Geographical Information Systems and Land Use Analysis

Workshop held in Yaoundé
September/October 1997

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The TCP is a research programme executed under the joint responsibility of the Ministry of Environment and Forests of the Republic of Cameroon and the Tropenbos Foundation

Tropenbos-Cameroon Reports 00-1

The Tropenbos-Cameroon Programme
Wageningen, The Netherlands
April 2000
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Summary

Workshop Geographical Information Systems and Land Use Analysis
From 20 to 30 September 1997, a workshop on GIS and Land Use Analysis was held in Yaoundé, Cameroon. The workshop was organised by ONADÉF in the framework of ITTO project PD 26/92. The DLO-Winand Staring Centre (SC-DLO, Wageningen, The Netherlands) was responsible for organising the workshop. Lectures and introduction were prepared and presented by J.D. Bulens (SC-DLO) in cooperation with G.W. Hazeu, B.S. van Gemerden, F. Mballa (all Tropenbos-Cameroun Programme) and J. Momo (CETELCAF). Thirty participants from Cameroon (20), Ivory Coast (2), Ghana (1), Democratic Republic of Congo (2), Gabon (3) and the Central African Republic (1) attended the workshop. The workshop was funded by the Common Fund for Commodities (CfC).

The opening ceremony took place at the Municipality of Yaoundé and was performed by the Minister of Environment and Forests (MINEF).

The workshop programme consisted of three main parts: GIS theory, a case study and an excursion to the Tropenbos-Cameroon Programme in Kribi.

In the theoretical part, the following topics were discussed: GIS concepts, geographic data, data collection, GIS output and organisational implications of GIS. The case study consisted of applying a geographic analysis to locate suitable areas for a game reserve within the Tropenbos-Cameroon research site. For this analysis, criteria had to be formulated and GIS related operations prepared. This was done in five groups of five to six persons, using Arcview and ARC/INFO GIS software on a personal computer. The visit to Kribi was attended by participants from outside Cameroon only and took the last two days. Visits were made to the Wijma sawmill and the Okoumé plantations of ONADÉF. At the Tropenbos office, presentations on project PD 26/93 and other components of the Tropenbos-Cameroon Programme were given.

The participants appreciated the workshop very much. Most of them could benefit from knowledge on GIS techniques within their work and organisation. It was the general feeling that the workshop was too short, and the participants would particularly have liked to spend more time doing GIS exercises.
1. Introduction

1.1. The Tropenbos Foundation

The Tropenbos Foundation has been established in 1988 by the Government of the Netherlands with the objectives to contribute to the conservation and wise use of tropical rain forest by generating knowledge and developing methodologies, and to involve and strengthen local research institutions and capacity in relation to tropical rain forests use and management. The Tropenbos Programme carries out research on moist tropical forest land at various locations around the world. At present permanent research sites are located in Colombia, Guyana, Indonesia, Ivory Coast and Cameroon. At the different locations, research programmes follow an interdisciplinary approach, facilitating data exchange.

1.2. The Tropenbos Cameroon Programme

The Tropenbos-Cameroon Programme (TCP) was established in 1992 by the Cameroonian Ministry of Environment and Forests (MINEF) and the Dutch Tropenbos Foundation. The general objective of the TCP is to develop methods and strategies for natural forest management directed at sustainable production of timber and other forest products and services. These methods have to be ecologically sound, socially acceptable and economically viable (Foahom & Jonkers, 1992).

The main implementing agencies are (in alphabetical order): Institut de la Recherche Agronomique pour le Développement (IRAD), Office National de Développement des Forêts (ONADEF), Tropenbos Foundation and Wageningen Agricultural University (WAU). The International Tropical Timber Organisation (ITTO) project PD 26/92 forms an integral part of the programme.

The research in Cameroon is carried out in an area of about 2000 km$^2$ near Kribi. The Tropenbos-Cameroon Programme (TCP) coordinates several interrelated projects in the fields of ecology, forestry, economy, social sciences, agronomy and soil science. One of the sub-projects identified under the ITTO umbrella is the Forest Land Inventory and Land Evaluation Project (Lu1). The Lu1 project forms an important component of the TCP because it will provide a scientific basis for future land use planning. Moreover, it serves as an overview for all ecologically oriented research activities and allows extrapolation of research results from detailed test areas to larger areas in Cameroon.

1.3. Winand Staring Centre for Integrated Land, Soil and Water Research (SC-DLO)

The involvement of SC-DLO in the Tropenbos-Cameroon Programme dates back to 1991 when an expert took part in the project formulation activities of phase 1. In 1991-1992, this SC-DLO expert participated in the preparation of document ‘A Programme for Tropenbos Research in Cameroon’, and particularly contributed to chapter 2 ‘Forest land inventory and evaluation’ (Foahom and Jonkers, 1992). In 1992, a substantial part of TCP was submitted to ITTO as project PD 26/92 ‘Development of Methods and Strategies for Sustained Management of Moist Tropical Forest in Cameroon’ and SC-DLO was
reconnaissance land survey, followed by a GIS assisted, qualitative ecological land evaluation. The study will not only provide a scientific basis for land use planning, but also knowledge regarding diversity in biotic and physical land characteristics to be used in other Tropenbos studies. The Lu1 project is followed by the two year Lu2 project entitled ‘Shifting cultivation in evergreen forest, farming systems and soil degradation’, in which SC-DLO assisted. It will provide a comprehensive description on shifting cultivation systems and their relation with soil degradation. SC-DLO contributed to the Lu2 project through the establishment of a hydrological network installation and the implementation of a computer model to assess the effects of land use changes on the hydrological cycle.

This workshop aimed at improving knowledge, insight and possibilities of the use of GIS and its contribution to the research for land use planning and forest management. In chapter two an outline of the workshop with its organisational aspects is given. Chapter three gives a summary of the GIS theory presented at the workshop. Chapter four is focussed on applying GIS in a case study on land use planning. In chapter five a brief description of the field trip to Kribi and in chapter six the workshop evaluation and some conclusions are discussed.
2. GIS workshop

SC-DLO was requested to take the scientific responsibility of the GIS and land use analysis workshop organized in Cameroon. At an early stage, in the beginning of 1996, contacts were made with ONADEF and CETELCAF with proposals on date, location and contents of the workshop. When agreement was met it was decided that the workshop should take place initially in October 1996. Because of several organisational constraints, the workshop could not be held in October 1996 and it was decided to postpone it to September 1997. For SC-DLO Mr. J.D. Bulens was involved and for TCP Mr. T. Bakkum assisted in the organisation and preparation (especially the case study).

