

**DEFORESTATION, COLONIZATION AND UTILIZATION
OF LAND RESOURCES IN THE ATLANTIC ZONE OF
COSTA RICA**

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October 1991

**CENTRO AGONOMICO TROPICAL DE
INVESTIGACION Y ENSEÑANZA - CATIE**

**UNIVERSIDAD AGRICOLA
DE WAGENINGEN - UAW**

**MINISTERIO DE AGRICULTURA Y
GANADERIA DE COSTA RICA - MAG**



Figure 1. Location of the study area.

PREFACE

General description of the research programme on sustainable Landuse.

The research programme is based on the document "elaboration of the VF research programme in Costa Rica" prepared by the Working Group Costa Rica (WCR) in 1990. The document can be summarized as follows:

To develop a methodology to analyze ecologically sustainable and economically feasible land use, three hierarchical levels of analysis can be distinguished.

1. The Land Use System (LUS) analyses the relations between soil type and crops as well as technology and yield.
2. The Farm System (FS) analyses the decisions made at the farm household regarding the generation of income and on farm activities.
3. The Regional System (RS) analyses the agroecological and socio-economic boundary conditions and the incentives presented by development oriented activities.

Ecological aspects of the analysis comprise comparison of the effects of different crops and production techniques on the soil as ecological resource. For this comparison the chemical and physical qualities of the soil are examined as well as the pollution by agrochemicals. Evaluation of the groundwater condition is included in the ecological approach. Criteria for sustainability have a relative character. The question of what is in time a more sustainable land use will be answered on the three different levels for three major soil groups and nine important land use types.

Combinations of crops and soils

	Maiz	Yuca	Platano	Piña	Palmito	Pasto	Forestal I II III
Soil I	x	x	x		x	x	x
Soil II						x	x
Soil III	x			x	x	x	x

As landuse is realized in the socio-economic context of the farm or region, feasibility criteria at corresponding levels are to be taken in consideration. MGP models on farm scale and regional scale are developed to evaluate the different ecological criteria in economical terms or visa-versa.

Different scenarios will be tested in close cooperation with the counter parts.

The Atlantic Zone Programme (CATIE-AUW-MAG) is the result of an agreement for technical cooperation between the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), the Agricultural University Wageningen (AUW). The Netherlands and the Ministerio de Agricultura y Ganadería (MAG) of Costa Rica. The Programme, that was started in April 1986, has a long-term objective multidisciplinary research aimed at rational use of the natural resources in the Atlantic Zone of Costa Rica with emphasis on the small landowner.

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ACKNOWLEDGEMENTS

I thank W.J.A.M. Brooijmans for sociological data, A.J. Nieuwenhuyse for soil data H. Waaijenberg for agronomic data of Cocori and S.B.Kroonenberg for useful comments on a draft of this paper.

ABSTRACT

The focus of this paper is on the interplay between deforestation and colonization on the one hand, and changes in the physical, biological and social environment of the Atlantic Zone of Costa Rica, on the other. The data will be used to guide sustainable development of this region.

The Atlantic Zone of Costa Rica is a perhumid tropical area with yearly rainfall of 3000 to 5000 mm and without a marked dry season. Soils developed from recent to relatively old alluvial deposits and consequently are fertile to relatively poor. Deforestation started in the last century with the introduction of banana plantations, but in the last thirty years the process accelerated so much that it threatens the last natural forests outside the parks and protected areas.

A detailed analysis is given of natural resources and colonization history and its effects in a 12,000 ha sample area. Emphasis is on the discrepancy between actual and desirable land use as seen from the point of view of ecologically sustainable production. Noteworthy is the predominance of large cattle holdings both in areas which should be protected and in areas which could be better used for intensive cropping. To understand this situation the role of the state in the colonization process is analyzed, particularly the effect of the law on utilization of natural resources and on land tenure. Suggestions for future land management are given.

INTRODUCTION

The Atlantic Zone of Costa Rica (Fig. 1) contains some of the last refuges of the natural forest outside the parks and protected areas in the country. Deforestation is now in full progress in these areas. Forest cover percentages of the country decreased from 67 in 1940 to 56 in 1950, 45 in 1961, 32 in 1977 and to 17 in 1983 (Sader and Joyce, 1988). Environmental profiles (Hartshorn et al., 1982; Leonard, 1985) stress the under-utilization of forest resources. The majority of cut trees remains in the field, where they are burnt or where they rot. Most forest destruction takes place for extensive cattle farming, which has a very low return per hectare and a very low labour requirement (Myers, 1981; Hedström, 1985).

