Biomass estimation on 0.25-ha FOS BCI data

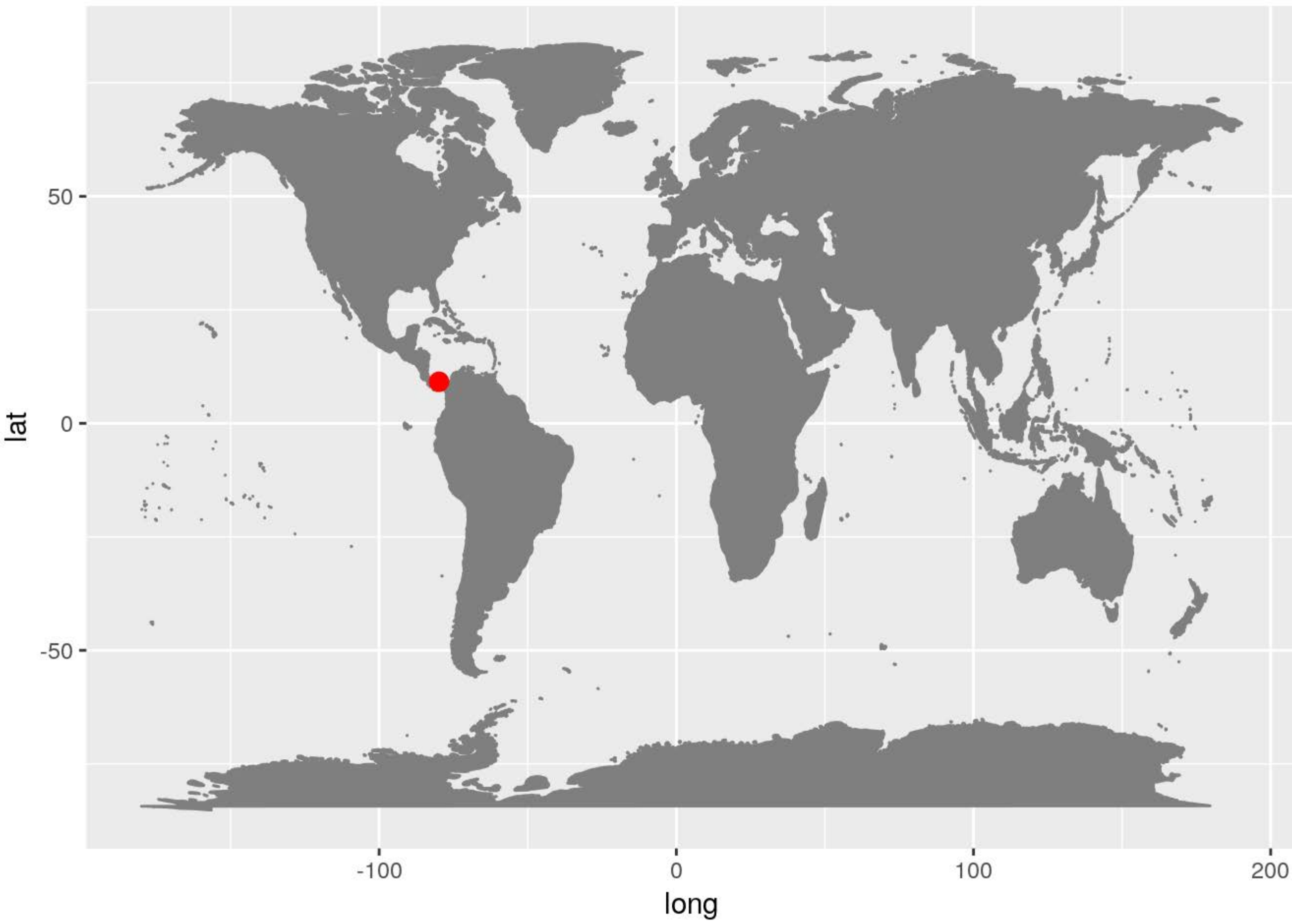
Maxime Rejou-Mechain

14 February 2017

Load data

```
library(BIOMASS)
library(proj4)
#Read in data
load("BCIdata7")
FosData<-BCIdata7
# D in cm
FosData$Dcm<-FosData$DBH/10
# Focus on trees > 10 cm
FosData<-FosData[FosData$Dcm>=10,]

# Quadrat indices
gxgy.2.indexH<-function(gx,gy,gridsize) output=paste(floor(gx/gridsize),floor(gy/gridsize),sep
="_")
FosData$QuadID<-gxgy.2.indexH(FosData$gx,FosData$gy,scale)
halfScale<-scale/2
QuadXrel<-rep(seq(halfScale,dimX-halfScale,scale),length(seq(halfScale,dimY-halfScale,scale)))
QuadYrel<-rep(seq(halfScale,dimY-halfScale,scale),each=length(seq(halfScale,dimX-halfScale,sca
le)))
QuadXabs<-(1-QuadXrel/dimX)*(1-QuadYrel/dimY)*CoordUTM[1,1]+QuadXrel/dimX*(1-QuadYrel/dimY)*Co
ordUTM[2,1]+QuadYrel/dimY*(1-QuadXrel/dimX)*CoordUTM[4,1]+QuadXrel*QuadYrel/(dimX*dimY)*CoordU
TM[3,1]
QuadYabs<-(1-QuadXrel/dimX)*(1-QuadYrel/dimY)*CoordUTM[1,2]+QuadXrel/dimX*(1-QuadYrel/dimY)*Co
ordUTM[2,2]+QuadYrel/dimY*(1-QuadXrel/dimX)*CoordUTM[4,2]+QuadXrel*QuadYrel/(dimX*dimY)*CoordU
TM[3,2]
Quadlatlong<-as.data.frame(project(cbind(QuadXabs,QuadYabs), proj=CodeUTM,inverse=T))
CoordQuadrat<-data.frame(QuadID=gxgy.2.indexH(QuadXrel,QuadYrel,scale),
                        X=QuadXabs,
                        Y=QuadYabs,
                        lon=Quadlatlong$V1,
                        lat=Quadlatlong$V2)
long.latChave<-cbind(lon=mean(CoordQuadrat$lon),lat=mean(CoordQuadrat$lat))
```

