Deforestation, environmental perception and rural livelihoods in tropical mountain forest regions of South Ecuador

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Profound knowledge of region-specific human ecological parameters is crucial for the sustainable utilization and conservation of tropical mountain forests in southern Ecuador, a region with heterogenic ethnic, socio-cultural and socio-economic structures. In order to satisfy the objectives of environmental protection of tropical mountain forests on the one hand and the utilization claims of the local population on the other hand, an integrated concept of nature conservation and sustainable land use development is being sought. In biodiversity-rich places local people usually have a detailed ecological knowledge of species, ecosystems, ecological relationships and historical or recent changes of them. At the local level, utilitarian and socio-cultural values, such as local perceptions and beliefs, are the driving force behind use, management and conservation of natural resources. Additionally, economic and political factors influence people's decision-making. Under current pressures of deforestation, fragmentation and species extinction, there is an urgent need to thoroughly study the issues of environmental perception and knowledge, livelihood strategies, land use conflicts and land tenure. The analysis and evaluation of these topics is indispensable for the sustainable management of a megadiverse mountain ecosystem.

Keywords: deforestation, environmental perception, livelihoods, tropical mountain forest, South Ecuador, Podocarpus NP

Entwaldung, Umweltwahrnehmung und kleinbäuerliche Lebenssicherung in tropischen Bergwaldregionen von Südecuador

Gründliche Kenntnisse regionalspezifischer humanökologischer Parameter sind eine wichtige Voraussetzung für die Entwicklung nachhaltiger Schutz- und Nutzungskonzepte in tropischen Bergregenwäldern Südecuadors, einer Region mit heterogenen ethnischen, soziokulturellen und sozioökonomischen Strukturen. Um einerseits den Zielen des Naturschutzes im tropischen Bergregenwald und andererseits den Nutzungsansprüchen der lokalen Bevölkerung gerecht zu werden, wird ein integratives Konzept des Naturschutzes und der nachhaltigen Landnutzung gesucht. In biodiversitätsreichen Regionen hat die lokale Bevölkerung zumeist ein detailliertes Wissen über Arten, Ökosysteme, ökologische Wechselbeziehungen und ihre historischen und rezenten Veränderungen. Auf lokalem Maßstab sind Daseinssicherung und soziokulturelle Werte, wie lokale Wahrnehmungen und Geisteshaltungen treibende Kräfte der Nutzung, des Managements und der Erhaltung der natürlichen Ressourcen. Zudem beeinflussen ökonomische und politische Faktoren die Entscheidungen. Unter dem aktuellen Druck von Entwaldung, Fragmentierung und Artenverlust ist es dringend nötig, Themen wie Umweltwahrnehmung und -wissen, livelihood-Strategien, Landnutzungskonflikte und Landbesitz zu untersuchen. Die Analyse und Bewertung dieser Themen ist für das nachhaltige Management eines megadiversen Bergökosystems unverzichtbar.

Deforestación, percepción del medio ambiente y medios de vida rurales en regiones de bosque tropical montano del sur del Ecuador

El conocimiento profundo de los parámetros antropoecológicos específicos de cada región es crucial para el uso sostenible y la conservación de los bosques tropicales de montaña en el sur del Ecuador, una región caracterizada por estructuras étnicas, socio-culturales y socioeconómicas heterogéneas. Con el

objetivo de satisfacer por un lado los objetivos de protección medioambiental de los bosques tropicales de montaña y por otro las reclamaciones de la población local, se hace necesario encontrar un concepto integrado de conservación de la naturaleza y de desarrollo sostenible del uso del territorio. En lugares con una alta riqueza en biodiversidad los habitantes tienen frecuentemente un conocimiento muy detallado de la ecología de las especies, de los ecosistemas, las relaciones ecológicas y de los cambios históricos recientes. A nivel local, los valores utilitarios y socioculturales, tales como las percepciones y creencias locales, son la fuerza conductora detrás del uso, el manejo y la conservación de los recursos naturales. Además, factores económicos y políticos influyen la toma de decisiones de las personas. Bajo las presiones actuales de deforestación, fragmentación y extinción de especies existe una necesidad urgente de estudiar la percepción y el conocimiento medioambiental, las estrategias de supervivencia, los conflictos por el uso del territorio y la posesión de tierras. El análisis y la evaluación de estos temas es indispensable para la gestión sostenible de un ecosistema de montaña megadiverso.

1 Introduction: conceptual framework, research area and ethnic groups

The tropical mountain rainforests of the eastern Andes in Ecuador constitute one of the most important hotspots of biodiversity worldwide (Barthlott et al. 2007; Jørgensen & Ulloa Ulloa 1994; Myers et al. 2000). However, this region contains some of the world's most rapidly changing landscapes due to deforestation (FAO 2007), and also faces the threat of stress from climate change (Malhi et al. 2008). Both problems are directly linked, as deforestation is considered to be responsible for approximately 20% of the annual global carbon dioxide emissions (UNFCCC 2008). Most land conversion can be attributed to new settlers or colonists (e. g. Pichón 1996) but indigenous peoples as well are turning to more intensive land uses and are assimilating themselves into local and regional market economies (e. g. Sierra 1999; Rudel et al. 2002). To understand how local people use forest resources is of outmost importance to develop sustainable productive alternatives that reduce deforestation while encouraging local development and poverty alleviation. In order to be successfully developed and implemented, these alternatives should take local and ethnic particularities into account.

