Chapter 16
Current Provisioning Ecosystem Services for the Local Population: Landscape Transformation, Land Use, and Plant Use

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16.1 Introduction

Provisioning ecosystem services are defined as products obtained directly from nature (e.g., freshwater, hunting and gathering of a range of species, fisheries, harvesting of plants for timber, fuel, fiber, and medicines). These services also come from domesticated species through pastoralism, agriculture, and aquaculture (Daily 1997; Millennium Ecosystem Assessment 2005). In rural areas of tropical developing countries, agricultural biodiversity plays a major role in the production of goods and provides local people with a wider range of responses to environmental or market risks (Coomes and Burt 1997). However, even if farmland in forest areas can support biodiversity through preservation of important forest ecosystem elements on a small scale (Mendenhall et al. 2011), the long-term sustainability of forests and the array of ecosystem services they provide may be under threat from the expansion of farming activities. Given the fragmented state of most tropical ecosystems, agricultural landscapes should be a crucial concern of any conservation strategy.

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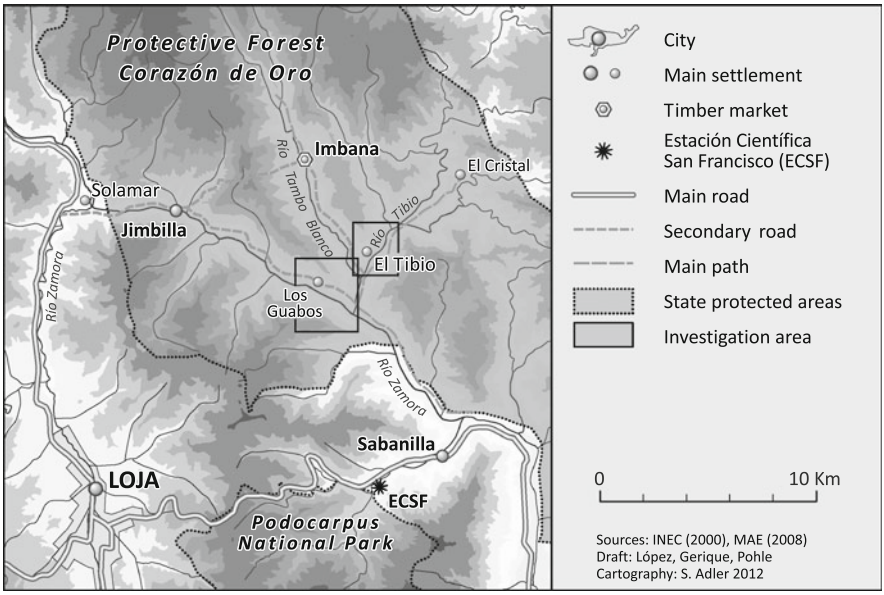


Fig. 16.1 Location of the study sites

16.2 Aims, Materials, and Methods

The megadiverse ecosystem of the tropical mountain forests of the eastern Andean Cordillera of southern Ecuador has been under severe pressure since the first colonists arrived during the first half of the twentieth century. Given the current fragmented stage of the former forest landscape which has been replaced by a mixed matrix of forest remnants, pastures, fields/gardens, and wasteland (*matorral*), the aims of the study are as follows:

1. To document and to analyze the landscape transformation process and its implications for provisioning ecosystem services for the local population,
2. To determine current ecosystem provisioning services for food production of smallholder farmers and to identify the services provided by local plant diversity for specific ethno-cultural communities.

The outcome of this study aims to help experts to develop strategies for biodiversity conservation and a sustainable use of ecosystem services.

Research was undertaken north of Podocarpus National Park in the Upper Zamora Valley (Fig. 16.1). The main study sites were the settlements of El Tibio (1,770 m a.s.l.) with an indigenous Saraguro population and Los Guabos (1,900 m a.s.l.) mainly inhabited by *mestizos*.[1] Other study sites were El Cristal

[1] The Saraguros are Quechua-speaking highland Indians who traditionally inhabit the northern Andean area of Loja Province. The mestizos are of Spanish and indigenous descent and represent at more than 80 % the major population group of southern Ecuador (Pohle 2008).

(1,980 m a.s.l.), a small Saraguro settlement north of El Tibio, and 12 *mestizo* farms along the road Loja–Zamora in areas known as Sabanilla, El Retorno, and La Fragancia (2,200–1,100 m a.s.l.).

The study makes use of data generated by 6 years of ethnobotanical/ethnoecological and agrogeographical research among the ethnic groups of southern Ecuador (Pohle and Gerique 2006, 2008; Gerique and Veintimilla 2008; Pohle et al. 2010). Three methodological approaches were used: (a) analysis of qualitative and quantitative data from field surveys concerning settlement history and livelihood strategies, (b) analysis of land use/land cover (LULC) changes, and (c) compilation of an ethnobotanical inventory of useful wild and cultivated plants.

16.3 Results and Discussion

16.3.1 Colonization, Access to Land, and Extraction of Plant Resources

Historical insights into the colonization process, access to land, and resource extraction are necessary preconditions to assess current ecosystem services. The conversion of land from natural ecosystems to agriculture by small-scale farming colonists has been a main factor of environmental change in Ecuador (Bromley 1981; Pichón 1996).

