

Human ecological dimensions in sustainable utilization and conservation of tropical mountain rain forests under global change in southern Ecuador

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Summary

Profound knowledge of region-specific human ecological parameters is crucial for the sustainable utilization and conservation of tropical mountain rain forests in southern Ecuador, a region with heterogenic ethnic, socio-cultural and socio-economic structures. In order to satisfy the objectives of forest conservation on the one hand and the utilization claims of the local population on the other, an integrated concept of nature conservation and sustainable land use development is being sought (e.g. Ellenberg 1993). Within the human ecological research project of the German Research Foundation (DFG) presented here, four research topics have been explored in detail in indigenous Shuar and Saraguro as well as local Mestizo communities of southern Ecuador:

Research topic 1 is concerned with the use of wild plants and local agrobiodiversity. In the research area land use is focused on cattle ranching, which poses the main threat to forests and to biodiversity. Based on an ethnobotanical survey conducted in Shuar, Saraguro and Mestizo communities, the use of non-timber forest products (NTFPs) and the cultivation of plant species in demand in home gardens have been identified as promising options for increasing household incomes.

Research topic 2 deals with the local people's perception and evaluation of the natural environment, environmental stress/risk factors and conservation measures. Although deforestation is an ongoing process within the research area, Saraguro and Mestizo farmers clearly prefer to live in areas with forest

and highly value the economic functions of the forests, e.g. as an agricultural reserve which can be inherited by their children. Conservation measures have long since been established in the research area, but local people are not aware and have not been informed about resource use regulations and restrictions.

Research topic 3 investigates livelihood strategies of local communities which to varying degrees depend on natural resources. Whereas the Shuar's livelihood strategies to a large extent depend on subsistence agriculture (shifting cultivation) combined with fishing, hunting, and gathering of wild plants, the Saraguros and Mestizos are mainly engaged in agro-pastoral activities that combine market economy (cattle ranching) and subsistence economy (crop production and horticulture).

Research topic 4 is concerned with the determination of the political and administrative use agreements including land tenure systems. North of Podocarpus National Park current land use and land tenure conflicts are founded primarily on the colonization process starting in the 1950s, and are severely dependent on state policies on land adjudication, increase of accessibility, and national or international concern for nature conservation and environmental protection.

Despite the remoteness of many communities living in the tropical rainforests of southern Ecuador, the local people have never been completely isolated from global processes of ecological, political, cultural and economic changes. Recently, the research area was declared as Biosphere Reserve Podocarpus – El C ndor. Since biosphere reserves are strongly rooted in cultural contexts, in southern Ecuador it thus can be the vehicle for protecting tropical mountain ecosystems and developing sustainable forms of land use at the same time.

Keywords: Human ecological dimensions, tropical mountain forests, sustainable utilization, conservation, Ecuador, indigenous people, agrobiodiversity, ethnobotany, non-timber forest products (NTFPs), local perception of the environment, local perception of conservation measures, livelihood strategies, household incomes, land tenure conflicts, global change, conservation strategies, cultural diversity, human ecology, ethno-ecology

1 Introduction: conceptual framework, research area and ethnic groups

The forests of the Andean Amazon constitute one of the most important hotspots of biodiversity worldwide (J rgensen & Ulloa Ulloa 1994, Myers et al. 2000, Barthlott et al. 2007). 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 (Pichón 1996, Gerold & Lanfer 2001, Tourrand et al. 2008) but indigenous peoples as well are turning to more intensive land uses and are assimilating themselves into local and regional market economies (Sierra 1999, Putsche 2000, Rudel et al. 2002, Gray et al. 2008). According to the Fourth Assessment Report of the IPCC (2007) the reduction and prevention of deforestation represents the mitigation option of carbon dioxide emissions with the largest and most immediate carbon stock impact in the short term. On its part, the Stern review (2006: 217) considers this option to be the most economical to stop global warming. Thus, to counteract climate change, projects that address the drivers of deforestation should be developed. Moreover, to understand how local people use forest resources is of utmost 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.

In the agricultural frontier zone of southern Ecuador, a region of heterogeneous ethnic, socio-cultural and socio-economic structures, profound knowledge of human ecological dimensions is crucial for the sustainable utilization and conservation of tropical mountain rain forests. Human ecological dimensions may encompass various aspects of the interplay of individuals or social groups with their natural environment (Weichhart 2007). In biodiversity-rich places local people usually have a detailed ecological knowledge, e.g. of species, ecosystems, ecological relationships and historical or recent changes to them (Warren et al. 1995, Alcorn 1999). At the local level, utilitarian and socio-cultural values as well as perceptions and beliefs are the driving forces behind use, management and conservation of natural resources. Economic and political factors also influence people's decision-making. Under current pressures of deforestation, fragmentation and species extinction, there is a need to thoroughly study the issues of environmental knowledge and perception, rural livelihood strategies, land use conflicts and land tenure systems. The analysis and evaluation of these four research topics or human ecological dimensions is essential for the sustainable management of a megadiverse mountain ecosystem and has thus been the focus of research within the human ecological research project of the DFG Research Unit FOR 816: "Biodiversity and sustainable management of a megadiverse mountain ecosystem in South Ecuador".

The conceptual framework of the human ecological research project is given in Figure 1. The overall problems in the research area are 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 al. 2009), land use conflicts (Pohle 2004: 20) 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

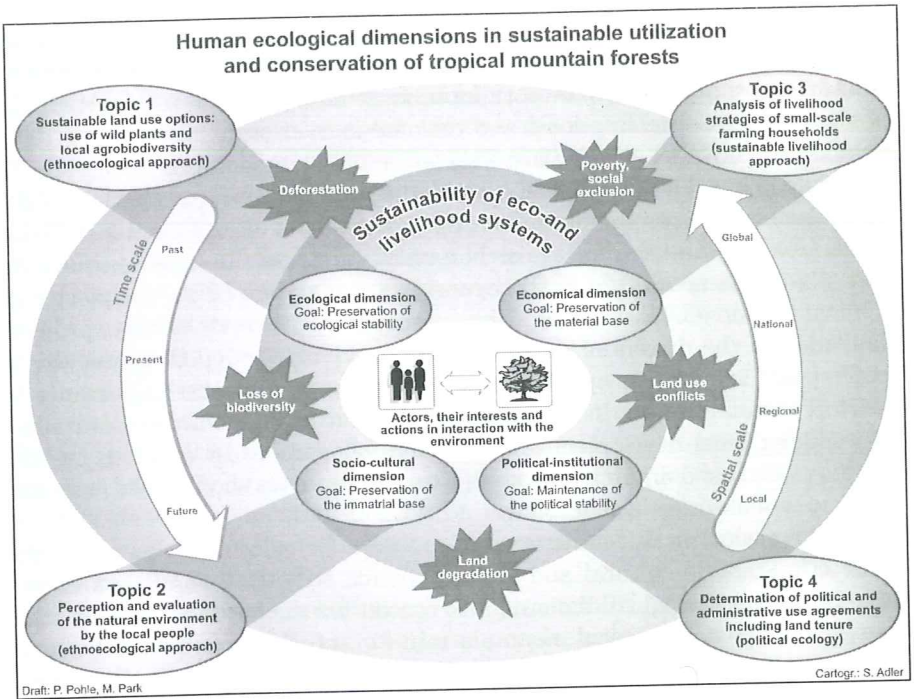


Fig. 1. Conceptual framework of the research project.