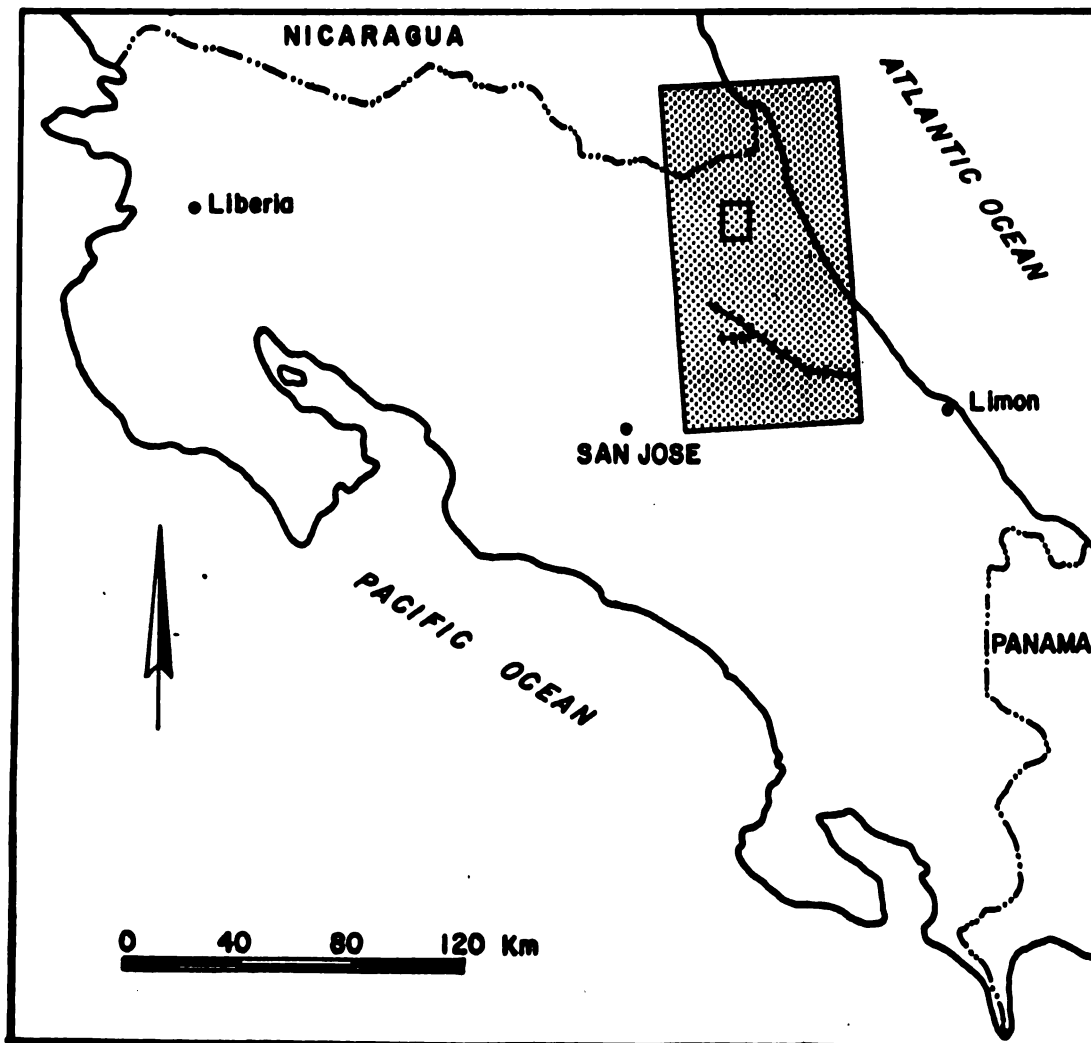


Fig. 1. Situation of the Atlantic Zone and of the Cocori area

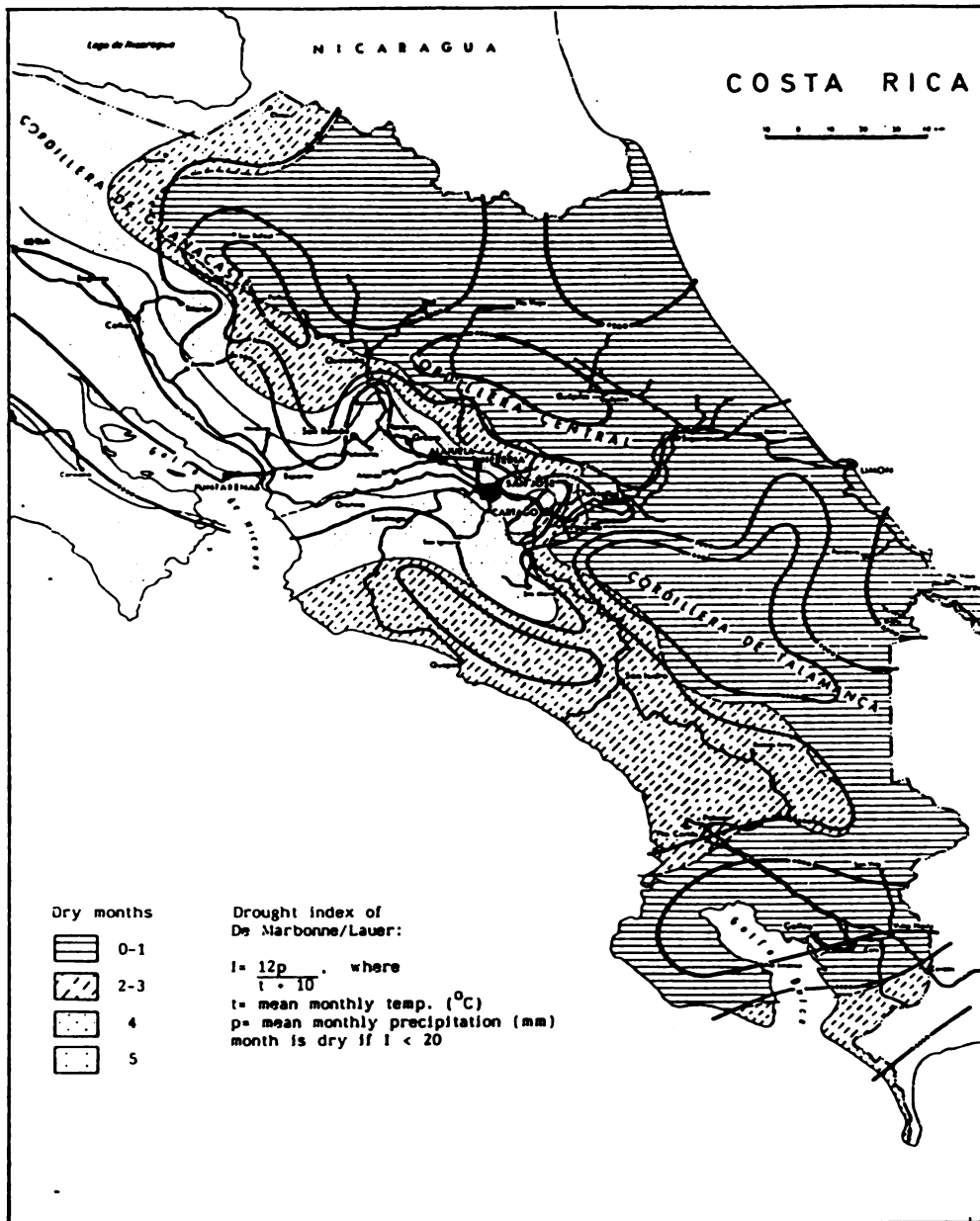


Fig. 2. Distribution of average annual rainfall (source Nuhn, (1978)).

Fig. 3 shows which areas were deforested during successive periods. The better land was taken first but with progressive deforestation also areas not suitable for agriculture were occupied. It is to be expected that, without restrictive measures imposed by the government, the Atlantic Zone will follow the example of earlier colonized areas where no natural forest is left, apart from a few protected areas.

The effect of deforestation and colonization on soils, land use and rural society is analyzed in the Cocorí sample area (12,000 ha) in the northeastern part of the Atlantic Zone. The studies are carried out in the framework of a multidisciplinary research programme of CATIE (Centro Agronómico Tropical de Investigación y Enseñanza) and the Agricultural University of Wageningen, The Netherlands (Anon., 1987). Its main objective is the study and development of sustainable types of land use for the perhumid Atlantic Zone of Costa Rica.

PHYSICAL CHARACTERISTICS OF THE ATLANTIC ZONE

Landforms, soils and land suitability

The Atlantic Zone comprises a mountain range and a plain at its foot, which forms the transition to the Caribbean Coast. The mountain chain is volcanic in its northern part with a number of active andesitic to basaltic volcanoes, and mainly non-volcanic in its southern part (Weyl, 1980). The plain is a zone of subsidence, filled with thousands of metres of Tertiary and Quaternary sediments derived from the mountains. In the northern part sediments are mainly pyroclastic. In the plain itself one finds a row of low hills, remnants of Tertiary or early Pleistocene basaltic volcanoes.

Four main land units are distinguished in the Atlantic Zone (Fig. 2): (1) Mountains and hills; (2) Piedmont; (3) Plain; (4) Coastal zone. The mountains and hills should be kept under forest to avoid soil erosion and ensuing flooding in lower lying areas and to conserve water and natural resources. The piedmont consists of mudflow and fluvial deposits of greatly varying age and soil fertility. Their agricultural potential varies accordingly. The alluvial plain consists of three units, the older terraces, the younger terraces and swamps, of which only the younger terraces are suitable for agriculture. The older terraces have well-drained soils which are very acid and low in nutrients, which makes them unsuitable for nutrient requiring crops, particularly annuals. Forestry would be the most appropriate use. The swamps are wetlands, consisting of unconsolidated peat and clay. These are not suitable for any type of agriculture or forestry, because of permanent waterlogging, and should be kept under natural vegetation. The coastal zone consists of sandy beach ridges, suitable for tree crops.