Location of the plot



Retrieve wood density

```
## [1] "Calling http://taxosaurus.org/retrieve/27facd63cb24dacdf9ed033dfc8a5caa"
## [1] "Calling http://taxosaurus.org/retrieve/b78662916b485bb791b41086f4a73e74"
## [1] "Calling http://taxosaurus.org/retrieve/b2455f37608fcf3283c60599605f92c7"
## [1] "Calling http://taxosaurus.org/retrieve/cbb6ef159d7e9e7cc863600d7a9c7c11"
## [1] "Calling http://taxosaurus.org/retrieve/927e22fec1899a10fbf8256488a2618f"
## [1] "Calling http://taxosaurus.org/retrieve/71a5adcf0f94778bbd12eec16958200a"
## [1] "Calling http://taxosaurus.org/retrieve/cf071aedf80bce935bf61ee071aeb428"
## [1] "Calling http://taxosaurus.org/retrieve/66a35026ea6af13b0e6a737a1396e6a2"
```

```
# Retrieve wood density
dataWD<-getWoodDensity(genus=tax.cor$genusCorrected,
                       species=tax.cor$speciesCorrected,
                       stand=FosData$QuadID)
```

```
## The reference dataset contains 16467 wood density values
## Your taxonomic table contains 222 taxa
```

```
FosData$WD=dataWD$meanWD
FosData$sdWD=dataWD$sdWD
```

Overall, 85.4 % of the values have been attributed at the species level, 14 % at the genus level, and 0.6 % at the

plot level.

Construct H-D models

No HD model for now

Estimating biomass and associated uncertainties

Below, we used a Bayesian Monte-Carlo scheme to estimate the mean AGB and associated credibility interval per plot.

Using Feldpausch et al. 2012 regional Weibull models

```
# Retrieving height
FosData$Hfeld=retrieveH(D=FosData$Dcm,region =FeldRegion)$H
FosData$RSEfeld=retrieveH(D=FosData$Dcm,region =FeldRegion)$RSE
# Retrieving agb per plot
resultMC<-by(FosData, FosData$QuadID,
              function(x) AGBmonteCarlo(D=x$Dcm,WD=x$WD,errWD=x$sdWD,H=x$Hfeld,
                                        errH=x$RSEfeld,Dpropag =0.0062*x$Dcm+0.0904),
              simplify=F)
credperplot<-t(as.data.frame(sapply(resultMC,"[",4)))/sizeha

ResFeld<-data.frame(Plot=names(resultMC),
                    AGB=round(unlist(sapply(resultMC,"[",1)),1)/sizeha,
                    Cred_2.5=round(credperplot[,"2.5%"],1),
                    Cred_97.5=round(credperplot[,"97.5%"],1))
```

Table 1. AGB estimates per plots using Feldpaush et al. 2012 H-D models

Plot	AGB	Cred_2.5	Cred_97.5
0_0	185.2	166.3	207.1
0_1	239.9	213.6	272.8
0_2	206.7	181.5	237.6
0_3	130.5	120.7	142.0
0_4	193.6	174.3	215.8
1_0	251.5	227.0	282.3
1_1	192.3	172.7	214.9
1_2	254.2	220.7	296.3
1_3	237.8	214.5	267.5
1_4	230.8	202.5	267.4
2_0	296.9	264.6	335.2
2_1	260.1	227.3	303.5
2_2	219.2	193.2	251.2
2_3	189.3	170.6	211.0
2_4	188.6	171.6	207.9
3_0	252.5	227.9	283.6
3_1	243.6	211.3	287.4
3_2	255.6	217.4	302.0
3_3	173.9	156.8	194.9

3_4	229.9	191.2	291.7
4_0	302.4	269.9	339.6
4_1	210.7	189.1	236.7
4_2	231.7	198.8	273.1
4_3	237.9	212.4	267.5
4_4	252.8	222.8	289.0
5_0	370.9	321.7	437.0
5_1	250.8	224.9	284.1
5_2	298.0	260.8	343.6
5_3	331.4	285.5	388.9
5_4	209.4	185.0	242.3
6_0	319.3	273.6	383.1
6_1	285.4	253.5	327.7
6_2	282.8	250.3	325.9
6_3	208.2	188.5	229.0
6_4	207.3	189.7	229.8
7_0	333.7	279.3	402.8
7_1	264.7	236.4	299.4
7_2	264.1	229.7	309.2
7_3	252.2	223.7	289.0
7_4	277.5	241.5	320.0
8_0	243.6	208.2	284.7
8_1	281.7	243.0	332.2
8_2	349.8	294.5	425.6
8_3	269.1	241.0	301.7
8_4	371.4	321.5	440.9
9_0	219.9	192.4	257.9
9_1	239.5	206.9	282.4
9_2	256.3	227.2	296.5
9_3	237.5	216.3	261.4
9_4	243.3	210.3	283.4