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, ethno-ecology, political ecology and the sustainable livelihood approach. 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. The ethnoecological approach (e.g. Münzel 1987, Posey & Balée 1989, Warren et al. 1995, Müller-Böker 1999, Nazarea 1999) is used with particular focus on the use of non-timber forest products (NTFPs) and local agrobiodiversity, as well as the perception and evaluation of the natural environment by local ethnic groups (Fig. 1). The sustainable livelihood approach (Chambers & Conway 1992, Chambers 1995, Bohle 2001, Derichs & Rauch 2001, Krüger 2003) is used to identify ethno-specific rural livelihood strategies and their dependence on natural resources. The concept of political ecology as an actor-oriented multi-layer approach is used to identify conflicts over utilization and agreements on resource use and land tenure systems (Blaikie & Brookfield 1987, Bryant & Bailey 1997, Krings 2008). All three concepts (ethnoecology, sustainable

livelihood approach, political ecology) are part of human ecology (geographical human ecology: e.g. Steiner & Wiesner 1984, Meusburger & Schwan 2003, Serbser 2004, Nentwig 2005).

The research area comprises the northern and eastern surroundings of the Podocarpus National Park within the Biosphere Reserve Podocarpus – El Cónдор (Fig. 2). Given their location between the Andean highlands and the lowlands of the Amazon, the tropical mountain rainforests of the eastern Andean slopes in southern Ecuador have an extraordinarily rich biodiversity. Podocarpus National Park and its surroundings are especially noteworthy for their species diversity and are a hotspot of vascular plant diversity worldwide (Myers et al. 2000, Barthlott et al. 2007). The tropical mountain rainforests of southern Ecuador play an important role as habitat for flora and fauna, and are of great relevance for the preservation of genetic resources (Die Erde 2001, Beck et al. 2008). At the same time, humans have lived here and sustained themselves for centuries. However, during the past five decades, these mountain rainforest ecosystems have come under enormous pressure due to the expansion of agricultural land - especially pastures (Mosandl et al. 2008, Göttlicher et al. 2009), the extraction of timber (Wunder 1996), the mining of minerals (Confeniae 2007, Mining Watch Canada 2007) the tapping of water resources and other forms of human intervention (e.g. road construction, power supply lines, Beck et al. 2008). According to the FAO report (2007), the annual deforestation rate of 1.7% for Ecuador is the highest of all South American countries. Within 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 Tuttillo (2009) using satellite images and aerial photograph analysis.

The population figures in the research area vary significantly between the two provinces of Loja in the west and Zamora Chinchipe in the east (Pohle 2008). Loja province, representing an ancient cultural landscape, has a significantly larger total population with 404,835 inhabitants according to the 2001 census, and a significantly higher population density with 36.8 inhabitants/km². The province of Zamora Chinchipe, being an area of recent agricultural colonization, has a total population of 76,601 inhabitants and a population density of only 7.3 inhabitants/km². Further, the two provinces differ in ethnic composition. In each case, Mestizos represent the major population group at 92.8% in Loja, and 83.2% in Zamora Chinchipe province (2001), but Zamora Chinchipe has a significantly larger proportion of indigenous inhabitants (12.2%) than Loja (3.0%). In Loja province the resident indigenous communities are for the most part Saragueros, while in Zamora Chinchipe the dominant indigenous communities are the Shuar (Fig. 2).

The *Shuar* area of settlement extends from the lower levels of the tropical mountain rainforest (approx. 1,400 m a.s.l.) down to the Amazonian lowland (Oriente) in the region bordering Peru (Fig. 2). The Shuar, Amazonian Indians, belong to the Jívaro linguistic group. They are typical forest dwellers who practice shifting cultivation in a subsistence economy (Fig. 3). They also

