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One of the most complex problems facing scholars is the interpretation of environmental change. Simplistic commentaries on rural situations such as those which ascribe soil erosion to poor farming practices and deforestation to individual and corporate rapacity without considering the broader context of farming and forestry are grossly inadequate. In this paper we seek to use field experience in a particular area in the Ecuadorean Andes over a twenty-year period to identify a series of changes in the physical environment which provides livelihoods for much of the rural population. Our analysis of these changes and the associated human responses will demonstrate the importance of broad national and regional social and economic changes as well as local situations in understanding why these changes have taken place.

Theoretical positions

Farm households take rational decisions, based on accumulated knowledge of their specific local environment, that are designed to sustain the household under a wide range of environmental situations. The variability of weather and the unpredictability of the effect of pests, for instance, make risk minimisation part of a logical goal for farmers. Members of farm households may dispose of their labour in various ways, and often in more than one place. They may work farming their own land, working for others on their land or work away from home in a city or a coastal plantation. They make use of those times when little work is needed on their own land but when labour is needed in another ecological area, whether it be urban or rural. Conceptualising this degree of individual mobility is complex but a useful framework in which both time and space use by human populations is elegantly presented by Carlstein (Carlstein 1982).

He collects a variety of information about the use of both space and time in a wide range of pre-industrial societies and highlights the ways in which different household members use time and space. Although he seeks to identify a range of factors associated with resource use intensification, he does not attempt to integrate any dynamic elements into his analysis other than demographic change and social differentiation (op.cit., 410-411). Our analysis of environmental change focuses on households as the basic social unit within which work is organised, recognises the importance of understanding local and regional historical development in order to understand present resource use, but sees broad patterns of human development to be determined by national and world-regional forces.

Historical analysis is particularly important since the variability of environmental conditions necessitates knowledge of environmental use strategies, their development and their ability to meet basic needs over a generation or more. Investigation of the pace of cultural and technological change also requires knowledge of previous land use systems, patterns of human mobility and household strategies in order to understand the degree of flexibility as well as the direction of change in ways of obtaining a livelihood.

In an attempt to comprehend the diversity of the elements of the physical environment and their interaction with human groups, increasing use has been made by some social scientists of the concept of the ecosystem, in which human existence is viewed as a system continually interacting with and modifying - yet being modified by - the natural environment. This method of viewing human society has proved attractive to anthropologists with a traditional focus on non-industrial societies and or small groups whose patterns of interaction are predominantly internal to the group, as well as geographically within a definable territory. For island populations, the seemingly bounded nature of the island physical

environment has further attracted ecosystem analysis as a means to understand land use systems (Brookfield 1980). Several distinguished studies of human groups in Latin America have also employed the ecosystem as an interpretive structure within which to set their analysis (Winterhalder and Thomas 1978, Nietschmann 1973) with considerable success. Both these studies, however, demonstrate the serious problems associated with this method of analysis. These are the limited ability of this level of ecosystem analysis to take account of relations with external systems and the use of energy as the unit of account used to demonstrate the distribution of any good within the system.

Energy has commonly been used, in part because inputs and outputs can be quantified, but also because it is believed by many that an underlying principle of human existence is the minimisation effort (Zipf 1965, Orlove 1980). This principle is based on western notions of work that may have only slight relevance to activities in predominantly rural societies. Although expressing values of goods in terms of energy has a certain simplicity, energy values in no way reflect the economic value of goods for exchange; those values are primarily a reflection of need, scarcity, and the political structure of the marketing system. Neither can energy values take into account the long- and short-term differences between market values of surplus produce sold and desired goods acquired. As such, therefore, this sort of analysis of human ecosystems cannot adequately deal with economic forces, particularly when these reflect national and international situations. However, as Ellen has suggested, the ecosystem method of analysis does have merit: it emphasises the importance of a number of key elements in the the investiga-tion of man-environment relations; it stresses the need for viewing the whole range of human relationships while also focussing on specific elements in livelihood strategies; it stresses too the complex networks of causality and the mechanisms that develop and disturb supposed equilibrium situations (Ellen

1982, pp.93-4).

The political economy approach to environmental change has tended to suffer from the polemical nature of some of the writings associated with it, although there are various detailed case studies which exemplify this approach, notably in northern Africa (Baker 1977, Watts 1983, and articles in O'Keefe and Wisner 1977). While it is necessary to recognise the critical and persuasive nature of external factors that in large measure control human development, it is also necessary to acknowledge that particular circumstances are a response to specific local situations, reflecting the precise nature of the environment and its inhabitants as well as a response to the nature of the global and national economy and the social and political structures in which local people are enmeshed. In the use of life histories, for instance, one can detect the pressures within the household and larger local community that influence groups of individual and domestic decisions but, by looking beyond that for broader patterns of influence that are important elsewhere, it is possible to detect such a process as that in which 'marginal people...[are]..quite literally pushed into marginal places' (Wisner 1977). One can search for an explanation of situations that have been associated with environmental change in terms of pressures from society (and from the economy) at large while still recognising the importance of individuals and local peoples in the precise nature of the response to environmental change. This analytical method has to be used in a framework which enables the use of information about the changes in the natural environment (forests, hydrological systems and climate, for instance) and in the human- modified environment (soils of cultivated areas, roads and human settlement) to be studied alongside changes at a local, regional and national scale in the economic, political and social environments which may influence the nature and pattern of environmental change. This is a demanding analytical

framework which needs a range of expertise and information but it does facilitate the development of general interpretations of change which clearly identify the root causes of deterioration and the relative importance of different factors at distinct geographical scales of analysis.

The political economic approach is far from an intellectual philosophers' stone since, however satisfying it is on the level presented, for instance by Blaikie (1981), it is profoundly unsatisfactory at a local level and for realistic prescription. But it is at this level that an understanding of local ecology is necessary and at which the understanding of local and regional level factors is important. Brookfield's disenchantment with human ecology revealed in a recent paper (Brookfield 1982) accurately reflects the limitations of this approach but should surely not be interpreted as a reflection on the nature of ecology but more the need to understand that at no level can conclusions be drawn from the analysis of a particular ecological situation without identifying the other systems that interact with it.

To demonstrate the potential of an analysis that embraces a wide range of human activities in more than one locality and which develops a short-term dynamic historical perspective we present an account of changes that have affected a part of the northern Ecuadorian Andes which spans two distinct ecological zones and where human settlement has existed since prehistoric times. We then offer an interpretation of the factors associated with these changes. The case study on which this analysis is based is the first of several field investigations intended to examine in depth the nature of recent environmental change and associated modifications of household survival strategies.

Environmental change in such a relatively densely-peopled area as the Andes is of long standing. Given the marked variations in ecological zone within relatively short distances many human groups have long been

accustomed to having access to various ecological zones. Much of the change in human ecology since the arrival of the Spanish and Portuguese has been a restriction in the freedom of access to different zones as land ownership became progressively concentrated in the hands of few families. This process is well-documented throughout the Andes. What is less well documented is the nature of environmental deterioration in the mountain system in relation to different socio-economic systems as they have evolved during the past century.