Using Chave et al. 2014 Equation 7 model

```
# Retrieving agb per plot
resultMC<-by(FosData, FosData$QuadID,
              function(x) AGBmonteCarlo(D=x$Dcm,WD=x$WD,errWD=x$sdWD,
                                        coord=long.latChave,
                                        Dpropag =0.0062*x$Dcm+0.0904),
              simplify=F)
credperplot<-t(as.data.frame(sapply(resultMC,"[",4)))/sizeha
ResChave<-data.frame(Plot=names(resultMC),
                    AGB=round(unlist(sapply(resultMC,"[",1)),1)/sizeha,
                    Cred_2.5=round(credperplot[,"2.5%"],1),
                    Cred_97.5=round(credperplot[,"97.5%"],1))
```

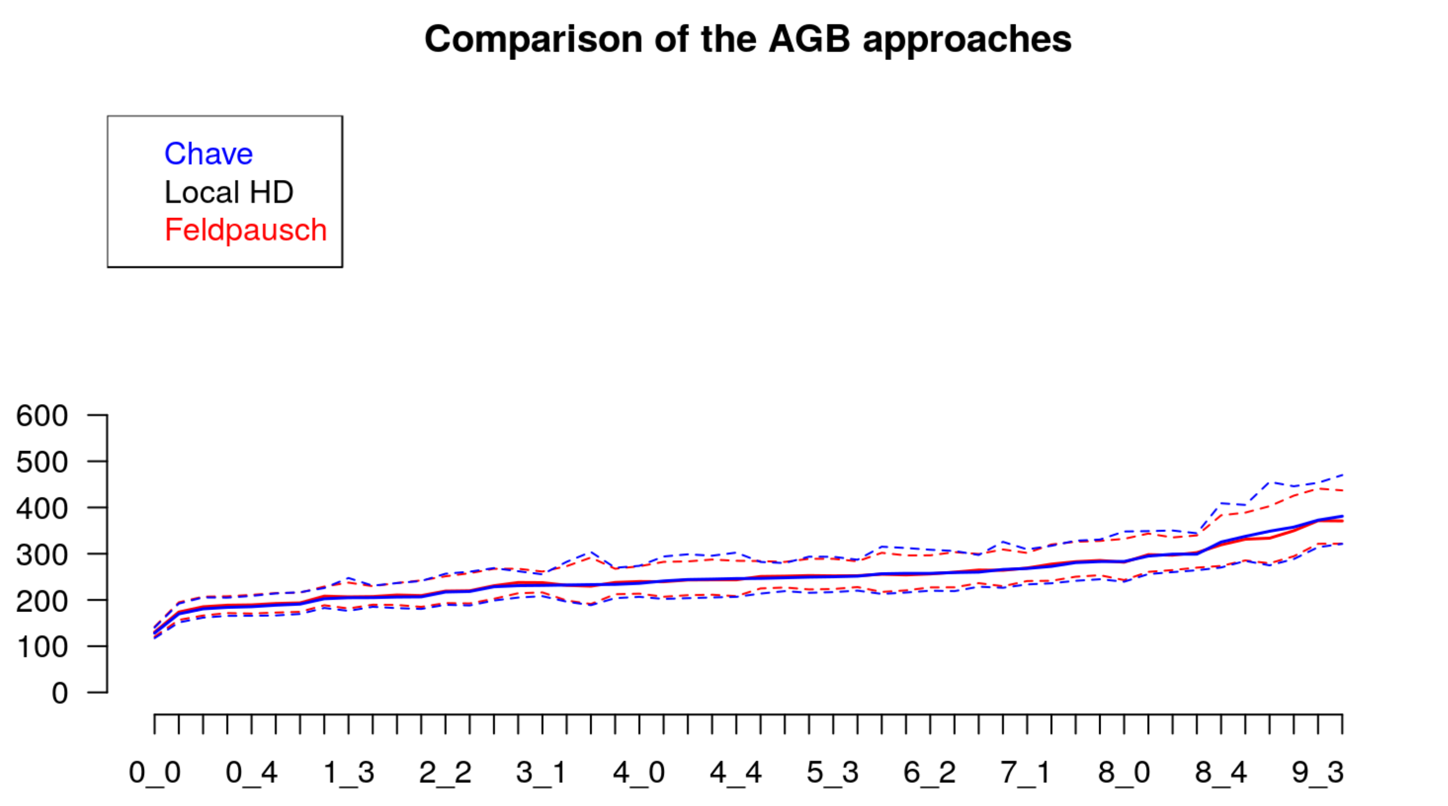
Table 4. AGB estimates per plots using Chave et al. 2014 model