Podocarpus National Park and the settlement areas of indigenous groups

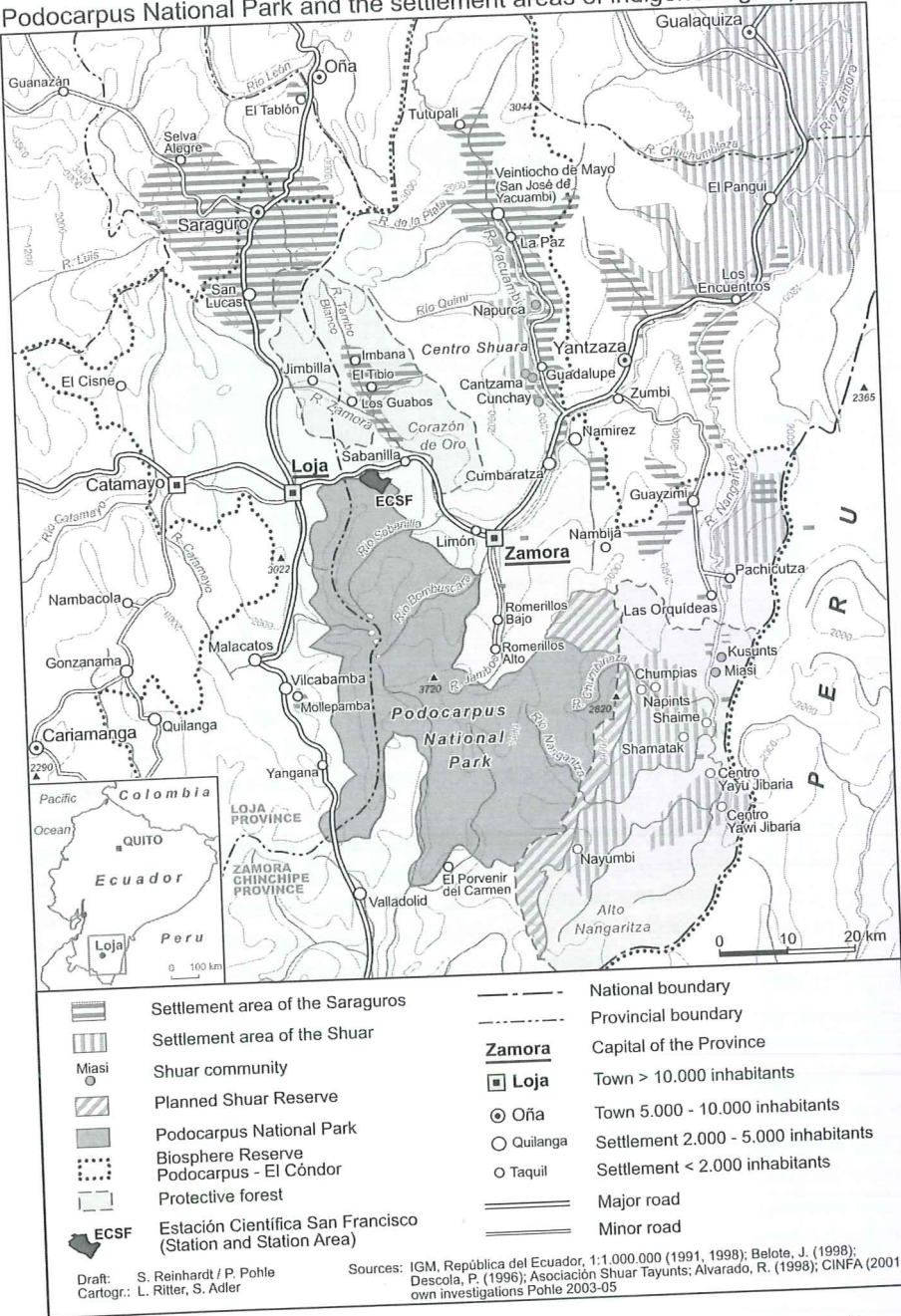


Fig. 2. The Podocarpus National Park and the settlement areas of indigenous groups.

fish, hunt and gather forest products. During the last decades some Shuar have begun to raise cattle and some are also engaged in timber extraction.



Fig. 3. Shuar women from Shaime taking a rest in their forest garden. Photo by A. Gerique.

The *Saraguros* are Quichua-speaking highland Indians who live as agropastoralists, in the most part in the temperate mid-altitudes of the Andes (Sierra) between 1,700 and 2,800 m a.s.l. (Fig. 4). 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 has developed as the main branch of their economy.

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 they arrived from the 1960s onwards, encouraged by the national land reform of 1964, to log timber and to practice cattle farming and agriculture. As colonizers they converted large areas of tropical mountain rainforests into almost treeless pastures (Fig. 5).



Fig. 4. Saraguro woman with her husband and children from El Tibio. Photo by P. Pohle.

2 Aims and methods of the human ecological research in southern Ecuador

Within the DFG Research Unit FOR 402 and FOR 816, beginning in 2004 and continuing until now, ethnoecological, agro-geographical, household-economical and political ecological research was undertaken in sample communities of indigenous Shuar and Saraguros as well as local Mestizos settling around Podocarpus National Park. The overall goal was to document the traditional ecological knowledge among the three ethnic groups, to analyse current forms of land use including the cultivation of forest and home gardens, and to evaluate ethno-specific life-support strategies as well as strategies for natural resource management. On the basis of these overriding objectives of inquiry, the aims of the presented human ecological research project may be summarized as follows (cf. Fig 1):

Topic 1: to identify sustainable land use options, especially regarding the use of wild plants (non-timber forest products, NTFPs) and local agrobiodiversity;

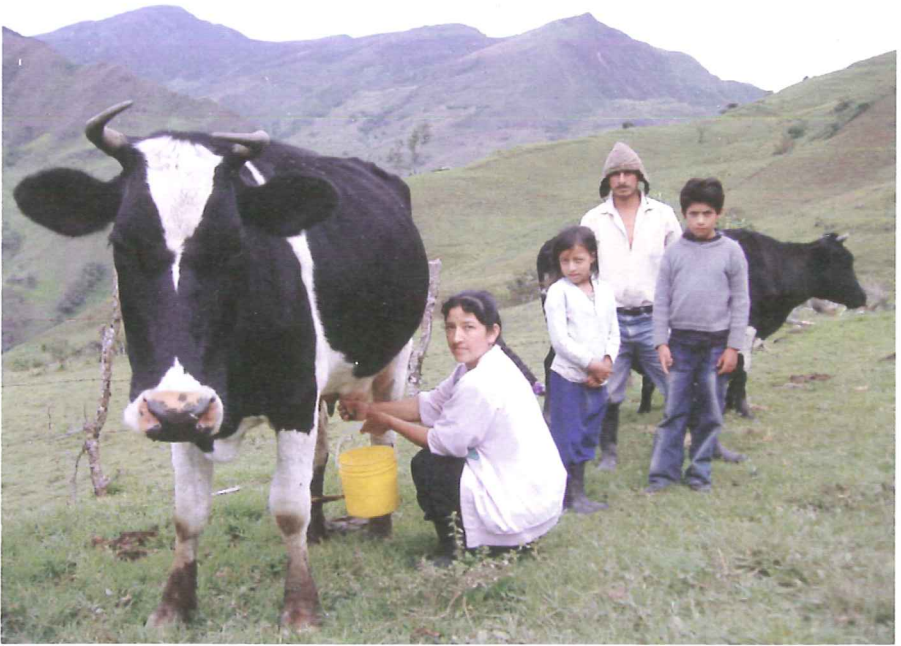


Fig. 5. Mestizos on their pasture in the Río Zamora valley. Photo by E. Tapia.

Topic 2: to make the ethno-specific knowledge, perception and evaluation of the natural environment, environmental stress/risk factors and conservation measures transparent;

Topic 3: to document and analyse ethno-specific livelihood strategies of rural farming households and their impact on natural resources;

Topic 4: to determine the political and administrative use agreements including land tenure systems.

Topic 1: To document traditional ecological knowledge and to identify sustainable land use options, an ethnobotanical survey was carried out between 2004 and 2007 in sample communities of the Shuar (Shaime, Chumpias, Napints), the Saraguros (El Tibio, El Cristal) and the Mestizos (Los Guabos, 12 fincas along the Loja – Zamora road). Various techniques of unstructured and semi-structured inquiry, such as participant observation techniques, artifact and plant use interviews, checklist interviews and group interviews (Alexiades 1996) were used. The ethnobotanical inventory technique was the main procedure used to collect ethnobotanical information. An inventory of wild and cultivated plants was compiled including botanical names as well as indigenous and Spanish names, with plants classified according to use categories such as medicine, food, fodder, construction material etc. (Gerique & Veintimilla 2008). A total of 68 male and female informants ranging from 14 to 75 years of

age were interviewed. In addition, 13 semi-structured expert interviews were conducted.

Topic 2: 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 Saraguro community of El Tibio and the Mestizo community of Los Guabos:

- 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 people's attitudes towards nature conservation and conservation measures.

