Informed Decision Making for Sustainable Natural Resource Management: Nine Tools that Help

3

Participative mapping, analysis, and monitoring of natural resources in a watershed

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1. Geographic information systems. 2. Participative methods. 3. Community participation. 4. Collective action.

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Introduction

To make accurate decisions about natural resource management at the level of a small-scale watershed, we need to know the actual state of the natural resources there, particularly in the smaller-scale watershed systems within it. This Guide presents a new methodology that facilitates the participative mapping, analysis, and monitoring of the set of natural resources existing in a small-scale watershed and in the watershed systems within it. The Guide is based on research experiences accumulated in the Calico River watershed, San Dionisio (Nicaragua) as part of the work of the CIAT Hillsides Project in Nicaragua. The methodology here presented was developed in the field with the active participation of key informants of the watershed, farmers, promoters, and technicians of different nongovernment organizations (NGOs) working in the zone.

Methodology Objectives

The methodology may be used to:

- ✓ Participatively map and analyze the state of natural resources at small-scale watershed level taking into account agroecological and socioeconomic aspects. The analysis includes identifying the problems and solutions that local actors face and perceive.

- ✓ Identify critical watersheds or critical areas in the process of degradation or already degraded that require a short-term intervention.

- ✓ Monitor changes in the natural resources over time and the impact of possible interventions for their better management. The monitoring is related to an organizational process that facilitates decision making based on the results of mapping and analysis.

Users of the Methodology

The methodology presented in this Guide is mainly directed towards technicians, researchers, and extensionists of government entities and NGOs interested in the sustainable and participative management of natural resources and sustainable rural development. It is also addressed to local authorities and their technical personnel interested in the sustainable and participative management of watersheds from a decentralization approach.

These individuals may also become instructors or disseminators of the methodology, having once received the training.

The participative nature of the methodology requires that local inhabitants are committed in its different steps or components, thus contributing to its better and quicker adoption.

Relation with other Guides of this series

This Guide is complemented by others in the Series, particularly with those dealing with the following topics:

- Participative method for identifying and classifying local indicators of soil quality at watershed level (No. 1);
- Photo-topographic analysis (PTA) of land use tendencies in hillsides (No. 2); Methodology for analyzing groups of interest for collective management of natural resources in watersheds (No. 4); and
- Developing organizing processes at local level for the collective management of natural resources (No. 9).

Tools of the Methodology

The methodology combines different participative techniques or tools with others based on recent technologies such as geographic information systems (GIS). The participative techniques used in combination are:

- Participative mapping of a watershed;
- A walk or traverse on foot following one or several transects of a watershed; and
- Analysis of key elements (e.g., forest, water, soils, production systems, crops, pastures, animals, crop yields, presence of organizations, projects or programs, and conflicts over the use of natural resources).

Also, a *maqueta* (a three-dimensional structure made of the watershed out of papier-mâché or other locally found materials) can be used to recognize the landscape and to visualize or project alternatives in the use of natural resources in watersheds of different scales.

The combination of these techniques also allows the elaboration of a set or series of indicators of natural resource quality at watershed level that is highly useful for comparing the situation in two or more watersheds and for monitoring natural resources over time. Local inhabitants can use these indicators, and if necessary they can be adapted to new conditions.

Use of the Guide

This Guide explains in a logical sequence how to use each of the techniques that constitute the methodology. The combination of different techniques that together allow better knowledge of a watershed and identify its critical points is something novel. Therefore, we suggest that the sections be followed in order because each one describes a methodological instrument.