The agricultural frontier zone of southern Ecuador is an area of heterogenic ethnic, socio-cultural and socio-economic structures (Pohle 2008). Here, profound knowledge of human ecological dimensions – the various aspects of the interplay of individuals or social groups with their natural environment (Weichhart 2007) – is crucial for the sustainable utilization and conservation of tropical mountain forests. In order to satisfy the objectives of forest conservation on the one hand and the utilization claims of the local people on the other, an integrated concept of nature conservation and sustainable land use development is being sought (e. g. Ellenberg 1993). Within the DFG-Research Unit 402 "Tropical Mountain Rainforest" (cf. Beck et al. 2008) and the DFG-Research Unit 816 "Biodiversity and Sustainable Management of a Megadiverse Mountain Ecosystem in South Ecuador" (cf. Bendix et al. 2013) the human ecological approach towards sustainability of eco- and livelihood systems has

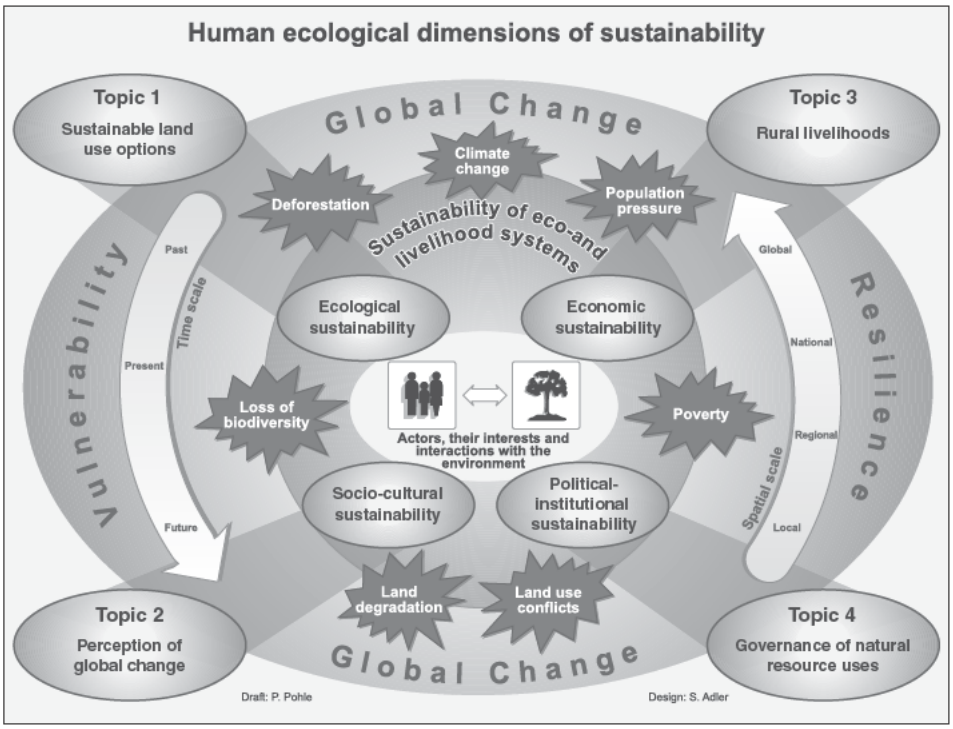

Fig. 1: Conceptual framework of the research project: the human ecological approach towards sustainability of eco- and livelihood systems

been developed and applied (Fig. 1, Pohle et al. 2010). Under current pressures of deforestation and agrarian colonization in biodiversity hot spot areas the analysis of four human ecological parameters or research topics have proved to be indispensable, and thus have been explored in detail in indigenous and local communities:

Topic 1: land use/land cover change at local scale to identify causes and driving forces of change;

Topic 2: environmental knowledge and perception of local people to evaluate traditional ecological knowledge;

Topic 3: livelihood strategies of small-scale farming households to estimate the household's dependence on natural resources and to assess strengths and weaknesses of livelihood assets;

Topic 4: governance of natural resource uses to determine political and administrative use agreements including land tenure systems.

The conceptual framework of the human ecological research approach is given in Figure 1. The overall problems in the research area are the typical global change problems like deforestation (Mosandl et al. 2008), loss of biodiversity (Koopowitz et al. 1994 cit. in Mosandl et al. 2008: 38), land degradation (Harden 1996; Göttlicher et

