DECISION SUPPORT SYSTEM FOR SUSTAINABLE ECOSYSTEM MANAGEMENT IN ATLANTIC RAIN FOREST RURAL AREAS (ECOMAN)

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Typology of the main socio-economic pressures, factors and agents of change in the selected areas

Deliverable 15

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INTRODUCTION

The present report aims at presenting the typology of main pressures for the two study areas of ECOMAN: Cachoeira Catchment (Bahia), in Brazil; and Central Volcanic Mountain Range Conservation Area, in Costa Rica.

In both study areas tropical deforestation drives land cover and land use changes, migratory processes, biodiversity changes, erosion processes. Nevertheless, the two case-studies are somewhat different. In the Cachoeira Catchment, the decrease of cocoa production in the last decades, without sustainable socio-economic alternatives, produced significant human pressures both on rural areas (land use changes and forest fragmentation) and urban areas (increase of built-up areas with few measures of territorial planning). On the other hand, the Conservation Area of Central Volcanic Range (Costa Rica) reflects the implementation of a solid forest conservation policy, which faced the strong deforestation rates felt in this country since the middle of the 20th century.

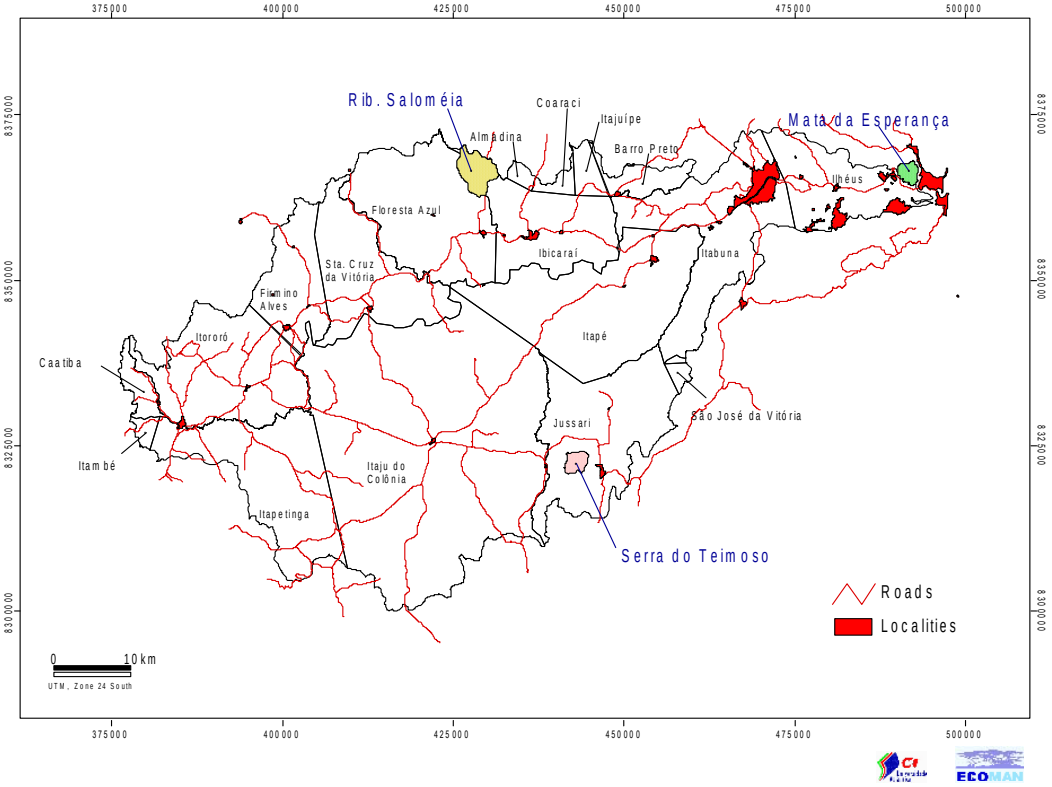
The report now being released relies on the analysis of the socio-economic databases (Deliverable D11) and on the maps of the most sensitive areas in terms of socio-economic change (Deliverable D5).

This analysis is structured in three parts. The first two chapters concern some socio economic variables (Population, Households and Agrarian Structures) for both case studies. The third chapter presents a typology of administrative units according with the main socio-economic pressures identified in the previous chapters.

1 CACHOEIRA CATCHMENT (BAHIA) BRAZIL

This area is located in southern Bahia, with a drainage surface of around 4 600 km^2, which encompasses twelve municipalities (Fig. 1). Around 600 000 inhabitants live in the area of the catchment. There are two main activities in these municipalities: cocoa production and cattle husbandry. Nevertheless, the coastal municipalities, especially Ilhéus, have a tourism potential, which is being developed in the last years. Three hotspots were defined in the catchment: Mata da Esperança (Photo 1), Serra do Teimoso (Photo 2) and Ribeirão Saloméia (Photo 3).

Fig. 1. Situation of Cachoeira Catchment



In this catchment, there is a striking diversity of agricultural areas that are marked by diverse natural features and intensity of human intervention. The cocoa production was introduced in the region in the middle of the 18 century, and since then has undergone a significant development being, in present times responsible by 600 000 ha. The system adopted uses the trees of Mata Atlântica to give shadow to the cocoa, being therefore a system (named cabruca) that not only generates income and settle the population to the rural land but also contributes to conserve fragments of the primary tropical forest. However, the intensification of this system contributed to increase the density of cocoa species by destroying the trees.

In the last decades the incidences of the illness known as "vassoura-de-bruxa"[1] (witches' broom), which attacked the cocoa plantation in a devastating manner, the cocoa farmers

[1] Fungal disease caused by the fungus *Crinipellis Perniciosa*, which attacks the cocoa plant (branches and fruits) triggering a drastic decrease of the production.

knocked down the trees in order to take advantage of its commercial value, and converted the land to other productions that do not need shade.

Photo 1. Urban sprawl in the margins of the park, near Banco da Vitória

In the upper catchment due to the less dense forest, a smaller amount of rain, and poor soils, aren't as much adequate to the cocoa production as the coastal areas. The livestock production system is extensive, with low-income and low labour force.

Mata da Esperança is the hot spot that comprises the Unit of Conservation of the Municipal Park of "Boa Esperança", being located in the municipality of Ilhéus, Bahia. It is one of the few places in the region presenting some traits of primary tropical forest structure within an urban perimeter (Ilhéus). The preservation of the forest results from being, until recently, the watershed for the city's reservoir. Although it has been designated as municipal reserve, it is an area subjected to severe anthropic pressures, which results mainly from the increasing urban growth expressed in the sprawl of slums that surround the area.

The region of Serra do Teimoso is located in the municipality of Jussari. The focus of this hotspot is a Private Ecological Reserve (RPPN - Reserva Natural da Serra do Teimoso) that presents a primary tropical Atlantic forest structure. However, this reserve is surrounded by agricultural fields where significant land use changes occurred during the last 20 years (cocoa, pasture, coffee).

Photo 2. Private Ecological Reserve of Serra do Teimoso

The Saloméia River Sub-Catchment is located in the municipality of Floresta Azul. This catchment, with an area of 5 800 ha, has a reservoir of 67.7 ha for the supply of water to a population of approximately 80 000 in the municipalities of Floresta Azul, Santa Cruz da Vitória, Firmino Alves and Ibicaraí. This hot-spot presents different types of land use (cocoa, pasture, corn, etc) and has the principal soil types of the Cachoeira River watershed. The socio-economic pressures identified in the area result mainly from the agricultural activity, which is visible along the perimeter of the reservoir.

Photo 3. Intensive agricultural use on the Ribeirão Saloméia banks

There are four main types of economic activity in the catchment:

- The cocoa production, with decreasing significance due to the disease “vassoura-de-bruxa” and the low prices of cocoa in the international markets;
- The cattle rising, showing a significant trend of increase in the cocoa areas;
- The tourism, more significant in the coastal areas of Ilhéus, is nowadays in a phase of growth with incentives to the ecotourism by using old cocoa farms and exploiting natural features such as waterfalls, lagoons, and forest reserves;
- The industrial activity was during several years related with agro-industrial activities: milk in Itabuna and cocoa processing in Ilhéus. In the last years, some incentives attracted some industries related with new technologies in Itabuna.

Due to the geographic location and the availability of adequate infrastructure, the cities of Ilhéus and Itabuna became the main centres of convergence and services of the region. On the other hand, they are the municipalities of greater population concentration in urban areas.

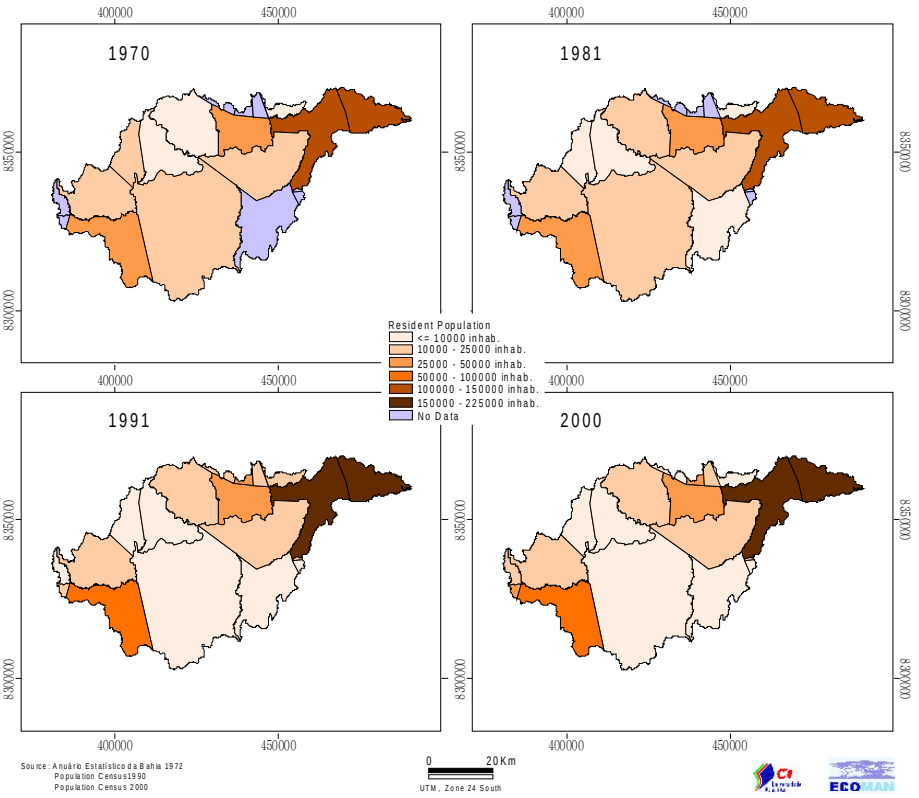
1.1 Population distribution

The Cachoeira River Catchment, comprising a total area of about 4600 km^2, encompasses eighteen municipalities, of which only twelve are almost completely within the catchment and considered in this analysis.

1.1.1 Resident Population

According to the Population Census of 2000 (IBGE, 2002), the population in the Cachoeira catchment is mainly assembled in the urban areas. Especially in Ilhéus and Itabuna that represent around 53% of the population in the municipalities of the catchment area. Because of this concentration of population, these are also the municipalities with bigger social problems related with the spreading of slums, underemployment and unemployment with the increasing of social disparities. The municipalities of Ilhéus and Itabuna concentrate the population of the catchment since the 1970s (Fig. 2).

Fig. 2. Resident population, Cachoeira catchment, 1970-2000

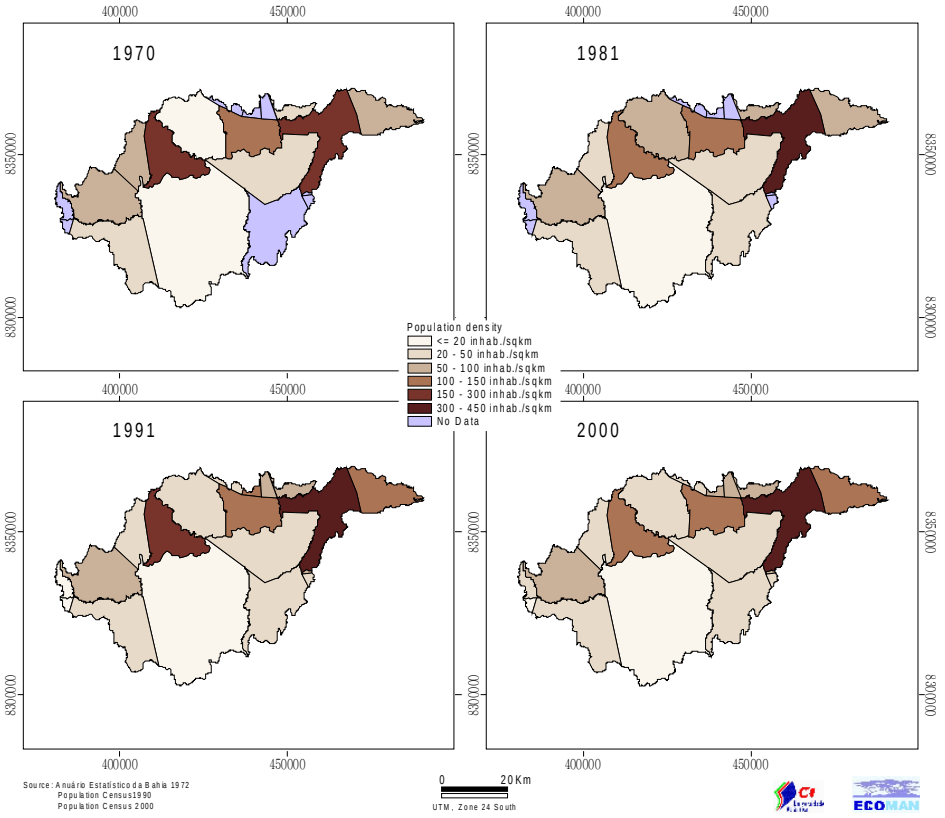


The total population, in 2000, of the municipalities that make part of the perimeter of the catchment is of 587 764 inhabitants. However, considering that the entire area of the municipalities is not included in the catchment, an estimation was made of the population resident within the catchment area. Therefore, the estimated population in the catchment is of 455259 inhabitants, in 1991 and of 471974 inhabitants, in 2000.

This estimation considered the total urban population of municipalities (except for Itapetinga, in which the urban area is located outside the Cachoeira catchment) and the rural population according with the percentage of the municipality area in the catchment (Ilhéus, 11%; Itabuna, 71%; Barro Preto, 31%; Floresta Azul, 100%; Ibicarai, 91%; Sta. Cruz Vitoria, 100%; Firmino Alves, 100%; Itape, 100%; Itaju do Colonia, 100%; Itororo, 100%; Jussari, 100%; and Itapetinga, 25%).

The average population density, in the catchment, increased since the 1970 from about 53 inhab./km^2 to about 82 inhab./km^2, in 2000 (Fig. 3). The municipalitiy of Itabuna registers the highest population density (442 inhab./km^2). Although Ilhéus has a high resident population, its dimension makes that the density is more lower than Itabuna (120 inhab./km^2).

Fig. 3. Population density, Cachoeira catchment, 1970-2000



1.1.2 Urban and Rural Population

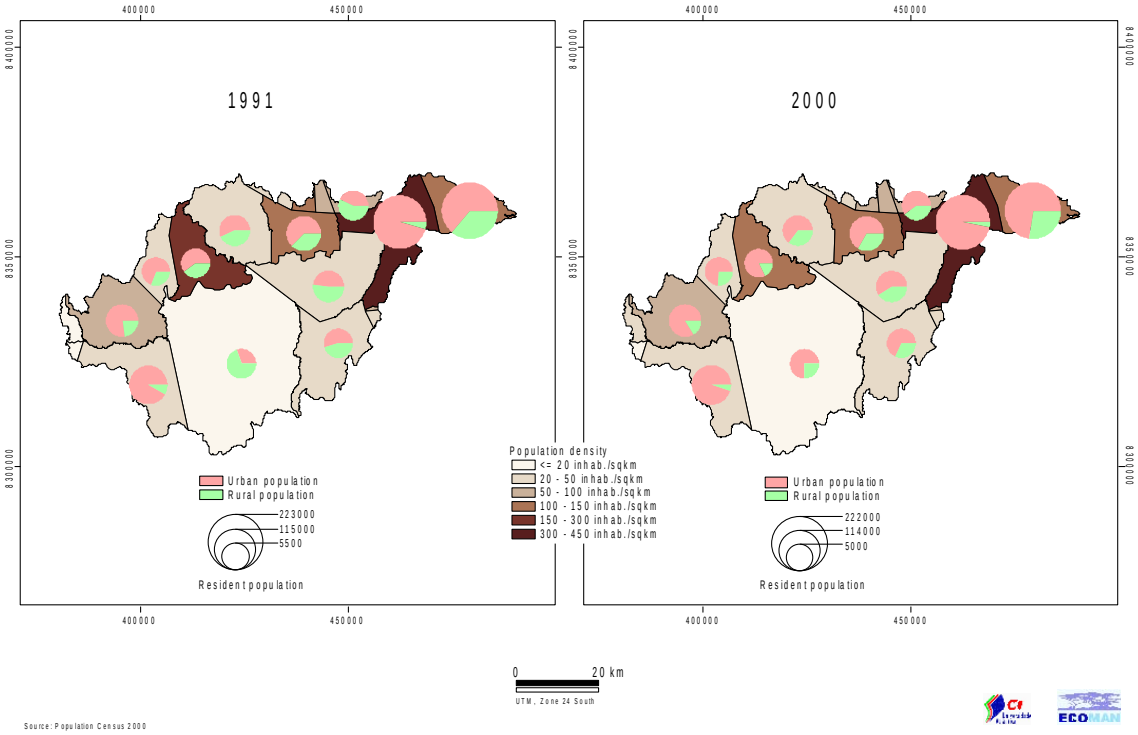
Nowadays, the municipalities of the Rio Cachoeira Catchment, there is the prevalence of the urban population in relation to rural. This urbanisation tendency, which increased in the last decades reaches about 83%, in 2000. Nevertheless, these figures should be read carefully because the criteria of urban population in Brazil consider as urban population, all the people who lives in the heads of municipalities, despite the size of the population[2].

[2] The analysis of urban and rural populations is always difficult due to the different types of definition used by the countries. In Brazil, as well in this part of the analysis, the definition of urban and rural population employed is the one presented by the Instituto Brasileiro de Geografia e Estatística (IBGE). According to this institute (IGBP, 1997), urban population is defined

Therefore, these figures are important to have a glimpse of the concentration of inhabitants in the cities and villages, with all the social and economic problems and pressures resulting from this. This significant concentration of the population is also related with migratory movements occurring in the last decades that were responsible for the abandonment of rural areas and the dislocation to the urban areas specially Ilhéus and Itabuna. There are several factors to explain the exit of population from the fields: the cocoa crisis induced many dismissals in the rural areas. The farmers give preference to temporary workers more then to permanent labour force.

The population considered has urban is quite high in the municipalities of the catchment (Fig. 4), both in 1991 and 2001 (average of 75.5% and 82.7%, respectively). Only the municipality of Itaju do Colonia is an exception. From 30%, in 1991, passes to 75%, in 2000.

Fig. 4. Urban and Rural Population, Cachoeira catchment, 1991-2000



In 2000, the highest weights of urban population are registered in the municipalities of Itabuna (97%, being the third municipality more urban in Bahia), Itapetinga (95%, but the urban area is located outside the catchment), Itororo (84%) and Ilhéus (73%). The successive partition of municipalities, with the autonomy of Ibicarai (1952), Buerarema (1959), Itape

by physical criteria and not by functional criteria. It is considered urban the entire population resident in the urban perimeters (urbanised or not) delineated by each municipality, surrounding any head of municipality (city) or district (village). These criteria are more of administrative type then geographical or economical, and contribute to an underestimation of the rural population (Camarano, & Abramovay, 1999 and Veiga, 2001). In fact, even if a head of municipality has only 20 inhabitants (all of them working only in agricultural activities) they will be considered always as urban population. Therefore, the growth of "urban" population in the study area must not be considered as integrated in a process of urbanisation but as a passage from field to villages, i.e. as a process of concentration of population.

(1961), Itaju do Colonia (1962) and Jussari (1985), which separated from Itabuna, explain partially the high weight of urban population in this municipality.

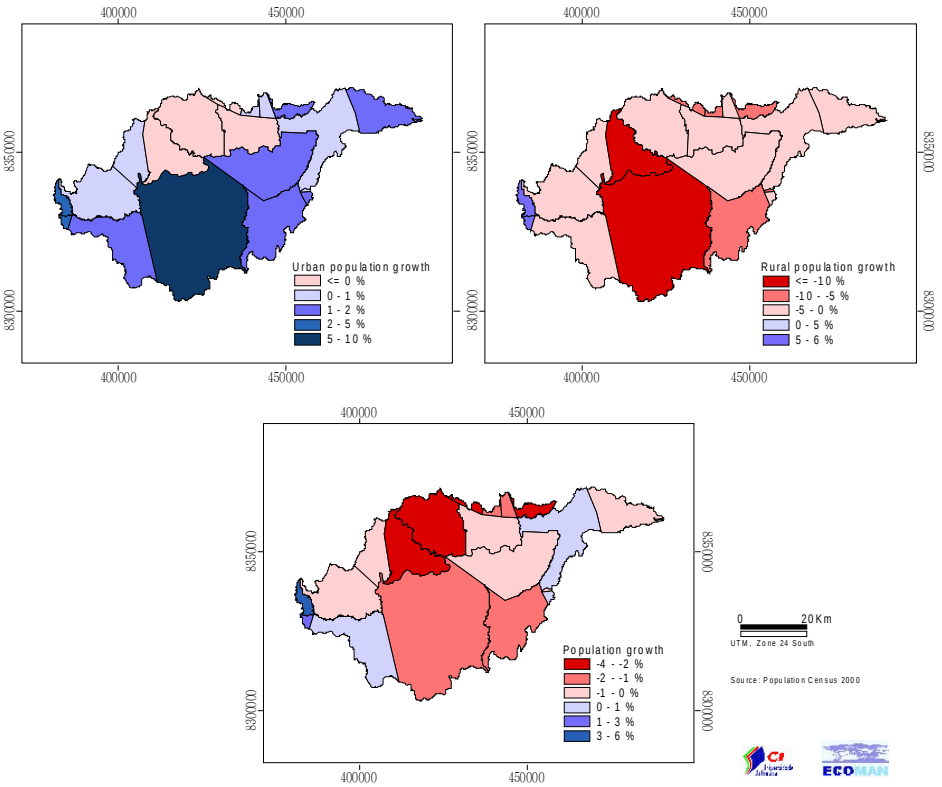
The municipality of Itapetinga, which is strictly cattle farm based, has a very low percentage of rural population (4.7%), which is characteristic of this type of activity that requests a very small number of workers, being an activity that does not maintain the man in the fields. The increasing of activities such as cattle farming (as it occurred in the municipalities of Itape, Itaju do Colonia, and Itororo) was therefore, responsible for the increase of the "urban" population.

1.1.3 Population Growth

The cocoa crisis, but also the dry years of the 1990s, produced a strong rural exodus, which was directed to the main regional urban centres. Ilhéus and Itabuna were, in south Bahia, the cities that more suffered with these migratory movements.

In general terms, the population in the Cachoeira catchment registered, between 1991 and 2000, a slight increase (0.03% per year). However, almost all of the municipalities (with the exception of Itabuna and Itapetinga) register a decrease of population in that period. This decrease of the population is accompanied by the diminishing (-3.8% per year) of the rural population and the slight growth (1% per year) of urban population (Fig. 5).

Fig. 5. Annual Average population Growth, Cachoeira, 1991-2000



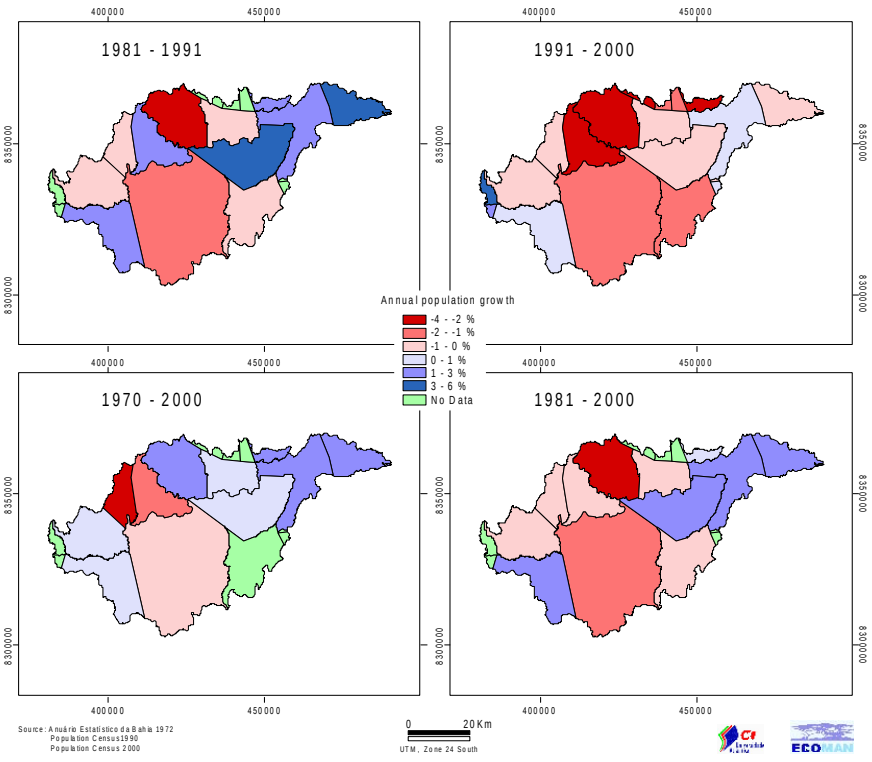
From the analysis of the municipalities during the period 1991-2000, it is important to point out the different situation of the municipalities of Ilhéus (small decrease of -0.08% per year)

and Itabuna (small increase of 0.67 per year). Furthermore, is also remarkable the circumstances of Itaju do Colonia and Jussari, which present a general decrease of the population (1-1.5% per year), and at the same time a significant growth of the urban population (especially in the case of Itaju do Colonia with 9.33% per year).

The analysis of the annual average population growth in three periods shows the following: in the period of 1991-2000, although the slight increase of population in the catchment, it is a phase of general decrease (or at least of maintenance) of population in the municipalities (Fig. 6). In fact, the global growth (0.03% per year) occurs only because the municipalities of Itabuna and Itapetinga growth 0.67 and 0.89, respectively. The volume of population affected in these municipalities is sufficient to produce an increase of population in the catchment.

The period of 1981-1991 is characterised by an acute increase of population in the Cachoeira catchment. With Ilhéus (5.46% per year) and Itape (3.24% per year) revealing the highest growths among the municipalities. When considering the period of 1981-2000 (or 1971-2000) the growth of population in the Cachoeira catchment is more moderated (1.3-1.5% per year).

Fig. 6. Annual Average Population Growth, Cachoeira, 1970-2000



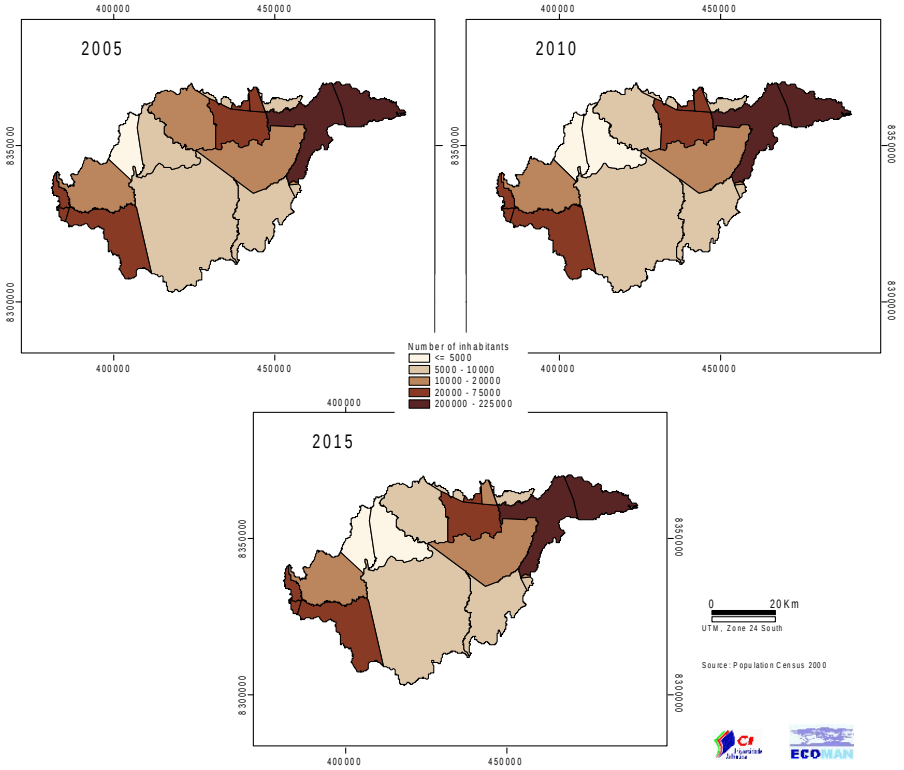
1.1.4 Population projections

The estimation of the population[3] for the years 2005, 2010 and 2015 shows that in terms of general distribution the two municipalities of Itabuna and Ilhéus will continue to concentrate

[3] These projections were made recurring to the formula of annual average population growth. They are simple estimation and not true population projections. However, the data available didn't permit to calculate true projections. The growth rate used in the formula was the referent to the period of less intense growth: 1991-2000.

the population of the catchment. However, Itapetinga and Ibicarai will increase their power of attraction of population (Fig. 7).

