Relationship between Plant Biomass and Gas Flux at Busby Forest

Lakeitha C. Mitchell* and Nsalambi V. Nkongolo

Abstract

Understanding of the relationship between plant biomass and fluxes of greenhouse is important in the estimation and monitoring of carbon stocks and greenhouse gas fluxes. We conducted an inventory of tree species in a 0.49 ha forest plot at Lincoln University's Busby forest in Jefferson City, Missouri. A total of four hundred twenty seven trees belonging to twenty three species were geospatially referenced, tagged and their diameters at breast (DBH) measured. Then, we calculated foliage biomass (FBM), branch biomass (BBM), stem biomass (SBM), root biomass (RBM) and total biomass (TBM). Using data on greenhouse gases (CO_2, CH_4 and N_2O) measured at this site, we developed linear trend surface models between each of these gases and their coordinates (Latitude and Longitude). These models were later used to predict CO_2, CH_4 and N_2O at locations where tree species were geo-referenced. Finally, we conducted Pearson correlation analysis to evaluate the relationship between plant biomass and greenhouse gases fluxes. Results showed that, except for foliage biomass (FBM), all plant biomass parameters were significantly correlated with greenhouse fluxes with correlation coefficients (r) ranging from 0.14 to 0.19. Branch biomass (BBM) had the highest correlation coefficients with CO_2 (p=0.0002, r= 0.19); CH_4 (p=0.0004, r=0.18) and N_2O (p=0.0005, r= 0.18). The low correlation coefficient (r) can be explained by the predictive models for which the coefficients of determination (R^2) were significant, but also low. Further studies will be conducted to better understand the relationship between plant biomass and gas fluxes.

Introduction

Greenhouse gas emissions and the climatic change risk make a decrease in atmospheric CO_2 concentrations necessary (Usuga, 2010). The carbon used to construct plant biomass is absorbed from the atmosphere as carbon dioxide (CO_2). When plant biomass is broken down, it releases the CO_2 back into the atmosphere, mainly as CO_2 or methane (CH_4, depending upon the conditions and process involved. If the plant biomass is burned the carbon is returned to the atmosphere as CO_2 which is later taken up again by plant. Understanding of the relationship between plant biomass and fluxes of greenhouse is therefore important to account for CO_2 partition. The objective of this study was to assess the relationship between plant biomass and gas flux at Lincoln University's Busby Forest.

Material and Methods

We conducted an inventory of tree species at in a 0.49 ha forest plot used as a research site for greenhouse gases fluxes study at Busby Forest of Lincoln University. A total of four hundred twenty seven trees belonging to twenty three species were tagged each and the diameter at breast (DBH) of each tree measured.

	CO_2	CH_4	N_2O
Mean	3.56E+06	-94.609	-3.238
SD	18.294	48.768	4.8955
C.V.	5.13E-04	51.547	151.19
Minimum	3.56E+06	-186.05	-12.392
Median	3.56E+06	-104.96	-4.2549
Maximum	3.56E+06	24.139	8.7531
Skew	4.24E-03	0.4983	0.5216
Kurtosis	-9.97E-01	-0.6939	-0.6732

Table 1: Summary of Statistics for CO_2, CH_4, and N_2O.

	TAGB	DBH	FOLBIO	BRANCHBIO	RTB	STEMBIO
Mean	187.79	19.17	9.19	36.55	37.56	142.06
SD	276.47	11.06	13.21	48.45	55.29	217.07
C.V.	147.22	57.70	143.78	132.56	147.22	152.80
Minimum	2.79	0.00	0.39	0.86	0.56	1.53
Median	76.91	15.49	4.51	16.84	15.38	55.56
Maximum	1776.70	64.77	99.21	276.36	355.33	1401.10
Skew	2.79	1.32	3.38	2.54	2.79	2.85
Kurtosis	8.78	1.54	14.16	7.08	8.78	9.17

Table 2: Summary of Statistics for TAGB, DBH, FolBio, BranchBio, RTB, and StemBio.

	CO_2	CH_4	N_2O	DBH	FOLBIO	STEMBIO	TAGB
CH_4	0.9161						
P-VALUE	0.0000						
N_2O	0.9043	0.9996					
	0.0000	0.0000					
DBH	0.1559	0.1488	0.1474				
	0.0029	0.0045	0.0049				
FOLBIO	0.0505	0.0263	0.0244	0.8674			
	0.3377	0.6180	0.6434	0.0000			
STEMBIO	0.1590	0.1436	0.1416	0.9324	0.8915		
	0.0024	0.0061	0.0069	0.0000	0.0000		
TAGB	0.1617	0.1462	0.1442	0.9364	0.8887	0.9998	
	0.0020	0.0052	0.0059	0.0000	0.0000	0.0000	
RTB	0.1617	0.1462	0.1442	0.9364	0.8887	0.9998	1.0000
	0.0020	0.0052	0.0059	0.0000	0.0000	0.0000	0.0000
BRANCHBIO	0.1964	0.1840	0.1819	0.9293	0.8047	0.9820	0.9847
	0.0002	0.0004	0.0005	0.0000	0.0000	0.0000	0.0000

Table 3: Correlation matrix between CO_2, CH_4, N_2O , DBH, TAGB, StemBio, FolBio, BranchBio and RTB.

Results and Discussion

Results showed that, except for foliage biomass (FBM), all plant biomass parameters were significantly correlated with greenhouse fluxes with correlation coefficients (r) ranging from 0.14 to 0.19. Branch biomass (BBM) had the highest correlation coefficients with CO_2 (p=0.0002, r= 0.19); CH_4 (p=0.0004, r=0.18) and N_2O (p=0.0005, r= 0.18). The low correlation coefficient (r) can be explained by the predictive models for which the coefficients of determination (R^2) were significant, but also low. Further studies will be conducted to better understand the relationship between plant biomass and gas fluxes. This data will enable us to monitor forest gas fluxes.

Summary

Overall, Total Above Ground Biomass (TAGB) showed the highest average amongst the plant biomass and CO_2 showed the highest average amongst the gas fluxes. Except for foliage, all plant biomass significantly correlated with the gas fluxes. This data will be useful in monitoring in gas fluxes and plant biomass and as well as other studies at Busby forest.

References

Biomass Energy Centre, Web 2010. What is biomass? http://www.biomassenergycentre.org.uk/portal/page?_pageid=76,15049&_dad=portal&_schema=PORTAL

Usuga, J.C.L., Toro, J.A. R., Alzate, M.V.R., Tapias, A.J.L., 2010. Estimation of biomass and carbon stocks in plants, soil and forest floor in different tropical forests. Forest Ecology and Management 260 (2010) 1906-1913.

UID: 73122