TIERRA RESOURCES

September 29, 2014

To Whom It May Concern:

Please accept the revisions to the following modules of the "Restoration of Degraded Deltaic Wetlands of the Mississippi Delta" modular methodology to further quantify prevented wetland loss due to project activities:

1) Wetland Restoration Methodology Framework (WR-MF)
2) Estimation of carbon stocks in the soil organic carbon pool (CP-S)
3) Estimation of baseline carbon stock changes from WR including projected wetland loss for the baseline scenario (BL-WR-HM)
4) Estimation of baseline carbon stock changes from WR where the project activity includes hydrologic management as well as projected wetland loss for the baseline scenario (BL-WR-HM-WL)

Summary

Wetland loss refers to vegetation death and conversion to open water. When vegetation death occurs, organic carbon undergoes complex cycling, with fate dependent on specific type and source;[1] part of the soil organic carbon is oxidized to CO_2 and part is buried, either in situ or exported and buried elsewhere. On average, the top 50 cm of wetland soil contains approximately 200 tons CO2e/ac.[2,3,4,5] The top 50 cm of the wetland soil horizon generally includes the living root zone, which is most geomorphically unstable, and has the greatest potential of being decomposed when the vegetation dies and released as CO_2 and CH_4. This carbon may be quantified as carbon offsets if restoration efforts are successful in preventing the loss of the wetland soil horizon.

[1] Reddy, K.R., & R.D. DeLaune, 2008. Biogeochemistry of Wetlands: Science and Applications. CRC Press, Boca Raton, FL.

[2] Delaune, R. D., & S. R. Pezeshki, 2003. The role of soil organic carbon in maintaining surface elevation in rapidly subsiding U.S. Gulf of Mexico coastal marshes. Water, Air, & Soil Pollution 3: 167-179.

[3] Hatton, R.S., R.D. Delaune, and J.W.H. Patrick. 1983. Sedimentation, accretion, and subsidence in marshes of Barataria Basin, Louisiana. Limnology & Oceanography 28: 494-502.

[4] Nyman, J.A., R.D. DeLaune, S.R. Pezeshki, and W.H. Patrick. 1995. Organic matter fluxes and marsh stability in a rapidly submerging estuarine marsh. Estuaries & Coasts 18: 207-218.

[5] Nyman, J.A., R.J. Walters, R.D. Delaune, and W.H. Patrick. 2006. Marsh vertical accretion via vegetative growth. Estuarine, Coastal & Shelf Science 69: 370-380.

When the methodology was initially written there was insufficient knowledge regarding the fate and transport of carbon during wetland loss to determine the rate of GHG emissions or what proportion of the carbon contained in the soil horizon results in greenhouse gas emissions during wetland loss. The initial methodology included equations that quantified the loss of biological sequestration capacity due to a reduced wetland area as a wetland converted to open water in the baseline scenario. However, equations were not included to address greenhouse gas emissions that result from the decomposition of soil organic matter during wetland loss due to a lack of supporting data.

Tierra Resources has been working with ConocoPhillips over the past several years to research the carbon impacts of preventing wetland loss. The results of this research will be published in the scientific literature in 2015. While this research is going through the scientific peer-review process we would like to get the corresponding revisions to the methodology certified. We believe that the financial incentive for the inclusion of prevented loss emissions will further encourage scientific research into this issue.

Methodology Revisions

The revisions to the methodology provide equations to quantify the greenhouse gas emissions resulting from the degradation and erosion of the wetland soil horizon, specifically the top 50 cm. The WR-MF module required very minor changes to the verbiage to describe prevented wetland loss and to Table 3 to describe the wetland emission sources. An equation (equation 3) was added to CP-S to quantify the soil carbon contained in the top 50 cm of the wetland soil horizon.

The baseline modules BL-WR-WL and BL-WR-HM-WL have been modified to account for the loss of sequestration capacity as wetland area decreases through time. This was done by simply taking the fraction of wetland area present at a given time and multiplying by the baseline carbon sequestration rates of soils and living trees and by the rate of GHG emissions. In addition, a subcomponent has been added to account for GHG emissions resulting from the decomposition of organic matter during wetland loss. Project proponents are required to provide supporting evidence and arguments supporting the emission values used. Monitoring methods remain the same for all the modules.