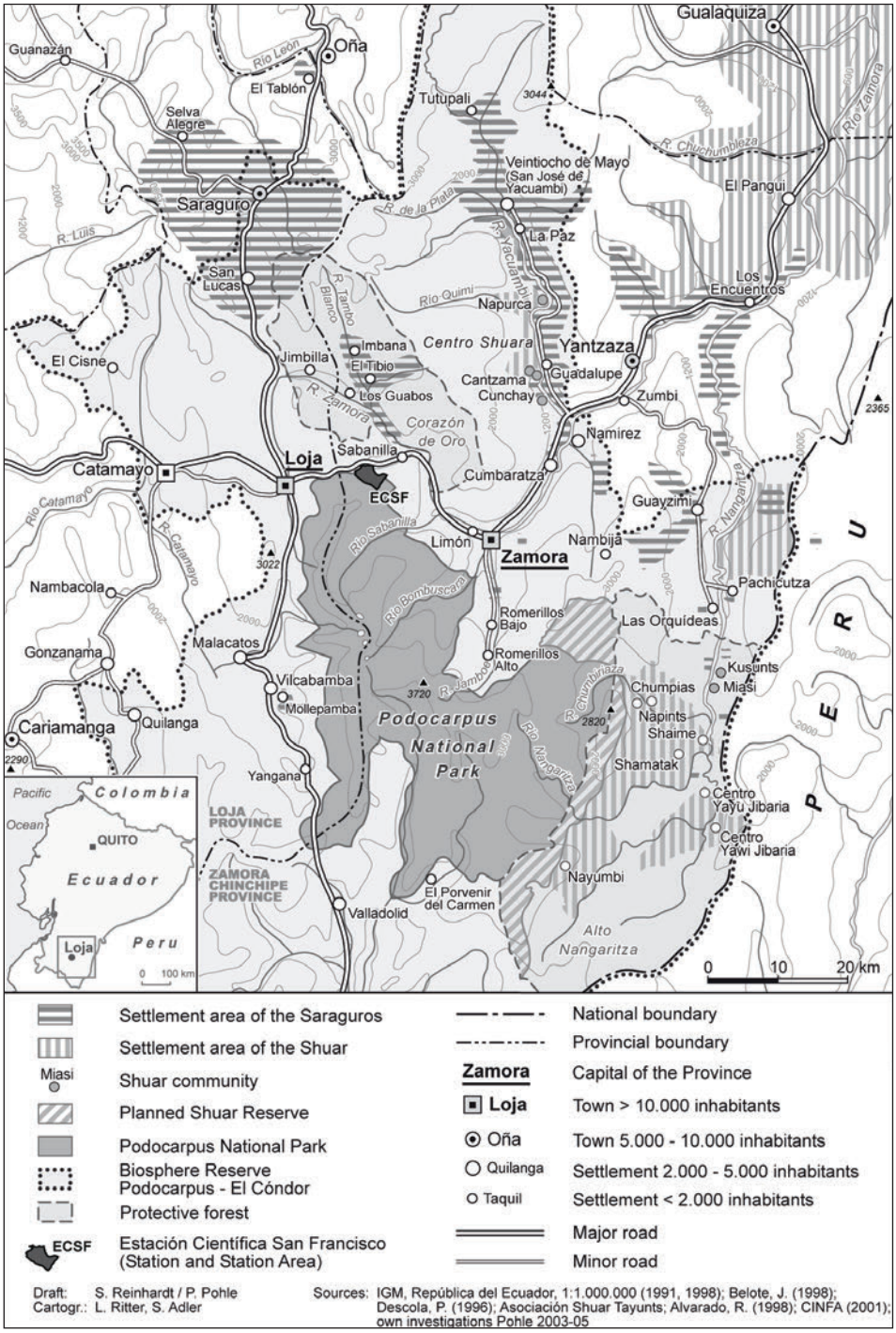

Fig. 2: The Podocarpus National Park and the settlement areas of indigenous groups

al. 2009), climate change (Bendix et al. 2013), land use conflicts (Pohle 2004: 20), colonization pressure (Pohle et al. 2010) and rural poverty (INEC 2003) – shown in their sometimes explosive character. At the centre of the research are the local people – either individuals or social groups – in their interaction with the natural environment. The main goal of the research project is to identify development strategies for achieving the sustainability of eco- and livelihood systems (e. g. Farrington et al. 1999). The project chose to use the human-environment related approaches of geographical development research (Scholz 2004), including the concepts of human ecology (e. g. Meusburger & Schwan 2003), ethno-ecology (e. g. Nazarea 1999), political ecology (e. g. Bryant & Bailey 1997; Krings 2008) and the sustainable livelihood approach (e. g. Chambers & Conway 1992). These integrative approaches are applied to explore interrelations and interactions between humans and societies with their natural environment. As conceptual and methodological frameworks they can considerably contribute to the solution of the conflict "protection versus utilization" of tropical mountain forests.

Research was undertaken north of Podocarpus National Park within the area of the Bosque Protector Corazón de Oro of the Biosphere Reserve Podocarpus – El Cóndor (Fig. 2). The tropical mountain rainforests of the eastern Andean slopes in southern Ecuador have an extraordinary rich biodiversity and are recognized as one of the "mega hotspots" of vascular plant diversity worldwide (Barthlott et al. 2007; Myers et al. 2000). However, during the past five decades, these mountain rainforest ecosystems, which have been described as particularly sensitive (cf. Die Erde 2001; Beck et al. 2008), have come under enormous pressure due to the expansion of agricultural land – especially pastures –, the extraction of timber, the mining of minerals, the tapping of water resources, road constructions and other forms of human intervention. According to the FAO-report (2007) the annual deforestation rate of 1.7% for Ecuador is the highest of all South American countries (FAO 2007). In the research area (catchment area of the Tambo Blanco) a deforestation rate of 1.16% (1976–1987) and 0.86% (1987–2001) was estimated by Tutillo (2010) using satellite images and aerial photograph analysis.