In the absence of detailed historical analysis of the use of land in the highlands during the colonial period only speculation is possible. Although the extent of population decline in the central Ecuadorian Andes remains to be analysed in detail, evidence collected by Larrain (1980) for the present-day Province of Imbabura suggests a fall of population by up to one third in the period up to 1600. Associated with the shortage of agricultural labour some farmland must have been abandoned and the regrowth of vegetation in such areas would have checked soil erosion. Although absolute population sizes increased only slowly after initial decline in the 16th century, the establishment of large estates both during the colonial period and after Independence in 1822 would have extended the area that might have been farmed. Sheep were plentiful however, to supply the burgeoning textile industry, and large areas must have been grazed, or over-grazed, by these newly-introduced ruminants and so subject to erosion. Erosion and soil depletion, however, seem not to have been associated with the great estates which occupied largely level, well-watered land and only used hill-land for pasture. Soil degradation occurs most frequently on land occupied by the increasingly marginalised indigenous and mestizo population who were frequently restricted to poorer, more steeply sloping land which was more subject to erosion because of its slope and the intensive cultivation to which it was subject. In some cases large estates did

develop agricultural systems which accelerated erosion while providing a good short- to medium-term profit. This occurred on the estates in Canton Pedro Moncayo north of Quito, where extensive cereal cultivation has been associated with widespread wind erosion.

Following a wide range of ecological studies by the Ministry of Agriculture and a French ORSTOM mission during the past decade, there is now a much better perception of the range of environmental changes that are taking place and important studies of the processes of soil erosion in the highlands have been initiated (MAG-PRONAREG-PRONACOS, 1984). There has been nothing pubished, however, that attempts to study the underlying causes of environmental deterioration, partly because this straddles natural and social science interests and because superficial analysis attributes soil erosion to the inappropriate agricultural practices followed by small farmers on land that cannot be cultivated without considerable loss of soil. There is no analysis of why farmers follow such practices or why they farm such poor land.

Detailed analyses of change in the Sierra by Ecuadorian and other social scientists based on thorough field investigation have appeared in recent years which advance our understanding of the processes of socio-economic change in the countryside as the traditional haciendas gradually disappear (Murmis 1978, Barsky 1978, Fauroux 1983, Guerrero 1977). The emergence of a rural middle class whose power is based on commercially-derived wealth and on the acquisition of farmland seems widespread. Archetti and Stolen have further identified that this process involves complex changes at a household level that may lead to important changes in the roles of household members according to their age and gender (Archetti & Stolen 1981, p.318). Pachano has further identified the important role of regional and local urban centres in new socio-economic formations which facilitate social mobility through the dynamic growth of small towns (Pachano 1984 & n.d.). Several writers highlight the contribution of

migration to change in rural areas (Martinez 1984, for instance) as have our own previous studies of the impact of migration on rural areas (Preston 1981).

The ecological impact of contemporary social change is considered rarely and then only in purely theoretical terms where existing practices that cause environmental deterioration are compared with a rational use of productive factors (including land) that would provide the maximum yield possible without disrupting the local or regional ecosystem (Sepulveda 1982). There is no analysis of rural change which makes a serious attempt to include specific environmental changes or that seeks to identify any associated social and economic changes.

2. IDENTIFYING ENVIRONMENTAL CHANGE

The area selected for study in 1983 was part of a region in which field work, including some land use survey, was first carried out in 1961 (Preston 1965) as part of a study of the human geography of the Chota valley. Further evidence of past settlement and land use is provided in the 1:25,000 topographic map prepared in 1935 by the Ecuadorian army map service but this covers only the area around and to the north of the town of Pimampiro. In the course of field work during 1961 photographs were taken that record the detailed land use of some areas. These give some visual evidence of land use and settlement patterns 22 years prior to the present period of investigation.

The investigation of environmental change was carried out at several different levels. Photographs taken in 1961 were compared with existing visible evidence of land use and local people were asked to comment on specific visible changes. Aerial photographs taken in 1966 and 1978 were obtained and the earlier ones were of high enough quality to detect details in small fields. It proved impossible to trace the photographs taken to

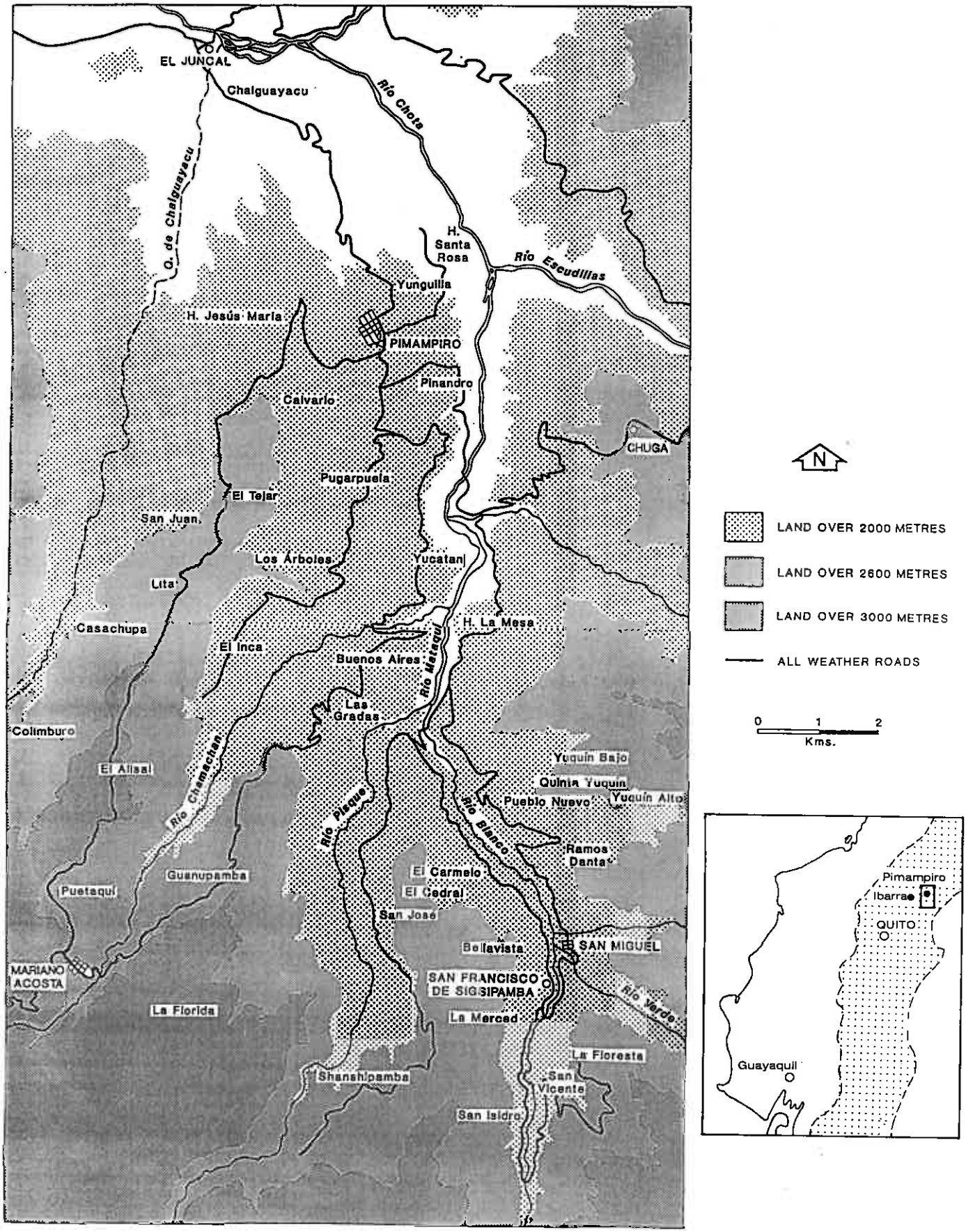
EL JUNCAL
Chalguayacu
Río Chota
Q. de Chalguayacu
H. Santa Rosa
Río Escudillas
Yunguilla
H. Jesús María
PIMAMPIRO
Pinandro
Calvario
CHUGA
Pugarpuela
El Tejar
San Juan
Los Árboles
Yucatan
Lita
Casachupa
H. La Mesa
El Inca
Buenos Aires
Río Mataquí
Las Gradas
Colimburo
El Alisal
Río Chamachan
Río Pisque
Río Blanco
Yuquín Bajo
Quinia Yuquín
Pueblo Nuevo
Yuquín Alto
Ramos Danta
Guanupamba
El Carmelo
El Cedral
Puetaquí
San José
Bellavista
SAN MIGUEL
MARIANO ACOSTA
SAN FRANCISCO DE SIGSIPAMBA
Río Verde
La Florida
La Merced
La Floresta
Shanshipamba
San Vicente
San Isidro
N
LAND OVER 2000 METRES
LAND OVER 2600 METRES
LAND OVER 3000 METRES
ALL WEATHER ROADS
0 1 2
Kms.
Pimampiro
Ibarra
QUITO
Guayaquil

