PINEMAP Year 3 Progress Report 2
April 2014
Aim 4 (Economics & Policy)

OUTCOMES/IMPACTS

Aim 4 activities contribute to project-level outcomes and impacts by providing the economic analysis that will underpin land manager decision-making in future management and climatic conditions. From the stand- to the regional-scale, economic impacts of disturbance, climate, management, and policy alternatives must form the basis of any viable and sustainable management change. Policy analysis will enable PINEMAP stakeholders to better assess management responses to future policy changes. Quantification of different ecosystem services will lead to a better understanding of tradeoffs among carbon, timber, and biodiversity. Finally, the life cycle assessment (LCA) carried out in this Aim will provide the framework necessary to analyze the stand to regional carbon sequestration implications of changes in management regimes.

OUTPUTS

Products

Peer-reviewed publications

Abt, R.C. and K.L. Abt. 2012. Potential impact of bioenergy demand on the sustainability of the southern pine resource. *Journal of Sustainable Forestry* 321(1-2):175-194. doi: http://dx.doi.org/10.1080/10549811.2011.652044

Dwivedi, P., Bailis, R., & Khanna, M. (2013). Is Use of Both Pulpwood and Logging Residues Instead of Only Logging Residues for Bioenergy Development a Viable Carbon Mitigation Strategy? *BioEnergy Research*. doi:10.1007/s12155-013-9362-z

Dwivedi, P., M. Khanna, R. Bailis, A. Ghilardi. 2014. Potential greenhouse gas benefits of transatlantic wood pellet trade. *Environmental Research Letters* 9 (2), 024007

Galik, C.S. and R.C. Abt. 2012. The effect of assessment scale and metric selection on the greenhouse gas benefits of woody biomass. *Biomass and Bioenergy* 44:1-7. doi: http://dx.doi.org/10.1016/j.biombioe.2012.04.009

Gan, J. 2013. Economic and environmental competitiveness of US-made forest products: Implications for offshore outsourcing. *Journal of Forestry* 111(2): 94-100. doi: http://dx.doi.org/10.5849/jof.12-053

Gan, J. and B. Cashore. 2013. Opportunities and challenges for integrating bioenergy into sustainable forest management certification programs. *Journal of Forestry* 111(1):11-16. doi: http://dx.doi.org/10.5849/jof.11-092

Gan, J., C.T. Smith, and J.W.A. Langeveld. 2012. Effects of considering greenhouse gas consequences on fertilizer use in loblolly pine plantations. *Journal of Environmental Management* 113: 383-389. doi: http://dx.doi.org/10.1016/j.jenvman.2012.09.015

Gonzalez-Benecke, C.A. Susaeta, T. Martin, E. Jokela, and D. Carter. 2013. Balancing revenue and nutrient removals in Pinus elliottii Engelm stands managed for pinestraw and wood production. *Forest Science*. doi: http://dx.doi.org/10.5849/forsci.12-144.

Grado, S.C., M.K. Measells, and D.L. Grebner. 2013. Revisiting the status, needs, and knowledge levels of Mississippi's governmental entities relative to urban forestry. *Journal of Arboriculture & Urban Forestry* 39(4):149-156.

Gruchy, S.R., D.L. Grebner, I.A. Munn, O. Joshi, and A. Hussain. 2012. An assessment of nonindustrial private forest landowner willingness to harvest woody biomass in support of bioenergy production in Mississippi: A contingent rating approach. *Forest Policy and Economics* 15:140-145. doi: http://dx.doi.org/10.1016/j.forpol.2011.09.007

Henderson, J., S.D. Roberts, D.L. Grebner, and I.A Munn. 2013. A graphical comparison of loblolly pine growth-and-yield models. *Southern Journal of Applied Forestry* 37(3):169-176. doi: http://dx.doi.org/10.5849/sjaf.10-013

James, N.A., R.C. Abt, K.L. Abt, R.M. Sheffield, F.W. Cubbage. 2012. Forecasting sustainability: Growth to removals ratio dynamics. In: Morin, R.S. and G.C. Liknes, Greg C. *Moving from status to trends: Forest Inventory and Analysis (FIA) symposium 2012* Gen. Tech. Rep. NRS-P-105. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. [CD-ROM]: 54-58.

