Analyzing and Influencing Carbon Sequestration in Harvested Wood Products

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Abstract

WOODCARB3 expands the capabilities of the WOODCARB2 spreadsheet model by changing to an R package platform. The conversion brings increased capability for data manipulation, analysis, and reporting. It also increases the ease of integration with other datasets. This poster describes some of the results and demonstrates some of the potential for the WOODCARB3 package. Examples of the types of analysis possible include uncertainty analysis, sensitivity analysis, alternate model dynamics, and alternate pathways.

Introduction

WOODCARB2 is used to document and calculate the total carbon stocks from harvested wood products (HWP). The statistics package R offers a wide variety of tools and interfaces with other software packages.

Sequestration of carbon in forests accounts for 87% of total CO_2 removals in 2014. Carbon mitigation efforts have thus focused much attention on reforestation, forest management, and forest based products. According to the most recent report to the UNFCCC, an estimated 18.7% of the total carbon in woody materials is contained in harvested wood (HWP and solid waste disposal sites (SWDS)).

The amount of carbon in HWP and SWDS depend on how much wood is harvested, what types of products are produced, how the products are use, the lifetime of the wood products, and how the wood is processed at the end of its primary product lifetime.

Methodology

- Input data comes from USFS reports as used in WOODCARB2.
- The following results use the production approach to carbon accounting. This assumes that a party is responsible for emissions from any produced HWP or SWDS, which includes exports but not imports.
- Stock change and atmospheric flow approach results are also available.
- Analysis is conducted on sensitivity of input parameters, uncertainty of estimates, and consequences of alternative decay distributions.
- Sensitivity and uncertainty calculations use Monte Carlo simulations.

Uncertainty Analysis

- Sources of error and uncertainty were defined previously by the USFS (Skog 2008).
- These sources include solid wood and paper production and trade time series, factor to convert solid wood and paper products to carbon, fractions of solid wood and paper products subject to decay in landfills, and decay rate for solid wood and paper in SWDS.
- Projection and imputation methods are currently under development.

Total HWP Carbon Stocks with Uncertainty

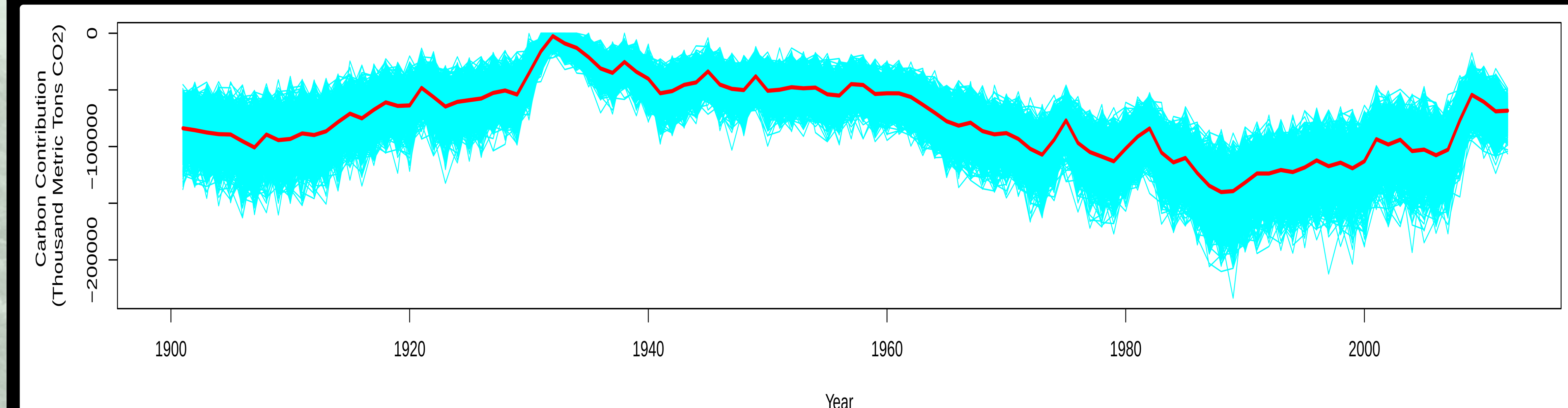

Figure 1. Reported HWP and SWDS carbon stock produced by WOODCARB3 (red) surrounded by simulations including reported uncertainties (blue)

Decay of Wood Products

- Decay functions are based on the gamma distribution:

$$\int_0^n \frac{1}{\Gamma(k)\theta(k)} x^{k-1} e^{-x/k} dx$$

- WOODCARB2 used an exponential decay where $k = 1$ in the gamma distribution.
- Two alternate decay functions, $k = 2$ and $k = 10$, were calculated by altering k in the gamma distribution and introduced in the WOODCARB3R package.