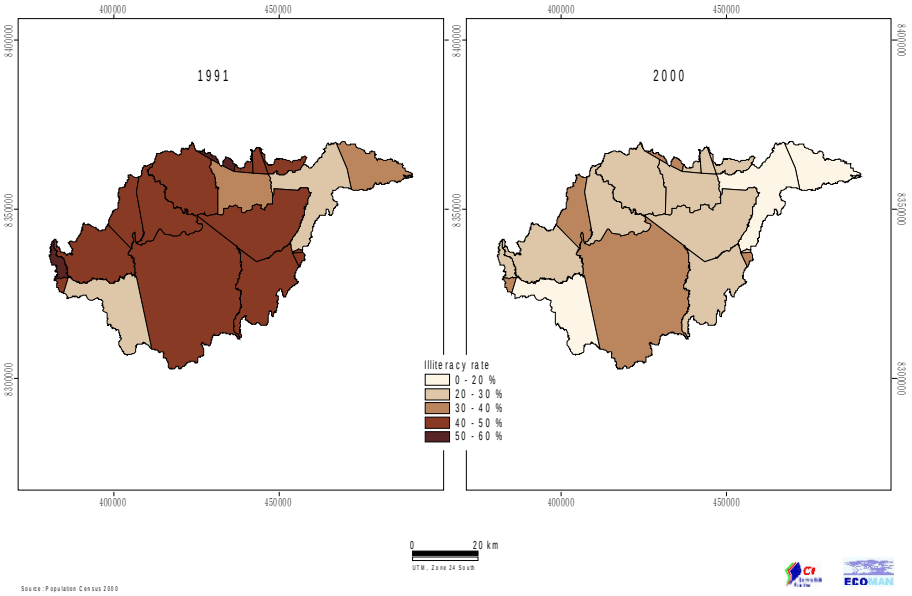
Fig. 7. Population projection for Cachoeira catchment, 2005, 2010 and 2015



1.1.5 Level of education

In Cachoeira catchment, the illiteracy rate, in 1991 and 2000, is rather high, although registering between these two years, from 40.3% to 25.9%, respectively (Fig. 8). The lowest levels of illiteracy occur in Itabuna (14.3%), Ilhéus (19.7%) and Itapetinga (19.9%).

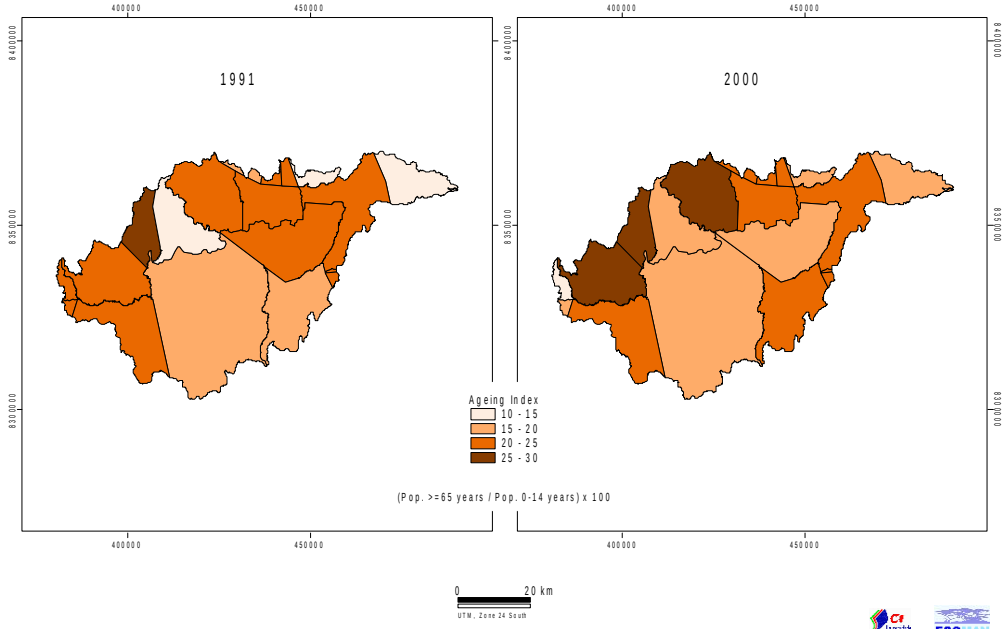
Fig. 8. Illiteracy rate, Cachoeira, 1991-2000



1.1.6 Groups of age

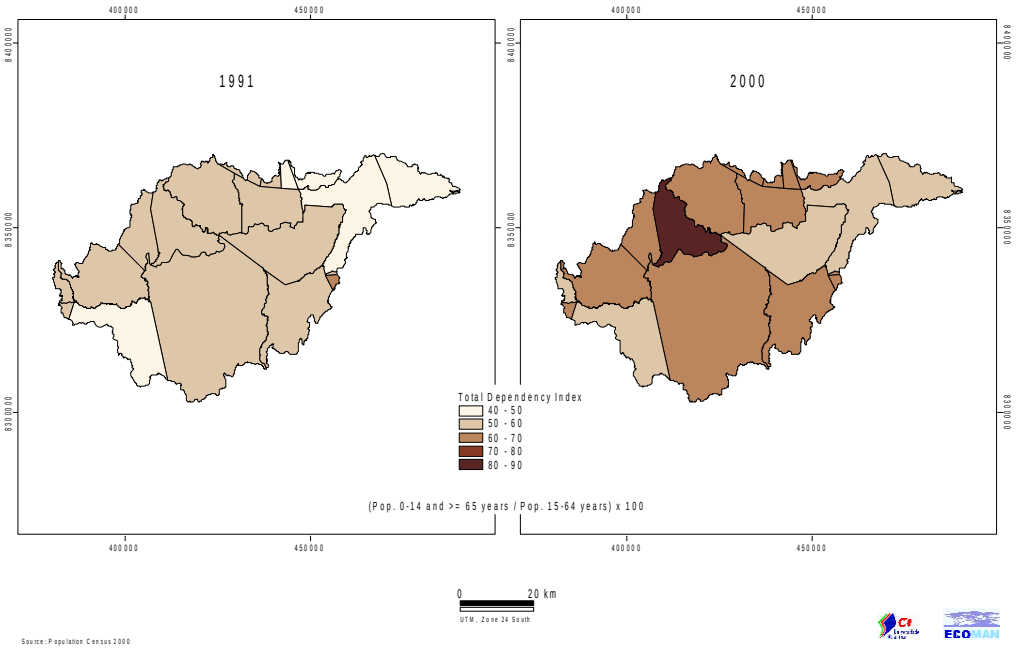
The ageing index, which represents the weight of elders in the younger population, shows an increasing from 19.7, in 1991, to 21.3, in 2000. The biggest increases occurred in Jussari and Floresta Azul (Fig. 9). In Jussari, Itabuna, Itape, and Itapetinga, this index slightly decreased.

Fig. 9. Ageing Index, Cachoeira, 1991-2000



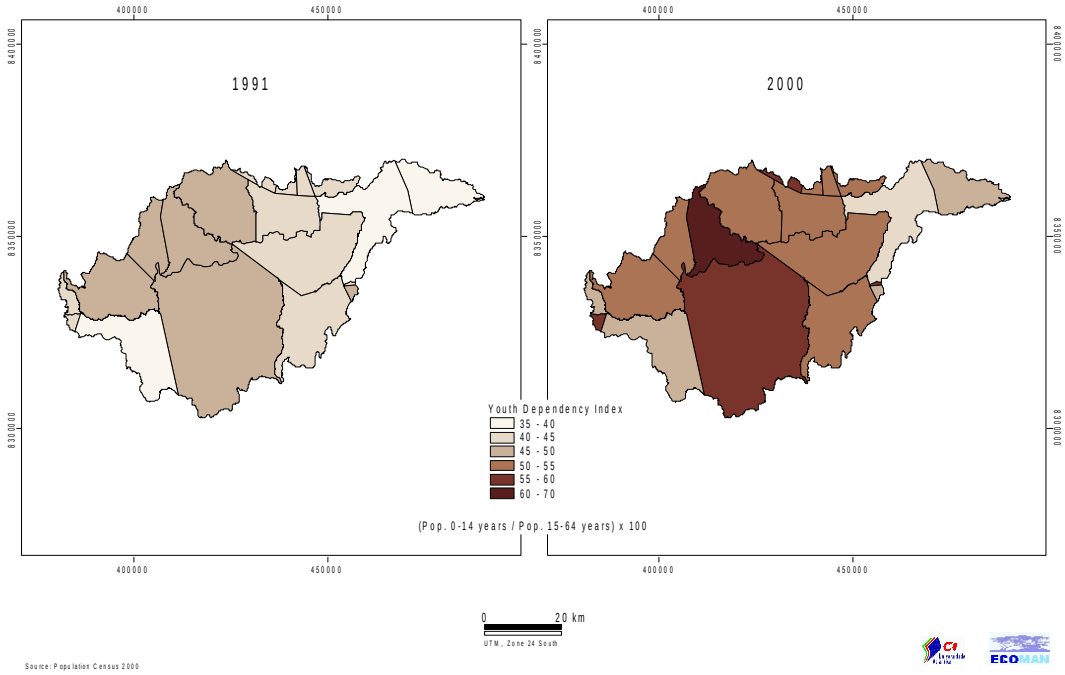
The total dependency index increased in all the municipalities of the catchment from 50.7, in 1991, to 64.5 in 2000 (Fig. 10). This increase was bigger in the inland municipalities of Sta. Cruz da Vitoria, Jussari, Itapetinga and Itaju do Colonia. This index shows the weight of youths and elders in the potential active population.

Fig. 10. Total Dependency Index, Cachoeira, 1991-2000



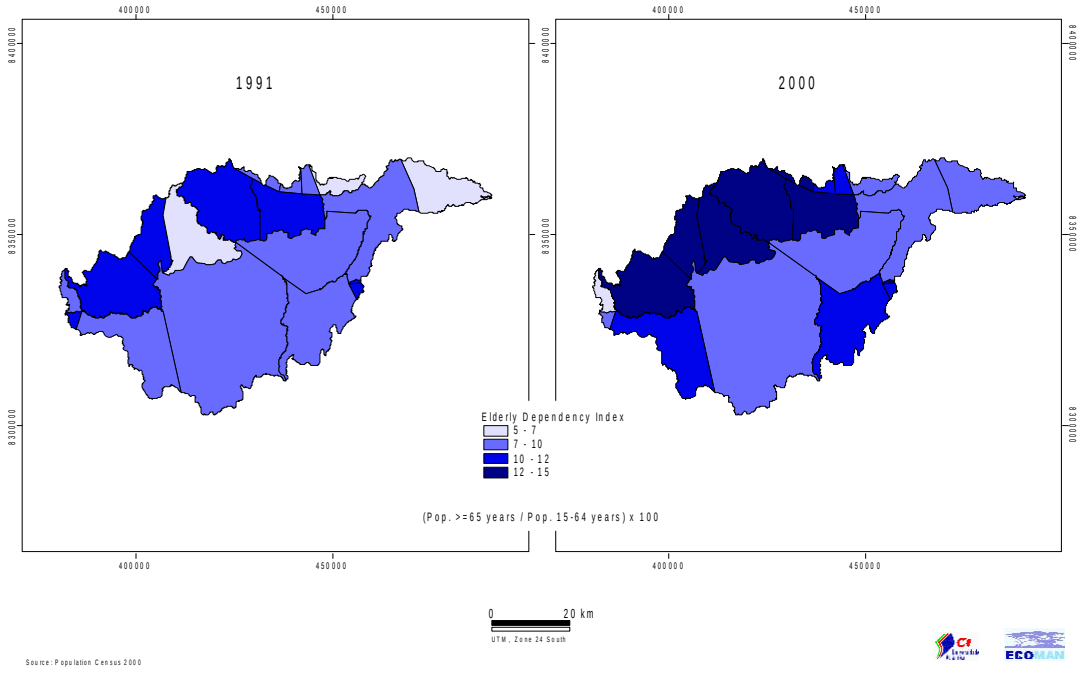
The youth dependency index strongly increased in all the municipalities of the catchment from 42.8, in 1991, to 53.2 in 2000 (Fig. 11). This increase was bigger in the municipalities of Sta. Cruz da Vitoria and Itaju do Colonia.

Fig. 11. Youth Dependency Index, Cachoeira, 1991-2000



The elderly dependency index increased in the municipalities of the catchment from 8.4, in 1991, to 11.3, in 2000 (Fig. 12). This increase was bigger in the municipality of Sta. Cruz da Vitoria.

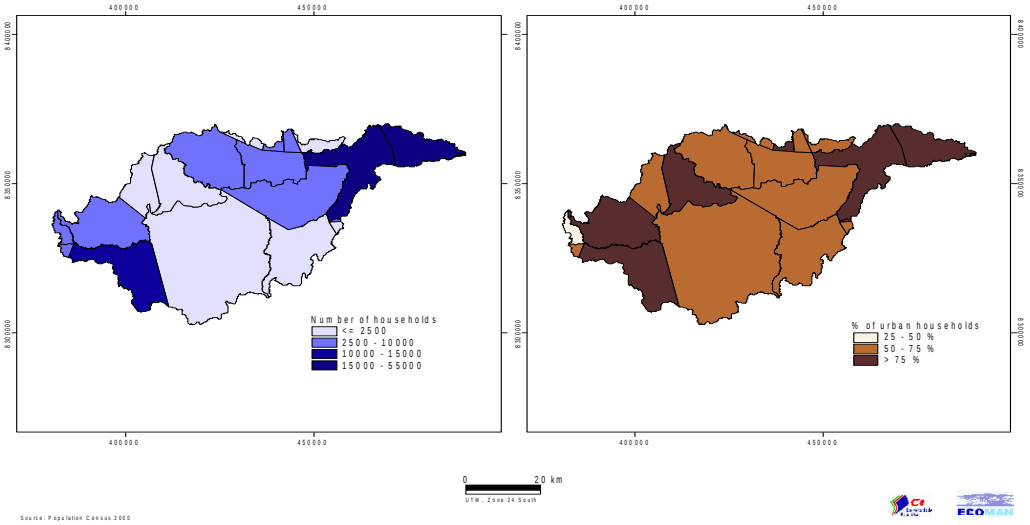
Fig. 12. Elderly Dependency Index, Cachoeira, 1991-2000



1.2 Analysis of households

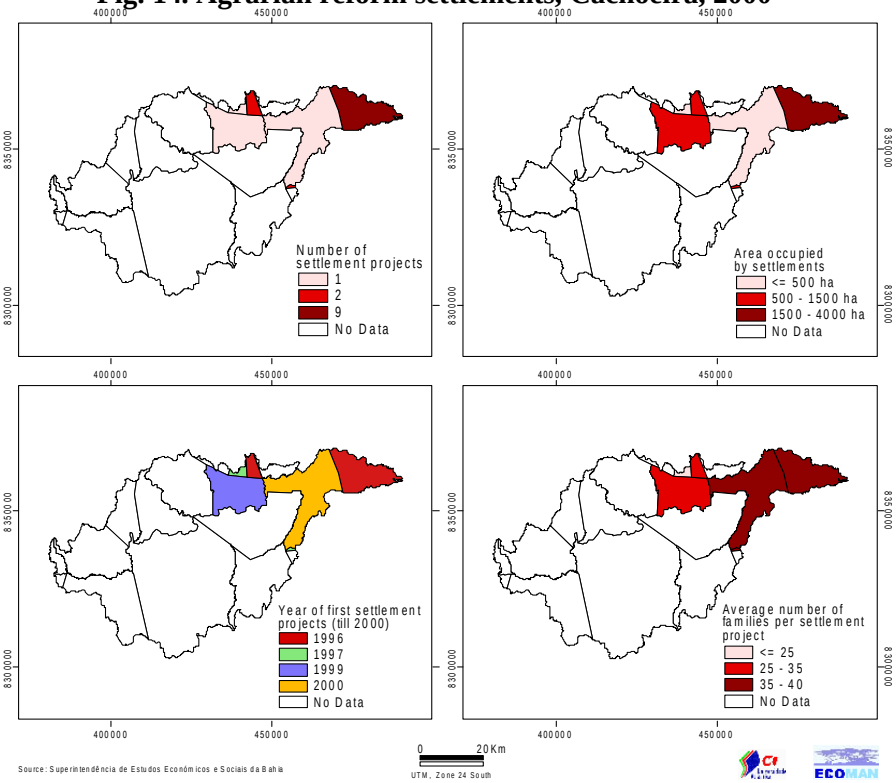
In 2000, the great majority (84%) of the population of Cachoeira catchment live in urban households (Fig. 13). The 146664 households, as the resident population, are concentrated in the municipalities of Itabuna and Ilhéus (34% and 28%, respectively). However also Itapetinga as a share of 9% of the households of the catchment, but are mainly located in the main city, wich is outside the catchment.

Fig. 13. Households, Cachoeira, 2000



The agrarian reform settlements, in 2000, exist only in the municipalities of Ilhéus (9 settlements with an average area of 445 hectares, Itabuna and Ibicarai, each with one settlement. 387 families are resident in these settlements, i.e. an average of 38 families per settlement.

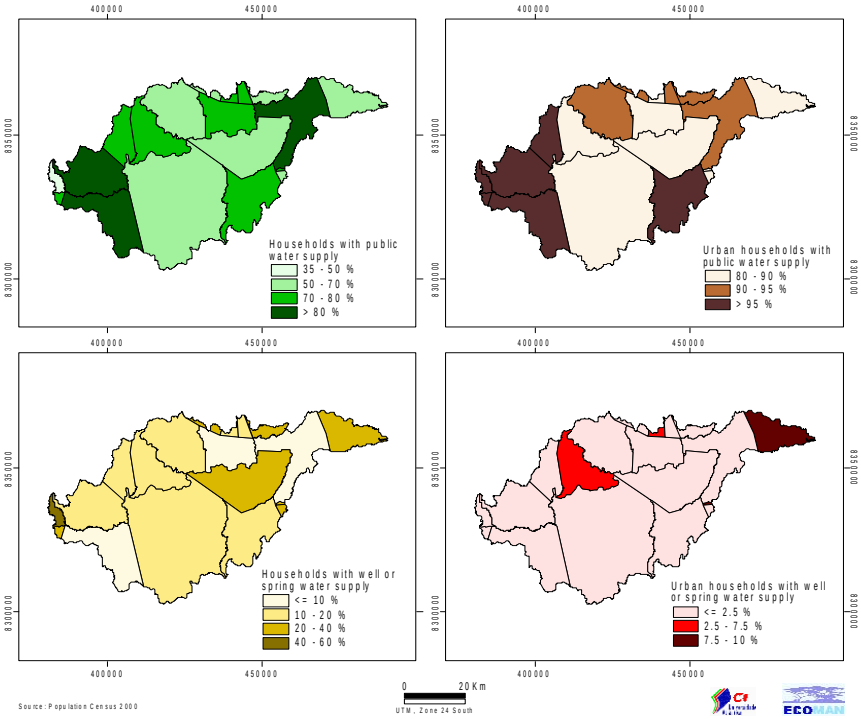
Fig. 14. Agrarian reform settlements, Cachoeira, 2000



1.2.1 Water supply

In 2000, the public water supply system is the major water supply of Cachoeira catchment (74% of the households), followed by wells or springs (16%) and other types of supply (10%). The supply of 90% of the urban households is the public system (Fig. 15).

Fig. 15. Water supply to the households, Cachoeira, 2000

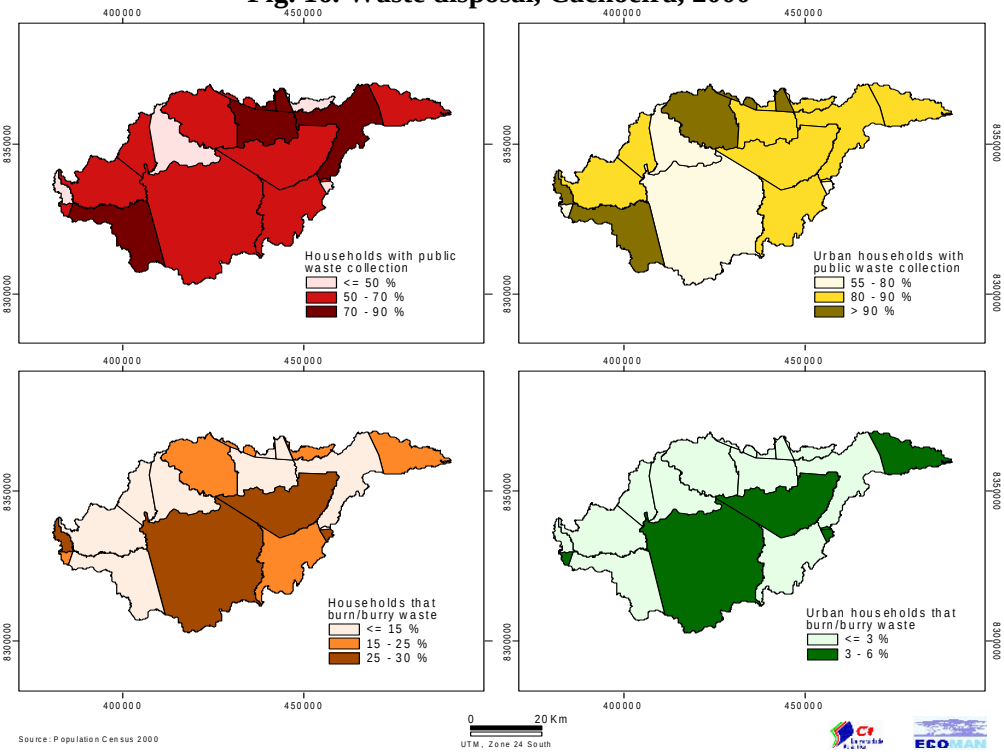


The highest values of households connected with the public water systems occur on the municipalities of Itabuna, Itapetinga and Itororo (more than 80%). However, the analysis of the supply to urban households reveals that the more populated municipalities (Itabuna and Ilhéus) aren't the ones with higher cover of the public system (Fig. 15), showing the bad conditions of great part of the slums that appeared in the periphery of this tow main cities of the catchment.

1.2.2 Waste disposal system

In 2000, 65% of the households in the catchment have public waste collection. This system is more significant in Itabuna (87%), Itapetinga (88%) and Ibicarai (74%). Only Sta. Cruz da Vitória presents less then 50% of the households with public waste collection (Fig. 16). The other means to disposal waste are related with burning or burring the residues (15% of the households of the catchment) and the disposal of waste in rivers or in the field (18% of the households). Ilhéus is one of the municipalities where these two types of waste disposal are more significant: 20% of the households burn or burry the waste and 15% use the rivers and the fields to dispose it. Moreover, this last type is used by 13% of the urban households of this municipality.

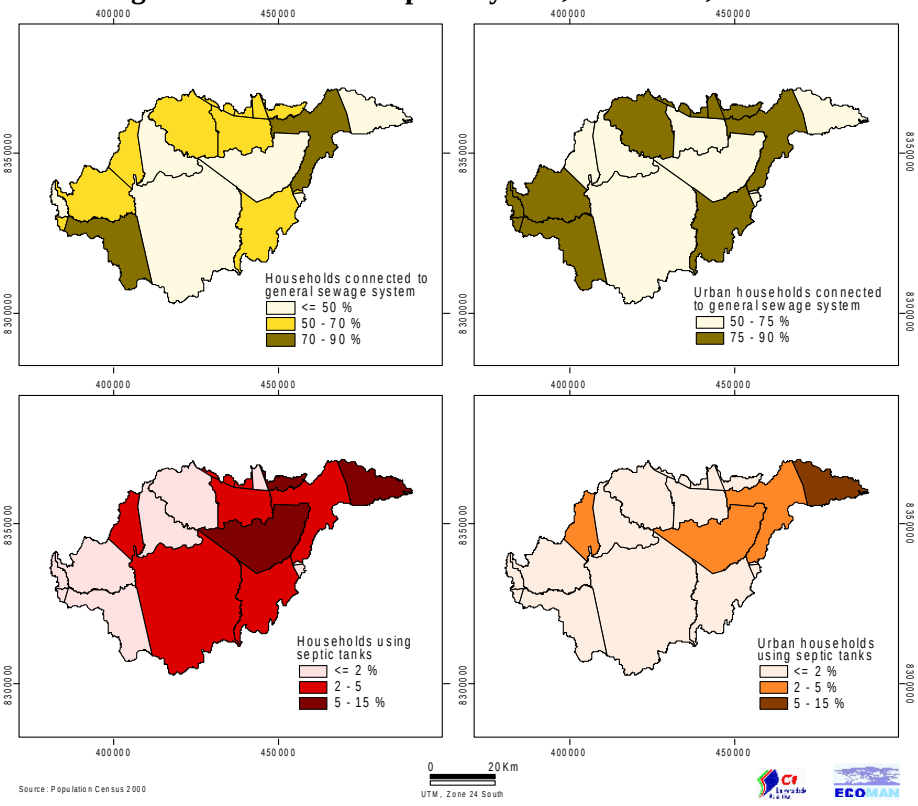
Fig. 16. Waste disposal, Cachoeira, 2000



1.2.3 Effluents disposal system

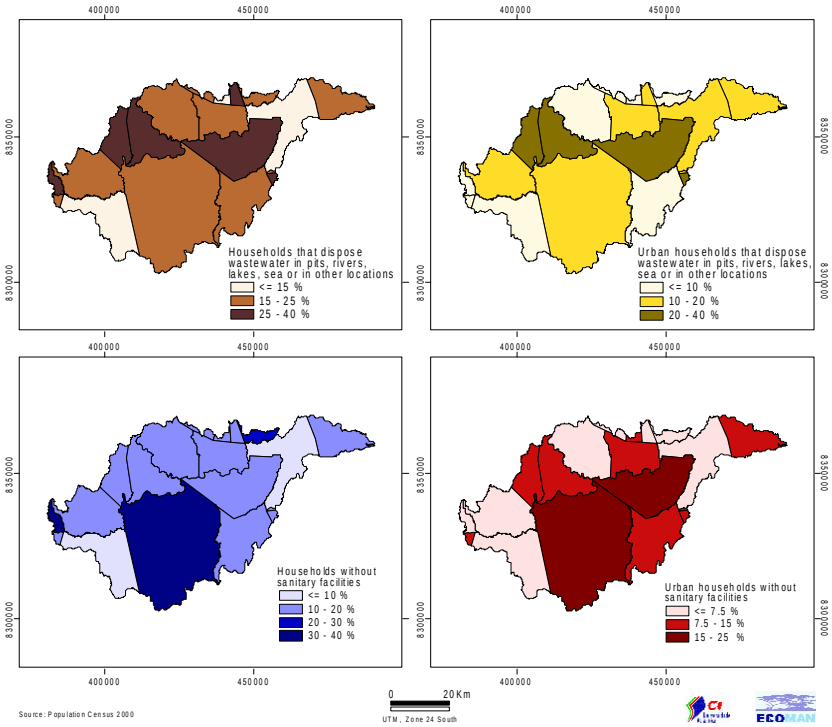
In 2000, only 57% of individual houses, and 72% of the urban households, (Fig. 17) of the

Fig. 17. Waste water disposal system, Cachoeira, 2000



Cachoeira catchment are connected with the sewage system. The municipalities of Itabuna and Itapetinga are the ones in which the weight of households connected with sewage system is higher (75% and 86%, respectively). The use of pits (22%) and septic tanks (5%) are the other methods of waste water disposal. However, 17% of the households in the catchment don't have any type of sanitary facilities (Fig. 18).

Fig. 18. Other types of waste water disposal, Cachoeira, 2000



It is important to note that in Itape and Itaju do Colonia 18% and 24%, respectively, of the urban households don't have any kind of sanitary facilities (Fig. 18).

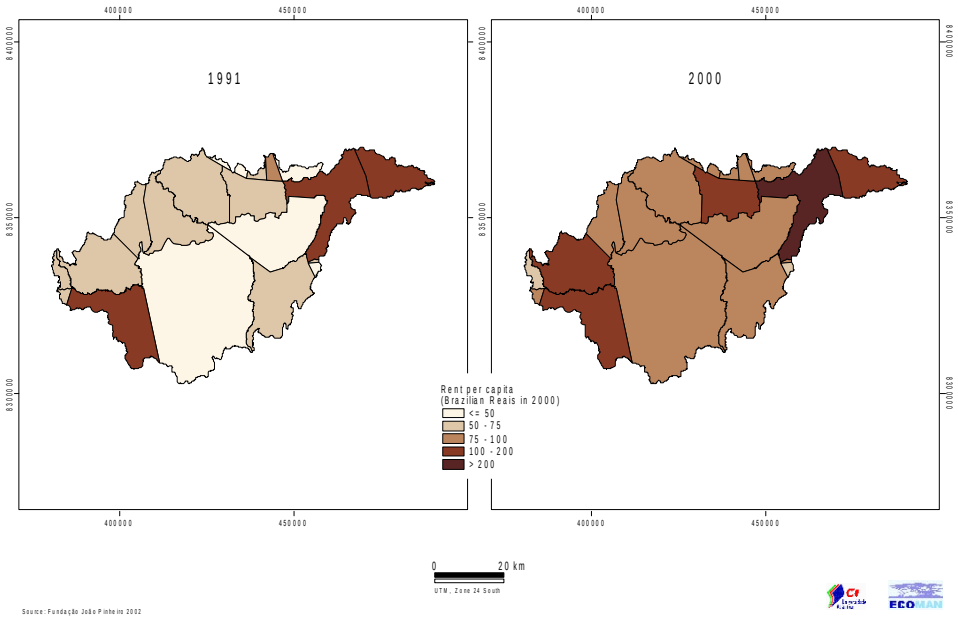
1.2.4 Local development

The analysis of local development will be made by using information related with the income per capita, which corresponds to the income of every individual resident in the municipalities of the Cachoeira catchment; the Human Development Index, which is the index developed by the United Nations applied to the municipalities of the catchment; and the contribution of each municipalities to the Gross Domestic Product.