Joshi, O., Grebner, D.L., Hussain, A., and S.C. Grado. 2013. Landowner knowledge and willingness to supply woody biomass for wood-based bioenergy: Sample selection approach. J*ournal of Forest Economics* 19(2):97-109. doi: http://dx.doi.org/10.1016/j.jfe.2012.11.003

Joshi, O., Grebner, D.L., Munn, I.A., Hussain, A. and S.R. Gruchy. 2013. Understanding landowner preferences for woody biomass harvesting: A choice experiment-based approach. Forest Science, 59(5): 549-558.

Joshi, O., D.L. Grebner, J.E. Henderson, S.C. Grado, and I.A. Munn. 2013. Input-output modeling of wood-based bioenergy industries in Mississippi. *Forest Products Journal* 62(7/8): 528-537

Nepal, P., R.K. Grala, and D.L. Grebner. 2012. Financial feasibility of increasing carbon

sequestration in harvested wood products in Mississippi. *Forest Policy and Economics* 14(1): 99-106. doi: http://dx.doi.org/10.1016/j.forpol.2011.08.005

Nepal, P., R.K. Grala, and D.L. Grebner. 2012. Financial implications of enrolling Mississippi forest landowners in carbon offset programs. *Southern Journal of Applied Forestry* 36(1): 5-10. doi: http://dx.doi.org/10.5849/sjaf.09-067

Nepal, P., R.K. Grala, D.L. Grebner, and R.C. Abt. 2013. Impact of harvest-level changes on carbon accumulation and timber stumpage prices in Mississippi. *Southern Journal of Applied Forestry* 37(3): 160-168. doi: http://dx.doi.org/10.5849/sjaf.12-020

Perez-Verdin, G., J.J. Navar-Chaidez, D.L. Grebner, and C. Soto Alvarez. 2012. Availability and production costs of forest biomass as a feedstock for bioethanol production. *Forest Systems* 21(3): 526-237. doi: http://dx.doi.org/10.5424/fs/2012213-02636

Prestemon, J.P., T.J. Hawbaker, M. Bowden, J. Carpenter, S. Scranton, M.T. Brooks, R. Sutphen, and K.L. Abt. 2013. Wildfire ignitions: A review of the science and recommendations for empirical modeling. USDA Forest Service General Technical Report SRS-171. Asheville, NC: USDA Forest Service Southern Research Station. 20 pages.

Radhakrishnan, S., J.O. Paz, F. Yu, S. Eksioglu, and D.L. Grebner. 2013. Assessment of potential capacity increases at combined heat and power facilities based on available corn stover and forest logging residue. *Energies* 69:4418-4428. doi: http://dx.doi.org/10.3390/en6094418

Rafel, C., R.C. Abt, R. Jonsson, J.P. Prestemon, and F.W. Cubbage. 2013. Modeling the impacts of EU Bioenergy demand on the forest sector of the Southeast U.S. J*ournal of Energy and Power Engineering* 7(6):1073-1081.

Rafel, C., R.C. Abt, F.W. Cubbage, R. Jonsson, and J.P. Prestemon. 2012. European Union pellet demand and its influence on forest market and carbon sequestration in the southeast U.S. P. 33-35 in Swedish Bioenergy Association, Proceedings of the World Bioenergy 2012 Conference and Exhibition on Biomass for Energy, May 29-31, 2012, Jönköping, Sweden.

Susaeta, A., Chang, S.J., Carter, D., Lal, P. 2014. Economics of carbon sequestration under fluctuating economic environment, forest management and technological changes: an application to forest stands in the southern United States. *Journal of Forest Economics* 20(1): 47-64.

Susaeta A., Carter, D., Adams, D. 2014 Impacts of climate change on economics of forestry and adapatation strategies in the United States South. *Journal of Agricultural and Applied Economics* 46(2): 1-16.

Susaeta A., Carter, D., Adams, D. 2014 Sustainability of forest management under changing climatic conditions in the southern United States: adaptation strategies, economic rents and carbon sequestration. *Journal of Environmental Management* 139: 80-87.

