	unknown	Clarocaliente
978	unknown	unknown	Colador
979	unknown	unknown	Copachi
980	unknown	unknown	Coroncoro
981	Bellucia	grossularioides	Bellucia grossularioides
982	unknown	unknown	Costillo
983	unknown	unknown	Cucharo
984	unknown	unknown	Cuerosapo
985	unknown	unknown	Cuerotocino
986	unknown	unknown	Culohierro
987	unknown	unknown	Curauva
988	unknown	unknown	Chagualo

989	unknown	unknown	Charro
990	unknown	unknown	Chicharron
991	unknown	unknown	Chiriguaco
992	Licania	platipus	Licania platipus
993	unknown	unknown	Espadero
994	unknown	unknown	Espermo
995	unknown	unknown	Estoraque
996	unknown	unknown	Forastero
997	unknown	unknown	Frijolillo
998	unknown	unknown	Gallinazo
999	unknown	unknown	Gaspadillo
1000	Catostemma	alstonii	Catostemma alstonii
1001	Aparisthium	cordatum	Aparisthium cordatum
1002	Matayba	scrobiculata	Matayba scrobiculata
1003	unknown	unknown	Indio viejo
1004	unknown	unknown	Jaboncillo
1005	unknown	unknown	Juana mestiza
1006	unknown	unknown	Linaza
1007	Zanthoxylon	sp.	Zanthoxylon sp.
1008	Mutigia	calabura	Mutigia calabura
1009	unknown	unknown	Malambo
1010	unknown	unknown	Manteco
1011	unknown	unknown	Manzano
1012	unknown	unknown	Marfil
1013	unknown	unknown	Mata
1014	unknown	unknown	Matarraton
1015	unknown	unknown	Melao
1016	unknown	unknown	Martindoble
1017	unknown	unknown	Mestizo
1018	unknown	unknown	Miao de caballo
1019	unknown	unknown	Miguel colorado
1020	unknown	unknown	Monadillo
1021	unknown	unknown	More
1022	unknown	unknown	Morroco
1023	unknown	unknown	Muerto
1024	unknown	unknown	Muñeco
1025	unknown	unknown	Naranjo
1026	Miconia	sp.	Miconia sp.
1027	unknown	unknown	Nipe
1028	Byrsonima	sp.	Byrsonima sp.
1029	unknown	unknown	Oreja mico
1030	unknown	unknown	Palanco
1031	unknown	unknown	Pan de mono
1032	unknown	unknown	Paragualo
1033	unknown	unknown	Pastorejo
1034	unknown	unknown	Pate vaca
1035	unknown	unknown	Pedro tomin
1036	unknown	unknown	Pegapega
1037	unknown	unknown	Peineto
1038	unknown	unknown	Piedro
1039	unknown	unknown	Piñon oreja
1040	unknown	unknown	Puerto
1041	unknown	unknown	Punte
1042	Minquartia	guianesis	Minquartia guianesis

1043	unknown	unknown	Puntelanza
1044	unknown	unknown	Quemayuca
1045	unknown	unknown	Quinino
1046	unknown	unknown	Raboiguana
1047	unknown	unknown	Rabomani
1048	unknown	unknown	Rango
1049	unknown	unknown	Rapabardo
1050	unknown	unknown	Rayo piedra
1051	unknown	unknown	Rejaljar
1052	unknown	unknown	Reijan
1053	unknown	unknown	Sapote
1054	unknown	unknown	Sietecueros
1056	unknown	unknown	Suan
1057	Phithecelobium	longifolium	Phithecelobium longifolium
1058	Trema	micrantha	Trema micrantha
1059	unknown	unknown	Tabaida
1060	Miconia	escorpicides	Miconia escorpicides
1061	unknown	unknown	Tamborero
1063	unknown	unknown	Timula
1064	unknown	unknown	Tocino
1065	Aspidosperma	dugandii	Aspidosperma dugandii
1066	unknown	unknown	Tostao
1067	unknown	unknown	Trapiche
1068	unknown	unknown	Turmetoro
1069	unknown	unknown	Ubrevaca
1070	unknown	unknown	Vara blanca
1071	unknown	unknown	Vara china
1076	Triplaris	americana	Triplaris americana
1077	unknown	unknown	Valdivio
1079	unknown	unknown	Yemahuevo
1080	unknown	unknown	Yuco
1081	Lunania	piltieri	Lunania piltieri
1082	unknown	unknown	Yuyo
1083	unknown	unknown	Zanquemuela
1084	unknown	unknown	Zen
1085	unknown	unknown	Garoero
1086	Genipa	americana	Genipa americana
1088	unknown	unknown	Mague
1089	unknown	unknown	Zorro
1090	Coclospermum	vitifolia	Coclospermum vitifolia
1091	unknown	unknown	Barrigon
1092	unknown	unknown	Peronico
1093	unknown	unknown	Palmicho
1094	unknown	unknown	Safiro
1095	unknown	unknown	Cerillo
1096	unknown	unknown	Lloron
1097	unknown	unknown	Nogal
1099	Eschweilera	odora	Eschweilera odora
2000	Couratari	sp.	Couratari sp.
2001	Tachigalia	myrmecophylla	Tachigalia myrmecophylla
2002	Coumarouma	odorata	Coumarouma odorata
2003	Nectandra	mollis	Nectandra mollis
2006	Guatteria	poeppigiana	Guatteria poeppigiana
2016	unknown	unknown	Amazonan tropical trees