Data provided by local informants and secondary sources (Arias Benavides 2004) mention the existence of large land holdings (*haciendas*) in the Upper Zamora Valley, such as the *hacienda* Los Guabos, which developed through land accumulation by absentee landowners (*terratenientes*) from the city of Loja since the late nineteenth century. Settlers who moved to the area from the beginning of the twentieth century were laborers of the large holdings or landless colonists in search of vacant public lands (*tierras baldías*). The colonization route mainly used by *mestizo* settlers was the ancient trail between the cities of Loja and Zamora (Fig. 16.1). Sabanilla originated as a resting place (*tambo*) along this trail. A second route followed the Río Tambo Blanco and was mainly used by Saraguro colonists from the high Andean town of San Lucas. They founded El Tibio in the 1950s. *Mestizos* established various settlements such as Los Guabos in the early twentieth century.

Formalization of land rights for peasants was only possible after the first Agrarian Reform and Colonization Law came into force in 1964. The law abolished the traditional forms of labor compensation inherited from the colonial period and encouraged the expropriation and adjudication of *haciendas* which were not productive (Barsky 1984). Landowners undertook indirect measures to avoid expropriation, such as selling parts of their property to the workers (Pohle 2008), as was the case in Los Guabos. The second Law of Agrarian Reform and Colonization in 1973 strengthened the opportunities for peasants to acquire land, both through

means of agrarian reform procedures (e.g., expropriation of private *haciendas*) or through colonization (e.g., adjudication of public land). Both processes occurred in the study site; according to local informants, many of the first settlers bought land from former *hacienda* owners or received it as compensation for their work (Tutillo 2005; Gerique 2010). The arrival of settlers was intense until the 1970s, and active pioneer fronts accompanied the development of settlements. Later pioneer activities continued mainly to establish pastures and to extract timber. Deforestation became the main condition to guarantee access to land in frontier areas as a response to the legal demands of the colonization laws requiring land clearance of between 25 and 50 % of the claimed land to get land titles (Southgate et al. 2009). Between 1975 and 1980 the greatest amount of land was granted by the state to colonists in the country (Gondard and Mazurek 2001). The Agrarian Development Law of 1994 derogated the Agrarian Reform Law and eliminated the condition of forest clearing for adjudication (Pohle et al. 2010).

As in other frontier areas (Rudel and Horowitz 1993; Marquette 2006), the welfare of the first settlers of the Upper Zamora Valley relied greatly on the provisioning services of the ecosystem. Important non-timber forest products (NTFPs) for medicinal purposes were overexploited, like the bark of *cascarilla* (*Cinchona* spp.) in the eighteenth and nineteenth centuries and again in the 1940s, and the latex of *sangre de drago* (*Croton lechleri* and *Croton mutisianus*) in the 1990s (Gerique 2010). Logging became the main source of income for the colonists, starting in the 1950s with intense extraction of the high quality timber of *romerillo* (*Podocarpus oleifolius* and *Prumnopitys montana*) in Sabanilla. These species were very abundant at that time and colonists perceived their existence as "inexhaustible." The road Loja–Zamora (1950–1960) also favored timber extraction. In the 1990s *romerillo* was scarce, and extraction was undertaken in remote areas inside or near the Podocarpus National Park (Romerillos, Tunantza Alto). Other species such as *cedro* (*Cedrela* spp.), *sanón* (*Hyeronima* spp.), *canelo* (*Nectandra* spp.), and *guayacán* (*Tabebuia chrysantha*) also became valuable and were heavily sought after (Gerique 2010).

During the 1990s a turnover of resource utilization took place. The pace of colonization decreased and, although pasture expansion continued to more remote sites, few new immigrants arrived in the area. Profitable timber species became overexploited, while cattle ranching became the main economic activity (see Sect. 16.3.3). The declaration of the Podocarpus National Park (1982) and the Bosque Protector Corazón de Oro (2000, see Table 13.1) notably influenced the allocation of land to conservation purposes and set legal barriers to the conversion of forests to agricultural land and to the acquisition of property titles. The existence of the Podocarpus National Park currently opens up opportunities for the implementation of conservation projects with the participation of local stakeholders. One example is the declaration of the Biosphere Reserve Podocarpus—El Condor in 2007 which aims to be an important instrument for further negotiations towards conservation and sustainable development.

16.3.2 Land Use/Land Cover Change Analysis at Local Scale

In the research area spatiotemporal landscape transformations are linked to the political and land use history, especially to the colonization process and the allocation of land. Additionally, land use/land cover changes largely depend on the decisions of individual farming households, especially at local scales.

The land use/land cover change maps of Los Guabos and El Tibio (Figs. 16.2 and 16.3)[2] give insights into the spatial distribution of three land use/land cover classes—forest, *matorral*, pasture[3]—and their spatiotemporal development in the period 1969–2001. Adjacent to the maps, change detection graphs are presented, in the case of El Tibio with three intermediate change periods.

The LULC change analysis shows two dynamics: (a) a main process of forest loss due to pasture expansion and (b) a secondary process of vegetation succession (*matorral* and forest). In both study sites a substantial loss of forest cover in favor of pastures has taken place: in 2001 the forest coverage in both areas was below 50 %.

Regarding the spatial distribution of land use/land cover classes, similar features can be observed for Los Guabos and El Tibio. The maps show a clear prevalence of pastures at lower altitudes, along riversides, and on the valley sides where settlements were established in order to keep distances short to control livestock. Accordingly, forest remnants are restricted to the upper parts of the slopes, the more inclined slopes, steep *quebradas*, and the valley sides opposite the villages. Thus, the deforestation process in both areas seems to have followed a general pattern: (a) from lower to higher altitude, (b) along rivers, and (c) from center to periphery (Lambin and Geist 2006).