Timilsina, N., F.J. Escobedo, W.P. Cropper, A. Abd-Elrahman, T.J. Brandeis, S. Delphin, and S. Lambert. 2012. A framework for identifying carbon hotspots and forest management drivers. *Journal of Environmental Management* 114: 293-302. doi: http://dx.doi.org/10.1016/j.jenvman.2012.10.020

Timilsina, N., W.P. Cropper, Jr., F.J. Escobedo, and J.M. Tucker Lima. 2013. Predicting understory species richness from stand and management characteristics using regression trees. *Forests* 4(1): 122-136. doi: http://dx.doi.org/10.3390/f4010122

Theses/Dissertations

Other publications

James, Natasha A. 2013. Projecting Sustainability: Growth to Removals Dynamics. M.S. Thesis, Raleigh, North Carolina: North Carolina State University. 74 p.

Joshi, O., Grebner, D.L., Munn, I.A., Grado, S.C., Henderson, J.E., and R.K. Grala. 2013. A preliminary assessment of issues related to mill residue utilization in Mississippi. In conference proceeding of Southern Forest Economists' Workshop (SOFEW), 2012. Retrieved from /sofew.cfr.msstate.edu/.

Khanal, P. N. and D.L. Grebner. 2012. A preliminary framework for evaluating the willingness of nonindustrial private forestland owners to practice optimum carbon sequestration regimes in Mississippi. In conference proceeding of Southern Forest Economists' Workshop (SOFEW), 2012. Retrieved from /sofew.cfr.msstate.edu/.

Kreye, M., Escobedo, F.J., Adams D.C., Stein, T., and Borisova, T. 2013. Valuing the Ecosystem Services of Florida's Forest Conservation Programs: The Economic Benefits of Protecting Water Quality. University of Florida- IFAS, EDIS, FOR 309 https://edis.ifas.ufl.edu/fr377

Schultz, E.B., T.G. Matney, and D.L. Grebner. 2013. A Tree Biomass and Carbon Estimation System. Proceedings of the 15th Biennial Southern Silviculture Research Conference, Hot Springs, AR. Editor: Guldin, J., e-Gen. Tech. Rep. SRS-GTR- 175. Asheville, NC: USDA, Forest Service, Southern Research Station.

Audio/video products

Events/Activities

Presentations

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Abt, R.C.	SRTS Model: Updates and Applications. Annual Meeting of the NCSU Southern Forest Assessment Cooperative.	Presentation	August 8, 2013.	Durham, NC.
Abt, K.L.	Modeling timber demand for use in SRTS.	Presentation	August 8, 2013.	Annual Meeting of the NCSU Southern Forest Assessment Cooperative. Durham, NC.
Abt, R.C. (presenter, invited), K.L. Abt, C. Galik, F.W. Cubbage.	Bioenergy Demand and the Southern Forest Resource.	Presentation	May 14, 2013.	Packard Foundation. Washington DC
Abt, R.C.	Expectations and sustainability.	Presentation	May 14, 2013.	Packard Foundation. Washington DC.
Abt, R.C. (presenter, invited), T. Adams, S. Houston, M. Luppold.	SC Forest Resource Projections: a 20/15 program assessment.	Presentation	October 2013.	South Carolina Forestry Association. Asheville, NC.
Abt, R.C. (presenter), K.L. Abt, C. Galik.	Bioenergy Demand and the Southern Forest Resource.	Presentation	September 20, 2013.	Energy Biosciences Institute, University of Illinois. Urbanna-Champagne, IL.
Abt, K.L. and R.C. Abt	Timber supply: too much or too little?	Presentation (Meeting)	April 23, 2012	Departmental Seminar, Department of Forestry, College of Natural Resources, NCSU
Abt, R.C. and K.L. Abt	Forest Markets, Spatial Scale, and Carbon Accounting	Presentation (Meeting)	April 27, 2012	CENREP Seminar, Center for Environmental Resource Economic Policy, NCSU
Abt, R.C.	Bioenergy demand and the southern forest resource	Presentation (Meeting)	October 2012	Soil and Mulch Producers Council, Atlanta, GA
Abt, R.C. and C.S. Galik	Southeastern U.S. Forest Bio-Economic Dynamics: The Impact of Spatial and Temporal Scale on Carbon Accounting	Presentation (Meeting)	September 21, 2012	Nicholas Institute for Environmental Policy Solutions & UPEP Environmental Institutions Seminar Series
Abt, R.C. and C.S. Galik	Southeastern U.S. Forest Bio-Economic Dynamics: The Impact of Spatial and Temporal Scale on Carbon Accounting	Webinar	November 15, 2012	ERPI Research Meeting Webinar
Abt, K.L., R.C. Abt, R. Sheffield, and M. Lupold	Timber famine meets wall of wood	Presentation (Conference)	March 2012	SOFEW Annual Meeting, Charlotte, NC
Abt, R.C. and K.L. Abt	The carbon impact of increased loblolly pine growth: Potential market and land use feedback	Webinar	December 12, 2012	PINEMAP Aim 4 Webinar

