Available online at www.sciencedirect.com
ScienceDirect
Applied Geography 28 (2008) 16–31
APPLIED GEOGRAPHY
www.elsevier.com/locate/apgeog

Spatial patterns and processes of bamboo expansion in Southern China

Benoit Mertens[a], Liu Hua[b], Brian Belcher[c,f,*], Manuel Ruiz-Pérez[d], Fu Maoyi[e], Yang Xiaosheng[e]

[a]*World Resources Institute, c/o IUCN, Avenue Ebeya, Kinshasa, Democratic Republic of Congo*
[b]*Institute of Forest Resources Information, Chinese Academy of Forestry, Dongxiaofu 2, Xiangshan Road, Haidian 100091, Beijing, PR China*
[c]*Center for International Forestry Research, P.O. Box 6596 JKPWB, Jakarta 10065, Indonesia*
[d]*Department of Ecologia, Facultad Ciencias, Universidad Autonoma de Madrid, 28049-Madrid, Spain*
[e]*Research Institute of Subtropical Forestry, Chinese Academy of Forestry, 73# Daqiao Road, Fuyang, Zhejiang 311400, PR China*
[f]*Centre for Non-Timber Resources, Royal Roads University, 2005 Sooke Rd., Victoria, BC, Canada*

Abstract

This paper analyzes the spatial distribution and patterns of land use change associated with expansion of bamboo production in three important bamboo-producing counties (Anji, Pingjiang and Muchuan) along a development gradient in China. Existing and new bamboo plantations tend to be located at higher elevation and on sloping lands around formerly established plantations, with different patterns of expansion related to the level of development of the bamboo industry and general economic development in the county. Distance to factory is more important for low value-added products where raw material represents a high percentage of production costs.

Keywords: China; Bamboo; Spatial analysis; Remote sensing; Land use change

Introduction

China has implemented economic and environmental policy reforms over the past two decades, with far-reaching implications. The Household Responsibility System (HRS), reforms in trade, exchange, and investment policies, and the "Natural Forest Protection Programme" and the "Conversion of Arable Land in Steep Slopes" policies, have all contributed to encourage rural development and environmental rehabilitation (Hyde, Xu, & Belcher, 2003). The results can be seen in China's economic statistics, from explosive GDP growth of 9%/annum at the national level, to high rural household growth in some areas. The impacts can also be seen on the landscape, with changes in land use patterns in response to environmental conditions, regulations and economic incentives (Verburg & Chen, 2000).

*Corresponding author. Tel.: +62 251 622622; fax: +62 251 622100.
E-mail address: b.belcher@cgiar.org (B. Belcher).

0143-6228/$ - see front matter © 2007 Published by Elsevier Ltd.
doi:10.1016/j.apgeog.2007.07.012

Forest products' demand has grown in parallel with this economic expansion. In the context of new environmental and forestry policies, this has brought unprecedented increases in timber imports (Sun, Katsigris, & White, 2004). Increasing land scarcity and competition between alternative landuses has resulted in a reallocation of forest-related activities, enhanced by land rehabilitation and other environmental schemes (Li, 2004). In this paper we focus on the bamboo sector, one of the fastest growing forest landuses in China, analyzing the spatial patters of expanding bamboo plantations in Central China.

With about 7 million hectares (ha), China has the largest bamboo resource in the world. Traditional, small-scale domestic use of bamboo has been overtaken in recent decades by rapid development of commercial bamboo processing, driven by market-oriented reforms. The economic importance of bamboo, its fast expansion and its potential as a major substitute for timber have been well documented (Gu, 1992; Li & Xu, 1998; Lin, 1999; Ruiz-Pérez, Belcher, Fu, & Yang, 2003). Consequently, a continuous expansion of bamboo plantations has taken place in China during the last 20 years.

However, little is known about the detailed spatial trends of this expansion: How much have bamboo plantations expanded and where? What are the major characteristics of these areas of expansion? What land use changes are being induced by the expansion of bamboo? What factors explain the different patterns of expansion? These are essential questions given the fast-changing land use patterns in China and the positive and negative economic and environmental implications associated with bamboo plantations and related industries (Ruiz-Pérez, Belcher, Fu, & Yang, 2004). Answering these questions can also help understanding the potential and constraints faced by the Chinese forest sector and its growing global implications.

This paper provides a comparative analysis of the spatial patterns and processes associated with the expansion of bamboo plantations in three counties with contrasting socio-economic and environmental conditions. It summarizes the key lessons learnt and the importance of understanding such processes when preparing new national level policies, local regulations and other measures affecting the forest sector.

The bamboo sector in China

Bamboo occurs naturally throughout the country except in high mountain areas and very dry areas, with the largest variety of species occurring south of the 40°N parallel. Most bamboo species are erect and tall, having woody stems; however, some are herbaceous, being present as forest undergrowth or at high altitude; some bamboo species showing climber-like properties can also be found. The last published forest inventory in 1998 recorded 4.2 million ha of bamboo forests and plantations, and 3 million ha of "mixed and mountain natural bamboo stands" (State Forest Administration, 2000). A significant amount of woody bamboo occurs in 17 provinces, with 11 provinces having over 100,000 ha each (Fig. 1). Four contiguous provinces (Fujian, Jiangxi, Zhejiang and Hunan) have more than half a million ha each, accounting for over 60% of total bamboo plantations in China. The bamboo resource base has increased steadily over the past two decades, both in surface area (31.6%) and in density of stands (40.8%) (State Forest Administration, several years). The combined expansion of plantations and increased density of stands has resulted in an exponential increase in output of bamboo culms and shoots (594% and 1048%, respectively) (State Forest Administration, several years). This contrasts sharply with the stagnant output of timber in the country during the 1990s and its sharp decline following the implementation of the Natural Forest Protection Programme and the accompanying Logging Ban (Bull & Nilsson, 2004).

There are two main categories of use of bamboo: (1) culms (stems) are used like wood in unprocessed form or in a variety of processed forms and (2) edible bamboo shoots are used as a vegetable, fresh, or in a variety of processed forms. Because of this dual utilization, bamboo has economic characteristics of both conventional timber-oriented forests and fruit-producing cash trees. In addition, bamboo plantations have several attractive attributes for farmers: (i) short rotation cycles with yearly or biennial production, (ii) low investment costs, multiple uses that allow for flexible markets and the feasibility of managing small areas make them easily adapted to the HRS, and (iii) the variable scale and diversity of processing units and the possibility of a degree of pre-processing by farmers makes local processing a viable option.

They also appear to be more profitable than timber trees (such as Chinese fir or *Pinus* plantations) and benefit from an expanding national and international demand, both as a substitute for wood fibre and for some superior goods like bamboo shoots and bamboo flooring. Modern processing technologies have been