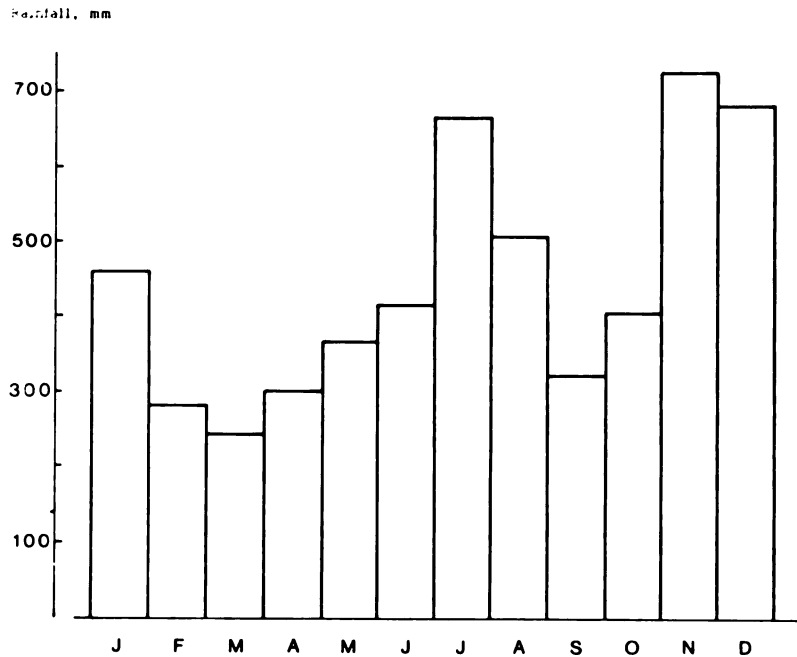


Fig 3. Average monthly rainfall of Tortuguero (1976-1986)

Climate

Rainfall varies from 3000 mm in the southern part to almost 6000 mm in the northern part (Fig.4). All months are wet but March and Abril usually have least rain (Fig.5). Highest amounts are recorded in November and December with up to 700 mm per month. The average annual temperature is about 26°C. On cloudy days daily temperatures vary between 23 and 26°C; on clear days these values are 20°C and 32°C respectively. Relative air humidity is seldom below 90% (IMN, 1981).

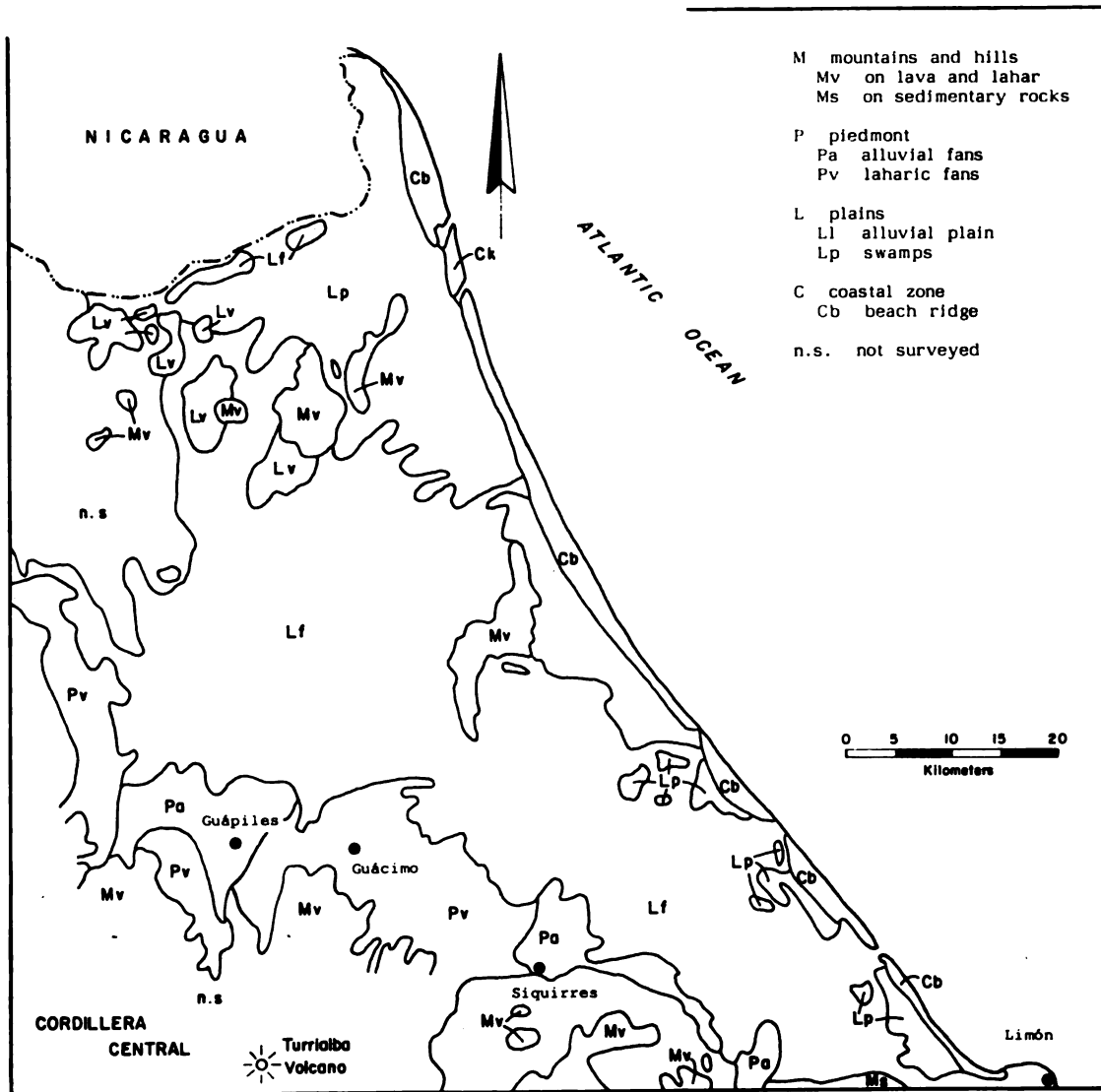
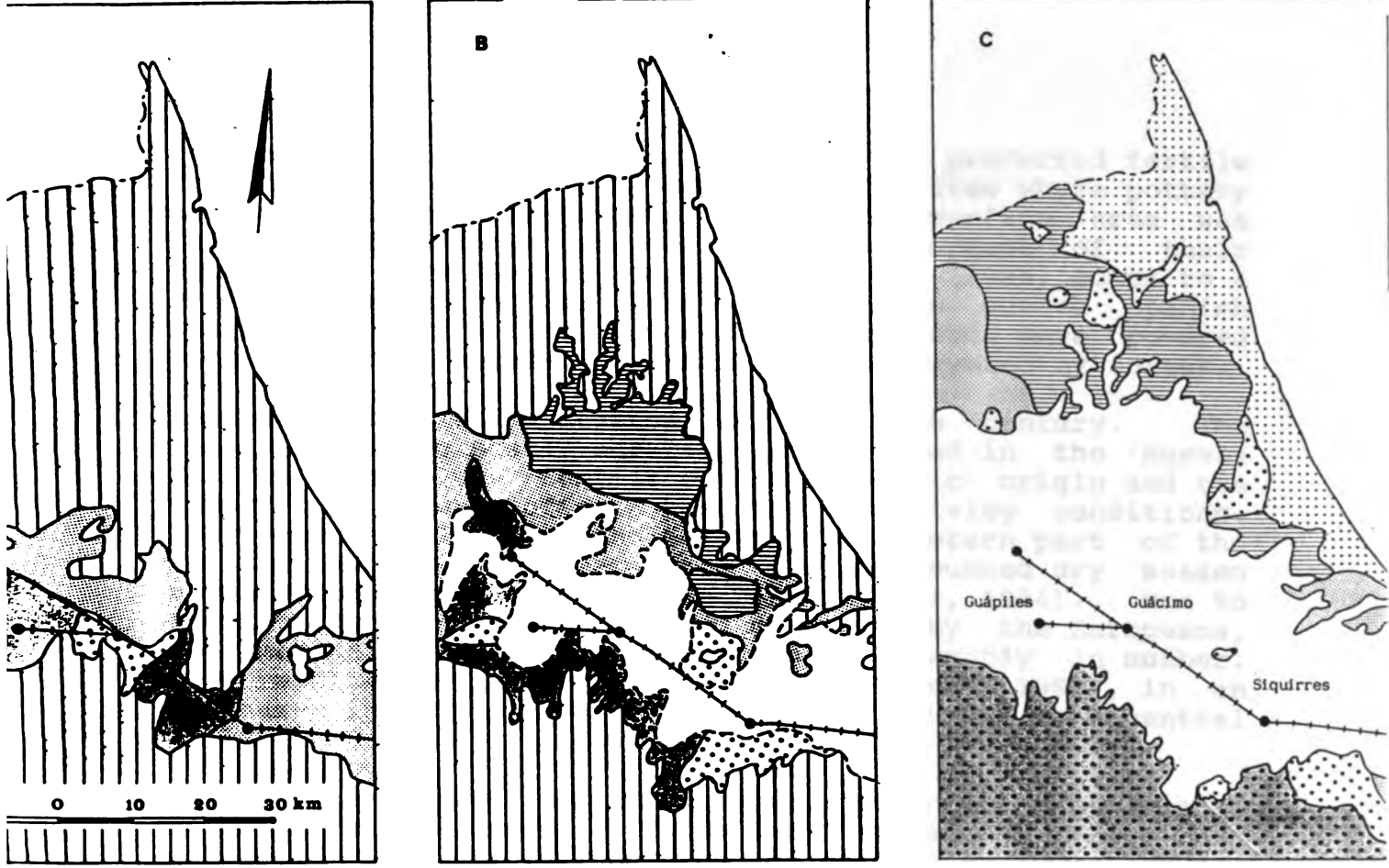