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Abt, R. and P. Dwivedi	Carbon consequences of changes in wood supply and product demand from pine plantations: Preliminary results from market and life cycle analysis	Presentation (Meeting)	April 24, 2013	PINEMAP 2013 Annual Meeting
Adams, D.C., J. Soto, and F. Escobedo	Estimating the Supply Of Forest Carbon Offsets: A Comparison Of Best-Worst And Discrete Choice Valuation Methods	Presentation (Conference)	December 10-14, 2012	ACES and Ecosystem Markets Conference, Ft. Lauderdale, FL
Cademus, R., Escobedo, F.J. Abd-Elrahman, A., Cohen M.J.	Evaluating and Mapping Interactions Among Multiple Ecosystem Services	Poster Presentation	April 2-3, 2013	Sustaining Economies and Natural Resources in a Changing World: Key Role of Land Grant Universities, Gainesville, FL
Dwivedi, P.	Does Wood-based Electricity Generation Reduce GHG Emissions? An Exploration Considering Forestland Holdings, Harvest Age, and Power Plant Capacities	Webinar	October 19, 2012	PINEMAP Internal Webinar Series
Escobedo, F.	Reducing vulnerabilities to climate change and increasing biodiversity	Presentation (Workshop)	July 23-24, 2013	USDA Forest Service International Programs Workshop, San Salvador, El Salvador
Gan, J.	Why should we buy US made forest products: economic and environmental perspectives	Presentation (Meeting)	April 9, 2014	Texas Society of American Foresters Annual Meeting, Athens, Texas
Grala, R.K., Grebner, D.L., Munn, I.A., and A. Hussain.	Capacity of southern mills to utilize woody residues for bioenergy production	Presentation (Conference)	March 10-12, 2013	Southern Forest Economics Workers Annual Meeting in Auburn, Alabama
Grala, R.K., Mutandwa, E., Munn, I.A., Grebner, D.L., Grado, S.C., Hussain, A., and D.R. Petrolia.	Willingness to Mississippi's forest landowners to manage their forests for ecosystems services.	Presentation (Conference)	March 10-12, 2013	Southern Forest Economics Workers Annual Meeting in Auburn, Alabama
Grebner, D.L., Grala, R.K., and O. Joshi	Current status of woody biomass research in the United States Mid-South	Presentation (Conference)	October 6-9, 2013	Forest Biomass Conference in Mierzęcin, Poland.
Grebner, D.L., Grala, R.K., and O. Joshi	Current status of woody biomass research in the United States Mid-South	Presentation (Conference)	January 29, 2014	Seminar Series, Northern Arizona University, Flagstaff, AZ