Background

Louisiana contains more than 4 million acres of coastal wetlands, representing 40% of the country's total. However, 80% of the coastal wetland loss in the entire continental United States has occurred in the Mississippi Delta, with about 90% of the current coastal wetland loss in the continental United States occurring in Louisiana.[6,7] The U.S. Geological Survey (USGS) and others have been studying the rates and causes of this wetland loss for many years. Coastal Louisiana has undergone a net change in

[6] Louisiana Department of Natural Resources (LDNR), 1998. Coast 2050: Toward a Sustainable Coastal Louisiana. Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. Louisiana Department of Natural Resources, Baton Rouge, LA, USA.

[7] Couvillion, B.R., Barras, J.A., Steyer, G.D., Sleavin, William, Fischer, Michelle, Beck, Holly, Trahan, Nadine, Griffin, Brad, and Heckman, David, 2011, Land area change in coastal Louisiana from 1932 to 2010: U.S. Geological Survey Scientific Investigations Map 3164, scale 1:265,000, 12 p. pamphlet.

land area of about -1,883 mi^2 from 1932 to 2010.[8,9,10,11,12,13,14,15] This net change in land area amounts to a decrease of about 25% of the 1932 land area.[16] Over 95% of this loss was wetland, primarily marsh, conversion to open water. Trend analyses from 1985 to 2010 indicate a wetland loss rate of 16.57 mi^2 per year[17], which is equivalent to losing an area the size of a football field per hour.[18]

Land loss in the delta is a result of the complex interactions of natural and human-induced processes. The Mississippi delta was formed over the past 6,000-7,000 years as a series of overlapping delta lobes fed by river distributaries.[19,20] In the past, seasonal flooding of the Mississippi River deposited large amounts of sediments and nutrients into the Mississippi River delta, compensating for subsidence by

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[8] Barras, J.A., Beville, S., Britsch, D., Hartley, S., Hawes, S., Johnston, J., Kemp, P., Kinler, Q., Martucci, A., Porthouse, J., Reed, D., Roy, K., Sapkota, S., Suhayda, J., 2003. Historical and projected coastal Louisiana land changes: 1978-2050. USGS Open File Report 03-334, 39 pp.

[9] Britsch, L.D., and Dunbar, J.B., 1993, Land-loss rates-Louisiana coastal plain: Journal of Coastal Research, v. 9, p.324-338.

[10] Boesch, D.F., Josselyn, M.N., Mehta, A.J., Morris, J.T., Nuttle, W.K., Simenstad, C.A., Swift, D., 1994. Scientific assessment of coastal wetland loss, restoration and management in Louisiana. J. Coastal Res. 20, 1-103.

[11] Boesch DF, Shabman L, Antle LG, Day JW, Dean RG, Galloway GE, Groat CG, Laska SB, Luettich RA, Mitsch WJ, Rabalais NN, Reed DJ, Simonstad CA, Streever BJ, Taylor RB, Twilley RR, Watson CC, Wells JT, Whigham DF (2006) A New Framework for Planning the Future of Coastal Louisiana after the Hurricanes of 2005. Working Group for Post-Hurricane Planning for the Louisiana Coast, 48p

[12] Shafer GP, Wood WB, Hoeppner SS, Perkins TE, Zoller J, Kandalepas D (2009) Degadation of baldcypress-water tupelo swamp to marsh and open water in southeastern Louisiana, U.S.A.: An irreversible trajectory? Journal of Coastal Research 54: 152-165

[13] Barras, J.A.; Bourgeois, P.E., and Handley, L.R., 1994. Land Loss in Coastal Louisiana, 1956–1990. National Wetlands Research Center Open File Report 94-01. Lafayette, Louisiana: National Biological Survey.