Shape of Decay Functions

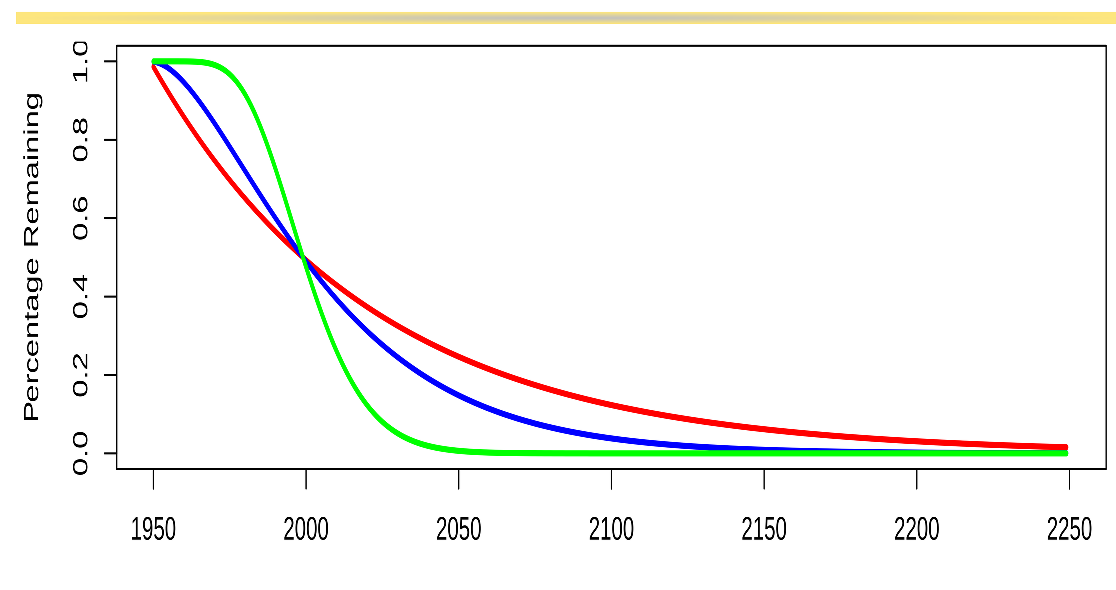

Figure 2. Decay of a product with 50-year half-life using exponential (red), $k = 2$ (blue), and $k = 10$ (green) functions

