COMMUNITY CLASSIFICATION AS A BASE FOR THE UNDERSTANDING OF DYNAMICS OF THE LAND COVER IN THE PROTECTED FOREST SUMACO

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Abstract

A series of publications make references to the problems about in the management of the Protected Forests in Ecuador. Nevertheless, the literature totally limits itself to a general description of the situation without considering neither the real problems of the local population in these areas nor the state of conservation in the natural resources. It is necessary to mention, that National Parks and other Protected Areas becomes synonymous with "Paper Parks and Protected Areas" in many developing countries after it was noted that conservation measures did not produce any visible impacts on the forest. More importantly, for effective and efficient conservation of a Protected Forest system, both realistic description on the local community's behavior and regional land use dynamics need to be taken into account. Furthermore, formulating of police requires better knowledge of what the community actually do. The study below responds to this need by providing some descriptive insight into the land use patterns of the communities in the Protected Forest Sumaco. In order to incorporate the spatial information into analysis, topographic maps and tenancy map were digitalized into Geography Information System (GIS) to use as input layers. Then these maps and temporal satellite images from 1995, and 1997 were used in GIS analysis to get a deep insight into the temporal and spatial variations in the land use dynamics of the areas. In additional, Participative Rural Appraisal (PRA) methodology was employed with a sampling intensity of 38%, which collected socioeconomics information of local communities and biophysical conditions of the local resources bases. Cluster Analysis was conduced with a view to aggregate the local communities, and Discriminate Analysis was also performed to identify the factors affecting the grouping of the communities of Protected Forest Sumaco. Three groups of communities with different effects on the forest cover and patterns of agricultural production systems were identified. Thus, laws and policies which are not responsive to the poor and not reflective to realities, as pointed out in this study, will usually discriminate against the poor people.

1. Introduction

The Ministry of the Environment of Ecuador have established a large areas of the protected areas systems around the country with a view to protect existing natural resources, which justify the public, scientific, tourist interests or conservation of the biodiversity (M. A., 1999). A surface delimited by a forest law or another legal disposition dictated by the Executive Function is defined as the Protected Forest. In accordance with law, certain developmental activities can be carried within the Protected Forests. Even though a substantial area of the protected areas were established, they have been quite often declared without the people' knowledge and without considering the subsequent management costs. Therefore, most of protected areas are created with a deficit of genuineness and a social debt (WHITE and MALDONADO, 1991; PERREAULT, 1996; WUNDER, 1996; BUSTAMANTE and VIDAL, 1999; WUNDER and SAYER, 2000; CAÑADAS and NENADIĆ, 2003a; CAÑADAS and NENADIĆ, 2003b). Further more, in formulation for such areas the dynamic nature of the land use has been hardly ever taken into account. Lack of an effective institutional coherence and ignorance of land use dynamic lead to instability in land use pattern. Because "A dynamic and growing society cannot be expected to live with a static land use pattern" (LAARMAN, 1997). In March 1987 a strong earthquake partially destroyed the road from *Quito* to *Lago Agrio* and interrupted the transportation between *Quito* and the main oil sediments of the region (A. and H., 1993). An alternative access road way Hollín-Loreto-Coca was constructed through the forested areas with the grant of *USAID* on condition that a certain area had to be declared as a Protected Forest land. The *National Forestry Directory* (*DINAF*) need to coordinate two responsible organizations the *Instituto Ecuatoriano de Reforma Agraria y Colonizacion* (*IERAC*) and the *Federación de Organizaciones Indígenas del Napo* (*FOIN*) for designating the protected area. However, the relationship between *IERAC* and

FOIN deteriorated and *FOIN* decided to allocate the land to its people, using the necessary "self-restraint". Compounding the problem was the fact that the *National Forestry Directory* (*DINAF*) had already designated the forest land through which the new road was cut as protected forest (*Protected Forest Sumaco*) in compliance with the *USAID* requirement 59,146 hectares were originally demarcated in 1987. The Protected Forest was soon enlarged to cover 100,045 hectares. Much of this land was claimed by indigenous communities, who strongly opposed the establishment of the forest reserves, and who saw it as yet another attempt by the state to alienate them from their lands (MACDONAL, 1999).

A monitoring of actual situation in protected areas is still insufficient in Canton Loreto. The aim of the present study is to explore the fundamental characters of interactions between nature and the local communities of the Protected Forest Sumaco in the Canton Loreto.