Since the perception survey is still under way, the findings are for the time being based on a limited number of interviews: 2 group discussions as a pre-test, and 22 individual interviews, each directed towards the perception of different cultural landscapes, environmental stress/risk factors and conservation measures.

Topic 3: In accordance with the concept of sustainable livelihoods (Chambers & Conway 1992), a household survey was conducted from September to November 2008 in six rural communities, including the Saraguro community of El Tibio and the Mestizo community of Los Guabos.¹ 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 human, social, natural, physical, and financial (Fig. 6). Also included was general information about household composition and biographical data of each household member. All data were entered into a SPSS database. Analysis and interpretation of the data is being undertaken.

Topic 4: Data and information concerning the colonization process, land use conflicts and land tenure systems were obtained through a combination of secondary data research with empirical field studies undertaken in 2008 and 2009. Historical data on land tenure and forest policy were gathered from literature, and in public and private archives. Statistical data on land tenure were obtained from the rural land register of the Cantón Zamora and the agrarian census of 1954, 1974, and 2001. To get in-depth information about land use and land tenure conflicts, 11 thematically focused interviews were conducted with representatives of governmental (Ministry of Environment, Municipality

¹ Four communities are situated in the Yacuambi Valley north of Zamora and will not be discussed in this paper. In total, 148 households comprising 731 persons participated in the survey.

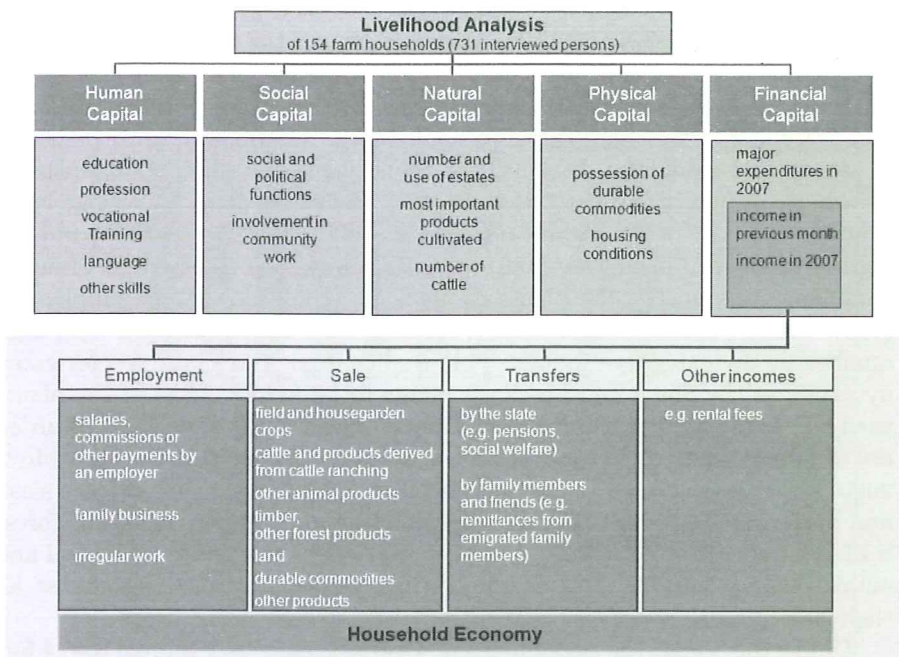


Fig. 6. Framework of the livelihood analysis conducted in six rural communities in southern Ecuador. Survey by M. Park.

of Loja and Zamora, Instituto Nacional de Reforma Agraria y Colonización - IERAC) and non-governmental (Nature and Culture International) institutions, village administrators and respected elders of the villages.

Further to the methods applied for the specific research topics mentioned above, various open interviews and group discussions with villagers were undertaken, along with land use mapping and multi-temporal analysis of satellite images and aerial photographs.

3 The use of wild plants and local agrobiodiversity

North of Podocarpus National Park land use is focused on cattle ranching. This type of land use constitutes the main threat to the forests and to biodiversity. Therefore, alternative activities for securing rural livelihoods are needed in order to reduce the pressure on the forests. Two promising options for increasing household incomes might be the use of non-timber forest products (NTFPs) and the production of plant species in demand in home gardens.

The ethnobotanical inventory undertaken in Shuar, Saraguro and Mestizo communities indicates differences in plant knowledge and plant use among the

three ethnic groups which are closely related to their specific ways of life. In Figure 7 the total number of useful plant species and the total number of plant uses recorded among the three ethnic groups is given. The uses of plants are presented according to use categories like medicine, food, construction etc., and according to the plant categories cultivated, ruderal and forest plants.

As typical rainforest dwellers, the Shuar have the most comprehensive knowledge of plants and their uses (Fig. 7). Their vast plant knowledge is for example reflected in the highest number of useful plant species (314) and the highest number of plant uses (489) recorded among the three ethnic groups.² The Shuar use most of the plants as medicine (106) and dietary supplement (100). Many plants are also used as construction materials (66). The high number in the category "fodder" (44) results from wild plant species eaten by game, as the Shuar consider such plants to be fodder. Most of the plants used by the Shuar are collected in the forest. 43.5% (213) of the uses recorded are of forest plants. Like other Amazonian ethnic groups (Cerón 1991, Moya 2000, Yépez et al. 2005), the Shuar base their livelihoods on subsistence slash and burn agriculture besides gathering, hunting and fishing. Thus, the forest is of great economic relevance to them and provides them with medicinal and edible plants, construction items and other materials that cover almost all their basic needs.

Unlike the Shuar, the Saraguros and Mestizos make very limited use of forest resources. Only about 7% of the plant uses recorded among the Saraguros and Mestizos are of forest plants (Fig. 7). As agro-pastoralists they have converted most of the primary forest into pastures, fields and home gardens, leaving forest remains only along mountain ridges or in river ravines. The forest basically supplies the Saraguros and Mestizos with timber for their own use or to sell occasionally outside the community. However, the Saraguros and Mestizos have considerable knowledge of cultivated plants, mainly used for food and medicine (Fig. 7). They also have profound knowledge of fodder species and plant species typical for living fences. Corn and bean provision is guaranteed by small crop fields (*chacras*) in ecologically favourable locations. Fruits, vegetables, spices, medicinal and ornamental plants are cultivated in home gardens (*huertas*), which constitute regional reservoirs of agrobiodiversity. For the Mestizos, the ornamental use of plants is significant (66). Ornamental plants are cultivated for the decoration of houses, gardens and chapels. Some are even sold outside the community like Azucena blanca (*Lilium candidum*).

Previous agrogeographical investigations of home gardens (*huertas*) of the Shuar and Saraguros (Pohle & Gerique 2008) have clearly shown their relevance as places of great agrobiodiversity and refuges of genetic resources. Furthermore, they contribute significantly to securing and diversifying food supplies. Within the home gardens studied, the majority of plants are of nu-

² Differences in data compared to previous publications reflect the collection of new data and a different categorization of plant uses.