Regarding the spatiotemporal development of specific land use/land cover classes, differences between both villages are obvious. Whereas in Los Guabos 33 % of the land use/land cover was classified as pasture in 1969 and 2001, respectively, in El Tibio the proportion of pastures increased considerably from 25 % in 1969 to 39 % in 2001, while forests declined dramatically from 68 % to 42 % (Figs. 16.2 and 16.3, bare graphs in black). Accordingly, in El Tibio the highest proportion of land use/land cover change can be attributed to the change category "forest to pasture" (44 %) compared to Los Guabos with 20 % (Figs. 16.2 and 16.3, bare graphs in color). On the valley side of El Tibio many acres of pasture were established between 1969 and 2001, whereas on the valley side of Los Guabos pastures were predominantly established before 1969. The differences in pasture

[2] The LULC change analysis is based on a visual interpretation of a sequence of orthorectified aerial photographs of Los Guabos (1969, 2001) and El Tibio (1969, 1976, 1989, 2001) with ArcGis. Field work for ground-truthing and qualitative data assessment was carried out between 2003 and 2007. The LULC change maps cover an area of about 2,000 ha (Los Guabos) and 500 ha (El Tibio).

[3] The forest category comprises tropical mountain forest, either as primary forest or in a successional stage. The category *matorral* comprises shrub (*lusara*) and bracken (*llashipa*) vegetation. Pastures in the research area are either *pastos naturales* (Sect. 15.2.1, prevalent in Los Guabos) or cultivated *mequerón* (*Setaria sphacelata*) pastures (dominant in El Tibio).

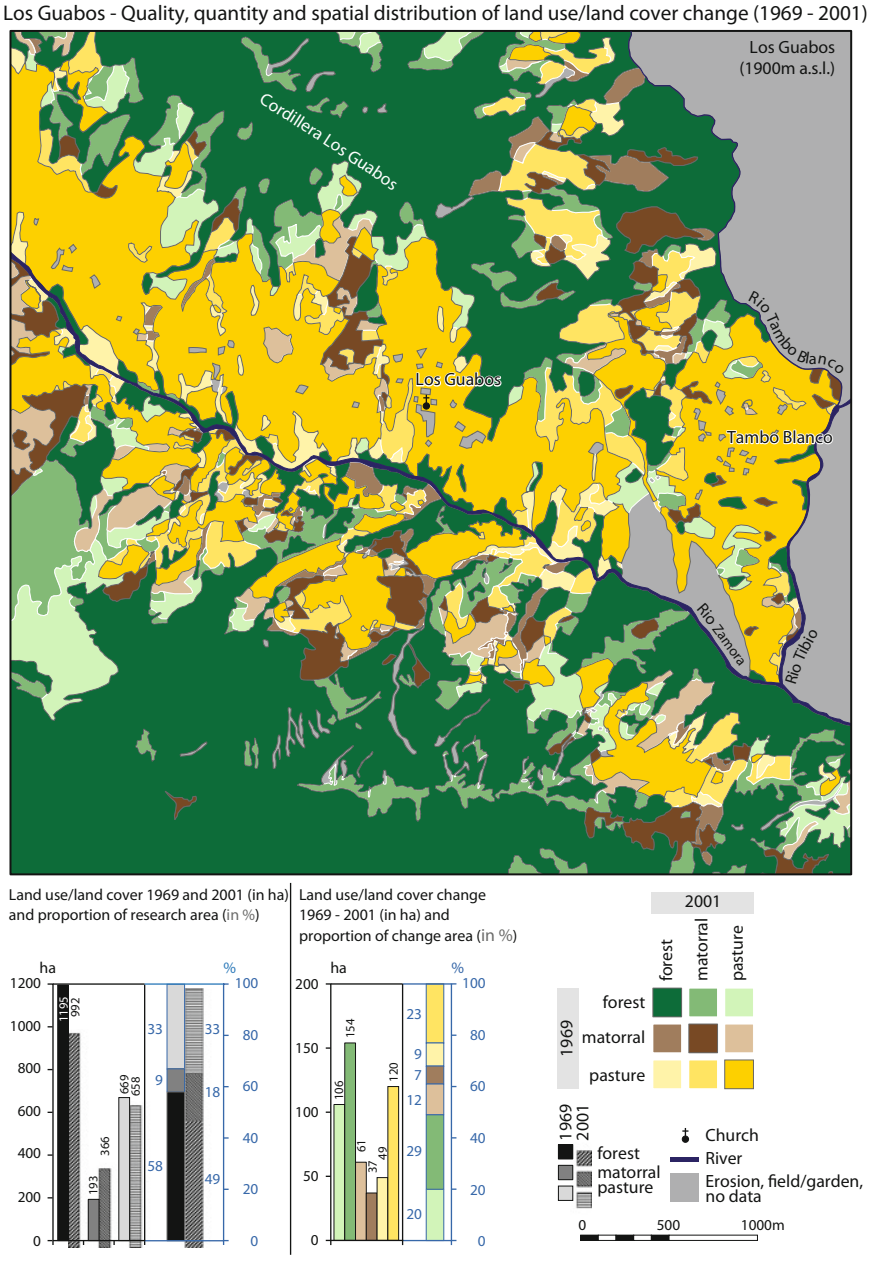


Fig. 16.2 Spatiotemporal land use/land cover change detection at Los Guabos between 1969 and 2001