Fig. 4. Generalized map of landforms of the northern part of the Atlantic Zone.



- Flat and fertile, highly suitable for a wide range of land use types.
- Fertile and stony, suitable for a wide range of land use types.
- Sloping and not fertile, to be protected.
- Sloping and mountainous, to be protected.
- Swamps and not fertile soils, partly suitable for perennial crops and forestry.
- Swampy areas, to be protected.

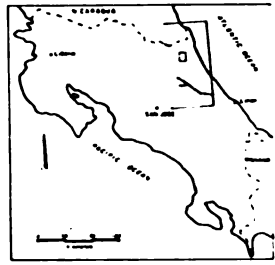


Fig. 5. Relation between soils deforested in different periods and their suitability: A till 1960, B from 1960 till 1987 and C not yet deforested. Deforestation till 1960 is according to Louette (1984).

OUTLINE OF COLONIZATION AND DEFORESTATION HISTORY OF COSTA RICA

Two phases in the history of Costa Rica are clearly distinctive:
 (1) the Pre-Columbian phase
 (2) the Post-Columbian phase
 More than 10,000 years ago Indians were already in Costa Rica and also in the Atlantic Zone, where they lived from hunting land gathering natural products. Later, they also cultivated tuber crops and several palm species and from 3000 B.C. they grew maize (Snarskis, 1982; Cooke et al., 1985). Gradually their agriculture

became more sedentary. They particularly preferred fertile land near good water. The abundance of sites where pottery has been found means that a large surface area was deforested during the maximum development of their agriculture from 500 B.C. onwards. Bonett (1985) comes to a similar conclusion for Panama, where he quotes Spanish sources who write that large areas in Panama were covered with a savannah vegetation, which are now covered by forest.

Spanish colonization started in the 16th century. The immigrants were mostly agrarian and settled in the 'Meseta Central', where the fertile soils of volcanic origin and the temperature climate offered them the best living conditions. They also settled in the hotter northwestern part of the country where the climate with its pronounced dry season reminded them of conditions in Spain (Hall, 1984). Due to the introduction of disease and epidemics by the Europeans, the Amerindian population decreased considerably in number. This resulted probably, as in Panama (Bonett, 1985), in an increase in forest cover especially outside the central valley.

During the 19th century the government stimulated colonization of areas outside the central valley. This coincided with the introduction of coffee, a lucrative new crop, especially for those who could afford the rather high investment costs, usually the bigger farmers. Smaller farmers often sold their land in order to profit from the rising land prices; others had to sell due to debts from investments in the coffee crop; they were the ones who looked for land or work elsewhere, thus forming the driving force behind deforestation elsewhere in the country (Sander, 1962).

A great incentive for the colonization of the Atlantic Zone was the contract made in 1871 for the construction of a railroad from Siquirres to Limon. In exchange for the construction, the contractor obtained a large concession of virgin land, of which later at least 100,000 ha came under control of the United Fruit Company (Sander, 1962; Hall, 1984). Up to 1937 this company developed extensive banana and cocoa plantations, mainly on the better soils in this region. The plantations attracted labour from elsewhere, but at the same time, the expulsion of labour from the plantations and the influx of people from elsewhere in the country, stimulated deforestation and the establishment of a farmer population. These people occupied land which legally belonged to the United Fruit Company, which caused land conflicts as early as 1907 (Bolanos and Ulate, 1988). Such conflicts and lack of opportunities for landless people were incentives for the government to buy land from the banana company to create agrarian settlements: Guapiles in 1931, then in 1934 Parismina, Guacimo, Hogar, La Rita and in 1958 part of the Santa Clara Plain.

In 1938 the United Fruit Company withdrew from the Atlantic Zone because of the occurrence of the Panama disease in their plantations. When the banana companies came back in 1960, they opened up areas to the North of Guapiles (Rio Frio and Cariari). They were, however, not the only ones in this area; a farming population had already established itself. The creation of infrastructure by the banana companies greatly stimulated colonization of the areas to the North and West (Jones, 1985) where also the Cocori area is located.

In 1961, the government, concerned about the lack of opportunities for landless people and the predominance of large holdings, tried to control deforestation and land settlement with a new law, as earlier efforts to do so had been virtually ineffective (Bolanos and Ulate, 1988).

To execute this law it created the Institute of Land and Settlement (ITCO). Its main objectives were:

- conservation of natural resources through the creation of wildlife refuges, national parks and protected areas.
- avoid the creation of large holdings; avoid land concentration.
- raise social and economic living conditions of small and medium producers through their participation in the economic development of the nation.
- increase productivity per hectare
- promote producer cooperatives (Government of Costa Rica, 1961).

The 1961 law declared all natural forest areas as natural reserves, which could only be cleared with the permission of the newly created institute. This institute attempted to set up a number of settlements. However, development of infrastructure and land clearing turned out to be so expensive, that land settlement by the institute itself was virtually stopped. Spontaneous settlement and invasion of forest areas went on as before. It was even supported or allowed by ITCO. According to the law, these settlers were precaristas (squatters) as the land did not belong to them. The law on "precarismo" (squatting) passed in 1941, legalized such occupation if settlers occupied land uninterruptedly without disturbance for more than 10 years; they then became owners. Even after 1 year of uninterrupted occupation they could claim certain rights on the land they occupied (Bolanos and Ulate, 1988).

From the foregoing it is clear that:

- (1) the government first stimulated the colonization and exploitation of its natural resources,
- (2) it hoped to create job opportunities and new farms for people without labour and/or land,

- (3) colonization resulted in concentration of land in the hands of large (multinational) companies and in the hands of large (cattle) holders,
- (4) later the government tried to check land concentration, create settlements for landless people, and to protect its natural resources.

Growing concern about the use of natural resources and the ineffectiveness of earlier laws to check deforestation (Porrás and Villarreal, 1986), urged the government to impose a new forest law (Government of Costa Rica, 1986). This law had great impact on land use and land tenure in the area of study as will be shown hereafter.

In short, the new law implies the following:

Reforestation is financed through the forest fund and stimulates the reforestation of areas which are only suitable for forest.

Investment in reforestation is subsidized with forestry tax credit certificates, which are negotiable. The certificates are not linked to ownership of land but to the investments done in reforestation (E. Cyrus, forest section of MAG, personal communication).

Deforestation is now only possible with a permit from the forest service after presentation of a title of the land, a management plan and a study showing the capability classes of the land. The classes are determined according to the manual issued by CCT in 1985, which is a modification of the Capability Classification of the Soil Conservation Service of the United States (SCS, 1966).