Projected Carbon Contribution

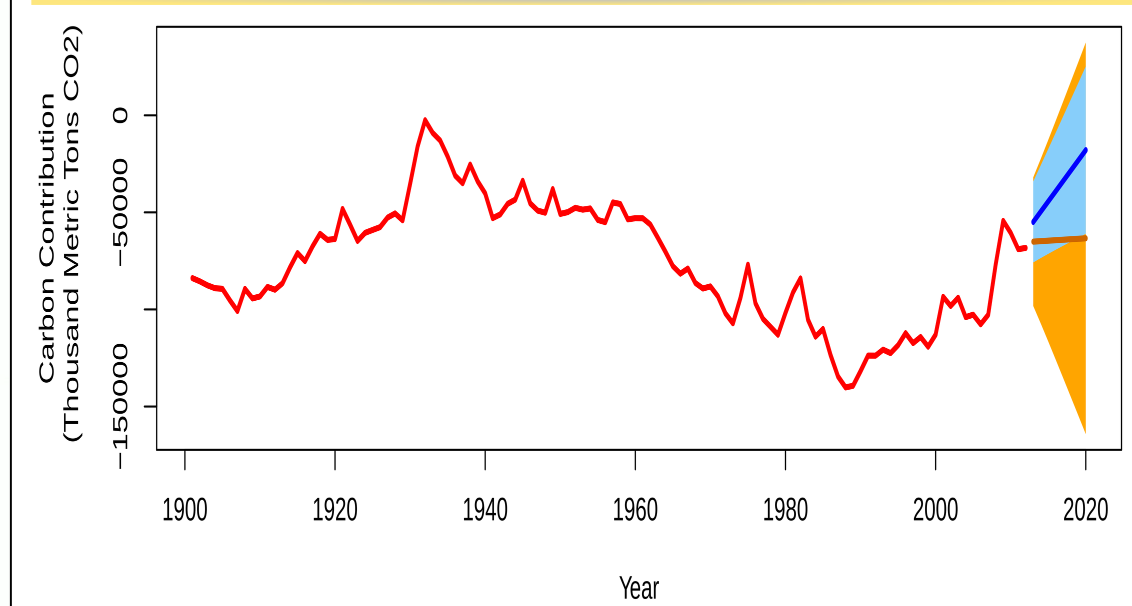

Figure 3. Projections based on 5-year (orange) and 10-year (blue) simple linear regression

Half-lives of End Products

	Half Life	1990	2000	2010
Single Family	78	49326.24	68293.97	68979.34
Multi Family	47.69	98724.8	2380.01	1756.76
Shipping	38.03	10878.75	13989.01	11874.62
House Furn	38.03	5175.2	9369.04	8638.16
Comm. Furn	38.03	1180.03	3612.24	3657.69
Industrial	38.03	34036.33	31405.34	26583.78
Other	38.03	12834.98	18264.28	16991.37
Resid Upkeep	23.13	167096.43	172797.32	114967.8
Paper	2.53	6391552.25	3603762.53	139374.49

Effect of Decay Functions

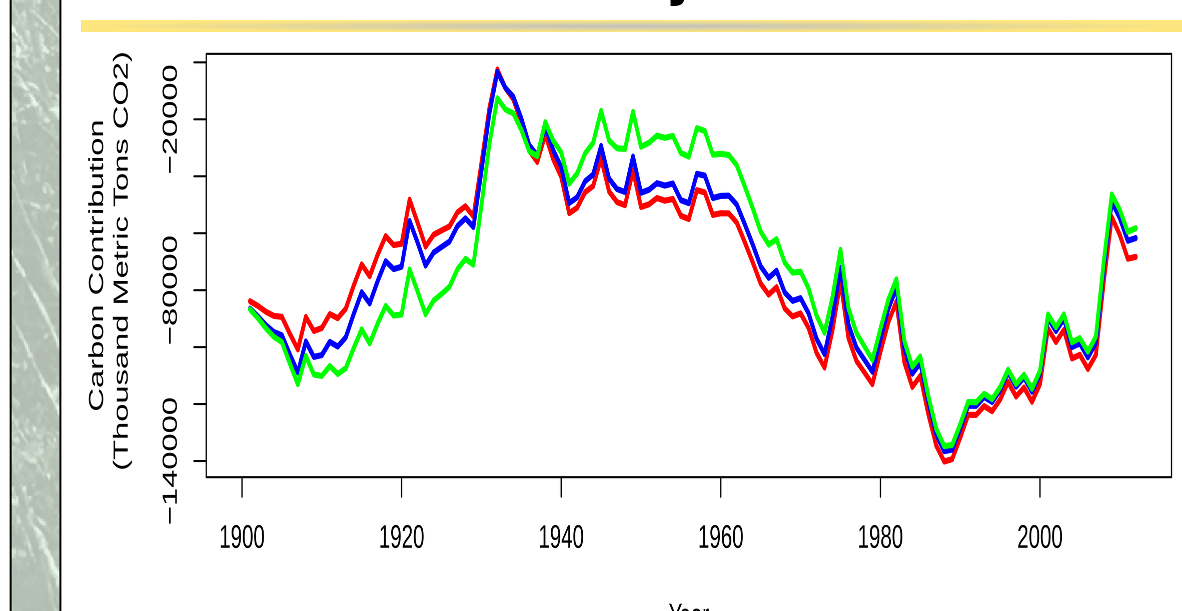

Figure 4. Carbon stock of HWP using exponential (red), $k = 2$ (blue), and $k = 10$ (green) decay functions

Half-life Sensitivity Analysis

- Error is assumed to be N(1,.2).
- Results show influence of small changes in half-life on HWP stock.