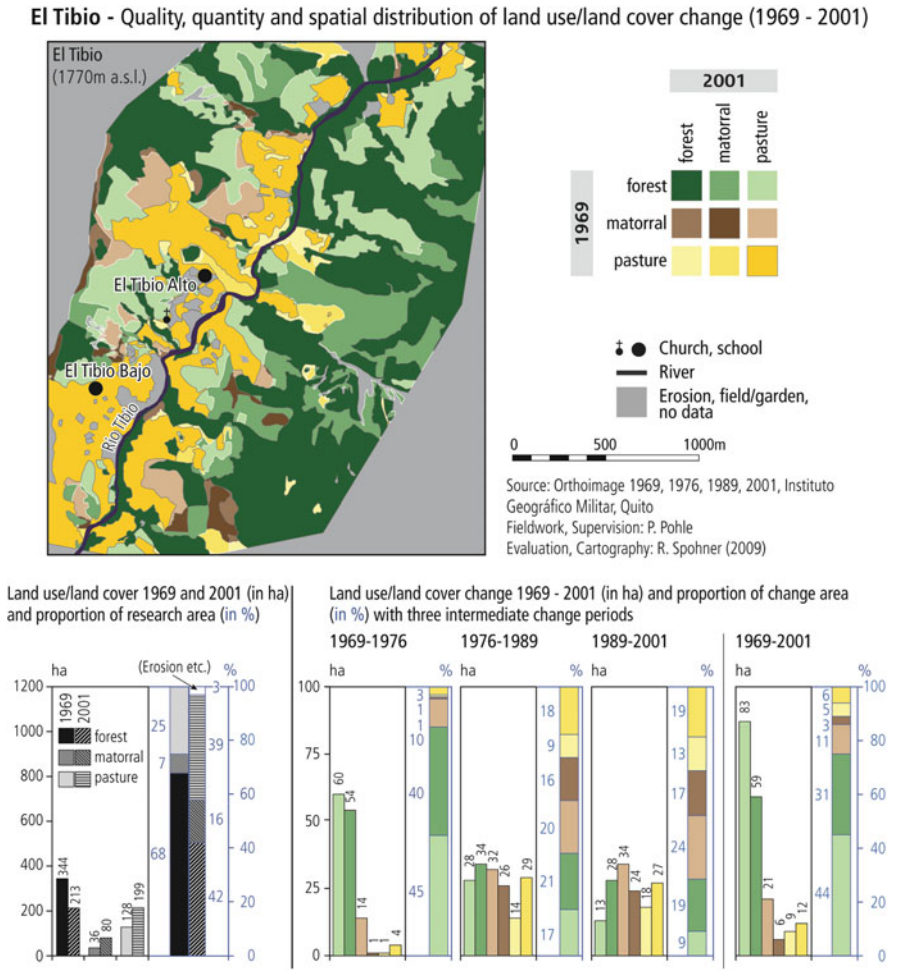


Fig. 16.3 Spatiotemporal land use/land cover change detection at El Tibio between 1969 and 2001

expansion between the two communities can be related to their history of settlement and colonization. As reported by the villagers, the area of Los Guabos was colonized more than 100 years ago, whereas El Tibio was founded in the 1950s. Thus it appears that Los Guabos with its stable or decreasing deforestation rate is in a more advanced phase of the landscape transformation process.

Concerning the process of vegetation succession, similar features could be observed in Los Guabos and El Tibio. From 1969 to 2001 in both research areas the proportion of the land cover class *matorral* at least doubled: from 9 to 18 % in Los Guabos and 7 to 16 % in El Tibio (Figs. 16.2 and 16.3, bare graphs in black). According to the transformation matrix (Figs. 16.2 and 16.3, bare graphs in color)

this doubling can be attributed mainly to the change category "forest to *matorral*" comprising 29 % of the change area in Los Guabos and 31 % in El Tibio, and to a lesser degree to the change category "pasture to *matorral*," in El Tibio with 6 %, whereas in Los Guabos this category is more pronounced with 23 %. While the changes from forest to *matorral* suggest an initial stage in postfire vegetation regeneration, changes of pasture to *matorral* indicate a degradation or abandonment of pastures to successional vegetation.

The relatively high rates of change from forest to *matorral* can be understood in view of the legal demands for land adjudications given by the two Laws of Agrarian Reform and Colonization in 1964 and 1973, which encouraged land clearing for obtaining official land titles (Sect. 16.3.1). As illustrated by the high proportion of the change category "forest to *matorral*" (40 %) in the intermediate change period 1969–1976 of the LULC change graphs of El Tibio (Figs. 16.3), obviously more forest was cleared than was needed for pastures. With the Law of Agrarian Development of 1994 forest clearing as a pre-condition for land adjudication was eliminated. Consequently, in El Tibio the proportion of the change category "forest to *matorral*" decreased from 40 % (1969–1976) to 28 % (1989–2001). As reported in the interviews, the cleared land was often too large or located too far from the village for effective maintenance. These areas were therefore left abandoned and secondary vegetation developed.