2. Material and Methods

2.1 Data acquisition and information matrix Generation

Land use maps developed by Ecociencia (1998) based on LANDSAT image of the Centro de Levantamiento Integrado de los Recursos Naturales por Sensores Remotos (CLIRSEN) dated October 1995 and September 1997 were acquired and integrated into the Geographical Information System ARC/VIEW. A land tenure map scale 1:100,000 (INDA, 1995) and the topographic maps of the Instituto Geográfico Militar (IGM, 1999) scale 1:50,000 were digitalized through the program ARC/INFO and incorporated into ARC/View for land tenure assessment and landscape analysis. Within the program ARC/VIEW, the digital elevation model was developed and the slopes classes were classified. Then the influence zones from the ways and rivers were also identified. The zone of the influence of roads and rivers were 3 km and 500 m respectively for either side. Such information relating to land tenure as number of hectares, number of Socios (partners), organization (indigenous other colonos, people who come from out side of the Amazonian region), title and proceeding of land tenure were collected from the records of the INDA in Tena.

Table 1. Factors to characterize each community in the Protected Forest Sumaco, Canton Loreto.

Factors	Unit	Maps and Information	Source
Sloping Land	%	Topographic Map (1:50,000)	IGM
Flat Land	%	Topographic Map (1:50,000)	IGM
Influence of Rivers	%	Topographic Map (1:50,000)	IGM
Secondary Forest	%	Satellite Image/GIS, 1995, 1997	ECOCIENCIA
Coffee Plantation	%	Satellite Image/GIS, 1995, 1997	ECOCIENCIA
Meadows	%	Satellite Image/GIS, 1995, 1997	ECOCIENCIA
Fruit Plantation	%	Satellite Image/GIS, 1995, 1997	ECOCIENCIA
Deforestation	Rate	Satellite Image/GIS, 1995, 1997	ECOCIENCIA
Number of Hectare	ha	Map of land tenure (1:100,000)	INDA
Land Title	%	Information	INDA
Title in Proceeding	%	Information	INDA
Influence of Roads	%	Topographic Map (1:50,000)	IGM
Families	#	Map of land tenure (1:100,000)	INDA
Origin of the Community	0 = Indigenous, 1 = Colonos	Information	INDA
Incomes High	0 = No, 1 = Yes	Made Surveys	Own
Incomes Middle	0 = No, 1 = Yes	Made Surveys	Own
Incomes Low	0 = No, 1 = Yes	Made Surveys	Own

The Rural Rapid Appraisal (RRA) and the Participatory Rural Appraisal (PRA) methodologies were applied to collect socio-economics information (CHAMBERS and GUIJT, 1995). The

survey was conducted with the sampling intensity of 38%. Afterwards, factors used for the classification of the communities in the Protected Forest were specified and presented in Table 1.

2.2 The characterization of the communities of the Protected Forest Sumaco

The distance between each pair of observations (i.e. communities) was measured using the Gower Method. This method enables to deal with deferent types of variables, standardizing them according to its rank (BORTZ, 1993). Based on the resulted distance matrix, the cluster analysis was done. The Ward's minimum variance and pseudo t^2 was applied in order to determinate the suitable number of clusters in the analysis. The Canonical Discriminate Analysis was then performed for determining caused variables of grouping. The Wilk's Lambda test was utilized to test the significance of the clusters defined. Means of different factors were also compared between Conglomerates: One–Way ANOVA was used for a quantitative ones whereas the contingent analysis for qualitative ones. Tukey's test was also carried out to rank the quantitative factors among Conglomerates.

3. Results

3.1 Cluster analysis

The test of pseudo t^2 suggested to conform three conglomerates or clusters. Table 2 is the distance matrix of the conglomerates generated.

Table 2. Matrix of distance generalized to square D^2 (i/j) between pairs of conglomerates Protected Forest Sumaco, Canton Loreto.

Conglomerate	1	2	3
1	0.00		
2	209.07	0.00	
3	424.11	265.82	0.00

The multivariate test of the Wilk's Lambda showed a high difference between groups ($P < 0.001$). The first group was conformed to 10 communities (55.5%), the second group with 5 communities (27.7%) and the third group with a 3 communities (16.8%), respectively.

Table 3. Canonical correlation, structure loading for the different factors. Protected Forest Sumaco, Canton Loreto.