[14] Chambers, J.L.; Conner, W.H.; Day, J.W.; Faulkner, S.P.; Gardiner, E.S.; Hughes, M.S.; Keim, R.F.; King, S.L.; McLeod, K.W.; Miller, C.A.; Nyman, J.A., and Shaffer, G.P., 2005. Conservation, Protection and Utilization of Louisiana's Coastal Wetland Forests. Final Report to the Governor of Louisiana from the Coastal Wetland Forest Conservation and Use Science Working Group. (special contributions from Aust, W.M.; Goyer, R.A.; Lenhard, G.J.; Souther-Effler, R.F.; Rutherford, D.A., and Kelso, W.E.), 121p. Available from: Louisiana Governor's Office of Coastal Activities, 1051 N. Third St. Capitol Annex Bldg, Suite 138 Baton Rouge, LA 70802. http://www.coastalforestswg.lsu.edu

[15] Barras, J.A., J.C. Bernier, and R.A. Morton. 2008. Land area change in coastal Louisiana - A multidecadal perspective (from 1956 to 2006). U.S. Geological Survey Scientific Investigations Map 3019, scale 1:250,000, 14 p. pamphlet.

[16] Louisiana Department of Natural Resources (LDNR), 1998. Coast 2050: Toward a Sustainable Coastal Louisiana. Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. Louisiana Department of Natural Resources, Baton Rouge, LA, USA.

[17] Couvillion, B.R., Barras, J.A., Steyer, G.D., Sleavin, William, Fischer, Michelle, Beck, Holly, Trahan, Nadine, Griffin, Brad, and Heckman, David, 2011, Land area change in coastal Louisiana from 1932 to 2010: U.S. Geological Survey Scientific Investigations Map 3164, scale 1:265,000, 12 p. pamphlet.

[18] Couvillion, B.R., Barras, J.A., Steyer, G.D., Sleavin, William, Fischer, Michelle, Beck, Holly, Trahan, Nadine, Griffin, Brad, and Heckman, David, 2011, Land area change in coastal Louisiana from 1932 to 2010: U.S. Geological Survey Scientific Investigations Map 3164, scale 1:265,000, 12 p. pamphlet

[19] Roberts, H.H., 1997. Dynamic changes of the holocene Mississippi river delta plain: the delta cycle. Journal of Coastal Research 13: 605-627.

[20] Day, J.W., D.F. Boesch, E.J. Clairain, G.P. Kemp, S.B. Laska, W.J. Mitsch, K. Orth, H. Mashriqui, D.J. Reed, L. Shabman, C.A. Simenstad, B.J. Streever, R.R. Twilley, C.C. Watson, J.T. Wells, and D. F. Whigham. 2007. Restoration of the Mississippi delta: lessons from hurricanes Katrina and Rita. Science 315: 1679-1684.

mineral matter deposition and organic matter production.[21] There was an increase in wetland area in active deltaic lobes and wetland loss in abandoned lobes, but there was an overall net increase in the area of wetlands over the past several thousand years. The construction of flood-control levees and closure of distributary channels began soon after colonization of New Orleans by the French in 1719,[22,23,24] and by mid-20th century the Mississippi River delta was almost completely separated from the river.[25,26,27] Since that time there has been massive amounts of wetlands lost irrespective of any "no net loss policy", primarily due to levee and canal construction that caused impoundment, sediment and nutrient deprivation, land subsidence, and saltwater intrusion.[28,29,30,31,32]

We are pleased to submit the revisions described above. Feel free to contact me at sarahmack@tierraresourcesllc.com or by phone at 504-339-4547 with questions.

Kind Regards,

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[21] Day, J.W., D.F. Boesch, E.J. Clairain, G.P. Kemp, S.B. Laska, W.J. Mitsch, K. Orth, H. Mashriqui, D.J. Reed, L. Shabman, C.A. Simenstad, B.J. Streever, R.R. Twilley, C.C. Watson, J.T. Wells, and D. F. Whigham. 2007. Restoration of the Mississippi delta: lessons from hurricanes Katrina and Rita. Science 315: 1679-1684.

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