The income per capita in the municipalities of the catchment registered an increase from 1991 to 2000. From about 75 Brazilian Reais, in 1991, augmented to around 114 Brazilian Reais, in 2000. The municipalities of Itabuna (207 Brazilian Reais), Ilhéus (170 Brazilian Reais) and Itapetinga (160 Brazilian Reais) show the highest income per capita (Fig. 19). There are the municipalities with larger cities, and therefore with economic activities that provide better wages to the working population.

Furthermore, the income of the head of household in Itabuna, corresponds to 115% of the average income of Bahia.

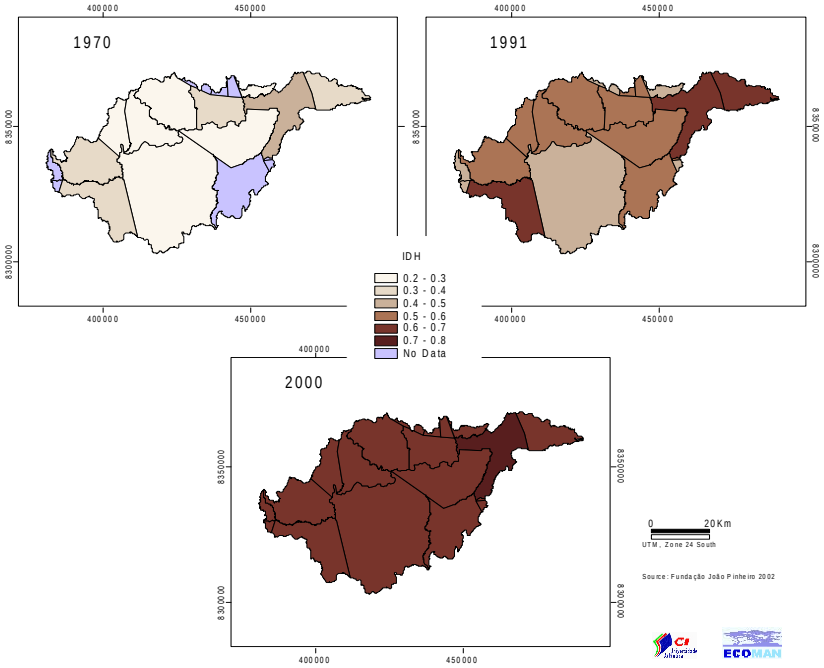
Fig. 19. Income per capita, Cachoeira, 1991 and 2000



The index of the United Nations Development Programme (UNDP) to measure human development synthesises information about income per capita, education level and longevity. An index higher the 0.800 corresponds to high stage of development; between 0,500 and 0,799 relates with medium stages of development; and lower than 0.500 refers to low stages of development. The great interest of this index resides in the fact that measures more than the economic growth, being an attempt to measure the quality of life conditions.

This index was calculated in the municipalities of Cachoeira catchment (Fig. 20). In the 1970s all the municipalities had an index less than 0.5, only Itabuna and Ilhéus were closer to the situation of medium stage of Development. The average of the catchment increased from 0.3, in 1970, to 0.5, in 1991, and 0.7, in 2000. In this year, Itabuna (0.75) and Ilhéus and Itapetinga (both with 0.7) are the municipalities that register the highest values of IHD.

Fig. 20. Human Development Index, Cachoeira, 1970-2000

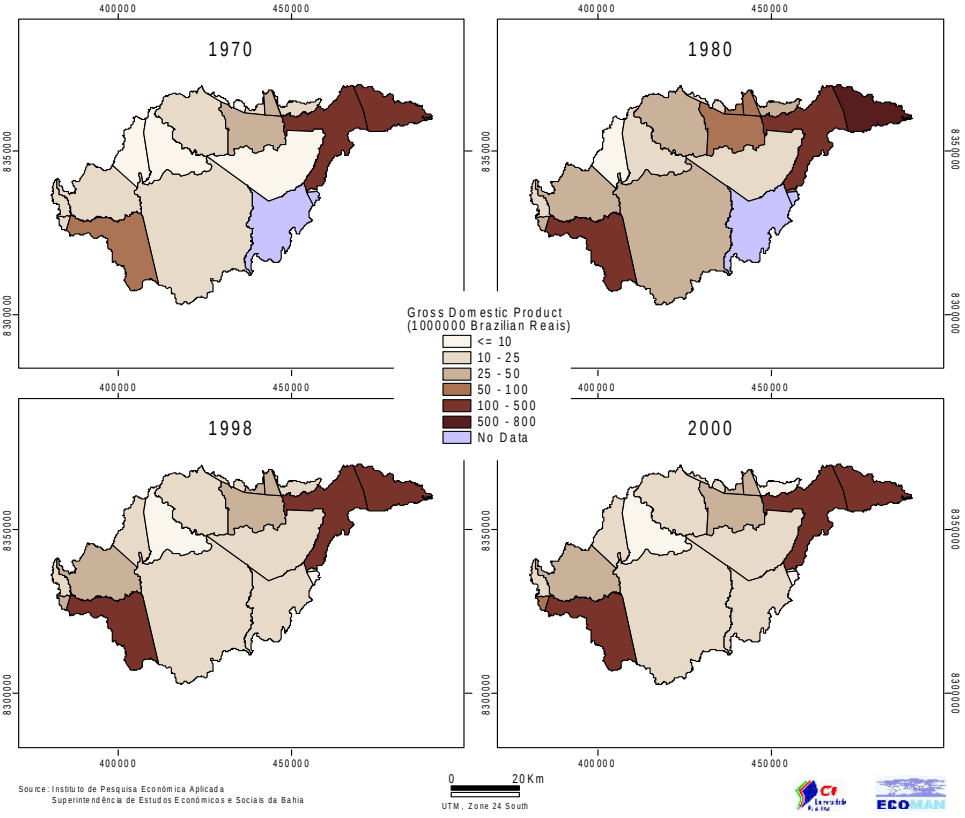


The Gross Domestic Product measures all the wealth produced in a given country during one year. It gives a measure of the economic dynamism of that country. Applied to the municipalities of Cachoeira catchment it is a mean to perceive the economic strength of those municipalities.

The Fig. 21 shows clearly the dichotomy existent in the catchment: on one side Itabuna and Ilhéus have the highest GDP since 1970, and in the more recent year also Itapetinga crosses the threshold of the 100 000 000 Brazilian Reais.

However, it was in 1980 (the time when the international market prices for cocoa were higher), that the municipal GDP was higher, especially in Ilhéus.

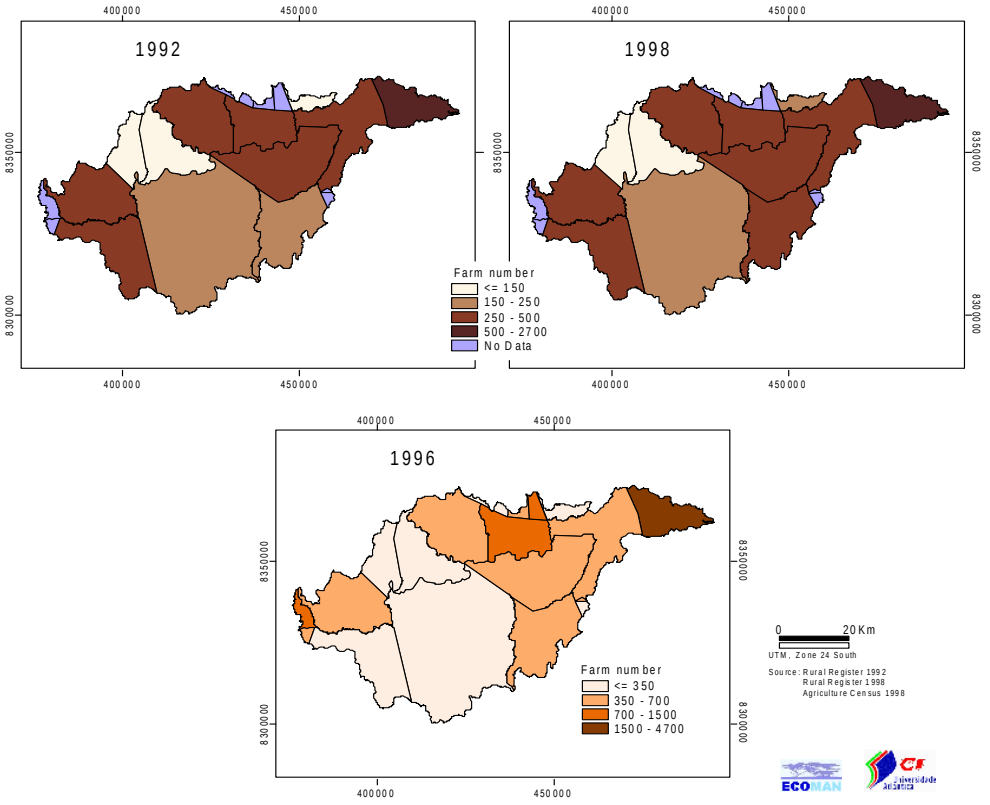
Fig. 21. Gross Domestic Product, Cachoeira, 1970-2000



1.3 Analysis of agrarian structures

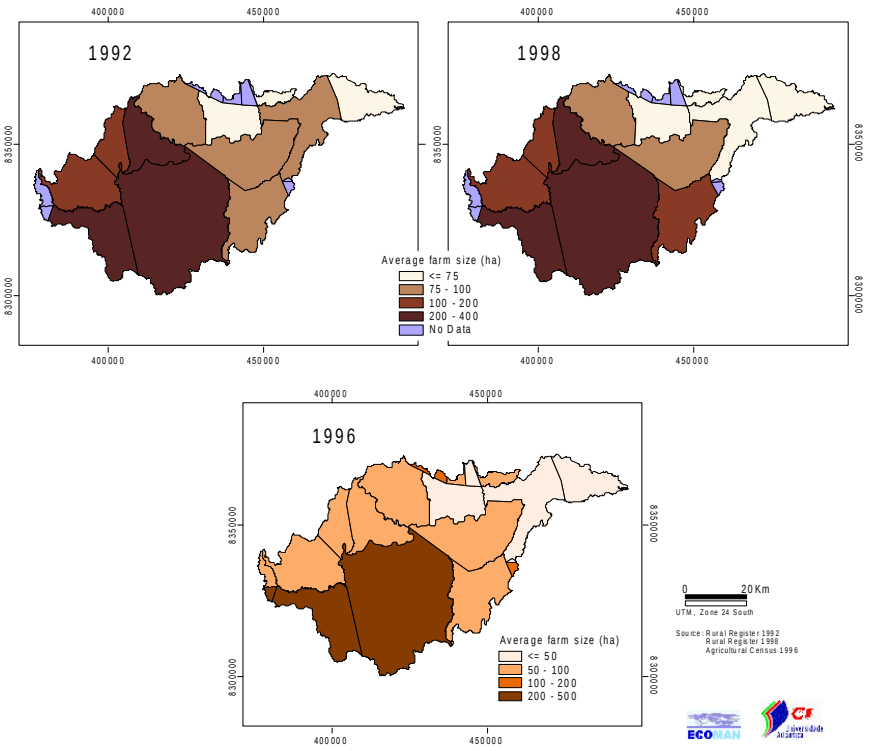
In 1998, the Cachoeira catchment had 5685 farms (35585.8 ha), which correspond to an average of farm size of 95.2 ha and 474 farms per municipality (Fig. 22). Ilhéus is the municipality with higher number of farms (2691) and Firmino Alves the one with less farms (134). Between 1992 and 1998 the number of farms and the farms land increased in all municipalities, especially in Ilhéus that has more 444 farms and more 15665.2 ha of farm land, in 1998.

Fig. 22. Number of farms, Cachoeira, 1992-1998



The maximum average farm size is 370 ha (Itapetinga and Itaju do Colonia) and the minimum is 41.2 ha (Ilhéus). In the all of the catchment the average farm size is 95.2 ha, in 1998. In general there was small decrease of the average farm size in the catchment (although the increase of farm land), especially in Itabuna and Itapetinga (about 10-15 ha).

Fig. 23. Average farm size, Cachoeira, 1992-1998



In average, in 1998, more then 50% of the municipality area corresponds to farmland. In the majority of the municipalities, farmland corresponds to 60-80% of the area. Some municipalities have a farm area higher than the municipality area itself. This occurs due to the definition of farm area, that considers the total area of the farm even if part of this farm is outside the municipality where is located its centre of exploitation.

1.3.1 Types of farms

In 1998, the municipalities of Cachoeira catchment have 57% of farms with 10-100 ha and 23% have less then 10 ha. The number of farms with more than 500 ha is quite low, and represents 4% of the farms in the catchment (Fig. 24 and Fig. 25). Ilhéus is the municipality where the small farms have more importance (34%, but only 4% of farm land); Itaju do Colonia and Itapetinga have a quite high weight of large farms (around 22%, and 63% of farm land). Around 99% of the farms are owned by the farmers.

Fig. 24. Farms according to farm size classes, Cachoeira, 1992-1998

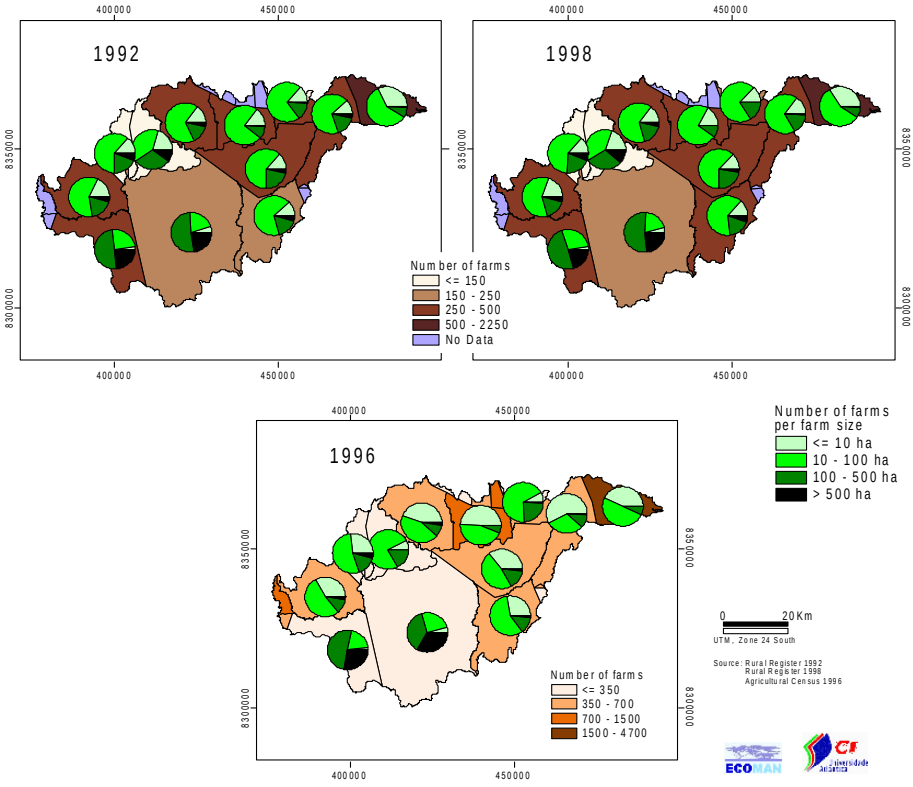
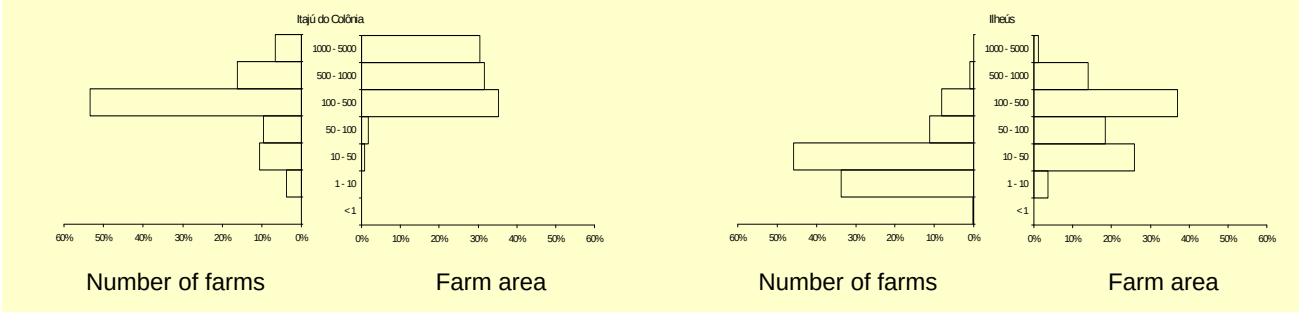


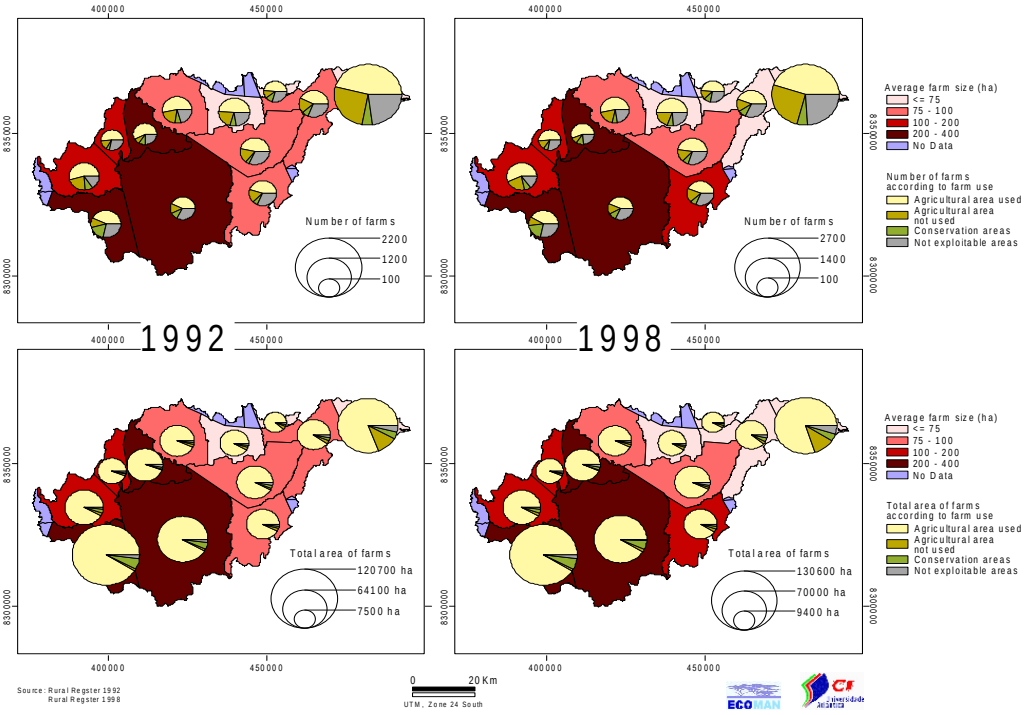
Fig. 25. Classes of area of farms, Itaju do Colonia and Ilhéus, 1998



1.3.2 Farms according to land use

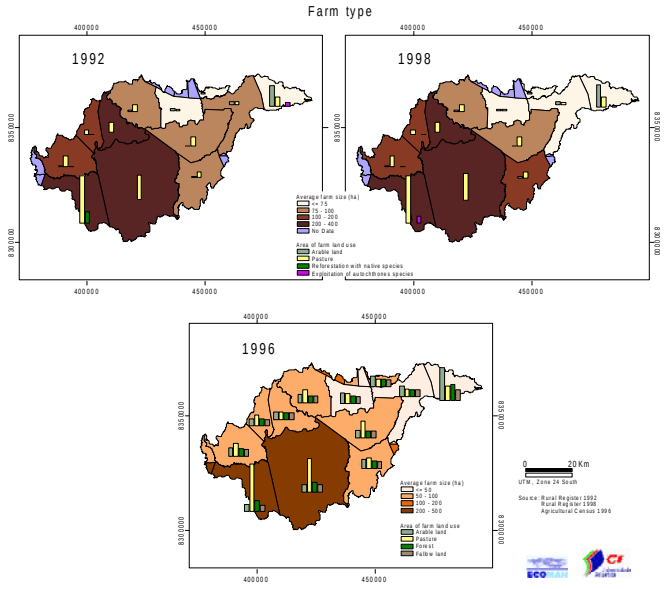
In Cachoeira catchment, in 1998, the main use of farm land (Fig. 26) is related with agriculture (around 90%, and almost totally used). Although the rather high number of farms with non agricultural land, the area of this type of uses is quite small (around 10%), and in great part used for environmental purposes as conservation areas (6.6%).

Fig. 26. Main farm uses, Cachoeira, 1992-1998



Pastures are the more significant (67%) land use in the catchment (especially in Itaju do Colonia, 88%; and Itapetinga, 89%) followed by arable land (20%), which has more significance in the municipality of Ilheus, 50% (Fig. 27).

Fig. 27. Farm main land use, Cachoeira, 1992-1998

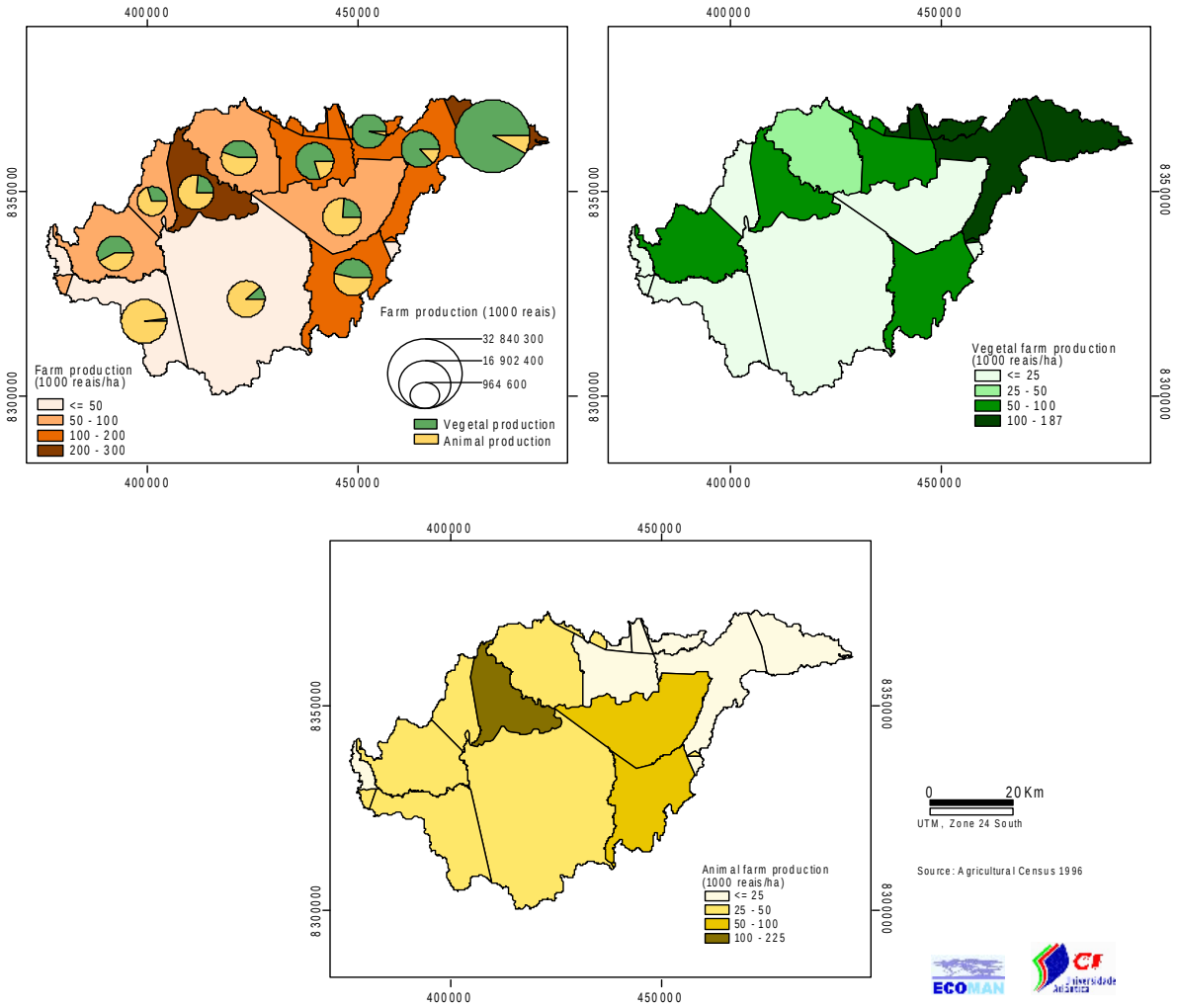


The areas of forest correspond to 9% of farm land, reaching around 20% in Sta. Cruz da Vitoria. The cultivated pastures represent around 83% of the total pasture land.

1.3.3 Farm production

According to the agricultural census of 1996 the main source of income for 65% of the farms in the municipalities of the catchment is the agricultural production (Fig. 28).

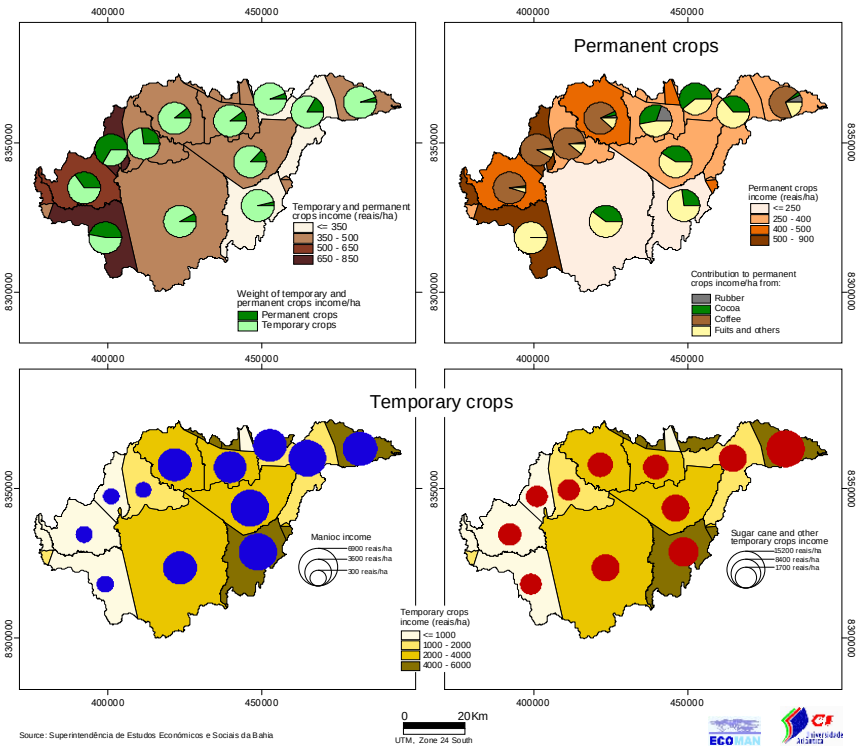
Fig. 28. Farm production, Cachoeira, 1996



However, it is possible to observe (Fig. 28) that this production is more significant in the municipalities of Ilhéus, Itabuna and Ibicarai with more than 80% of the income produced in the farms. The main source of income in the other municipalities (and almost exclusive in Itapetinga) is livestock production. Ilheus presents the higher farm income of all municipalities.

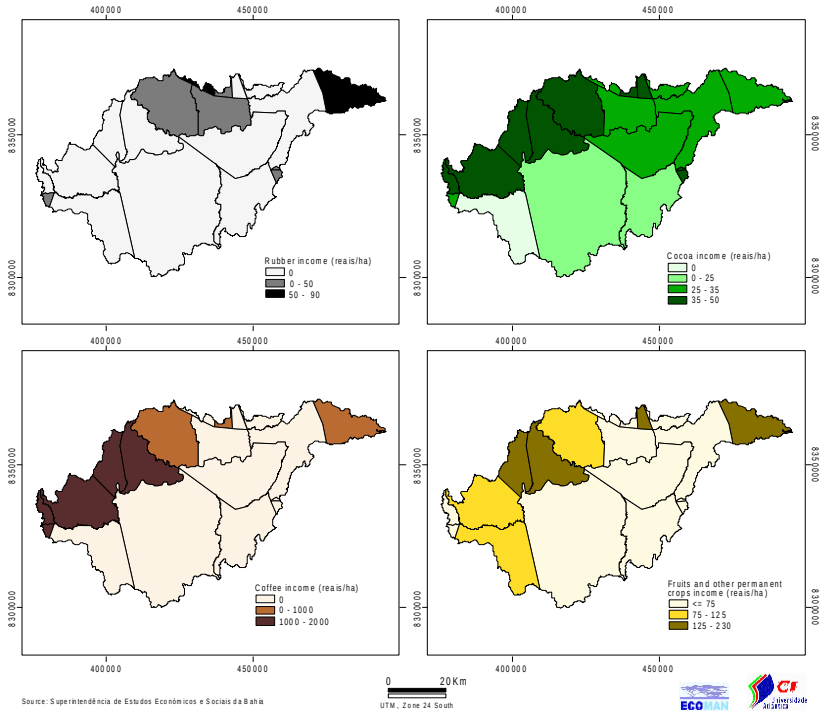
In 2000, the temporary crops are the main producers of income per hectare (87%), however Itororo (35%) Itapetinga (47%) and Firmino Alves (66%) have an important contribution for the agricultural income per hectare from the permanent crops (Fig. 29 and Fig. 30). In relation with the income generated by permanent crops, there is a clear division of the municipalities

Fig. 29. Income of temporary and permanent crops, Cachoeira, 2000



of the catchment. Ilhéus, Itororo, Firmino Alves, Sta. Cruz da Vitoria and Floresta Azul have a strong importance of coffee income per ha. In the other municipalities, the weigh of income generated by cocoa production and fruits is more important.

