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Burning biodiversity: Woody biomass use by commercial and subsistence groups in western Uganda's forests

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ARTICLE INFO

Article history:
Received 15 June 2005
Received in revised form
14 March 2006
Accepted 8 August 2006
Available online 19 October 2006

Keywords:
Deforestation
Fuelwood
Charcoal
Devolution
Community-based conservation

ABSTRACT

Woodfuels are the most heavily used energy source in sub-Saharan Africa. We analyzed the ecological impacts and modes of access of five user groups (domestic consumers, gin distillers, brick manufacturers, charcoal producers, and tea companies) drawing biomass energy from natural forests in western Uganda. While domestic consumers use the most species for fuelwood (>50), their consumption is likely sustainable because they generally harvest fast-growing species from fallows on their own land or their neighbors'. Charcoal producers prefer old-growth hardwood species and are responsible for the greatest loss of natural forests. They access forests by finding landholders who, either willingly or through coercion, allow trees on their lands to be cleared. The impact of charcoal production is exacerbated by a license system that undervalues natural forests and rewards rapid harvests across large areas. The tea industry consumes mainly eucalyptus wood (*Eucalyptus* spp.) from corporate plantations, but they indirectly create pressure on natural forests by hiring immigrants who subsequently settle in and clear forest remnants. If such practices continue, forest remnants will soon be exhausted, leaving Kibale National Park as the last natural forest in the region. Forest remnants are a vital source of water, medicinal plants, and energy for local citizens and to protect them from over-exploitation, policy makers should target the charcoal and tea industry for reform. Support for local land management institutions governing access to fallows and successional forests will inevitably enhance the policy interventions.

1. Introduction

1.1. *Woodfuel consumption and forest ecosystems*

Approximately half of the wood cut annually worldwide is used as fuel, and of this amount, nearly 90% is produced and consumed in developing countries, where firewood and charcoal constitute the primary source of energy for the poor (Okello et al., 2001; Parikka, 2004; Dovie et al., 2004). This reliance is even more pronounced in sub-Saharan Africa, where woodfuels are the dominant energy source, both in terms of primary energy supply and the number of people relying on

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doi:10.1016/j.biocon.2006.08.020

them (Bailis et al., 2005). Even in countries with large endowments of fossil fuels like Gabon and Nigeria, woodfuels are a significant energy source. Heavy reliance on woodfuels can result in a range of negative environmental impacts, with both local and global consequences, including forest loss and degradation, health problems for charcoal producers and households where biofuels are combusted (Ezzati and Kammen, 2002), and increased greenhouse gas emissions (Bailis et al., 2005). In addition, the expenses associated with both collected and purchased woodfuel are a major economic burden on the poor (Ezzati et al., 2001). The African humid tropics may not yet suffer the acute fuelwood shortages common in arid African regions, but fuelwood harvesting in these regions is extensive and significantly impacts biodiversity.

It is estimated that the extraction of wood from tropical forest for timber, charcoal burning and fuelwood constitute 68% of the proximate causes of deforestation in Africa, 89% in Asia and 51% in Latin America (Geist and Lambin, 2001). Even if forest is not entirely cleared, selective harvesting may change forest composition and ecosystem function (see Ndangalasi et al., this volume). For example, the harvesting of trees from old-growth forest may result in slow growing species being replaced with faster growing secondary species. Secondary growth is more susceptible to fire. If the burn frequency is sufficiently high, these disturbed forested areas, which were originally mature forest, can be converted to grassland that can be maintained indefinitely by fire. Unlike other tropical regions, many African mid-elevation secondary growth species do not provide food for frugivorous birds or primates (Struhsaker, 1997). Thus the replacement of old-growth trees with secondary growth reduces populations of many frugivores (Struhsaker, 1997). This reduction has been documented to last for over 30 years (Chapman et al., 2000) and is speculated to last much longer (Chapman and Chapman, 2004). Depending on the extent of disturbance produced through harvesting, plant evolutionary characteristics such as timing of reproduction, resource allocation, reproductive value, seed size, seed crop size, and seed germination may be significantly altered (Silvertown and Lovett-Doust, 1993). This may lead to the disruption of ecosystem, community or population structure and changes in resource and substrate availability or the physical environment. Changes in ecosystem characteristics such as species diversity, nutrient output, and biomass as well as changes that reset succession in one or more sites may be significantly disturbed (Mooney and Godron, 1983; White and Pickett, 1985; Turner et al., 1993; Burrows, 1993). In this paper, we measure patterns of fuelwood extraction in the moist, evergreen forests of western Uganda and discuss its effect on biological diversity.

1.2. *Woodfuel consumption in Uganda*

The forests of western Uganda contain biological diversity of global importance (Struhsaker, 1987) and are vital to local populations for sustaining ecosystem processes and providing multiple resources, especially fuelwood (Chapman and Chapman, 1996). Yet rapid population growth (3.3% per year), expanded commercial charcoal and brick production, as well as urban and industrial fuelwood demands are fundamentally altering the relationship between forests and forest users with resultant negative impacts on the forest resource base. In addition, the demand for forest products has intensified in the context of insecure property rights. The resulting rapid deforestation in Uganda (~600 km^2 per year) is threatening the long-term sustainability of land use in the region (Banana and Gombya-Ssembajjwe, 1996).

Given Uganda's poor record of state-centered forest conservation policies, contemporary researchers and practitioners alike are calling for new approaches to forest management (Banana et al., 2004). Community-based forest management has become a popular model, bolstered by political and ethical arguments regarding local resource access and self-determination (Agrawal and Gibson, 1999). At the heart of the community-based approach is the question of resource access—who has the ability and the right to use and benefit from forest resources? Throughout Uganda, community-based forest management is promoted with a vague concept of who constitutes "the local community" (Mugisha, 2002). To evaluate the feasibility of community-based management, local forest conditions and the ecological impacts of various user groups need to be thoroughly studied and understood in a holistic resource availability and use framework. Customary and formal forest access rules must also be accounted for, as well as the influence of national policies on local forest management.

Here we analyze the ecological impacts and modes of access by five user groups drawing biomass energy from natural forests in western Uganda. The five groups are (1) domestic consumers, (2) gin still operators, (3) brick manufacturers, (4) charcoal producers, and (5) tea companies. We selected these groups because they are embedded differently in markets and regulatory systems. Each has varying ability to benefit from forest resources by means of transport, labor, capital, and political power. Together, these oft-reinforcing factors shape fuelwood consumption patterns and the resulting impacts on ecosystems. They also influence how each user group responds to growing resource scarcity. By identifying species preferences of these groups, the volumes and rates of fuelwood harvest, and source forests, we aim to identify activities that most immediately threaten biodiversity. Thus we hope to guide efforts to promote sustainable community-based forest management in western Uganda and other African forests that are under similar pressure to supply fuelwood.

2. Study area

2.1. *Ecological characteristics*

The study area is located around Kibale National Park (795 km^2), in the Kabarole District in western Uganda, lying immediately northeast of the Rwenzori Mountains. Kibale National Park holds the last substantial tract of premontane forest in East Africa (Chapman and Chapman, 1996) (Fig. 1). Surrounding Kibale National Park is a mosaic of grasslands, smallholder agriculture, papyrus swamps, tea, eucalyptus plantations, and patches of natural forests. These forest patches average 32 ha in size (range 3 to 350 ha) and are located almost entirely in wet lowlands or steep slopes.