Figure 1

prepare the 1:25,000 maps made in the 1930s. Comparison of the 1966 photographs with the 1983 situation in the field, and subsequently with colour transparencies, enabled some changes in land use to be identified over the whole of the area studied. Finally, interviews with a 20 per cent random sample of occupied houses in Pimampiro (except Chalguayacu in the Chota valley), San Francisco de Sigsipamba and the Guanupamba section of Mariano Acosta enabled collection of a range of further historical and contemporary data including changes in crop yields, experience of soil erosion, and loss of land through landslip (Fig.1).

The area of study contains a range of ecological situations. The three parishes of Pimampiro canton - Pimampiro, San Francisco de Sigsipamba and Mariano Acosta - each contain farmland that ranges from 1700 to 3600 metres above sea level. They include hot dry areas in the Chota valley where tropical crops are grown with the aid of irrigation and high altitude grassland (**paramo**) beyond the normal limit of cultivation. The eastern limit of the area studied is formed by the crest of the eastern cordillera of the Andes beyond which lies the Amazon basin. The most pronounced difference is between the intensively farmed area around the town of Pimampiro (altitude about 2160 m) where rainfall is less than 500 mm and where irrigation is widespread and necessary for the production of tomatoes, aniseed, chili peppers, sweet cucumbers, sugarcane and various varieties of beans and the higher, cooler and better-watered land of the other two areas - Mariano Acosta and Sigsipamba - where rainfall is more than 1100 mm and where the altitude of arable land varies from 2400-3200 m. The whole area is dissected by deeply incised rivers cutting through mainly volcanic deposits often to 500 m below the less steeply-sloping farmland. Several near-level terrace formations exist in a number of locations - below Pimampiro, at San Juan, Buenos Aires, El Inca and Shanshipamba - as well as much of the community of Puetaqui to the north of the village of

Mariano Acosta. Forest cover remains on steep slopes near to the limit of cultivation south of Mariano Acosta and in the mountains towards the eastern crest of the Cordillera. At the beginning of the century much of the parishes of Mariano Acosta and Sigsipamba were forest-covered.

Land use history

The Pimampiro area has been used by human groups since prehistoric times and extensive archeological remains occur throughout the area. The majority of the remains date from the 9th century, representing the Capuli and Tuza styles, when the political structure of the area was centred around a series of regional chiefdoms (Echeverria 1981). By the time of the Inca Conquest in the late 1500s it seems likely that farming was widespread in this area including higher land in the upper parts of the Chamachan and Pisque valleys but particularly in the area near Pimampiro where extensive terracing can still be seen on the steep valley sides of the Rio Mataqui. The detailed account of the area written by Padre Borja in 1582 speaks of cotton and fruit being grown in the Chota valley, of extensive coca fields near Pimampiro and of numerous indians in the area south of Pimampiro (Borja, 1582).

There was a sharp decline in native population following the Spanish Conquest and exposure to European diseases: the population of the Pimampiro area seems to have fallen by 28 per cent in the short period between 1570 and 1598 (Larrain 1980). The agricultural area diminished, forest grew where fields had existed - as recently discovered field patterns suggest (Preston 1984) - and the extensive system of terraces was no longer used for farming. The establishment of large estates by Spaniards and the arrival of slaves in the 16th and 17th centuries provided the basis for new methods of farming. By 1900, much of the land east and south of the town was part of the Hacienda Santa Rosa, owned by Nicolas Tobar, although it is uncertain what proportion of the vast area he claimed was ever cultivated.

During the first decade of the present century indians moved east from the communities of Angochagua and La Rinconada (south of Ibarra) in search of cultivable land. They crossed the **paramo** to the east and descended into the forested basin in the centre of which now stands the village of Mariano Acosta. The children of the early settlers recall the dense forest which was cleared and farming, basically similar to that in the areas from which they had come, started on the fertile forest soils. Other groups of settlers arrived in succeeding years and conflict with the Tobar family, who claimed ownership of the land on which the indians had settled, began that was not resolved until 1925, by which time most of the least steeply-sloping land had been cleared. Two distinct communities had emerged, one in Puetaqui (on the west side of the Rio Chamachan) and the other in Guanupamba (on the east side) by the time the parish of Mariano Acosta was founded in 1920. Its central settlement was located in Puetaqui but close to the river where access to Guanupamba was guaranteed. In 1929 Nicolas Tobar died and the great estate was split between his heirs. His daughter Carmela married Victor Elias Borja and took Hda. San Nicolas and much of the eastern part of the property while Juan Jose Tobar took Hda. Santa Rosa and much of the western part of the domain.