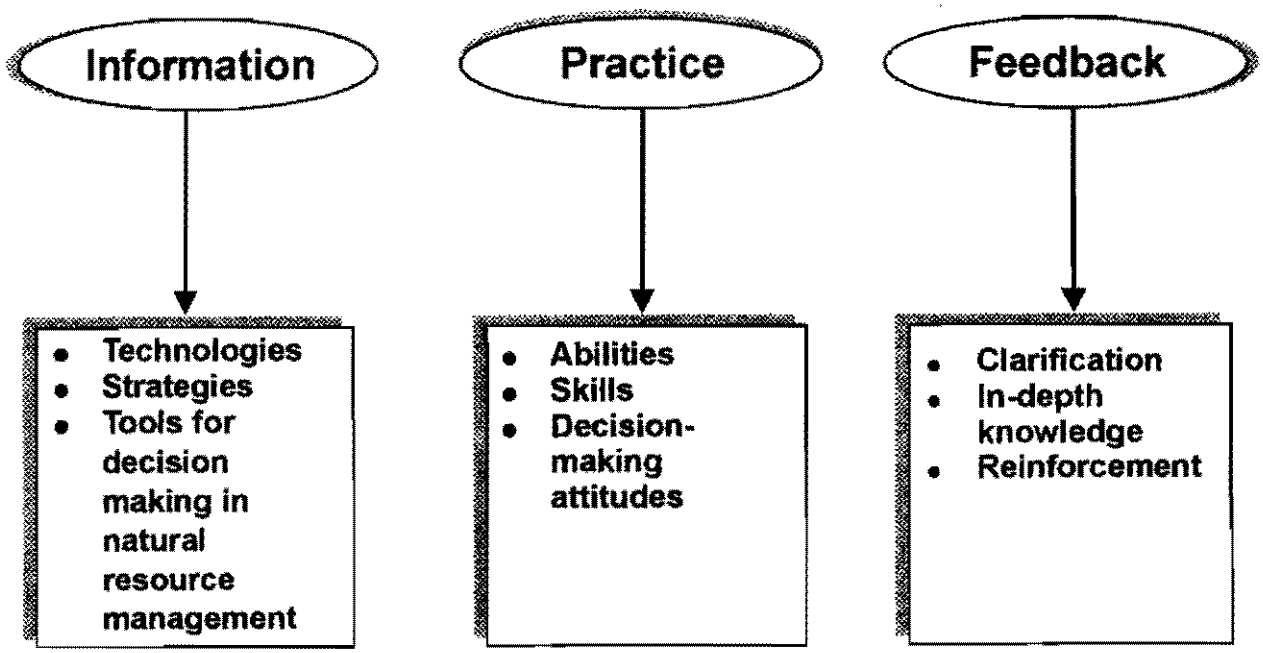
Users of the Guides

This Guide was translated from one of a Spanish-language series of nine Guides on "Informed Decision Making for Sustainable Natural Resource Management". They are directed towards three specific types of users. The first includes professionals and technicians working in agencies and institutions of the public and private sectors, dedicated to research, development, and training in the management of renewable natural resources. This level of users can use the Guides for planning, executing, monitoring, and evaluating their own initiatives in these three fields of action. But most importantly, this group, once trained in the application of these methodologies, will hopefully exert a multiplier effect on hundreds of professionals, technicians, volunteers, and producers. These in turn will promote, analyze, and adapt these methodologies to decision making in natural resource management (NRM) at the local, regional, and national levels.

The second group of users comprises inhabitants of the watersheds of tropical America, the ultimate legitimate heirs of the proposals of NRM generated by research and presented in these Guides. Through training, consultation, and support from diverse nongovernment organizations (NGOs) and state agencies, these people can use the methods and strategies described here to actively participate in the management and conservation of natural resources.

Lastly, this material is especially directed towards the teaching staff of colleges and university faculties of agricultural sciences, environmental sciences, and natural resources. These train professionals and technicians, who will collaborate with agricultural communities in the arduous task of maintaining or recovering natural resources, placed under their custody, for future generations.

The Learning Model



The series of Teaching Guides on Methodological Tools for Making Decisions in Natural Resource Management is based on a 'learning by doing' teaching model, shown above. This model presents trainers and multipliersthe immediate users of these Guideswith a training scheme whereby they learn to use the information resulting from field research as input for developing the abilities, skills, and attitudes needed by end users to make appropriate decisions on NRM.

Users will find that the methodological components of this Guide differ from those of other materials on the dissemination of technologies. Each of the sections dividing the Guides contains design elements that help the trainer in facilitating the learning process.

A set of objectives orients the Guides and helps both the instructor and the participant direct the learning activities. Exercises are carried out in the field or other realistic scenarios in which analysis and decision making are practiced. They include outings, simulations, dramatizations, and application of different tools for collecting and analyzing information.

Another methodological component comprises feedback sessions in which trainees and instructors have the opportunity to revise the practicals carried out and further examine those aspects that need strengthening. Feedback is the last activity of each section and provides the necessary opportunity for the instructor and participants to synthesize conceptually and methodologically each aspect studied.

In summary, the model consists of three elements:

1. Technical and strategic information, generated by research and constituting the technological content required for decision making;

2. Practicals in the form of exercises at the training sites and field activities directed towards developing abilities, skills, and attitudes for decision making; and

3. Feedback, which is a type of formative evaluation that strengthens the learning process and the adequate application of the fundamental theoretical principles involved.