Canonical Variables	**CAN 1**	**CAN 2**
Canonical Correlation	0.99	0.98
Eigenvalue	54.45	37.36
Explanation of Variability	59.31	40.70
Factors		
Organization	-0.69	
Influence of Rivers	0.69	
Sloping Land	-0.59	
Flat Land	0.59	
High income		0.80
Influence of Roads		0.77
Coffee plantation		-0.64
Meadows		0.52
Low income		-0.51
Land title		0.50
Middle income		-0.46
Deforestation		0.38
Fruit Plantation		0.26
Secondary Forest		-0.13

The extracted canonical variables scores can be used to plot pairs of canonical variables in a two-dimensional bi-plot to aid visual interpretation of group's differences. The canonical structure and loadings for the two canonical variables are presented in Table 3. The first canonical function accounts for 59.3% of the variance in the matrix and is related with a group of factors: the organization, influence of rivers, slopes and flat topography (Table 3). The interrelationship among the multi-variables and the discriminations of the three groups are presented in Figure 1.

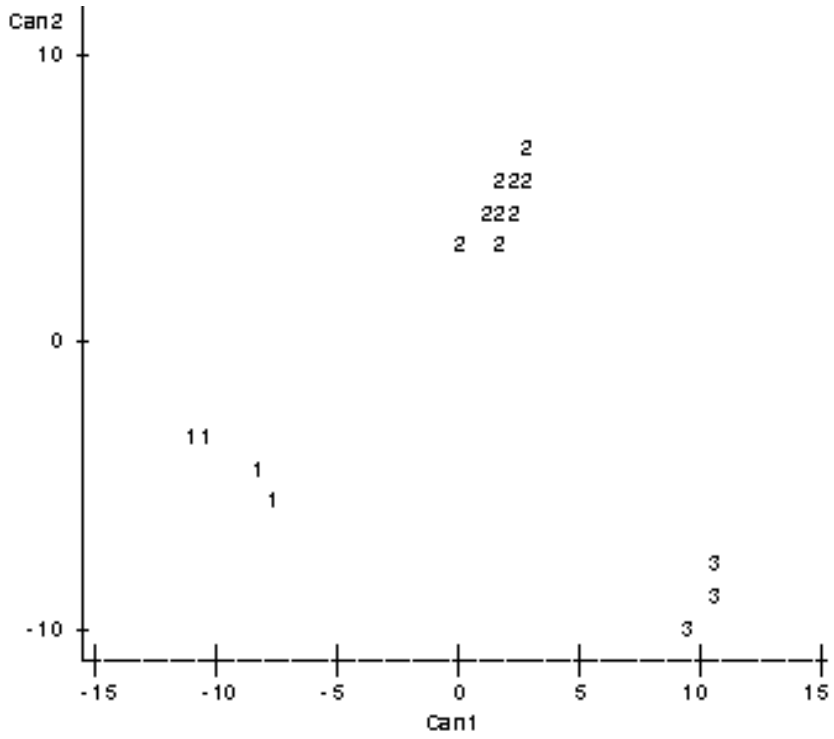

Figure 1. Scatter plot of the different conglomerates of communities in the Protected Forest Sumaco on two discriminate axes. Can 1 = Canonical function 1, Can 2 = Canonical function 2.

Organization and sloping land present an inverse relation with other factors. The second canonical function accounts for the next 40.7% of variance, relating to the factors in sequence of weight: high income, influence of roads, coffee plantation, meadows, low income, land title, middle income, deforestation, fruit plantation and secondary forest. With the exception of coffee plantation, low income, middle income and secondary forest, the other factors show a direct relation between them (Table 3). On the one hand, the graphical representation reveals, why it is possible to discriminate groups of the located to the right, while Conglomerate 1 remains in the left. On the other hand, Conglomerate 1 and 2 tend to be located upwards, in to the opposite position of the Conglomerate 3 (Figure 1).

The mean of factors for concerning Conglomerates, the significant value p of the ANOVA and the ranks of significance of the Tukey's Test are mentioned in the Table 4. A high statistical significance among Conglomerates was found for rivers buffer, slope and flat topography, coffee plantation and meadows.

The contingent analysis between three Conglomerates and the interaction between factors is presented in Table 5. There was no significant difference between the origins of the communities and there was a high statistical significance between income and conglomerates.