2017	Mimosa	ophthalmocentra	Mimosa ophthalmocentra
2018	Fraxinus	americana	Fraxinus americana
2019	Nothofagus	pumilio	Nothofagus pumilio
2020	Eriotheca	pentaphylla	Eriotheca pentaphylla
2021	Pinus	elliottii	Pinus elliottii
2022	Cryptocaria	mandiocanna	Cryptocaria mandiocanna
2023	Abarema	jupunba	Abarema jupunba
2024	Anacardium	giganteum	Anacardium giganteum
2026	Annona	ambotay	Annona ambotay
2027	Apeiba	echinata	Apeiba echinata
2028	Aspidosperma	spruceanum	Aspidosperma spruceanum
2029	Astronium	le-cointei	Astronium le-cointei
2030	Bagassa	guianensis	Bagassa guianensis
2031	Batocarpus	amazonicus	Batocarpus amazonicus
2032	Bixa	arborea	Bixa arborea
2033	Bowdichia	nitida	Bowdichia nitida
2034	Brosimum	acutifolium	Brosimum acutifolium
2035	Brosimum	gaudichaudii	Brosimum gaudichaudii
2036	Brosimum	guianense	Brosimum guianense
2037	Brosimum	lactescens	Brosimum lactescens
2038	Castilloa	ulei	Castilloa ulei
2039	Celtis	schippii	Celtis schippii
2040	Cedrela	lilloi	Cedrela lilloi
2041	Cedrela	balansae	Cedrela balansae
2042	Astronium	urundeuva	Astronium urundeuva
2043	Chrysophyllum	sp.	Chrysophyllum sp.
2044	Cochlospermum	orinocense	Cochlospermum orinocense
2045	Conceveiba	guianensis	Conceveiba guianensis
2046	Copaifera	multijuga	Copaifera multijuga
2047	Cordia	ecalyculata	Cordia ecalyculata
2048	Cordia	sp.	Cordia sp.
2049	Cordia	sprucei	Cordia sprucei
2050	Croton	palanostigma	Croton palanostigma
2051	Diplotropis	purpurea	Diplotropis purpurea
2052	Diplotropis	triloba	Diplotropis triloba
2053	Drypetes	variabilis	Drypetes variabilis
2054	Ecclinusa	guianensis	Ecclinusa guianensis
2056	Eugenia	anastomosans	Eugenia anastomosans
2057	Fusaea	longifolia	Fusaea longifolia
2058	Guapira	noxia	Guapira noxia
2059	Guarea	humaitensis	Guarea humaitensis
2060	Guarea	grandifolia	Guarea grandifolia
2061	Guarea	kunthiana	Guarea kunthiana
2063	Anacardiaceae	spp.	Anacardiaceae spp.
2064	Annonaceae	spp.	Annonaceae spp.
2065	Apocynaceae	spp.	Apocynaceae spp.
2066	Arialaceae	spp.	Arialaceae spp.
2067	Bignoniaceae	spp.	Bignoniaceae spp.
2068	Bombacaceae	spp.	Bombacaceae spp.
2069	Boraginaceae	spp.	Boraginaceae spp.
2070	Burseraceae	spp.	Burseraceae spp.
2071	Celastraceae	spp.	Celastraceae spp.
2072	Dichapetalaceae	spp.	Dichapetalaceae spp.
2073	Eleaeocarpaceae	spp.	Eleaeocarpaceae spp.