Fig. 30. Income of permanent crops, Cachoeira, 2000



1.3.4 Livestock production

Cattle are the main livestock production in the municipalities of Cachoeira, in 1996. The coastal municipalities have a bigger diversification of animal production with goats and swine. Although with more individuals, the municipalities of Itaju do Colonia and Itapetinga, due to the size of the farms, register the lowest number of cattle per pasture area (Fig. 32).

Fig. 31. Livestock, Cachoeira, 1996

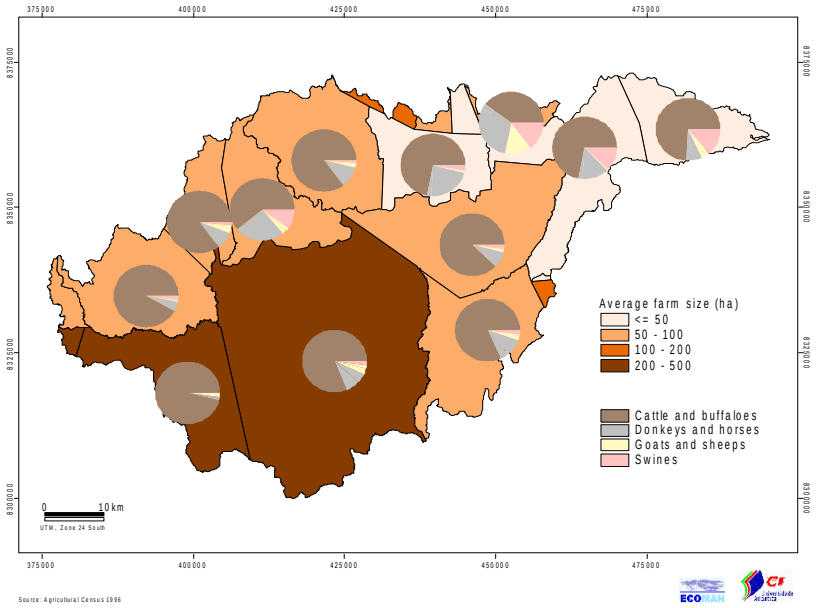
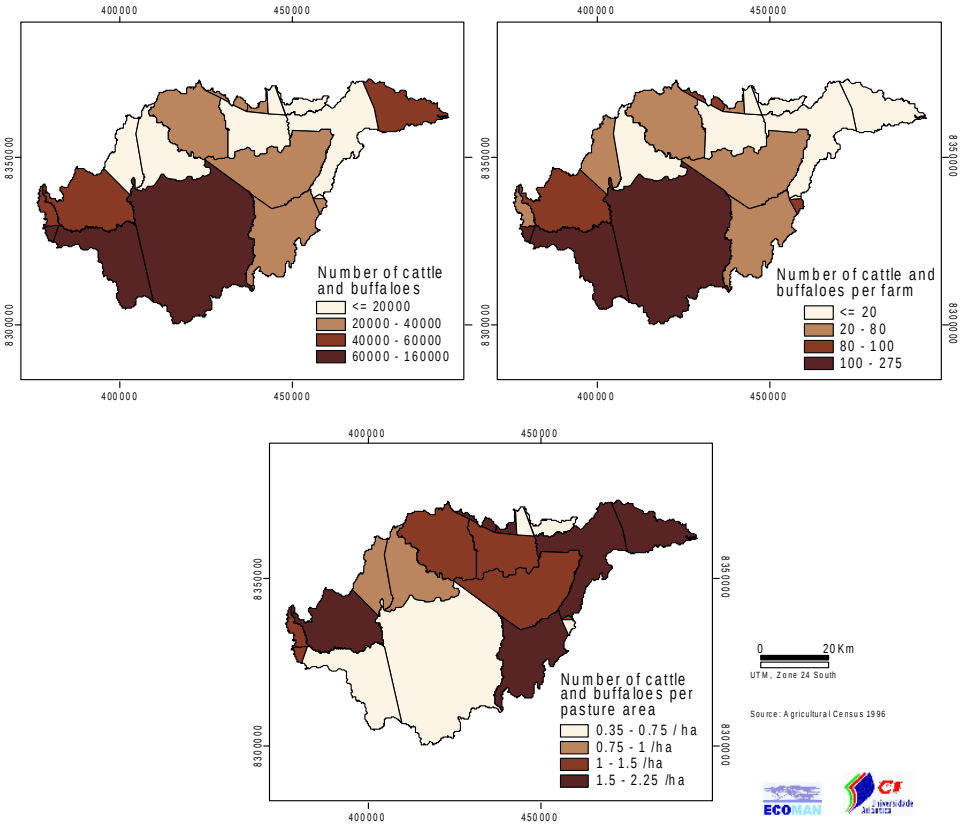


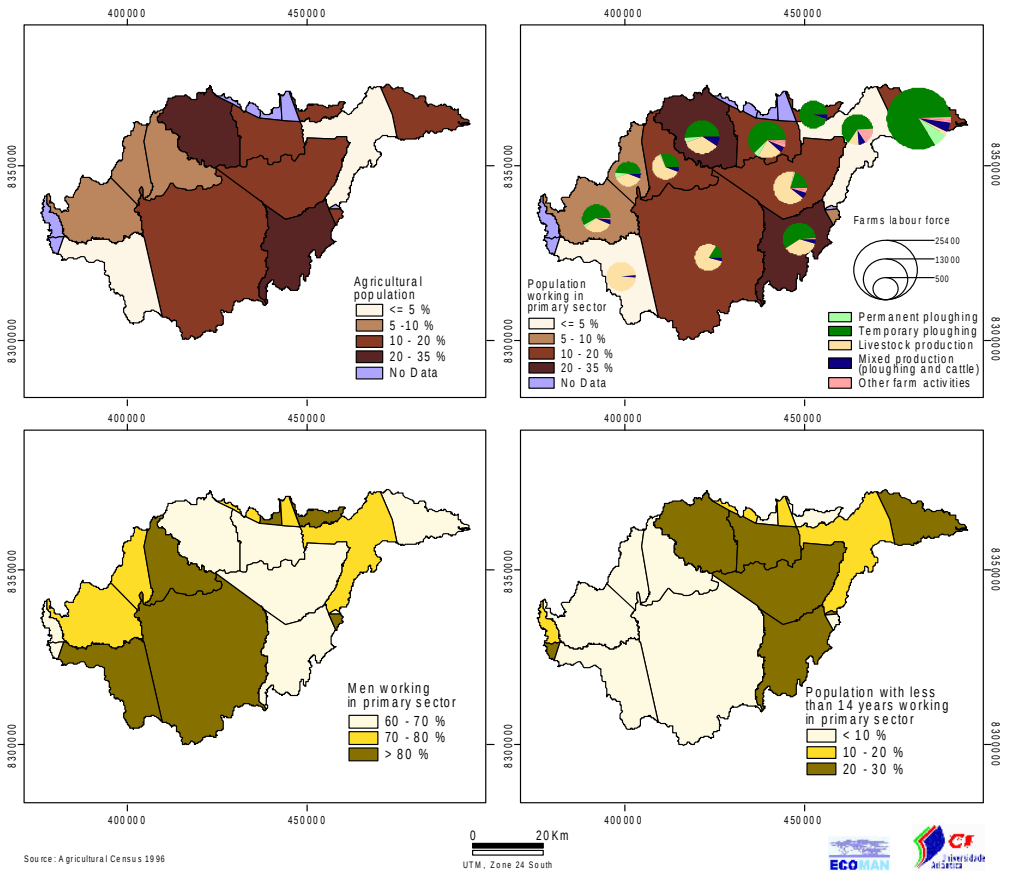
Fig. 32. Cattle and Buffaloes, Cachoeira, 1996



1.3.5 Farms working population

In 1996, 8% of the catchment population was working in agriculture. Jussari (33%) and Floresta Azul (25%) are the municipalities with higher population involved in agriculture (Fig. 33). Itabuna (1%) and Itapetinga (3%) register the lowest percentages. In the catchment, 70% of the population working on primary sector is men, being 98% in Itaju do Colonia. 20% have less than 14 years.

Fig. 33. Working population, Cachoeira, 1996



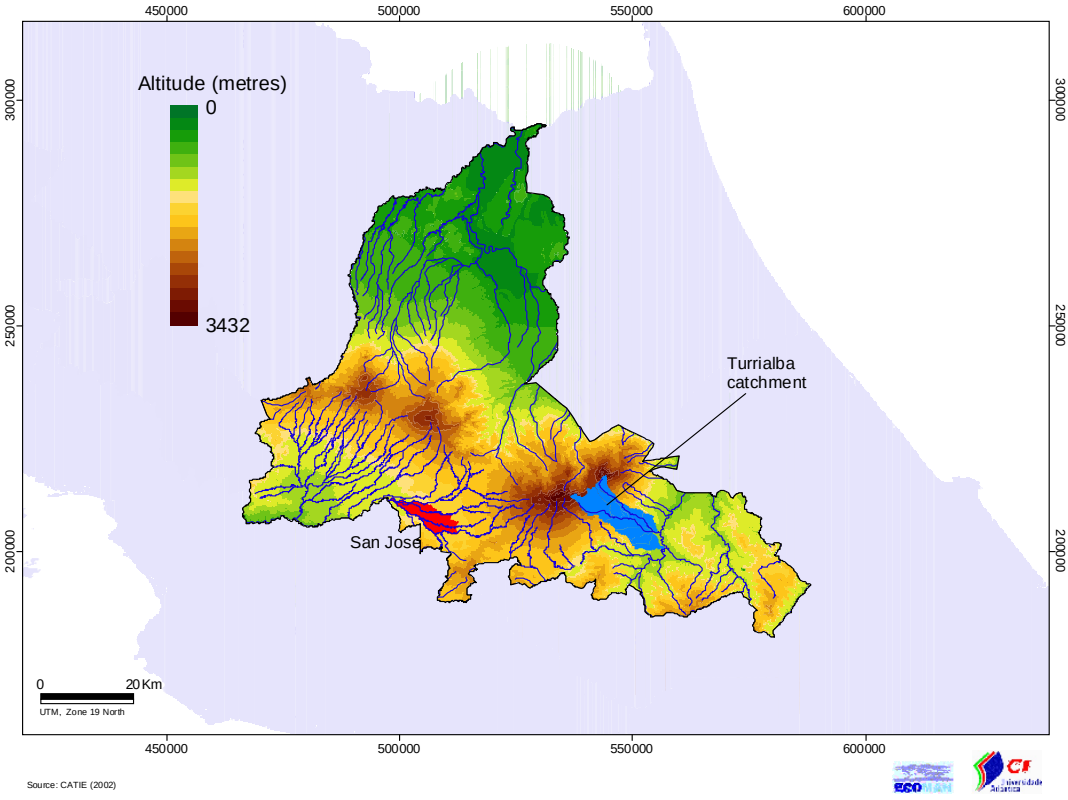
The activities of permanent and temporary ploughing involve 72% of the population working on Primary sector. Ilhéus presents one of the highest percentages of population working on permanent and temporary ploughing (90%).

Livestock production is another activity with significant amount of labour force, in the catchment (19%). Sta. Cruz da Vitoria (62%), Itape (68%), Itaju do Colonia (79%), and Itapetinga (97%) are the municipalities with higher labour force in livestock production.

2 CENTRAL VOLCANIC MOUNTAIN RANGE CONSERVATION AREA, COSTA RICA

The project study area is called ACCVC – the Area of Conservation of the Central Volcanic Mountain Range (Area de Conservación de la Cordillera Volcánica Central) with a total area of about 5 662 km2, containing around 2 200 000 inhabitants distributed by 34 Cantones (the municipal level of territory administration). The ACCVC, located in the central and northern parts of Costa Rica, stretches from the metropolitan area of San José to the border with Nicaragua (Fig. 34).

Fig. 34. Area de Conservación de la Cordillera Volcánica Central and Turrialba Catchment



The ACCVC presents near to 23% of its area under some category of protection, and comprises seven volcanic massifs (Platanar, Porvenir, Palmira, Barva, Poás, Irazú and Turrialba), of which some present volcanic activity. It dominates the northern lowlands and the Central Valley to the south. The contrasts of the dominant land uses between these two main areas (humid forests along the rivers and in the steepest and less accessible mountain areas, agricultural crops in the lowlands) are very significant.

The most outstanding feature of this area concerns the existence of the different national parks and reserves, aiming at implementing a policy of conservation and rational management of natural resources, of which the tropical rainforest is one of the main concerns. By its richness in natural resources and cultural heritage, the ACCVC was considered by UNESCO, in 1988, a biosphere reserve.

The forests in the area are managed by FUNDECOR (Fundación para el Desarrollo de la Cordillera Volcánica Central), a NGO founded in 1991 to protect and increase the Costa Rican forests located in the country's central plateau. The forest coverage of its territory is one of the largest in Costa Rica, and comprises many of the country's National Parks (Photo 4).

During the recent years, the area of ACCVC has been under constant land-use pressure due to various factors: the vicinity of the San José Metropolitan Area with around 1.5 million inhabitants; tourism; forestry; and agriculture, including animal husbandry.

Photo 4. Tropical Rainforest in National Park Braulio Carrillo

In 2000, the population living in the ACCVC was around 2 200 000 inhabitants, of which 60% is resident in urban areas. Therefore, this resident population is unevenly distributed, and around 80% live in the Great Metropolitan Area (GAM) of San José, corresponding to the occupation of about 25% of the total ACCVC.

From 1984 to 2000, the average annual growth of population is close to 3%, which shows the great attraction and subsequent pressures on the environment exerted by the GAM. The labour force in the ACCVC is mainly occupied in the Tertiary sector (60%), but around 15% works on the Primary sector.

One hotspot was defined in the ACCVC to be more intensively analysed: the Turrialba Catchment (Photo 5) with around 80 km2 and altitudes ranging from 580 m to 3116 m, located near the city of Turrialba in the southern slopes of Irazú and Turrialba volcanoes. This sub-catchment presents a high ecological and land use diversity. In the low catchment, the expanding city of Turrialba dominates among sugar cane and coffee plantations; in the high catchment pastures and forests, which cover mainly the highest and steepest areas of the slopes, follow the horticulture area.

Different types of natural hazards, of which the ones related with flash-floods, landslides, volcanic activity and earthquakes are the most significant, also affect the Turrialba catchment.

Photo 5. Upper catchment of Turrialba River, near the summit of Irazú Volcano

Photo from C. R. Machado

2.1 Population distribution

The following analysis concerns 37 cantons of Costa Rica included in the Central Volcanic Mountain Range Conservation Area (ACCVC). However, it must be considered that some of these cantons aren't completely included in this area. Despite that, the analysis was made considering the information for the totality of the cantons, introducing, so, information that concerns areas outside the ACCVC.

2.1.1 Resident population

In ACCVC there are 2376400 residents (64227 inhabitants per canton) of which 49% are men. The Great Metropolitan Area (GAM) of San José is made up of 27 cantons with 1928195 residents (71414 inhabitants per canton), corresponding to 81% of total. The GAM of San José includes the cantons San José and Alajuela, which have the highest number of residents (200000-350000 inhabitants).

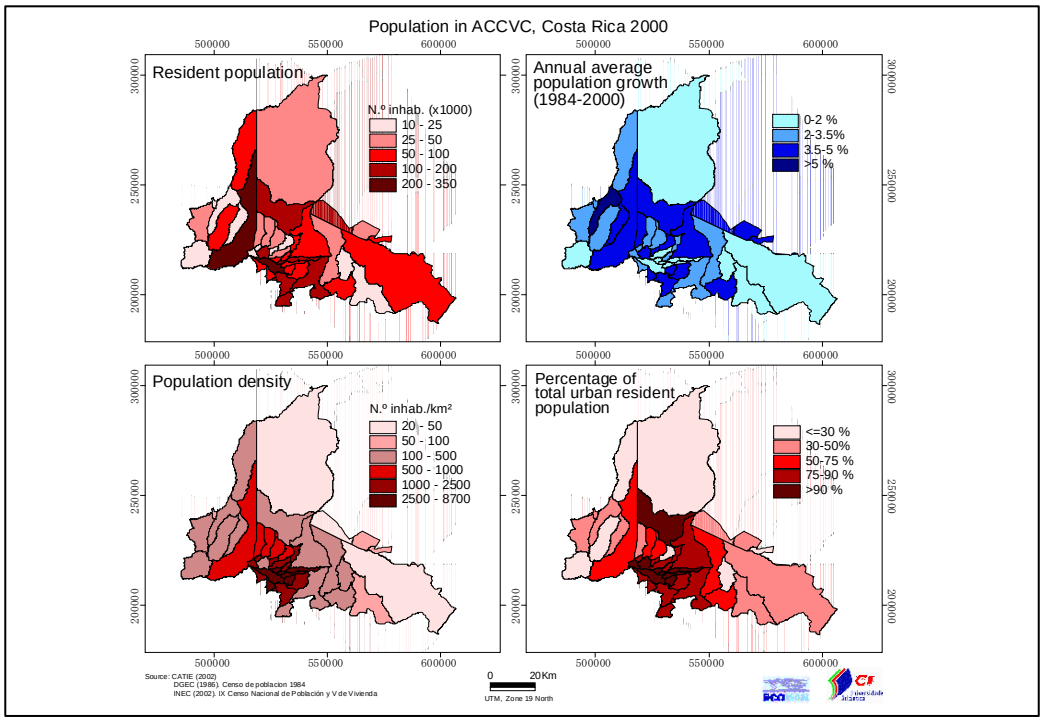
The San José canton and some of the peripheral cantons have a high population density (2500-8700 inhab./km^2) and a high percentage of total urban[4] resident population (above

[4] The analysis of urban and rural populations is always difficult due to the different types of definition used by the countries. In Costa Rica, as well in this analysis, the definition of urban and rural population employed is the one presented by the Instituto Nacional de Estadistica e Censos of Costa Rica (INEC, 2002). According to this institute, urban population refers to:

The population living in urban centres, i.e., the administrative capitals of the country's cantons, and contiguous areas defined in relation to physical and functional criteria;

90%). However, between 1984 and 2000 this area had a low annual average population growth (0-2%). The highest annual average population growth was registered in Valverde Vega (above 5%), a canton that is apart from GAM. The lowest population density occurs in the cantons Sarapiqui (northern lowlands), Turrialba and Pococi, which are also among the biggest cantons in ACCVC (Fig. 35).

Fig. 35. Resident population in ACCVC, 2000



Between 1984 and 2000, 8 cantons crossed the threshold of 50% of urban population, joining up the other 14 cantons where the urban population was already dominant in 1984. In 1984, the canton of Valverde Vega had no total urban population and, in 2000, 30-50% of the population of this canton resided in urban and/or peri-urban areas.

The three cantons that surround the Turrialba catchment have lower density population (especially Turrialba – 20-50 inhab/km^2), low percentage of total urban resident population (bellow 50%) and are some of the cantons that registered the lowest annual average population growth (0-2%).

The population living in peri-urban areas, i.e., areas near the former ones, and that present availability of services, type of economic activities and ways of life similar to the ones existing in urban centres and their contiguous areas.

In what concerns rural population, INEC defines it as Population residing in areas other than those classified as urban. They are divided in:

Population in Rural Centres, i.e., population resident in agglomerations, which are located outside urban areas, and where the activities related with agriculture and livestock are dominants, as well as some other physical criteria related with the spreading of houses and the existence of equipments such as schools, church, health centre, etc.

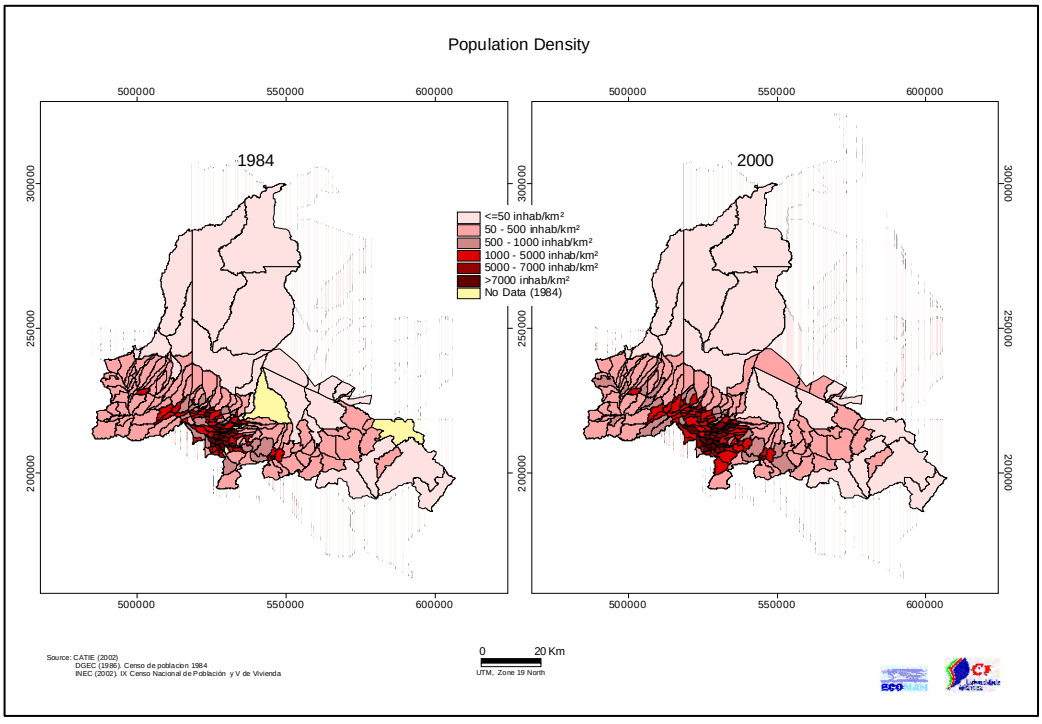
Population outside Rural Centres, i.e., areas not contemplated in the previous categories. Usually with higher dispersion of housings and population, and the dominant use of territory is related with agricultural and livestock activities.

2.1.1.1 The population in the districts of ACCVC

The GAM of San José is made up of 158 districts, of which 12 are not included in ACCVC. The remaining 146 that constitute the GAM of San José have 1886828 residents (12923 inhabitants per district), corresponding to 87% of the total. The districts that register the highest number of resident population (>45000 inhabitants) are Payas and Hatillo, both from the canton of San José. Between 1984 and 2000, the ACCVC average resident density increased from 175 inhabit./km^2 to 279 inhabit./km^2, respectively. The population density increased especially in the central zone of ACCVC (Fig. 36). However, during that time, the annual average population growth registered in the central zone of ACCVC was not very high (some of the districts even recorded a negative (or null) annual average population growth).

In the three cantons that surround the Turrialba catchment, the Turrialba district registers the highest number of residents (25000-45000). Int the region of the Turrialba catchment there is an apparent relationship between the districts located in the highlands and a higher population density.

Fig. 36. Population density in ACCVC, per district, 1984 and 2000



2.1.2 Urban and rural population

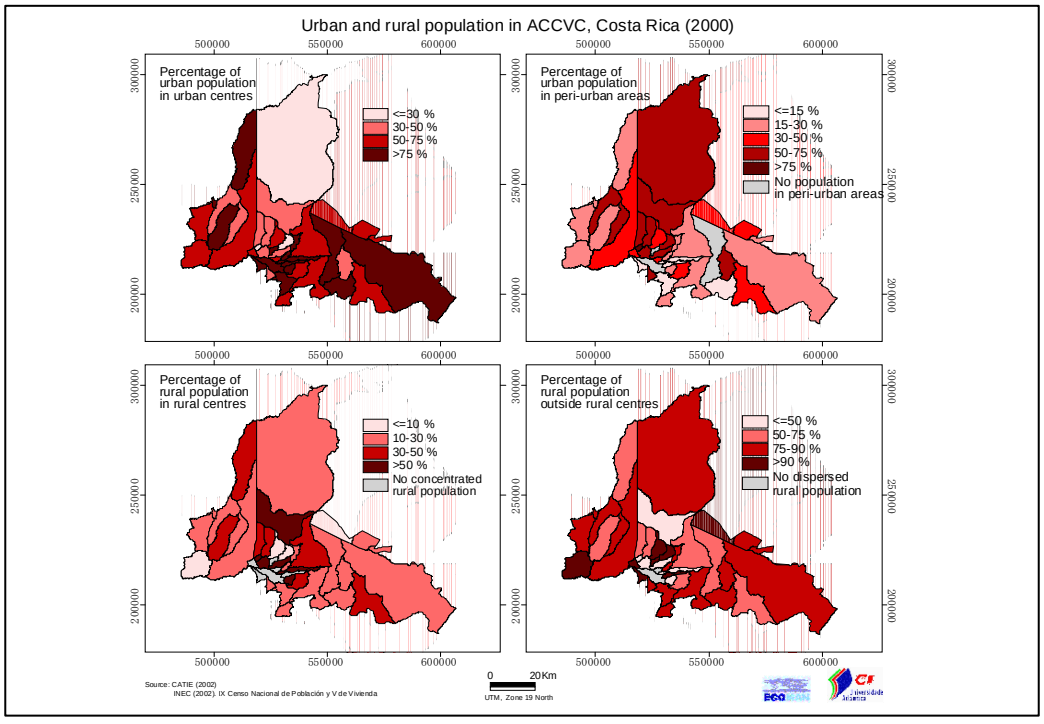
In ACCVC almost 75% of population (1710395 residents) lives in urban areas. From this urban population, an average of 75% resides in urban centres. In what concerns the total rural population, an average of 80% inhabits outside rural centres.

In ACCVC, the highest percentage of urban population resident in urban centres (above 75%) occurs in several cantons, such as, Turrialba, San José and some surrounding cantons of San José (Fig. 37). The lowest percentage exists in Sarapiqui (northern lowlands), Flores and San Isidro (bellow 30%). San José, Oreamuno and San Pablo are cantons without peri-urban population.

As referred above, the rural population resident outside rural agglomerations is more significant than that resident in rural centres. The highest percentage (above 90%) occurs in Pococi, Atenas and some cantons of GAM of San José. The metropolitan area of San José has a diversified situation concerning the rural population. At the same time that some cantons reach more than 90% of rural population outside rural centres, others registers the lowest percentage (bellow 50%). Moreover, in this metropolitan area the cantons of Belen, Escazu, Montes de Oca and San Pablo don't have rural population in rural centres and in the cantons of San José and Tibas there is no rural population.

Rural population is more significant in the three cantons of Turrialba catchment, being the population in rural centres more important in Jimenez and the population resident outside rural agglomerations more significant in the other two cantons.

Fig. 37. Urban and rural population, ACCVC, 2000



2.1.2.1 Urban and rural population in the districts of ACCVC

In the districts of the Turrialba catchment, Turrialba is the district with the highest percentage of urban population (60-80%), in 1984 and 2000 – remember that this district also has the highest resident population of that region. Besides that, between 1984 and 2000, 4 districts of the cantons of the Turrialba catchment started to have urban population.

During 1984 and 2000, as stated before, the annual average population growth registered in the central zone of ACCVC was not very high (some of the districts even recorded a negative (or null) annual average population growth). In general terms, although there are few districts in ACCVC with negative (or null) annual average population growths between 1984 and 2000, the same cannot be said in terms of urban and rural population (especially urban): 1) 41% of the districts have negative (or null) annual average urban population growth; 2) 38% of the districts have negative (or null) annual average rural population growth. 4% of the districts of ACCVC register the highest class of annual average urban population growth (above 9%) – all of them are located in the GAM of San The districts of Puerto Viejo, Jesus (Vasquez de Corornado canton), San Rafael (Desamparados canton), Rio Azul (2% of the districts of ACCVC) have the highest class of annual average rural population growth (above 8%). These four districts also have high annual average urban population growth (5-9%), with the exception of Rio Azul (no urban population in 2000). The negative (or null) annual average rural population growth is registered especially in the central and east zone of ACCVC

The majority of the districts of Turrialba catchment exhibit a negative (or null) annual average urban population growth or no urban population. In terms of rural population, the majority registers a low, but positive annual average population growth.

Between 1984 and 2000, there was an increase of population residing in urban areas of ACCVC, from 67% (909107 residents) to 75% (1622668 residents), respectively. Although the number of population residing in urban centres has increase between that period of time (832691 to 1224039 residents), the correspondent percentage of the total population decreases (92% to 75%, respectively). This means that this increase is due to an increase of percentage of population residing in peri-urban areas (8% to 25%). Still, the population residing in urban centres has higher significance than the population residing in peri-urban areas. There was a decrease of 54% districts without population in urban centres and a decrease of 23% districts without population in peri-urban areas.