2.1 Objectives

The objectives of the workshop were to
- present an introduction to GIS at a general level, that is on theory as well as the use of GIS in an applied user environment
- demonstrate the use of GIS within the Tropenbos Cameroon Programme.

With the material presented during this workshop the participants should have an overall view of GIS on headlines, on the functioning and knowledge of GIS-software, geographic data, data collection and constraints on introducing GIS within an organisation. A field trip to Kribi, where introductions relevant to GIS use were given on the various TCP sub-projects, was part of the workshop.

2.2 Organisational aspects

Several different organisations were involved in the organisation of the workshop. SC-DLO was responsible for the scientific content of the workshop, ONADEF for location related facilities, ONADEF (and TCP) for selecting and inviting participants, CETELCAF and TCP for workshop equipment, and ONADEF and TCP for coordination and communication.

Presentations and documentation were in English. On the first day of the workshop however it appeared that this was a big problem for a great number of participants. From the second day on the lectures were translated simultaneously in French sheet by sheet. This was greatly appreciated by the participants.

Participants from outside Cameroon encountered transport delays, which led to late arrivals up to three days after the beginning of the workshop.

GIS-software used was ARC/INFO and Arcview, products of ESRI. Licences for using this software on a temporary base were provided by SC-DLO, Logisterion (vendor of ESRI-products in the Netherlands), TCP and CETELCAF. Most frequent use was made of Arcview because of its user-friendly interface.

CETELCAF and TCP contributed equipment by providing PC's and in this way seven PC-workstations were made available. All supported PC-ARC/INFO and six Arcview, because
The first days of the workshop was also attended by a lot of observers. Due to lack of space only people explicitly invited to this workshop were admitted after two days.

The workshop included a visit to the Kribi research area. Due to weather conditions the roads were in a bad condition complicating access to the area by minibus. Last minute changes to the programme were radical. It was decided that the Kribi field trip could only be attended by participants from outside Cameroon as those from Cameroon were already familiar with TCP activities.

The visit to Kribi took place at the end of the workshop. As a consequence, the case study had to follow at the end of the first week and was cut short by one day, ending on Saturday.

2.3 Programme

The opening ceremony took place at the Municipality of Yaoundé and was performed by the Minister of Environment and Forestry (MINEF) and was attended by a representative of ITTO, Mr. Zemeka. The ceremony was broadcasted on television that night.

The workshop programme consisted of three main parts, GIS theory, case study and TCP field trip. The first part of the workshop on the theory of GIS covered four days. Main subjects concerned GIS concepts, geographic data, data collection, GIS products, GIS output and organisational implications of GIS. Theory was presented in lectures and alternated by exercises with Arcview demonstrating the presented material.

The second part was a case study using TCP data collected the last years. The case consists of applying a geographic analysis to locate suitable areas within the TCP research area for a game reserve. For this analysis criteria had to be formulated and GIS related operations should be prepared. The case study was carried out in five groups of 5-6 people. In plenary sessions progress of the activities was reported.

The third part, the Kribi field trip was only attended by the participants from outside Cameroon and took place from Monday to Tuesday and visits were made to the sawmill of Wijma in Bidou II and Okoume plantations of ONADEF. Introductions were presented of the different sub-projects carried out by TCP. For the full programme see annexes III and IV.

2.4. Workshop material

For this workshop a manual was prepared based on the self study workbook ‘Understanding GIS' published by ESRI software company of ARC/INFO and Arcview. Arcview exercises have been derived from the ESRI course ‘Introduction to Arcview'. The ARC/INFO exercises were made to illustrate the lectures presented. For these exercises look alike copies were made to be practised with Arcview.

All the participants received a complete manual (420 pages), a handout in french titled ‘ARC/INFO et les Systèmes d'Information Géographiques' prepared by the people from TCP-office in Kribi with a general introduction on GIS and a presentation of the first results obtained in the TCP-project Lu1 ‘Overall forest inventory and ecological land evaluation'.
3. Theory of GIS

In many research fields the real world is subject of study. Mostly the study involves only a part of the real world and the study is meant to reach a certain goal. For this reason one is often interested in an accurate description of objects or activities taking place in that part of the real world. Schematically the process of modelling the real world is shown in figure 1.

In this figure the real world is presented at one end and the researcher, the user, at the other end. The user defines this part of the real world as a collection of data representing the object under study with the relevant processes taking place. Analysing data and processes provide us with the information we want to know about the real world. Many times one would like to make a presentation of this and since the real world objects often have a geographic component GIS is used to visualize these objects and to analyse spatial processes. Based on the results the user is able to influence the real world by certain activities shown on the left side of the figure. The real world changes and the cycle is closed. The changes can be described and analysed again and so on and so on.

A Geographic Information System (GIS) is a computer-based tool for mapping and analysing objects that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with geographic analysis and visualisation by maps. These abilities distinguish GIS from other information systems and make it a valuable tool to a wide range of public and private enterprises for analysis, prediction and planning.
Map making and geographic analysis are not new, but a GIS performs these tasks better and faster than the old, manual methods did. In the past only a few people had the skills required to employ geographic information in the decision making and problem solving process.

For successful GIS operation the following components are required:

**Hardware**

Hardware is the computer on which a GIS operates. Today, GIS software runs on a wide range of hardware types: centralized servers, desktop computers stand-alone or in a network. Besides the central processing unit peripheral equipment is used, most commonly a digitizer, plotter and/or printer.

**Software**

GIS software provides the functions and tools needed to store, analyse, and display geographic information. Key software components are tools for the input and manipulation of geographic information, a database management system (DBMS) that support geographic query, analysis, and visualization, and a graphical user interface (GUI) for easy access.

**Data**

Data are an essential component of a GIS. Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. A GIS will integrate spatial data with other data resources and can even use a DBMS, to organize and maintain their data.

**People**

GIS technology is of limited value without adequately trained people who manage the system and develop plans for applying it to real world problems. GIS users range from technical specialists who design and maintain the system to those who use it to facilitate their day to day tasks.

**Methods**

A successful GIS operates according to a well-designed plan and business rules specific for each organisation

**3.1. Geographical data**

**Map information**

There are two basic types of map information:

- Spatial information describing the location and shape of geographic features and their spatial relationships to other features;
- Descriptive information about the features.
The information conveyed by a map is represented graphically as a set of map components.

**Locations**

Information is represented by points for features such as wells and telephone poles, by lines for features such as roads, streams and pipelines and surfaces for features such as lakes, county boundaries, and census tracts.

**Point, line and area features**

A point feature is represented by a discrete location defining a map object whose boundary or shape is too small to be shown as a line or area feature. Or, it could represent a point that has no area, such as the elevation of a mountain peak. A special symbol or label usually depicts a point location.