The practicals are the core of the learning process. They simulate reality for those who use the decision-making tools presented in each Guide. Through the exercises, trainees experiment in using the tools, face the difficulties arising from their application at local level, and perceive the advantages and opportunities of introducing these tools into different decision-making environments at the local or regional level in whatever country.

The exercises included in the Guides were drawn from the authors' local research experience in watersheds of Honduras, Nicaragua, and Colombia. However, instructors from other countries and regions can draw excellent examples and cases from their own research projects and fieldwork with which practicals can be remodeled and tailored to the local context. Each instructor has available Guides that are flexible working tools and that can be adapted to the needs of assorted audiences in different scenarios.

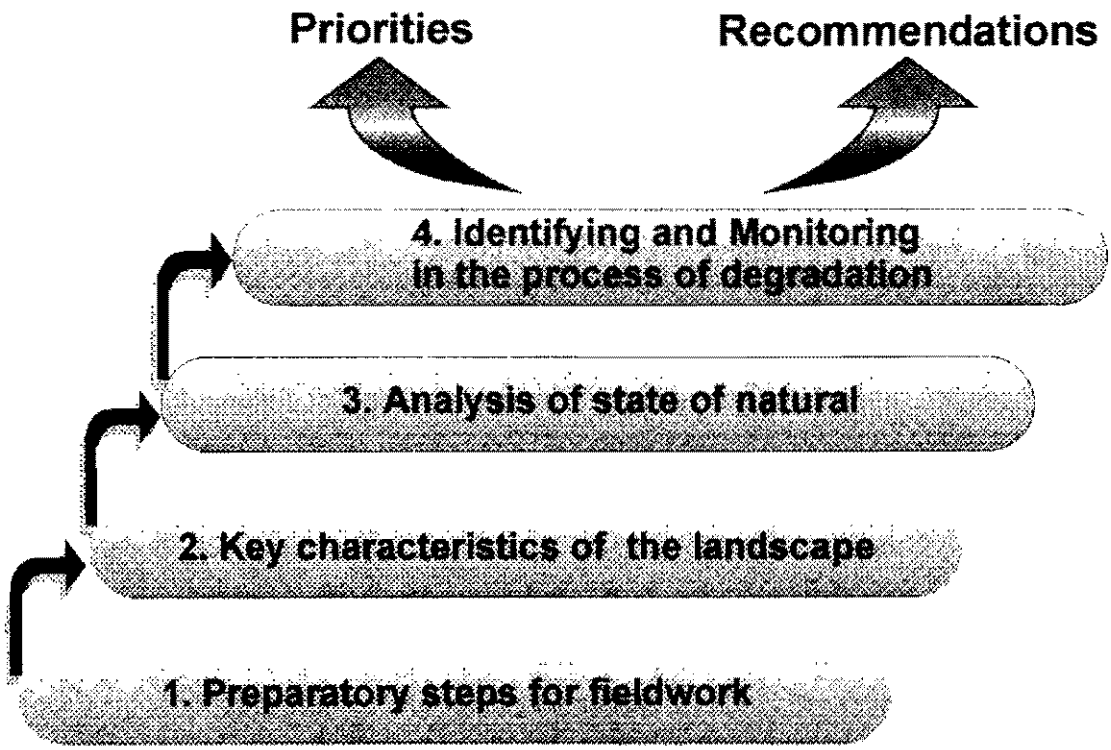
Uses and Adaptations of the Model

Users (instructors, multipliers) of these Guides must be familiar with its didactic structure to use it advantageously to the benefit of end users. They are the ones who will make the decision to introduce these tools into the local development process.

Flow charts are for the instructors' use when presenting the different sections. The *Guiding Questions* help instructors establish a dialogue and motivate the participants before going deeper into theory. *Originals for Transparencies* can be adapted to different needs by adjusting their presentation. The *Appendices* cited in the text give further information on those aspects treated briefly within each section. As already mentioned, the suggested exercises and practices can be adapted or replaced by practices on site-specific problems. Feedback sessions can also include local, regional, or national data to help identify more relevant topics. The didactic appendices (Final Evaluation, Evaluating the Training Session, the Instructor's Performance, the Training Materials, etc.) help complement the training activities.

Finally, the central idea of the Guides' training model stresses that if practice is the base for learning, then the training time should be sufficient to give the trainees the opportunity to develop abilities, skills, and attitudes that reflect the learning objectives. Only thus will training have the expected impact on decision makers involved in natural resource management.

The Guide's General Structure



Explanation:

This Guide's structure consists of four correlated steps or topics that, when executed in sequence, allow the general objectives to be reached.

