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The forest resources input–output model: An application in China

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ABSTRACT

Understanding the state of forest resource utilization in China and correctly evaluating the role and function of forest resources in national economic development are essential for realizing balanced development of forests, the environment, and the economy. This is especially true given the present situation of increasingly scarce forest resources. Using data from Chinese forest industry statistical yearbooks, forestry development reports, and other documents, this paper examines the current state of forest resource utilization in China from the angle of combining quantities and values based on input–output tables. We show that demand for and input use of forest resources varies greatly across industrial sectors; the paper products and furniture manufacturing industries have the greatest direct consumption coefficient for timber use. When considering direct and indirect demand, it is clear that forest resources restrict different industrial sectors in diverse ways. These results provide an important set of reference values regarding the utilization of forest resources and coordinated industrial development in China.

1. Introduction

Forests are a key component of the terrestrial ecosystem. They perform many ecological functions, such as conserving water, preserving soil and water, and maintaining an ecological balance. Simultaneously, they provide diverse products and production materials to fuel economic, social, and environmental development. Hence, forests are of great environmental and economic value. However, the existence and development of forest resources are closely related to their human uses: if forest resources are improperly used, it will be impossible to recover them. Such concerns are real and pressing: China's "Eighth National Forest Resources Investigation (2009–2013)" states that the "total quantity of forest resources in China is relatively insufficient" and that their "quality is not very good." As demand for ecological and forest products increases, China's forest resources will come under increasing pressure. It is thus highly important to understand the current state of forest resource utilization in China and to evaluate the role and function of forest resources in national economic development in order to realize balanced development among forest resources, the environment, and the economy.

Considering the interrelations among resources, the environment, and the economy, many scholars have studied input–output theories involving various aspects of the resource-environment-economy interaction. For example, Su et al., (2013),Su and Ang (2014) analyzed the relationship between carbon dioxide emissions and exports in China. Weinzettel et al. (2014) argued that a country's carbon footprint is an important reflection of its environmental burden and evaluated it using three methods. This included establishing an input–output model for multi-area environmental extensions, but it remains difficult to obtain the data necessary to assess this. Similar research was also undertaken by B. Zhang et al. (2014) and Onat et al. (2014).

In related research, Galina (2014) analyzed the development of the mining industry in Queensland, Australia using an input–output method to explore the relationships among employment, income, and the local environment. L.X. Zhang et al. (2014) analyzed the direct and indirect demand for and consumption of energy sources for 30 industrial sectors of the national economy based on nine-year input–output tables for Beijing. Y. Zhang et al. (2014) created an urban ecology physical input–output table to describe the circulation of different ecological elements within urban metabolic processes by using each city as an individual unit and building an ecological network system. Matinez et al. (2013) analyzed the influence of sugarcane resources in northeastern Brazil on the society and economy and found that sugarcane resources can significantly affect the increase in added value and reduction in employment resulting from mechanization. Logar and Bergh (2013) evaluated the mutual interactions between petroleum resources and the tourism industry by using the input–output method, while Kuswardhani et al. (2013) applied the energy input–output model to analyze the differences between vegetables grown in greenhouses and those grown in open environments; the

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results indicated that the energy inputs needed by the vegetables and their outputs are different, as are the final economic benefits and efficiencies.

Morrissey and O'Donoghue (2013a,b), considering ocean resources, analyzed the contributions of Ireland's oceanic sectors to the national and local economy, the mutual relationships among oceanic sectors, and the effects on production and employment in related sectors as well as the input–output potential of resource and industrial clustering. Chen et al. (2013) examined the effects of carbon emissions in Beijing in 2007 on the local economy and analyzed their total quantities, sources, and directions via three levels of input–output models. Similar research was also undertaken by Shao et al. (2013). Mattila et al. (2013) argued that an extended input–output model is necessary for analyzing sustainable development. He extracted elements such as resources, discharge strength, and final demands from the Finland EEIO (environmentally extended input–output) model in order to carry out a sensitivity analysis. Dias et al. (2014) applied the extended environmental input–output model to analyze greenhouse gas emissions and fossil fuel consumption in Aveiro, Portugal. Similar research was undertaken by Silva (2001). Loizou et al. (2000) designed an environmental input–output model for Macedonia, Greece to examine harmful relationships between local economic development and protection of the natural environment as well as the direct and indirect negative effects of production processes on the natural environment.