A line feature is a set of ordered coordinates that, when connected, represents the linear shape of a map object too narrow to be displayed as an area. Or, it could be a feature that has no width, such as a contour line. In ARC/INFO, lines are referred to as arcs.

An area feature is a closed figure and its boundary encloses a homogeneous area, such as a state, county, or water body.

**Topology**

Topology is a mathematical procedure for explicitly defining spatial relationships. These relationships are interpreted by identifying connecting lines, by defining the areas enclosed within these lines, and by identifying contiguous areas.

In digital maps, such spatial relationships are depicted using topology. For maps, topology defines connections between features, identifies adjacent polygons, and can define one feature, e.g. an area, as a set of others (e.g. lines).

Creating and storing topological relationships has a number of advantages. Data is stored more efficiently when topology is used. Therefore, one can process data faster and process larger data sets. When topological relationships exist, one can also perform analysis functions, such as modelling flow through the connecting lines in a network, combining adjacent polygons with similar characteristics, and overlaying geographic features.

The three major topological concepts are:

- Arcs connect to each other at nodes (connectivity)
- Arcs that connect to surround an area define a polygon (area definition)
- Arcs have direction and left and right ends (contiguity)

**3.2. Digital data and data collection**

Data on a map can be captured by digitizing each feature, one by one, or by using an electronic scanner to capture an entire sheet of features. Data in the form of known coordinate values can also be captured by typing in the x- and y-coordinates. Both of these options require some preparation of the data before the computer can properly interpret it.

Digitizing converts the spatial features on a map into digital format. Point, line, and area data can be captured with a digitizer. An electronic scanner can capture a large number of features at once from a map.
procedure for capturing a series of points and lines.

Digitizing involves manually tracing all features on a map. This can be demonstrated by taking any map manuscript and breaking it into its component parts; a number of points and lines.

Creating topology for a coverage also creates the feature attribute table containing the descriptive data for the coverage. Once these relationships are made explicit, you can query, analyse, and display your data. Even if you are very careful while digitizing, you will not be able to make all of your lines connect perfectly. So making this spatial data usable really means making your coordinate data free of errors and topologically correct. This is accomplished by establishing the existing spatial relationships (constructing topology), identifying errors, correcting them, and then reconstructing the topology.

3.3. Geographic analysis

Geographic analysis allows you to study real-world processes by developing and applying models. Such models illuminate underlying trends in the geographic data and thus make new information available. A GIS enhances this process by providing tools which can be combined in meaningful sequences to develop new models. These models may reveal new or previously unidentified relationships within and between data sets, thus increasing our understanding of the real world.

Results of geographic analysis can be communicated with maps, reports, or both. A map is best used to display geographic relationships, whereas a report is most appropriate for summarizing the tabular data and documenting any calculated values. Maps and reports allow you to share with others the data contained in your geographic database.

Before starting any analysis, you need to assess the problem and establish an objective. Think through the process before making any judgements about the data or reaching any decisions. Ask questions about the data and the model. Generate a step-by-step procedure to monitor the development and outline the overall objective. The steps below outline the basic procedure for geographic analysis.

Step 1: Establish the objective and criteria for the analysis;
Step 2: Prepare data for spatial operations;
Step 3: Perform spatial operations;
Step 4: Prepare data for tabular analysis;
Step 5: Perform the tabular analysis;
Step 6: Evaluate and interpret the results;
Step 7: Refine the analysis as necessary.

For step 3 overlaying geographic information, which is one of the major functions of GIS, can be used. Polygon overlay is a spatial operation which overlays one polygon coverage onto another to create a new polygon coverage. The spatial locations of each set of polygons and their polygon attributes are joined to derive new data relationships. Joining
polygons enables you to perform operations requiring new polygon combinations. Other overlay operations include line-in-polygon overlay, in which line features assume the attributes of the polygon they lie within, and point-in-polygon overlay, in which point features assume polygon attributes.

3.4. GIS products and outputs

You need to answer three basic questions before creating a map. First, ‘Why is the map being constructed?’; second, ‘For whom is the map?’; and third, ‘How will the map be presented?’. The overall aim is to define the scope of the map, set out a list of objectives and develop a plan to create the map.

What is a map?

A map is a graphic representation of part of the earth’s surface. The structure of a map is such that it conveys information easily and readily to the reader. A map contains a series of layers or coverages which are often combined to form the final product. A map also includes descriptive information which helps the reader interpret the information on the map. Here are some of the main components of a map:

Geographic features

Geographic map features include areas, lines and points drawn from various coverages in the geographic database.

- Areas are polygon features, such as land use areas. Polygon boundaries are drawn using line symbols. Polygons can be shaded based on attributes using colours, patterns, or both. They can also be labelled with attributes using text symbols.
- Line elements are arcs, such as roads or streams. Arcs are drawn using line symbols and labelled with attributes using text symbols.
- Point elements represent point features or polygon label points. They are drawn with marker symbols and labelled with attributes using text symbols.

Cartographic elements

Cartographic elements help make the map easier to read and interpret.

- Titles and explanatory text describe the purpose of the map and are drawn using text symbols.
- Neatlines create borders and partitions within a map and are drawn using line symbols.
- Legends describe the symbols used to represent the geographic elements and are drawn using line, shade or marker symbols and text.
- North arrows and scale bars describe the orientation and scale of the map. They are drawn using line, shade and text symbols.

The maps message

A map is a means of communication. It can be packed with detail or be very simple in content and yet contains the overall message. Maps are usually designed for a specific purpose. For example, a road map emphasizes transportation networks, a demographic
Intended audience

Our powers of correct interpretation depend very much on personal knowledge and experience. There are skills involved in reading a map successfully, and proficiency can vary between groups of people and between ages.

The content of a map is often governed by its users and why it is produced. Consideration must always be given to the reader's ability to interpret the given information. Some people are less able to read a map, in which case the theme must be quite clear and the content limited to relevant information.

3.5. Organisational implications

Geo information management is not only a technology, or spatial data or the use of a GIS, but it is a coherent entity of spatial data, technical infrastructure, working procedures, processes and management.

In general there are four different stages of development to go through when a GIS is implemented within an organisation. This is shown in figure 2.

The characteristics of the four stages are:

1. Initiation
   Somewhere in the organisation people start to experiment with GIS. Hard- and software is purchased and the focus is on the technology. Most of the problems at this time have a technical character.

2. Diffusion
   After the technology has proven its usefulness, it will spread throughout the organisation. People from several departments or sections learn how to use the technology and the need for data is growing.

3. Consolidation
   After a while the attention moves from technology to organisation. There is a growing need to consolidate the results of the past period. New, mainly organisational problems are showing up like how to manage the data. What data is already collected and how can it efficiently and effectively be stored and retrieved. Researchers need to be supported by well trained GIS staff. Procedures have to be developed for basic activities.