During the 1930s, areas of largely forested land, part of San Nicolas, in the south-east of Pimampiro parish were settled, at first illegally,by residents of Pimampiro town and by people from the adjacent northern province of Carchi and from Colombia. Some land was also sold to former estate workers during the following decade, some of whom re-sold their land to colonists from outside. Clearing of forest and the establishment of small-scale agriculture started in the valleys of the Rio Pisque, Rio Blanco and the smaller valleys on the western margins of the Cordillera Oriental. The best and most level land was largely farmed by the Borja or Tobar families but many townsfolk from Pimampiro had access to estate land

in different areas as sharecroppers (**partidarios**). In 1945 the estate was sold to a dynamic Colombian-born entrepreneur, Marco Restrepo, whose fortune had been made exploiting timber resources used for sleepers and as fuel on the new Ecuadorian railway system and who already owned a large estate (Hda. Leito) in the Patate area of Tungurahua, south of Quito. Restrepo's attitudes to land and people are plainly documented in his autobiography El rey de la lena (1958) and he transformed many aspects of the land use of the estate, now re-named Pinandro. Many of the sharecroppers from Pimampiro had their tenancy terminated, much of the existing servile labour force of huasipungueros was expelled and the estate was farmed with workers who were paid cash, received no land and who often came from elsewhere, especially from Tungurahua near Hda. Leito. Cereal production replaced pasture in many cases. The old estate house was abandoned because Restrepo thought it too large, old-fashioned and non-functional; fields were enlarged and walls demolished and the former archaic enterprise was replaced by a modern capitalist agricultural production unit. He proved willing to sell outlying parts of the property that he considered marginal to the cereal enterprise; 1000 ha at Sabanalarga (San Jose and Shanshipamba) was sold in 1955 to a cooperative of some 50 people most of whom were from Sigsipamba but including 15 from Pimampiro. The fierce opposition to his policies from the former sharecroppers in the town, now deprived of their living, may well have played some part in his willingness to sell off land.

To the north of Pimampiro town farming, on the basis of irrigation from a long canal from the Rio Chamachan in Mariano Acosta, concentrated on sugarcane, tomatoes and occasionally cotton. The irrigated area has not changed markedly since the 1930s and the two haciendas of Santa Rosa and Jesus Maria (including Paragachi) occupy land that has been farmed since colonial times; indeed Jesus Maria was one of several estates in the Chota valley owned by the Jesuits until their expulsion in 1767. Hacienda Santa

Rosa was divided in 1946 following the death of Juan Jose Tobar. One part comprising the existing hacienda house and the land adjacent to it was sold to a cooperativecomposed of Pimampiro people, dominated by two rich families, while the remainder stayed in the hands of the Tobar family but was rented to and effectively appropriated by Humberto Roman, a Pimampiro capitalist with large and varied economic resources butwho was largely self-made.

By the middle of the 1950s the main expansion of agricultural settlement had taken place; the better farmland in the valleysof the Chamachan, Pisque and Blanco rivers had been cleared as had the higher slopes of the Mataqui. New farmland was only being cleared high on the valley sides or on estate land which the landowner had little incentive to clear given the high labour costs, as in Shanshipamba (Hda. San Leonardo). The last change in the evolution of land use was the financial ruin of Restrepo following illness and continued local hostility and theconsequent sub-division of most of the outlying areas between local people in about 1970. This has led to dramatic land use changes that will be referred to below.

The evidence of change

Scrutiny ofphotographs, the use of old maps and interviews enables certain types of environmental change to be identified and the importance of each change to be assessed.

1. Forest cover. The area of land covering much of the east and south of Pimampiro canton was covered with forest earlier this century. Thehigher areas below the tree line to the south are still forest-covered although the area of forest is seldom more than 700 m wide and predominantly on slopes of more than 50 per cent. The valleys bordering the eastern cordillera are steeper-sided and a larger area is forest-covered, sometimes

as much as 2 km wide. In all cases the forest has been cut over for selected trees whose wood is highly prized, such as **cedro** (Cedrela montana),**olivo, aliso** (alnus forcillensis), **yalte** and **matachi**, but the areas where forest cover has been removed since 1966 are only small, except for one larger area in Chuga, beyond the limits of field work (see Fig.2). A series of small plots have obviously been cleared on the edge of the terrace of Shanshipamba, largely in Hda. San Leonardo, but clearly the majority of the forest clearance took place before 1950, that is in the first three decades after settlement, and most of the areas that are still forest-covered are on slopes too steep to be satisfactorily farmed.

2. Cultivation. The major change in the pattern of agricultural land use is a switch from concentration on cereals in the extensive terrace lands of Pinandro in the 1950s to mixed cultivation including varieties of beans, vegetables and maize after the sub-division of the estate.

Some 150-200 hectares of good quality near-level land has been affected by these changes in El Inca, Buenos Aires and Yucatan where beans, maize and tomatoes have replaced barley or wheat. The remaining land belonging to the Restrepo family, adjacent to Pimampiro, is now devoted solely to dairying and intensive tomato and chili pepper production for their sauce-bottling plant. A second change, noticeable on a small scale throughout the area particularly near the villages, is an increase in the number and size of trees (Table 1).

Table 1. Tree planting

Area	% planting trees recently	type of tree			N=
		fruit	eucalyptus	both	
Pimpampiro town	61	78	13	9	38
Rest of P. parish	50	0	81	19	34
Sigsipamba & Yuquin	50	0	68	0	67
Mariano Acosta	50	12	63	25	16


Paragachi
Hda. Santa Rosa
Hda. Jesus Maria
Yunguilla
Calvario
Hda. Pinandro
Hda. San Juan
AREAS OF CULTIVATED LAND
NEWLY CULTIVATED LAND
AREAS OF NEW FRUIT TREES
0
½
1 Km.

Figure 2

Interviews showed that half of all households had planted trees, mainly eucalyptus but, in the immediate area of Pimampiro, fruit trees, particularly avocados, were popular (Fig. 2). Eucalyptus has been planted largely on land marginal for farming, to provide firewood and timber of construction while avocado trees are most common in the lower elevations and have the considerable advantage of a long harvest season and thus capable of generating some income over a long period as well as providing fruit for the household. Plots of land in Yucatan, Buenos Aires and Valle Hermoso on the banks of the Mataqui river and in Paragachi (all below 2000 m) have been planted with avocados and also citrus trees (see Fig. 2). Around Pimampiro town and in the house gardens to the north of the town centre a wide range of fruit trees and bushes were grown, largely for household use, including bitter cherries (**capuli**), guavas, tree tomatoes and grenadines, but it is predominantly the planting of eucalyptus and avocados that has occurred most recently.

Changes in the relative importance of each of the cash crops planted in the Pimampiro area are difficult to detect because of the wide range of crops grown. The area of sugarcane has decreased and, at least in 1983, the area of tomatoes and avocados had increased. All crops recorded in 1961 are still present which testifies to the continuing high level of diversification of cash crops in this area. In Sigsipamba it was suggested by informants that the area of pasture had increased at the expense of annual crops. Comparison of photographs taken in 1961 and 1983 near San Miguel suggests that some areas previously cleared for crops have been allowed to revert to scrub, although this cannot be detected from the air photos because of the small scale and poor definition of recent aerial photography. Several informants commented that low yields from arable farming had led to more land being used for livestock.

The few areas that were not cultivated in 1961 but which are now

farmed (see Fig. 1) are in what are or used to be estates. Three areas to the north of Pimampiro, formerly part of Hda. Santa Rosa, are being farmed and irrigated possibly as a result of more efficient use of irrigation water. Land on a hillside on the margins of San Juan is also being farmed for the first time in living memory, allegedly to strengthen the landowner's image as a dynamic innovative person in the face of litigation potentially leading to expropriation. Careful comparison of air photographs and other evidence of the 1960s land use shows no sign that the area farmed in the localities where smallholdings predominate has changed even though it is difficult to distinguish between land that is in fallow or pasture and land completely abandoned.