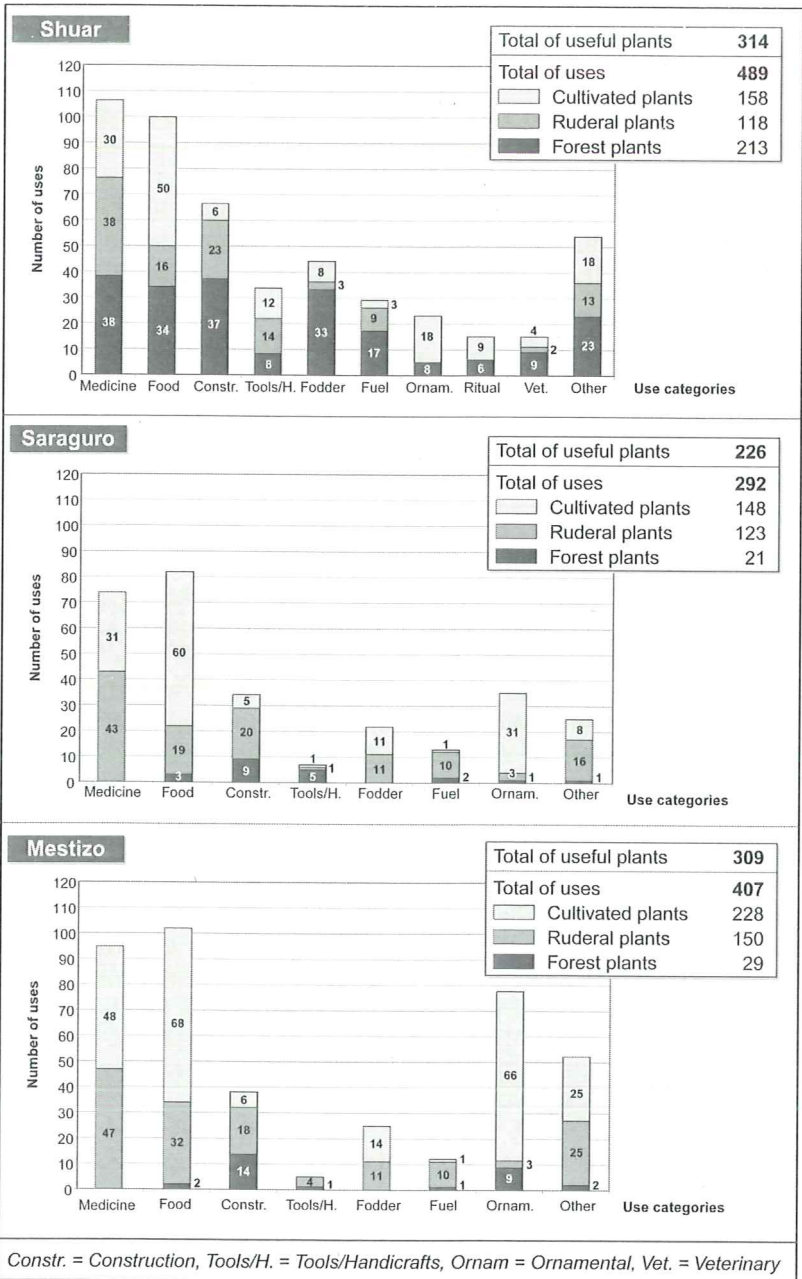


Fig. 7. Useful plants of the Shuar (Shaime, Chumpias, Napints), the Saraguros (El Tibio, El Cristal) and the Mestizos (Los Guabos, Sabanilla). Note: one plant species can be found in more than one use category. Ethnobotanical survey by A. Gerique.

tritional value, followed by medicinal and ornamental plants. The most important cultivated products are plantains, tubers and various types of vegetables and fruit. Given their relatively dense and tall stands of trees, the multi-tiered arrangement of plants, and the great diversity of species, the gardens of the three ethnic groups can be seen as an optimal form of exploitation in the region of tropical rainforests.

As the ethnobotanical and agrogeographical surveys indicate, there is a potential for the production of plant species in demand in home gardens. Two options which may improve local livelihoods and decrease the pressure on forests should be considered:

- the sustainable commercialization of non-timber forest products (NTFPs), and
- the sustainable production of plant species and plant products of a high demand in regional markets³.

Since the use of NTFPs for income generation is in contest, due to the risks of destructive harvesting practices and because of the low densities of many NTFP species in natural forests (Cunningham 2001, Van Deijk 1999), special attention was paid to NTFPs that could be domesticated or produced in a sustainable way, e.g. in home gardens. Based on the ethnobotanical research, an inventory of NTFPs and horticulture products that grow in the region under study and that could be of commercial interest was elaborated. The inventory includes wild species like *Fuchsia canescens* (edible fruits), *Trianea* sp. (edible fruits), *Solanum caripense* (edible fruits), and a number of Bromeliaceae and Orchidaceae (ornamental plants) that are being used by the local people and that could be considered for domestication. Other species (e.g. *Tibouchina oroensis*, ornamental) are not being used but could be considered for domestication as well. Table 1 shows further plant species that might be of potential interest and that are being cultivated in the region. Since the Mestizos of Los Guabos and the Saraguros of El Tibio already have experience in market oriented gardening – some of them sell ornamental plants (e.g. *Lilium candidum*, *Zantedeschia aethiopica*) or ingredients for the famous Horchata tea in the markets of Loja – the cultivation of plant species in demand in regional markets could generate additional income opportunities without requiring high investments.

³ A market analysis of NTFPs, horticulture products, and products derived from cattle ranching was conducted from March – June 2009 in the market places of Loja. Analysis of data takes place at the moment.

Table 1. Potential plant species for market-oriented production in home gardens.