2074	Euphorbiaceae	spp.	Euphorbiaceae spp.
2075	Flacourtiaceae	spp.	Flacourtiaceae spp.
2076	Guttiferaceae	spp.	Guttiferaceae spp.
2077	Humeriaceae	spp.	Humeriaceae spp.
2078	Icacinaceae	spp.	Icacinaceae spp.
2079	Lauraceae	spp.	Lauraceae spp.
2080	Lecythidaceae	spp.	Lecythidaceae spp.
2081	Leguminosae	spp.	Leguminosae spp.
2082	Loganiaceae	spp.	Loganiaceae spp.
2083	Melastomataceae	spp.	Melastomataceae spp.
2084	Meliaceae	spp.	Meliaceae spp.
2085	Monimiaceae	spp.	Monimiaceae spp.
2086	Moraceae	spp.	Moraceae spp.
2087	Myristicaceae	spp.	Myristicaceae spp.
2088	Myrtaceae	spp.	Myrtaceae spp.
2089	Olacaceae	spp.	Olacaceae spp.
2090	Polygonaceae	spp.	Polygonaceae spp.
2091	Rosaceae	spp.	Rosaceae spp.
2092	Rubiaceae	spp.	Rubiaceae spp.
2093	Sapindaceae	spp.	Sapindaceae spp.
2094	Sapotaceae	spp.	Sapotaceae spp.
2095	Simaroubaceae	spp.	Simaroubaceae spp.
2096	Sterculiaceae	spp.	Sterculiaceae spp.
2097	Tiliaceae	spp.	Tiliaceae spp.
2098	Ulmaceae	spp.	Ulmaceae spp.
2099	Violaceae	spp.	Violaceae spp.
2100	Vochysiaceae	spp.	Vochysiaceae spp.
2101	Palmae	spp.	Palmae spp.
2102	Dilleniaceae	spp.	Dilleniaceae spp.
2103	Anacardium	excelsum	Anacardium excelsum
2105	Mimosa	tenuiflora	Mimosa tenuiflora
2106	Araucaria	araucana	Araucaria araucana
2107	Eucalyptus	grandis	Eucalyptus grandis
2110	Balizia	elegans	Balizia elegans
2111	Protium	sp.	Protium sp.
2112	Protium	tenuifolium	Protium tenuifolium
2113	Pseudima	frutescens	Pseudima frutescens
2114	Pseudolmedia	laevis	Pseudolmedia laevis
2115	Pseudolmedia	macrophylla	Pseudolmedia macrophylla
2116	Pseudoxandra	obscurinervis	Pseudoxandra obscurinervis
2117	Qualea	paraensis	Qualea paraensis
2118	Quararibea	ochrocalyx	Quararibea ochrocalyx
2119	Rinoreocarpus	ulei	Rinoreocarpus ulei
2120	Sapium	glandulosum	Sapium glandulosum
2121	Sarcaulus	sp.	Sarcaulus sp.
2122	Schefflera	morototoni	Schefflera morototoni
2123	Sclerolobium	micropetalum	Sclerolobium micropetalum
2124	Sclerolobium	setiferum	Sclerolobium setiferum
2125	Simarouba	amara	Simarouba amara
2126	Siparuna	sp.	Siparuna sp.
2127	Spondias	lutea	Spondias lutea
2128	Machaerium	multifoliolatum	Machaerium multifoliolatum
2129	Protium	guianense	Protium guianense
2130	Abuta	rufescens	Abuta rufescens