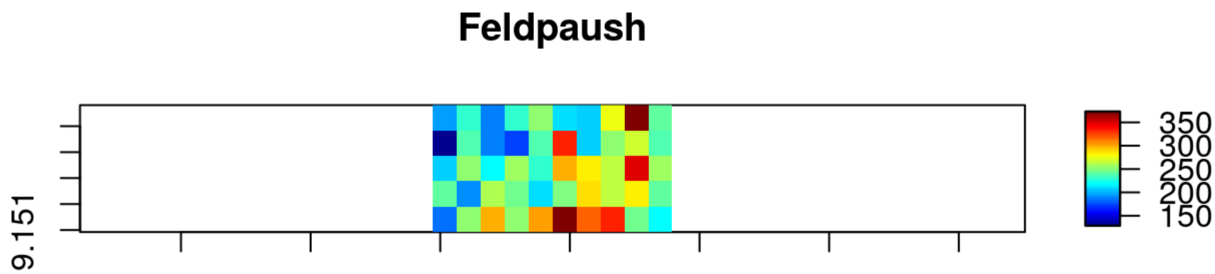
Plot	AGB	Cred_2.5	Cred_97.5

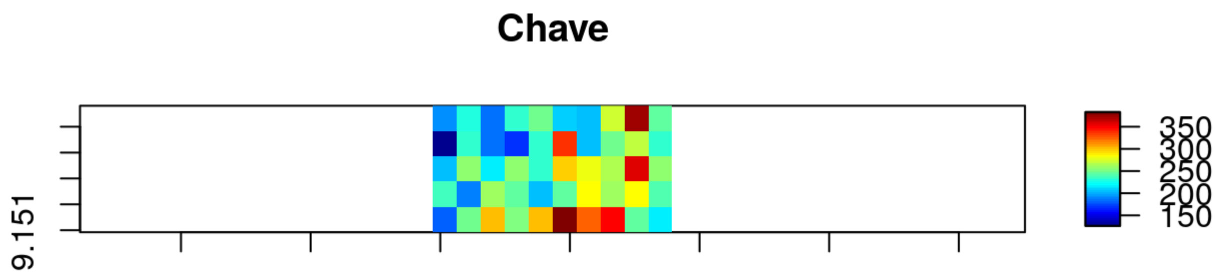
0_0	180.8	161.8	205.4
0_1	236.0	206.7	273.8
0_2	204.8	176.4	247.5
0_3	128.3	117.4	140.3
0_4	191.0	169.7	216.7
1_0	248.0	219.1	279.8
1_1	188.7	166.5	214.1
1_2	257.5	216.1	312.4
1_3	231.0	205.2	262.1
1_4	228.6	198.8	268.9
2_0	299.0	260.2	350.2
2_1	259.3	219.1	305.9
2_2	217.2	189.5	256.7
2_3	185.4	165.8	208.7
2_4	184.0	165.7	205.0
3_0	251.5	220.2	287.0
3_1	245.1	205.4	295.7
3_2	256.6	213.1	315.2
3_3	169.9	151.4	192.2
3_4	233.2	188.7	303.8
4_0	299.1	264.2	344.2
4_1	206.3	182.3	236.6
4_2	232.4	196.3	282.5
4_3	233.7	203.9	269.6
4_4	249.4	215.5	293.6
5_0	381.1	321.3	470.1
5_1	246.6	213.8	282.2
5_2	295.0	256.0	348.9
5_3	337.6	284.4	405.6
5_4	206.7	180.6	241.0
6_0	325.3	270.2	409.1
6_1	283.0	244.8	330.6
6_2	280.8	241.5	328.2
6_3	202.6	182.7	225.8
6_4	205.0	185.2	230.9
7_0	348.7	274.9	455.3
7_1	260.2	228.7	297.3
7_2	265.9	226.4	325.7
7_3	250.2	217.0	293.4
7_4	272.6	236.1	317.2
8_0	246.3	206.7	302.4
8_1	283.2	239.5	348.1
8_2	357.6	288.5	445.9
8_3	268.1	233.7	309.4
8_4	372.6	314.1	453.4
9_0	218.4	188.1	261.1
9_1	241.1	202.2	294.0
9_2	257.5	220.0	308.6

9_3	231.5	208.2	255.5
9_4	244.2	203.9	298.7

```
# Calculating the maximum height and the Lorey's height per (sub)plot
FosData$Hchave<-retrieveH(D=FosData$Dcm,coord=long.latChave)$H

# Max height
maxHchave<-tapply(FosData$Hchave,FosData$QuadID,max)
maxHfeld<- tapply(FosData$Hfeld,FosData$QuadID,max)

# Lorey height
FosData$BAm<-(pi*(FosData$Dcm/2)^2)/10000
FosData$HBAchave<-FosData$Hchave*FosData$BAm
FosData$HBAfeld<-FosData$Hfeld*FosData$BAm
LoreyChave<-tapply(FosData$HBAchave,FosData$QuadID,sum)/tapply(FosData$BAm,FosData$QuadID,sum)
LoreyFeld<-tapply(FosData$HBAfeld,FosData$QuadID,sum)/tapply(FosData$BAm,FosData$QuadID,sum)

# Mean wood density
meanWD=tapply(FosData$WD,FosData$QuadID,mean)
```




