INFORMATION FOR SUSTAINABLE LAND USE PLANNING AND CONSERVATION IN THE GUAVIARE DEPARTMENT, COLOMBIAN AMAZONIA

L.J. Martínez M.
The Tropenbos-Colombia programme

INTRODUCTION

For administrative and planning purposes, the Amazon region of Colombia is divided into six departments: Guaviare, Guainia, Vaupés, Amazonas, Caquetá and Putumayo (Figure 1). The Guaviare department was created in 1991 and is divided into four municipalities covering an area of 5,484,700 hectares, or 15 % of the total area of the Amazon region.

Figure 1 Location of the study area

The total population of Guaviare was estimated at 80,000 inhabitants in 1995, most of whom are colonists from the Andean region. Colonisation of the Amazonian forest implies the introduction of land use types characterised by instability and low productivity, leading to intensive degradation of the ecosystem. These uses are based mainly on pastures for livestock raising and on illegal crop cultivation.

In 1991, as a strategy to determine and apply solutions to these problems, the Guaviare department began a planning process with participation of the community, official and private organisations, and the Departmental and Municipal Governments. A first product of this process was the development plan for a 6-year period from 1994 to 2000. The main objective of the development plan was to promote a gradual change in the present economic condition of the Department by identifying and introducing sustainable production alternatives as a substitute for illegal crop cultivation and to preserve the natural resources (Gobernación del Guaviare, 1993). Some characteristics of the planning process are:

- Participatory approach aiming to increase popular participation in decision-making, which is

achieved by involving the community at various stages of the planning process;
- Introduction of additional criteria to make decisions and a proposal for the definition of priorities to invest the scarce financial resources of the budget;
- Emphasis on the execution of participatory research focused on identifying solutions for specific problems;
- Focus on planning and management of natural resources defining priority areas.

1. LAND USE PLANNING AS A STRATEGY FOR THE WISE USE AND CONSERVATION OF NATURAL RESOURCES

In Guaviare, land use planning is one component of the entire spatial planning strategy. The process encompasses a wide range of actions related to identifying problems, assessing alternatives and applying solutions towards the conservation and sustainable use of natural resources. The implementation of this process has some favourable factors:
- The precepts of the new National Constitution, new laws and rules about planning, community participation and environment have generated needs for changing traditional planning methods;
- An institutional structure with specific functions related to environmental policies, definition, research, planning and natural resources management;
- Increased concern about conservation of Amazonian forests among the colonists, the governmental agencies, NGOs, the private sector, and also about the present problems and the need to improve the situation;
- Availability of nearly 4,500,000 ha still covered by natural forest with a low degree of intervention, and 1,000,000 ha which have already been affected to some degree by intervention in the ecosystem.

To support the land use planning process, a problem-oriented project was carried out to develop and apply methods and tools for sustainable land use planning and conservation. The project was executed by Tropenbos, the international Institute for Aerospace Survey and Earth Sciences (ITC), the former Corporación Araracuara (today SINCHI institute) and the Departmental Government of Guaviare.

After finalising the project and publishing the results in May 1997, the outputs obtained are being used by local government and local organisations for specific purposes. In this article, I will present the main benefits of the research results for local users and identify gaps in information and research needed to continue supporting the land use planning and conservation process.

II. MAIN OUTPUTS OF THE RESEARCH CONDUCTED

- The main output included a method for sustainable land use planning and conservation (Figure 2). This method integrates planning concepts, local policies and rules, existing research results and local needs. It is supported by tools such as GIS, remote sensing and modelling techniques to produce and manage the information required.
  Specific research topics such as landscape ecology, land evaluation, farming system analysis and environmental impact assessment, which are usually carried out and used in a isolated way, were integrated in the land use planning approach. The integration of biophysical and social/economic components is another important feature of this approach.
- An important achievement of the project was a model to evaluate land suitability. It included biophysical and social/economic criteria to define suitability. Based on the results, a plan with specific activities for production, conservation, and land restoration was established to increase sustainability and profitability of existing farm systems and to stabilise the colonisation area that

decreases the rate of forest destruction.

- A GIS tool including spatial and non-spatial databases for soil, climate and socio-economic aspects was developed and implemented.
- A publication with the results of the project was done in the Tropenbos-Colombia Series.