Another reason for the high rates of change from forest to *matorral* can be seen in the slash and burn practice to establish pastures among the *mestizos* and Saraguros where fire often gets out of control. The unintentionally burned forest areas just give way to the development of a secondary bracken and shrub vegetation (see Sect. 15.2). These plots—sometimes extensive—are mainly located next to the recently established pastures.

The higher percentage of change from pasture to *matorral* in Los Guabos (23 %) can partly be related to the emigration of landowners to Loja and the scarcity of labor for the maintenance of pastures as stated by the interviewed farmers. These plots are found in favorable locations close to the village or close to previously (before 1969) established pastures (Fig. 16.2).

From the LULC change analysis it can be concluded that due to the substantial loss of forest cover in favor of pastures, forest products play only a marginal role in food and income (from timber) supply for the local population who are becoming increasingly dependent on cattle ranching and products derived from that source. Although *matorral* areas in general are of limited use for the regulating and provisioning ecosystem services, their potential towards sustainable land use options—either for forest recovery by succession, for reforestation with native tree species (Chap. 13), or for pasture rehabilitation (Chap. 15)—might be rated as promising, with complementary financial incentives, as suggested by Knoke et al. (2011, see also Chap. 25).

16.3.3 Food Production of Small-Scale Farming Households: Livelihood Strategies, Cattle Ranching, Field and Garden Cropping

16.3.3.1 Livelihood Strategies

The Saraguros and the *mestizos* of the research area are mainly engaged in agro-pastoral activities that combine both a market economy (cattle ranching for cheese, milk, and meat production) and a subsistence economy (crop production, horticulture, and cattle ranching for subsistence needs). Whereas corn and beans are cropped in shifting fields (*chacras*), vegetables, fruits, spices, and other useful plants are cultivated in permanent home gardens (*huertas*). The main product drawn from cattle ranching is cheese, which is sold weekly in the markets of Loja.

According to the livelihood survey (Pohle et al. 2010, 2012) in the communities of El Tibio and Los Guabos revenues from employment and cattle ranching were the most important sources of household income, comprising in 2007 83 % (El Tibio, $n = 28$ households) and 80 % (Los Guabos, $n = 18$ households). Revenues from cattle ranching (mainly sales of cheese) are far higher in Saraguro households (41.2 %) than in m*estizo* households (25.5 %). The contribution of employment (mainly in the form of irregular work, day labor) is higher in the *mestizos* households (54.5 %) than in those of the Saraguros (41.8 %).

The stronger engagement of Saraguros in cattle ranching becomes obvious also in the share of land per land use category and the number of cattle per household: the Saraguros of El Tibio maintain more pasture (11.0 ha per household, $n = 29$) than the *mestizos* of Los Guabos (8.4 ha per household, $n = 18$) and own more cattle (11.4 head compared to 9.4 head). In contrast, the *mestizos* of Los Guabos show a stronger engagement in cropping than the Saraguros (4.2 ha crop fields (*chacras*) per household compared to 2.1 ha).

16.3.3.2 Cattle Ranching

In the study area cattle ranching is the most relevant productive activity and from the farmers' point of view the most profitable. *Quesillo*, an unsalted fresh white cheese, is the main product drawn from raising cattle. Production usually takes place in the pastures, since cheese is easier to transport and more durable than milk. Only farmers who have good access to roads can sell milk to regional producers of dairy products. Although cattle farming for meat production requires less labor input and produces high benefits, it is only practiced by ranchers who do not depend on daily or weekly revenues, as cows must be raised for 1 year before they can be sold.

Slash and burn is the traditional way of establishing pastures (see Chap. 15). The Saraguros and *mestizos* follow a system of rotations on pasture paddocks (*potreros*) of about 4–10 ha. Giving cattle enough access to fodder, farmers move livestock

between paddocks at intervals of 8–60 days, preferably every 15 days. Decisions about when to move the cattle depend on the grass species, the number and type of animals grazing (dairy cows, heifers, bulls, steers, calves), and the weather conditions. The *potreros* are used again when fodder grasses have recovered, which takes 45–90 days, again depending on the grass species. Rotations keep grasses from going to seed which preserves forage quality and avoids damage to the udders of cows from the rigid culms. Pregnant dairy cows and cows with calves are kept in *potreros* close to the houses, as they need milking every day. Bulls which do not require daily care are usually raised on distant pastures. One farmer with enough pasture land can manage up to 25 dairy cows and many more bulls, especially if there is assistance for seasonal activities. Another method of pasture management, especially applied by the Saraguros, is the tethering of cattle with a rope. Thus, 4–6 animals can be kept in 1 ha for 15 days. Although this method requires more labor, it allows for higher stocking density and has a second advantage: between the grazing periods, the farmers can take care of the pastures, in particular removing nasty weeds like bracken (Gerique 2010).

Stock density in the research area varies between 0.5 and 1.5 head/ha with an average of 0.7, a density which has also been reported for the Province Zamora Chinchipe (Aguirre and Maldonado 2004). Most ranchers in El Tibio and Los Guabos are smallholders who keep five or less cows per household (24 of a total of 47 households) and consider people with 20 or more cows (6 of 47 households) wealthy. The herds of the farmers in the *fincas* along the road Loja–Zamora are clearly larger: in 2005/06 the number of cattle varied between 9 and 65 head; 7 of a total of 12 households had more than 20; the mean was 25.7 head of cattle per household (Gerique 2010).