4. Integration
   In this stage the use of the GIS technology is accepted as an essential part of the production process. All the departments and sections are using GIS when necessary.

When a new or additional technology is introduced, these stages have to be gone through again, to let the organisation grow to a higher level of technological development.
To successfully implement a GIS, each organisation must perform ten general functions. Each requires certain capabilities, skills, and knowledge, although one individual often performs more than one function.

1. manager
2. GIS analyst
3. database administrator
4. GIS processor
5. photo interpretation specialist/drafts person
6. digitizer/key entry operator
7. cartographer
8. computer systems administrator
9. Programmer/Applications Developer
10. End Users

The end users are the people ultimately served by the GIS. Experienced users are important. End users are easier to serve if they understand the functions and capabilities of the GIS and know how it can benefit their operations. Therefore, it is important that end users be educated and trained in the benefits of GIS. They do not need to know how the GIS works, rather they need to know how the GIS can be applied to meet their needs.

Whatever the structure in your organisation, over time all of these functions will be performed in a successful GIS. Other specialized positions may also be required (e.g., surveying and land records specialists in a Tax Assessor's office). One common approach to meet the important functions at the beginning of GIS implementation is for two individuals to work as a team to perform most of the leading technical functions. The first person performs database design, digitizing, processing and analysis, while the other
depart, they take with them your system's experience, knowledge and momentum.

Implementation Strategies

A number of successful strategies have been applied to GIS implementation. Here are five common strategies:

The ‘team-of-two' strategy.

As mentioned earlier, one of the most common strategies used by successful organisations has been to use a team of two key players who perform most of the fundamental GIS functions to help start the GIS within a single department.

'Sneak it in the door' strategy.

One common approach has been to buy small and let one (or perhaps two) individuals use the GIS. Relatively little money is spent up front (about $20,000 US-dollar).

The ‘Pay as you go' Service Bureau.

This strategy involves applying GIS on a project-by-project basis for which other users pay for your services. One need only consider the large number of consulting firms that provide GIS services to know that this strategy can work. One of the most common services is that of database digitizing and automation.

The ‘Cost-Benefit' strategy.

In this strategy, a study is conducted and a report is prepared to demonstrate how the use of a GIS will result in greater economic benefits for the organisation. Often, this study involves a clearly defined implementation plan in which a user-needs study is performed, a pilot project is conducted, and from these, an implementation plan for the GIS is developed.

The Interdepartmental ‘Economies of Scale' strategy.

A number of departments work together to implement a single, integrated GIS that benefits the entire organisation.

Of course, other strategies are often pursued for GIS implementation. Yet, regardless of the strategies applied, we often find the following similarities at successful sites:

• They performed small pilot studies before trying to implement their entire GIS. This taught them how to use their technology, how to organize their database, and what costs and pitfalls were associated with their project.

• They took ‘ownership' of their system. They did not expect, nor did they necessarily want, vendors controlling every stage of development.

• They usually had at least two strong, technical people who led the effort.

• They kept their staff employed. Their knowledge and experience increased over time and staff did not walk out to greener pastures.

Another important implementation key will be the ability of the organisation to create multi-user views and menus, each in the language of the end user. Thus, an application system must be built for each department so that its users can readily apply the GIS without knowing specific details about the GIS.
4. Case study TCP research area

The case study showed how theory of GIS can be used in practice. For this reason a typical land use planning problem was defined, a set of data provided and the participants worked in groups to solve the problem.

4.1. Land evaluation and land use planning

The tropical rain forest in South Cameroon is used by many different groups. The claims on land increase every year and as a result virgin forest is becoming scarce. Activities of loggers and farmers will result into environmental problems if this situation continues. Erosion, habitat destruction of animals, exhaustion of land by farming and socio-economic instability in the region could be the results of this uncontrolled situation.

The Tropenbos Cameroon Programme has started to develop methods and strategies for sustainable management and to create a management plan for the region.

Land (mapping units and their qualities) combined with land utilization types and strategies with recommendations derived from research will result in land suitability maps. By defining the demands of the land user groups and arriving at a consensus on a land use plan a land management plan should evolve.

To be able to make this kind of management plans land evaluation studies are carried out. Detailed land inventories are made and Land Utilisation Types (LUT's) are defined. For land planning an optimum allocation of land for a certain type of use must be made. GIS is a powerful tool in land evaluation and land use planning studies.

4.2. Case study description

As an exercise for the workshop it was decided to use the data which were collected by TCP so far and to formulate a fictive case for which a problem had to be solved. The problem should be relatively simple and concern only one type of land utilisation. The participants were asked to allocate the best suited areas for a game reserve within the TCP-research area.

To solve the problem a geographic analysis had to be carried out using the steps outlined during the GIS-lectures:

Step 1: Establish the objective and criteria for the analysis;
Step 2: Prepare data for spatial operations;
Step 3: Perform spatial operations;
Step 4: Prepare data for tabular analysis;
Step 5: Perform the tabular analysis;
Step 6: Evaluate and interpret the results;
Step 7: Refine the analysis as necessary.
The TCP data set consisted of the following layers:

1. topographic data (200 meter interval altitude classes)
2. administrative border (TCP-research area boundary)
3. rivers
4. roads
5. villages
6. land use map
7. landscape ecological map
8. fauna

In Map 1 'Basic data of the TCP research area' an overview is shown of the most important data for the case study, villages (layer 5), roads (layer 4) and a shifting cultivation map (layers 6 and 7).

The last data set is an additional map which was generated to show favourable conditions for two different animals: Gorilla and Collared Mangabey. These data were not digital available so a rough estimate was generated using maps drawn in Bekhuis (1997) and presented using a square km grid for the TCP-research area. They are shown on the right side of Map 1.