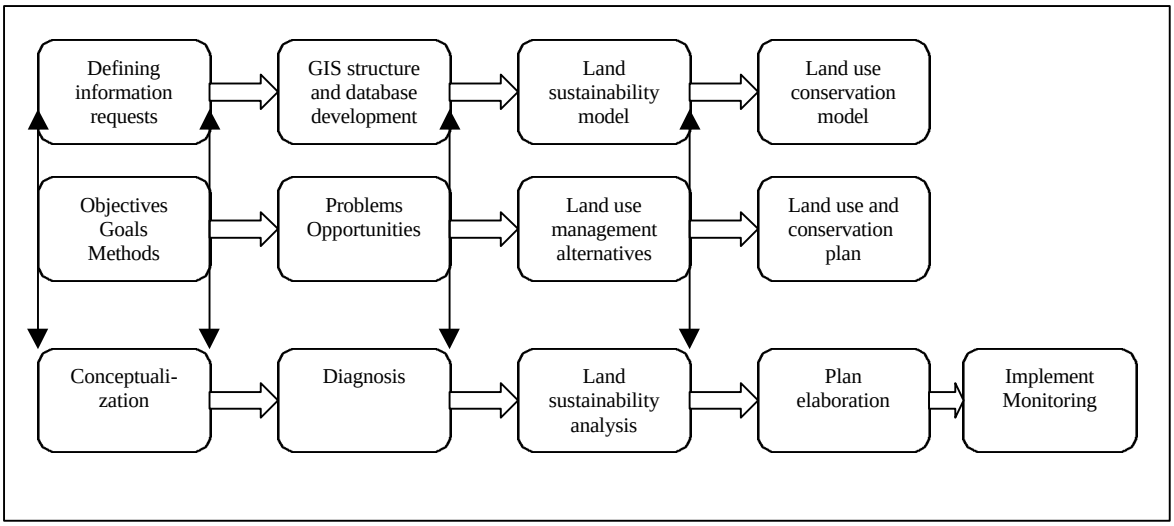

Figure 2 Main component of land use planning method

III. MAIN BENEFITS OF RESEARCH RESULTS

Although the process of using and applying the outputs of the project is still in its early stages, there are already important and positive achievements to be noted. I will present the main benefits obtained so far and specific applications that are being conducted by local government together with research, management and planning organisations.

(a) Awareness

An important benefit is the change in attitude of people in local government and organisations. At the moment, there is great interest to continue improving the decision making process by using geographic information. Tools such as GIS, databases and modelling techniques are now part of institutional structures. Methods such as land evaluation and spatial analysis of farming systems were incorporated in research and planning processes. Three important achievements are:

- Planning is perceived as an efficient way to identify and apply activities for the wise use and conservation of forests and natural resources, as well as to improve the present situation of local people;
- Information is considered to be an important support for the planning and decision-making process. GIS techniques are basic tools for data storage, management and analysis to produce the geographic information required;
- The approach to land use planning and geographically developed information appears to be an important strategy to direct the research process. It allows the identification of needs and priorities for research and will permit assessment of the impact of research. This approach constitutes an important link between demand (local problems) and supply of research.

(b) Institutional development and personnel training

As part of the project, personnel of local institutions were trained in basic aspects of land use planning,

land evaluation, farming system analysis and database development. Most of them are working in applying or improving the methods and tools developed within their institutions.

Databases containing maps, satellite images, non-spatial data of soils, climate, and social/economic aspects were transferred to the Department and are being used and improved for new applications. It is the first set of digital data available in Guaviare for local institutions.

An important step towards the integration of institutional actions was the creation of a framework for the production, use and management of information. It will avoid the duplication of efforts for collecting and storing data and will contribute to improving the efficiency and use of information.

(c) Institutional structure to produce, manage and use geographic information

A working group of local institutions co-ordinated by the Departmental Government is designing and implementing a GIS for storing, managing and analysing data and producing information related to 7 main subjects: environmental, social, cultural, economic, infrastructure, institutional and political aspects.

The first outputs of this working group are the creation of an institutional structure, defining information objectives, improvement of database design and institutional functions.

The objective of GIS is to provide adequate and updated information to support the regional planning process (*ordenamiento territorial*) which must be conducted in the Guaviare territory. For this purpose, a first version of a database was defined and the structure and content of the tables established.
Institutions working on this issue are the Departmental Government (Planning Division and Secretariat of Agriculture and Environment), SINCHI Institute (responsible for research), CDA Corporation (natural resources management) and INCORA (agrarian reform institute).