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Joshi, O., D.L. Grebner, I.A. Munn, A. Hussain, and S.R. Gruchy	Analyzing landowners' preferred harvesting methods for supplying feedstock to potential wood-based bioenergy industries: A choice experiment approach	Presentation (Conference)	October 24-28, 2012	Society of American Foresters National Convention, Spokane, WA
Joshi, O., D.L. Grebner, A. Hussain, and S.C. Grado	Landowner knowledge of and willingness to supply woody biomass for bioenergy in Mississippi	Presentation (Conference)	June 6-9, 2012	IUFRO 4.05.00-Managerial economics and accounting annual symposium, Knoxville, Tennessee
Joshi, O., D.L. Grebner, I.A. Munn, S.C. Grado, R.K. Grala, and J.E. Henderson	An econometric analysis of utilizing unused woody biomass from wood processing facilities in Mississippi	Presentation (Meeting)	March 19-22, 2012	Southern Forest Economics Workers Meeting, Charlotte, NC
Joshi, O., Grebner, D.L., Henderson, J.E., Grado, S.C., and I.A. Munn.	Input-output modeling of wood-based bioenergy industries in Mississippi.	Presentation (Conference)	March 10-12, 2013	Southern Forest Economics Workers Annual Meeting in Auburn, Alabama
Joshi, O., D.L. Grebner, I.A. Munn, S.C. Grado, R.K. Grala, and J.E. Henderson	An econometric analysis of utilizing unused woody biomass from wood processing facilities in Mississippi	Presentation (Conference)	September 9-12, 2012	Fourth International Faustmann Symposium, Saariselkä, Lapland, Finland
Khanal, P., D.L. Grebner, I.A. Munn, S.C. Grado, J.E. Henderson, O. Joshi., and R.K. Grala	Determining Optimum Carbon Sequestration Strategies for Pine Plantations in Nonindustrial Private Forestlands of Mississippi	Poster Presentation	October 24-28, 2012	Society of American Foresters National Convention, Spokane, WA
Khanal, P., D.L. Grebner, I.A. Munn, S.C. Grado, J.E. Henderson, O. Joshi., R.K. Grala, and J.E. Henderson	Assessing Non-Industrial Private Forest Landowners' Attitude and Willingness to Carbon Sequestration in the Southern Region	Poster Presentation	April 24-26, 2013	PINEMAP Annual Meeting, Athens, GA
Khanal, P. and D.L. Grebner	Factors affecting NIPF willingness to sequester forest carbon in the South	Presentation (Conference)	March 7, 2014	International Society of Forest Resource Economics Annual Meeting, St. Louis, MO
Khanal, P. and D.L. Grebner	Non-industrial private forest landowner obstacles to forest carbon sequestration in the Southern United States	Presentation (Conference)	March 16-18, 2014	Southeastern Natural Resources Graduate Student Research Symposium, Mississippi State University, MS
Kreye, M.M., D.C. Adams, F. Escobedo, and J. Soto	Using best-worst scaling choice experiments to measure preferences for forest conservation programs that protect water quality	Presentation (Conference)	December 10-14, 2012	ACES and Ecosystem Markets Conference, Ft. Lauderdale, FL

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Kreye, M.M., D.C. Adams, T. Borisova, and F. Escobedo.	Valuing nutrient pollution prevention in well-conserved aquatic systems: A meta-analysis	Presentation (Conference)	November 1-4, 2011	38th Natural Areas Conference, Tallahassee, FL
Kreye, M.M., D.C. Adams, T. Borisova, and F. Escobedo.	The Value of Water Quality Protection Programs: A Meta-Analysis [poster]	Presentation (Conference)	November 2-6, 2011	Society of American Foresters National Convention, Honolulu, HI
Prestemon, J.P (presenter), U. Shankar, A. Xiu, K. Talgo, D. Yang, E. Dixon IV, and K.L. Abt.	Human and Lightning Wildfire Projections for the Southeastern U.S.: 2015-2060.	Presentation (Conference)	March 17, 2014.	International Society for Forest Resource Economics. St. Louis, MO.
Prestemon, J.P (presenter), U. Shankar, A. Xiu, K. Talgo, D. Yang, E. Dixon IV, and K.L. Abt.	Wildfire and Climate Change in the South.	Presentation (Conference)	October 21, 2013.	Forestry and Environmental Resources Departmental Seminar, NCSU. Raleigh, NC.
Soto, J.R. and D.C. Adams	Estimating the Supply of Forest Carbon Offsets: A Comparison of Best-Worst and Discrete Choice Valuation Methods	Presentation (Meeting)	August 12-14, 2012	Agricultural and Applied Economics Association Meeting, Seattle, WA
Soto, J.R. and D.C. Adams	Estimating the Supply of Forest Carbon Offsets: A Comparison of Best-Worst and Discrete Choice Valuation Methods	Poster Presentation	December 10-12, 2012	ACES and Ecosystem Markets Meeting, Ft. Lauderdale, FL
Steen, J.D., Grado, S.C., Munn, I.A., Measells, M.K., Hussain, A., Henderson, J.E., Grala, R.K., Grebner, D.L., and R.J. Rousseau.	Factors influencing nonindustrial private forest landowner willingness to grow short-rotation woody crops for bioenergy in Mississippi.	Presentation (Conference)	March 10-12, 2013	Southern Forest Economics Workers Annual Meeting in Auburn, Alabama
Susaeta, A., D. Carter, and D. Adams	Economics of climate change in even-aged forest management	Poster Presentation	June 12-15, 2013	Third IUFRO Latin American Congress: Forest, Competiveness and Sustainable Landscapes, San Jose, Costa Rica
Susaeta, A.I., D.R. Carter, and S.J. Change	A generalized economic model for carbon sequestration: Implications for sustainability of forestlands in the U.S. South	Presentation (Conference)	October 13-16, 2012	The 2nd Forest Science Forum: Forest Management Adapting to Climate Change. Beijing, China
Susaeta, A.I., D.R. Carter, S.J. Change, and D.C. Adams	The impact of hurricane risk on optimal forest management in southern U.S. pine plantations: Application of a generalized Reed model	Presentation (Conference)	September 9-12, 2012	The Fourth International Faustmann Symposium: Forest Economics under Multiple Challenges. Tunturihotelli, Saariselkä, Lapland, Finland

