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Woody species diversity in a changing landscape in the south-central highlands of Ethiopia

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ABSTRACT

Ethiopia hosts one of the richest flora and fauna resources in tropical Africa. However, this rich bioresource is decreasing due to extensive deforestation. The objectives of this study were to (i) investigate woody species diversity on smallholder cultivated land (crop fields and homegardens) and its implication for biodiversity changes over time; (ii) assess the dynamics of woody species diversity, density and structure with age of crop fields since conversion from natural forest using a chronosequence of farm fields; and (iii) assess the effects of some household and homegarden characteristics on woody species diversity around homegardens in the south-central highlands of Ethiopia. Woody species diversity in the adjacent natural forest was used as a reference. Systematic sampling was used to collect vegetation data from crop fields and natural forest, while simple random sampling within wealth categories was used to select sample households and their homegardens. In total, 70 woody species were recorded. The highest number of woody species (64) was recorded in homegardens, followed by crop fields (32) and the lowest number (31) in remnant natural forest. Despite the low species number, natural forest showed higher Shannon and Simpson diversity indices and Shannon evenness than crop fields and homegardens. This was due to the uniform distribution of species in natural forest compared with homegardens or crop fields. The diversity and density of woody species declined with increasing age of crop fields, while diversity of woody species increased with increasing age and size of homegardens. Wealth status of the households also affected species diversity in homegardens. Rich households kept a greater number of woody species, probably due to their larger-sized homegardens. Generally, the study showed that conversion of natural forest into cultivated land (mosaics of homegardens and crop fields) typical of the smallholder system in the highlands of Ethiopia does not result in a dramatic loss of species but that the spatial distribution, density and species composition may be altered.

1. Introduction

Tropical ecosystems are renowned for their rich biological diversity. However, population growth and the resulting expansion of cultivated land are threatening the sustainable management and use of the rich biological resources in the tropics. In Ethiopia in particular, deforestation for farming purposes and the subsequent habitat loss and fragmentation are major threats to the biodiversity resources of the country (Ayele, 2003; Lemenih and Teketay, 2004). A report by Reusing (1998) showed that the annual rate of deforestation in Ethiopia is 163,600 ha, which is one of the highest in Africa. Such massive forest degradation is always accompanied by loss of genetic resources (Woldemariam and Teketay, 2001; Woldemariam et al., 2001, 2002).

Although agricultural expansion is often alleged to be the major driver of biodiversity losses, there are variations among farming practices with respect to their impacts (Hamito and Abate, 1994; Harvey and Haber, 1999). For instance, intensive commercial monocropping is likely to result in low species diversity, while some of the traditional farming practices common to the tropics are known to support a high level of diversity (Harvey and Haber, 1999; Abebe, 2005).

Some studies have shown that cultivated land in different parts of Ethiopia is characterised by a high diversity of woody species and thus provides a refuge for native woody species (Hamito and Abate, 1994; Asfaw, 2003; Abebe, 2005). The practice of managing woody species in the cultivated landscape can play a key role in the maintenance of biodiversity (Harvey and Haber, 1999; Nikiema,

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2005), but is relatively less studied (Polasky et al., 2003; Nikiema, 2005). Most studies that have considered the role of woody species in farming landscapes in Ethiopia have focused on their impact on soil properties and crop production (e.g. Yadessa, 1998; Hailu et al., 2000; Asfaw, 2003). Fewer studies have considered their role in biodiversity conservation (e.g. Asfaw and Nigatu, 1995; Asfaw and Woldu, 1997; Asfaw, 2003; Abebe, 2005). The objectives of this study were to (i) investigate woody species diversity changes over time on cultivated land (crop fields and homegardens); (ii) assess the dynamics of woody species diversity, density and structure with age of crop fields since conversion from natural forest using a chronosequence method; and (iii) assess the relationships between household or homegarden characteristics and woody species diversity in homegardens.

2. Materials and methods

2.1. Site description

The study was conducted in Beseku-Ilala Peasant Association (PA), Arsi Negelle district, south-central Ethiopia. Beseku is located between 7°20′ and 7°25′N and 38°45′ and 38°50′E. Beseku belongs to the warm sub-humid eco-climatic zone (Lemenih, 2004). The rainfall in the area is bimodal, with the main rainy season from July to October and the short rainy season from March to May. Mean annual rainfall amounts to 1200 mm (Anonymous, 1990). Mean annual minimum and maximum temperatures vary between 10 and 25 °C, respectively (Teshome and Petty, 2000). The soils of the study area are classified as Mollic Andosols (Lemenih, 2004). The major farming activities in the area include crop production and livestock rearing. Maize, wheat, sorghum, potatoes and barley are the major crops grown in the area.