Population figures on the provincial level show an increase of the total population in Loja province from 404,835 in 2001 (population density 36.8) to 448,966 in 2010 (population density 40.8) with an increase of the annual population growth rate of 0.46% between 1990 and 2001 to 1.15% between 2001 and 2010 (INEC 2001, 2010). It is mainly the urban population growth that has been responsible for the total population growth in Loja province, while the rural population in total numbers has even decreased (e. g. *Parroquia* Imbana: total population 1,300 in 2001, 1,126 in 2010). Regarding the ethnic composition *mestizos* represent the major population group at 92.8% in 2010 (INEC 2010). The *mestizos*, a term generally used to indicate people of mixed Spanish and indigenous descent, are a very heterogeneous group who either live in towns, rural communities or scattered farms (*fincas*). In the area north of Podocarpus National Park, along the road Loja – Zamora, many arrived from the 1960s onwards, encouraged by the national land reform of 1964, to log

Fig. 3: Mestizos on their pasture in the Río Zamora valley (Photograph by E. Tapia)

timber and to practice cattle farming and agriculture. As colonizers they converted large areas of tropical mountain rainforests into almost treeless pastures (Fig. 3). Indigenous inhabitants in Loja province are for the most part *Saraguros* (3.7%). The Saraguros are Quichua-speaking highland Indians who predominantly live as agro-pastoralists in the temperate mid-altitudes of the Andes (Sierra) between 1,700 and 2,800 m a. s. l. As early as the 19th century the Saraguros kept cattle to supplement their traditional "system of mixed cultivation", featuring maize, beans, potatoes and other tubers (Gräf 1990). Now, cattle ranching is the main branch of their economy (Fig. 4).

2 Land Use and Land Cover Change (LULCC): Landscape transformation and deforestation north of Podocarpus National Park

Patterns of land use and land cover change at local scale are to the one hand influenced by regional and national resource use regulations but depend to the other also on decisions of individual farming households. Thus, its analysis provides important insights into the human-environment relations underlying current common and individual resource use strategies.

In the research area spatio-temporal landscape transformations are mainly 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 the *mestizo* or Saraguro farming households. As consequence, deforestation rates in the research area have not followed a constantly increasing trajectory as high rates interfere with decreasing rates and to a lower extent even with forest recovering.

To analyse the landscape transformation process, land use / land cover change detection (1969–2001) was undertaken in the communities of Los Guabos (*mestizos*)

Fig. 4: Saraguro woman milking one of her cows (Photograph by A. Gerique)

and El Tibio (Saraguros) in the upper Zamora valley north of Podocarpus National Park (cf. Fig. 2, Pohle et al. 2013). The analysis was based on a visual interpretation of a sequence of orthorectified aerial photographs with ArcGis. Field work for ground-truthing and qualitative data assessment was carried out between 2003 and 2007. The analysis was focused on three land use / land cover classes – forest, *matorral*, pasture –, and their spatio-temporal development in the period 1969 to 2001. 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* (prevalent in Los Guabos) or cultivated *mequerón* (*Setaria sphacelata*) pastures (dominant in El Tibio).

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% (Table 1). Regarding the spatio-temporal 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%. 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% (Table 2). The differences in pasture 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.

Table 1: Land use/land cover 1969 and 2001 in Los Guabos (1,900 m a. s. l.) and El Tibio (1,770 m a. s. l.)

Proportion of research area[1] (%)	Los Guabos (*mestizo*)		El Tibio (Saraguro)	
	1969	2001	1969	2001
Forest	58	49	68	42
Matorral[2]	9	**18**	7	**16**
Pasture	33	33	25	39

[1] The LULC change analysis covers an area of about 2000 ha (Los Guabos) and 500 ha (El Tibio)
[2] Schrubbery comprising shrub (*lusara*) and bracken (*llashipa*) vegetation
Source: Land use/land cover change maps of Los Guabos and El Tibio (Pohle et al. 2013)

Table 2: Land use/land cover change 1969–2001 in Los Guabos (1,900 m a. s. l.) and El Tibio (1,770 m a. s. l.)

Proportion of change area (in %)	Change period 1969 to 2001	
	Los Guabos (*mestizo*)	El Tibio (Saraguro)
Forest to pasture	20	**44**
Forest to *matorral*[1]	**29**	**31**
Matorral to pasture	12	11
Matorral to forest	7	3
Pasture to forest	9	5
Pasture to *matorral*	**23**	6

[1] Schrubbery comprising shrub (*lusara*) and bracken (*llashipa*) vegetation
Source: Land use/ land cover change maps of Los Guabos and El Tibio (Pohle et al. 2013)

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 (Table 1). According to the transformation matrix (Table 2) 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 post-fire 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 (Barsky 1984; Sierra 1996; Pohle et al. 2010). During that time obviously more forest was cleared than was needed for pastures. 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. With the Law of Agrarian Development of 1994 forest clearing as a pre-condition for land adjudication was eliminated. 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.

The higher percentage of change from pasture to *matorral* in Los Guabos (23%) can partly be related to the emigration of landowners to the town of Loja, and the scarcity of labour 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.

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. In areas, which are in a more advanced stage of the landscape transformation process (Los Guabos), forest clearing occurs side by side with land abandonment, the latter may give new possibilities for reforestation and rehabilitation measures (Bendix et al. 2013). Although *matorral* areas in general are of limited use, their potential towards sustainable land use options – either for forest recovery by succession, for reforestation with native tree species, or for pasture rehabilitation – might be rated as promising, with complementary financial incentives, as suggested by Knoke et al. (2011).