2131	Swartzia	tessmannii	Swartzia tessmannii
2132	Tabebuia	sp.	Tabebuia sp.
2133	Talisia	cerasina	Talisia cerasina
2134	Tetragastris	altissima	Tetragastris altissima
2135	Theobroma	microcarpum	Theobroma microcarpum
2136	Theobroma	speciosum	Theobroma speciosum
2137	Tocoyena	sp.	Tocoyena sp.
2138	Torresia	acreana	Torresia acreana
2139	Toulicia	guianensis	Toulicia guianensis
2140	Tovomita	sp.	Tovomita sp.
2141	Trattinnickia	peruviana	Trattinnickia peruviana
2142	Trichilia	rubra	Trichilia rubra
2143	Trichilia	guianensis	Trichilia guianensis
2144	Trichilia	micrantha	Trichilia micrantha
2145	Trichilia	quadrijuga	Trichilia quadrijuga
2147	Vantanea	guianensis	Vantanea guianensis
2148	Vantanea	sp.	Vantanea sp.
2149	Virola	venosa	Virola venosa
2165	Pouteria	glomerata	Pouteria glomerata
2172	Andira	inermis	Andira inermis
2196	Eucalyptus	spp.	Eucalyptus spp.
2197	Schinus	fasciculata	Schinus fasciculata
2198	T.	usillo	T. usillo
2199	A.	lampa	A. lampa
2200	S.	divaricata	S. divaricata
2201	S.	aphyla	S. aphyla
2202	Larrea	divaricata	Larrea divaricata
2203	Larrea	cuneifolia	Larrea cuneifolia
2204	Mimozyganthus	carinatus	Mimozyganthus carinatus
2205	A.	gilliessi	A. gilliessi
2206	Bulnesia	retama	Bulnesia retama
2207	A.	gratisima	A. gratisima
2208	C.	pallida	C. pallida
2209	L.	ciliatum	L. ciliatum
2210	Parkinsonia	praecox	Parkinsonia praecox
2211	Geoffroea	decorticans	Geoffroea decorticans
2212	Prosopis	torquata	Prosopis torquata
2213	A.	emarginata	A. emarginata
2214	Condalia	microphylla	Condalia microphylla
2215	Aspidosperma	sp.	Aspidosperma sp.
2216	Zizyphus	mistol	Zizyphus mistol
2217	Adenophaedra	grandifolia	Adenophaedra grandifolia
2218	Alchornea	triplinervia	Alchornea triplinervia
2219	Alexa	grandifolia	Alexa grandifolia
2220	Aniba	sp.	Aniba sp.
2221	Bocageopsis	pleiosperma	Bocageopsis pleiosperma
2222	Bocageopsis	sp.	Bocageopsis sp.
2223	Bombacopis	macrocalyx	Bombacopis macrocalyx
2224	Brosimum	sp.	Brosimum sp.
2225	Caraipa	rodriguesii	Caraipa rodriguesii
2226	Chamecrista	negrensis	Chamecrista negrensis
2227	Duguetia	asterotricha	Duguetia asterotricha
2228	Duguetia	pycnastera	Duguetia pycnastera
2229	Endlicheria	bracteata	Endlicheria bracteata

2230	Erisma	bicolor	Erisma bicolor
2231	Eschweilera	rhodrodendrifolia	Eschweilera rhodrodendrifolia
2232	Heterostemon	elipticus	Heterostemon elipticus
2233	Hevea	guianensis	Hevea guianensis
2234	Hymenaea	parvifolia	Hymenaea parvifolia
2236	Iryanthera	coriacea	Iryanthera coriacea
2237	Iryanthera	lancifolia	Iryanthera lancifolia
2238	Iryanthera	paradoxa	Iryanthera paradoxa
2239	Licaria	matiniana	Licaria matiniana
2240	Macrolobium	sp.	Macrolobium sp.
2241	Micrandra	sp.	Micrandra sp.
2242	Micropholis	cylindricocarpa	Micropholis cylindricocarpa
2243	Ocotea	nigrescens	Ocotea nigrescens
2244	Protium	paniculatum	Protium paniculatum
2245	Rinorea	guianensis	Rinorea guianensis
2246	Schizolobiium	amazonicum	Schizolobiium amazonicum
2247	Scleronema	micranthum	Scleronema micranthum
2249	Sloanea	sp.	Sloanea sp.
2250	Swartzia	cuspidata	Swartzia cuspidata
