Land Use / Land Cover Changes and Deforestation Trends over 55 years (1941-1996) in a Costa Rican Cloud Forest Watershed Area

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1. Introduction

For many years considerable tracts of forest have been converted for agricultural and other non-forestry land uses (Myers, 1980). Although basic trends are known for tropical lowlands, many uncertainties persist concerning the rates and trends of tropical montane forest clearing. The need for ongoing monitoring of conversion trends in these tropical montane forests is urgent. These ecosystems are considered to be among the most fragile of the world (Ewel, 1980), and only through continuous assessment can we remain aware of how fast the biome continues to lose its cover and which areas are most threatened. Management and planning towards sustainable land use and conservation of montane forested areas require accurate mapping of forest cover disturbances.

This study was conducted in order to obtain insight in past and present land cover and land use patterns in a tropical montane cloud forest watershed area. Retrospective deforestation over a period of 55 years was mapped, as well as the vegetation cover patterns currently present in the study area. Land use surveys were carried out through interviews with local inhabitants in the area. The results of the study in this watershed can be used as an example for other areas in the Cordillera de Talamanca, and may serve as a reference for tropical montane forests around the world.

2. Methods

The study area, the 5,400 ha upper Savegre River watershed area, is a protected river basin located in the partially deforested 62,000 ha Los Santos Forest Reserve. It is situated between 2200 m and 3491 m a.s.l. on the Pacific slope of the Costa Rican Cordillera de Talamanca, which encloses Central Americas largest tract of montane ecosystems. Two small settlements, inhabited by a dozen families, are located along an unpaved road which is running through the area, from the Pan-American Highway down to the river valley.

Current land cover of the 5,400 ha upper Savegre River watershed area, was mapped using Black & White aerial photographs (1:10,000) taken in 1992. For ground-truthing, stratified representative vegetation sampling was carried out from April to July 1996. Plant species were collected and identified and vegetation was classified using the TWINSPAN software package. Subsequently, Black & White aerial photographs of 1941, 1956, 1969 and 1984 were interpreted in terms of forest conversion, and combined with the information from 1992 and 1996 into a deforestation map. Deforestation was expressed as the forest cover area cleared in percentages for each reference year and rates were calculated dividing the percentage area cleared in a time interval, by the number of years during that time interval. Maps were digitized and analyzed using the ITC developed ILWIS package (Van Omme et al. in prep). Data on land use changes were obtained through interviews with local inhabitants of the area, conducted in 1991, 1992 and 1996.

3. Results

3.1 Land cover

Nine vegetation and six other cover types (bare ground, two types of roads, rivers, rivulets and powerline-clearings) could be distinguished (Table 1). Primary montane forest (70.8%) comprised the largest area, followed by three other natural vegetation types. The successional vegetation cover types (secondary shrub vegetation and secondary forest) together accounted for 6.4% of the watershed. Pasture lands and orchards covered respectively 3.3 and 1.0 %.

Table 1: Land use, altitudinal range (m), and cover (%) of the various land cover types in 1996

Land Cover	Land Use	Altitudinal range (m)	Cover (%)
Bamboo paramo	conservation	3200 - 3491	4.2
Shrub paramo	conservation	3200 - 3491	6.4
Subalpine dwarf forest	conservation	3100 - 3400	7.7
Primary montane cloud forest	conservation	2200 - 3100	70.8
Secondary forest	fallow after grazing	2200 - 3100	5.3
Secondary shrub vegetation	fallow after grazing /	2200 - 3100	1.1
	blackberry gathering		
Pasture land	dairy cattle ranging	2200 - 3000	3.3
Orchard	fruit tree cultivation	2200 - 2500	1.0
Timber plantation	timber production	2300 - 2400	0.05
Bare ground	basalt mining	2900 - 3400	0.2
Others (roads, rivers, powerline-clearings)	transportation, conservation	2200 - 3491	0.85

3.2 Deforestation

Deforestation started with the construction of the Pan-American Highway (1940-1943). In 1941, a total of 99.9 % of the total potential montane cloud forest area was covered with undisturbed primary mature montane forest. Until 1956 only 0.3 % of this area was cleared, just after the first colonising farmer families arrived. Until 1969 some 6.2 % of the montane forest cover was lost, whereas a total of 13.3 % was lost from 1941 to 1984. The increase of forest loss from 1984 to 1996 was only 0.1 % (Table 2). Deforestation rates are shown in Table 3.

Table 2: Cover of primary montane cloud forest (4454 ha before 1941)

deforestation (%) over the past 55 years					
	1941	1956	1969	1984	1996
Primary montane cloud forest	99.9	99.7	93.4	86.5	86.4
Deforested area	0.1	0.3	6.6	13.5	13.6

Table 3. Deforestation rates

Time interval	%cleared area	%cleared area/yr.
1941 - 1956	0.2	0.01
1956 - 1969	6.3	0.48
1969 - 1984	6.9	0.46
1984 - 1996	0.1	0.01

3.3 Land use changes

The first settlers arrived in the area during the 1950s. Traditionally, blackberry gathering, charcoal production and animal husbandry with dairy cattle were practiced. In the 1980s, some of the low productive grasslands located between 2200 and 2500 m a.s.l. were changed into fruit tree plantations, and planted with apple, peach, and to a lesser extent, plum trees, which are rainfed and harvested from March to June (Kappelle & Juárez, 1995). Recently, on-farm production of rainbow trout in small artificial ponds is becoming a considerable source of income. Ecotourism is

a second recent and growing activity in the watershed area, and has already become a major source of income to a few families.

Land use of the various cover types in 1996 is shown in Table 1.

4. Discussion

Deforestation rates presented in this study are low in comparison to studies conducted in the tropical lowlands of Central America (Myers, 1980; Sader & Joyce, 1988). High mountain areas, such as this study area, were relatively inaccessible and generally less desirable for agriculture and pasture development (Sader & Joyce, 1988). However, as tropical montane forests are less abundant, and considered to be very fragile, disturbances in forest cover due to human activities, may have a strong effect and must therefore be taken seriously.

The deforestation rate in the study area increased significantly between 1956 and 1969, and decreased from 1984 to 1992 (Table 3). These trends are explained by the fact that local peasant communities settled in the 1950s, cleared large patches of forest for charcoal production and dairy cattle ranging in the 1960s and 1970s, and finally changed low productive grasslands into fruit tree plantations in the 1980s. Extensively grazed pasturelands were abandoned giving way to forest succession. The creation of a forest reserve in the 1970s and the rise of ecotourism as a major source of income for the local people both have stimulated forest conservation. In 1996 a total of 59.6 % of the montane forest area cleared since 1941 was observed regenerating (Table 4). Therefore, it is expected that montane forest cover in the upper Savegre River watershed area will be successfully maintained and restored on the long term. However, when taking this study as a model for other watershed areas, possibilities for alternative land uses, as well as population pressure and presence of regulations have to be taken into consideration.

Table 4: Present vegetation cover of the deforested areas

Vegetation cover type	Area cover (%)
Secondary forest	49.3
Secondary shrub vegetation	10.3
Pasture land	29.8
Orchard	8.6
Timber plantation	0.5
Bare ground	1.5

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6. Literature

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