(d) New applications for development

Developed methods and tools are being applied by local institutions for new applications. Since these processes are not yet finished, I will present some progress made thus far:

1. Land use and conservation plans for small watersheds

The land use planning method developed was applied in a project carried out by the Departmental Government, the Fund for Rural Development (DRI) and a local NGO. The objective was to define and agree with communities a management plan for six small watersheds (90,000 ha of total area). GIS, and other geographic databases developed, were used to support phases in diagnosing and evaluating land use and management alternatives, and the elaboration of plans.

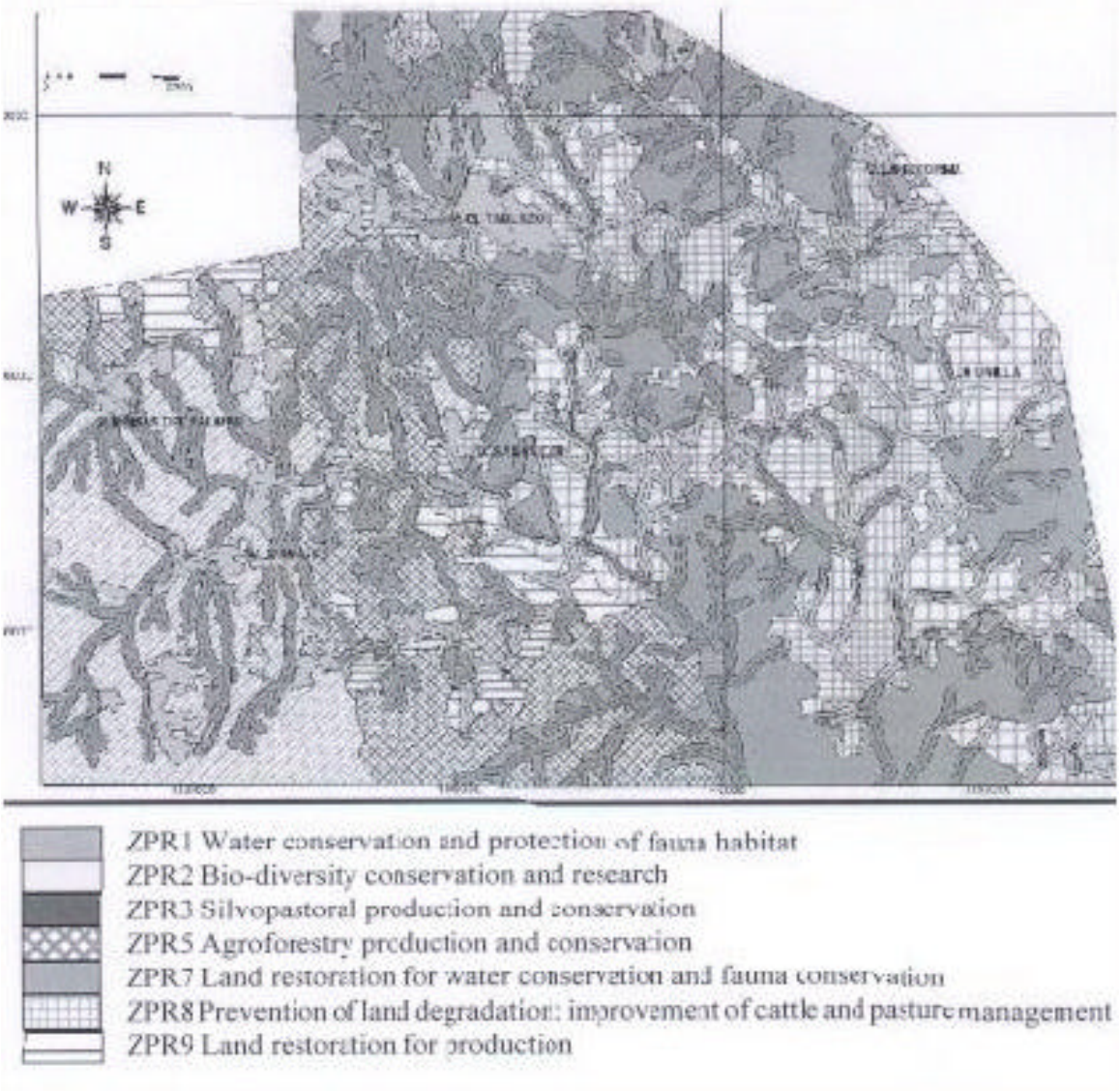

Figure 3 Zoning for land use, management, conservation and restoration - La Unilla Watershed

The main outputs are the zoning of each catchment (Figure 3) showing areas for production, forest and water conservation and for restoration of degraded lands. Specific projects were elaborated to improve the present land use systems with forestry and agroforestry, soils and forest restoration, education, pasture and livestock management.