2251	Swartzia	panacoco	Swartzia panacoco
2252	Swartzia	recurva	Swartzia recurva
2253	Swartzia	reticulata	Swartzia reticulata
2254	Swartzia	sp.	Swartzia sp.
2255	Swartzia	sp.2	Swartzia sp.2
2256	Swartzia	tomentifera	Swartzia tomentifera
2257	Unonopsis	duckei	Unonopsis duckei
2258	Virola	minutiflora	Virola minutiflora
2259	Vitex	sprucei	Vitex sprucei
2260	Populus	deltoides	Populus deltoides
2261	Pseudotsuga	menziesii	Pseudotsuga menziesii
2262	Salix	babilonica var. sacramenta	Salix babilonica var. sacramenta
2263	Aspidosperma	desmanthum	Aspidosperma desmanthum
2264	Brosimopsis	acutifolia	Brosimopsis acutifolia
2265	Canaresco	comumis	Canaresco comumis
2266	Cecropia	paraensis	Cecropia paraensis
2267	Chrysophyllum	excelsum	Chrysophyllum excelsum
2268	Chrysophyllum	sericeum	Chrysophyllum sericeum
2269	Chrysophyllum	sp. 1	Chrysophyllum sp. 1
2270	Chrysophyllum	sp. 2	Chrysophyllum sp. 2
2271	Chrysophyllum	sp. 3	Chrysophyllum sp. 3
2272	Chrysophyllum	sp. 4	Chrysophyllum sp. 4
2273	Chrysophyllum	sp. 5	Chrysophyllum sp. 5
2274	Chrysophyllum	sp. 6	Chrysophyllum sp. 6
2275	Chrysophyllum	sp. 7	Chrysophyllum sp. 7
2276	Chrysophyllum	sp. 8	Chrysophyllum sp. 8
2277	Chrysophyllum	sp. 9	Chrysophyllum sp. 9
2278	Chrysophyllum	sp. 10	Chrysophyllum sp. 10
2279	Cinamomum	zeylanicum	Cinamomum zeylanicum
2280	Dinizia	excelsa	Dinizia excelsa
2281	Dipteryx	odorata	Dipteryx odorata
2282	Enterolobium	schomburgkii	Enterolobium schomburgkii
2283	Eschweilera	mata-mata	Eschweilera mata-mata
2285	Euplassa	pinata	Euplassa pinata
2286	Fevillea	uncipetala	Fevillea uncipetala

2287	Hancornia	speciosa	Hancornia speciosa
2288	Hevea	brasiliensis	Hevea brasiliensis
2289	Hymenolobium	petraeum	Hymenolobium petraeum
2290	Inga	fagifolia	Inga fagifolia
2291	Inga	marginata	Inga marginata
2292	Licania	heteromorpha	Licania heteromorpha
2293	Mabea	taquary	Mabea taquary
2294	Manilkara	amazonica	Manilkara amazonica
2295	Micropholis	paraensis	Micropholis paraensis
2296	Ocotea	guianensis	Ocotea guianensis
2297	Ocotea	neesiana	Ocotea neesiana
2298	Ormosia	excelsa	Ormosia excelsa
2299	Parahancornia	amapa	Parahancornia amapa
2300	Parinarium	barbatum	Parinarium barbatum
2301	Parinarium	rodolphi	Parinarium rodolphi
2302	Piper	arthante	Piper arthante
2304	Rheedia	macrophylla	Rheedia macrophylla
2305	Ryania	augustifolia	Ryania augustifolia
2306	Saccoglotis	guianensis	Saccoglotis guianensis
2307	Sagotia	racemosa	Sagotia racemosa
2308	Sloanea	dentata	Sloanea dentata
2309	unknown	unknown	Louro tamaquare
2310	Terminalia	catappa	Terminalia catappa
2311	Thalia	geniculata	Thalia geniculata
2312	Theobrama	subincanum	Theobrama subincanum
2313	Tryanthera	sagotiana	Tryanthera sagotiana
2314	Vatairea	paraensis	Vatairea paraensis
2315	Ocotea	wachenheimii	Ocotea wachenheimii
2316	Ocotea	rubra	Ocotea rubra
2321	Xylopia	frutescens	Xylopia frutescens
2322	Miconia	argentea	Miconia argentea
2323	Inga	cocleensis	Inga cocleensis
2324	Vismia	macrophylla	Vismia macrophylla
2325	Trichospermum	galeottii	Trichospermum galeottii
2326	Byrsonima	crassifolia	Byrsonima crassifolia