Author(s)/Presenter(s)	Title	Type	Date	Venue/Location
Susaeta, A.I., D.R. Carter, S.J. Change, and D.C. Adams	The generalized Reed model and its application to determine the impact of hurricane risk on even-aged plantation management in southern United States	Poster Presentation	April 24-26, 2013	PINEMAP Annual Meeting, Athens, GA
Susaeta, A.I., S.J. Chang, D. Carter, and P. Lal	Economics of carbon sequestration under fluctuating economic environment, forest management and technological changes: an application to forest stands in the southern United States	Poster Presentation	April 24-26, 2013	PINEMAP Annual Meeting, Athens, GA
Susaeta, A., D. Carter, and D. Adams	Impacts of climate change on economics of forestry and mitigation strategies in the United States South	Poster Presentation	April 24-26, 2013	PINEMAP Annual Meeting, Athens, GA
Timilsina, N., W. Cropper Jr., and F. Escobedo	Assessing trade-offs among different ecosystem services in pine flatwoods of the southeastern coastal plain	Poster Presentation	May 15-16, 2012	PINEMAP Annual Meeting, Atlanta, GA

Trainings, workshops, and courses

Experiments, surveys, and data collection

D.C. Adams (co-PI), M.M. Kreye (PhD student), and Justin Soto (undergraduate PINEMAP intern) conducted pilot tests and M.M. Kreye implemented the full survey on willingness to pay for forest-based water quality improvement, which will inform the bioeconomic modeling non-market ecosystem services.

D.C. Adams (co-PI) and Jose Soto (PhD student) have finished the second and final wave of surveys to estimate non-industrial private forest landowners' willingness to accept carbon offset payments. The results of this survey will inform landowner adoption of mitigation and adaptation strategies, and our assessment of policies and programs that affect C mitigation in planted pine forests.

D.L. Grebner and Puskar Khanal (PhD student) completed the design, development, and delivery of a survey instrument to forest landowners across the southeastern United States. A landowner list of forest landowners across the southern United States was purchased from List Grant. Four mailings were sent to selected landowners. After the initial mailing of the survey instrument, a follow up post card reminder was sent one week later which was followed by a second mailing of the survey instrument. After the second mailing of the survey instrument, it was decided that a third mailing of the survey instrument was needed to boost the response

rate. Approximately 5,100 non-industrial private forest landowners were contacted. Seven hundred and thirty four surveys were returned giving an adjusted response rate of 15.02%. This response rate was similar to that found by Thompson and Hansen in 2012 using the same vendor List Grant. Currently, the survey data is being evaluated and analyzed.

N. Timilsina (Post-Doc), W. Cropper (Co-PI) and F. Escobedo (Co-PI) have supplemented the FIA database with US Census data and plot-level understory species richness data from Timilsina et al.'s (2013) species richness predictive model. This diversity data was supplied to the PINEMAP group working on developing a decision support system (DSS) and has been integrated into the TerraC database. Additionally, FIA tree and plot-level remeasurement data for several periods has been matched to obtain gross C sequestration estimates. The data is being used to develop a genetic algorithm that can analyze plot-level trade-offs among carbon, timber, understory diversity.