The native vegetation of the study area belongs to the dry afromontane evergreen forest (Teketay, 1996), and the dominant tree species is *Afrocarpus falcatus*. Other associated tree species include *Celtis africana*, *Olea hochstetteri*, *Prunus africana* and *Croton macrostachys*. According to Chaffey (1978), the forest of Beseku and its surroundings have been intensively logged to feed sawmills located in different parts of the country. In addition, the forest boundary was continuously encroached by local farmers in search of agricultural land (Seifu, 1998). Seifu (1998) estimated that arable land was increasing at a rate of 2.8% per year, while natural forest, woodlands and grasslands were declining at rates of 1.7%, 2.6% and 6.4% per year respectively in the area.

For this study, crop fields that have been in existence for different periods since conversion from natural forest (chronosequence of crop fields), homegardens belonging to households in different wealth classes and adjacent natural forest were sampled.

2.2. Wealth ranking of households

In terms of the local administration system, Beseku-Ilala PA (the study area) is sub-divided into five villages: Menderafi Beseku, Shibeshi, Sidafi Beseku, Gudeli and Gudeli-shero. The names of all household heads (total 309) in the villages were obtained from the PA office and cross-checked with key informants from each village for inclusiveness. Wealth ranking of individual households was carried out by adapting a technique described by Crowley (1997). The criteria for differentiating households into different wealth classes were set by key informants and the households living in the site were categorised into three wealth classes (rich, medium, poor) according to these criteria. The key informants were elderly people and village heads who had lived in the area for a long period. Key informants were also selected from the different villages and from different religious groups. A total of seven key informants, mostly elders, were involved in the classification of households. The wealth-ranking criteria set by the key informants mainly centred on number of cattle, amount of annual crop production, land area owned and type and standard of housing. Of the households in the study area, 19% were categorised as rich, 38% as medium and 43% as poor. After wealth ranking, 12 households from each wealth class were randomly selected for homegarden assessment, i.e. a total of 36 homegardens were assessed.

2.3. Definition of chronosequence classes and vegetation data collection

The study area was divided into five chronosequence classes describing when the major transformation from natural forest to cultivated land took place. The chronosequence classification was based on information from key informants combined with interpretation of aerial photographs of the area taken in three different years: 1967, 1972 and 1986 (Fig. 1).

To assess the change in tree cover along the chronosequence, the aerial photographs from each period were scanned, imported

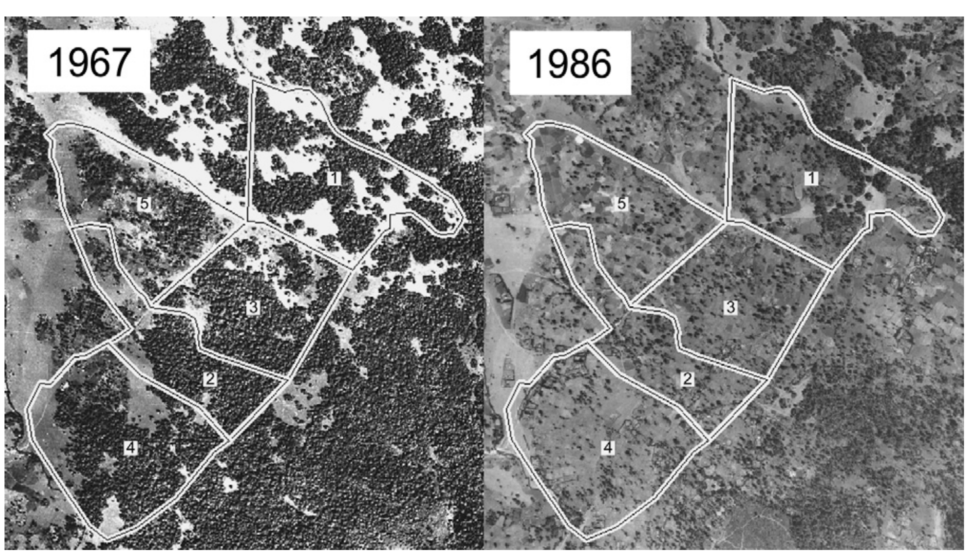

Fig. 1. Aerial photographs from 1967 and 1986 with the selected chronosequence classes.