Family	Species	Use (plant parts used)
AMARANTHACEAE	<i>Alternanthera porrigens</i>	Medicine, tea (leaves)
BUDDLEJACEAE	<i>Buddleja americana</i>	Medicine (leaves)
CANNACEAE	<i>Canna indica</i>	Food (leaves, tubers)
JUGLANDACEAE	<i>Juglans neotropica</i>	Food (seeds), medicine (leaves)
MIMOSACEAE	<i>Inga</i> spp.	Food (fruits)
MUSACEAE	<i>Musa</i> spp.	Food (fruits)
PASSIFLORACEAE	<i>Passiflora</i> spp.	Food, juices (fruits)
PIPERACEAE	<i>Piper aduncum</i>	Teas (leaves)
ROSACEAE	<i>Fragaria</i> spp.	Food (fruits)
ROSACEAE	<i>Rubus</i> spp.	Food (fruits)
SAPOTACEAE	<i>Pouteria lucuma</i>	Food (fruits)
SOLANACEAE	<i>Physalis</i> cf. <i>Peruviana</i>	Food (fruits)
SOLANACEAE	<i>Trianea</i> sp.	Food (fruits)

4 Local people's perception and evaluation of the natural environment, environmental stress/risk factors and conservation measures

Although the Shuar have not yet been integrated into the perception survey, from the literature (e.g. Münzel 1977, 1987) it is evident that the Shuar as traditional forest dwellers have a special relationship to the forest. The Shuar not only make a livelihood from the forest (cf. chapter 5), but the forest has a deep cultural and spiritual meaning for them and provides them with their cultural identity. The Shuar have an expert's feel for the forest, being well acquainted with the biological diversity of their circumscribed living space; they can distinguish between an astonishingly large number of plant and animal species, and possess what, from a Western point of view, is an extensive knowledge of the ecosystem. Their detailed knowledge of plants, for instance, is reflected in a precise plant terminology in the Shuar language (Van den Eynden et al. 2004). But the Shuar not only know a large number of forest plants, they also know how to use them (chapter 3) - until now in a sustainable way (Pohle & Gerique 2008). While the Shuar's forest management at present low population levels can be evaluated as preserving plant biodiversity, the sustainability of the Saraguros' and Mestizos' use of the environment has yet to be rated. Market-oriented cattle raising in particular has led to the rapid increase of pastures at the expense of forest in recent decades.

To find out how Saraguros and Mestizos 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. 8 & 9). They were then asked: *Where would you prefer*

to live? The Saraguro and Mestizo farmers both clearly prefer to live in areas with forests. “I will not stay in an area that looks like a desert”, was the comment of one farmer. The Saraguro and Mestizo farmers highly value economic functions of the forests: forests are agricultural reserves (potential land for grass), forests can be inherited by the children, forests are good to provide work, forests are a safety net, forests provide people with construction wood, fuel, and to a limited extent with food and medicinal plants – were the forest benefits mentioned by the interviewees. Further to the economical functions of the forests, 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. 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 the men actively engaged in agro-pastoralism, in all interviews pointed out the benefits from the forests, some women and old people preferred the open landscape. Among young women forests were even perceived as fearful and dangerous places.



Fig. 8. Photo comparison to evaluate farmers’ perception of two cultural landscapes, one totally deforested and one still with forests (Figures 8 & 9). Photo by P. Pohle.



Fig. 9. Photo comparison to evaluate farmers' perception of two cultural landscapes, one totally deforested and one still with forests (Figures 8 & 9). Photo by P. Pohle.

When people were asked about their estimation of whether forest land is increasing or decreasing, astonishingly almost all interviewees of Los Guabos answered: "it remains the same". In contradiction to this incorrect perception, half of them 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: in 1982 the Podocarpus National Park was declared, in 2002 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 (cf. chapter 6).

Although forests are highly valued economically by the local Saraguro and Mestizo 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 El Tibio (Saraguro) and Los Guabos (Mestizo) 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 (chapter 5).

5 Analysis of livelihood strategies of small-scale farming households

Livelihood strategies of local communities still depend largely on natural resources which show clear signs of over-use in the area (Fig. 8). Some of the key questions are:

- Which livelihood strategies are typical for the different ethnic groups?
- To what extent do households' livelihood strategies depend on natural resources?
- How does use and over-use of natural resources correspond with economic welfare or poverty (measured in terms of monetary income and dependency on social transfer by the state) of households and communities?

The Shuar are traditionally engaged in a number of livelihood activities that typically include fishing, hunting, gathering of wild plants and animal products, keeping domesticated animals, and cultivating forest gardens with starchy roots, tubers and plantains (Fig. 3). Their traditional livelihood system was based to a large extent on subsistence activities that enabled them to live almost autonomously and made little or no use of market integration. Until today, some Shuar try to conserve this traditional way of life. However, it cannot be ignored, that in recent times a number of Shuar households is increasingly involved in markets. The selling of timber, fruits and vegetables (sometimes to intermediary vendors), cattle raising and the production of handicrafts provide Shuar with monetary income. Employment can still be considered as an exception, but is sometimes the case for those Shuar working for governmental institutions or within Shuar political organizations. Despite this partial market integration, until today, the Shuar's livelihood system still depends to a large extent on natural resources.

The Saraguros and Mestizos, in contrast to the Shuar, have long been involved in the market system. They are engaged in agro-pastoral activities that combine market economy (cattle ranching) and subsistence economy (crop production and horticulture). 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 products drawn from cattle raising are neither meat nor milk, but cheese, which is called *quesillo* or *cuajada* by Ecuadorians. It is a white fresh unsalted cheese that is produced by adding lab-ferment to fresh milk and separating the precipitating proteins from the whey. Production usually takes place in the pastures, since cheese is easier to transport and less perishable than fresh milk.

Data from the livelihood analysis show that the sale of mainly agricultural products is one of the most important sources of income for households in the studied Saraguro and Mestizo communities: an average of 52.4% of the total income is obtained from sales (Tab. 2). Among the agricultural products sold, cheese plays an especially important role. In those households selling cheese, an average of 30.9% of the total household income in 2007 was derived

from cheese vending. Of 47 households 11 stated to have obtained even more than half of last year's income from cheese. Households not able or willing to maintain their livelihood by selling agricultural products depend to a great degree on payments for informal work (day labour). On average, 52.3% of the households' income is generated from irregular work in the form of day labour. Formal employment, in contrast, plays an inferior role in the livelihood systems of the communities studied. Only two out of 47 households interviewed receive regular income from formal employment. Illegal logging seems to be of importance as well, although data are difficult to obtain from household interviews. Migration has gained importance during the past decades and must be considered as another livelihood strategy (Pohle 2008). It is directed either towards the towns of Ecuador, mainly the city of Loja and the capital Quito, or is directed abroad, to foreign countries like the U.S.A. and Spain. Out-migration is more frequently practised among the Mestizos.

Table 2. Average household incomes for selected income categories in 2007 in the communities of Los Guabos and El Tibio.

	All households (N = 47)		Households that received income from this category		
	Average income 2007 [US \$]	Average percentage of total income [%]	N	Average income 2007 [US \$]	Average percentage of total income [%]
Total income	4773	—	47	—	—
Income from paid work	1875	37.3	28	3039	60.5
Income from irregular work	765	27.8	25	1438	52.3
Income from sale ¹	1842	37.4	35	2578	52.4
Income from sale of cheese	377	15.1	23	770	30.9
Income from transfers ²	938	22.7	36	1277	30.9

¹ E.g. sale of field and housegarden crops, cattle and products derived from cattle ranching, timber and other forest products, commodities, land etc.