3. Soil erosion. The extent of soil erosion is difficult to assess objectively. The measurement of soil loss requires data collection and monitoring over a prolonged period and this has not been carried out anywhere in Ecuador, although current monitoring is being undertaken near Quito. This work suggests that soil loss on a steep hillside (28°) where maize was being grown but with contoured cultivation could be as little as about 100 tonnes per hectare per year while a poor growth of grass on a thin soil but similar slope could result in over twice that soil loss. Such figures are not helpful given the huge range of variation in cropping practice, of conservation measures and of rainfall intensity which makes the identification of areas of high potential soil loss at a micro-level extremely difficult. Maps of soil erodability produced recently by PRONAREG of the Ministry of Agriculture give only a very broad picture of erosion risk and the Universal Soil Loss Equation is of very limited value in calculating potential soil loss where so few parameters are adequately measured.

In the Pimampiro area soil loss is clearly a universal problem although the degree of adoption of conservation practices and the

perception of the gravity of the problem varies as our data show (Table 2).

Table 2. Attitudes to and experience of soil erosion

	Near Pimampiro town	Elsewhere in Pimampiro	Sigsipamba, Yuquin	Mariano Acosta
	(percentages)			
"Can't do anything to combat erosion"	30	35	45	13
Households using conservation measures	40	12	35	53
Households with experience of landslips	19	35	52	29

The feeling about the possibility of taking any action to check soil erosion varies between Mariano Acosta, where only 13 per cent felt that nothing could be done to combat erosion to the moist, lower and more recently-settled areas in Sigsipamba, and Yuquin where 45 per cent felt no action was possible. Not surprisingly a higher proportion of farmers in Mariano Acosta had taken some action to conserve soil. In the immediate neighbourhood of Pimampiro town where steep, dry slopes are farmed and where poor irrigation techniques facilitate erosion, less than a third of respondents felt that erosion could not be combatted and 40 per cent of households took some conservation measures.

Although considerable erosion takes place on the dry hillsides above Pimampiro town, observation during the period of residence in the town showed that farmers regularly carry quantities of topsoil from the lower areas of fields into which it has been washed to the upper parts. Where the hard volcanic ash pan - cancagua - has been exposed this is sometimes broken up with pickaxes, as well as covered with soil in order to improve the growth of crops. Several farmers said that this was a common and

the growth of crops. Several farmers said that this was a common and necessary practice but was done every 5-10 years rather than annually.

The clearing of the steep slopes, heavy rain in abnormally wet years and lack of conservation measures result in small landslips. These are most common in the humid areas of Sigsipamba and Yuquin that have been most recently settled (see Table 2). In three places in El Inca careless irrigation had caused landslides earlier in 1983. Clearly soil erosion is widespread but there is no straightforward way of finding out the extent to which it is increasing or diminishing. In the areas that have only been farmed for 40 years there is more visible soil erosion now than at the beginning of the century and such erosion is more obvious than in any other part of the area studied. Whereas farmers in the long-established farming zone of Pimampiro are conscious of the problems of soil loss and aware of what needs to be done to combat it, farmers in other areas are less certain about conservation measures other than abandoning land and seeking out plots long since in pasture for renewed cultivation.

4. Field size and shape. One consequence of the dismemberment of several estates is a proliferation of small fields where big fields once predominated. The change in the size of field can be important in relation to environmental degradation for smaller fields may diminish the amount of soil erosion. Two large terraces, Yucatan (c. 33 ha) and Buenos Aires (c. 70 ha), farmed by Hda. Pinandro in 1961 as single areas sown to cereals have now been sub-divided into about 14 small fields in which a variety of crops are grown (Fig.3). Evidence from photographs and field observations suggests that the size of the fields has not changed much in areas predominantly of smallholdings.

5. Settlement patterns. The size of Pimampiro town has increased considerably since 1961 although the population of the parish has

decreased. The town has expanded both to the west and to the north and new barrios have been created. By comparison, villages such as Mariano Acosta and especially San Francisco de Sigsipamba have barely changed since 1961. In the rural areas, the acquisition of land by sharecroppers and by others has been usually linked with house construction, and sharecroppers frequently build a house even if they may only have the land for two or three years. The sale of plots on the margins of estate land to former workers has usually also heralded the building of houses on the newly-acquired land, as in San Juan. Where small-scale forest clearing is taking place in the valleys above Mariano Acosta and Sigsipamba houses are built to shelter those living there, even on a temporary basis. One new nucleus, which represents a relocation of some people, is the formation of a new settlement known as Pueblo Nuevo on a terrace overlooking the Rio Blanco by some families from various parts of Yuquin. Some dozen houses have been built or are being completed, two billiard halls, a shop and a football pitch complete the present amenities although a new school building is planned. Farm families come down to the new plaza to meet on Saturdays and are actively concerned with the development of their 'town' in something of the same way as those concerned with the new urban settlements that characterise some parts of rural Bolivia (Preston 1970). Evidence of abandoned homes in outlying rural areas is hard to collect, because some families possess various homes such as the main farmstead near a road, perhaps a small house on the edge of the forest higher up the valley which is only occasionally occupied and even a house in Pimampiro where an elder child might be in High School.

6. Highways. Connections for vehicular traffic with the main national highway, which crosses the Chota valley to the north-west of Pimampiro were completed in 1930-32, on the initiative of townsfolk, particularly

merchants. Connections with the rest of the parish were then possible by horse and mule, although heavy rain made rivers difficult to cross and steep paths impassable. In 1953 the high road following the ridge SW of Pimampiro was completed, largely at the instigation of two Pimampiro merchants who in 1946 had acquired land in the highland areas of Alisal and Lita when Hda. Santa Rosa was sub-divided. By 1961 it was possible to get to Mariano Acosta and to San Francisco de Sigsipamba by vehicle during the dry season but no vehicular connection was possible with Chuga or the extensive area to the east of the Rio Mataqui and Rio Blanco. In the past 20 years more roads have been built and existing roads up-graded to remain passable all the year round. A good road now reaches all the settlements east of the Mataqui and the high road to Alisal has been continued to Mariano Acosta; a road now runs west of Mariano Acosta giving direct access to Ibarra and another road enters the eastern side of the Pisque valley as far as Shanshipamba although this, and the road to Ibarra, are impassable during the rainy season. With the recent creation of a new canton based on Pimampiro a team of heavy machines is on hand for road-building and maintenance and both cantonal and provincial politicians are lobbying for a new highway to the Oriente to be built from Pimampiro.

3. EXPLANATIONS OF ENVIRONMENTAL CHANGE

The environmental changes that emerge as visible and important in the Pimampiro region are a consequence of the changing social and economic context in which people have tried to make a living here. At one level we may identify a phenomenon such as emigration as being the sign of personal failure to farm appropriately but at the level of analysis preferred here such migration may rather reflect the inadequacy of prices in local markets, and the onerous conditions of sharecropping plus the increasing cultural isolation as mountain hamlets (for instance) fail to offer modern amenities such as shops, television and electricity.