Feldpausch
9.151
-79.865
-79.855
-79.845
-79.835
350
300
250
200
150


Chave
9.151
-79.865
-79.855
-79.845
-79.835
350
300
250
200
150

Biomass estimation on 1-ha FOS BCI data

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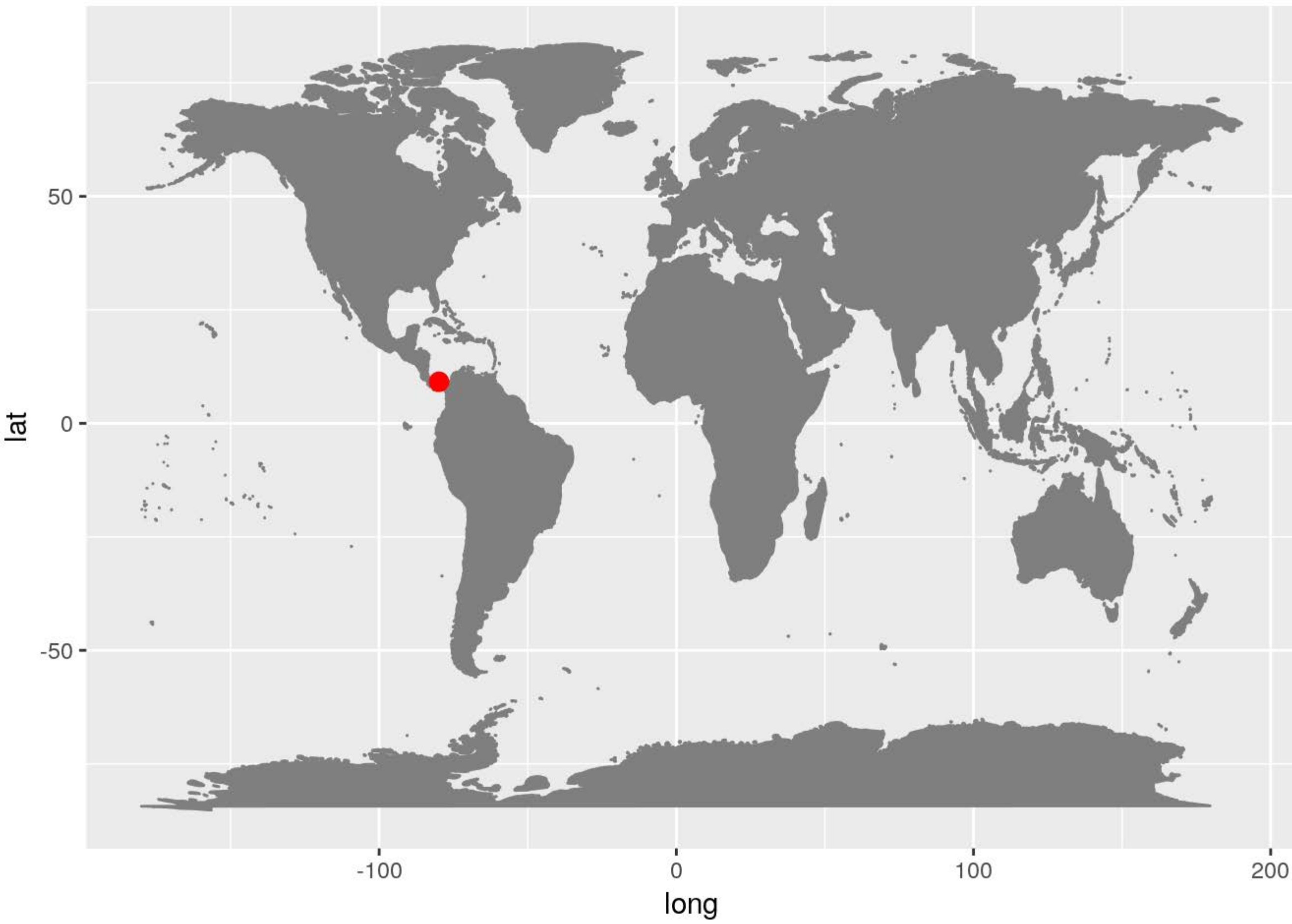
Load data

```
library(BIOMASS)
library(proj4)
#Read in data
load("BCIdata7")
FosData<-BCIdata7
# D in cm
FosData$Dcm<-FosData$DBH/10
# Focus on trees > 10 cm
FosData<-FosData[FosData$Dcm>=10,]

# Quadrat indices
gxgy.2.indexH<-function(gx,gy,gridsize) output=paste(floor(gx/gridsize),floor(gy/gridsize),sep
="_")
FosData$QuadID<-gxgy.2.indexH(FosData$gx,FosData$gy,scale)
halfScale<-scale/2
QuadXrel<-rep(seq(halfScale,dimX-halfScale,scale),length(seq(halfScale,dimY-halfScale,scale)))
QuadYrel<-rep(seq(halfScale,dimY-halfScale,scale),each=length(seq(halfScale,dimX-halfScale,sca
le)))
QuadXabs<-(1-QuadXrel/dimX)*(1-QuadYrel/dimY)*CoordUTM[1,1]+QuadXrel/dimX*(1-QuadYrel/dimY)*Co
ordUTM[2,1]+QuadYrel/dimY*(1-QuadXrel/dimX)*CoordUTM[4,1]+QuadXrel*QuadYrel/(dimX*dimY)*CoordU
TM[3,1]
QuadYabs<-(1-QuadXrel/dimX)*(1-QuadYrel/dimY)*CoordUTM[1,2]+QuadXrel/dimX*(1-QuadYrel/dimY)*Co
ordUTM[2,2]+QuadYrel/dimY*(1-QuadXrel/dimX)*CoordUTM[4,2]+QuadXrel*QuadYrel/(dimX*dimY)*CoordU
TM[3,2]
Quadlatlong<-as.data.frame(project(cbind(QuadXabs,QuadYabs), proj=CodeUTM,inverse=T))
CoordQuadrat<-data.frame(QuadID=gxgy.2.indexH(QuadXrel,QuadYrel,scale),
                        X=QuadXabs,
                        Y=QuadYabs,
                        lon=Quadlatlong$V1,
                        lat=Quadlatlong$V2)
long.latChave<-cbind(lon=mean(CoordQuadrat$lon),lat=mean(CoordQuadrat$lat))
```