² Transfers by the state (= social aid, "*Bono de pobreza*") and remittances from emigrated family or community members.

Household types are heterogeneous in the Saraguro and Mestizo communities studied and vary by, for example, household size, age and composition, owned land and cattle, as well as income structure in general. Since data were only obtained recently, the statistical investigation is still under way. Informal conversations during field work indicate that there is quite a number of landless 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 (Tab. 2).

It was difficult to empirically substantiate this finding, since only a minority of the inhabitants of the study area hold official land titles, and questions directed towards land ownership are delicate, especially if asked as part of a questionnaire, as was done for the livelihood analysis. Concerning the question of which household type participates most in the deforestation process, these yet to be quantified 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. also Wunder 1996).

6 Determination of the political and administrative use agreements including land tenure systems

In the research area numerous land use conflicts exist, such as forest conservation versus forest exploitation and pasture extension. Knowledge of actual and historical land tenure systems gives insight into land use and land right conflicts and shows the explosive nature of the land issues in times of rapid economic, social and cultural change. To understand the mechanisms of deforestation and forest degradation, knowledge of land tenure and access rights to both land and resources and the associated regulations are an essential precondition (Ostrom & Schlager 1996, Wunder 1996, Cunningham 2001).

Land tenure conflicts are based on irregular and unequal land tenancy, which is the result of historical and political developments. The Spanish conquerors established the foremost restrictions to land access to indigenous people and introduced "formal" or "legal" property rights, based on written law. A first element for conflictive land tenure, especially in the Andes (Sierra), was the asymmetric distribution of land between big landowners and indigenous people who were kept in a state of dependency (Barsky 1984, Pohle 2008). A second element was the disparity between traditional customary (ancestral) community based land tenure and legal land property rights (Viteri 2007). Starting in the 1950s up to the 1970s, land redistribution and colonization policies introduced through modern laws of colonization and agrarian reform resulted in numerous tenure conflicts dealing with expropriation of used land and adjudication of colonized areas. Both land redistribution and colonization policies promoted intensive processes of agricultural frontier expansion and therefore, deforestation (Brown et al. 1992, Sierra 1996), which affected especially the Andean foothills and the lowlands of the Pacific coast and the Amazon area. In the past two decades, the modern policy of environmen-

tal conservation and the establishment of a system of protected areas added further constraints to land regulation processes.

North of Podocarpus National Park current land use and land tenure conflicts are founded primarily on the colonization processes starting in the 1950s, and are severely dependent on state policies on land adjudication, increase of accessibility, and national or international concern for nature conservation and environmental protection (Fig. 10). Furthermore, local city governments (Loja, Zamora) have strong interest in watershed management and water supply, adding a new element to land tenure conflicts. The conflicts over land tenure (as an effect of the land occupation processes described above), resulted in unsustainable land use forms. Both timber extraction and pasture expansion at the beginning of the colonization process in the past century were basic requirements to prove possession of land in order to get property titles from the state (Barsky 1984). Although these requirements were eliminated in the law of Agrarian Development (1994), they were the agents for deforestation and the clearing up of most of the forest cover of the entire Amazonian region, including the eastern Andean slopes (Barsky et al. 1982, Gerold & Lanfer 2001).

One consequence of the varying land tenure regimes in the region is the insecurity of access to land and resources. Data of the agrarian census of 2001 report less than 30% of farms having property titles in the province of Zamora Chinchipe, the lowest proportion at the provincial level in Ecuador (INEC 2002). Field information gathered in 2008 through semi-structured interviews showed that informal buy-sell contracts of possessor rights (*compra de derechos posesorios*) have been a widely accepted form of land market transactions. These contracts have neither been inscribed in the office of property registration nor been registered in the cadastre.

Population pressure, land scarcity and resource use restrictions in conservation zones have recently increased the interest of farmers in entitlement of their land. Currently, interest in regularization of land property is severely influenced by three factors:

1. As a strategy for "reactivating the economy and alleviating poverty" the improvement of land tenancy security and the enhancement of the dynamism of rural property markets were the main issues for the neo-liberal politics in the 1990s (Francescutti 2000: 1).
2. Nowadays, several forms of social aid introduced by the current government (e.g. bonus for housing, formal leasing from the National Development Bank) demand land titles in order to qualify for them.
3. With the declaration of protective areas within the National System of Protected Areas (SNAP) formal limitations for frontier expansion and timber extraction were introduced and therefore, clear limits of property and borders of conservation areas demanded in order to assure conservation practices.

