# Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda Research Application Summary

### Carbon stock trends in selected agro ecological zones of Uganda

Nampijja, J.<sup>1</sup>, Isubikalu, P.<sup>1</sup>, Mukwaya, P.<sup>2</sup>, Majaliwa, J.G.M.<sup>3</sup> & Adipala, E.<sup>4</sup> <sup>1</sup>Department of Extension Education Faculty of Agriculture, P. O. Box 7062, Kampala, Uganda <sup>2</sup>Department of Geography, Faculty of Arts, P. O. Box 7062, Kampala, Uganda <sup>3</sup>Institute of Environment and Natural Resources Makerere University, P.O. Box 7062, Kampala, Uganda <sup>4</sup>Regional University forum Building in Agriculture (RUFORUM), Plot 151 Garden Hill, Makerere University, P.O. Box, 7062, Kampala, Uganda Corresponding author: josenapijja@yahoo.com Abstract This study determined the trend in carbon densities and stocks from major land uses/covers of semi arid and sub humid areas of Uganda. Carbon densities were estimated from soils and woody biomass pools of the major homogenous units in terms of land-use/cover, topography and soil. In Soroti, preliminary results show that the carbon density was generally highest in soil than in above ground wood plants (P $\leq$ 0.05). The highest carbon density was observed under woodland (248.2Mg/ha) and fallow (213.1 mg/ha), followed by grazing land (173.2 mg/ ha) and annuals (167.66 mg/ha); and the lowest was observed under perennial agriculture (Orchard) (56.6 mg/ha) (P<0.05). Key words: Agro-ecological zones, carbon densities, carbon stocks, land-use cover/change, Uganda Résumé Cette étude a déterminé la tendance dans les densités de carbone et ses stocks à partir des principales utilisations de terre/ couvertures végétales des régions semi-arides et sub-humides de l'Ouganda. Les densités de carbone ont été estimées à partir des sols et des ensembles boisées de biomasse des unités homogènes principales en termes d'utilisation de terre/ couverture végétale, topographie et sol. A Soroti, les résultats préliminaires prouvent que la densité de carbone était généralement la plus haute dans le sol que dans les arbres audessus du sol (P<0.05). On a observé la densité de carbone la plus élevée dans la région boisée (248.2Mg/ha) et la jachère (213.1 mg/ha), suivie de la prairie (173.2 mg/ha) et les plantes annuelles (167.66 mg/ha) On a enfin observé la plus basse densité sous l'agriculture prolongée (verger) (56.6 mg/ha) (P<0.05). Mots clés: Zones agro-écologiques, densités de carbone, stocks de carbone, couverture d'utilisation du terre/changement, Ouganda

#### Background

Literature Summary

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Carbon emissions from human activities have contributed significantly in upsetting the natural balance and depletion of carbon (C) storage in terrestrial ecosystem (Bhadwal and Singh, 2002). In the tropics, land use/cover change has also aggravated the situation in attenuating the effects of local wind patterns. It has been observed that the current rate of deforestation in the tropics exceeds secondary forest regrowth and C sequestration (Kauffman et al., 2009). Changing land-use strategies that maintain standing forests are recognized as among the least expensive of climate change mitigation options (Virgilio and Marshall, 2009). Further, secondary tropical forests have been suggested to have great value for their potential to sequester atmospheric C (Lugo and Brown, 1992). These options require an understanding of and capability to quantify C dynamics at landscape scales. Because of the diversity of physical and biotic features of tropical forests as well as approaches and intensities of land uses within the tropics, there are tremendous differences in the capacity of different landscapes, and agro-ecological zones to store and sequester C (Bhadwal and Singh, 2002). Major gaps in our current knowledge include quantification of C pools, rates and patterns of carbon loss following land-cover change, and quantification of the C storage potential of secondary forests following abandonment (Kauffman et al., 2009).

Global climate is being affected by human activities through altering the natural balance of certain greenhouse gases (GHG) into the atmosphere. Carbon dioxide (CO<sub>2</sub>) is one of the GHG that contributes considerably to global warming (IPCC, 1995). One possible strategy to reduce GHGs with great potential is to use forest to sequester CO<sub>2</sub> (Prentice et al., 2000). On the other hand, the possibility of expanding carbon storage in forests has been identified as a potential measure to mitigate climate change (DeFries et al., 2000; FAO, 2001). Recent studies in Uganda have demonstrated that some other land use/cover, such grassland could play a significant role in C sequestration (Majaliwa et al., 2010). The dynamics of carbon that is present in a certain land use systems over its life span can be reflected with time-averaged carbon stocks. Different percentages of forest cover store different amounts of carbon and the changes in forest cover, as expressed in a greenness factor to effectively surrogate biomass, are used in the model to calculate the annual changes of carbon (Houghton and Hackler, 2000; Myneni et al., 2001; Song and Woodcock, 2003).

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This study was conducted in Soroti and Rakai districts situated in the cattle corridor. Homogenous units in terms of soil, landuse/cover and topography were identified using SWAT software. In each homogenous unit, soil carbon and above ground woody carbon was estimated in four replications of each homogenous unit (Hairiah *et al.*, 2001). Soil samples were obtained from two soil depths: 0-15 and 15-30 cm. The carbon stock was estimated as a sum of soil and above ground carbon stocks (Woomer and Palm, 1998).

