Comparison of Three Methods to Project Future Baseline Carbon Emissions in Temperate Rainforest, Curiñanco, Chile

Patrick Gonzalez¹
Antonio Lara²
Jorge Gayoso²
Eduardo Neira²
Patricio Romero²
Leonardo Sotomayor¹

1 The Nature Conservancy, 4245 North Fairfax Drive, Arlington, VA 22203-1606 USA
2 Universidad Austral de Chile, Facultad de Ciencias Forestales, Isla Teja, Valdivia, Chile

July 14, 2005

Topical Report
Award DE-FC-26-01NT41151
U.S. Department of Energy, National Energy Technology Laboratory, Morgantown, WV USA
Disclaimer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United State Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.
Comparison of Three Methods to Project Future Baseline Carbon Emissions in Temperate Rainforest, Curiñanco, Chile

Abstract

Deforestation of temperate rainforests in Chile has decreased the provision of ecosystem services, including watershed protection, biodiversity conservation, and carbon sequestration. Forest conservation can restore those ecosystem services. Greenhouse gas policies that offer financing for the carbon emissions avoided by preventing deforestation require a projection of future baseline carbon emissions for an area if no forest conservation occurs. For a proposed 570 km$^2$ conservation area in temperate rainforest around the rural community of Curiñanco, Chile, we compared three methods to project future baseline carbon emissions: extrapolation from Landsat observations, Geomod, and Forest Restoration Carbon Analysis (FRCA). Analyses of forest inventory and Landsat remote sensing data show 1986-1999 net deforestation of 1900 ha in the analysis area, proceeding at a rate of 0.0003 y$^{-1}$. The gross rate of loss of closed natural forest was 0.042 y$^{-1}$. In the period 1986-1999, closed natural forest decreased from 20 000 ha to 11 000 ha, with timber companies clearing natural forest to establish plantations of non-native species. Analyses of previous field measurements of species-specific forest biomass, tree allometry, and the carbon content of vegetation show that the dominant native forest type, broadleaf evergreen (bosque siempreverde), contains 370 ± 170 t ha$^{-1}$ carbon, compared to the carbon density of non-native Pinus radiata plantations of 240 ± 60 t ha$^{-1}$. The 1986-1999 conversion of closed broadleaf evergreen forest to open broadleaf evergreen forest, Pinus radiata plantations, shrublands, grasslands, urban areas, and bare ground decreased the carbon density from 370 ± 170 t ha$^{-1}$ carbon to an average of 100 t ha$^{-1}$ (maximum 160 t ha$^{-1}$, minimum 50 t ha$^{-1}$). Consequently, the conversion released 1.1 million t carbon. These analyses of forest inventory and Landsat remote sensing data provided the data to evaluate the three methods to project future baseline carbon emissions. Extrapolation from Landsat change detection uses the observed rate of change to estimate change in the near future. Geomod is a software program that models the geographic distribution of change using a defined rate of change. FRCA is an integrated spatial analysis of forest inventory, biodiversity, and remote sensing that produces estimates of forest biodiversity and forest carbon density, spatial data layers of future probabilities of reforestation and deforestation, and a projection of future baseline forest carbon sequestration and emissions for an ecologically-defined area of analysis. For the period 1999-2012, extrapolation from Landsat change detection estimated a loss of 5000 ha and 520 000 t carbon from closed natural forest; Geomod modeled a loss of 2500 ha and 250 000 t; FRCA projected a loss of 4700 ± 100 ha and 480 000 t (maximum 760 000 t, minimum 220 000 t). Concerning labor time, extrapolation for Landsat required 90 actual days or 120 days normalized to Bachelor degree level wages; Geomod required 240 actual days or 310 normalized days; FRCA required 110 actual days or 170 normalized days. Users experienced difficulties with an MS-DOS version of Geomod before turning to the Idrisi version. For organizations with limited time and financing, extrapolation from Landsat change provides a cost-effective method. Organizations with more time and financing could use FRCA, the only method where that calculates the deforestation rate as a dependent variable rather than assuming a deforestation rate as an independent variable. This research indicates that best practices for the projection of baseline carbon emissions include integration of forest inventory and remote sensing tasks from the beginning of the analysis, definition of an analysis area using ecological characteristics, use of standard and widely used geographic information systems (GIS) software applications, and the use of species-specific allometric equations and wood densities developed for local species.