THE COCORI SAMPLE AREA

The Cocori area (12,000 ha) in the extreme NE part of the Atlantic Zone was studied in detail as a representative area for the most recent phase of colonization. Processes of change are more rapid here. This area is being colonised only now because of its remoteness and low agricultural potential, in contrast with the early stages of colonization in Costa Rica when especially suitable areas were occupied (Fig. 3). It is one of the last "free" areas for colonization and this certainly increases the pressure on land.

Landforms, soils and soil suitability

The area comprises 4 contrasting landscapes (Fig. 6):

- volcanic hills

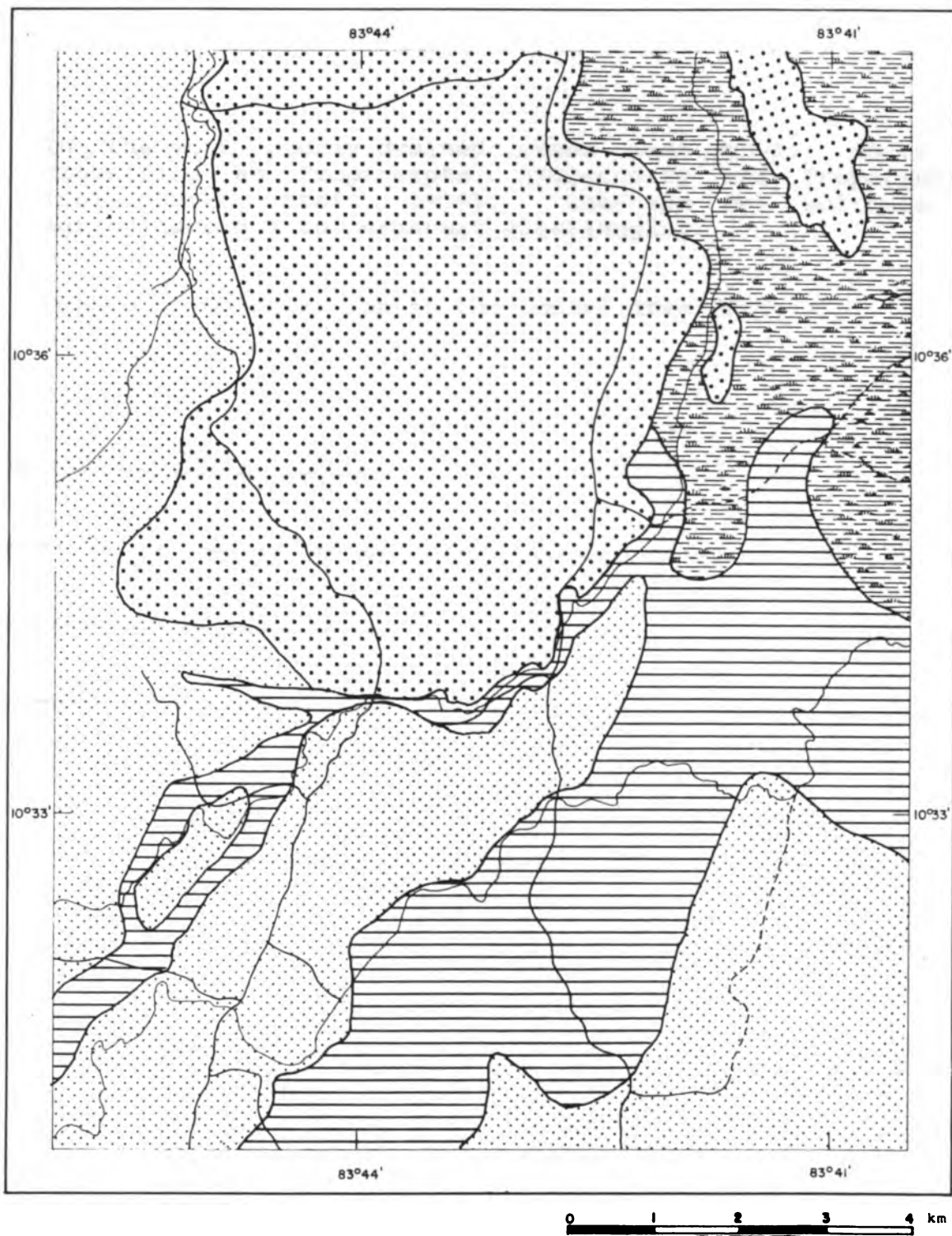
- residual hills
- fluvial plains (mainly sandy)
- marshy fluvial plains (mainly clayey)

The volcanic hills, which are 20 to 250 m high, are deeply dissected remnants of Late Tertiary to Early Pleistocene volcanoes. They consist of lava flows with intercalated pyroclastics, mainly of basaltic composition. Their slopes are steep (up to 90%) and are covered with a mantle of 1 to 2 m well structured clay over saprolite. Soils have a kaolinitic to halloysitic clay mineralogy and are rather acid with pH in water ranging from 4.5 to 5.0. They would best classify as andic Humitropepts (ICOMAND, 1987), for their low bulk density (800 kg/m³) and high phosphate retention capacity (70-80%). Steep slopes and low fertility limit their agricultural suitability. These hills should therefore be kept under forest.

The residual hills form the remnants of a Pleistocene alluvial plain and low outcrops of deeply weathered basaltic rocks. The residual hills which are 8 to 25 metres higher than the valleys are covered with a mantle of very deep reddish to brownish clays (2-3 metres deep) with characteristics similar to those on the volcanic hills. Apart from forest the less steep slopes could be used for perennials, provided they are acid-tolerant. The small valleys between the hills are poorly drained and swampy, or even occupied by small lakes. Soil in the valleys are classified as Tropaquepts and Tropofibrists (Soil Survey Staff, 1975). They are not suitable for agriculture due to their very poor drainage.

The sandy fluvial plain consists of Holocene fluvial sediments of volcanic origin. The rivers which deposited them dissected the residual hills in a northern to northeastern direction. Many sediments are coarse sandy and gravelly which indicates that once river discharges here were much higher than today. These changes are attributed to a change in course of a river Chirripo to the west after an eruption of the Irazu volcano. The soils along the river courses are classified as Vitrudands and Hapludands (ICOMAND, 1987) as they have clear andic properties. Their pH in water varies from 5.5 to 6.5. Further away from the river, where they are clayey and poorly drained, soils are classified as Tropaquepts (Soil Survey Staff, 1975). They are fertile flat soils and suitable for agriculture if drainage is not too poor.

The marshy fluvial plain occurs in the NE at an altitude of 10 metres above mean sea level and is very poorly drained. The deposits are mainly clayey and often poorly consolidated.



- | | | | |
|---|----------------|---|--------------------------------------|
|  | Volcanic hills |  | Fluvial plain (mainly sandy) |
|  | Residual hills |  | Marshy fluvial plain (mainly clayey) |

Fig. 6. Principal landforms of the subarea Cocori.

In the most poorly drained areas peat grows. Soils are classified as Tropaquepts, Hydraquents and Tropofibrists (Soil Survey Staff, 1975). They are not suitable for agriculture due to permanent waterlogging.