2327	Pachira	sessilis	Pachira sessilis
2328	Vismia	baccifera	Vismia baccifera
2329	Annona	spraguei	Annona spraguei
2330	Conostegia	xalapensis	Conostegia xalapensis
2331	Apeiba	tibourbou	Apeiba tibourbou
2332	Cordia	bicolor	Cordia bicolor
2333	Cochlospermum	vitifolium	Cochlospermum vitifolium
2334	Banara	guianensis	Banara guianensis
2335	Thevetia	ahouai	Thevetia ahouai
2336	Casearia	sylvestris	Casearia sylvestris
2337	Cupania	cinerea	Cupania cinerea
2338	Cupania	scrobiculata	Cupania scrobiculata
2339	Miconia	affinis	Miconia affinis
2340	Lacistema	aggregatum	Lacistema aggregatum
2341	Vernonanthura	patens	Vernonanthura patens
2354	Aspidosperma	sandwithianum	Aspidosperma sandwithianum
2355	Perebea	laurifolia	Perebea laurifolia
2356	Licania	hupoleuca	Licania hupoleuca
2357	Swartzia	benthamiana	Swartzia benthamiana

2358	Sclerolobium	albiflorum	Sclerolobium albiflorum
2359	Qualea	albiflora	Qualea albiflora
2360	Carapa	procera	Carapa procera
2361	Eschweilera	longipes	Eschweilera longipes
2363	Mora	gonggrijpii	Mora gonggrijpii
2364	Eschweilera	amara	Eschweilera amara
2366	Micropholis	guianensis	Micropholis guianensis
2368	Eperua	falcata	Eperua falcata
2369	Eperua	grandiflora	Eperua grandiflora
2370	Sterculia	pruriens	Sterculia pruriens
2371	Swartzia	viridiflora	Swartzia viridiflora
2372	Chaetocarpus	schomburgkianus	Chaetocarpus schomburgkianus
2373	Couratari	stellata	Couratari stellata
2374	Inga	alba	Inga alba
2375	Macrosamanea	pedicellaris	Macrosamanea pedicellaris
2376	Saceglottis	guianensis	Saceglottis guianensis
2377	Caryocar	glabrum	Caryocar glabrum
2441	Amomyrtus	luma	Amomyrtus luma
2442	Dasyphyllum	diacanthoides	Dasyphyllum diacanthoides
2443	Eucryphia	cordifolia	Eucryphia cordifolia
2444	Drimys	winteri	Drimys winteri
2445	Gevuina	avellana	Gevuina avellana
2446	Laureliopsis	philippiana	Laureliopsis philippiana
2447	Nothofagus	dombeyi	Nothofagus dombeyi
2448	Nothofagus	nitida	Nothofagus nitida
2449	Podocarpus	nubigena	Podocarpus nubigena
2450	Saxegothaea	conspicua	Saxegothaea conspicua
2451	Weinmannia	trichosperma	Weinmannia trichosperma
2458	Juglans	olanchana	Juglans olanchana
2463	Strychnos	pseudoquina	Strychnos pseudoquina
2464	Stryphnodendron	adstringens	Stryphnodendron adstringens
2465	unknown	unknown	Mulato
2467	Pinus	spp.	Conifers
2468	unknown	unknown	Amarillo
2469	Vochysia	sp.	Vochysia sp.
2472	Paraqueiba	sericea	Paraqueiba sericea
2474	Micrandra	sprucei	Micrandra sprucei
2475	Mouriri	uncitheca	Mouriri uncitheca
2476	Virola	guianensis	Virola guianensis
2477	Xylopia	spruceana	Xylopia spruceana
2479	Iryanthera	sp.	Iryanthera sp.
2480	Cedrelinga	sp.	Cedrelinga sp.
2481	Virola	calophilla	Virola calophilla
2482	Guatteria	schomburgkiana	Guatteria schomburgkiana
2484	unknown	unknown	Cajeta
2485	unknown	unknown	Cedrillo
2486	Parkia	appositifolia	Parkia appositifolia
2488	unknown	unknown	Polvillo
2490	unknown	unknown	Guacimo
2491	Pourouma	sp.	Pourouma sp.
2501	Ryania	speciosa	Ryania speciosa
2502	unknown	unknown	Combo
2503	unknown	unknown	Congo
2507	Virola	bicuhyba	Virola bicuhyba