Many paddocks in the studied communities are more than 50 years old. Since ranchers do not use artificial fertilizers nor improve the soil quality by a targeted cultivation of nitrogen fixing plants, probably an optimized use of pastures has made such a long use possible, at least in favorable sites with good soils and a low risk of erosion (Gerique 2010).

16.3.3.3 Field Cropping

Maize (*Zea mays*) as the basis of the traditional diet is the most common crop in both ethnic groups. However, it is not produced for the market. Maize is intercropped with beans and squash is commonly planted at the edge of the fields. The average size of the crop fields is 0.5–1 ha. October is the main sowing period and after the harvest in February the remnants are used as fodder for the cattle which fertilize the fields with their dung. Maize is commonly not grown for more than 2 years in the same field. However, the *mestizos* of Los Guabos apparently have optimized maize cultivation. According to local informants, they have been cultivating maize by intercropping with beans (which are known to fix atmospheric nitrogen and in turn fertilize the soil) in the same plots without interruption for more than 20 years, allegedly without using any chemical fertilizer (Gerique 2010).

Farmers also cultivate maize after slashing and burning (Beck et al. 2008). This occurs mainly on marginal steep slopes and entails further clearing of forest (around 0.5 ha each time) adjacent to the pastures. Once the forest parcel has been cleared and the soil has cooled down, farmers use planting sticks for sowing the maize. On steep slopes soils are poor and crop production is limited to 1 or 2 years; afterwards the plot is abandoned or pasture grass is planted (Gerique 2010).

16.3.3.4 Gardening

Home gardens (*huertas*) of the Saraguros and *mestizos* of El Tibio and Los Guabos host a high agrobiodiversity (Pohle and Gerique 2006, 2008) and play an essential role not only in supplying food, in particular, fruits, vegetables, spices, and teas but also in the growing of medicinal and ornamental plants. As in the case of field cropping, Saraguros and *mestizos* cultivate similar plants in their *huertas* and apply analogous cultivation methods. Differences result from the altitude, the age of the gardens, and personal preferences.

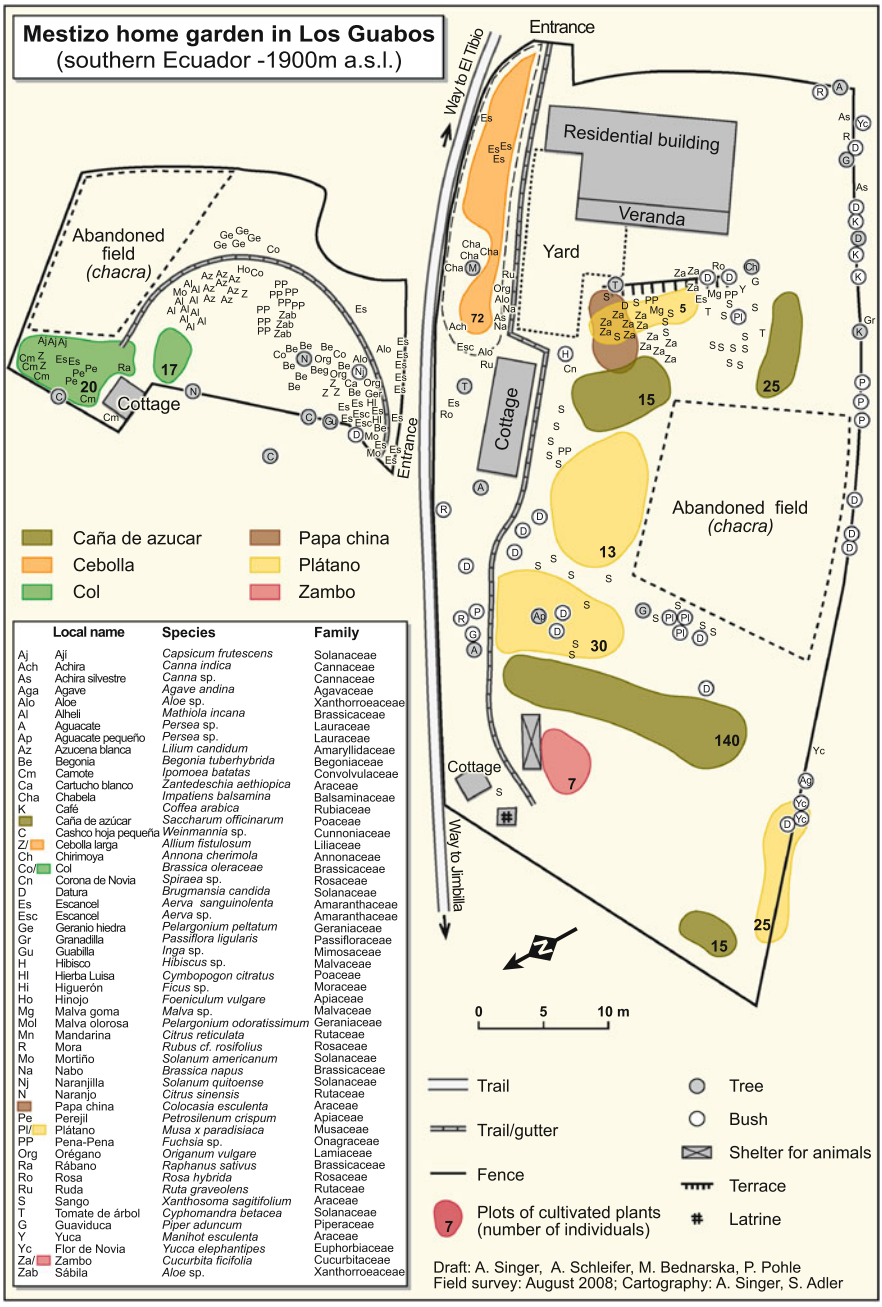
Huertas are laid out adjacent to the homes in rectangular shapes (Fig. 16.4). Inside the home garden, vegetables are often cultivated in fenced plots to keep plants safe from poultry. Obligatory is an area with banana (*Musa* × *paradisiaca*) which is used as pigsty and also as latrine. Sugar cane (*Saccharum officinarum*) is either cultivated in plots inside the home gardens or in small fields outside the garden. The plant composition of a home garden in Los Guabos is given in Fig. 16.4.