Table 4 Mean of factors for concerning Conglomerates, the significant value p of the ANOVA and the rank of significance of the Tukey's Test between Conglomerates in the Protected Forest Sumaco, Canton Loreto. (= P< 0.05, ** = P< 0.01, *** = P< 0.001, ns = no significant. Tukey's Test, a = first range of significance, b = second range of significance).*

Variable	Unity	Conglomerates			P
		1	2	3	
Influence of Rivers	%	8.80^{b}	16.73^{b}	39.24^{a}	0.0006***
Sloping Land	%	24.07^{a}	8.35^{b}	10.77^{b}	0.0078**
Flat Land	%	75.93^{b}	91.65^{a}	89.23^{a}	0.0078**
Influence of Roads	%	11.78^{b}	69.10^{a}	10.34^{b}	0.0006***
Coffee plantation	%	5.01^{b}	1.91^{b}	23.51^{a}	0.0028**
Meadows	%	1.40^{b}	21.52^{a}	9.83^{a}	0.01**
Land Title	%	0.00^{a}	24.58^{a}	0.67^{a}	0.094**
Deforestation	Rate	-0.08	-0.30	-0.19	0.27^{ns}
Fruit Plantation	%	0.28	21.66	9.83	0.44^{ns}
Secondary Forest	%	24.15	22.51	27,42	0.86^{ns}

Table 5. Contingent analysis between Conglomerates for the variables: groups, organizations and income in the Protected Forest Sumaco, Canton Loreto (= P< 0.05, ** = P< 0.01, *** = P< 0.001, ns = no significant).*

Factors	Conglomerates	Organization	High	Middle	Low
Organization	0.51^{ns}				
High	0.33^{ns}	0.15^{ns}			
Middle	0.74^{ns}	0.53^{ns}	0.0174^{*}		
Low	0.28^{ns}	0.27^{ns}	0.0045^{**}	0.310^{ns}	

3.2 Classification of the communities of the Protected Forest Sumaco

3.2.1 Conglomerate 1

The Conglomerate 1 consists of the following communities: Asociación Ávila, Santa Rosa de Arapino, Zona no Delimitada, Alto Chacayacu and Aso. Río Huacamayos. The deforestation rate within this group of communities is low. The small-scale coffee production and cattle ranching characterize the communities and hence the income level is low. The origin of the people is 100% indigenous. None of the communities has a land title. The influence of rivers and roads is very limited in these communities. The topography is characterized mostly by the sloping lands.

3.2.2 Conglomerate 2

The Communities of 10 de Agosto, Comunidad 24 de Mayo, Huataracu, Huaticocha, Manga Cocha, Manga Cocha, Aso. Luis Chongo, Centro Balino, El Triunfo río Suno, Asoc. 15 de Febrero, and Pasohurco belong to the Conglomerate 2. The communities associated with a higher rate of deforestation. They have a mixed production system; cattle ranching are more prominent than fruit plantation (naranjilla) and coffee production. The economic income is high. The anthropological constitution of this group is equal between indigenous and colonos. 35 % of the socios (partners) have a land title. This group is strongly influenced by the roads; the influence of river is not significant. This group has an extremely flat topography.

3.2.3 Conglomerate 3

Blacón Hermoso, Tormenta de la Selva and Mesetas del Huataracu comes into this Conglomerate. The rate deforestation in these communities is not severe. All communities belong to the colonos organization. Coffee production is more predominant than cattle ranching and fruit

production. This group has a middle income. Only 1% of the socios has an individual land title. This area is strongly influenced by the rivers, which has a direct relation to the coffee production and receives little influence by the roads. Mainly, its topography is flat, with little slope areas.

4. Discussion

The article 15 of the Protected Forest law prescribed the activities allowed inside the Protected Forest, prior permission of the National Forest Program the following activities can be conducted: a.- Establishment of fire break; b.- Control on disease outbreak; c.- Conservation of flora and fauna; d.- Execution of high-priority public works; e.- Implementation of the National Forest Program and f.- Organization of scientific, tourism and recreational activities (M. A., 1999). Nevertheless, the results obtained in this research show discrepancies between the Protected Forest law and real interests of the local people. More deforestation trends are expected due to the following factors:

4.1 Organization

Rudel (1993) mentions that in Ecuador the indigenous Shuar in contrast to migrants (colonos) usually clear only a smaller portion of their lands. This tendency can also be observed in a Conglomerate 1 (i.e. 100% Kichwa indigenous communities). Nonetheless; yet other factors, such as the year of settlement, population growth, road constructions, and land titling requirements, act as factors equalizing the two groups of land use patterns. This result suggests that there were a few differences between the indigenous and the colonos production system and probably exogenous impacts may change their traditional practices considerably in the indigenous communities. There can thus be no doubt that the indigenous or colonos prefer the open lands to the forest for many reasons (WUNDER, 1996). This study combined a realistic description of household behavior and the regional dynamics in the Protected Forest Sumaco.