4.3. Defining land evaluation criteria

During the first plenary discussion the four groups working on the case study presented these criteria:

- group I:
  1. area of 20,000 - 40,000 hectares
  2. presence of rivers
  3. no roads nearby
  4. no villages nearby
  5. terrain should be hilly
  6. contain different water catchments
  7. possibility for creation of a buffer zone around the reserve

- group II:
  1. free from settlements
  2. water sources available
Basic data of the Tropenbos Cameroon Programme research area

Habitat conditions for Gorilla and Collared Mangaby
5 rich soils
6 hilly area
7 at least 30,000 ha
8 rich in edible plants

group III:
1 primary forest with presence of protected species
2 absence of human activity
3 accessible by roads
4 hilly in areas with average heights
5 containing at least two different administrative regions
6 at least 10,000 ha

group IV:
1 area of 20,000-40,000 ha
2 primary forest
3 presence of endangered species
4 good habitat for these species
5 water
6 accessible by roads
7 no human activities (logging etc.)
8 no roads

The criteria lists as shown above have a lot in common. Using this material this is worked out to a final list of criteria for each of the species for which data were provided

<table>
<thead>
<tr>
<th>Gorilla</th>
<th>Collared Mangabey</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 presence of endangered species (Gorilla)</td>
<td>1 presence of endangered species (collared Mangabey)</td>
</tr>
<tr>
<td>2 primary and old secondary forests (relative undisturbed areas)</td>
<td>2 primary and old secondary forests</td>
</tr>
<tr>
<td>3 minimal surface of 10,000 ha</td>
<td>3 minimal surface of 2500 ha</td>
</tr>
<tr>
<td>4 minimal 3 km away from high intensity shifting cultivation areas</td>
<td>4 minimal 3 km away from high intensity shifting cultivation areas</td>
</tr>
<tr>
<td>5 minimal distance of 4 km to human settlement</td>
<td>5 minimal distance of 4 km to human settlement</td>
</tr>
<tr>
<td>6 not fragmented by large roads</td>
<td>6 not fragmented by large roads</td>
</tr>
</tbody>
</table>
4.4. Defining the geographic analysis

Many of the spatial operations had to be performed by ARC/INFO. The results of these actions could be easily viewed in Arcview. For each of the two species the same procedure is followed except for the last criteria used for the Gorilla. In order to meet all the criteria and given the TCP data set the following steps are executed (the numbers correspond with the numbered maps inside Map II and Map III):

1. locate the areas suitable for the endangered animal. On the fauna data a RESELECT is carried out for those grids (of 1 km²) with moderate suitable and suitable conditions, i.e. a code larger or equal than 1. The resulting grids converted to contiguous areas with favourite conditions using a DISSOLVE.

2. CLIP this map with a map resulting form a RESELECT of relatively undisturbed areas (code 5 on the land use map) to obtain primary and secondary forests.

3. create a buffer of 3000 meter around areas with high intensity shifting cultivation (codes 3 on the vegetation map). This resulting map can also be subtracted but now on the resulting map of step 3 using ERASECOV.

4. create a buffer of 4000 meter around villages (as a point feature). The resulting map should be subtracted from the map resulting from step 2 using ERASECOV.

5. for Gorilla the roads must be excluded. There is a buffer of 1000 meter around the roads created, which are represented as line features. There is a polygon overlay performed on this buffered map and the result of step 4 using IDENTITY.

6. the last step is a RESELECT on the table in TABLES of the result of step 5 for those polygons are not inside the road buffers and with an area greater than 10,000 ha for Gorilla and 2500 ha for Mangabey. The result of the selected features can be stored as an attribute added to the feature attribute table with ADDITEM (ARC/INFO) belonging to the in the previous step generated map with the CALCULATE command in TABLES.

4.5. Evaluation results

The results are presented as maps in Arcview (Maps 2 and 3). The green areas are suitable, of which the dark green areas meet the minimum size criteria. It can be concluded that differences reflected on both maps concern the presence of favourable conditions which is different for both animals. The use of the criteria ‘roads’ is recognised on the Gorilla reserve results. Because of the minimum size criteria more suitable locations for the Mangabey Reserve are found then for the Gorilla Reserve.
Land suitability analysis for a Gorilla reserve

1. Moderately to well suitable (forage conditions)
2. Primary and secondary forests
3. Buffer of 3 km around areas with high and low shifting cultivation
4. Buffer of 4 km around centers of human settlements
5. Buffer of 1 km around main roads

*With favorable forage conditions for Gorilla, area not excluded and < 10000 ha*
Area with favorable forage conditions for Mangabey:
- Area not excluded and < 2500 ha
- Area not excluded and > 2500 ha
- Area excluded: too near to settlements (4 km)
- Area excluded: too near to agricultural areas (3 km)

Moderately to well suitable (forage conditions)

Primary and secondary forests

Buffer of 3 km around areas with high and low shifting cultivation

Buffer of 4 km around centers of human settlements
5. Visit Kribi

The non Cameroonian participants went to Kribi to visit the Tropenbos site. They spent two days and the detailed programme is shown in Annex IV. The participants valued the visit to Kribi very much. Several participants underlined the importance of the research carried out by TCP. They confirmed that related research could be carried out by Tropenbos in their own countries (especially Gabon).

5.1. Visit Wijma Sawmill and Okoumé plantations
On Monday a short field trip to Okoumé and Bidou II was made. At Bidou II the sawmill of Wijma was visited. A tour was directed by Mr. J. Hollander, chief of the Wijma Sawmill. Discussions were held concerning logging and sustainable Forest Management. At Okoumé two experimental plantations were visited: the plantations of d' llomba and d' Assamela.

5.2. Introduction TCP projects
On Tuesday the TCP-office in Kribi was visited where presentations and discussions were held. At the TCP-office presentations were given on the programme as a whole and more in detail on studies concerning topics on forestry, sociology and economy related to the Kribi research area. Introduction were given by Messrs. W.F. van Driel, B. Mbarga, F. Tiayon and R. Eba’a Atyi.
6. Workshop evaluation and conclusions

6.1. Evaluation

At the end of the workshop an evaluation form was handed out to the participants. This questionnaire should give insight in whether or not the participants could use GIS in their work back home. It also served to obtain an idea of the knowledge and experience gained of GIS during the workshop. It was also important to have feedback on whether or not theory and practice of GIS (on headlines) became clear during this workshop. There were also questions about organisational aspects concerning this workshop. The evaluation form is presented in annex V.

The results of the evaluation are presented in the following sections.

Personal background

From the participants 7 are engineer and most of them ‘Ingénieur des forêts et des eaux’; 2 are working in the field of informatics; 1 in education of geography. Four participants are in management positions, i.e. heads of different departments.

Knowledge of and experience with computers was low: 3 were used to work with them, 10 had moderate experience and 10 little experience. Knowledge with GIS was also low: 20 had moderate to little knowledge and only 3 stated to have advanced knowledge of GIS.

Overall appreciation

Overall appreciation of the workshop was very positive and working with people with different background and countries was not felt as a disadvantage.

Understanding the principals of GIS became clear for 50% of the group and the other half stated to have more or less a good overview of using and introducing GIS. Most of the participants want to use GIS in the field of forestry especially for management tasks.

Presentation

75% of the participants rated the presentations and documentation as good, 25% as moderate. The use of English caused some difficulties for 75% of the participants. Translation in French was found very necessary. Only 50% stated to understand both French and English well. A few participants suggested to provide the documentation in the two languages. One suggested to make the exercises available on floppy disk. This question also arised in the workshop and it was explained that this was only usefull in combination with the software of ESRI. We were not in the position to do so.