In what concerns the total rural population, in 2000 an average of 77% inhabits outside rural centres (dispersed rural population), which is an increase from 1984 (in this year the percentage of 69%). There was an increase of 22% districts without population inside rural centres (concentrated rural population) an increase of 35% districts without population outside rural centres. There are more districts without concentrated rural population than dispersed rural population. The concentrated and dispersed rural population is inexistent in the many o the districts of the GAM of San José (in terms of dispersed rural population the districts of the GAM of San José are almost the only ones without this type of population).

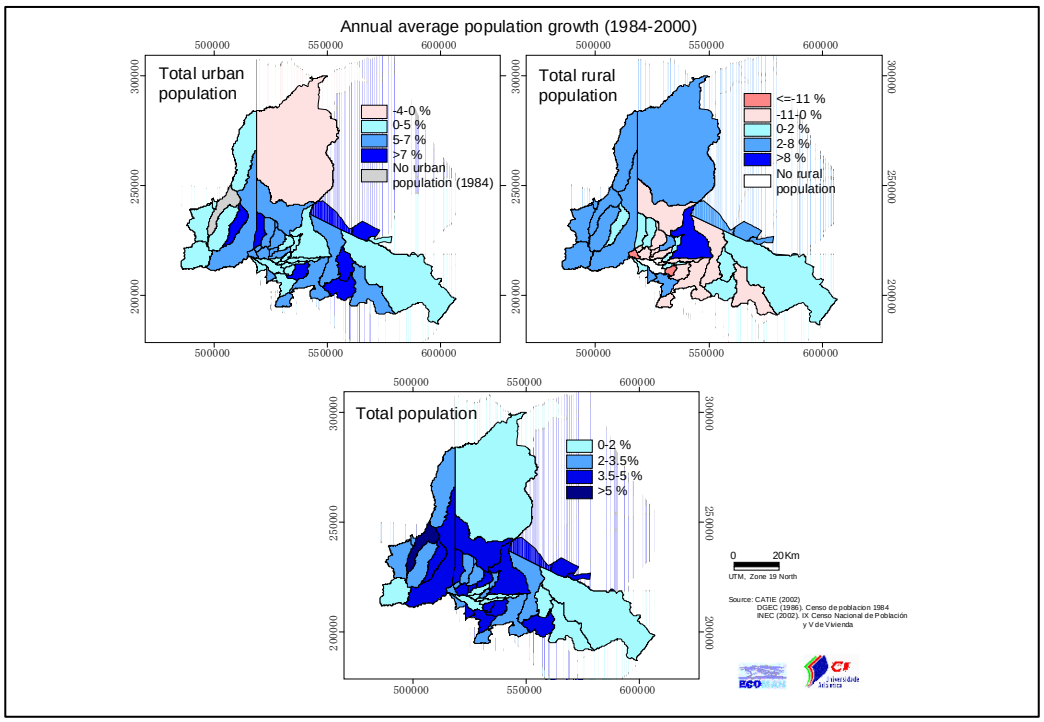
In the districts of Turrialba catchment, the rural population, especially outside rural centres has more significance. However, between 1984 and 2000, there was an increase of residents in urban areas.

2.1.3 Population growth

Although there is no negative (or null) annual average total population growth between 1984 and 2000, the same cannot be said in terms of urban and rural population (Fig. 38). Sarapiqui is the only canton with a negative annual average urban population growth (-4-0%). In terms of growth of rural population there are several cantons with negative values, such as, Curridabat and Belen (bellow -11%) and Jimenez (-11-0%). Vasquez de Coronado registers the highest annual average total rural population growth (above 8%).

The three cantons of Turrialba catchment exhibit, as mentioned before, a low growth of total population (0-2%), but Alvarado has a high growth of urban population (above 7%). In Jimenez the growth of total urban population is positive and of rural population is negative (or null), which can mean that a passage of population from the rural to urban areas exists and/or a growth of the urbanisation process of the canton.

Fig. 38. Annual Average Population Growth, ACCVC, 2000

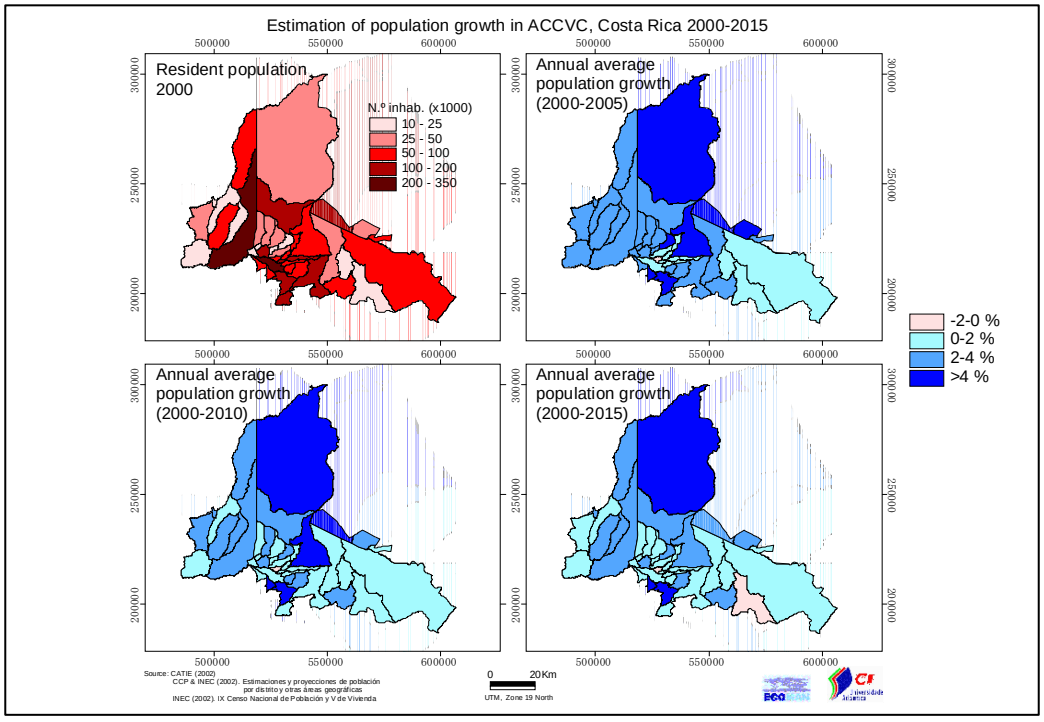


2.1.4 Population projections

The estimation of the annual average population growth in ACCVC (Fig. 39) registers a decrease of 3.0% (2000-2005), 2.5% (2000-2010) and 2.3% (2000-2015).

In the three cantons that surround the Turrialba catchment there is also a decrease in the annual average population growth estimation of 1.1% (2000-2005), 0.6% (2000-2010) and 0.4% (2000-2015). Tibas is the only canton that has always an estimated negative annual population growth, whatever the period of time; Jimenez has an estimated negative annual population growth between 2000 and 2015. Alajuelita, Sarapiqui and Desamparados are the only cantons with an estimated annual population growth above 4%, whatever the period considered.

Fig. 39. Population Growth, ACCVC, 2000-2015



2.1.5 Active population

In ACCVC, from 1984 to 2000 the percentage of active occupied population working in the primary diminishes, while the percentage of active occupied population working in the secondary and tertiary sector increases. The same can be said in terms of the three cantons that surround the Turrialba catchment (Fig. 40 and Fig. 41).

In 2000, 60% of the active occupied population of ACCVC work in the tertiary sector, 28% in the secondary sector and only 12% in the primary sector. However, taking into account only the cantons of the Turrialba catchment, the percentage of active occupied population working in the tertiary sector is much less (40%); the majority of the active occupied population in these three cantons work in the primary sector (57%). The GAM of San José has a predominance of the tertiary sector. Sarapiqui, Guacimo, Siquirres and Alvarado are the cantons with the highest percentage of population working in the primary sector (above 70%).

Both in 1984 and 2000 the secondary sector is never dominant. In 1984, the dominance of the tertiary sector confines itself to the zone of the GAM of San José and some peripheral cantons. However, in 2000, there is a dominance of the tertiary sector in almost every canton

of ACCVC. Therefore, between 1984 and 2000, in ACCVC, exists a movement from the primary to the tertiary sector. Only in six cantons the primary sector remains dominant: Sarapiqui, Pococi, Jimenez, Alfaro Ruiz, Guacimo, Siquirres and Alvarado (Fig. 41).

In the cantons of the Turrialba catchment, in 1984, exists a dominance of the primary sector, but, in 2000, only Alvarado upholds that dominance (Jimenez remains with a dominance of the primary sector and Turrialba changes to dominance of the tertiary sector).

Fig. 40. Working population, ACCVC, 2000

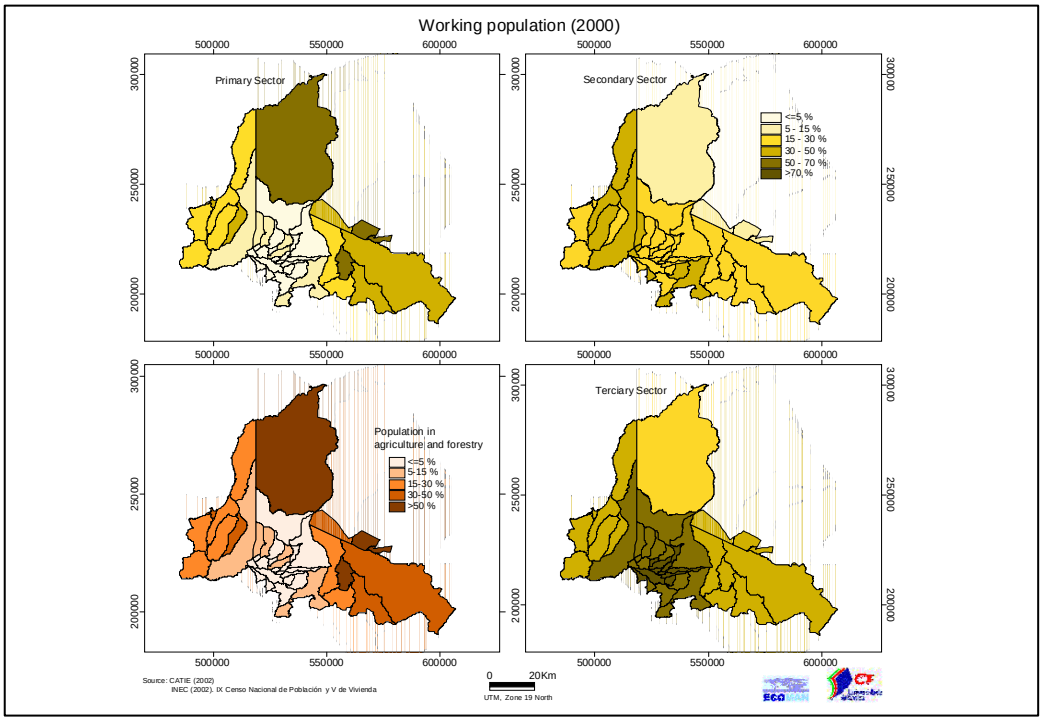
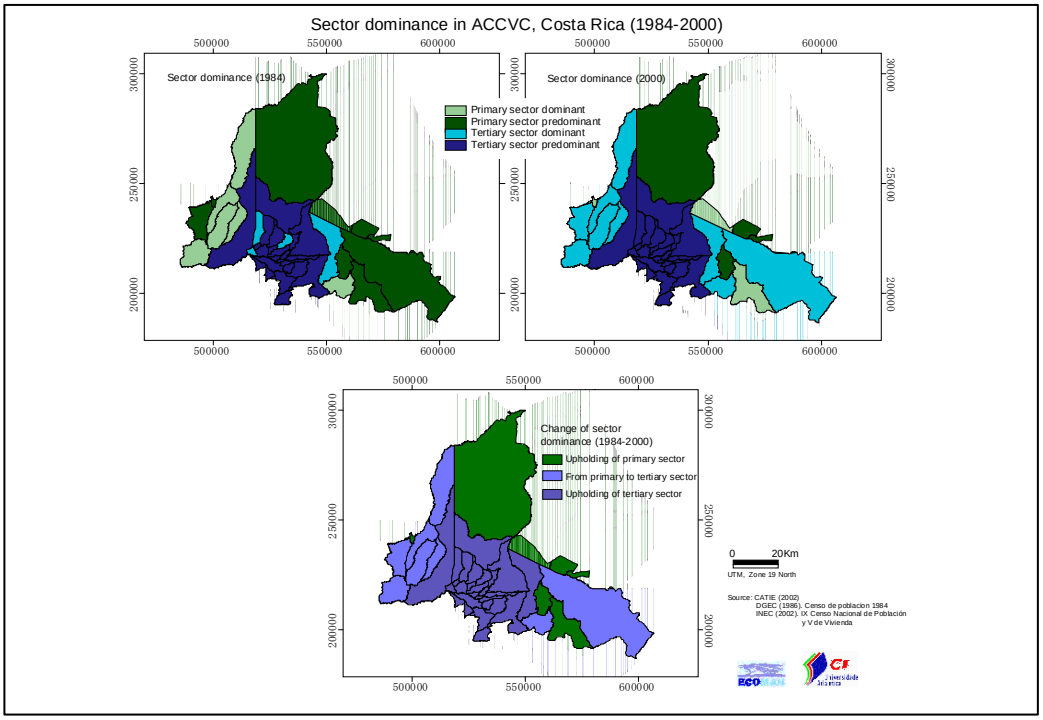


Fig. 41. Sectors of Economic Activities, ACCVC, 2000



2.1.5.1 Active population in the districts of ACCVC

In ACCVC, from 1984 to 2000 the percentage of active occupied population working in the primary sector is the same, while the percentage of active occupied population working in the secondary and tertiary sector increases (the percentage of this last sector increases almost to the double). The same can be said in terms of the three cantons that surround the Turrialba catchment, with exception of the percentage of active occupied population working in the primary sector, which diminishes.

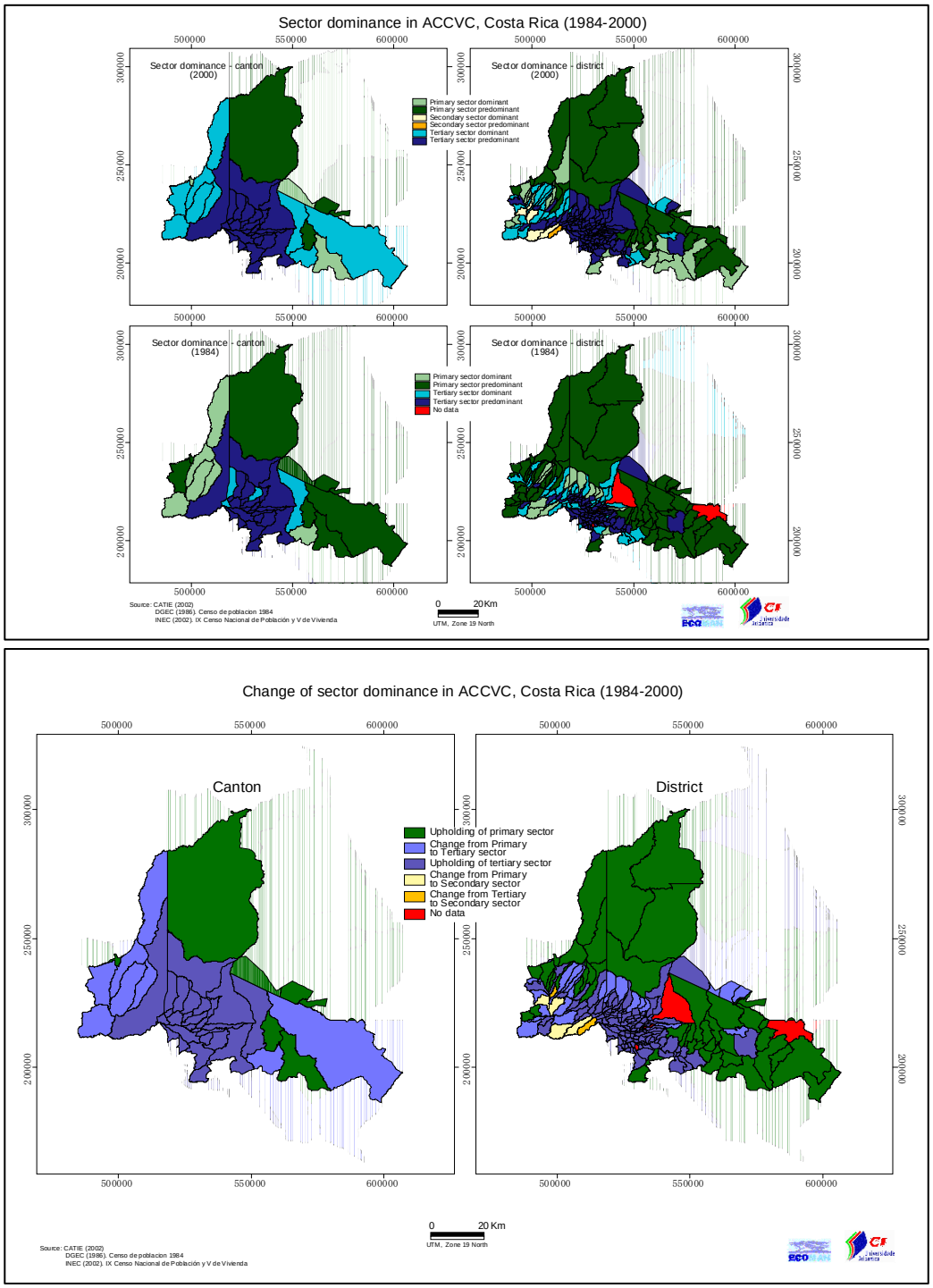
In 2000, 62% of the active occupied population of ACCVC work in the tertiary sector, 29% in the secondary sector and only 10% in the primary sector. Taking into account only the cantons of the Turrialba catchment, the percentage of active occupied population working in the tertiary sector is much less, although still predominant (40%); however, the percentage of active occupied population working in the primary sector is almost the same (39%). The GAM of San José has a predominance of the tertiary sector.

In 1984 the secondary sector is never dominant (Fig. 42). In 2000, it is dominant in Puente Piedras, Rosario (Naranjo canton), Sarchi Sur, Turrucares, Guacima and predominant in San Rafael (Alajuela). However, in an overall analysis, the significance of the secondary sector in ACCVC remains very low when compared with the importance of the other two sectors.

In 1984, the majority of the districts of ACCVC have a dominance of the tertiary sector (74%). Despite that fact, the dominance of the tertiary sector confines itself especially to the zone of the GAM of San José and some peripheral cantons. In 2000, there is an increase in the percentage of districts with dominance of the tertiary sector (17%) and in area occupied by them (although continues to restrains itself especially to the central zone of ACCVC). Therefore, between 1984 and 2000, in the districts of ACCVC, exists a significant movement from the primary to the tertiary sector (12% of the districts). Of the districts that had a dominance of the primary sector in 1984, 61% uphold that dominance in 2000.

All the districts of the Turrialba catchment, in 1984, had a dominance of the primary sector, with the exception of Turrialba, and in 2000, Santa Rosa and Turrialba were the only districts without a dominance of the primary sector (dominance of the tertiary sector). However, that dominance of the teritiary sector in those two districts made a shift of the dominant sector from primary to tertiary of the Turrialba canton between 1984 and 2000.

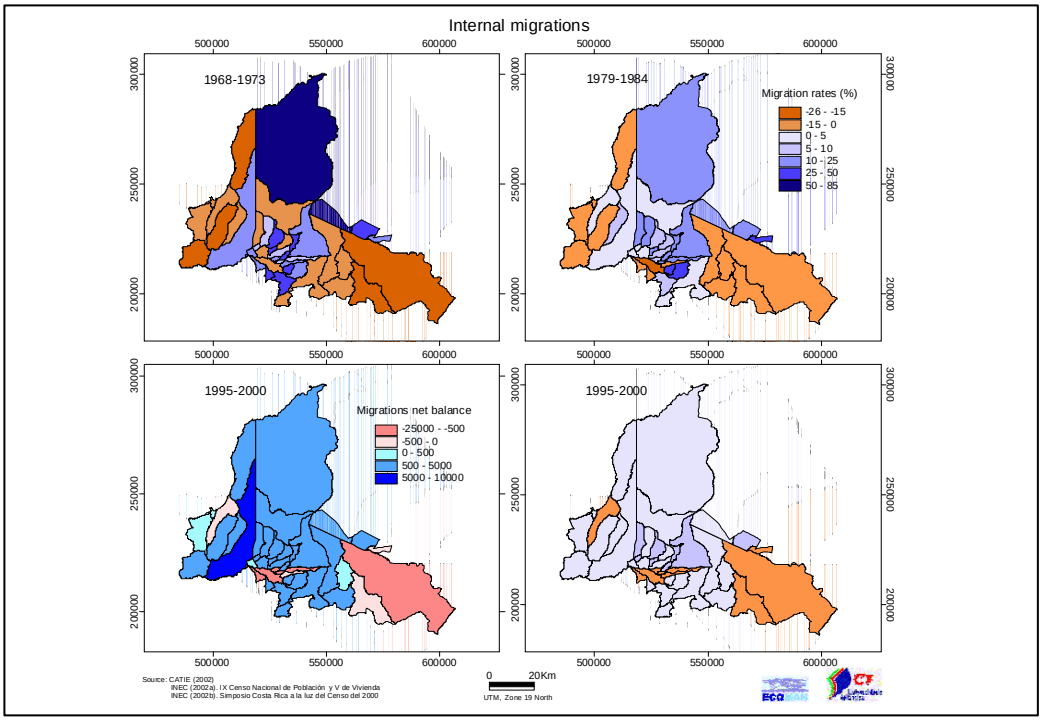
Fig. 42. Sectors of Economic Activities, in the districts of ACCVC, 1984 and 2000



2.1.6 Internal Migrations

Between 1995-2000, Turrialba, Jimenez and Valverde Vega and the cantons from the core of the GAM of San José, were the only ones in ACCVC with negative net balance of internal migrations (Fig. 43). Especially in the canton of San José this balance is quite significant, registering a loss of about 23000 inhabitants. The highest positive net balance is registered in Alajuela (around 9000 inhabitants).

Fig. 43. Internal Migrations, ACCVC, 2000



The ACCVC is an area of Costa Rica that attracts population. It registers a positive net balance of internal migrations of almost 16000 persons. On the other hand, the three cantons of Turrialba catchment reveal a negative net balance of around 1500 people.

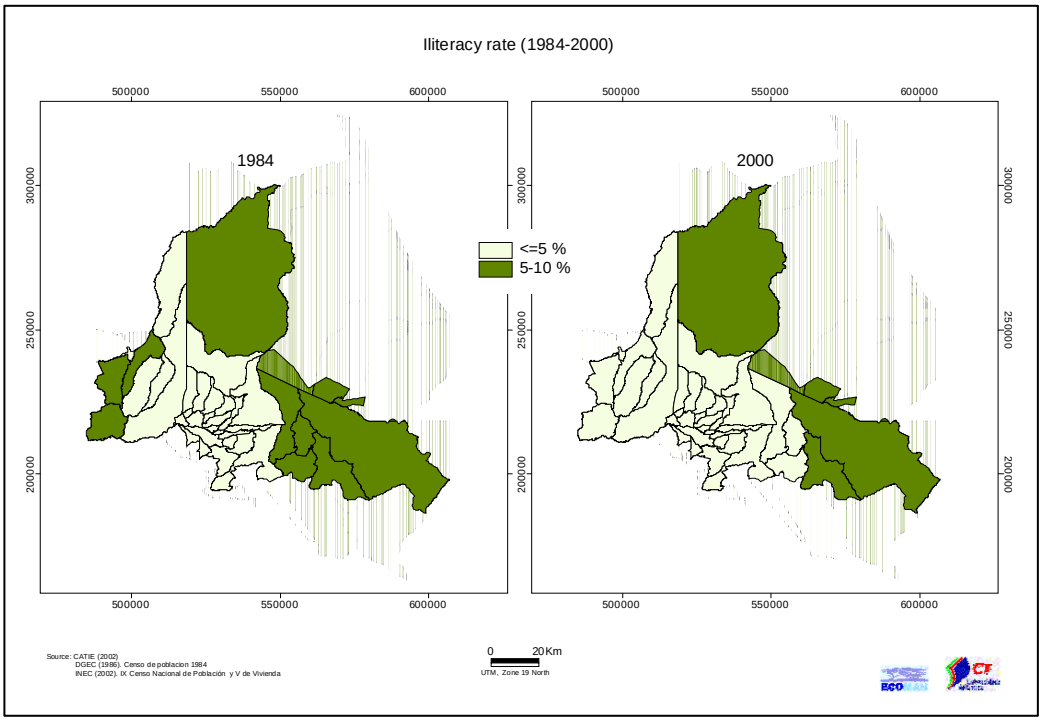
Between 1968 and 2000, the average migration rate of ACCVC is always positive (higher number of entrances), but it decreases along time (1968-1973: 10.4%; 1979-1984: 5.9%; 1995-2000: 2.2%). However, in that period, there is an increase in the number of cantons with a positive migration rate. The highest migration rates were registered in the period 1968-1973 in the cantons of Pococi and Sarapiqui (50-85%). The San José canton has always a negative migration rate between 1968 and 2000. All the three cantons of the Turrialba catchment have a negative migration rate (lower number of entrances), whatever the period, with exception of Alvarado between 1995 and 2000. However, the average migration rate in these three cantons increases along time (1968-1973: -17.2%; 1979-1984: -5.4%; 1995-2000: -0.9%)

2.1.7 Level of education

In ACCVC, the illiteracy rate, in 1984 and 2000, is quite low, and registers a decrease between these two years, from 4% to 3%, respectively. In 2000, all the GAM of San José has an illiteracy rate of less than 5%.

In 1984, the three cantons of Turrialba catchment have a illiteracy rate of 5-10% (in average, 8%), but in 2000, this value decreased to reach 6%, especially due to the decline in the illiteracy rate of Alvarado (bellow 5%).

Fig. 44. Illiteracy rate, ACCVC, 1984 and 2000

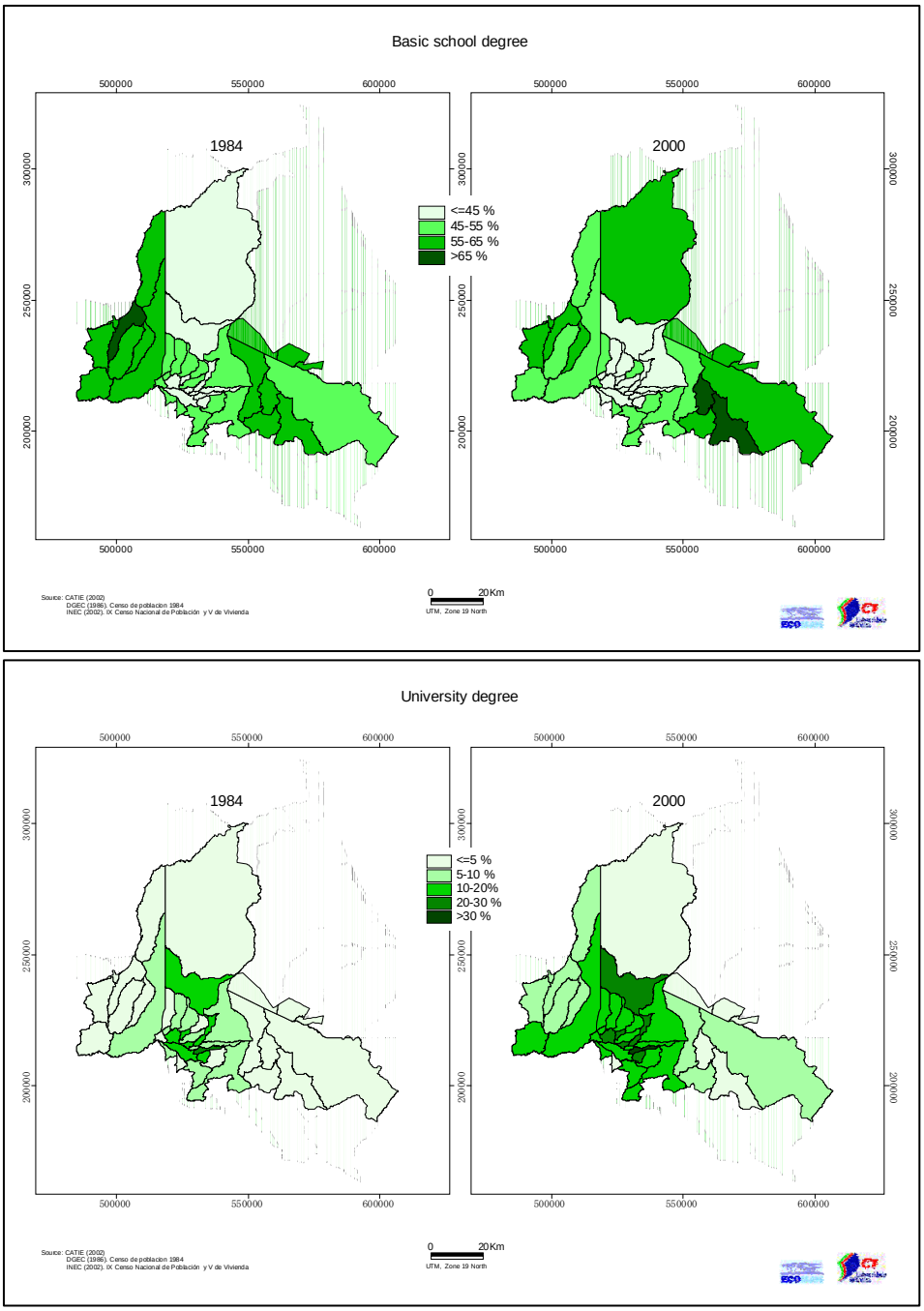


The percentage of population with a basic school degree is basically the same between 1984 and 2000 (47% and 48%, respectively). However, it can be seen a decrease in the cantons included in the GAM of San José and an increase in some of the peripheral cantons of ACCVC. The canton with the highest basic school degree (above 65%) was Valverde Vega, in 1984, and Jimenez and Alvarado, in 2000 (Fig. 45).