4.2 Influence of rivers

In these areas, the best alluvial soil within river buffer can be found and the farmers concentrated on these lands for establishment of coffee plantations and hence enjoy good earnings (CAÑADAS, 1983). The same scenario was found by Jones *et al.,* (1995) in Rondonia, Brazil. Therefore, soil fertility is not a prime factor for deforestation in these communities.

4.3 Sloping and flat land

The results reveal that flatter lands have much higher chance of being deforested and that some areas with a gradient larger than 45% remain intact and they are in an excellent state of conservation. Findings of Cropper *et al*., (1997), Pfaff (1997), Deininger and Minten (1996), Krutilla *et al*., (1995), and Southgate *et al*., (1990) all support this situation.

4.4 Income

The evidences gained from this study describe the direct positive relation between income level and deforestation rate. It is not assure that whether the situation will follow the trend of the Environmental Kuznets Curve (EKC), describing the relationship between declining environmental (deforestation) quality and income as an inverted – U. The idea implies that the course of economic growth and development environmental quality initially worsens but ultimately improves with improvements on income levels. In this connection, empirical findings from a cross-country statistical study of Gangadharan and Valenzuela (2001) supports the U – Hypothesis, but -stresses that the turning point may occur only at extremely high income levels.

In contrast, a WWF comparative study of selected individual countries (Thailand, Mexico, Ivory Coast) concludes that the U – curve is not deterministic, nor is a turning – point guaranteed (REED, 1992). Therefore, the effective conservation of the Protected Forest Sumaco is still a big question in the light of income level of the communities.

4.5 Influence of roads

The most studies demonstrated that forest clearing rapidly declines beyond distance of two or three kilometers form a road in Belize (CHOMITZ and GRAY, 1995) in México (DEININGER and MINTEN, 1996) in Costa Rica (ROSERO–BIXBY and PALLONI, 1996). Thus, more deforestation can be expected in communities with the influence of the road network.

4.6 Agriculture

Three agricultural activities – coffee plantations, fruit plantations, and cattle ranching- can be recognized in these communities. Coffee plantations are established more on fertile alluvial lands whereas the other two activities are connected to forest clearing. Therefore, the group of communities with production systems based on cattle ranching and fruit production (i.e. Conglomerate 2) will have more the forest encroachments. The communities whose production system is less extensive agriculture (i.e. Conglomerate 1) may have less impact on forests. Likewise, the Conglomerate 3 formed by the communities having coffee plantation as a major production system, but complemented with cattle production and fruit plantations may exert a certain degree of pressure on forests. These conditions conforms to the conclusions made by (GODOY *et al.,* 1996; PICHÓN, 1997), mentioning that the presence of more cattle is associated with more forest clearing in Latin American context.

5. Conclusion

Policies and Laws formulated without the social and institutional coherence will seldom support the effective and efficient management and conservation of the forests. The policy stipulations and law prescriptions also need to reflect the changing circumstances and realities. The present study highlights the fact that inconsistent policy formulation would never embrace the stipulated goals. The study also points out needs to incorporate the local situations into policy formulation to win the active and genuine participation of local communities for the effective conservation activities. The laws that ignore the local realities will not support the smooth implementation of the policy objectives. The legal and administrative procedures such as land tenure system; land titling, properties right and tributary regime also have a strong repercussion and impact on the management of the resource. It is advisable that these procedures are necessary to improve for effective implementation of policy statements.

Acknowledgements

We are grateful to the German Technical Society (GTZ), especially to Ing. Hans Knoblauch, Ing. Wolfgang Lutz and Dr. Arthur Zimmerman and German Academic Exchange Service (DAAD) for financial support and logistic. We also highly appreciate Min Thant Zin from the Institute of Forest Management; Göttingen University for his support in improving manuscript.

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