GIS theory and concepts

Most of the participants judged the theory of GIS as moderately easy to easy to understand. Working with the GIS software and the exercises did not cause difficulties and assistance was valued good. A few remarks concerned limited knowledge of software and informatics, shortness of number of computers and time. One remark was made concerning the availability of the GIS software after the workshop in order to continue practising the exercises.
judged. Developing strategy and performing the geographic analysis was valued moderate and for some difficult. The inventory data of the research area did not meet all demands. Remarks concerned the difficulties to translate the formulated criteria into geographic analysis and linked spatial operations. Suggestions are made to have more examples of this kind of exercises.

Organisational aspects

Most organisational aspects (workload, accommodation, number and quality of computers) were found to be moderate. 80% stated the duration of the workshop was too short. Travel and lodging facilities were valued moderate and a few did not approve the hotel facilities. Some people complained about their financial compensation.

One participant suggested to have this workshop organized after the elections (held shortly after the workshop), to prevent the change in programme as the one that appeared now. A participant from outside Cameroon suggested to mail the invitation well ahead of time in order to be able to properly plan everything.

6.2. Conclusions

The participants positively appreciated the workshop. They all have an idea on the different aspects associated to GIS. The workshop should have been conducted in both English and French.

Also in my opinion it seems clear that the time period was much too short in order to get a perfect understanding of GIS and land evaluation. In the limited amount of time the workshop only provided a general introduction on the possibilities of the use of GIS. Nevertheless an overview of organisational aspects related to the introduction of GIS became clear to all participants. One should realize that this workshop did not train people to use GIS right away. For this a more thorough course should be attended in the future to become GIS experts.

Considering the background of the participants it seems to be clear that for all of them use of GIS could be an important part of their work. Also the presence of several participants in leading positions can play an important role in introducing GIS in their organisation. This being the objective of this workshop one can conclude that the workshop has been succesfull.
References


Bekhuis, P., 1997, Habitat requirements and potential distribution of some large mammals in Southwest Cameroon, June, 1997, graduation report animal ecology (H300-724), Wageningen Agricultural University (dept. terrestrial ecology & Nature Conservation), Wageningen, the Netherlands.


ESRI, 1996, Introduction to ArcView GIS, Two day course notebook, ESRI educational services, Environmental Systems Research Institute, Inc. Redlands, California, USA.


Gemerden, B.S. van, G.W. Hazeu, 1997, Landscape Ecological Survey (1:100.000) of the Bipindi - Akom II - Lolodorf region Southwest Cameroon, Report 153 and Tropenbos Cameroon series 1, Tropenbos Cameroon programme, DLO-Winand Staring Centre, Wageningen the Netherlands.


Mballa, F.G.W., Hazeu and B.S. van Gemerden, ARC/INFO et les Systèmes d'Information Géographiques, 1997; Séminaire OIBT/Tropenbos sur les Systèmes d'Information Géographiques, Yaoundé, septembre 1997, Programme Tropenbos-Cameroun, Kribi, Cameroun.
### Annex I. List of actions and actors

<table>
<thead>
<tr>
<th>number</th>
<th>activity</th>
<th>actor</th>
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<tbody>
<tr>
<td>1</td>
<td>Prepare draft proposal and send to Cameroon and ITTO for comments</td>
<td>Van Kekem/ Jonkers</td>
</tr>
<tr>
<td>2</td>
<td>comment on proposal and return to Jonkers</td>
<td>ONADEF/TCP</td>
</tr>
<tr>
<td>3</td>
<td>identify foreign institutes/participants and inquire about interest in participation</td>
<td>ONADEF in coll. with TCP</td>
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<tr>
<td>4</td>
<td>finalise workshop programme and send to TCP and ONADEF</td>
<td>Van Kekem/ Bulens</td>
</tr>
<tr>
<td>5</td>
<td>select and invite foreign participants workshop</td>
<td>ONADEF in coll. With TCP</td>
</tr>
<tr>
<td>6</td>
<td>after confirmation of participants, send PTA to foreign participants</td>
<td>ONADEF</td>
</tr>
<tr>
<td>7</td>
<td>identify local participants and invited guests for opening ceremony</td>
<td>ONADEF and TCP</td>
</tr>
<tr>
<td>8</td>
<td>logistical arrangements (meeting room, lunch on day 1, cocktail, transport to Yaounde, transport to Kribi v.v., ...)</td>
<td>ONADEF and CETELCAF</td>
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<tr>
<td>9</td>
<td>preparations case study and demonstrations</td>
<td>ONADEF, CETELCAF and Bulens</td>
</tr>
<tr>
<td>10</td>
<td>preparation lectures</td>
<td>Bulens and ONADEF</td>
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<td>11</td>
<td>preparation of printed final workshop programme with summary of lectures</td>
<td>ONADEF/ Bulens</td>
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<td>11a</td>
<td>try-out case studies and demonstrations</td>
<td>CETELCAF/ Bulens</td>
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<td>12</td>
<td>workshop</td>
<td>Bulens/ ONAEEF</td>
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<tr>
<td>13</td>
<td>workshop report</td>
<td>Bulens</td>
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### Annex II. List of participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>function</th>
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<tr>
<td>Meng, Abe Meka Paul</td>
<td>SI/DF/MINEF Cameroun</td>
<td>Ingénieur Eaux et Fôrets</td>
<td>Dir. Forêts MINEF Yaoundé Cameroun</td>
<td>Cameroon</td>
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<tr>
<td>Tene, Obam James</td>
<td>ONADEF/CETELCAF</td>
<td>Cartographe</td>
<td>BP 1341 Yaoundé</td>
<td>Cameroon</td>
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<tr>
<td>Bilié, Valentin</td>
<td>SODEFON</td>
<td>Sous-Directeur de l'Amenagement</td>
<td>BP 3770 Abidjan</td>
<td>Côte d'Ivoire</td>
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<tr>
<td>Amfo, Robert</td>
<td>Forestry Commission</td>
<td>Head Forest &amp; Wildlife Development and Utilization Department</td>
<td>P.O. Box m 434 Accra</td>
<td>Ghana</td>
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<tr>
<td>Tene, Denis</td>
<td>MINEF direction de Forêts</td>
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<td>Cameroun</td>
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<td>Iloy, Catherine</td>
<td>MINAT/DAT</td>
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<td>Wangoy, Bankanza</td>
<td>SPIAF</td>
<td>Chef du bureau</td>
<td>35, Av. Pumbu BP 10.120 Kinshasa I</td>
<td>Rép. Démocratique du Congo</td>
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<tr>
<td>Flaa-Obiang, Dominique</td>
<td>MEF DIARF</td>
<td>Ingénieur Eaux et Fôrets</td>
<td>BP 152 LBV</td>
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<td>Akoa Akoa, Armandouis Paul</td>
<td>DFAP/MINEF</td>
<td>Chef de Bureau, Ingénieur Eaux et Fôrets</td>
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<tr>
<td>Alaina</td>
<td>MINAGRI</td>
<td>Ingénieur de Génie Rural</td>
<td>DGRDC/MINAGRI</td>
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<td>Imba, Ernest</td>
<td>Directions des forêts MINEF representant de MEC/SA/OITB</td>
<td>Ingénieur Eaux et Fôrets, Chef de Service des aménagements</td>
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<td>Ortunato, Eneme</td>
<td>DG de production y comercializaciación</td>
<td>Ingeniero</td>
<td>M.P. et F. Malabo</td>
<td>Guinée Equatoriale</td>
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<td>Gamo Gamo, Alphonse</td>
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<td>BP1341 Yaoundé</td>
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<td>Medjo, Frédéric</td>
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<td>Ndjeré, Adamou</td>
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<td>Nganteh Martin</td>
<td>ONADEF</td>
<td>Director Southern Bakundu Project</td>
<td>BP 400 Kumba</td>
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<td>Njib Ntep, Dieudonné</td>
<td>ONADEF</td>
<td>Directeur Adjunct de la Production</td>
<td>BP 1341 Yaoundé</td>
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<td>Nounamo, Laurent</td>
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<td>Agro-Ecologist researcher in Agriculture</td>
<td>BP 2067 Yaoundé</td>
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<td>Poukalé, Pierre</td>
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<td>Professeur</td>
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Annex III. Workshop programme