3 Perception and evaluation of the natural environment by the local people

In biodiversity-rich places local people usually have a detailed ecological knowledge e. g. of species, ecosystems, ecological relationships and historical or recent changes of them, collectively named 'Traditional Ecological Knowledge' (TEK) (Warren et al. 1995; Alcorn 1999). Numerous case studies have shown, how traditional ecological knowledge and traditional practices serve to effectively manage and conserve natural and man-made ecosystems and the biodiversity contained within (e. g. Posey 1985; Toledo et al. 1994; Alcorn 1999; Berkes 1999; Müller-Böker 1999; Fujisaka et al. 2000; Pohle 2004). At the local level, utilitarian and socio-cultural values such as local perceptions and beliefs are the driving force behind use, management and conservation of natural resources. Besides, economic and political factors influence people's decision-making. Under current pressures of deforestation, fragmentation and species extinction, traditional ecological knowledge has a high importance. According to their specific cultural tradition and according to the time spent in the specific region, local people usually have a differentiated perception and evaluation of their natural environment and of environmental stress / risk factors like deforestation, loss of biodiversity and land degradation. They may also have reacted to certain risks and

developed risk avoiding strategies (Stadel 1989, 1991). By now it is also well understood that nature conservation is only possible if the local population is included or, better yet, if conservation is managed by the local population. In this respect the local peoples' attitudes towards nature conservation and conservation measures are of major concern and form the basis for a sustainable development.

To reveal the local people's perception and evaluation of the natural environment, environmental stress / risk factors, and conservation measures, the following investigations have been undertaken in 2008 and 2009 in the *mestizo* community of Los Guabos and the Saraguro community of El Tibio (Pohle et al. 2010):

- Gathering of qualitative data with the help of contrasting photographs concerning the perception and evaluation of different cultural landscapes;
- Based on a standardised questionnaire, assessment of environmental stress / risk factors like land degradation (landslides), deforestation, loss of biodiversity etc. perceived by the rural population (awareness, reaction, risk-avoiding strategies);
- Based on a half-standardised questionnaire, investigation of the local peoples' attitudes towards nature conservation and conservation measures.

Two group discussions as a pre-test, and 28 individual interviews could be recorded, each directed towards the perception of different cultural landscapes, environmental stress / risk factors and conservation measures. In Los Guabos members of 11 *mestizo* households (2 female, 9 male), and in El Tibio members of 17 Saraguro households (7 male, 4 female, 6 male and female) were participating.

To find out, how *mestizos* and Saraguros perceive and evaluate different cultural landscapes, two photographs taken north of the Podocarpus National Park were shown to them, one with a totally deforested landscape and another still with forests (Fig. 5 & 6). They were then asked: Where would you prefer to live? The *mestizo* and Saraguro farmers both clearly prefer to live in areas with forests (Los Guabos: 9 of 11; El Tibio: 13 of 17). „I will not stay in an area that looks like a desert", was the comment of one farmer. The photograph without forest was described as exhausted and empty land. "If you have fertilizer, you can use it", was one farmer's statement. However, gender and age related differences could be observed as well. While the household heads and men being actively engaged in agro-pastoralism in all interviews pointed out the benefits from the forests, women and old people also preferred the open landscape. Among young women forests were even perceived as fearful and dangerous places. The landscape with forest was also highly valued as a clean and tranquil place, characterised by a healthy environment with fresh water supply and pure air.

In the interviews the *mestizo* and Saraguro farmers highly valued the aesthetic, health related and economic functions of the forests. All interviewees stated that forests are important to them because the forest landscape is most beautiful and peaceful ("*ambiente es mas bueno y tranquillo*"), because forests provide fresh air and water ("*se respire air puro", "con arboles hay agua*"), and because forest have multipurpose economic functions (to have work, pasture for the animals, wood and other commodities for the household) and thus provide a safety net and a traditional risk-avoid-

Fig. 5 & 6: Photograph comparison to evaluate farmers' perception of two cultural landscapes, one totally deforested and one with forests remaining (Photographs by P. Pohle)

ing strategy to the farmers. The most frequently mentioned forest benefits named by the interviewees of both ethnic groups were:

- forests are good to provide work (24),
- forests are a fresh water supply (23),
- forests are agricultural reserves (potential land for grass) (18),
- forests can be inherited by the children (18),
- forests are a safety net (10),
- forests provide people with construction wood, fuel, and to a limited extent with food and medicinal plants (9).

When people were asked about their estimation of whether forest land is increasing or decreasing, astonishingly all *mestizo* interviewees of Los Guabos (11) answered: "it remains the same" whereas the Saraguros of El Tibio (14) stated that the forest is decreasing. The *mestizo* perception reflects the more advanced stage of Los Guabos in the forest transition process where deforestation has slowed down and land abandonment with different stages of vegetation succession occurs (cf. Rudel 1998; Farley 2010). Accordingly, the last time forest clearing in Los Guabos was reported to be 3–40 years back, whereas in El Tibio it was reported to be 1 day to 25 years back. In contradiction to the incorrect perception that forest land remains the same, half of the *mestizo* interviewees could enumerate disappeared native tree species due to deforestation. Romerillo (*Prumnopitys montana*), Cedro (*Cedrela odorata*), Laurel (*Aniba cf. hostmanniana*), and Nogal (*Juglans neotropica*) were the most commonly named disappeared species.

When people were asked if they consider afforestation important, only a few interviewees stated that it is not important because there is still enough forest, but the majority estimated afforestation as an important task to protect nature, as a measure against species extinction, and to maintain fresh water supply and pure air. Almost all interviewees had experience with planting trees, especially along the edges of their pastures and to a lesser degree in their home gardens. As the most commonly planted species Pino (*Pinus patula*) and Cipre (*Cupressus macrocarpa*) were named; only a few had also planted native tree species like Romerillo (*Prumnopitys montana*) and Cedro (*Cedrela odorata*).