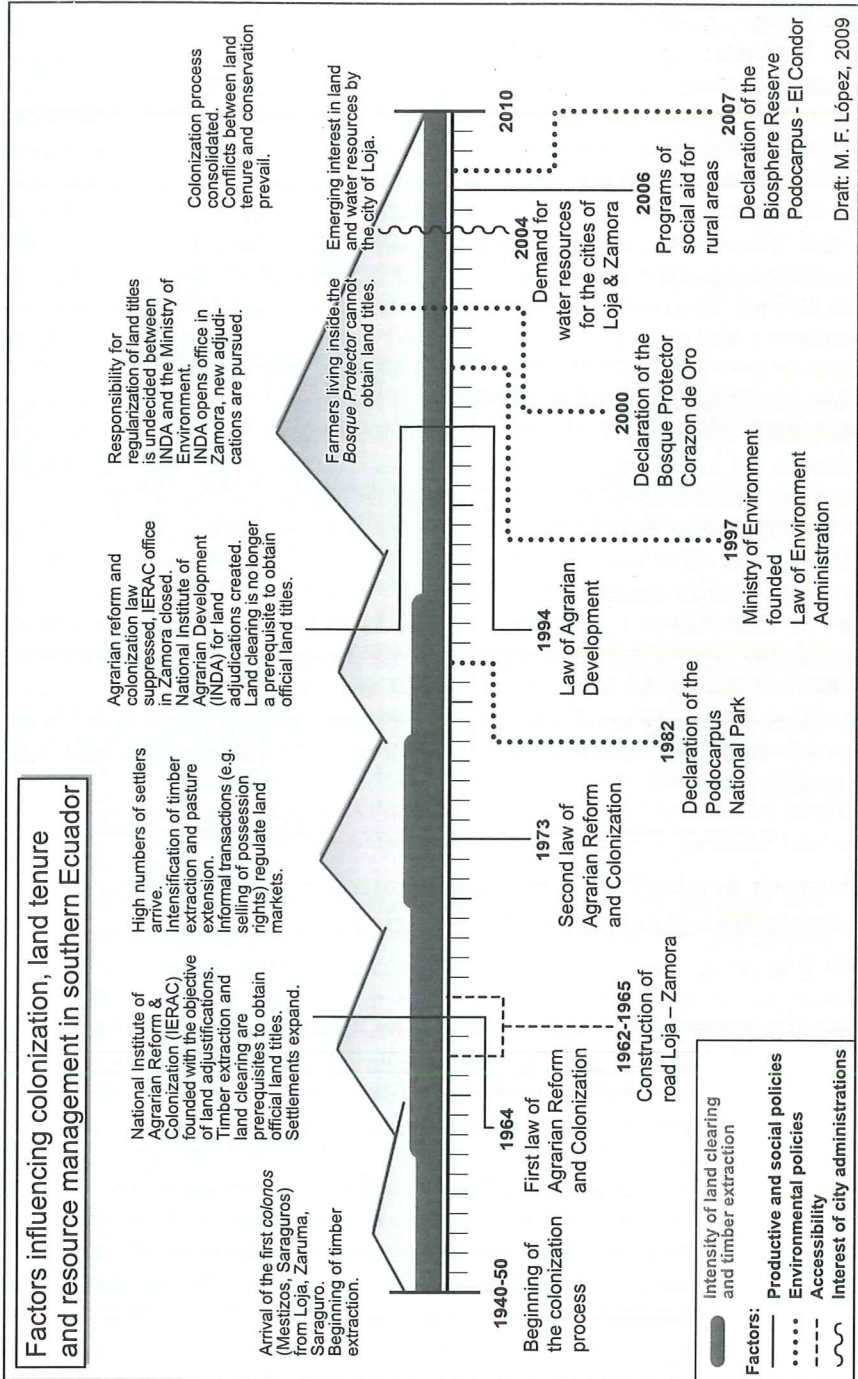


Fig. 10. Factors influencing colonization, land tenure and resource management in southern Ecuador.

Around 14 conservation areas including protective forests exist within the Biosphere Reserve Podocarpus – El C ndor (NCI-MAE 2006). People who have settled the region for more than 50 years and live inside these areas or in the buffer zones either do not know about it or do not have enough information about its implications for land entitlement or legal access to forest and water resources. In the research area a special conflict exists between the local people and the Bosque Protector Coraz n de Oro. At the time of declaration in 2000, the Bosque Protector encompassed more than 15 settlements; 30% of the area was already converted into pastures and another 30% of the forest cover was interspersed with pastures (CINFA 2006). Since the establishment of the Bosque Protector, tenure of land which has been in use for decades (sometimes a half century) cannot be passed to the next generation and farmers cannot get legal land titles for formal leasing. This is due to jurisdiction problems for land entitlement between the National Institution of Agrarian Development (INDA) and the Ministry of Environment. While the latter is responsible for entitlement in protected areas and national forest patrimony, entitlement in rural areas not being under any category of conservation, is in legal jurisdiction of INDA. In both cases procedures are complicated, time-consuming and expensive (Burbano 2008). Semi-structured interviews on the local perception of conservation measures carried out in the villages of El Tibio and Los Guabos in 2008 and 2009 by M.F. Lopez and P. Pohle showed a remarkable lack of information and participation that led to uncertainty and distrust among the local people. These unsolved problems have resulted in people in the study area being highly sceptical towards conservation measures: for them, conservation means restrictions for resource use and land entitlement.

7 Human ecological dimensions under global change: conservation strategies of biological and cultural diversity

Despite the remoteness of many communities living in the tropical rainforests of Ecuador, the local population has never been completely isolated from global processes of ecological, political, cultural and economic change. As an example of external influence in earlier centuries, the cultural transformation in the fields of religion or language by the Spaniards can be mentioned. In more recent times the global improvement in medical care has resulted in an increase in population. In the past few years, people in even distant villages have been connected to roadways and have become integrated in global information and communication systems via telephone, radio and the internet. Currently, the following effects of globalization are of special relevance in the rural areas of southern Ecuador:

1. The confrontation of traditional, non-industrial societies with the western concept of nature conservation and global protection of biodiversity and climate (Pohle 2004, Sælemyr 2004, Pohle & Gerique 2006).
2. The exploitation of minerals by international companies (Confeniae 2007, Mining Watch Canada 2007).
3. The integration of local people into the worldwide labour market by economically induced out-migration (Caritas Española et al. 2004, Pohle 2008: 34f.).
4. The vulnerability of local populations to the fluctuations of the world economy, e.g. in the field of labour migration and tourism (Süddeutsche Zeitung 2008).

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 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 Cónдор. 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. A 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.

The Shuar’s traditionally practiced plant biodiversity management, which has been described as clearly sustainable at present low population levels (Pohle & Gerique 2008), will only be preserved by the following preconditions: the complete legalization of their territorial claims, a comprehensive protection of their territories and support for the Shuar’s traditional way of life and cultural identity. To improve livelihood in an economic sense, additional sources of financial income are essential. In line with this, promotion of ecotourism, support of traditional handicrafts, and the cultivation of useful plants for a regional market are potential options requiring discussion.

For the Saraguro and Mestizo households alternative incomes should be found since cattle ranching poses the main threat to the forests in southern Ecuador. 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 private 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 for a regional market could be discussed. In this respect the cultivation of medicinal herbs, fruits, vegetables and ornamental flowers in home gardens may be considered. Another option could be the use of non-timber forest products like the production of honey, teas, liquors and preserves (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 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.

The chaotic land property rights regime in southern Ecuador represents a further chance, if sustainable activities in exchange for land property rights contracts could be arranged. Local inhabitants would get legal land titles only after a partial renunciation of cattle raising. These measures could be accompanied by technical assistance, capital input to establish alternative production systems and monitoring. Finally, a system of payments for preserved forests that works as a private pension insurance fund is conceivable; land owners would get payments for preserving and enlarging their forest land only after retirement. Pension payments would be in accordance with the total number of years of forest possession, thus allowing the purchase and sale of land and making forest possession and its preservation attractive. Assurances to cover forest fires and similar disasters could complete the system. After a series of financial crisis and bankruptcies the Ecuadorian State as well as the traditional banking sector count with little credibility among Ecuadorians. Thus, all these activities would be managed by recognized social investing institutions (e.g. Oikocredit); their small loan programmes could help to start the implementation of these innovations.

And what could the carbon markets do? To date, afforestation and reforestation project activities under the Clean Development Mechanism (CDM) of the Kyoto Protocol have shown very limited potential. As of October 2008, only one afforestation project had been registered in the CDM executive board worldwide (SAF 2008, Settelmayr & Schlamadinger 2008). Nevertheless, a more promising possibility could be the voluntary carbon market (Gillenwater et al. 2007: 87, Speckman 2008: 8). Moreover, the expected post-Kyoto agreement will in all probability include REDD (Reducing emissions from de-

forestation and degradation) projects that could provide the seed money for such initiatives (Hamilton et al. 2008: 61, Speckman 2008).

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