As the ethnobotanical and agrogeographical surveys indicate, there is a potential for the production of plant species in demand for regional markets in home gardens (Pohle et al. 2010). Since some *mestizos* and Saraguros already have experience in market oriented gardening—they sell ornamental plants (e.g., *Lilium candidum*, *Zantedeschia aethiopica*) or ingredients for the famous *horchata* tea in the markets of Loja—the further promotion of horticultural products could generate additional income on a low investment basis.

16.3.4 Plant Use

The central role of plants in the everyday life has obvious significance in developing countries, where all kinds of daily living activity include the direct use of plant resources (FAO 2007). In this way, indigenous and local people have generated vast bodies of knowledge about the use of plant resources.

As shown in Table 16.1, plant resources provide the Saraguros and *mestizos* of the research area with a wide array of services, mainly for food, medicine, decoration, and construction. The plant inventory of the Saraguros comprises 230 plant species with a total of 310 uses; among the *mestizos* 312 useful species with a total of 409 uses have been recorded. The differences in number might not necessarily



	Local name	Species	Family
Aj	Ají	*Capsicum frutescens*	Solanaceae
Ach	Achira	*Canna indica*	Cannaceae
As	Achira silvestre	*Canna* sp.	Cannaceae
Aga	Agave	*Agave andina*	Agavaceae
Alo	Aloe	*Aloe* sp.	Xanthorroeaceae
Al	Alheli	*Mathiola incana*	Brassicaceae
A	Aguacate	*Persea* sp.	Lauraceae
Ap	Aguacate pequeño	*Persea* sp.	Lauraceae
Az	Azucena blanca	*Lilium candidum*	Amaryllidaceae
Be	Begonia	*Begonia tuberhybrida*	Begoniaceae
Cm	Camote	*Ipomoea batatas*	Convolvulaceae
Ca	Cartucho blanco	*Zantedeschia aethiopica*	Araceae
Cha	Chabela	*Impatiens balsamina*	Balsaminaceae
K	Café	*Coffea arabica*	Rubiaceae
	Caña de azúcar	*Saccharum officinarum*	Poaceae
C	Cashco hoja pequeña	*Weinmannia* sp.	Cunnoniaceae
Z/	Cebolla larga	*Allium fistulosum*	Liliaceae
Ch	Chirimoya	*Annona cherimola*	Annonaceae
Co/	Col	*Brassica oleraceae*	Brassicaceae
Cn	Corona de Novia	*Spiraea* sp.	Rosaceae
D	Datura	*Brugmansia candida*	Solanaceae
Es	Escancel	*Aerva sanguinolenta*	Amaranthaceae
Esc	Escancel	*Aerva* sp.	Amaranthaceae
Ge	Geranio hiedra	*Pelargonium peltatum*	Geraniaceae
Gr	Granadilla	*Passiflora ligularis*	Passifloraceae
Gu	Guabilla	*Inga* sp.	Mimosaceae
H	Hibisco	*Hibiscus* sp.	Malvaceae
Hl	Hierba Luisa	*Cymbopogon citratus*	Poaceae
Hi	Higuerón	*Ficus* sp.	Moraceae
Ho	Hinojo	*Foeniculum vulgare*	Apiaceae
Mg	Malva goma	*Malva* sp.	Malvaceae
Mol	Malva olorosa	*Pelargonium odoratissimum*	Geraniaceae
Mn	Mandarina	*Citrus reticulata*	Rutaceae
R	Mora	*Rubus cf. rosifolius*	Rosaceae
Mo	Mortiño	*Solanum americanum*	Solanaceae
Na	Nabo	*Brassica napus*	Brassicaceae
Nj	Naranjilla	*Solanum quitoense*	Solanaceae
N	Naranjo	*Citrus sinensis*	Rutaceae
	Papa china	*Colocasia esculenta*	Araceae
Pe	Perejil	*Petrosilenum crispum*	Apiaceae
Pl/	Plátano	*Musa x paradisiaca*	Musaceae
PP	Pena-Pena	*Fuchsia* sp.	Onagraceae
Org	Orégano	*Origanum vulgare*	Lamiaceae
Ra	Rábano	*Raphanus sativus*	Brassicaceae
Ro	Rosa	*Rosa hybrida*	Rosaceae
Ru	Ruda	*Ruta graveolens*	Rutaceae
S	Sango	*Xanthosoma sagitifolium*	Araceae
T	Tomate de árbol	*Cyphomandra betacea*	Solanaceae
G	Guaviduca	*Piper aduncum*	Piperaceae
Y	Yuca	*Manihot esculenta*	Araceae
Yc	Flor de Novia	*Yucca elephantipes*	Euphorbiaceae
Za/	Zambo	*Cucurbita ficifolia*	Cucurbitaceae
Zab	Sábila	*Aloe* sp.	Xanthorroeaceae