The interactions between forest resources, the environment, society, and the economy are an important sub-area of research on resource-environment-economy relationships. Suh (2014) comparatively analyzed management experiences of the forestry industry and community forestry in India and the Philippines via an input–output model; results indicated that effects of the forestry industry on community forestry in the Philippines were smaller than those in India and that the areas' different policies had divergent effects on national timber demands and forestry production. Kebede et al., (2013) analyzed an area with high forest coverage using the input–output model and found that different-sized wood pallets have effects that vary across economic sectors, including the forest-related service industries such as commercial logging and forest product production. Shakur and Haque (2012) adjusted and analyzed the input and output of Bangladesh's forestry industry to explore the degree of damage that forestry activities wrought on the environment. Mattila et al. (2011) investigated the effects of sustainability of the entire forestry industry on Finland's economy in 2005 via an extended environmental input analysis model. Factors such as direct greenhouse gas emissions, land use, employment, and exports from each industrial sector could be transformed into a measure of the strength of that sector's products' influence; this measure could then be used to guide the final demands of environment-based activities such as exports, investment, and consumption. American researchers have analyzed the influence of logging and other forestry activities on local economic development and the utilization and protection of forest resources via input–output tables for some American states (Moore, 1981; Koljonen, 1983; Teeter and Alward, 1989; Hussain, 1996). England, Finland, Japan, and the United Nations have also carried out empirical analyses of forest-related inputs and outputs, but research combining the entity and value of forest resources is rare, especially in China.

In this article, we present an input–output model for forest resources in China by combining entity and value. We then analyze forest resources' effects on and contributions to each industry, using the input–output method to investigate the distribution of forest resource inputs. The results can be used as a reference for improving efficient utilization of forest resources, thereby stimulating coordinated development of China's economy and its natural resources.

2. Chinese forest resource utilization: the current situation

China's rapid economic growth has fuelled an increase in the supply and consumption of resources. Market supply and consumption of timber products in China each consist of two components, domestic and imported. Because there is little statistical data on demand in the Chinese market, in our analysis we proxy demand for timber with timber consumption.

Fig. 1 shows that both supply of and demand for timber products in China have seen recent growth trends. Importing the needed logs and forest products has generally kept supply and demand balanced. In 2002, the total supply of timber was 187,871,500 m^3; in 2012, it was 494,915,900 m^3, representing an average annual increase rate of 9.20%. In 2002 and 2012, timber consumption was 183,404,300 and 494,915,900 m^3, respectively, showing an average annual increase of 9.44%. In terms of imports, the total quantity of timber imported was 94,458,000 m^3 in 2002 and increased to 234,967,000 m^3 in 2012, an average annual increase of 8.64%. Meanwhile, timber exports were 21,527,800 m^3 in 2003 and increased to 88,556,800 m^3 in 2012, showing an average annual increase rate of 13.72%. Taken together, these data indicate that there has been a large gap between supply and demand for timber in China; indeed, import dependence averaged

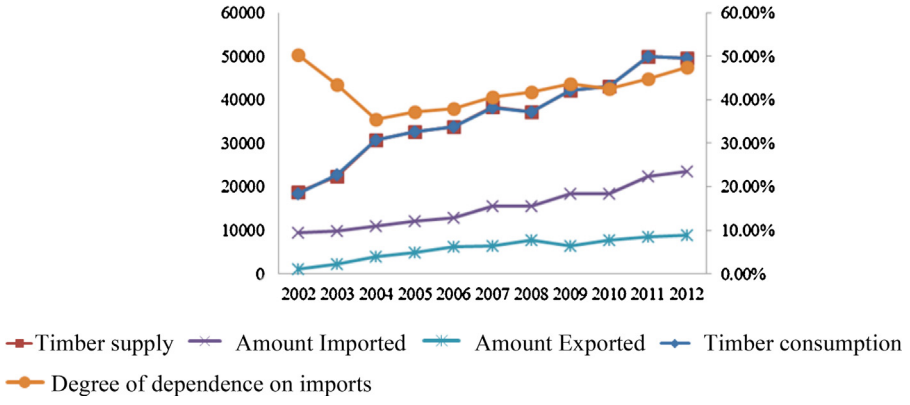

Fig. 1. The trend of timber supply and consumption in China, 2002–2012.
Data comes from Chinese forestry development reports, 2003–2013. Left vertical axis unit: 10,000 m3 (timber supply, consumption, and exports/imports), right vertical axis unit: percent (degree of dependence on imports).