Phases of colonization in the Cocori area (Fig. 7)

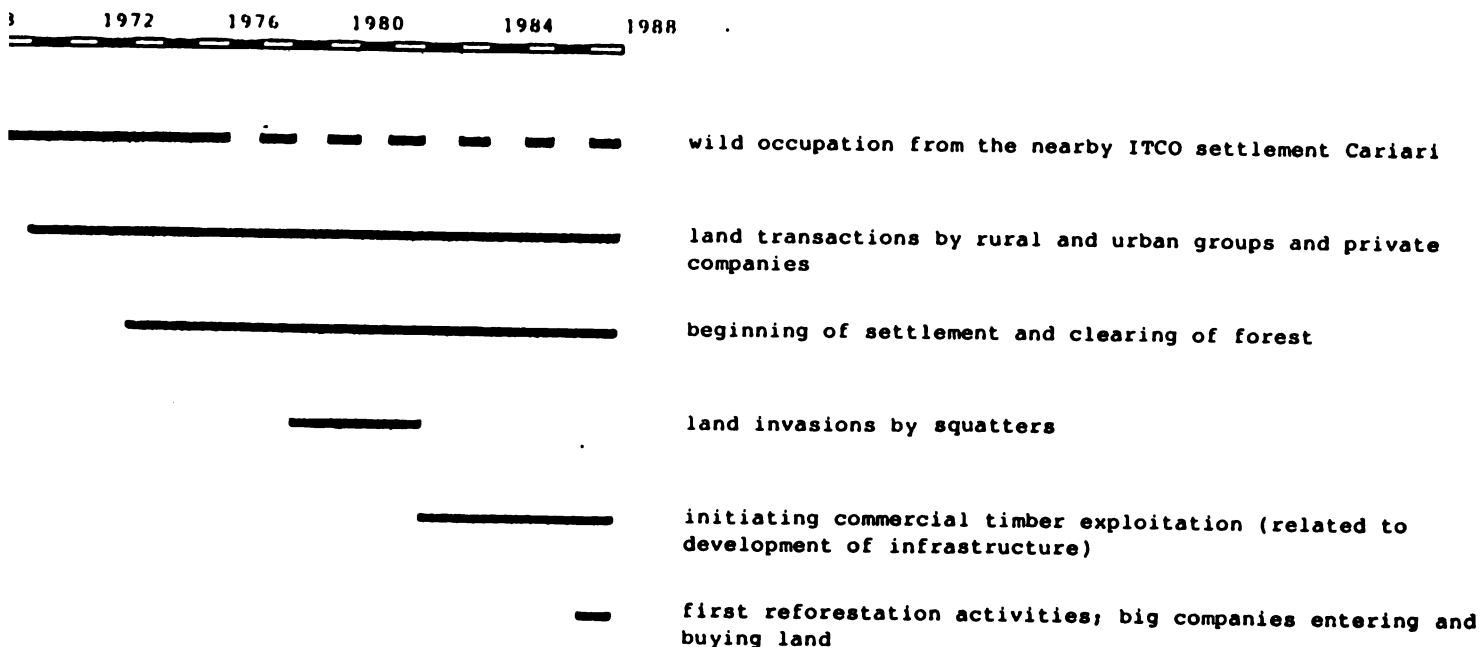


Fig. 7. The different phases of the colonization process in Cocori.

When the first settlers arrived in the late sixties, the area was completely covered with forest except for the swamps and the very recent river deposits, where a lower vegetation occurred. The first 5-year period was one of spontaneous and wild occupation from the nearby ITCO settlement at Cariari or via the Río Colorado in the North and via Tortuguero in the East. They mainly occupied land along river courses, where one finds the best soils (sandy fluvial plain) and where access is easiest. Soils of the other units were not suitable for agriculture, but could partly be used for extensive grazing. Land was demarcated with 3 m wide corridors ("carriles"), cleared from forest. These first settlers were a varied group, mostly young unmarried men, who were driven by various motives: some were unable to find land in the nearby settlement Cariari, others hoped to find "free land" to escape civilization, again others just wanted to grasp land. Conditions were harsh in that first period as no infrastructure existed. Moreover, the different groups were engaged in numerous conflicts over the borders of their land, which were difficult to control. It even happened that food brought from Cariari was burnt, forcing the 'would be' settlers to return to Cariari so that their land could be taken.

Disputes over land increased even more in the late seventies when land claims or land "improvements" were sold to others. Lack of properly and legally described land rights contributed much to this situation. Land rights and maps were usually legalized in San José, without a check of the real situation. Under such circumstances it is understandable that land transactions executed in San José and without a check or visit by the new owner of his property, contributed to the confusion. It was only in a later stage, when squatters occupied seemingly "virgin" land, that the full extent of the judicial mess about land rights came to the fore. The squatters were confronted with several owners, who all claimed ownership of the same piece of land (Fig. 8). This situation shows that many so-called owners had no real interest in developing their land, which suggests that speculation might be an important motive. Speculation certainly is a lucrative business in the area as land prices rose from 40-100 Colones per hectare in 1972 to 50,000 in 1987. However, it is dangerous to generalize the motives of the settlers: without infrastructure and far from the market, it was difficult to depend only on the farm.

From 1970 onwards the activities in the area are limited to extensive cattle raising and subsistence agriculture. Many farmers in the area are engaged in economic activities elsewhere; they invest the revenues in their farm. Some live on the farm, others have an administrator or guardian. Whether to develop their farm or to sell their land is usually not planned. It depends on their perspective of future possibilities, success or failure and of the presence of potential buyers.



Fig. 8. Map of overlapping landclaims of the subarea Cocori (source: IDA, agrarian development institute).

From 1982 onwards, when wood started to be exploited commercially, the economic situation changed drastically. Wood extraction is made possible through the construction and improvement of roads in the area (Fig. 9). The loggers exploit their own holding or the property of others. The wood is mainly exported to processing plants in the central valley. The new enterprise is an important source of income for the farmers which helps them to develop their farms. It also speeds up the rate of deforestation, at the same time stimulating the construction of new roads and the maintenance of existing ones.

To what extent deforestation has proceeded up to 1986, is shown in Fig. 10. Road construction apparently stimulated deforestation in areas which are not suitable for agriculture (Fig. 10). A farm survey in the area revealed that deforested areas are mainly used for extensive grazing both on fertile and unfertile soils (80 % of the cleared land). The area under crops varies from 2-10 % of the farm surface and is negatively correlated with farm size. Nearly the whole crop production is used for subsistence either of the family or of domestic animals like chickens and pigs. Most important crops are maize, rice, beans, cassava, plantain. Main cash crops encountered are cocoa and pineapple. Their surface area is very limited. The near absence of cash crops is mainly due to the large distance to the market. Under such circumstances, and knowing that land is cheap, extensive grazing is a very attractive land-use alternative. Its main advantages are: low risk, low labour requirement, low input requirement for farm development, easy management, little dependency on distance to the market, easy way to confirm land claims (it avoids problems with squatters). Ratana (Ischenum ciliare), a grass type with very low requirements, allows this land-use type even on soils with a very low agricultural potential. However, its productivity and quality are low.

It is clear from the foregoing that cattle holding predominates where deforestation is in progress (Gudmundson, 1983; Hecht, in prep.), particularly on soils with a marginal suitability for agriculture. As returns per hectare are low, a remunerative cattle farm needs to be large. In 1986, 300 ha seemed necessary in Cocori to work economically (Wielemaker, 1990). According to Leonard (1985), it earns the country only \$ 42/km² in export revenues, compared with \$ 6036/km² for banana.

Apart from its impact on forest clearance, extensive grazing appeared to have the following effects on reddish clay soils of the residual hills. Due to compaction of topsoil under the trampling of cows, its infiltration rate decreased from about 1000 cm/day to about 40 cm/day (Spaans et al., in prep.); the organic matter percentage decreased from 9 to 7 during a 17-year period (Fig. 11). Mechanical logging on the fragile Andisols on the fluvial land unit resulted in destruction of topsoil structure of 30 to 50 % of the land surface (unpublished data).