Fig. 16.4 *Mestizo* home garden in Los Guabos

Table 16.1 Plant uses among Saraguros (Sarag.) and *mestizos* (*mest.*) according to use categories and area of collection

	Uses from forest plants[a]		Uses from wild plants growing in disturbed areas[b]		Uses from cultivated plant species		Total of uses in each category	
Use categories	Sarag.	*mest.*	Sarag.	*mest.*	Sarag.	*mest.*	Sarag.	*mest.*
Food	9	10	15	25	60	68	84	103
Medicinal uses	1	2	43	49	31	48	75	99
Ornamental uses	1	10	4	2	34	66	39	78
Construction	16	14	15	16	6	7	37	37
Fodder	0	0	11	14	11	15	22	29
Living fences	0	0	3	2	10	16	13	18
Fuel	4	4	8	8	1	2	13	14
Shade trees	1	5	5	6	0	0	6	11
Other uses[c]	11	6	7	7	3	7	21	20
Total uses[d]	43	51	111	129	156	229	310	409

[a]This category includes wild species growing in home gardens, pastures, and fields. Forest species protected during forest clearing have been included in this category, even if the forest has disappeared

[b]Native pioneer species that develop on disturbed areas after clearing have been included in this category

[c]This category includes plants used to make or prepare tools, baskets, remedies for domestic animals, fibers, soaps, perfumes, dyes, amulets, incense, pesticides, and soil indicators

[d]All categories are nonexclusive categories; thus, one plant species can be represented in more than one use category if it provides more than one service. *Source*: Gerique (2010, modified)

reflect differences of ethnospecific knowledge but they can be attributed to the higher number of *mestizo* settlements studied and to the wider altitudinal gradient they cover.

More than half of the useful plants are cultivated plant species growing in fields, home gardens, and pastures. Disturbed areas and pastures are important collection sites of useful wild plants; more than 40 % of them are gathered here. Less than 10 % of the species used are from the forests, most of them are timber species (Sect. 13.3.2).

Despite the difference in numbers, the use of plants is similar in both ethnic groups. Food (including spices and infusions) and medicine (especially plants to treat gastrointestinal ailments, respiratory diseases, and skin problems) are the principal provisioning services. Both ethnic groups cultivate and collect a great variety of ornamental plants for the decoration of houses, gardens, and chapels. The *mestizos* use 78 species for such purposes which is remarkably high. Timber as construction material is another basic need, especially for house construction and furniture. The importance of pasture economy among both ethnic groups explains the relevance of fodder plants, shade trees, and species used for living fences. However, the latter are being gradually substituted by barbed wire fences. Moreover, due to the widespread availability of subsidized gas cylinders, the use of forest plants as fuel is substantially decreasing. Other plant species used to make or prepare tools and baskets, soaps, perfumes, fibers, or used as remedies for domestic

animals, and as ritual or mythical plants have considerably lost importance and are often only known by older people. In general, the use of wild plants has lost importance today, as monetary income from cattle ranching and increasing supply on the market allow replacing traditional self-made products with manufactured goods.

16.4 Conclusions

Similar to other tropical frontier areas the land use/land cover changes in the research area are characterized by a substantial loss of forests and a concomitant loss of biodiversity due to pasture extension. However, the trajectories of change are nonlinear, showing high deforestation rates in the 1960s and 1970s as a result of national colonization policy and land reforms, but also various stages of vegetation succession and even some forest recovery.

The study shows that current land use does not necessarily lead to a spiral of deforestation. Local examples demonstrate that with a proper management pastures and fields can be used for a long time reducing the need for more land to convert. Furthermore, the home gardens of the Saraguros and *mestizos* conserve high levels of agrobiodiversity (Pohle and Gerique 2006). These traditional and ecologically sound agricultural practices should be promoted and conserved (Harvey et al. 2008).

Regarding cultural preferences, Rudel and Horowitz (1993) pointed out that generic factors such as land-titling requirements, year of settlement, population growth, and improvement of infrastructure homogenize the land use patterns of different ethnic groups. Indeed, the Saraguros and the *mestizos* share modes of land and plant use and are engaged in similar agro-pastoral activities. However, the Saraguros of El Tibio have a stronger engagement in cattle ranching and seem to be more successful from an economic perspective.

In order to protect the remaining biodiversity and the ecological services it is necessary to develop land use systems that conserve the existing forest patches and offer attractive and affordable alternatives for cattle ranching (Marquette 2006, Sects. 17.3 and 25.4). But due to the multiple objectives that this activity fulfills, a complete substitution will be almost impossible. As one promising approach, the use of wasteland (matorral)—either for reforestation with useful native tree species in demand or for pasture rehabilitation—could be discussed (Stimm et al. 2008; Roos et al. 2011, Sect. 13.3.3 and Chap. 26). An additional option, among others (cf. Pohle et al. 2010; Gerique 2010), might be the cultivation of useful plants (e.g., medicinal herbs, fruits, vegetables, and ornamental flowers) in home gardens for a regional market. In any case, alternative land use systems should incorporate existing sustainable practices, should be based on local knowledge and experience and should take into account cultural preferences in order to be socially accepted.

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