N. Timilsina (Post-Doc), F. Escobedo (Co-PI), and W. Cropper (Co-PI) are working with S. Gezan (Statistician from UF) in developing models that predict carbon, timber and biodiversity in order to develop scenarios (different management regime). These predictive models are using several FIA explanatory variables that contain several interactions among the variables or polynomials. Models are being developed using a Bayesian approach based on posterior probabilities and the Bayes factor as a model selection criteria. Collinearity issues are being addressed and models will be developed for specific FIA units.

F. Escobedo (Co-PI), D. Adams (Co-PI), Mohamad Traboulsi (PhD student) and W. Cropper (Co-PI) are working on integrating FIA plot data with hydrologic unit watersheds and subwatersheds in Florida. Watershed-level WASSI water yield outputs will then be integrated with FIA C, Timber and diversity data to identify watersheds with optimal provision levels and use/non-use values for water yield, C, timber and understory diversity.

A. Susaeta (Post-Doc), D. Adams (Co-PI) and D. Carter (Co-PI) are developing a nonparametric model to evaluate the efficiency of forest plots in the provision of ecosystem services under changing climatic conditions. This model will employ FIA data to determine the optimal levels of carbon sequestration, timber volume and biodiversity values.

MILESTONES

Assess policies and programs that may affect C mitigation in planted pine forests

We have completed a draft summary of market-based programs and policies that are likely to impact C mitigation, and have started work summarizing federal and state programs and policies. We have also identified and mapped forest carbon storage hotspots (areas of high carbon storage) and other forest areas with low carbon storage (i.e. coldspots) in the state of Florida and the biophysical and forest management characteristics that are driving these hot/coldspots (Timilsina, N., F. Escobedo, W. Cropper, Jr., T. Brandeis, S. Delphin, and S. Lambert. A framework for identifying carbon hotspots and forest management drivers. *Journal*

of Environmental Management 114: 293-302 doi: http://dx.doi.org/10.1016/j.jenvman.2012.10.020

Regional market impacts based on business-as-usual assumptions

We have added welfare calculations to the regional timber market model (SRTS).

NPV analysis and regional market impacts of adaptation strategies

An economic framework has been developed and will be applied as soon as we have the information about predicted pine productivity change and carbon accounting under climate change from other Aims.

Document landowner adoption of mitigation and adaptation strategies

We have completed a first wave of surveys to estimate willingness to accept carbon offset payments by non-industrial private forest landowners in the southeast. Survey data are being analyzed; manuscripts reporting the results are being drafted.

Life cycle assessment of wood products within forest and various management strategies

NPV and regional market impacts of altered disturbance risks

We have completed two publications in which we assessed the impacts of climate change on the economics of loblolly pine and slash pine. Both articles have been accepted for publications by the Journal of Agricultural and Applied Economics and Journal of Environmental Management.

We also have integrated climate extremes and adaptations into the modeling of southern pine beetle (SPB) infestations. We are working on incorporating the predictions of future climate extremes under various IPCC emissions scenarios into the estimation of future SPB infestation risk though predicting future climate extremes seems challenging.

Wildfire forecasts under varying climate and socio-economic scenarios have been developed. Using county level wildfire, socioeconomic and downscaled climate, we estimated a model using a three-stage heckman to account for the irregular missing observations. Forecasts were then generated on an annual basis for 9 climate/socio scenarios. A monte carlo analysis will be used to develop an uncertainty profile for each year's forecast for each ecoregion. The mean, median and confidence interval data will be available for use in a DSS or stand level NPV calcuations. The analysis accounts for uncertainty in both wildfire recording and in climate forecasts.

Bioeconomic modeling of nontimber market ecosystem services

We developed an FIA database with plot-level understory species richness data from Timilsina et al.'s (2013) species richness predictive model is now available in the TerraC database, and are currently identifying biophysical and forest management characteristics to model ecosystem services (for example model carbon storage and species richness) for Florida. We are also developing an economic framework to assess changes in forest management and biophysical characteristics due to climate change and their impacts on ecosystem services.

Using FIA data, we are employing data envelopment analysis to determine the efficiency of forest plots in the provision of ecosystem services. We are considering forest plots in Florida as a decision making units with inputs (for example, number of trees per ha, stand development, and site productivity) and outputs (timber production, species richness and carbon sequestration). This nonparametric approach would compare the efficiency of each forest plot with the most efficient plot given the existing conditions. Furthermore, the performance of each plot would be evaluated assuming changes in precipitation, temperatures and forest productivity.