3.1 New land settlement and the break-up of the estates

The most striking landscape changes in the past 50 years are (1) the settlement of previously unused forested land on the western flanks of the eastern Cordillera and, (2) the sub-division of land that belonged to large estates. The new land settlement can be seen as a process starting at the beginning of the century when indians settled the distant highland areas of Hda. Santa Rosa. In this case the impetus for the settlement was a combination of factors. First, the land on the southern extremity of the Pimampiro parish was little used, heavily forested and accessible from Pimampiro town only by many hours' walk and after crossing one or more deep gorges whose rivers were apt to flood after storms. Second, the indian population south of Ibarra occupied only restricted areas of poor land since a series of large estates occupied most of the best and a large proportion of the mediocre land. Communities such as La Rinconada and Angochagua were hemmed in by haciendas and only possessed communal land on the high mountain slopes above the central village. Such limited land resources forced many to work on haciendas. Those with restricted contact with the estates were forced to seek opportunities elsewhere and it was in this context that families from these indian areas first settled in the early years of this century (Farga and Almeida 1981). MAG-PRONAREG (1979) asserts that this movement was also stimulated by the expulsion of serfs from some estates but informants in Guanupamba and Puetaqui claimed that their parents had been free and only occasionally worked for haciendas. The land that they settled was ecologically similar to their parents' land, save only for the dense forest. Much of the land settled initially was gently undulating and is is unlikely that major soil loss took place in the decades immediately following settlement. As the number of settlers increased - and Theissen and Costales (1969) record more families moving into the area in 1940, 1945 and 1955 - more people worked as sharecroppers and labourers for estates nearer Pimampiro.

Settlement of the much wetter and warmer land on the margins of the Cordillera to the S.E. of Pimampiro, also on land belonging to Hda. San Nicolas, took place after 1930 and those acquiring land were from Pimampiro town, from the province of Carchi, to the north, and from adjacent parts of Colombia. The settlers were all from areas where estates predominated alongside microfundia that could not support a family let alone be sub-divided and sustain several households. Their farm land was in a very dry area and subject to extensive erosion. The combination of lack of access to further land for cultivation as a consequence of the absolute domination of regional society by an oligarchy of landowners and the lack of fertility of what land small farmers did possess forced people to search for alternative places to farm (MAG-PRONAREG 1979, 44). Migrants from southern Colombia were motivated to leave both by the social and economic pressures and by political insecurity and violence. Although settlers included some with capital resources, others were poor and all were clearing land in an environment very different from that of their homeland. The steep slopes and heavier rainfall made cleared slopes unstable and the rivers were torrents which were often difficult to cross. Not only was San Francisco de Sigsipamba parish settled in this way but also much of the upper slopes of that part of Chuga and Pimampiro lying to the east of the Mataqui river.

The dense forest and, for migrants from Carchi and Colombia, the high rainfall created an impression of an area sufficiently fertile to grow crops and raise livestock successfully. While the indians in Mariano Acosta could use the same farming techniques as in the areas from which they came, the settlers in the S.E. areas had to contend with more striking ecological differences from the cool dry highlands from which they had come. In their case particularly it could be argued that they settled land that was marginal to the big estates and also ecologically more fragile.

The contrast of the mammoth estate of San Nicolas alongside the tiny farms of the hillsides around Pimampiro town became modified as the southern and eastern periphery of the great estates became a zone of small and middle-sized properties until the final break-up of Hda. Pinandro in the 1970s when some of the best quality, most level farmland became available to small-scale farmers. By 1980 only one person still farmed a very large area. His land was located in three separate parishes and for only a part of them did the occupier have legal title. Estate workers and disgruntled townsfolk are contesting his rights to one area, the eldest children of his family live elsewhere including in the USA, and the sub-division of this, the last big estate, is only a matter of time.

The break-up of the estates must be seen as part of a widespread process whereby properties shrink in size with inheritance sub-division and as the urban earning power of the privileged, well-educated minority of landed proprietors' children entices them to city life and to divest themselves of rural properties. This process is now well recognised and seems to be widespread in highland Ecuador (Redclift and Preston 1980, CEPLAES-FLACSO 1980) and is associated with a process of intensification and commercialisation of farming on some small farms and many of the farms formed from the sub-division of the large estates. This latest phase of settlement is not part of a movement of impoverished peasants to new and more productive farms from the poor land to which they had previously been confined but rather a more complex multi-faceted movement spearheaded by the urban-based petty bourgeois who gradually acquired more and better land from which to make money.

It was only such people who had the financial resources to be able to acquire the land offered for sale. Some of them, in turn, have employed poor peasants to work for and with them as sharecroppers and day labourers thereby ensuring adequate care for the crops in an area where wage

labourers are hard to come by. In Pimampiro this group of sharecroppers seems to have grown and to include not only the poorest of the Pimampiro area population but also poor people from further afield, particularly from highland areas between Pimampiro and Ibarra (Penaherrera in particular). The more open nature of the social and economic regional framework enables sharecropping to be not only a livelihood for the poorest but also a step on the ladder towards socio-economic success. In particular growing tomatoes on good-quality former estate land allowed several of the households interviewed to buy their own land from the profits of sharecropping. Farming steeply sloping, less productive land as a sharecropper was less likely to enable savings to be accumulated with which land could be bought.

The most important social change in past decades has been the broadening of the apex of the regional class structure. Although the leading families in the 1980s, in terms of land ownership and economic power, include all those who held similar positions in the 1960s, other individuals and families have emerged, acquired considerable economic resources and wield some political power. Whereas the principal merchants buying local produce in the 1960s came from just two or three families, now dozens of people buy produce and a number of shops sell agricultural chemicals. The ease of access to the retail and wholesale markets of Ibarra forces Pimampiro shops and buyers to be competitive. The opening of a State Secondary School has likewise brought more business to shops selling school necessities and the educated young teachers employed there spend some of their salary in the town. The possibility of buying farmland or renting land from absentee medium-scale landowners offers another way of making a living without sacrificing the benefits of urban life. The success of the Pimampiro bus cooperative has brought another important source of income and prestige to over a dozen families in the town. Town informants frequently asserted that the most striking social feature of contemporary

Pimampiro was the number of people who have some political and economic power. From interviews in outlying areas it was evident too that a proportion of the better-off farmers from the hills either moved to Pimampiro permanently or bought or rented a house there and occupied it during termtime to allow elder children to attend High School or at weekends to facilitate access to the Sunday market.

3.2 Changes in agricultural systems

The rural environment in areas of arable farming is also affected by change in agricultural systems - for instance, the substitution of one crop by another or of livestock for arable farming. We have already indicated the changes in land ownership that gave the opportunity for intensification of land use which has transformed the agrarian landscape in several areas of what was Hacienda Pinandro. The crops that were planted on this newly-acquired land were not new but they included the two crops that had been introduced into the Pimampiro farming system during the past 40 years, avocado pears and tomatoes. Each has specific advantages for this area. Avocados, which grow well below about 2200 m, were introduced into the Chota valley in about 1960 by the UN Andean Mission which worked in several negro villages on the valley floor. Avocado seedlings were established at a nursery in Chalguayacu and Pimampiro townspeople noticed them and enquired whether they too could acquire them since avocado trees were grown in the town. The new variety, known as Guatemalteco, was a prolific producer, grew quickly, was of shorter stature and more easy to harvest (although it was also more prone to theft of fruit) and the fruit commanded a good price in Quito. The trees produce fruit over several months of the year thus offering the steady income so desired by small-scale farmers. Little special care of the trees was necessary and so, for a number of households, this became a useful cash crop. Several small areas of avocado trees planted near Pimampiro town since 1960 are shown in Fig. 2.