2508	Sloanea	guianensis	Sloanea guianensis
2510	Ecclinusa	ramiflora	Ecclinusa ramiflora
2511	Licania	hoehnei	Licania hoehnei
2512	Chrysophyllum	viride	Chrysophyllum viride
2516	unknown	unknown	Palms
2517	Cyathea	spp.	Tree ferns
2522	Leucaena	leucocephala	Leucaena leucocephala
2526	unknown	unknown	Riparian forest
2528	unknown	unknown	Secondary forest
2533	Pinus	occidentalis	Pinus occidentalis
2534	Phyllostylon	rhamnoides	Phyllostylon rhamnoides
2535	Piptadenia	macrocarpa	Piptadenia macrocarpa
2536	Calycophyllum	multiflorum	Calycophyllum multiflorum
2537	Piptadenia	excelsa	Piptadenia excelsa
2538	Patagonula	americana	Patagonula americana
2539	Cheiloclinium	cognatum	Cheiloclinium cognatum
2540	Chrysophyllum	lucentifolium	Chrysophyllum lucentifolium
2541	Chrysophyllum	prieurii	Chrysophyllum prieurii
2542	Tabebuia	avellanedae	Tabebuia avellanedae
2543	Eugenia	sp.	Eugenia sp.
2546	Pisonia	sp.	Pisonia sp.
2548	Schisnopsis	sp.	Schisnopsis sp.
2549	Zizyphus	sp.	Zizyphus sp.
2550	Prosopis	alba	Prosopis alba
2551	Prosopis	nigra	Prosopis nigra
2552	Guarea	trunciflora	Guarea trunciflora
2553	Guatteria	citriodora	Guatteria citriodora
2554	Guazuma	sp.	Guazuma sp.
2555	Gustavia	augusta	Gustavia augusta
2556	Heisteria	spruceana	Heisteria spruceana
2557	Hirtella	racemosa	Hirtella racemosa
2558	Hirtella	sp.	Hirtella sp.
2559	Hymenolobium	pulcherrimum	Hymenolobium pulcherrimum
2565	Inga	stipularis	Inga stipularis
2567	Inga	thibaudiana	Inga thibaudiana
2568	Iryanthera	sagotiana	Iryanthera sagotiana
2569	Isertia	hypoleuca	Isertia hypoleuca
2570	Maquira	sclerophylla	Maquira sclerophylla
2571	Matayba	purgans	Matayba purgans
2572	Metrodorea	flavida	Metrodorea flavida
2573	Miconia	holosericea	Miconia holosericea
2574	Mouriri	duckeanoides	Mouriri duckeanoides
2577	Ocotea	aciphylla	Ocotea aciphylla
2579	Ocotea	nitida	Ocotea nitida
2580	Ocotea	sp.	Ocotea sp.