Sensitivity Plot

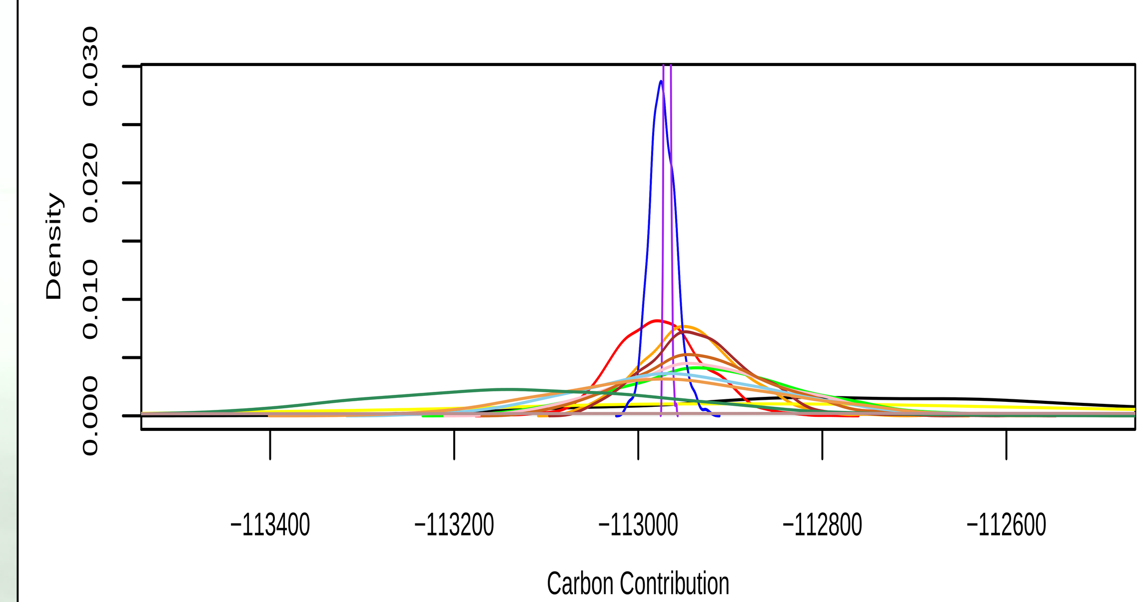

Figure 6. Sensitivity of total HWP stock to changes in half-life

Half-life Sensitivity Effect

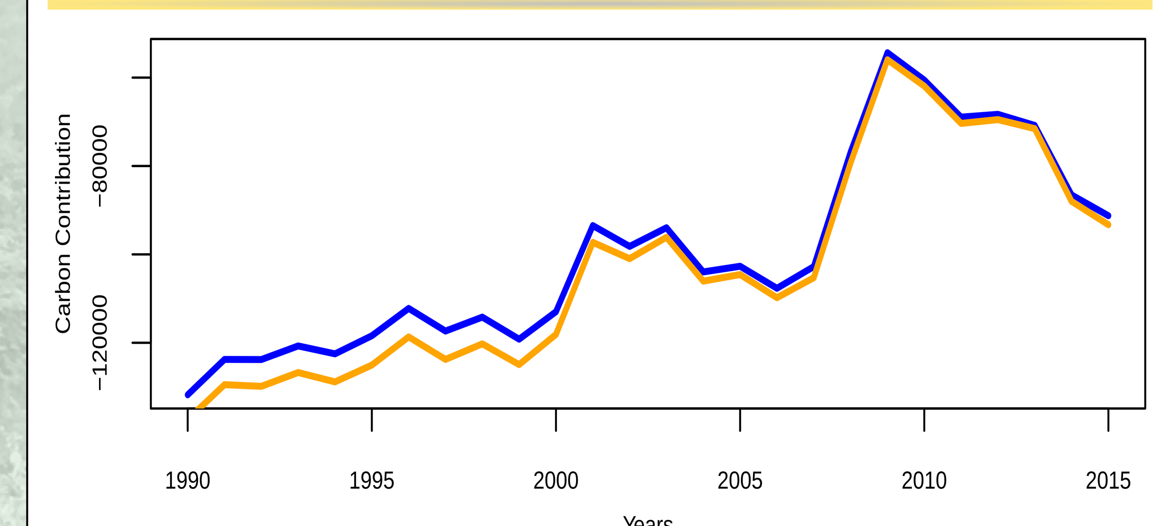

Figure 5. Targeted increase in half-life of paper (blue) by 50-percent (orange)

Discussion

- Targeted changes in average half-life can increase total stocks.
- End of life dynamics make a big difference in stock size.
- Sensitivities help channel reductions in uncertainty.

Acknowledgements

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Contact Information and Package Access

- Email: marlandes@appstate.edu
- Online link: WOODCARB3R package