Workshop programme

**Monday 22/9/97**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tr>
<td>10.00-12.30</td>
<td>registration participants</td>
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<tr>
<td>12.30-14.30</td>
<td>lunch</td>
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<tr>
<td>14.30-15.00</td>
<td>introduction SC-DLO</td>
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<tr>
<td>15.00-16.00</td>
<td>introduction GIS</td>
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<td>16.00-17.30</td>
<td>introduction TCP-WAU + presentation first results</td>
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**Tuesday 23/9/97**

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<tr>
<td>9.00-10.00</td>
<td>geographical data concepts part 1</td>
</tr>
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<td>10.00-11.00</td>
<td>exercise 'coverage'</td>
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<td>11.00-11.30</td>
<td>coffee break</td>
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<tr>
<td>11.30-12.00</td>
<td>geographical data concepts part 2</td>
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<td>12.00-12.30</td>
<td>exercise data relate</td>
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<td>12.30-14.30</td>
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<tr>
<td>14.30-15.30</td>
<td>introduction Arcview 3.0</td>
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<tr>
<td>15.30-16.00</td>
<td>exercise AV1</td>
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<td>16.00-16.30</td>
<td>tea break</td>
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<td>16.30-18.00</td>
<td>introduction CETELCAF/ONADEF</td>
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**Wednesday 24/9/9**

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<th>Time</th>
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<tr>
<td>9.00-10.00</td>
<td>digital data and data</td>
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<tr>
<td>10.00-11.00</td>
<td>demonstration digitising</td>
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<td>11.00-11.30</td>
<td>coffee break</td>
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<tr>
<td>11.30-12.00</td>
<td>exercise 'Geographic analysis'</td>
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<td>12.00-12.30</td>
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<td>12.30-14.30</td>
<td>lunch</td>
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<td>14.30-15.30</td>
<td>Arcview 3.0 : creating views and themes</td>
</tr>
<tr>
<td>15.30-16.00</td>
<td>exercise AV2a</td>
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<tr>
<td>16.00-16.30</td>
<td>tea break</td>
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<tr>
<td>16.30-17.30</td>
<td>Arcview 3.0 : view properties</td>
</tr>
<tr>
<td>17.30-18.00</td>
<td>exercise AV2b</td>
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</table>
10.00-11.00 exercise AV3A
11.00-11.30 coffee break
11.30-12.00 Arcview 3.0: map layout
12.00-12.30 exercise 8
12.30-14.30 lunch
14.30-15.30 organisational implications of GIS
15.30-16.00 tea break
16.00-18.00 Arcview 3.0 demonstrations

Friday 26/9/97

9.00-10.00 summary GIS techniques
10.00-11.00 summary objectives Tropenbos
   Land evaluation and land use planning
11.00-11.30 coffee break
11.30-12.30 introduction case study
12.30-14.30 lunch
14.30-15.30 discussion in small groups
   composing criteria list
15.30-16.00 plenary discussion
16.00-16.30 tea break
16.30-17.30 discussion in small groups
   quantification of requirements
17.30-18.00 plenary discussion

Saturday 27/9/97 (morning)

9.00-10.00 evaluation case study
10.00-11.00 evaluation workshop
11.00-11.30 coffee break
11.30-12.00 closing ceremony

Sunday 28/9/97

Lectures and introductions DLO-Winand Staring Centre
   J.D. Bulens, GIS, Informatics and Agricultural Scientist

Lectures and introductions Tropenbos Cameroon Programme
   F. Mballa, Engineer Informatics
   G.W. Hazeu, Physical Geographer and Soil Scientist
   B.S. van Gemerden, Vegetation Ecologist

Introduction and assistance Cetelcaf/Onadef
   J. Momo, Engineer Water, Forestry and Hunting
   F. Medjo, Engineer Water, Forestry and Hunting
Annex IV. Programme field trip to Kribi

Field trip to the Tropenbos research area at Kribi
from 29/9/97 to 30/09/97

29 September 1997
8.30: departure from Yaoundé to Kribi
12.00 arrival at Kribi
12.30 lunch
15.30 departure for Bidou III
16.00 - short presentation on the 'Kienké Sud' area
- visits to some plantations of Okoumé, Ilomba and Assamela
17.00 visit to the sawmill of Wijma at Bidou II
17.30 departure for return to Kribi
18.00 arrival
20.00 diner

30 September 1997
7.30 breakfast
8.30 presentation the Tropenbos Cameroon Programme (TCP) and visit to the office of TCP
9.00-9.30 Tropenbos Cameroon Program (TCP), Wim F. van Driel
9.31-10.15 forestry studies of TCP, Bibani Mbarga
9.16-10.45 break
10.46-11.20 sociological studies of TCP, François Tiayon
11.21-11.50 economical studies, Richard Eba’A
11.51-12.00 general discussion and closing

12.00 lunch
13.30 departure for Yaoundé
16.30 arrival at Yaoundé

End of field trip
Annex V. Evaluation form

Seminar GIS and Land use Analysis
September 22 - October 1, 1997
Yaoundé, Cameroon

Organized by ONADEF and Tropenbos Cameroon Programme
Funded by ITTO (project PD 26/92)

EVALUATION OF SEMINAR
form to be filled in by participants

Personal background of participant
Function: ............................................................................
My knowledge of computers in general is
☐ high ☐ moderate ☐ little ☐ none

My knowledge of Geographic Information Systems, before starting this course, was:
☐ high ☐ moderate ☐ little ☐ none

I am proficient in
☐ English ☐ French ☐ both English and French

General remarks and specifications:
..............................................................................................................................