Each step is carried out with the support of methodological tools, for example, participative mapping, the walk and participative analysis of natural resources, GIS, and the list of indicators of natural resource quality. The Guide is a work instrument that completes the sequence and integration of these tools.

Self-Evaluation

Instructor's Guidelines

Before beginning the presentation of the topics of this Guide, we recommend exploring the general knowledge of participants on the subject. In particular, it is in our interest to know how they perceive their environment and its present or past natural resources. We suggest the use of cards so that answers will be short and focussed (a wide analysis of the topics is not required).

The instructor may employ the recommended strategy (cards) or any other that permits him to start the training with a discussion that includes all themes. The feedback information is intended as support.

Questions

1. What methods do you know for identifying and delimiting a project area, when the main interest is the sustainable management of natural resources?

2. How can you tell the state of natural resources in the community where you work?

3. How can you identify, in the community where you work, the areas with problems in the use and management of natural resources?

4. What tools are available for comparing the state of natural resources in the different communities that form part of your working zone?

5. Do you have any suggestions about how to measure, in a simple way, the changes that occur in the state of natural resources in your community or work area?

Feedback on Self-Evaluation

Instructor's Guidelines

We recommend making a synthesis of the answers, grouping them (easier done when on cards) for each of the five topics:

1. Methods for identifying a study area relevant for NRM,
2. Ways of knowing or analyzing the state of natural resources,
3. Ways of knowing and identifying problem areas,
4. Comparing the state of natural resources in different watersheds, and
5. Ways of measuring the changes in the state of natural resources.

Answers to questions

1 Maps, both those produced with the support of modern technology such as GIS and those by local inhabitants, make it easy to identify a study zone relevant for NRM, especially watersheds. In combination with the knowledge of key inhabitants and secondary information already available, such maps allow us to identify the limits of a watershed, and the smaller-scale watersheds of which it consists, taking into account geographic, ecological, and socioeconomic aspects. The knowledge of key inhabitants helps identify topics related with access to and distribution of resources, and the changes that have occurred.

2 Walking across a small-scale watershed following one or several representative transects in the company of local key collaborators people with good knowledge of their environment facilitates a direct, on-site vision about the state of natural resources. The participation of different people (men, women, old, and young) assures an integral vision of the situation.

3 You can use the remarks made and knowledge obtained during the traverse. Additionally an analysis or diagnostic is made of the key elements related with the use of natural resources. This facilitates qualitative knowledge of the state of natural resources and locates sites with problems. It also allows a visit in situ to a critical area with problems of degradation or an area in danger of becoming so. Here again you may use the maps elaborated by the local inhabitants and can introduce orthophotomaps or maps produced with GIS tools that permit identifying heights, degree of slope, land use, and changes that have occurred.

4 First, similar studies must be carried out in the different communities and watersheds with the support of the tools mentioned above, that is, participative maps, GIS maps, traverses, *maquetas*, and diagnostic tools. Second, a meeting or workshop should be programmed to present and discuss the results of these studies, comparing the situations in the different communities and watersheds. We suggest simultaneously using a list of indicators of natural resources' quality that permits measuring and comparing, in a simple way, the state of the watershed.

5. With the information obtained using the tools already mentioned, you can work out a set of indicators of the quality of a watershed's natural resources. This set or list is a field tool that local inhabitants can use to measure, over time, the state of and changes in natural resources.

Objectives

General

Those trained in the use of this Guide will be able to:

✓ Define priorities and recommendations for decision making on NRM at watershed levels through the application, in their working zone, of the methodology for the participative mapping, analysis, and monitoring of natural resources.