Location of the plot



Retrieve wood density

```
## [1] "Calling http://taxosaurus.org/retrieve/fe33b60b46547d477db41ceee138af4f"
## [1] "Calling http://taxosaurus.org/retrieve/e66173ee31d7a9e9299c51a2b6b28d85"
## [1] "Calling http://taxosaurus.org/retrieve/e87ac4cef8f4e738e066bafbde0db0ee"
## [1] "Calling http://taxosaurus.org/retrieve/cd0b53284d7a505d1cefe768200fc40a"
## [1] "Calling http://taxosaurus.org/retrieve/30f0962c73417670be4f28f69032bbf3"
## [1] "Calling http://taxosaurus.org/retrieve/1609b8ce3e15b69112a213277e5aaada"
## [1] "Calling http://taxosaurus.org/retrieve/e3006fffac69ad9f90114b1891f12ca3"
## [1] "Calling http://taxosaurus.org/retrieve/0eb62ac5a83ebf8a58efd05afe814f9b"
```

```
# Retrieve wood density
dataWD<-getWoodDensity(genus=tax.cor$genusCorrected,
                       species=tax.cor$speciesCorrected,
                       stand=FosData$QuadID)
```

```
## The reference dataset contains 16467 wood density values
## Your taxonomic table contains 222 taxa
```

```
FosData$WD=dataWD$meanWD
FosData$sdWD=dataWD$sdWD
```

Overall, 85.4 % of the values have been attributed at the species level, 14 % at the genus level, and 0.6 % at the

plot level.

Construct H-D models

No HD model for now

Estimating biomass and associated uncertainties

Below, we used a Bayesian Monte-Carlo scheme to estimate the mean AGB and associated credibility interval per plot.

Using Feldpausch et al. 2012 regional Weibull models

```
# Retrieving height
FosData$Hfeld=retrieveH(D=FosData$Dcm,region =FeldRegion)$H
FosData$RSEfeld=retrieveH(D=FosData$Dcm,region =FeldRegion)$RSE
# Retrieving agb per plot
resultMC<-by(FosData, FosData$QuadID,
              function(x) AGBmonteCarlo(D=x$Dcm,WD=x$WD,errWD=x$sdWD,H=x$Hfeld,
                                        errH=x$RSEfeld,Dpropag =0.0062*x$Dcm+0.0904),
              simplify=F)
credperplot<-t(as.data.frame(sapply(resultMC,"[",4)))/sizeha

ResFeld<-data.frame(Plot=names(resultMC),
                    AGB=round(unlist(sapply(resultMC,"[",1)),1)/sizeha,
                    Cred_2.5=round(credperplot[,"2.5%"],1),
                    Cred_97.5=round(credperplot[,"97.5%"],1))
```

Table 1. AGB estimates per plots using Feldpaush et al. 2012 H-D models

Plot	AGB	Cred_2.5	Cred_97.5
0_0	185.8	166.5	208.9
0_1	238.9	211.5	269.7
0_2	206.7	181.8	241.7
0_3	130.9	119.8	141.9
0_4	193.7	174.9	215.5
1_0	251.0	227.1	279.7
1_1	191.8	171.4	215.7
1_2	255.1	221.1	299.0
1_3	237.7	213.3	267.8
1_4	230.4	203.3	263.5
2_0	297.4	262.0	341.3
2_1	259.4	224.0	303.2
2_2	219.5	194.4	252.1
2_3	189.1	170.5	210.1
2_4	188.2	170.9	207.9
3_0	252.8	225.3	283.6
3_1	244.0	211.0	286.9
3_2	256.1	219.0	307.5
3_3	173.8	157.2	193.3

3_4	230.3	191.8	287.7
4_0	302.2	269.9	339.0
4_1	210.7	189.9	234.2
4_2	231.2	198.9	273.0
4_3	237.5	210.7	270.6
4_4	253.1	223.9	290.1
5_0	370.7	321.0	429.4
5_1	250.1	224.4	279.8
5_2	298.1	262.2	344.7
5_3	330.7	283.9	386.8
5_4	208.7	184.2	240.9
6_0	318.8	273.7	381.5
6_1	285.4	254.6	325.1
6_2	282.9	249.0	324.5
6_3	207.8	189.9	229.1
6_4	207.2	188.7	228.3
7_0	334.4	280.2	414.4
7_1	264.2	239.0	301.9
7_2	263.4	230.1	308.0
7_3	252.1	222.0	287.6
7_4	277.3	243.9	317.3
8_0	243.6	211.4	289.2
8_1	280.9	241.2	332.5
8_2	352.1	295.8	434.6
8_3	268.8	239.0	303.9
8_4	368.0	319.3	432.6
9_0	218.7	189.9	253.4
9_1	239.4	204.7	286.4
9_2	256.7	226.4	297.1
9_3	237.5	216.2	260.6
9_4	243.2	210.0	287.6