Environmental stress/ risk factors as perceived by the rural population form – beside other parameters – the basis for the need for sustainable development. Every year the Saraguros of El Tibio have to struggle with flooding and river erosion; a large landslide is endangering the settlement due to backward erosion. According to the perception survey the local people are very much aware of environmental risks such as erosion and landslides. All people consider too much rain as a stressor and almost all number erosion and landslides as environmental risk. Only the moving away from endangered places could be observed as a traditional risk-avoiding strategy. Besides, remnants of forests preserved in river ravines can be taken as a form of biological erosion control. Severe environmental problems reported by all interviewees included plant diseases (lancha), animal pests and the lack of timber.

The research area has a long history of conservation efforts (CINFA 2006): in 1982 the Podocarpus National Park was declared, in 2000 the Bosque Protector Corazón de Oro and in 2007 the Biosphere Reserve Podocarpus – El Cóndor (Fig. 2). However, concerning the perception of conservation measures, the survey indicates that only a minority of local inhabitants know about conservation areas. The majority do not even know of the Podocarpus National Park and, although they are living within it, they do not know of the Bosque Protector Corazón de Oro. All of the interviewees claimed to have no idea of what the specific conservation areas are for, where the borders are, and what resource use regulations and restrictions exist. Moreover, at the moment there are considerable jurisdiction problems between national institutions

in the land legalization process within the Bosque Protector Corazón de Oro that in future will make local people very sceptical about conservation measures.

Although forests are highly valued economically by the local *mestizo* and Saraguro farmers, deforestation is an ongoing process in the area. In colonization areas the main reason for forest clearing is the arrival of new settlers, the founding of new households and the subsequent conversion of forests into agricultural land. In the vicinity of the two investigated villages of Los Guabos (*mestizo*) and El Tibio (Saraguro) the colonization process, however, is mainly completed. In these areas the clearing of forests seems to be a household-based decision which takes place under the following circumstances:

- if land is divided after inheritance, the clearing of new lots often follows;
- if soil and pasture gradually lose their fertility, forest is cleared to gain new pastures;
- if the farmer has the strong desire to improve livelihood, this is mainly realised by means of extensive cattle ranching and consequently in forest clearing.

The latter might be the main reason for deforestation in the area. In this respect the distribution of land among the farmers and landownership has to be investigated more closely to find out which household type is contributing most to the deforestation process.

4 Analysis of livelihood strategies of small-scale farming households

To document and analyse ethno-specific livelihood strategies of rural farming households and their impact on natural resources a household survey was conducted in accordance with the concept of sustainable livelihoods (Chambers & Conway 1992) from September to November 2008 in six rural communities, including the *mestizo* community of Los Guabos and the Saraguro community of El Tibio (cf. Pohle et al. 2010, 2012, 2013). In these two communities a complete inventory of households was undertaken comprising data from 48 households and 240 permanently present household members. The household survey included 161 mainly standardized questions directed towards the five capitals or resources – financial, physical, human, social and natural (Fig. 7). Also included was general information about household composition and biographical data of each household member. All data were entered into a SPSS database.

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 cul-

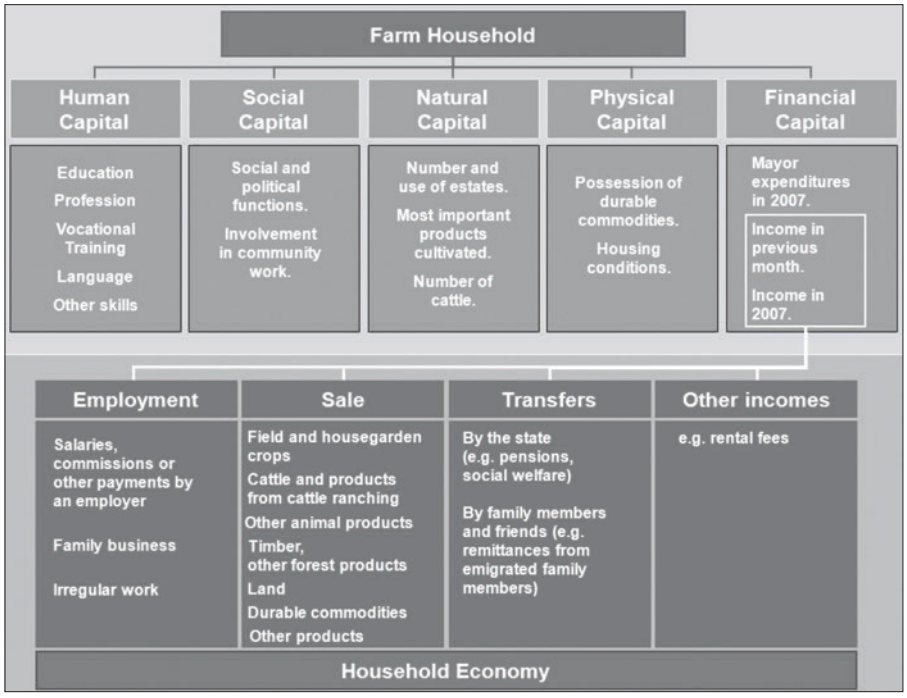

Fig. 7: Framework of the livelihood analysis conducted in six rural communities in southern Ecuador. Survey by M. Park

tivated in permanent home gardens (*huertas*). The main product drawn from cattle ranching is cheese, which is sold weekly in the markets of Loja.