Overall appreciation of GIS seminar
My overall appreciation of the GIS workshop is:
☐ good ☐ fair ☐ bad

I enjoyed working in a team with people from different disciplines and countries
☐ yes ☐ slight ☐ no

At present, I have a good overview of headlines of GIS, enabling me to use and introduce GIS:
☐ yes ☐ more or less ☐ no

The GIS is useful for my work
☐ very ☐ moderate ☐ little ☐ not useful

If useful please specify field: ...........................................................

I have got a good overview of headlines for introducing and using GIS
☐ yes ☐ a little ☐ no

General remarks and specifications:
..............................................................................................................................
Presentation of lectures
☐ good ☐ moderate ☐ bad

Seminar documentation
☐ good ☐ moderate ☐ bad

Use of English language
☐ no problem ☐ some difficulties ☐ not comprehensible

Translation in French
☐ necessary ☐ additional ☐ not necessary
☐ too much ☐ just right ☐ too little

General remarks and specifications:

GIS theory and concepts
Explanation of theory about concepts of GIS
☐ difficult ☐ moderate ☐ easy to understand
☐ too much detail ☐ all right ☐ too general

working with Arcview
☐ difficult ☐ moderate ☐ easy to understand

exercises with Arcview
☐ easy ☐ moderate ☐ difficult

assistance exercises
☐ good ☐ amply sufficient ☐ bad

General remarks and specifications:

Case study (planning a game reserve)
Introduction of case study was
☐ good ☐ moderate ☐ bad

Presentation of concepts of Land use planning
Development of strategy for the geographic analysis
- easy
- moderate
- difficult

Performing geographic analysis for assessing suitable areas for game reserve
- easy
- moderate
- difficult

The inventory data from the Tropenbos Cameroon Programme research area were:
- well suitable
- moderately suitable
- not suitable

Plenary discussions and presentations
- clear
- just fine
- confusing

General remarks and specifications:

[Blank space]
Travel and lodging arrangements
- good
- moderate
- bad

Work load of seminar
- too high
- balanced
- too little

Duration of seminar
- too short
- sufficient
- too long

Accommodation of seminar
- well suited
- moderate
- not suited

Availability of computers
- sufficient
- moderate
- not sufficient

Quality of available computers
- good
- moderate
- bad

Hotel facilities
- good
- moderate
- bad

Transportation facilities
- good
- moderate
- not well

General remarks and specifications:

Thank you very much for your cooperation!
Annex VI. Results evaluation

Personal background of participant
Function:

3
1 professeur geography
5 Ingenieur des forêts et des eaux
1 system manager
1 ingenieur genie rural
1 ingenieur forestal
1 director of studies ONADEF
1 director of production ONADEF
1 director
1 adjoint chef CETELCAF
1 informaticien

My knowledge of computers in general
high 3
moderate 10
little 10
none 0

My knowledge of Geographic Information Systems, before starting this course, was:
high 4
moderate 9
little 7
none 3

I am proficient in
English 1
French 10
both English and French 12
?

General remarks and specifications:

Overall appreciation of GIS seminar
My overall appreciation of the GIS workshop is:
good 21
fair 2
bad 0
?

I enjoyed working in a team with people from different disciplines and countries
yes 20

At present, I have a good overview of headlines of GIS, enabling me to use and introduce GIS:

yes 9
more or less 13
no 0
?

The GIS is useful for my work
very 17
moderate 4
little 2
not useful 0

If useful please specify field:
1 Map
1 developement de l'hydraulique agricole
1 elaboration et approbation des plans d'aménagement
2 cartographie forestiere, plan utilisation de terre
8 for sustainable forest management
1 forestry maps, vegetation survey
1 l'evaluation des resources forestieres (diagnostic) et decisions d'aménagement
1 agriculture
1 forest and wildlife conservation, planning, development and utilisation
6

I have got a good overview of headlines for introducing and using GIS

yes 13
a little 10
no 0
?

Presentation
General presentation
Good 17
### Presentation of lectures

<table>
<thead>
<tr>
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### Seminar documentation

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### Use of English language

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### Translation in

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### GIS theory and concepts

**Explanation of theory about concepts of GIS**

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**Working with Arcview**

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### Exercises with Arcview

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### Assistance exercises

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### Case study (planning a game reserve)

**Introduction of case study was**

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**Presentation of concepts of Land use planning**

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**Development of strategy for the geographic analysis**

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**Performing geographic analysis for assessing suitable areas for game reserve**

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The inventory data from the Tropenbos-Cameroon Programme research area were:
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<table>
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<table>
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<table>
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<table>
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<table>
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### Annex VII. List of abbreviations

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<th>Abbreviation</th>
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<tbody>
<tr>
<td>CETELCAF</td>
<td>Centre de Télédétection et de Cartographie Forestière</td>
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<tr>
<td>GIS</td>
<td>Geographic Information Systems</td>
</tr>
<tr>
<td>IRAD</td>
<td>Institut de la Recherche Agronomique pour le Développement</td>
</tr>
<tr>
<td>ITTO</td>
<td>International Tropical Timber Organisation</td>
</tr>
<tr>
<td>Lu1</td>
<td>Overall forest land inventory and qualitative ecological land evaluation</td>
</tr>
<tr>
<td>Lu2</td>
<td>Shifting cultivation in evergreen forest, farming systems and soil degradation</td>
</tr>
<tr>
<td>MINEF</td>
<td>Ministère de l'Environnement et des Forêts</td>
</tr>
<tr>
<td>ONADEF</td>
<td>Office National de Développement des Forêts</td>
</tr>
<tr>
<td>SC-DLO</td>
<td>Winand Staring Centre for Integrated Land, Soil and Water Research</td>
</tr>
<tr>
<td>SIG</td>
<td>Systèmes d'Information Géographique</td>
</tr>
<tr>
<td>TCP</td>
<td>Tropenbos Cameroon Programme</td>
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<td>WAU</td>
<td>Wageningen Agricultural University</td>
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