The percentage of population with a school degree has enlarged since 1984 (8%) to 2000 (13%). The highest percentage in 2000 exists in Montes de Oca (above 30%).

In the three cantons that surround the Turrialba catchment, there is an increase in the average population percentage with a basic school degree, from 57% (1984) to 59% (2000), due to an increase in all the three cantons to above 65% (Jimenez and Alvarado) and to 55-65% (Turrialba). In terms of school degree, between 1984 and 2000, there is an increase, from 3% to 7%, due to the enhancement in the canton of Turrialba.

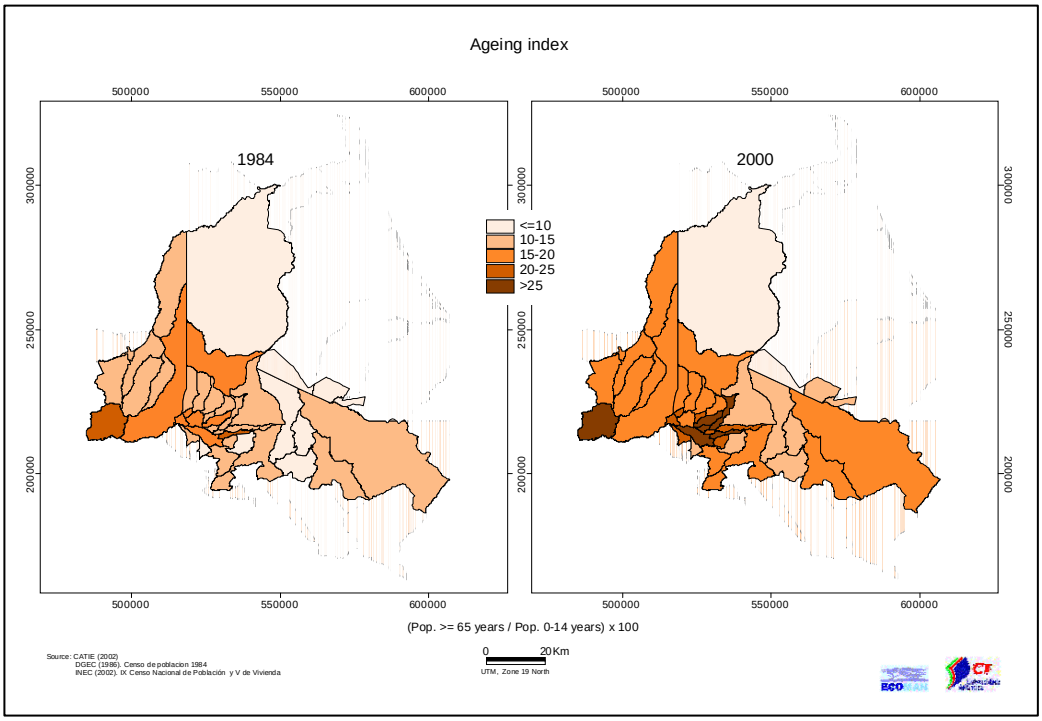
Fig. 45. Basic school and university, ACCVC, 1984 and 2000



2.1.8 Groups of age

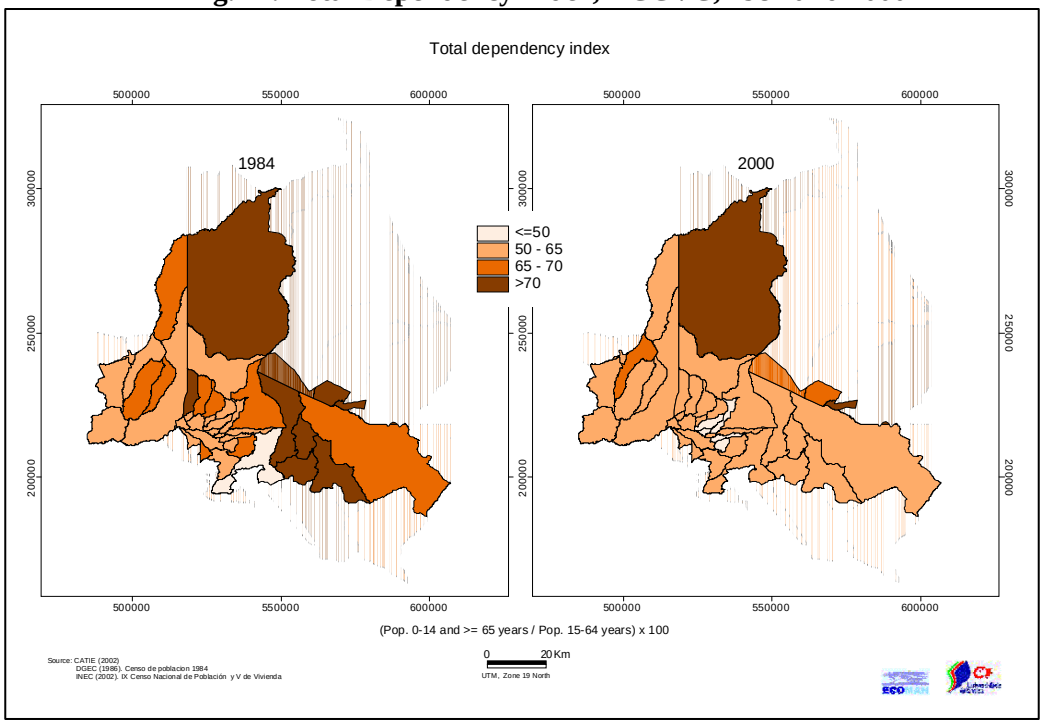
The ageing index is also known as “Vitality Index”. It represents the weight of elders in the younger population. There is an increase of this index in ACCVC from 14 (1984) to 19 (2000). The Ageing Index also increased in the area of Turrialba catchment from 11 (1984) to 18 (2000). In 1984, the majority of the cantons have an Ageing Index of 10-15, while in 2000 the majority have an index of 15-20. Atenas and some cantons that belong to the GAM of San José are the only cantons that have an Ageing Index higher than 25 in 2000 (Fig. 46).

Fig. 46. Ageing index, ACCVC, 1984 and 2000



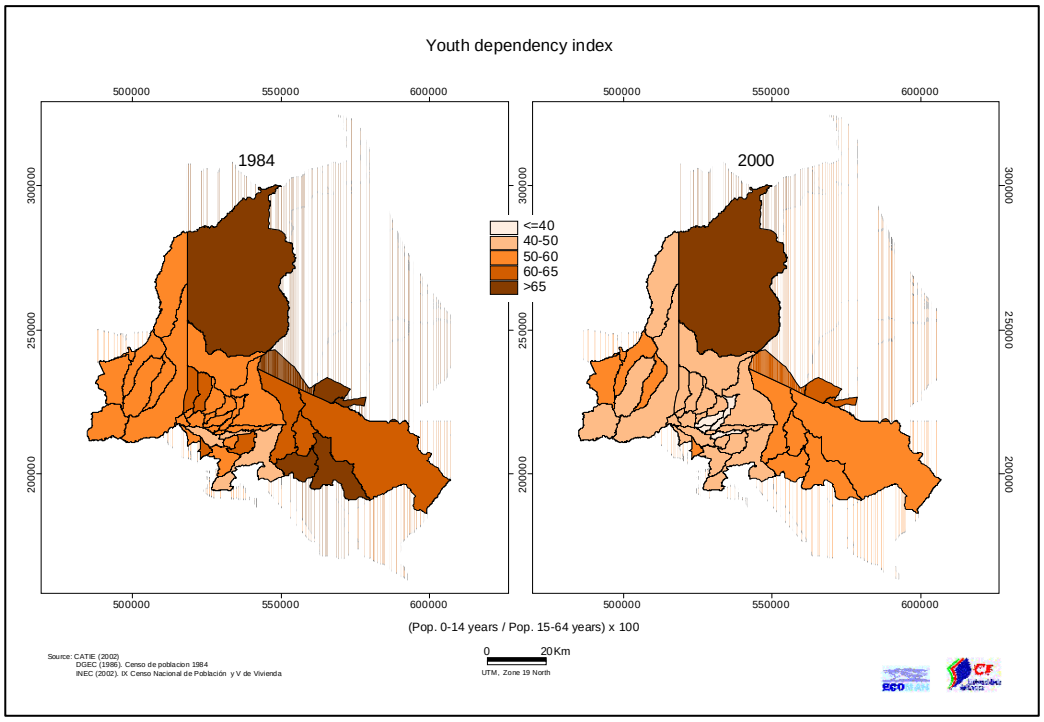
There is a decrease in the Total Dependency Index in ACCVC from 63 (1984) to 56 (2000). The Total Dependency Index also decreased in the area of Turrialba catchment (Fig. 47) from 70 (1984) to 62 (2000). In 2000 the majority of the cantons have a Total Dependency Index of 50-65 (including the three cantons that belong to the Turrialba catchment). Sarapiqui and Siquirres are the only cantons that have a Total Dependency Index above 70, both in 1984 and in 2000. Valverde Vega and Cartago are the only cantons where the Total Dependency Index increases in that period.

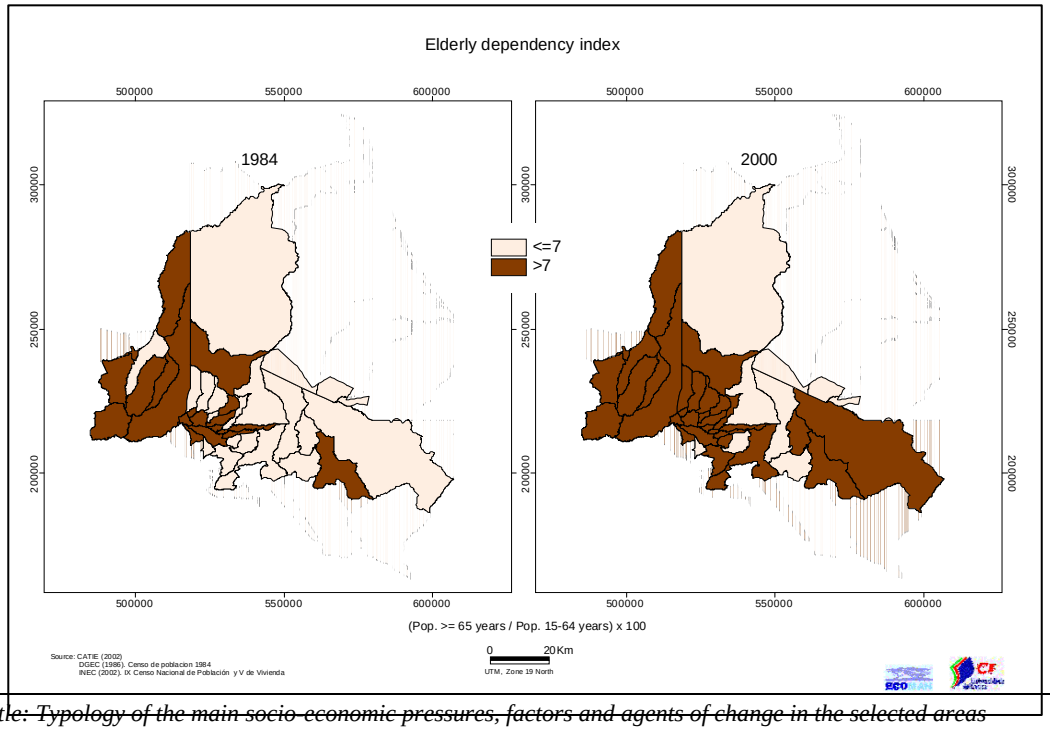
Fig. 47. Total Dependency Index, ACCVC, 1984 and 2000



This decrease in the Total Dependency Index implies a decrease in the weight of youngsters and elders in the potentially active population between 1984 and 2000. By observation of the Maps "Youth Dependency Index" and "Elderly Dependency Index" (Fig. 48) it can be seen that the decrease in the Total Dependency Index is due to a decrease in the Youth Dependency Index and an increase in the Elderly Dependency Index. This suggests that, between 1984 and 2000, the: 1) weight of youngsters in the potentially active population decreases while the weight of elders in the potentially active population increases; 2) weight of youngsters in potentially active population is higher than the weight of elders in that same population.

Fig. 48. Youth Dependency Index and Elderly Dependency Index, ACCVC, 1984 and 2000





The Youth Dependency Index in ACCVC decreased from 55 (1984) to 47 (2000). Sarapiqui is the only canton that has a Youth Dependency Index above 65, both in 1984 and in 2000. In 1984, the majority of the cantons have a Youth Dependency Index of 50-60, while in 2000 the majority have an index of 40-50. The Youth Dependency Index also decreased in the area of the Turrialba catchment from 63 (1984) to 52 (2000); this situation is higher in the canton Jimenez (from a Youth Dependency Index above 65 in 1984 to one of 40-50 in 2000).

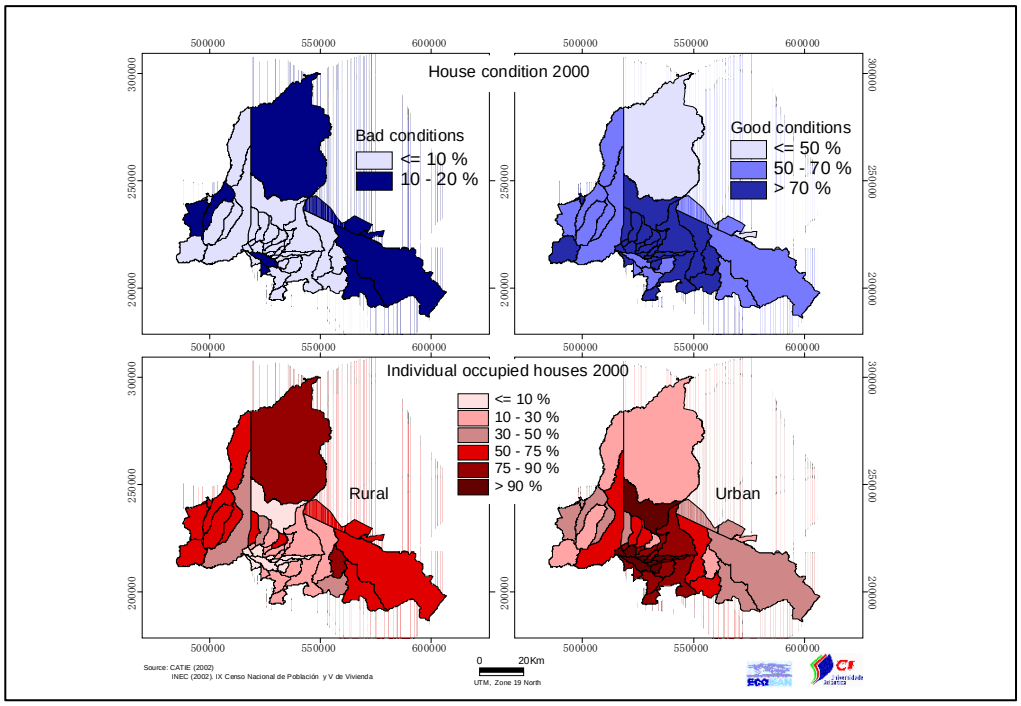
On the other hand, the Elderly Dependency Index in ACCVC increased from 8 (1984) to 9 (2000). In 1984 the majority of the cantons have a Elderly Dependency Index less than (or equal to) 7, while in 2000 the majority of the cantons have a Elderly Dependency Index above 7. The Elderly Dependency Index also increased in the area of the Turrialba catchment from 7 (1984) to 10 (2000); of these three cantons, Jimenez is the only canton that has a Elderly Dependency Index above 7, both in 1984 and in 2000.

2.2 Analysis of households

In 2000, the great majority of the population of ACCVC (69%) live in good house conditions. This is especially significant in the central zone of ACCVC (class above 70%). Only 8% of the population of ACCVC live in bad house conditions (Fig. 49).

The same can be said about the three cantons that surround the Turrialba catchment, where 65% and 10% of the population live in good and bad house conditions, respectively. Less than 10% of the population of Alvarado live in bad house conditions, but that percentage is higher (10-20%) in Jimenez and Turrialba.

Fig. 49. House conditions, ACCVC, 2000



The main urban areas of ACCVC are specially located in its central zone, including the GAM of San José. The three cantons of the Turrialba catchment are manly rural, particularly Alvarado (75-90% of the individual occupied houses).

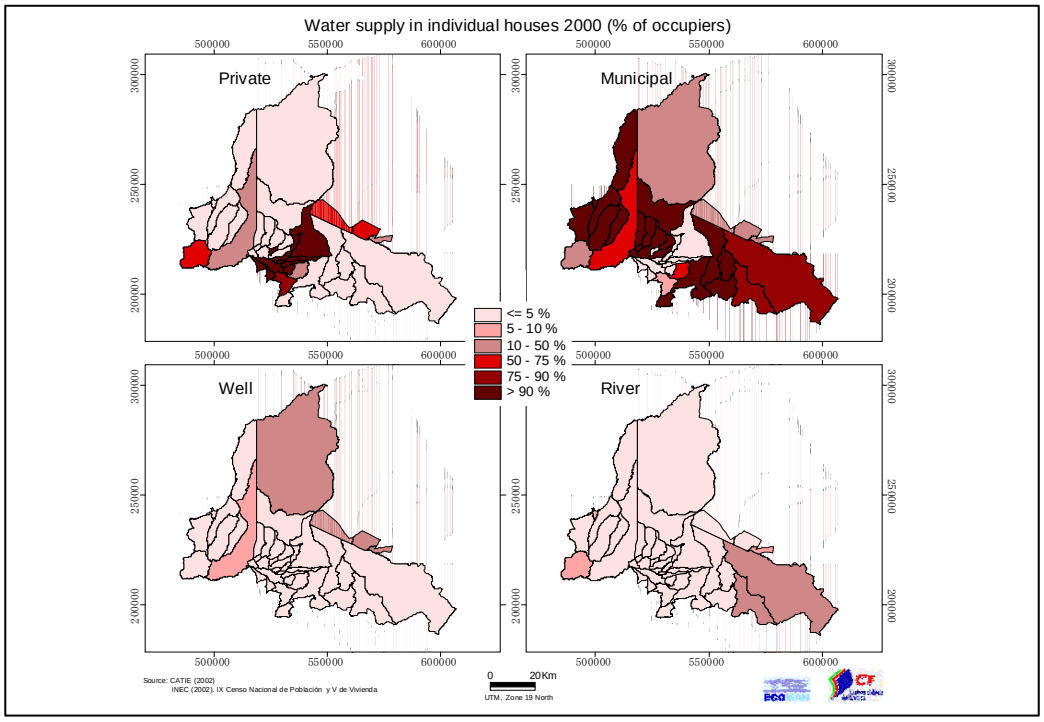
Apparently, there is some relation between the dominance of rural individual occupied houses and higher percentage of bad house conditions and between the dominance of urban individual occupied houses and the higher percentage of good house conditions.

2.2.1 Water supply

In 2000, the private system is the major water supply of ACCVC (52% of the occupiers of individual houses), followed by the municipal system (42%), wells (4%) and rivers (2%). The private system has a higher importance in ACCVC due to its significance in the core zone of the GAM of San José (Fig. 50).

In the three cantons of Turrialba catchment, the situation is different: the municipal system has higher significance in water supplying (86% of the occupiers of individual houses), followed by rivers (14%), wells (1%) and by the private system (0%).

Fig. 50. Water supply, ACCVC, 2000



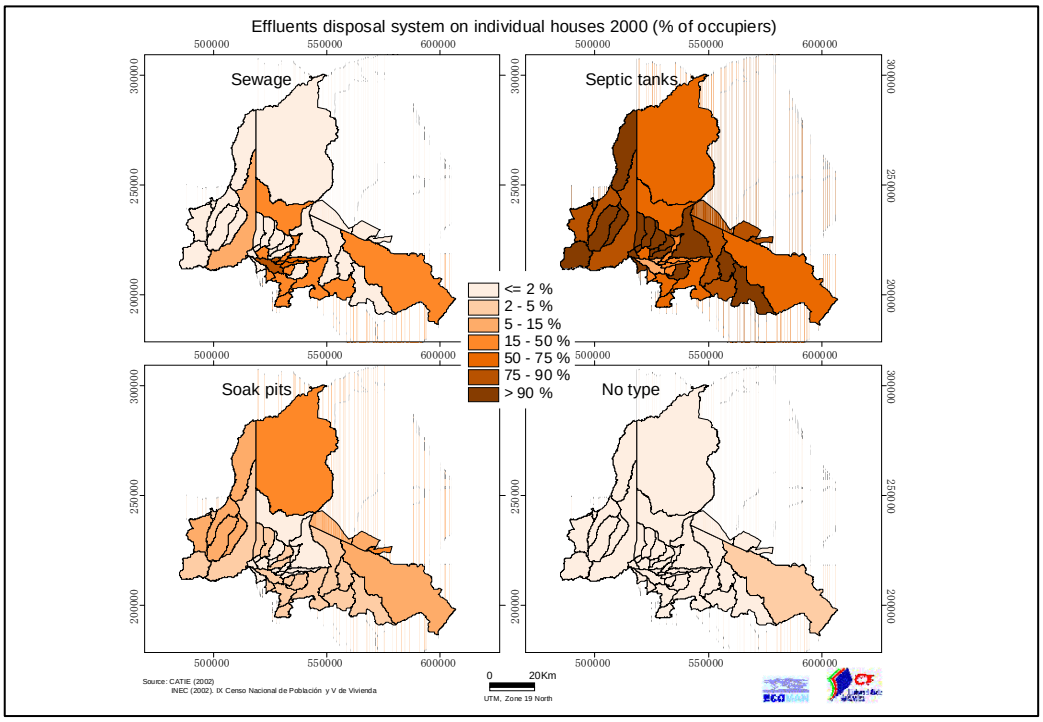
2.2.2 Effluents disposal system

In 2000, the majority of the population on individual houses of ACCVC have some type of effluents disposal system; only 0.7% of the occupiers of individual houses do not have it (Fig.

51). This means there was a decrease of the number of occupiers without an effluents disposal system to half between 1984 and 2000. The canton Jimenez registers the highest percentage of occupiers of individual houses with no type of effluents disposal system (2-5%); Sarapiqui, Guacimo and Siquirres decreased the percentage of occupiers of individual houses with no type of effluents disposal system from 5-15% to less than 2% between 1984 and 2000.

The septic tanks are the major effluents disposal system of ACCVC (64% of the occupiers of individual houses), followed by the sewage system (30%) and soak pits (5%). San José and Tibas are the cantons with the highest percentage of occupiers of individual houses with sewage system as the primary effluent disposal system (above 90%). The use of septic tanks and soak pits as an effluent disposal system by the occupiers of individual houses has decreased from 1984 to 2000.

Fig. 51. Effluents disposal system, ACCVC, 2000



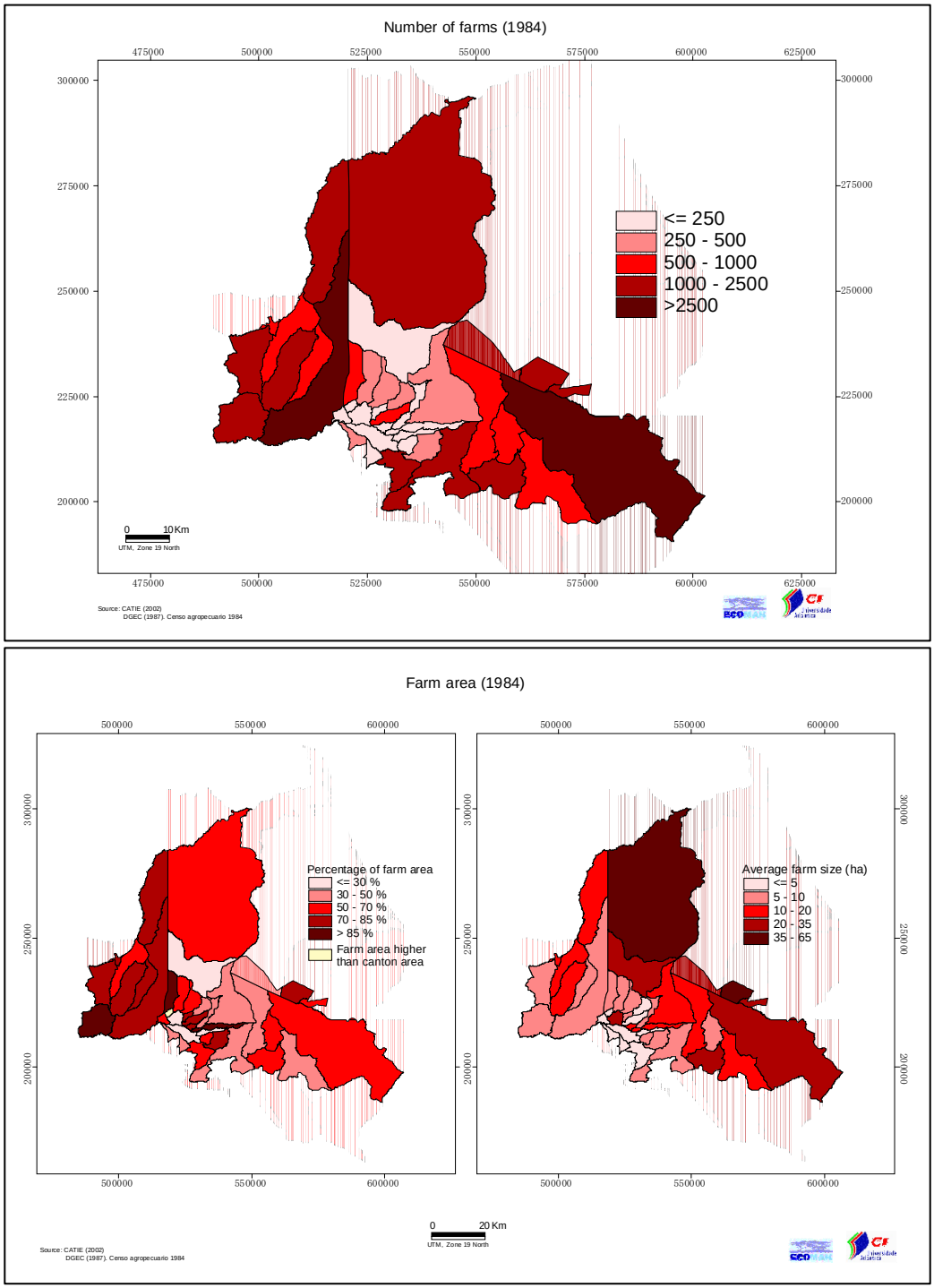
In the three cantons of Turrialba catchment, the majority of the population on individual houses of ACCVC also have some type of effluents disposal system – only 2% of the occupiers of individual houses do not have it. This means that, in these cantons there was a decrease of the number of occupiers without an effluents disposal system between 1984 and 2000. In terms of the significance of the several types of systems of effluents disposal the situation is somewhat the same as in the total area of ACCVC: the septic tanks have the highest significance in effluent disposing (78% of the occupiers of individual houses), followed by the sewage system (12%), and soak pits (6%).

The use of septic tanks as an effluent disposal system by the occupiers of individual houses has increased and the use of soak pits has decreased from 1984 to 2000.

2.3 Analysis of agrarian structures

In 1984, the ACCVC had 33767 farms (617744.9 ha), which correspond to an average of farm size of 18 ha and 912 farms per canton (Fig. 52).

Fig. 52. Farms, ACCVC, 1984



The cantons with less number of farms correspond to the core of the Grand Metropolitan Area (GAM) of San José, where the cantons have also small size. Nevertheless, in some of the

peripheral cantons of GAM, the number of farms can be higher than the average. The three cantons that surround Turrialba catchment also have a number of farms quite high, being Turrialba the second canton in ACCVC with more farms (3290 farms).

The maximum average farm size is 63ha (Sarapiqui, in the northern lowlands) and the minimum is 2.5ha (San Jose, San Jose Province). In the three cantons surrounding the Turrialba Catchment (Turrialba, Alvarado and Jimenez) the average farm size varies from 5-10ha in Alvarado to 20-35ha in Turrialba.

