Journal of Forest Economics 17 (2011) 214–229

Contents lists available at ScienceDirect

Journal of Forest Economics

journal homepage: www.elsevier.de/jfe

# Consequences of increasing bioenergy demand on wood and forests: An application of the Global Forest Products Model

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ARTICLE INFO

*Article history:*
Received 19 July 2010
Accepted 11 February 2011

*JEL classification:*
C54
C61
F18
L73
O13
A23
Q41

*Keywords:*
Forest sector
Modeling
Bioenergy
Fuelwood
Wood products
Prices
Demand
Supply
Trade

ABSTRACT

The Global Forest Products Model (GFPM) was applied to project the consequences for the global forest sector of doubling the rate of growth of bioenergy demand relative to a base scenario, other drivers being maintained constant. The results showed that this would lead to the convergence of the price of fuelwood and industrial roundwood, raising the price of industrial roundwood by nearly 30% in 2030. The price of sawnwood and panels would be 15% higher. The price of paper would be 3% higher. Concurrently, the demand for all manufactured wood products would be lower in all countries, but the production would rise in countries with competitive advantage. The global value added in wood processing industries would be 1% lower in 2030. The forest stock would be 2% lower for the world and 4% lower for Asia. These effects varied substantially by country.



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1104-6899/$ – see front matter 
doi:10.1016/j.jfe.2011.02.008

## Introduction

This study was part of the 2010 Forest Assessment of the USDA Forest Service, mandated by the Resources Planning Act (RPA). One goal is to fit the national assessment in its global context. Thus, the trade of the United States, and the related demand, supply and prices should be consistent with global developments.

Two of the tools used for the Forest Assessment are the Global Forest Products Model (GFPM, Buongiorno et al., 2003), and the United States Forest Products Module (USFPM, Kramp and Ince, 2010) which has the same structure as the GFPM but a finer description of products and regions within the United States.

The 2010 RPA Forest Assessment uses scenarios of the Intergovernmental Panel on Climate Change (IPCC) (Nakicenovic et al., 2000). The IPCC scenarios project global and regional economic activity, population, land uses, and greenhouse gases. Each scenario also projects biofuel demand, which could have serious implications for forests and related industries.

Biomass energy consumption may increase by as much as five to seven times by 2050 (Alcamo et al., 2005). Kirilenko and Sedjo (2007) note that past estimates of the impact of climate change (e.g., IPPC, 2001; Perez-Garcia et al., 2002; Sohngen and Mendelsohn, 1998) have tended to ignore this potentially large demand.

Raunikar et al. (2010) did recognize the effects of bioenergy demand on forests in comparing the IPCC scenarios A1B and A2, but since other assumptions are not the same in the two scenarios (in particular, economic and demographic growth are quite different in A1B and A2), one cannot identify the partial effect of bioenergy demand from that study. Other previous studies that have dealt quantitatively with the economics of wood bioenergy supply and demand, and its implications for forests have concerned more national or regional issues. In particular, Stennes et al. (2010) have studied the implications of expanding bioenergy production from wood in British Columbia with a regional wood fiber allocation model, while Bright et al. (2010) made an environmental assessment of wood-based biofuel production and consumption scenarios in Norway, with their implications for the trade of paper products.

This paper attempts to determine, other things being equal, the consequences for the world forest sector and specific countries of a fast acceleration of bioenergy demand. The next part of the paper describes how the GFPM was used for this purpose. The results, consisting of projections to 2030 are then presented for the production, consumption, and prices, of various products, globally and for the main countries. The paper concludes with a discussion of the method and the potential for further developments.

## Methods

### *The GFPM model*

The Global Forest Products Model is a spatial dynamic economic model of the forest sector (see Appendix A). The model is dynamic: the equilibrium in a particular year is a function of the equilibrium in the previous year. It assumes that markets work optimally in the short-run (one year) to maximize consumer and producer surplus for all products in all countries (Samuelson, 1952). It further assumes that imperfect foresight prevails over longer time periods so that there is no inter temporal optimization but a recursive dependency of the current equilibrium on the past, along the principles originally proposed by Day (1973), and implemented in the dynamic part of the GFPM as shown in Appendix A. Validation with historical data suggests that this is a plausible approach to model the global forest sector (Buongiorno et al., 2003, pp. 75–88).

The GFPM and several applications are described in detail in Buongiorno et al. (2003). The current version of the model, together with the software, data, and documentation are available at: http://fwe.wisc.edu/facstaff/buongiorno/.

The GFPM recognizes 180 individual countries and their interaction through imports and exports. In each country the model simulates the changes in forest area and forest stock. It also calculates the consumption, production, trade, and prices, of 14 commodity groups covering fuelwood, industrial