## **Preliminary Results**

**Study Description** 

Figures 1 and 2 present the soil contribution to carbon density and carbon density of different land-use/covers in two parishes of Soroti district. Soil contribution was observed highest in



Figure 1. Contribution of 0-30 cm soil depth to carbon density in Soroti and Gweri sub counties, Soroti district.



Figure 2. Carbon density of the major land-use/cover in Soroti and Gweri sub counties, Soroti district.

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	grazing land (90.1%), followed by settlement (77.4%), fallow (67.7%) and by annuals (64.0%), the lowest soil contribution was seen in woodlot (30%) (P $\leq$ 0.05). The highest carbon density was observed under woodlot with (248.17Mg/ha), fallow (213.1Mg/ha), grazing land (173.2 Mg/ha) annual (167.7Mg/ha); and the lowest was observed under Perennial (Orchard) (56.55 Mg/ha) (P $\leq$ 0.05).
Research Application	The findings suggests that this information is very useful in designing adaptation and mitigation strategies to climate change and variability. Based on the results of this study, and interaction with the study communities, it is recommended that;
	<ul> <li>There is need to create awareness on climate change and variability effects on peoples' livelihoods to the whole range of stakeholders including farmers, extension workers and policy makers.</li> <li>Farmers should be advised to utilize the local materials to enhance their carbon stock for improving soil fertility and</li> </ul>
	water and conservation.
Acknowledgement	We thank RUFORUM and Agricultural Innovations for Dryland Africa (AIDA-EU Project) for providing the funds for this study.
References	<ul> <li>Bhadwal, S. and Singh, R. 2002. Carbon sequestration estimates for forestry options under different land-use scenarios in India. Tata Energy Research Institute, Darbari Seth Block, Habitat Place, Lodhi Road, New Delhi 110 003, India.</li> <li>Breiman, L., Friedman, J., Olshen, R. and Stone, C. 1984. Classification and Regression Trees (New York: Chapman and Hall), 358 pp.</li> <li>DeFries, R., Hansen, M., Townshen, J.R.G., Janetos, A.C. and Loveland, T.R. 2000. A new global 1 km data set of percent tree cover derived from remote sensing. <i>Global Change Biology</i> 6:247-254.</li> <li>FAO (Food and Agriculture Organization), 2001. Global forest resources assessment 2000: Main report. FAO Forestry Paper 140, FAO, Rome, Italy. 479 pp.</li> <li>Hairiah, K., Sitompul, S. M., van Noordwijk, M. and Palm, C. A. 2001. Methods for sampling carbon stocks above and below ground. ASB LectureNote 4B, International Centre for Research in Agroforestry (ICRAF), Bogor. http://www.icraf.cgiar.org/sea/Training/Materials/ASBTM/Datas/ASBLecNote%204B.pdf</li> </ul>

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- Houghton, R.A. and Hackler, J.L. 2000. Changes in terrestrial carbon storage in the United States. I: The roles of agriculture and forestry. *Global Ecology Biogeography* 9:125-144.
- Inter-Government Panel on Climate Change (IPCC), Climate Change, 1995. A report of the intergovernmental panel on climate change, IPCC report, Geneva, Switzerland, 64 pp.
- Kauffman, J.B., Hughes, R.F. and Heider, C. 2009. Carbon pool and biomass dynamics associated with deforestation, land use, and agricultural abandonment in the neotropics. Institute of Pacific Islands Forestry, USDA Forest Service, Pacific Southwest Research Station, 60 Nowelo Street, Hilo, Hawaii 96720, USA.
- Lugo, A.E. and Brown, S. 1992. Tropical forests as sinks of atmospheric carbon. Institute of Tropical Forestry, USDA Forest Service Southern Forest Experiment Station, Call Box 25000, Río Piedras, PR 00928-2500, USA.
- Majaliwa, J.G.M., Twongyirwe, R., Nyenje, R., Oluka M., Ongom, B., Sirike, J., Mfitumukiza, D., Azanga, E., Natumanya, R., Mwerera, R. and Barasa, B. 2010. The effect of land cover change on soil properties around Kibale National Park in South Western Uganda. *Applied and Environmental Soil Science*.
- Myneni, R.B., Dong, J., Tucker, C.J., Kaufmann, R.K., Kauppi, P.E., Liski, J., Zhou, L., Alexeyev, V. and Huhges, M.K., 2001. A large carbon sink in the woody biomass of Northern forests. *Proceeding of the National Academic Science*, USA 98(26):14784-14789.
- Prentice, C., Heimann, M. and Sitch, S. 2000. The carbon balance of the terrestrial biosphere: Ecosystem models and atmospheric observations. *Ecological Applications* 10(6): 1553-1573.
- Virgilio, N. and Marshall, S. 2009. Forest carbon strategies in climate change mitigation: Confronting challenges through on-the-ground experience. The Nature Conservancy. Arlington, Virginia.
- Woomer, P.L., and Palm, C.A., 1998. An approach to estimating system carbon stocks in tropical forests and associated land-uses. *Commonwealth Forestry Review* 77:181-190.