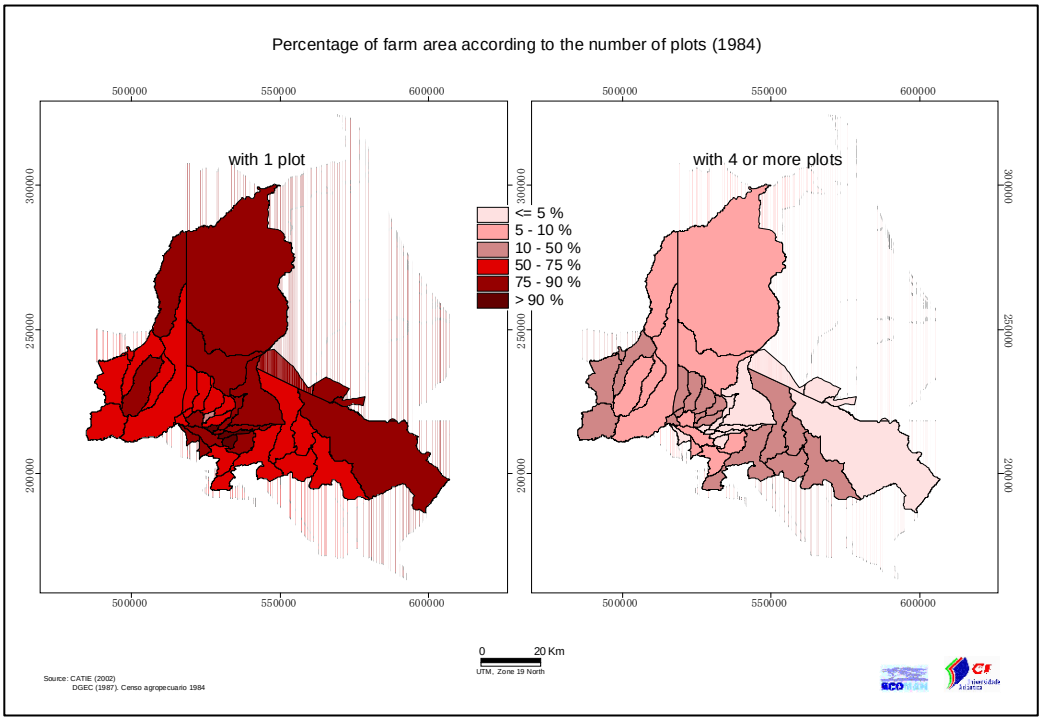
In average, 54% of the canton area corresponds to farmland, with cantons such as the ones from Alajuela Province with more than 70% of farmland, and cantons such as Heredia, San Jose and Montes de Oca with less than 30% of farmland. In the canton Flores (Heredia Province), the farmland area is higher than its canton area.

The three cantons of the Turrialba Catchment have 30-70% of their area with farmland.

2.3.1 Farm land fragmentation

The land fragmentation is rather low. To almost all the cantons, more than 50% of the farms only have one plot, and the more fragmented farms (more than four plots) correspond to 10%. In the three cantons of the Turrialba Catchment, 50-90% of their farms have only one plot (Fig. 53).

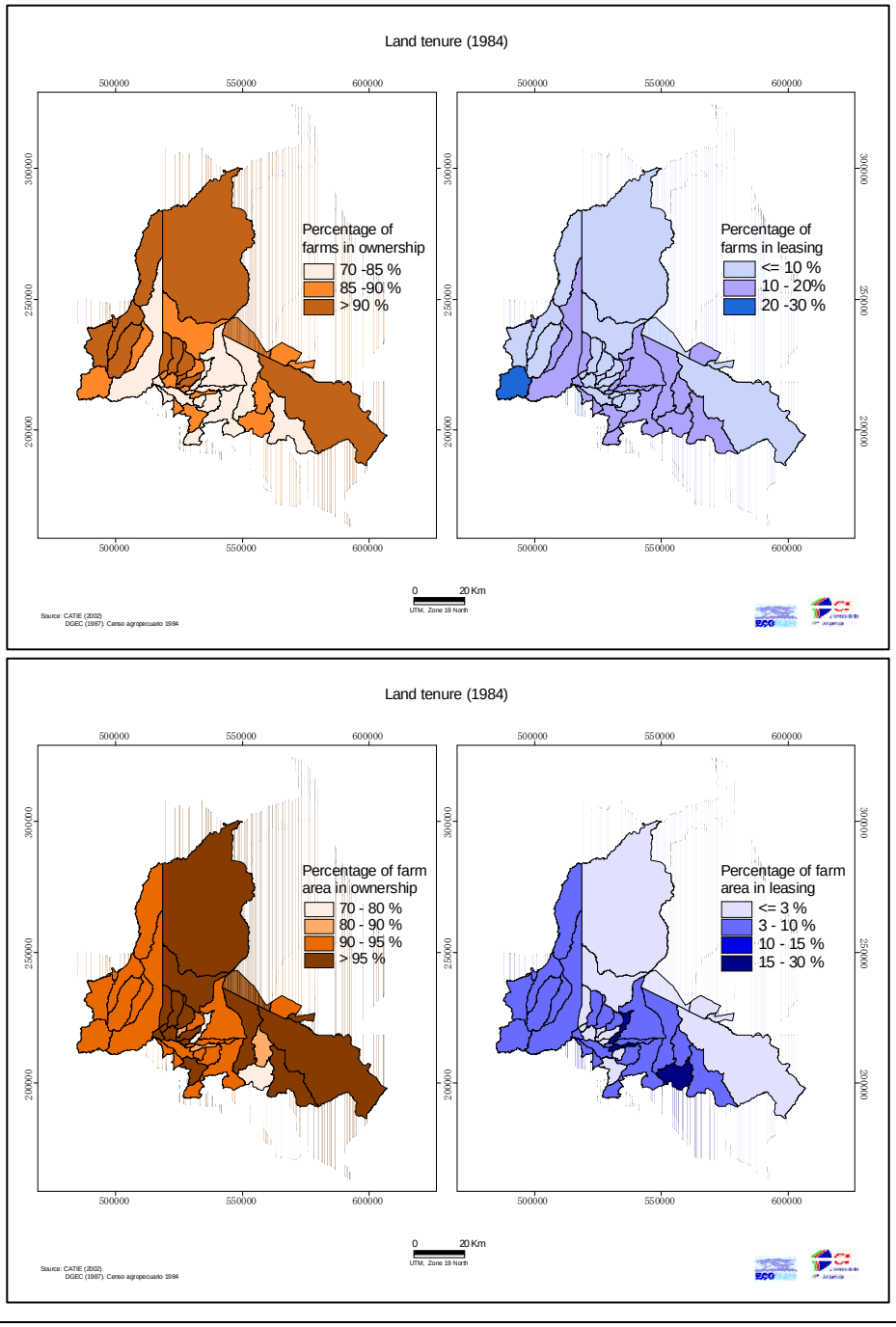
Fig. 53. Fragmentation of farms, ACCVC, 1984



2.3.2 Types of farms

It appears to exist a predominance of individual farms (58%) in detriment of society ones, although that predominance isn't very obvious. In terms of the three cantons, there is an overall balance (average of 50% on both types of farms). However, Jimenez has 50-70% of farm area with society farms, while Alvarado and Turrialba have 50-70% of farm area with individual farms. Ownership is the dominant land tenure system (Fig. 54), with more than 70% of farms and farm area under this type of land tenure. In the three cantons of Turrialba catchment this is also visible. The canton Turrialba has more than 90% of farms and more than 95% of farmland owned by the farmers.

Fig. 54. Land tenure system

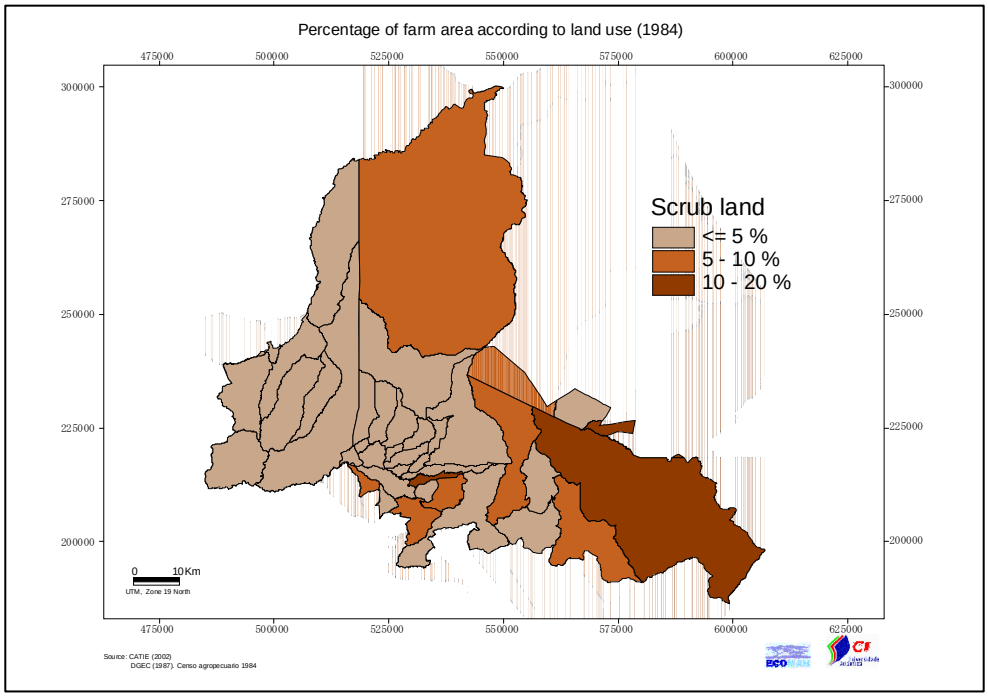


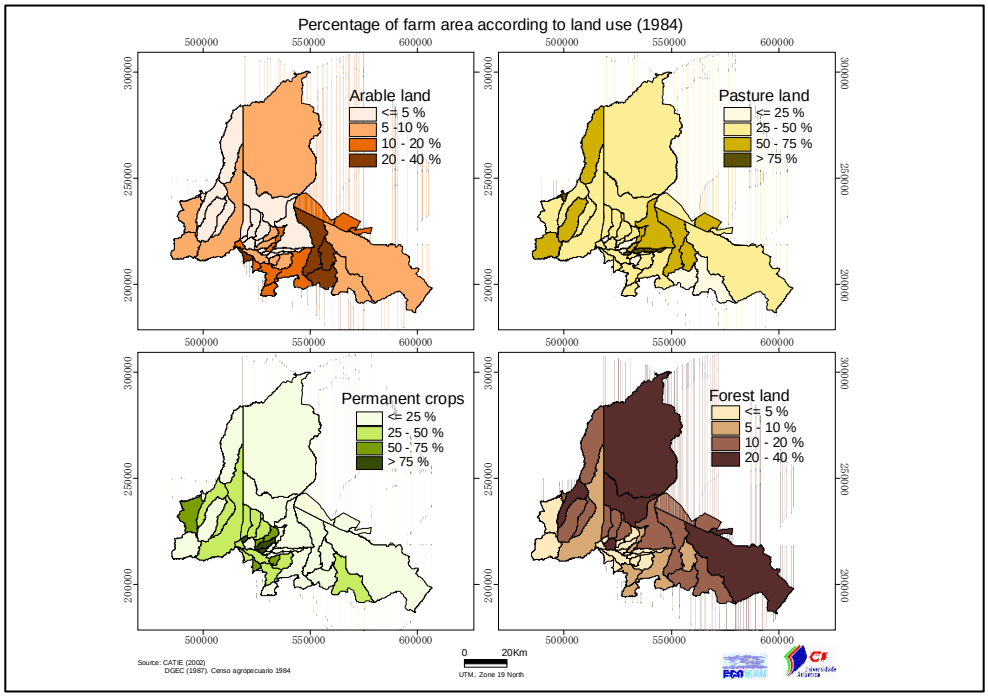
2.3.3 Farms according to land use

In the ACCVC, the areas with scrubland are of little importance. Nevertheless, Turrialba canton presents the highest percentage of this type of land cover (10-20%). In average, ACCVC has significant areas under pasture (44%) and forest (22%). Arable land (10%) and permanent crops (16%) are less importance in terms of area occupied in the farms.

In the cantons of Turrialba catchment, forest is more important in Turrialba (as scrub land); Alvarado has significant parts of its farms under pasture (50-75%) and arable land (20-40%); in Jimenez, permanent crops correspond to 25-50% of the farmland.

Fig. 55. Farms' land use



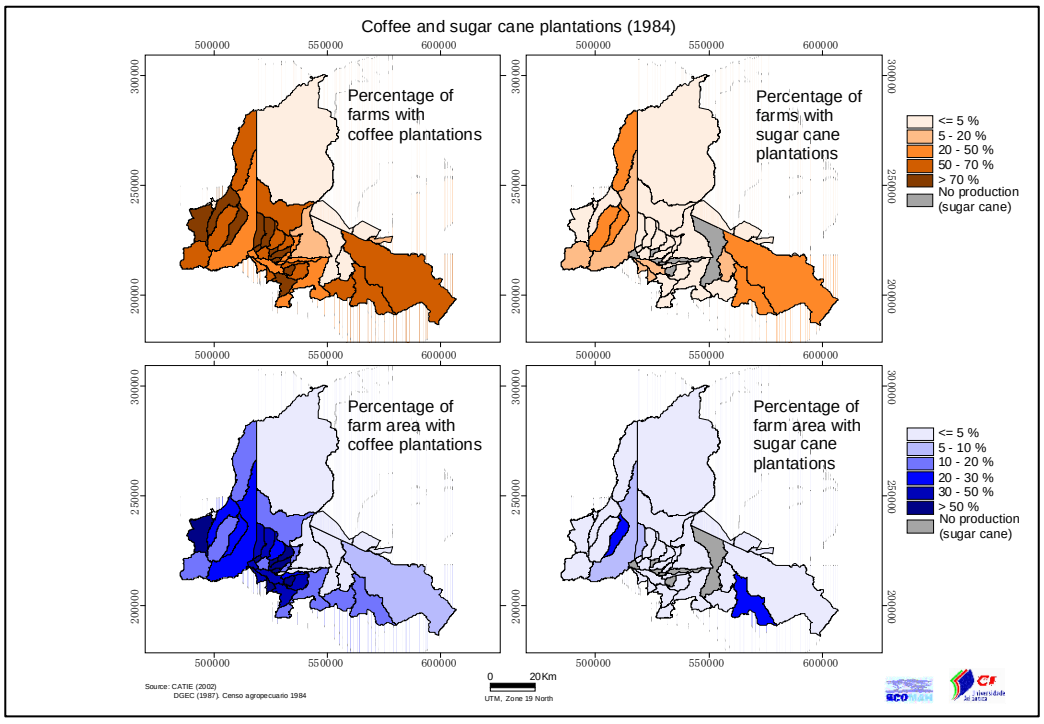


2.3.4 Significant crops: coffee and sugar cane

Comparing the two types of plantations, coffee is more significant (Fig. 56). Coffee plantations exist in all the cantons of ACCVC, while in seven cantons there is no sugar cane production. Furthermore, coffee plantations are present in 44% of all farms, corresponding to 8% of farmland and 5% of the total area of ACCVC. Sugar cane plantations concern only 9% of all farms and 2% of farmland in ACCVC. Although all the cantons have coffee plantations, one of the cantons (Oreamuno) has no coffee production, because the coffee plants haven't reached a productive stage. Oreamuno is the only canton of ACCVC that does not have coffee and sugar cane production.

In the three cantons of Turrialba catchment, the situation is diversified. In Turrialba and Jimenez, the coffee and sugar cane plantations exist in a great number of farms (50-70% with coffee and 20-50% with sugar cane). In Alvarado, the number of farms with coffee and sugar cane plantations is less relevant (less than 20%). In Jimenez, the sugar cane plantations are dominant in terms of farmland occupation.

Fig. 56. Coffee and sugar cane plantations, ACCVC, 1984



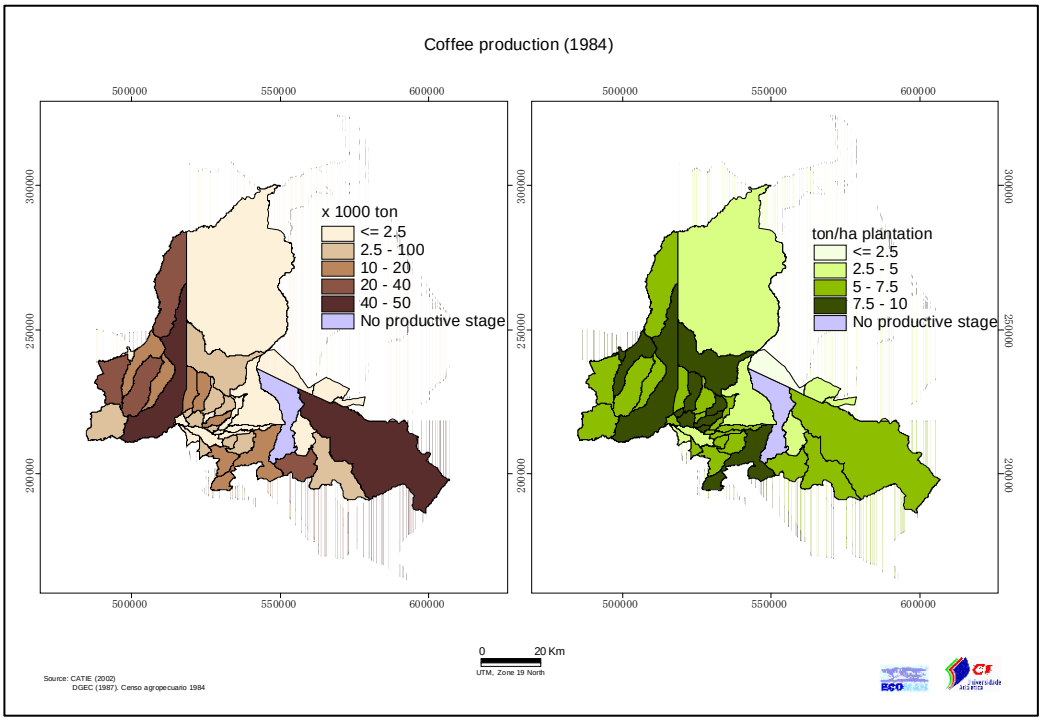
In 1984, 357652ton of coffee (9666ton per canton) were produced in the ACCVC. The cantons with highest production of coffee are Turrialba and Alajuela (40000-50000ton). The sum of the coffee production of the cantons Alajuela, Narranjo and Turrialba correspond to 37% of the total coffee production of ACCVC.

However, taking into account the area occupied by the plantation, it can be inferred that the plantations with the highest productivity (7.5-10ton/ha plantation) are from cantons located in

the central zone of ACCVC (Alajuela continues as one of the highest). All of them belong to the GAM of San José.

The three cantons of the Turrialba catchment produced 54877ton of coffee (18292ton per canton), which corresponds to 15% of the total production in ACCVC (Fig. 57). Turrialba has high production of coffee, as said before, but Jimenez and Alvarado production is lower (under 100ton). In terms of production per area of plantation, Jimenez increases its importance, being its productivity equal to the one of Turrialba (5-7.5ton/ha plantation) while Alvarado productivity is a little bit lower (2.5-5ton/ha plantation).

Fig. 57. Coffee production, ACCVC, 1984

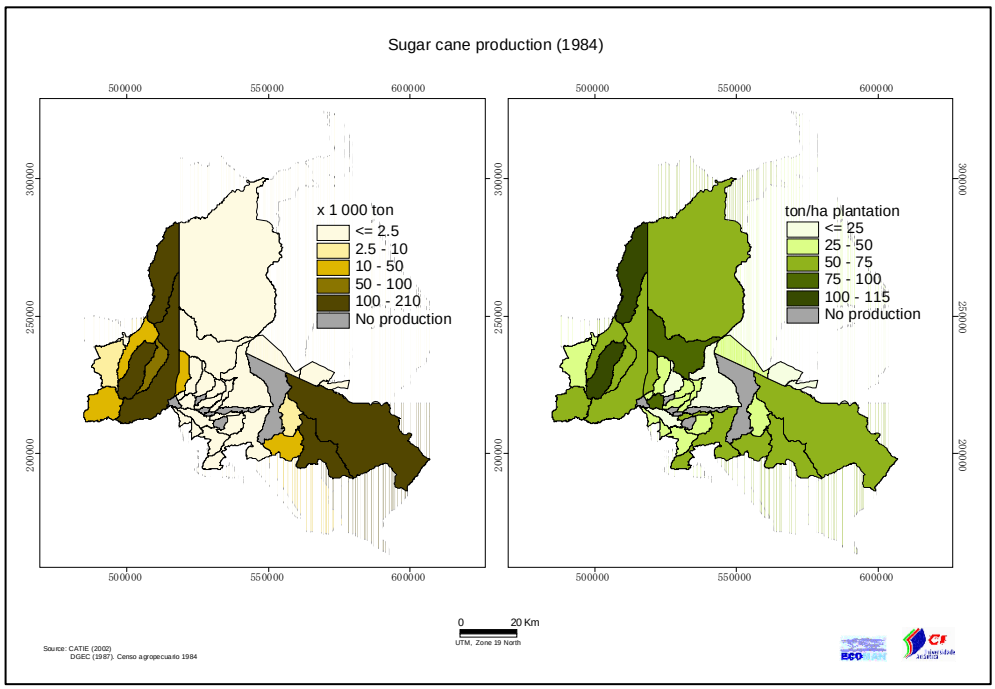


In ACCVC, the sugar cane production is higher than coffee production. In 1984, 875253ton of sugar cane (23655ton per canton) were produced in the ACCVC. The five cantons with highest production of coffee are Grecia, Poas, Jimenez, Turrialba and Alajuela (100000-210000ton), which concentrate 87% of the total sugar cane production of ACCVC (Fig. 58). Recall that Turrialba and Alajuela are also cantons with high coffee production.

Analysing the production of sugar cane per area of plantation, the cantons with the highest productivity are Grecia (100-115ton/ha plantation) and Heredia (75-100ton/ha plantation).

The three cantons of the Turrialba catchment produced 386490ton of sugar cane (10438ton per canton), which corresponds to only 3% of the total production. Turrialba and Jimenez have high production of sugar cane, as said before, but Alvarado production is lower (2500-10000ton). In terms of production per area of plantation, all the three cantons have relative low importance (25-75ton/ha plantation).

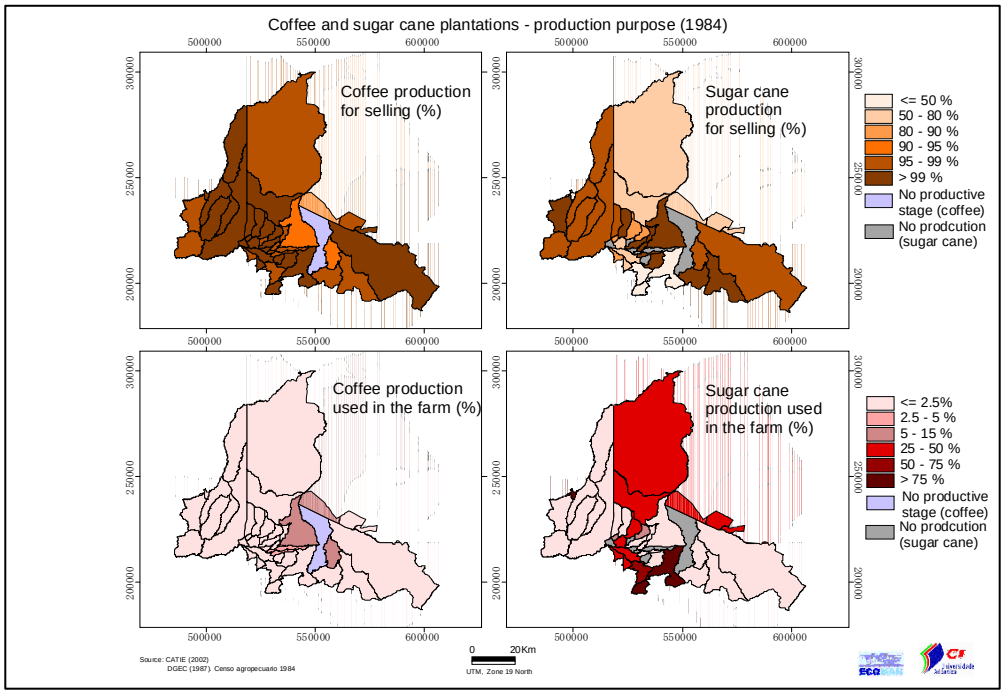
Fig. 58. Sugar cane production, ACCVC, 1984



Although the purpose of coffee and sugar cane production is essentially the market, it can be seen that in coffee production, market is more significant, with more than 80% of the production being sold in the cantons of ACCVC. On the other hand, the maximum percentage of coffee production used in the farm is less than 15%, for example, in Alvarado. The sugar cane production presents a higher balance between selling and farm use production. In Jimenez, the purpose of almost all the production is the market.

Like in the ACCVC, the three cantons of Turrialba catchment have a predominance of coffee and sugar cane production for selling.

Fig. 59. Coffee and sugar cane purpose of production, ACCVC, 1984



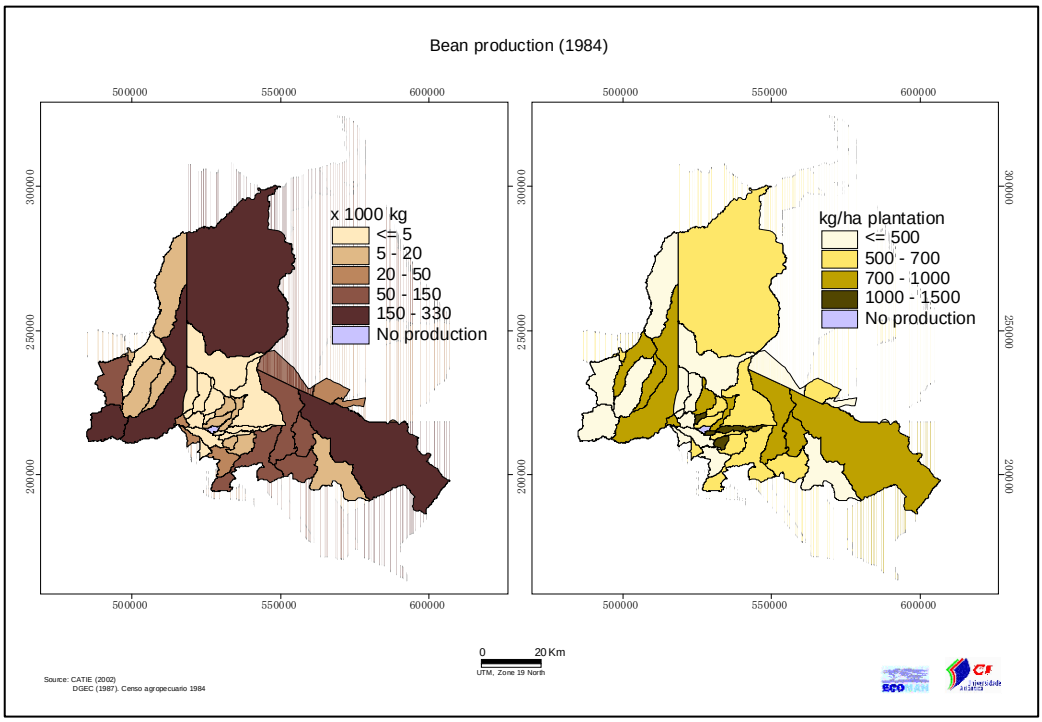
2.3.5 Other crops: beans

In ACCVC the bean production is almost residual when compared with sugar cane and coffee production. Tibas has no production of this product (along with no sugar cane).

In 1984, 1642 ton of bean (44 ton per canton) were produced in the ACCVC. The cantons with highest production of bean are Alajuela, Atenas, Turrialba and Sarapiqui (150-330 ton), corresponding to 51% of the total production of ACCVC. Besides high bean production, Turrialba and Alajuela are also cantons with high coffee and sugar cane production. However, the cantons with the highest bean production per area of plantation are Goicochea, Curidabata and San Pablo (1-1.5 ton/ha plantation).

The three cantons of the Turrialba catchment produced 254 ton of bean (7 ton per canton), which corresponds to only 3% of the total production. Turrialba has high production of bean, as said before, Alvarado production is lower (50-150 ton) and Jimenez production is even less (5-20 ton). In terms of production per area of plantation, Jimenez importance remains low (lower than 0.5 ton/ha plantation) while Turrialba and Alvarado maintains higher (0.7-1 ton/ha plantation).

Fig. 60. Beans production, ACCVC, 1984

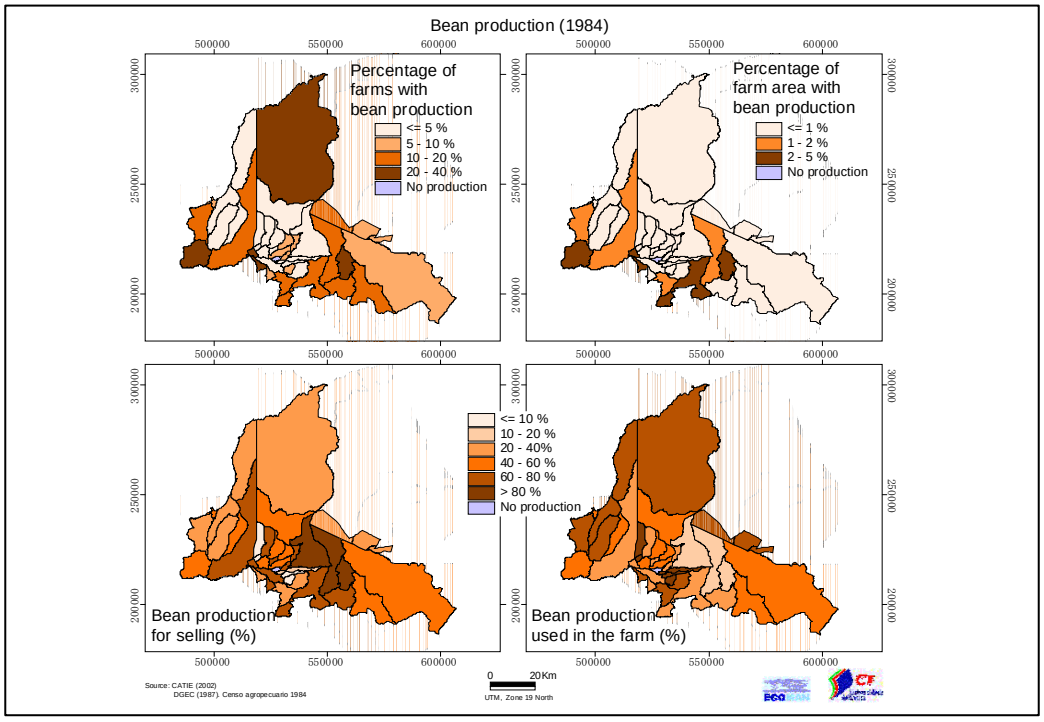


The majority of cantons have less than 10% of farms with bean production and the maximum of farms is 20-40% (for example, Alvarado). In the three cantons of the Turrialba catchment, the average is around 12% (Fig. 61).