The major innovation of the 1950s however was the tomato. Introduced originally by an Italian who rented a part of Hacienda Santa Rosa, tomatoes grown with irrigation proved prolific and, initially at any rate, disease-free. Demanding intensive labour for the necessary transplanting, staking and picking, tomato growing needed a ready supply of labour which was easily available both in the town and from the micro-parcels nearby. Middle-sized landholdings were quick to plant some areas of tomatoes, often by means of sharecroppers. Tomato prices in Quito fluctuate wildly but, while only a small profit is possible when the national market is fully supplied from coastal and highland growers, when the crop is devastated by unusually heavy rains on the coast, as in 1983, prices rise quickly and huge profits are made by highland producers. It is thus a speculative crop unlike avocado and one attractive to the merchant landowners of Pimampiro rather than to small-scale, impoverished farmers who cannot afford the outlay of labour and agro-chemicals which may barely be recouped if the market is oversupplied.

Both avocados and tomatoes were adopted in response to external stimuli: a buoyant urban demand and also the improved road communications which made the major highland metropolitain market - Quito - gradually more accessible from the 1950s onwards. The planting of new crops and the use of agro-chemicals in association with tomato-growing was further stimulated by increased contact with agricultural extension workers and the two-way movement of people between Quito and Pimampiro which facilitated flows of both information and goods.

The third change in the agrarian system, less easy to observe and associated with economy of labour use rather than intensification, is increased livestock rearing. In the humid mountain zone of San Francisco de Sigsipamba, and in adjacent areas, there are more areas of pasture and more cattle than 20 years ago as numerous households interviewed stated.

The change towards a greater emphasis on livestock, albeit still within a diversified agricultural system, seems to be the result of a series of factors most of which are largely internal to the area. In the first place, livestock require only the labour of taking them to and from the pasture which is normally the role of children. For households, some of whose male members are absent migrants, livestock can therefore be maintained by women or by children. Cattle suffer from relatively few diseases and their capital value can be realised quickly. They represent more liquid assets than a grove of avocado trees or a field of beans and livestock prices are relatively stable. They are also associated with an important land use change, from cultivated plots to pasture. On steep hillsides, such as in the valleys near San Francisco de Sigsipamba where slopes are frequently in excess of 30°, soil erosion is reduced as uncontoured row crops are replaced by grasses. Livestock may locally accelerate erosion by wearing paths across slopes and even by destroying palatable vegetation but this is far outweighed by the checking of runoff and the stabilisation of soil that in effected by a grass sward. The reported decline in yields of arable crops - often quoted as having decreased to a third of yields twenty years ago - is a further factor encouraging an increase in the area of pasture. In households where an increase in the relative importance of livestock could be detected, the reasons given for the change usually included all three of those suggested here.

3.3 Soil erosion, perception and the process of change

There is ample evidence of soil erosion in the Pimampiro area. The nature of the relief and the intensity of rainfall coupled with the sparse nature of the remaining vegetation in the part of the area near the Chota valley combines to make erosion and loss of soil universal. The steep-sided valleys on the western slopes of the eastern Cordillera, even though forest covered, also show signs of landslips and the water courses even

high upstream carry heavy silt loads after a storm.

Soil erosion is seen by farmers not as an occasional problem but one that is always present and which is one of the usual environmental problems that farm households must face. Soil erosion is perceived very differently in different parts of Pimampiro canton. The basic contrast is between three areas. The farmers in the dry area near the town have a land management system that is well-established and not subject to many changes although new crops have appeared; the farmers of Mariano Acosta are using farming techniques of long standing in an environment similar to where they or their parents came from a generation ago, and the farmers of the wetter lands near the Cordillera whose physical environment is new and different from where they were raised are still in the process of developing a farming system that is appropriate to the area. At the same time this last group is attempting to modify their livelihoods to take into account considerable emigration, and the declining yields of the crops which they have been growing for 30-40 years.

The amount of soil erosion in each area is a function of the slope of the land, the intensity of the rainfall, the soil structure and the vegetative cover and only the last two of these are controlled in any way by the farmer. In seeking to explain the incidence of soil erosion (including landslips) it is necessary to identify the elements in the farming system that accentuate the erosion and comment on the extent to which farmers have been able to respond to the erosion either by preventing it or by overcoming its consequences.

Erosion is concentrated in those cultivated areas on steep slopes - often 20-35° - where the land is bare for some parts of the year. In the area of Mariano Acosta little evidence of erosion is visible and even the steepest cultivated slope, whose angle was measured at 40°, showed an adequate soil depth for cultivation and the contour ploughing and careful

ridging along the contour clearly minimised what must still be considerable erosion. Located some 8 km west from the crest of the eastern Cordillera, the rainfall here is much less than in San Francisco de Sigsipamba, of lower intensity and frequency, with less erosive potential. With a climate and range of soils similar to the area near Ibarra from which the original settlers came the agricultural system seems to accentuate erosion less than in other parts of the Pimampiro area.

Further north, in the region of Pimampiro town, the more level areas of El Inca, Buenos Aires, Yucatan, Pinandro, San Juan, Jesus Maria and Santa Rosa have few problems of erosion but the steep slopes farmed on the margins of El Inca, Los Arboles, Calvario, Casachupa, and Lita and the area adjacent and to the west of the town all show signs of considerable erosion, thin soils with poor plant growth and gullying even in cultivated fields. Certainly the farming of maize and other cereals seems unproductive because of the thin soils and steep slopes. The steep slopes adjacent and to the west of the town of Pimampiro have every sign of having been continuously cultivated since before the colonial period. This area was never part of any estate, by contrast with the land on every other side of the town, and the scattering of houses, the network of paths and walled fields, some with mature trees all suggest a mature agrarian landscape. This area shows ample evidence of soil erosion, largely surface washing but with some gullying. One field, typical of many that were eroded, was on a 13° slope, some 65 m long upslope and showed a deep accumulation of soil against a hedge at the bottom of the slope while fully 6m of the top part of the field had no topsoil and the hard cancagua subsoil was exposed. However, within a month the field was being prepared for cultivation with soil being carted up to the top of the field to cover the exposed subsoil. Many fields here are only 1500 m^2 and, not only does this small size slightly check erosion, but it also means that the accumulation of soil washed downslope is not so great as to make carrying it upslope too

impossible a task. Farmers' perception of erosion here was that it was manageable as the information tabulated in Table 2 suggests. Even so, the lack of terracing of any form, of careful contour ploughing and of other erosion control measures suggests that, although farmers here have learnt to live with soil erosion, they have not developed a farming system that makes full use of the environmental potential.