Figure 8 shows the monetary household incomes of the studied *mestizo* and Saraguro communities in 2007 according to different revenue categories. In all communities revenues from employment and pasture economy were the most important sources of household income, comprising in 2007 in El Tibio 83% (n = 28 households) and in Los Guabos 80% (n = 18 households). Revenues from cattle ranching (mainly sales of cheese) are far higher in Saraguro households (El Tibio 41.2%) than in *mestizo* households (Los Guabos 25.5%). The contribution of employment (mainly in the form of irregular work, day labour) is higher in the *mestizo* households of Los Guabos (54.5%), than in those of the Saraguros of El Tibio (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 (Fig. 9 and 10). 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).

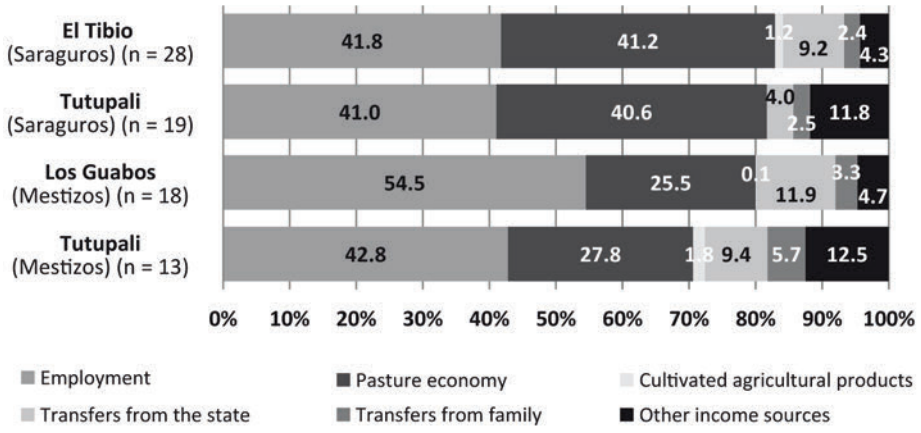

Fig. 8: Monetary household incomes in 2007

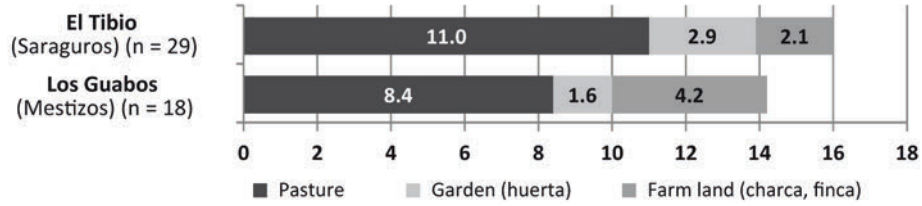

Fig. 9: The households' average share of land per land use category (in ha)

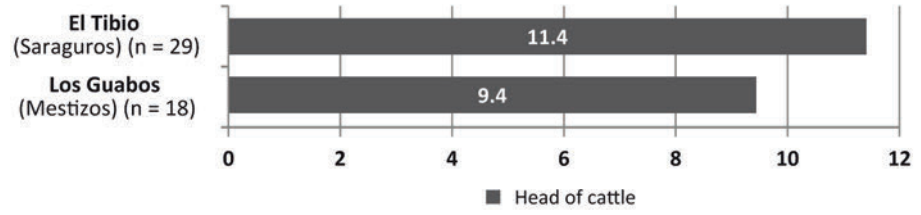

Fig. 10: Average number of cattle per household

Household types are heterogeneous in the *mestizo* and Saraguro communities studied and vary e. g. by household size, age and composition, owned land and cattle, as well as income structure in general. Figures 11 and 12 show the number of cattle and total area of land under use for all *mestizo* households of Los Guabos and all Saraguro households of El Tibio. It becomes obvious, that household types are very heterogeneous regarding their natural capital assets. A small number of privileged households owns a high number of cattle and maintains a big area of land (mainly pastures), whereas the majority of households has access to only small land holdings and owns very few head of cattle. There is also quite a number of landless

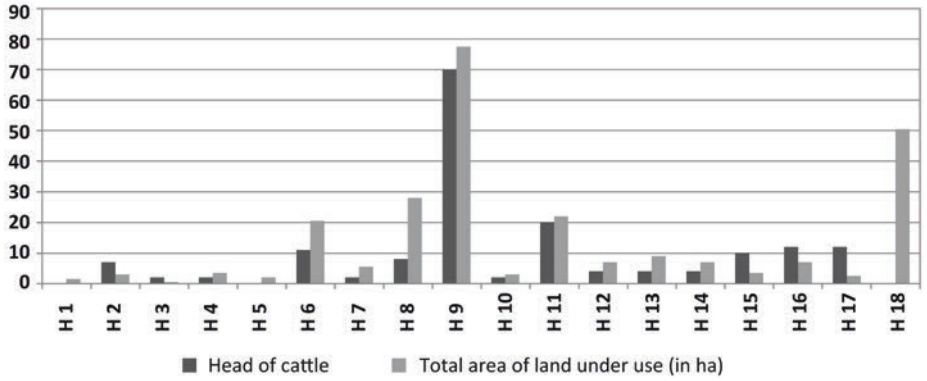

Fig. 11: Los Guabos: Number of cattle and total area of land under use per household

households and households with extremely small holdings (less than one ha) especially among the *mestizos*. Their household income mainly stems from day labour on the pastures and fields of the bigger landowners. Concerning the question of which household type participates most in the deforestation process, these landless and poorest households are probably no relevant actors in this respect. Rather, the decision to clear forest is apparently undertaken by the small number of more privileged landowners who also have the equipment and can afford to hire workers. Their decision is often based on a strong desire to improve their livelihood by integrating more into the market economy and this is realised especially by means of extensive cattle ranching. Concerning the "poverty-forest-debate", these findings would contradict the frequently held belief that poverty increases deforestation, at least on a household level (cf. Wunder 1996).