Using Chave et al. 2014 Equation 7 model

```
# Retrieving agb per plot
resultMC<-by(FosData, FosData$QuadID,
              function(x) AGBmonteCarlo(D=x$Dcm,WD=x$WD,errWD=x$sdWD,
                                        coord=long.latChave,
                                        Dpropag =0.0062*x$Dcm+0.0904),
              simplify=F)
credperplot<-t(as.data.frame(sapply(resultMC,"[",4)))/sizeha
ResChave<-data.frame(Plot=names(resultMC),
                    AGB=round(unlist(sapply(resultMC,"[",1)),1)/sizeha,
                    Cred_2.5=round(credperplot[,"2.5%"],1),
                    Cred_97.5=round(credperplot[,"97.5%"],1))
```

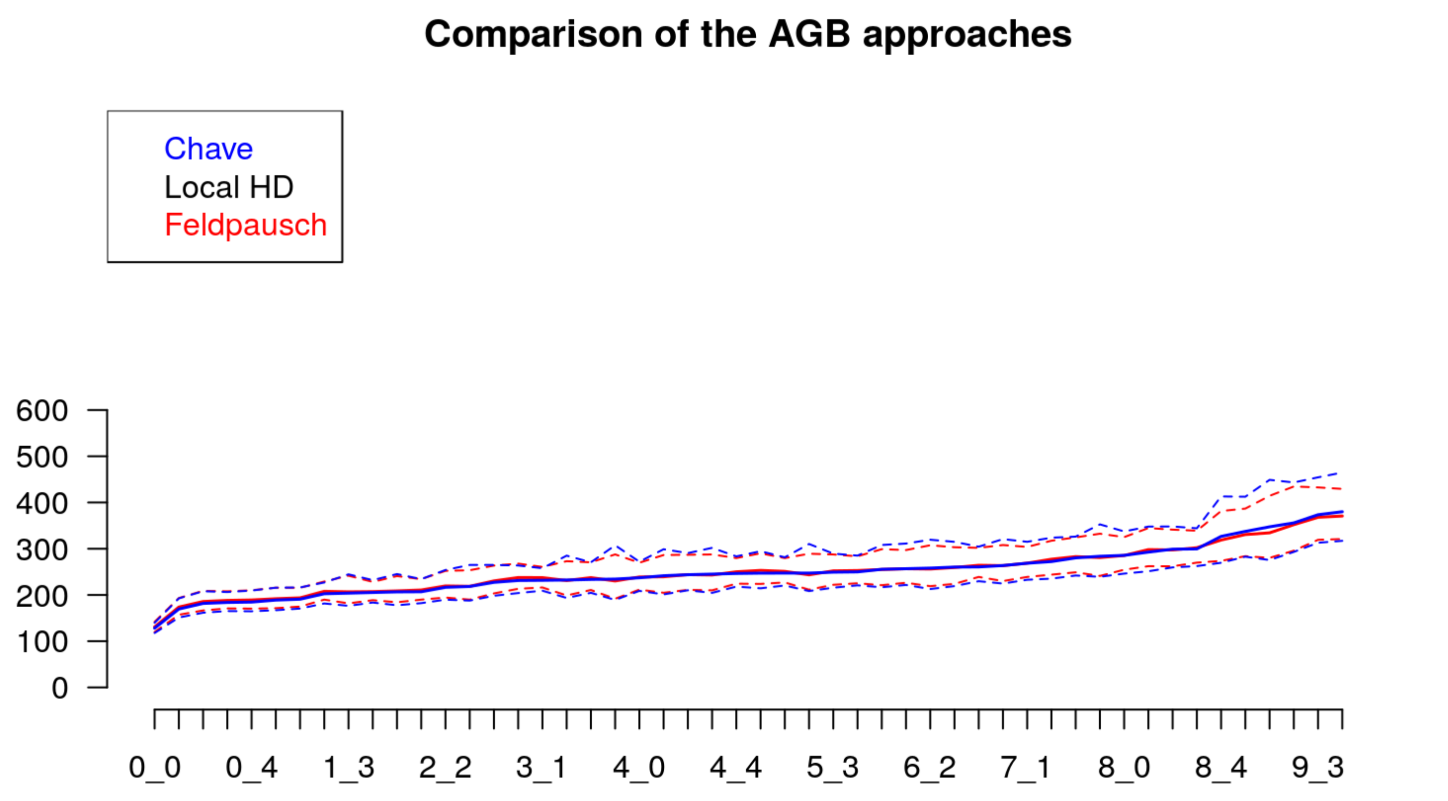
Table 4. AGB estimates per plots using Chave et al. 2014 model