These plans are in the stage of evaluation for later implementation. Financial problems are the main limiting factor for implementation.

2. Spatial study of farming systems

The objective of this project, conducted by the SINCHI Institute with participation of local government and other institutions, is to identify and characterise the present farm systems, their spatial trends and their environmental impact as a basis for defining improvements in the present situation. Methods, tools and geographic databases developed are being used as inputs into the study process. The study covers about 2,000,000 ha in Guaviare and will extend into new areas in other departments of Amazonia.

(e) Dissemination of results

Results of the project were published in the Tropenbos-Colombia Series and an automated demonstration (DEMO) was done with a summary of the method and procedures developed. These are important tools that are being used to support training and the diffusion of activities not only in Guaviare but also for other organisations and universities.

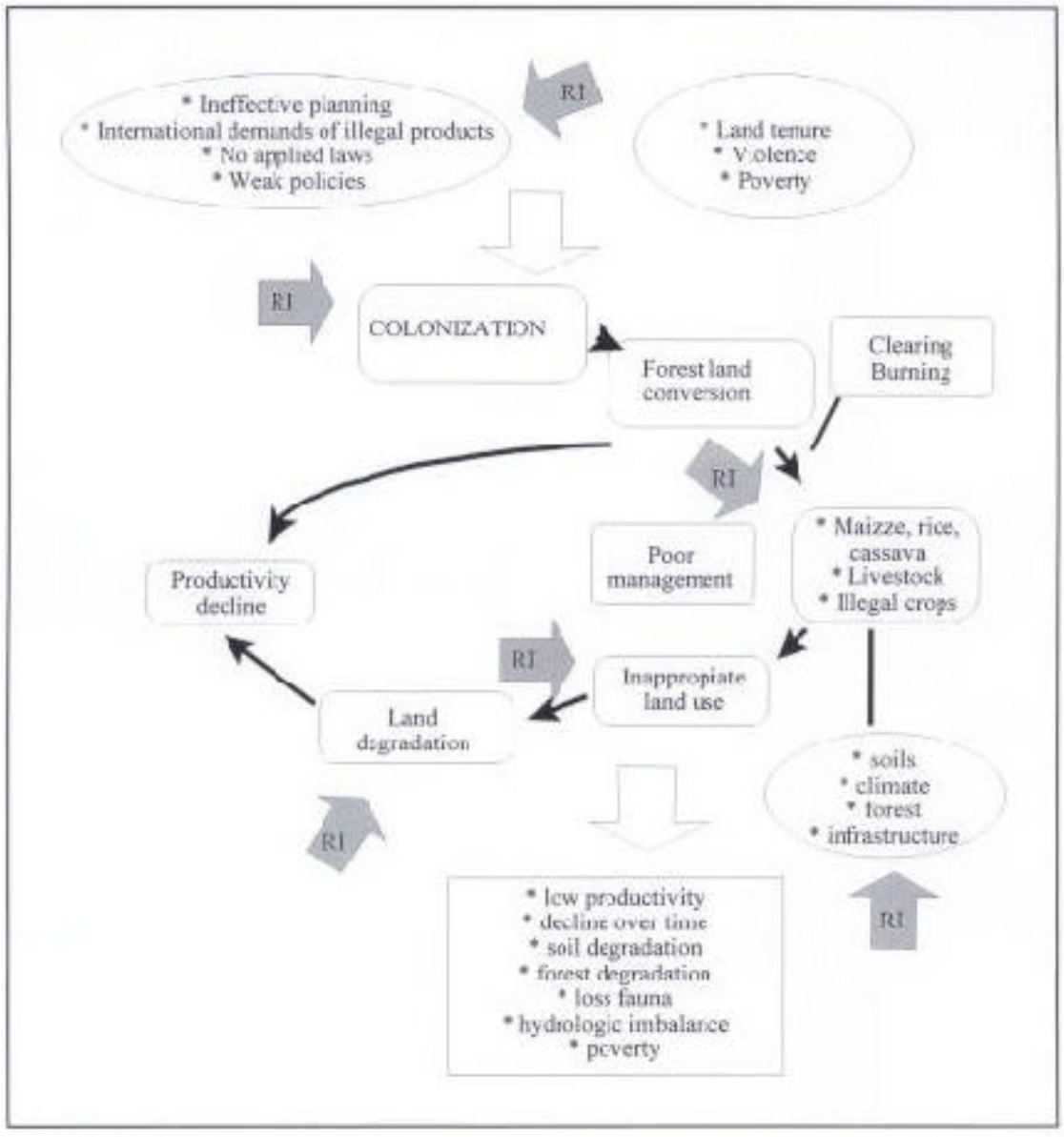

Figure 4 Cause and effect model of present land use situation in Guaviare

IV. LACK OF INFORMATION AND RESEARCH

(a) Main problems to be addressed by research

The model in Figure 4 presents the main causes and effects related to use, management and conservation of natural resources in Guaviare. This model offers points for introducing changes and for the identification of research needs to improve the present situation.

1. Limited impact of research on local problems

Most research projects conducted in Guaviare have considered the conservation and appropriate utilisation of tropical rain forests as its main objectives. However, the question that often arises is: how much has research contributed to reaching the objectives?