2583	Parkia	sp.	Parkia sp.
2584	Paypayrola	grandiflora	Paypayrola grandiflora
2585	Poeppigia	procera	Poeppigia procera
2586	Pourouma	tomentosa	Pourouma tomentosa
2587	Pourouma	minor	Pourouma minor
2588	Pouteria	anomala	Pouteria anomala
2589	Pouteria	campanulata	Pouteria campanulata
2590	Pouteria	cladantha	Pouteria cladantha
2591	Pouteria	engleri	Pouteria engleri

2592	Pouteria	reticulata	Pouteria reticulata
2594	Protium	decandrum	Protium decandrum
2595	Protium	spruceanum	Protium spruceanum
2596	Ocotea	opifera	Ocotea opifera
2598	Vismia	lauriformis	Vismia lauriformis
2600	Astrocaryum	sp.	Astrocaryum sp.
2602	Alcornea	sp.	Alcornea sp.
2606	Ocotea	esmeraldana	Ocotea esmeraldana
2608	Eperua	purpurea	Eperua purpurea
2610	Humeria	balsamifera	Humeria balsamifera
2612	Vochysia	obscura	Vochysia obscura
2614	Monoterix	uaucu	Monoterix uaucu
2616	Dalbergia	spp.	Dalbergia spp.
2617	Aspidosperma	quebracho-blanco	Aspidosperma quebracho-blanco
2619	Sterculia	excelsa	Sterculia excelsa
2621	Cayaponia	coriaceae	Cayaponia coriaceae
2622	Coccoloba	sp.	Coccoloba sp.
2623	Derris	sp.	Derris sp.
2624	Doliocarpus	dentatus	Doliocarpus dentatus
2625	Gnetum	nodiflorum	Gnetum nodiflorum
2626	Gnetum	schackeanum	Gnetum schackeanum
2627	Menispermaceae	spp.	Menispermaceae spp.
2628	Peritassa	laevigata	Peritassa laevigata
2629	Pseudoconnarus	macrophyllus	Pseudoconnarus macrophyllus
2630	Hymenolobium	modestum	Hymenolobium modestum
2631	Hymenolobium	nitidum	Hymenolobium nitidum
2632	Hymenolobium	sericeum	Hymenolobium sericeum
2633	Inga	flagelliformis	Inga flagelliformis
2635	Leonia	glycycarpa	Leonia glycycarpa
2636	Lueheopsis	duckeana	Lueheopsis duckeana
2637	Maquira	calophylla	Maquira calophylla
2638	Neea	oppositifolia	Neea oppositifolia
2639	Naucleopsis	caloneura	Naucleopsis caloneura
2640	Naucleopsis	glabra	Naucleopsis glabra
2641	Ocotea	longifolia	Ocotea longifolia