F. Escobedo (Co-PI) and R. Cademus (MS student working for a separate project): Developed an ecosystem service provision level classification framework to examine, in a spatially explicit manner, output levels of carbon sequestration, timber production and water yield provision and their interactions (i.e. synergies vs. tradeoffs) in slash pine ecosystems in north Florida. Literature on ecosystem service "tradeoffs" and "synergies" has been compiled as well as on the effect of biophysical drivers (e.g. age, basal area, tenure, silvicultural treatments, disturbance regime) on these interactions. A manuscript describing this work has been submitted for peer review: Cademus, R., Escobedo F.J., McLaughlin, D., Abd-Elrahman, A. In Review. Ecosystem service tradeoffs, syneriges and drivers in *Pinus Elliotii* forests.

Daniel Taylor-Rodriguez and Salvador A. Gezan (working with Co-PI Escobedo) completed "Ecosystem Service Interaction Analysis and Management-Ecological Driver Predictive Models using objective Bayes Procedures". This statistical analysis developed predictive models based on several FIA-based management and ecological factors that contains 2-way ecosystem service interactions among these variables. Interactions between aboveground carbon, herbaceous richness, net timber volume and saw timber volume were analyzed. Factors or drivers influencing these interactions were predicted and identified.

BROAD IMPACTS

None to report at this point.

TRAINING

Last name	First name	Position	University	Role
An	Hyunjin	Ph.D. Student	TAMU	Assessing climate change impact on southern pine beetle infestations and associated economic and carbon consequences.
Dwivedi	Puneet	Postdoc	University of Illinois-Urbana Champaign	Working with Dr. Gan to assess impacts of climate change on southern pine beetle infestation and exploring life cycle impacts of different wood products produced using southern pines.
Khanal	Puskar	Ph.D. Student	MSU	Research focus: Evaluating forest management practices that enhance carbon sequestration in stands and developing a survey instrument to determine small forest landowner's willingness to implement these practices and identify potential incentives that increase carbon sequestration at the stand level.
Kreye	Melissa	Ph.D. Student	UF	Completed a literature review on the economic value of forest-based changes in water quality; conducted a meta-analysis of forest-based water quality values; and specified an econometric model that predicts willingness to pay for forest-based water quality. Using a benefit transfer method, she has applied the model to two representative sites.
Soto	Jose	Ph.D. Student	UF	Research focus: Assessing and summarizing competing programs and policies that incentivize carbon sequestration at the local, state, national, and international level. He has also developed, pre-tested, and implemented a survey of non-industrial private forest landowners to determine their willingness to accept payments for carbon offsets based on offset program characteristics. Results of this work will be used to predict participation rates in programs that incentivize changes in land use that increase carbon sequestration and will be integrated in a bioeconomic model of non-market ecosystem services produced under competing approaches for climate change adaptation and mitigation.
Soto	Justin	Undergraduate Intern	UF	2012 Undergraduate Fellow; assisted Melissa Kreye at University of Florida with assessment of the economic value of forest-based ecosystem services under alternative management and policy regimes.
Susaeta	Andres	Postdoc	UF	Primarily involved in developing a forest stand-level model to assess expected economic rents for forest landowners under hurricane risks associated with future climate change conditions. He has also played a key role in developing an economic model to analyze carbon sequestration in loblolly pine plantations under various carbon subsidies and tax rates in the context of climate change. Working on FIA plot data to analyze the efficiency in the provision of ecosystem services (C sequestration, timber production and biodiversity values) under changing climatic conditions in the U.S. South.
Timilsina	Nilesh	Postdoc	UF	Working on assessing the interactions between different ecosystem services in pine flatwoods and optimizing modeling to maximize a particular ecosystem service and asses the tradeoff of the others.
Traboulsi	Mohamad		UF	Working on integrating FIA plot data with hydrologic unit watersheds and subwatersheds in Florida. Watershed-level WASSI water yield outputs will then be integrated with FIA C, Timber and diversity data to identify watersheds with optimal provision levels and use/non-use values for water yield, C, timber and understory diversity.

Last name	First name	Position	University	Role
Tucker	Joanna	Postdoc	UF	Assisting with analysis and manuscript preparation for a project involving the use of available USDA Forest Service FIA forest inventory data to estimate understory species richness (i.e. biodiversity).