It is clear that the knowledge of the Amazonia ecosystem has improved as a result of the research conducted. However, an important application of these results has not taken place and therefore no influence or improvement in the conservation and management of tropical rain forests has occurred.

In the developed method an attempt was made to integrate results of existing research and local knowledge for producing useful information for planning. This method seems to be a suitable and efficient approach and allows us to make some recommendations:

- Research must be linked to local management and conservation policies, programmes and objectives;
- Research must contribute to solving specific problems; therefore, these should be important criteria in order to decide what to investigate;
- Local organisations and communities must be involved in the research process. It is important to consider them not only as sources of data and information but as part of the decision-making process in defining research priorities and how to execute the research.

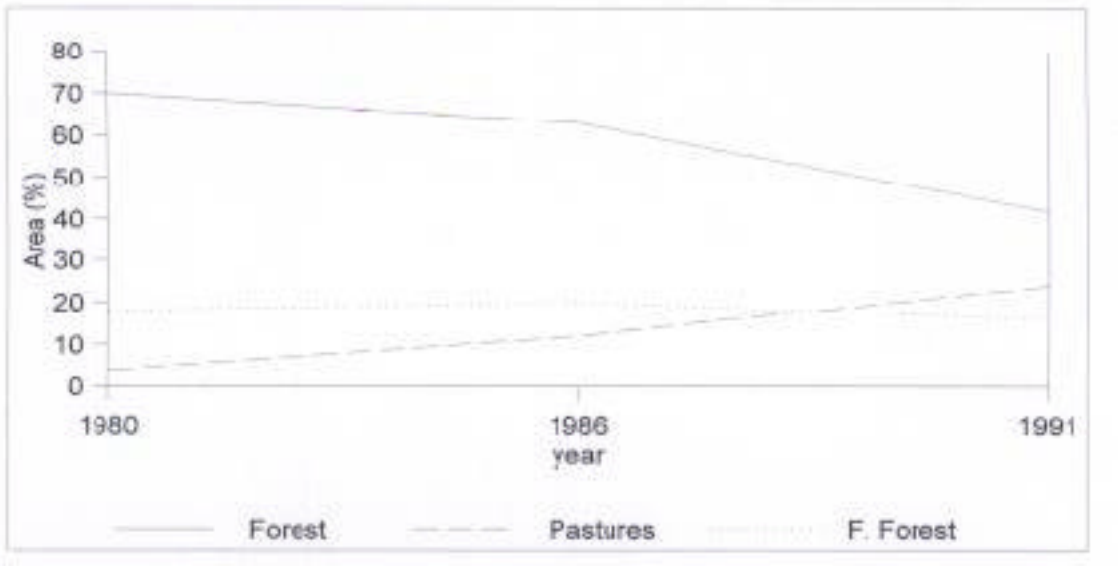

Figure 5 Rate of forest land conversion

2. The forest land conversion process

A pilot area (237,000 hectares) and the dynamics of converting forest land to pasture over a 10-year period were analysed by comparing maps of different years. From the results shown in Figure 5, during the period 1980-1991 there was an important decrease in the forest area and increase in pasture area. In 1980, about 73% of the area was covered by natural forest, by 1986 this had decreased to 61% and by 1991 to 43%. On the other hand, pasture area increased from 4% in 1980 to 12% in 1986 and to 25.3% in 1991. These data demonstrating the rate of deforestation permits us to assess the future situation if present trends continue.