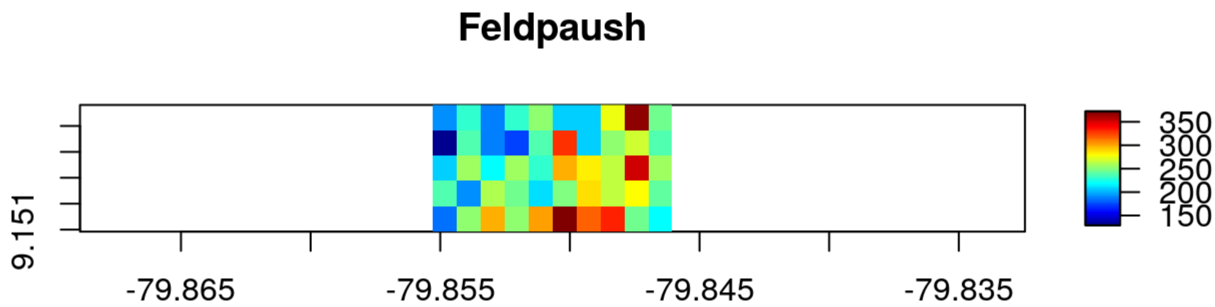
Plot	AGB	Cred_2.5	Cred_97.5

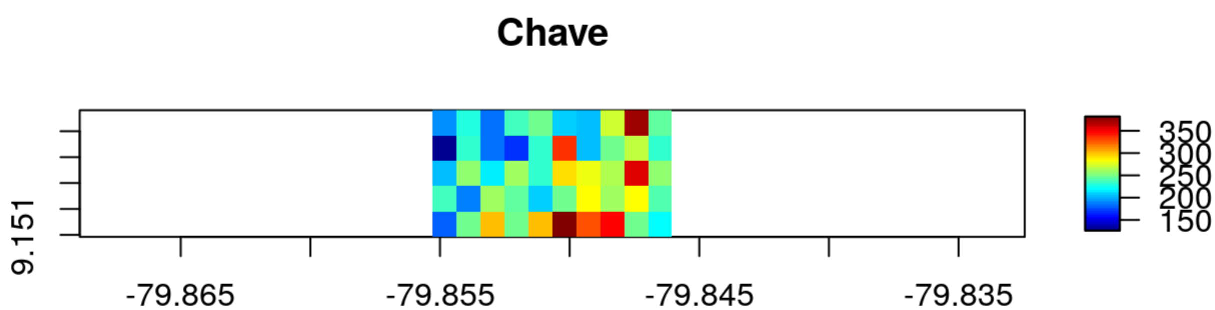
0_0	181.7	161.6	208.0
0_1	237.2	208.8	271.9
0_2	203.9	176.5	244.6
0_3	128.1	117.7	139.8
0_4	190.8	170.6	216.2
1_0	247.3	220.5	281.4
1_1	188.9	167.0	215.7
1_2	255.5	216.7	308.1
1_3	231.3	204.1	263.7
1_4	227.3	198.2	264.9
2_0	299.0	259.6	348.2
2_1	260.3	219.2	314.9
2_2	216.5	189.8	254.0
2_3	184.6	164.7	209.5
2_4	183.8	165.2	206.3
3_0	249.9	220.8	285.1
3_1	243.8	210.1	290.5
3_2	258.1	212.8	319.5
3_3	169.6	151.2	192.6
3_4	234.4	189.3	307.4
4_0	299.6	262.4	344.2
4_1	206.9	182.3	234.3
4_2	232.4	193.5	285.0
4_3	233.6	204.6	270.6
4_4	247.2	214.4	294.6
5_0	380.0	317.1	464.8
5_1	246.5	218.1	283.4
5_2	292.7	251.2	347.9
5_3	337.5	282.8	412.5
5_4	206.6	177.7	245.2
6_0	326.7	269.6	413.1
6_1	285.6	246.2	337.4
6_2	280.2	242.1	326.2
6_3	202.6	181.6	227.0
6_4	205.3	183.6	232.1
7_0	347.4	275.5	449.0
7_1	260.6	229.8	304.4
7_2	263.6	224.7	320.8
7_3	249.3	215.7	289.4
7_4	272.2	235.3	323.9
8_0	247.3	208.4	310.3
8_1	283.7	239.3	352.7
8_2	355.9	293.1	443.3
8_3	268.6	232.9	315.0
8_4	373.5	312.9	454.4
9_0	218.4	187.8	264.9
9_1	241.6	201.2	298.9
9_2	256.8	221.7	311.2

9_3	231.7	209.2	257.8
9_4	245.1	204.5	301.9

```
# Calculating the maximum height and the Lorey's height per (sub)plot
FosData$Hchave<-retrieveH(D=FosData$Dcm,coord=long.latChave)$H

# Max height
maxHchave<-tapply(FosData$Hchave,FosData$QuadID,max)
maxHfeld<- tapply(FosData$Hfeld,FosData$QuadID,max)

# Lorey height
FosData$BAm<-(pi*(FosData$Dcm/2)^2)/10000
FosData$HBAchave<-FosData$Hchave*FosData$BAm
FosData$HBAfeld<-FosData$Hfeld*FosData$BAm
LoreyChave<-tapply(FosData$HBAchave,FosData$QuadID,sum)/tapply(FosData$BAm,FosData$QuadID,sum)
LoreyFeld<-tapply(FosData$HBAfeld,FosData$QuadID,sum)/tapply(FosData$BAm,FosData$QuadID,sum)

# Mean wood density
meanWD=tapply(FosData$WD,FosData$QuadID,mean)
```




Feldpausch
9.151
-79.865
-79.855
-79.845
-79.835
350
300
250
200
150


Chave
9.151
-79.865
-79.855
-79.845
-79.835
350
300
250
200
150