5 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 non-linear, 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.

In order to protect the remaining biodiversity 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). The experience in international nature conservation during the past 2–3 decades (Ellenberg 1993; Ghimire & Pimbert 1997; Müller-Böker et al. 2002) has shown that resource management, if it is to be sustainable, must serve the goals of both nature conservation and the use claims of the

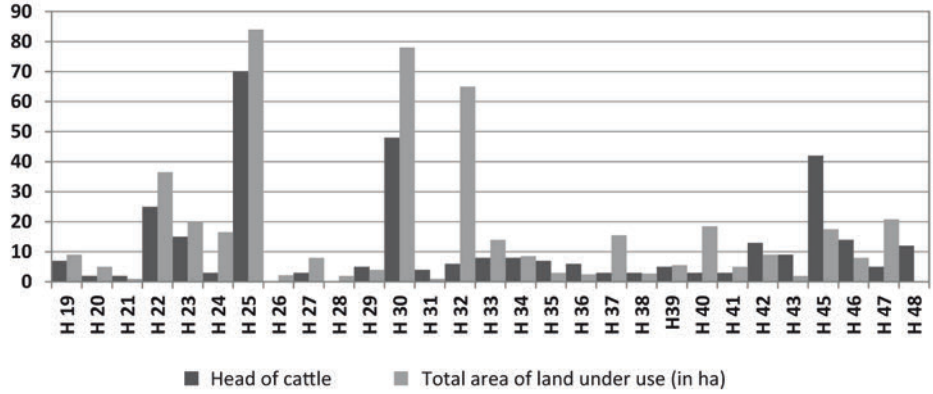

Fig. 12: El Tibio: Number of cattle and total area of land under use per household

local population. The strategy is one of "protection by use" instead of "protection from use", a concept that has emerged throughout the tropics under the philosophy "use it or lose it" (Janzen 1992, 1994). In line with this concept is the integrated concept of conservation and development exemplified by UNESCO's Biosphere Reserve (UNESCO 1984). Since September 2007 the research area belongs to the Biosphere Reserve Podocarpus – El Cóndor. Programmatically, Biosphere Reserves are strongly rooted in cultural contexts and traditional ways of life (Bridgewater 2002). With regard to the area under study, in the buffer and transition zone of Podocarpus National Park measures to be taken should take into account ethno-specific environmental knowledge and know-how. The Biosphere Reserve in southern Ecuador could thus be the vehicle for protecting tropical mountain ecosystems and developing sustainable forms of land use at the same time.

Regarding cultural preferences, Rudel & 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.

Since cattle ranching poses the main threat to the biodiversity rich tropical mountain rainforests of southern Ecuador alternative activities for securing rural livelihoods are needed in order to reduce the pressure on the forests. Decades of global efforts to conserve biodiversity have shown that people are more likely to incorporate new sources of income as complements to their existing activities than as substitutes for them (Ferraro & Kiss 2002). Moreover, in the research area cattle ranching fulfils multiple objectives within the farmers' livelihood strategies that are very difficult to substitute: as well as providing households with regular income, cattle awards a prestigious social status; cattle also represents a way of accumulating wealth as a pri-

vate insurance, which is especially important in regions with weak loan and pension systems. Therefore, only a partial substitution of pasture land appears to be realistic. As one promising approach, the cultivation of useful plants (e. g. medicinal herbs, fruits, vegetables, and ornamental flowers) in home gardens for a regional market could be discussed (cf. Pohle & Gerique 2008; Pohle et al. 2010; Gerique 2011). An additional option could be the use of non-timber forest products like the production of honey, teas, liquors and conserves (Añazco et al. 2005; Ordoñez & Lalama 2006). However, in order to stem the further loss of forests and biodiversity, it may be necessary to convince local people that scrub and wasteland (*matorral*) should be replanted with native tree species, preferably with useful native trees in demand (Mosandl & Günter 2008; Stimm et al. 2008; Knoke et al. 2009). The introduction of silvipastoral and agroforestry systems should also be taken into account (v. Walter et al. 2008). Additionally, the improvement of the pasture economy (Roos et al. 2011) as well as the veterinary service is indispensable. Finally, the promotion of off-farm employment opportunities as well as payments for environmental services to protect the watershed area of Loja would benefit the local farmers. 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.

Acknowledgements

The research carried out in southern Ecuador was very much inspired by the comprehensive work of Christoph Stadel. His detailed studies concerning the Andean farmer's perception of environmental stress (natural and human) in the northern Ecuadorian Sierra were guiding the presented research project (Stadel 1989, 1991).

For their hospitality and generous participation in this study I wish to thank the inhabitants of the communities of Los Guabos and El Tibio. My gratitude also goes to Eduardo Tapia and Tatiana Ramón for their contribution to this work. We are grateful to the German Research Foundation (DFG) for funding this project within the research units FOR 402 and FOR 816.

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