The complex system of terraces visible on the valley side east of Pimampiro and on air photographs of La Mesa suggest that pre-Hispanic use of steep mountainsides was more intensive than at present. The cultivation of coca, for which Pimampiro was famous in the early colonial period, probably made use of the more level land around the town that was appropriated by estates during the last 280 years. Small-scale farmers were probably gradually forced to move into less desirable areas as the estates grew in size.

Soil erosion in the humid lands in the Cordillera (Yuquin, Ramos Danta, San Miguel and San Francisco) is distinctive. The high rainfall, allied with the virtual absence of near-level land and the fact that farming here started on newly-cleared land in the 1930s, all combine to produce widespread erosion. The selling of much of the land within a decade of initial settlement to small-scale farmers meant that very little forest was left uncut except on the steepest slopes furthest from the trails and highway. The good yields encountered on newly-cleared land encouraged continuous cropping with little use of fertilisers until yields dropped, often within a decade. By 1950 most older farmers remember that there was little newly-cleared land and subsequently crops were sown with newly-available chemical fertilisers. The deterioration of soils with continuous cropping, the removal of much of the forest cover and the occasional series of excessively wet years combined to produce a crisis in 1974-76 when prolonged rain reduced harvests dramatically. Landslides

occurred in various places which destroyed some houses in Ramos Danta and accelerated emigration. Emigration is of much longer-standing and the excessively wet years of the mid 1970s are the most recent quasi-disaster in people's memories but this situation highlights the longer-standing environmental deterioration that is generally perceived in this area. The frequent sale of land, such that few of the original settlers of the 1930s remain, further ensured that few of the farmers had experience of farming in this sort of environment and most anyway came from much drier areas further north in Ecuador and from southern Colombia.

Soil erosion is most noticeable in areas of smallholdings but principally in the humid hill lands of the Cordillera and on the hillsides around Pimampiro town. We have already explained the erosion in the Cordillera as a consequence of the influx of poor rural families without previous experience of farming such hilly wet land. Such people were forced to move in search of land for farming as a result of the monopolisation of good land by estate owners who had gradually divested themselves of a large part of their labour force during the past 50 years (CIDA 1966, MAG-PRONAREG 1979). Their poverty made it inevitable that they could only obtain access to a marginal area and the misfortune that their previous experience ill-prepared them for this new environment made it all the more likely that they would develop a farming system that accelerated soil erosion and made modifications of the land use necessary.

4. HOUSEHOLD LIVELIHOOD CHANGES

Households that have experienced most change in their means of making a living are located near the parish centre or have moved there in recent years. Households on the periphery, in Yuquin, Ramos Danta, and San Francisco de Sigsipamba, have experienced few changes in the range of work performed outside agriculture, unless it was associated with emigration.

Changes in the roles of males and females in locally-based work occur

in response to the absence of some members of the family which necessitates their tasks being performed by others. It is uncertain whether emigration is predominantly a male or female phenomenon. Data in the 1982 census suggest that the female population of San Francisco de Sigsipamba has declined more than the male during the 1974-82 intercensal period (by 22.5 per cent compared with 20.1 per cent) but that in Mariano Acosta the converse is true. There male emigration seems to have been more important during the 1974-82 period. In Pimampiro during this same period there was only a small population decrease but the male population decreased to a far greater extent than did the female population (3.4 per cent cf 0.3 per cent). Pimampiro parish however includes very diverse areas and half the population lives in the town. Mariano Acosta and San Francisco are more homogeneous. Our own data on the migration of children of informants suggests that the same proportion of males and females migrate from each of the areas studied, with the exception of Mariano Acosta where female migration predominates.

Many of the jobs are associated with the intensification of agriculture on former estate land and with satisfying the short-term labour demands of crops like tomatoes where child and female labour is used intensively. The nature of the change in land ownership in the Pimampiro area has meant that many of those acquiring new land have been from the town and already owned land elsewhere. Much of this newly-acquired land has subsequently been leased to sharecroppers, some of whom are from Pimampiro area but others are from elsewhere in the province. Although some sharecroppers come with their family, build a house and work the land with a family team, others work alone, sometimes employing labourers while their wives and children remain to cultivate the small amount of land they have in their original community.

The most important changes in livelihood strategies are those

associated with the loss of household members' labour during absences away, whether to earn money or for some form of education (including military service). These changes include women performing tasks previously done by men or children, the use of young children to perform a greater proportion of domestic and farming tasks and an overall attempt at labour-saving strategies which might include abandoning the cropping of some marginal land in favour of keeping more livestock.

Alongside the new sources of work and income it is worth remembering that some domestic, non-agricultural production does continue. A few families still make rope from cactus fibre although they now use cabuya fibre imported from the western foothills of the Andes bought from merchants in the regional urban centres rather than locally-produced fibre. The demand for such rope is limited and it only provides a cash return less than half of the daily wage of a farm laburer. It is worthwhile because it produces a small regular income and provides work for the old and mentally handicapped who would otherwise not be gainfully employed. Only one family still makes rope-soled sandals (alpargatas).

Two specifically female occupations have grown in importance in the Pimampiro area and in Mariano Acosta. The growth of the use of cash in household economies has resulted in fewer households making their own clothes. While in town this creates employment for male tailors, in the countryside it is women with sewing machines who make clothes for both males and females. In a number of households where earnings had enabled the purchase of one or more sewing machines money was earned making clothes to order. In Mariano Acosta the handsomely embroidered blouses of the women have attracted the attention of entrepreneurs seeking craft goods for sale to tourists. A number of women in different parts of the parish embroider but almost all work is under contract and they earn relatively little. This income is important, particularly for young women, for it provides an income, independent from farming, that can be earned at home.

5. CENTRE-PERIPHERY ENVIRONMENTAL CHANGES

This analysis of environmental change stresses the differences between the area around Pimampiro town and the outlying areas. Many of the changes that have affected the outlying areas, save for Mariano Acosta where ethnic friction minimises the importance of Pimampiro, originate from the town. The initial settlers in the Cordillera were often townsfolk; it was also townsfolk who bought the good farmland that became available in the 1970s on which they often installed tenants; finally, many of the more successful households in the mountain periphery established themselves in the town, at first to house children who attend the superior town schools. Subsequently others of the family would establish residence, even to set up a small business making use of their connections with the original outlying area. The household thus came to occupy both an outlying farm and a town house. This follows a pattern observed previously in the Bolivian highlands which was a result of the 1952 Agrarian Reform (Preston 1978). The advantages of such an arrangement are evident, and other households who have not obtained a foothold in the town find themselves at a disadvantage. Their links with town merchants are relatively more tenuous if only because they see them less often than their migrant former neighbours. Thus the centre-periphery relationship, which is so often a theme in Latin America, attains a new meaning in Pimampiro.

6. CONCLUSION

Considerable environmental changes have occurred in the different ecological zones that comprise the area studied in Pimampiro canton. In part they reflect the difference in physical environment in relation to the conditions that obtained when settlement was established. They can also be interpreted in relation to the changing social situations that have developed in the different parts of the canton. More investigation is

needed to establish the precise degree of environmental degradation in different land use situations, but ample evidence is available to demonstrate the different levels of land degradation that characterise each ecological zone, and this environmental degradation is related to differences in local socio-economic circumstances.

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