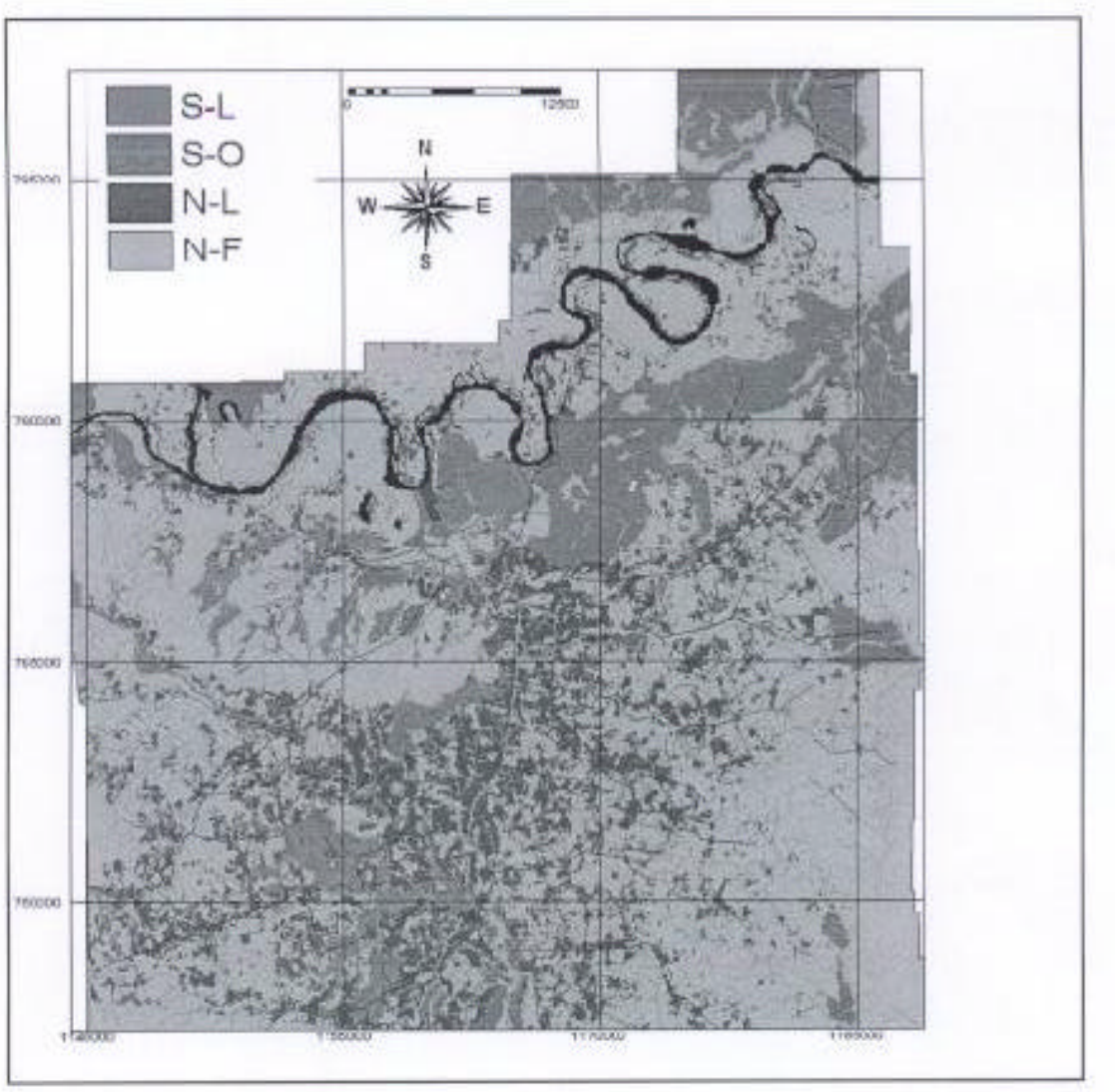

Figure 6 Inappropriate land uses
Land suitability for cattle: S = Suitable; N = Unsuitable
Present land use: L = Cattle; F = Forest; O = Other