The majority of the cantons have less than 1% of the farm area occupied with bean production, being the maximum percentage 2-5%, for example, in Alvarado. In the three cantons, percentage of farm area occupied is less than 5% (average-0.4%).

The purpose of bean production is balanced between market and use in the farm; nevertheless the production for selling is slightly higher (56%). In the three cantons the difference is higher, with an average of 65% of the production being for sale and Alvarado registers more than 80% of the production for selling.

Fig. 61. Beans production and purpose, ACCVC, 1984



2.3.6 Livestock production: cattle and swine

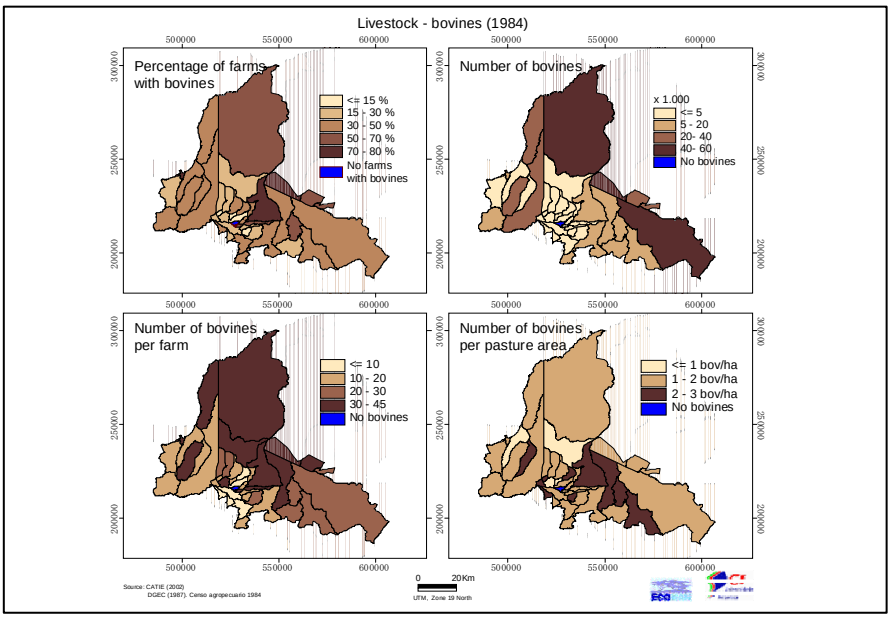
In the ACCVC there are 13965 farms with bovines (377 farms with bovines per canton), corresponding to 42% of all the farms of ACCVC (Fig. 62). Tibas is the only canton of the ACCVC that has no farms with bovines. The majority of the cantons have a percentage of 30-50% of farms with bovines. However, this percentage increases to 70-80% of the farms in Vasquez de Coronado and Pococi.

In these farms, there are 377124 bovines, i.e., 10192 bovines per canton. In the central zone of GAM of San José, there is a low number of bovines (less than 5000 bovines). The northern and central area of ACCVC has higher number of bovines per farm (30-45 bovines). However, the highest number of bovines per pasture area (2-3 bovines/ha pasture area) occurs in a group of cantons located in the southeast area of the ACCVC, which includes Alvarado and Jimenez.

Examining the cantons that surround Turrialba catchment, there are 2057 farms with bovines (686 farms with bovines per canton), corresponding to 43% of all the farms of these three cantons. In Alvarado, 50-70% of the farms have bovines, while only 30-50% of the farms of Jimenez and Turrialba have these animals. There are 54555 bovines in these three cantons (1474 bovines per canton and 20-30 bovines per farm), which correspond to 15% of the total

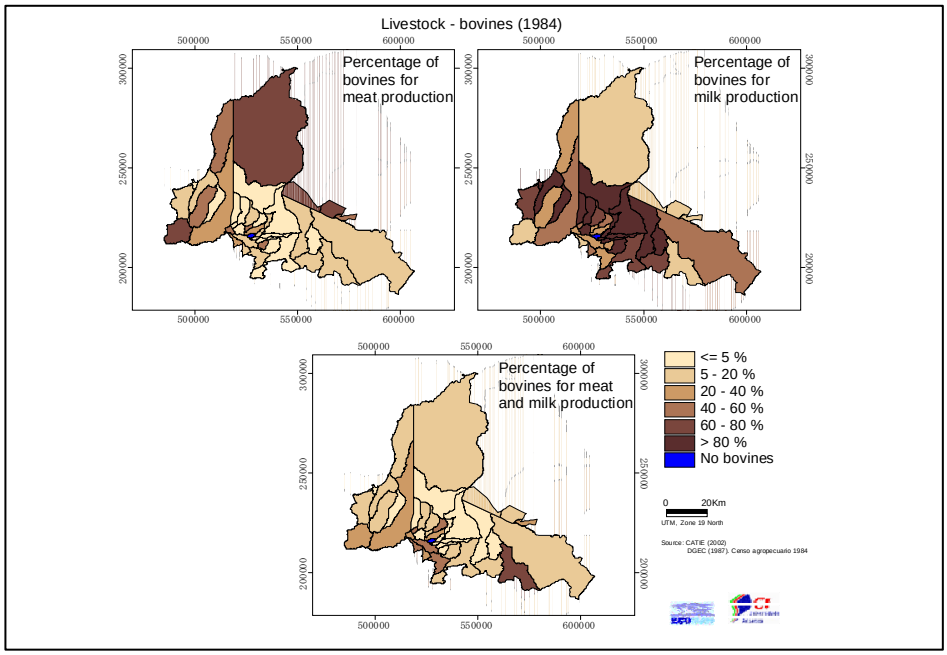
number of bovines in the ACCVC. Due to the size of the cantons and the area occupied with pastures, Turrialba has 1-2 bovines/ha pasture area while, as stated before, Jimenez and Alvarado have 2-3 bovines/ha pasture area.

Fig. 62. Farms with cattle, ACCVC, 1984



In the ACCVC, meat production is the most important purpose (46%) of bovines' livestock. Nevertheless, the cantons in the central part of ACCVC have more than 80% of bovines for milk production (Fig. 63). The four cantons that have higher percentage of bovines for meat production are Sarapiqui, Pococi, Guacimo and Atenas. In Alvarado, the purpose of more than 80% of bovines is milk production. In Turrialba, although less significant (40-60% of bovines), milk production is the dominant intent. In Jimenez, 60-80% of bovines are related with meat and milk production.

Fig. 63. Purpose of cattle rising, ACCVC, 1984



In the ACCVC, 43% of the farms have small size herds (1-5 bovines); in six cantons (being Jimenez one of them), the weight of this small size herds increases to 65-75%. The canton Sarapiqui presents 10-25% of the farms with big size herds (more than 100 bovines).

The swine production has less significance than the bovine production. In the ACCVC, the majority of the cantons have a percentage of 5-15% with swines, which corresponds to an average of 176 farms with swines per canton; in some cantons, like Sarapiqui, Pococi, Guacimo and Turrialba this number can reach 500-1110 farms. The information about swines' livestock is confidential in two cantons (Montes de Oca and Tibas).

In these farms there are 109979 bovines, i.e., 2972 swines per canton. This number of swines per canton rises to 10000-34500 in Cartago and Alajuela. In terms of number of swines per farm, the highest values exist in Belen and Santa Barbara (80-140 swines/farm). Making a general analysis, the central zone of ACCVC has lower number of swines, but higher number of swines per farm.

Examining the cantons that surround Turrialba catchment, there are 937 farms with swines (312 farms with swines per canton), corresponding to 20% of all the farms of these three cantons. In Alvarado and Turrialba, 15-30% of the farms have swines, while only 5-15% of the farms of Jimenez have this kind of animals. There are 6309 swines (2103 swines per canton), which corresponds to 6% of the total number of swines in the ACCVC. Alvarado has 15-40 swines per farm and Turrialba and Jimenez have less than 15.

3 TYPOLOGY OF THE MAIN SOCIO-ECONOMIC PRESSURES

The main goal of this report is to make a brief summary of the work done in integrating information concerning biological resources (agricultural, sylvicultural, biodiversity, vegetation) and socio-economic data in scenario simulation. Furthermore, the first results of scenario simulation, to be presented and discussed in ECOMAN coordinating meeting of Hamburg, are also described.

The work done until now is based on qualitative judgments of the data available. Of course, for improving our simulations the contribution of every one of you is crucial.

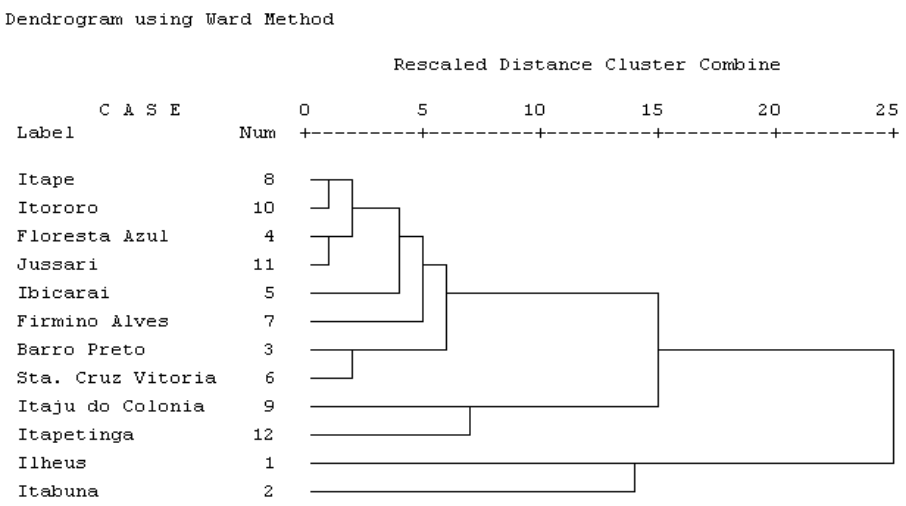
3.1 First phase: Factorial and Cluster analysis of the socio-economic variables of each case study.

The procedures of the analysis of socio-economic data started with the factorial analysis of the variables and the construction of a typology of the administrative units (municipalities in Cachoeira Catchment and Cantons in Conservation Area of Cordillera Volcánica Central).

3.1.1 Main groups of municipalities in Cachoeira Catchment

The cluster analysis applied to 245 socio-economic variables defines, in a first classification, three clusters (Fig. 64). Cluster 1 (Municipalities of Ilhéus and Itabuna) represents the more significant urban areas. Cluster 2 (Municipalities of Itapetinga and Itajú do Colônia) correspond to the areas were the pastures (and the associated economic activities) have more importance.

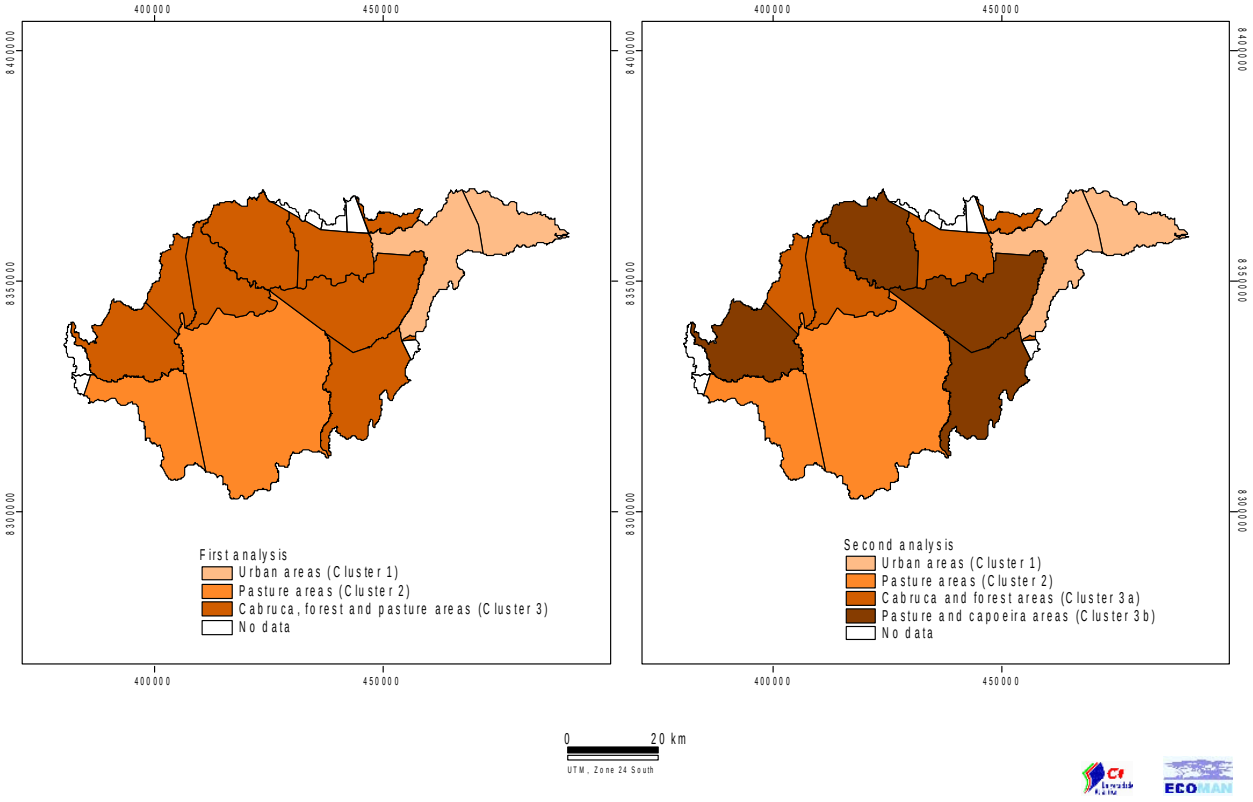
Fig. 64. Hierarchic Cluster Analysis of Cachoeira Catchment



Cluster 3 (remaining eight municipalities of Itapé, Itoróró, Floresta Azul, Jussari, Ibicaraí, Firmino Alves, Barro Preto, and Santa Cruz da Vitória) is more undifferentiated, but with some relation with areas were a mix of land uses (permanent crops, forest and pastures) can be seen (Fig. 65).

The cluster 3 was subdivided in two clusters: Cluster 3a (Ibicaraí, Firmino Alves, Barro Preto, and Santa Cruz da Vitória) that is more associated with the areas of Cabruca and forest; and Cluster 3b (Itapé, Itoróró, Floresta Azul, and Jussari) in which the pastures and Capoeira areas are more significant (Fig. 65).

Fig. 65. Results from cluster analysis for Cachoeira Catchment



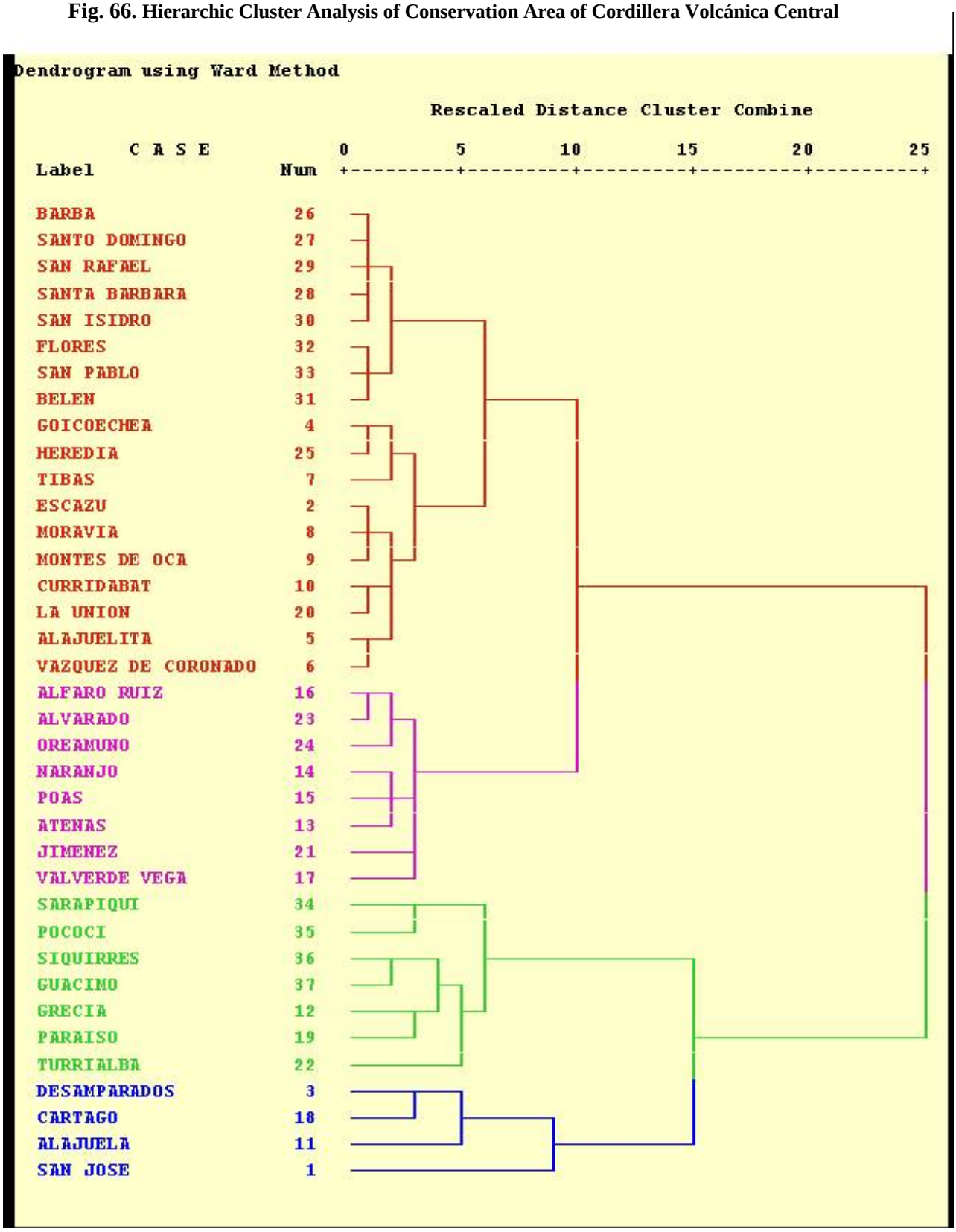
This classification is not yet the final because a more detailed analysis must be made. In fact, the classification of some municipalities (as Itapetinga) is not yet well defined. In some of the cluster analysis, this municipality appears very associated with Itabuna (with great population and rather big income and GDP). It must be examined the importance of this city and of the economic activities.

3.1.2 Main groups of Cantons in Conservation Area of Cordillera Volcánica Central

The Cluster analysis made for the Cantons of Conservation Area of Cordillera Volcánica Central was based on 114 socio-economic variables. This analysis grouped the cantons in five

clusters (Fig. 66). Two attempts were made to understand this classification and the final choice corresponds to the classification in four clusters (Fig. 67). This process of understanding the distribution of the cantons per cluster was made in relation with types of land use and landscape patterns.

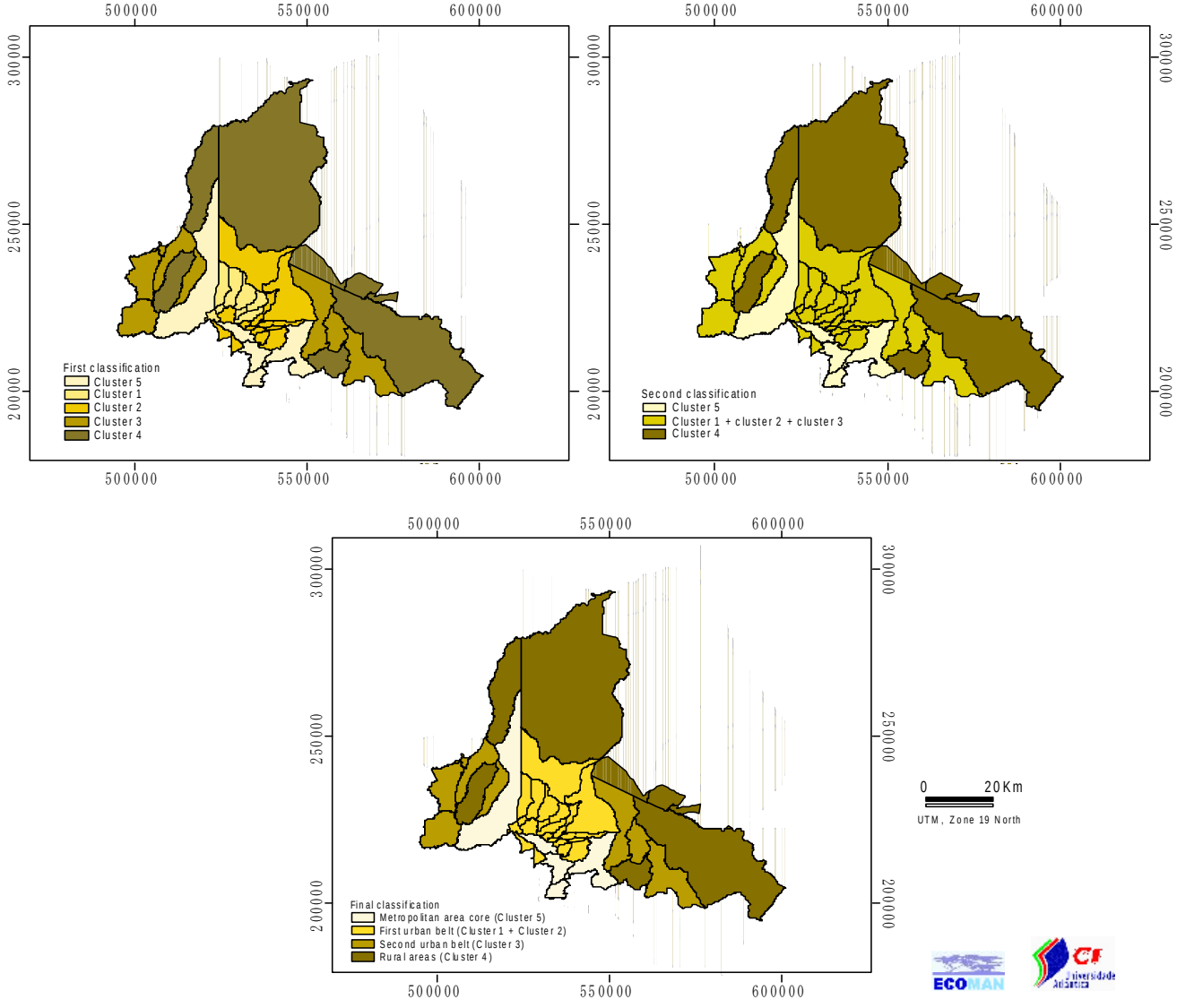
Fig. 66. Hierarchic Cluster Analysis of Conservation Area of Cordillera Volcánica Central



This classification distributes the cantons as follows (the names attributed to the clusters are simply descriptive and based on a first reading of the results obtained. An effort must be made to find better labels): Metropolitan Area Core (San Jose, Alajuela, Cartago, Desamparados); First urban belt (Barva, Santo Domingo, San Rafael, Santa Barbara, San Isidro, Flores, San Pablo, Belen, Goicochea, Heredia, Tibas, Escazu, Moravia, Montes de Oca, Curridabat, La Union, alajuelita, Vasquez de Coronado); Second urban belt (Alfaro Ruiz, Alvarado, Oreamuno, Naranjo, Poas, Atenas, Jimenez, Valverde Vega); and Rural Areas (Sarapiqui, Pococi, Siquirres, Guacimo, Paraiso, Grecia, Turrialba).

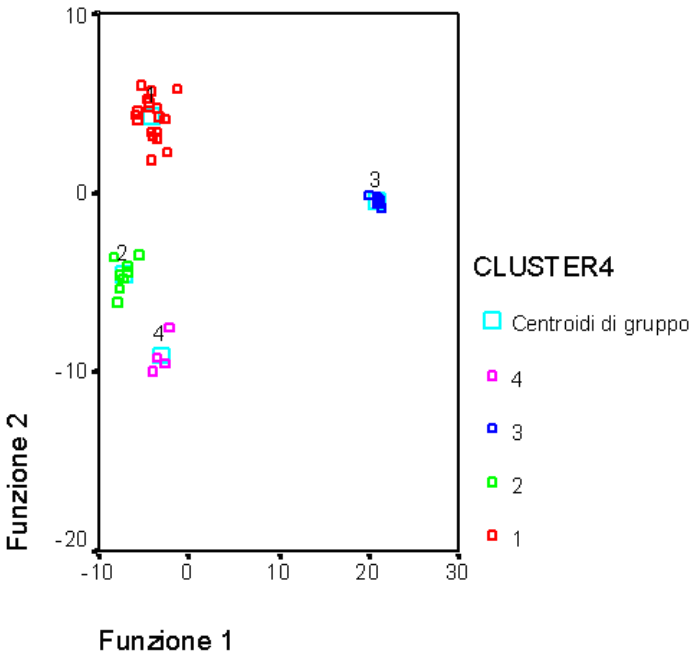
The first group shows cantons with strong urban characteristics. The two groups described as urban belts are differentiated by the fact that in the second belt, the rural features are more significant that the urban. The last group refers to the areas where the activities related with agriculture and forest are more significant.

Fig. 67. Results from cluster analysis for Conservation Area of Cordillera Volcánica Central



In the sequence of this cluster analysis was made a Discriminant Analysis that shows the four clusters identified very well separated (Fig. 68). Nevertheless, also in this study area, an effort must be made to ameliorate the analysis and typology since it is not quite well explained the grouping of the cantons.

Fig. 68. Discriminant Analysis, clusters of Conservation Area of Cordillera Volcánica Central



3.1.3 Typology of administrative units

The typologies of municipalities and cantons will be very useful at the moment of spatialising the scenarios of alternatives for local sustainable development. They will allow for the application of the scenarios according to the different characteristics of each cluster.

3.1.3.1 Main pressures identified in Cachoeira Catchment

The dynamics of territorial change in the Cachoeira catchment, identified trough the analysis of socio-economic data, are specially related with the cocoa production. In fact the strong dependence from this product makes that any incident affecting it, influence significantly the changes in the territory, both in socio-economic and biophysical terms:

- ***Dynamics related with the permanent crops***. The most significant permanent crops in the catchment are: cocoa, coffee and sugar cane. These permanent crops have an important role in settling the rural population in the farms, preventing the massive migration towards the villages and bigger cities of the catchment or outside it. However, the events occurred during the 1990s drive to a crisis in the majority of the cocoa farms with their conversion to other uses and the release of a significant number of workers that migrated towards the heads of municipalities and to Itabuna and Ilhéus.

However, in the last few years, some changes occurred. The international market prices growth again (in consequence of social instability on other cocoa producing countries in Africa) and great number of cocoa plantations were restructured by using clones resistant to the disease. Therefore, it is foreseeable for the next years a strong impact of the cocoa production in the areas suitable for this production.

- ***Dynamics related with the pastures area***. The recent increase of pastures, which occurred mainly in the 1950s, is associated directly with cattle rising, and indirectly with the cocoa crisis. In fact, both the decrease of the international market price and the disease known as "Wishes Broom" drive to the abandonment of the cocoa plantations. The cocoa farmers knocked down the trees in order to take advantage of its commercial value, and converted the land to other production, such as livestock farming.

  On the other side, the relative high income derived from cattle rising (both for meat and milk production) stimulates farmers in changing their production systems to this kind of activity. However, frequently they only change the type of dependence and not diversify the activities in the farm.

- ***Dynamics related with the expansion of urban areas***. The expansion of urban areas is, in great part, associated with the cocoa crisis. The labour force released from the farms migrated towards the small villages and cities, and especially to Itabuna and Ilhéus. This migration process produced an expansion of built up areas, which wasn't accompanied by the increase of quality of life of this migrants. Actually, this migration produced pouches and belts of "favelas" in the main cities of the Cachoeira Catchment.

3.1.3.2 Main pressures identified in Conservation Area of Cordillera Volcánica Central

The pressures identified in the Costa Rican case-study are related with two main aspects, although subdivided.

- ***Dynamics related with the expansion of the Great Metropolitan Area of San Jose***. This metropolitan area has a process of development in which a core of cantons can be identified. In this core it is identified a decrease of the population to the periphery of the metropolitan areas. These cantons don't attract the population but the economic activities. The population working in these cantons reside on the other ones that form different belts, more or less surrounding the tertiary core.

  However, we can see that these belts have some type of influence on the resources and its expansion if continues can powerfully damage the remnants forest resources.

- ***Dynamics of agriculture, sylviculture and livestock farming***. These activities are dominant in the rural areas and are associated with:

  - Permanent crops, such as coffee and sugarcane;
  - Intensive agriculture, associated with the production of vegetables, potatoes, fruits, etc.
  - Logging activities
  - Pasture areas

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