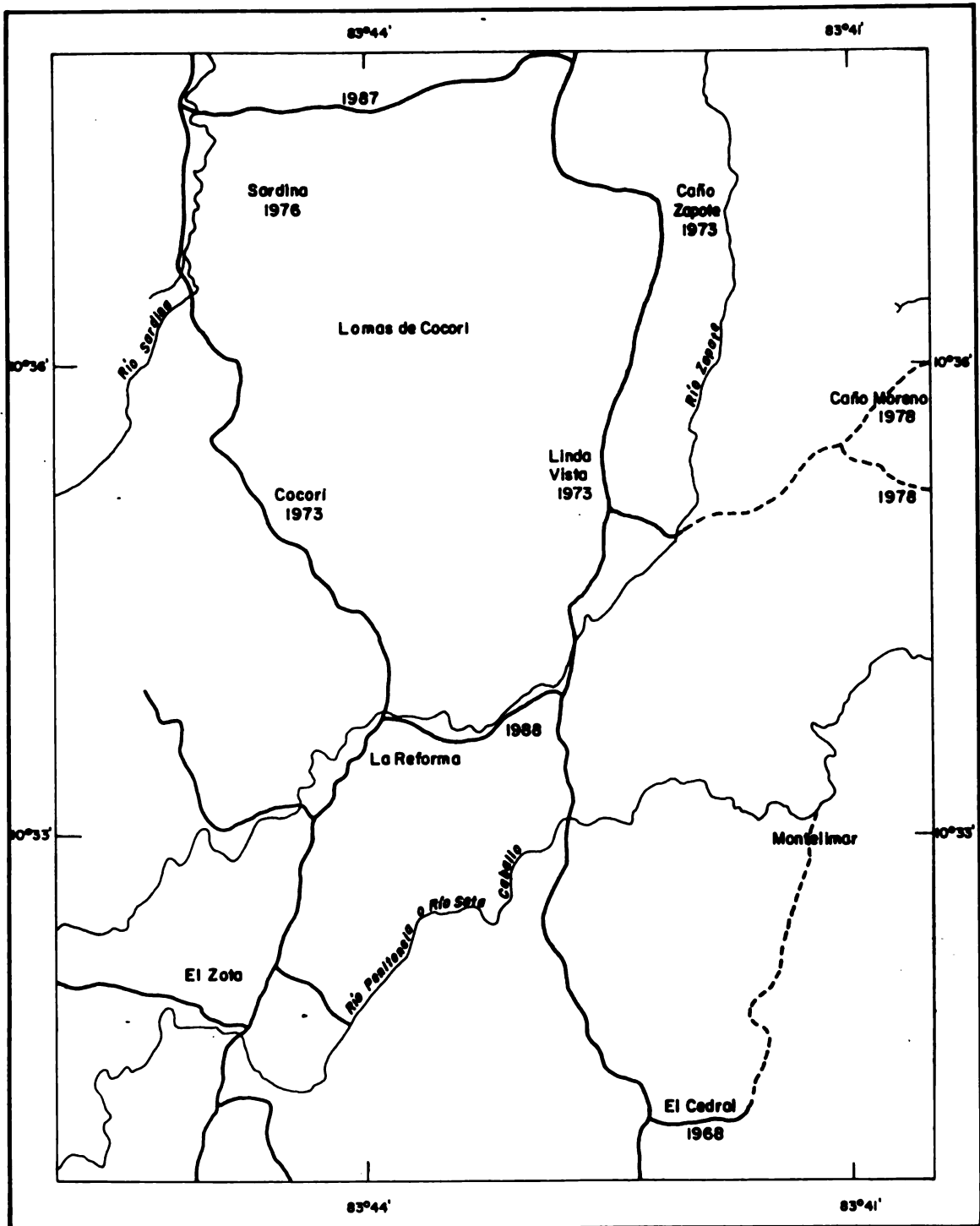
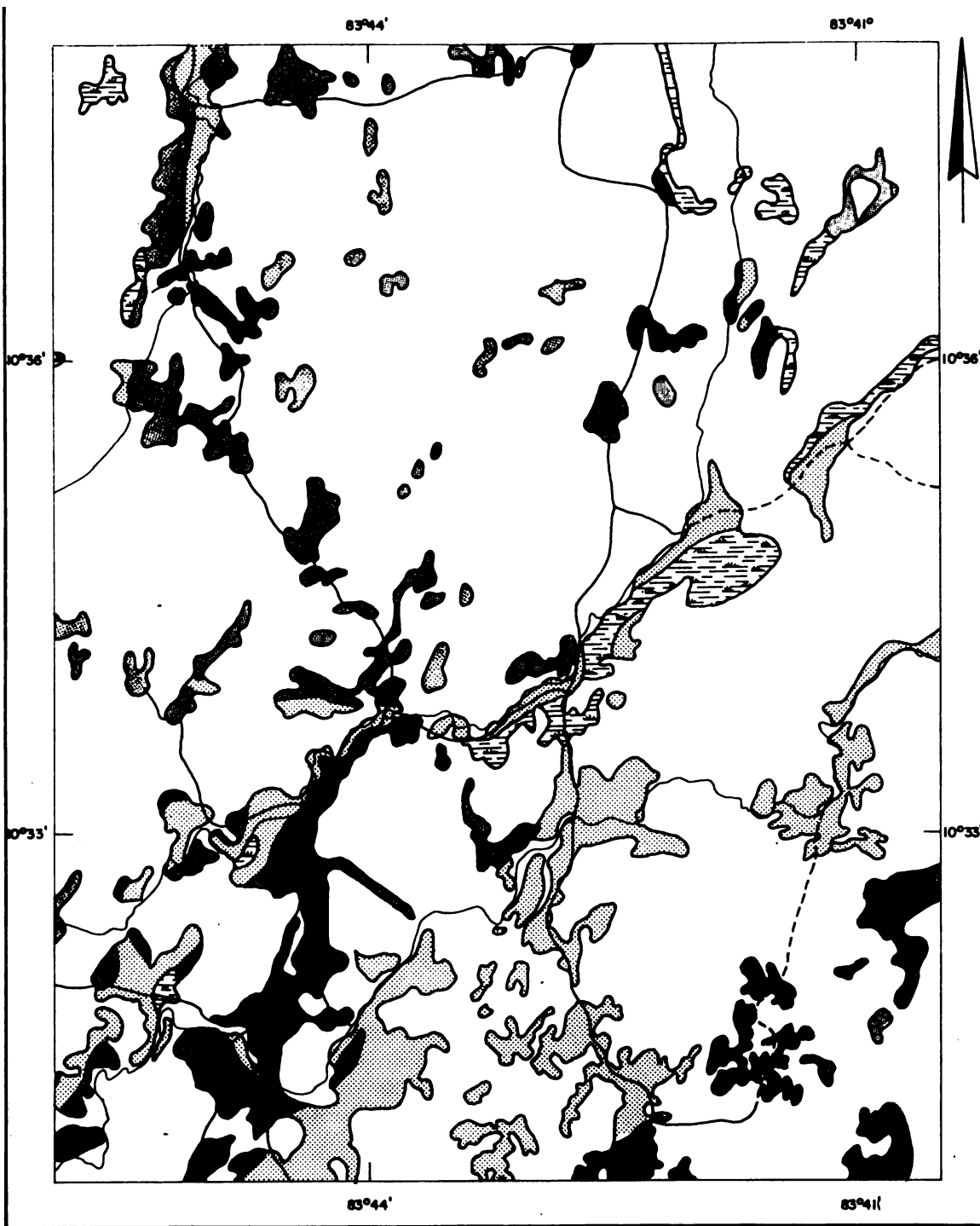


Fig. 9. Development of infrastructure in the subarea Cocori.







-  Soils moderately suitable for agriculture; suitability improved if drained
-  Well-drained, moderately sloping to sloping soils of low fertility, only suitable for forest and non-demanding perennials
-  Very poorly drained soils, not suitable for anything except protection
-  Soils under forest, 1986 situation

Fig. 10. Soil suitability in areas deforested in the subarea Cocori till 1986.