3. Inappropriate land uses

Inappropriate land use results from the discrepancy between present land use and land suitability. In Figure 6, the present area occupied by livestock is compared to land suitability for the same system. The data analysis demonstrates that 19.5% of the area is used for livestock although the land is not suitable for that use.

Another aspect is the potential inappropriate use of land. These include unsuitable areas not yet converted to livestock production, which occupy 60% of the area. If the present trends continue, pastures will gradually occupy these areas.

4. Lack of sustainable land use options

Colonisation implies the introduction of land use systems characterised by instability and low productivity, leading to intensive degradation of the ecosystem. After the initial cutting and burning of the forest, colonists plant crops, such as maize, cassava or rice, for one or two years. Thereafter, most of the holding is converted to pasture and cattle are introduced. Initially, the pastures support relatively high cattle densities, but the productivity is difficult to sustain and the carrying capacity falls.

The instability of the present land use systems and the lack of alternative sustainable land uses result in continuous intervention in forest areas. As a result of soil and pasture degradation processes, land productivity declines and more forested areas must be converted into pastures for breeding cattle.

5. Soil degradation and productivity decline

If a specific use is implemented in an unsuitable area several problems will occur. In our case soil and pasture degradation processes are taking place in the cattle pastures and consequently land productivity is declining. The degraded lands are abandoned and new forest areas are incorporated into the production frontier.

6. *Financial constraints*

The low amount of financial resources assigned to research, planning, management and conservation of natural resources is one of the most limiting factors. Many research and conservation projects have to wait a long time for a budget, others are finalised without having fulfilled their objectives, and several projects never begin.

(b) Specific demands of research

1. Efficient methods to produce, manage and use information

Results of the project are in the process of implementation by local government and by local institutions and, therefore, no specific changes in natural resources policies or in land use and management rules have been noted yet. However, there are good perspectives for positive impacts in the future and more support is needed while taking account of the following aspects:

- Introducing changes in land use policies and rules, and applying them to practical cases, is not an easy issue. This is a challenge that needs time, financial, technical and human resources.
- The present stage is critical for a successful introduction of changes. The approach developed is important but is not finished and improvements and more developments are needed.

Based on these aspects it is essential to continue working on a more complete strategy to ensure: the supply of good quality information at the lowest possible cost; the optimum role of information in planning and in the decision making process; and maximum impact of information and research.

Specific topics to be addressed in the future regarding this matter are:

1.1 Conceptualisation

It is essential to continue promoting conceptualisation and the strengthening of issues such as planning, information requirements and functions of information in the decision making process. It is also important to continue analysing and developing GIS as a tool to support the planning process whilst considering not only the technical issues, but also institutional, financial and human factors.

1.2 Data and information quality

Inadequate information could result in incorrect decisions and poor data quality may result in useless or incorrect information. Research is needed to develop clear and operational procedures to evaluate data and information quality; to determine the effect of data and information quality on decisions, and to define a minimum or acceptable quality of data and information for land use planning.

1.3 Data and information quantity

In Guaviare, data collection and data capture are the most expensive stages in information production. No clear procedures are in place for sampling or defining the amount of data required for a specific purpose. Updating of developed databases and collecting additional data are now points of interest.

It is important to establish criteria for defining a minimum quantity of information required for adequate and reliable planning and for establishing the minimum set of data essential for generating the required information.

1.4 Access to and dissemination of information

One of the most important factors limiting the use of information in planning and decision-making processes is the problem of access to information. A general situation is the lack of a mechanism to exchange information between researchers, planners, farmers and decision-makers. If this problem is not solved, research and information will never have an important effect on the wise use and conservation of natural resources. Some needs are:

- Methods to support the present technology transfer process carried out by the UMATAS (Municipal Units for Technology Transfer);
- Methods to support the formal education process. The existing education laws allow the introduction of regional subjects as part of the curriculum.