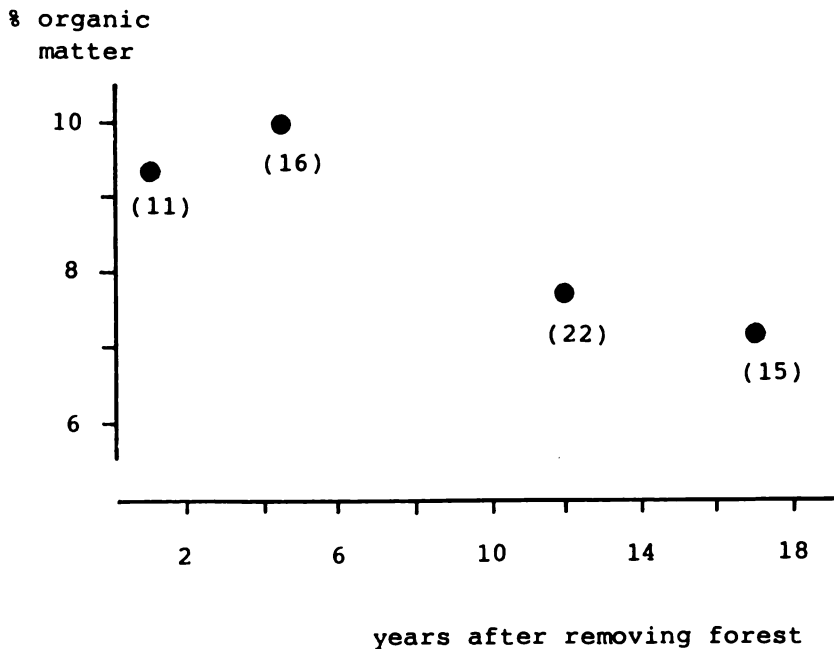


Fig. 11. Decline in organic matter in topsoils of an Andic Humitropept under pasture in relation to years after clearing the forest.

Since its introduction the 1986 forest law had the following effects in the Cocorí area:

- (1) Deforestation is only allowed if people have a permit. Such a permit is more easily obtained by large owners than by small 'owners' as the last ones do not have the means or the connections to comply with the rules of the new law. Moreover, the tax benefits are not so attractive to the latter.
- (2) While most holdings with a title had an area of not less than 200 ha (Registro Nacional de Costa Rica, 1988), the size per title increased dramatically since 1986. Large companies for which the law is very favourable, buy vast areas of land: 5000 ha were bought by one company, which also has a claim on 20,000 ha; another company is buying 1,000 ha and again another claims 9000 ha. The companies preferably buy land with natural forest, so that they profit from both deforestation and reforestation. In case the land has a suitability for agriculture, they will use it for other purposes than forest.
- (3) Large tracts of land will be converted in monocultures of trees, which compared to the natural ecosystem with its enormous biological diversity, means a serious impoverishment.

(4) The law limits strongly the possibilities for squatters in areas under forest as they cannot comply with its requisites.

At last, in February 1987, in the Conference of the International Union for the Conservation of Nature, the government declared the northern part of the Atlantic Zone, including the Cocorí area, part of a Peace Park to be established on both sides of the border with Nicaragua. The plan for this park foresees several management options, which have to be elaborated further (Si a Paz, 1988).

DISCUSSION

The policy of the government in regulating the process of land settlement seems geared towards three main objectives, i.e. (1) the economic exploitation and development of its natural resources, (2) the creation and just distribution of opportunities for land and labour among its people, (3) the protection and rational use of its natural resources.

The attention given to those objectives was not always balanced and it changed also in the course of history. Sometimes one objective received much more attention than the others, which urged the government to issue laws and new policies to curtail negative effects. In that sense it is a policy of trial and error: measures were taken after the negative effects of a former policy became visible. An example of such a policy is the development of the Atlantic Zone by multinational companies, which led to a monopoly of these companies regarding access to land and jobs.

To correct the situation, the government bought land from those companies and got involved in the active settlement of landless people. In addition it issued the law on 'precarismo' in 1941 (Bolaños and Ulate, 1988), which legalized occupation of land by precaristas. This indeed created opportunities for people without land, but negative effects of the same law became a threat to existing natural resources, as former owners had to be amply compensated with cheap virgin land.

The settlement law (Government of Costa Rica, 1961), ought to correct these effects but was hardly effective as was explained previously. Then in the last 20 years we note an increasing awareness that virgin land becomes scarce and must be protected. It leads to the creation of parks and reserves, but measures to control or regulate forest destruction and land invasions outside the parks are of no avail. Interest groups, speculation, scarcity of resources and ineffective control measures are here at play.

Growing concern, both within and outside Costa Rica leads then in 1986 to a law, which for the first time in the history of Costa Rica attempts to regulate resource utilization according to the capability of the land. Emphasis is clearly on the third objective, i.e. the protection and rational utilization of its resources. The 1986 law certainly is very effective as was explained in the preceding section, because it (1) promotes reforestation as an attractive alternative for extensive grazing, (2) it protects natural resources in areas which are not suitable for exploitation, and (3) it regulates land use according to land capability.

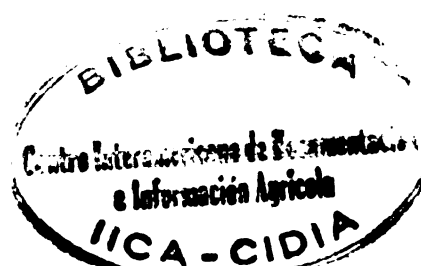
Negative effects regard particularly the second objective, i.e. the creation and just distribution of opportunities for land and

labour among the people. Now that land becomes scarce, squatters are driven more and more to areas which are only suitable for forest. That is where land is less vigilated and where they hope to maintain themselves. In actual fact, this means a threat for the conservation of natural resources. However, under the 1986 law, chances are remote that those people are able to develop their 20 to 30 ha plots in areas only suitable for forest.

While the new law restricts the opportunities for landless people, it greatly stimulates opportunities for companies and large holders, leading to concentration of land and capital. Developments in Cocorí are very illustrative of this situation and were rightful denounced by action groups of the Canton Pococí (La Nación, 1988).

Another possible loophole in the law is the requirement to determine the land capability class of land prior to deforestation or reforestation. Because presently available soil and land capability maps (Nuhn, 1967; Jimenez Fallas, 1972; Vasquez, 1979) are too general, more detailed studies will be executed on contract. In view of the interests involved, it is tempting for contracted specialists to adapt criteria to the interests of the landowner. Adequate control measures are also essential to verify the execution of approved management and reforestation plans.

Despite the negative effects, as discussed above, the Costa Rican government makes a sincere attempt to plan and guide the use of its natural resources. Hopefully it evolves towards an encompassing land use policy.



CONCLUSIONS AND RECOMMENDATIONS

The following recommendations are based on experiences in the area of study, but may not be limited to this area.

- Protect that part of the area that is not suitable for agriculture and investigate adequate forms of management as follows:

(1) Selective extraction of trees without changing the functioning of the system. Such a labour intensive system was shown to be feasible in Suriname (de Graaf, 1986; Jonkers, 1987; Poels, 1987).

(2) Conservation of the natural forest in areas to be protected

(3) Diversify commercial tree plantations, planting also natural indigenous species

(4) Restrict tree monocultures to those areas which have no possibilities for the development of ecotourism.

- To guide and plan the management of the various land units, technicians need sufficiently detailed maps of soils and their suitability. The peace park offers conditions for the testing of management options as proposed above. To study its socio-economic feasibility, the various social groups living in the area should be involved.

Because of the scarcity of virgin land and because of the needs of people without land, it might be worthwhile for the government to consider the following measures:

(1) Acquire suitable land for agriculture from already cleared areas that are presently underutilized, for people who are in need of it.

(2) Create a land taxation system that corrects suboptimal use of resources and charges according to land capability and size of holding.

(3) Work out a strategy so that people without land and jobs may also benefit from the new forest law.

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