2. Basic surveys of natural resources

To continue with the land use planning process geographic information of the whole territory is required. At the moment only 10% of the Guaviare area has adequate spatial and non-spatial data, the remaining 90% presents only very general maps (1:500,000) supported with very few field data. Research is needed on identification, mapping and characterisation of land units at the appropriate scale considering:

- Identification and distribution patterns of forest and soil types, and fauna population and dynamics;
- Characteristics of each land unit in terms of forest (structure, biodiversity indicators, species of potential use), soil characteristics (physical, chemical, morphological properties).

3. Sustainable land use options to improve the present farming systems

Conservation of natural forests will be possible only if there are sustainable land use options. In Guaviare, alternative land uses are being investigated but few of them are available for implementation by the farmers. Some priorities for research are:

- Non-conventional uses of forest;
- Technologies for restoration of degraded soils;
- Methods for monitoring soil degradation and its impact on production;
- Agroforestry and forestry systems;
- Uses based on adequate management of fauna and hydro-biological resources;
- Marketing of non-conventional products.

4. Land evaluation methods for natural forest areas

As stated before, in Guaviare more than 4,500,000 ha still remain covered by natural forests that will form part of the planning process. The main aspects of research are:

- Identification and description of forest land uses and functions;
- Definition and quantification of inputs and outputs;
- Establishment of criteria to define suitability.

V. REFERENCES

Gobernación del Guaviare. (1993). Plan de Desarrollo Departamental, San José, Costa Rica.

Gobernación del Guaviare-Secretaria de Agricultura y Medio Ambiente. (1997). Sistema de Información Geográfica.

Instituto SINCHI. (1997). Desarrollo de una aplicación de SIG para el estudio de los Sistemas de Producción en el Guaviare. Research proposal.

Martínez, J. and Vanegas, D. (1997). *Sistema de Información Geográfica para la Amazonia: el Caso Guaviare*. Tropenbos-Colombia Series XIII.

Martínez, J. and Vanegas, D. (1994). GIS applications for spatial planning in the Colombian Amazon region: a case study of the Guaviare colonization area. Part 1-Diagnosis. *ITC-Journal* 1994-3:215-223.

Martínez, J. and Vanegas, D. (1994). GIS applications for spatial planning in the Colombian Amazon region: a case study of the Guaviare colonization area. Part 2- Evaluating alternatives. *ITC-Journal* 1994-3:224-232.

Martínez, J. and Zinck, A. (1994). Modelling spatial variations of soil compaction in the Guaviare colonization area, Colombian Amazonia. *ITC-Journal* 1994-3:252-263.

República de Colombia (1991). Constitución Nacional.

INFORMATION FOR SUSTAINABLE LAND USE PLANNING AND CONSERVATION IN THE GUAVIARE DEPARTMENT, COLOMBIAN AMAZONIA

Achievements

- Development of a method for planning of sustainable land use and conservation using planning concepts, GIS, remote sensing and modelling techniques.
- Integration of different disciplines, such as landscape ecology, land evaluation, farming system analysis and environmental impact assessment; and of biophysical and socio-economic components.

Challenges and Problems; Information Needs

- Lack of sustainable land use options, leading to intervention in forest.
- Soil and pasture degradation leading to low productivity of the land.
- Low amount of financial resources assigned to research, planning, management and conservation of natural resources.
- Poor mechanisms to exchange information between researchers, planners, farmers and decision-makers.

Points for Future Research

- Description of natural forest areas including the spatial component.
- Identification and description of forest land uses and functions; establishment of criteria to define suitability of land use.
- Methods and procedures for analysis in land use planning; environmental assessment of measuring soil degradation; restoration of degraded soils.
- Sustainable land use options to improve the present farming systems

Impact of research

- A change in attitudes of people in local organisations, an increased use of analytical methods such as GIS and land evaluation; a great interest in improving the decision making process by using and applying information.
- Application of advanced methods for land-use planning at catchment level; farming systems; for definition of priority areas for social investment.
- The creation of a institutional framework for information use, production and management.
- Dissemination in local publications.

Conclusions

- Research must be linked to local policies, programs and objectives of management and conservation.
- Research must contribute to solve specific problems, therefore, these should be important criteria to decide on what to investigate.
- One of the most important factors limiting the use of information in planning and decision making processes is the lack of mechanism to exchange information between researchers, planners, farmers and decision-makers.