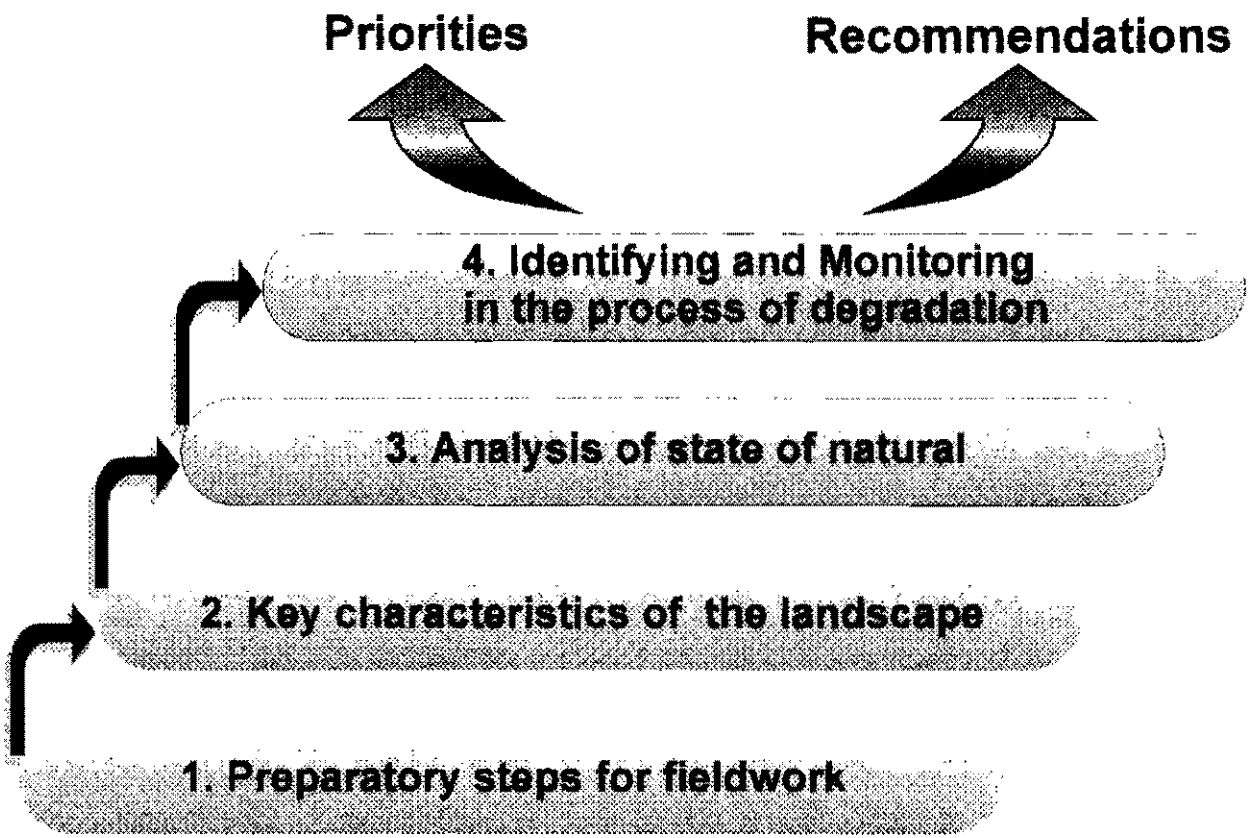
Specific

- Participants will be able to:
- Prepare the fieldwork stage with the support of secondary information, maps, and key collaborators.
- Identify, with the support of maps elaborated by means of GIS tools and secondary information, a watershed with the smaller-scale watersheds of which it is composed, taking into consideration geographic, ecological, and socioeconomic aspects.
- Identify a group of key collaborators to elaborate a preliminary vision of a watershed.
- Facilitate and lead the design of a watershed map elaborated by local inhabitants (key collaborators).
- Identify key characteristics of the landscape by means of a traverse on foot and the support of a map of the watershed elaborated with the participation of the region's inhabitants, and other maps available (e.g., orthophotomaps).
- Define the transect/s for a traverse on foot through a watershed to analyze the state of natural resources, accompanied by local inhabitants.
- Identify a set of components representing the problematics of access, use, and management of natural resources in a watershed.
- Identify in the field the representative places of natural resource use, associated problems, and existing opportunities.
- Carry out a participative analysis of natural resources in a watershed making use of a set of biophysical and socioeconomic components.

- Make a participative analysis with the support of the information collected from the maps and traverse, according to the components identified.
- Integrate the participative maps to a GIS.
- Identify the characteristics of a GIS at local level.
- Taking as a basis the analysis of the state of natural resources, define a set of indicators (with their respective values) of the quality of natural resources.
- Using a list of indicators of the quality of natural resources, identify the critical watersheds, or critical areas within the same, in process of degradation of natural resources.

Originals for Transparencies

GUIDE STRUCTURE



GENERAL OBJECTIVE

Define priorities and recommendations on natural resource management at watershed and small-scale watershed level

SELF-EVALUATION

1. What methods do you know for identifying and delimiting a project area when the main interest is the sustainable management of natural resources?

2. How can you tell the state of natural resources where you work?

3. How can you identify, in the community where you work, the areas with problems in the use and management of natural resources?

SELF-EVALUATION

4 What tools are available for comparing the state of natural resources in the different communities that form part of your working zone?

5 Do you have any suggestions about how to measure, in a simple way, the changes that occur in the state of natural resources in your community or work area?

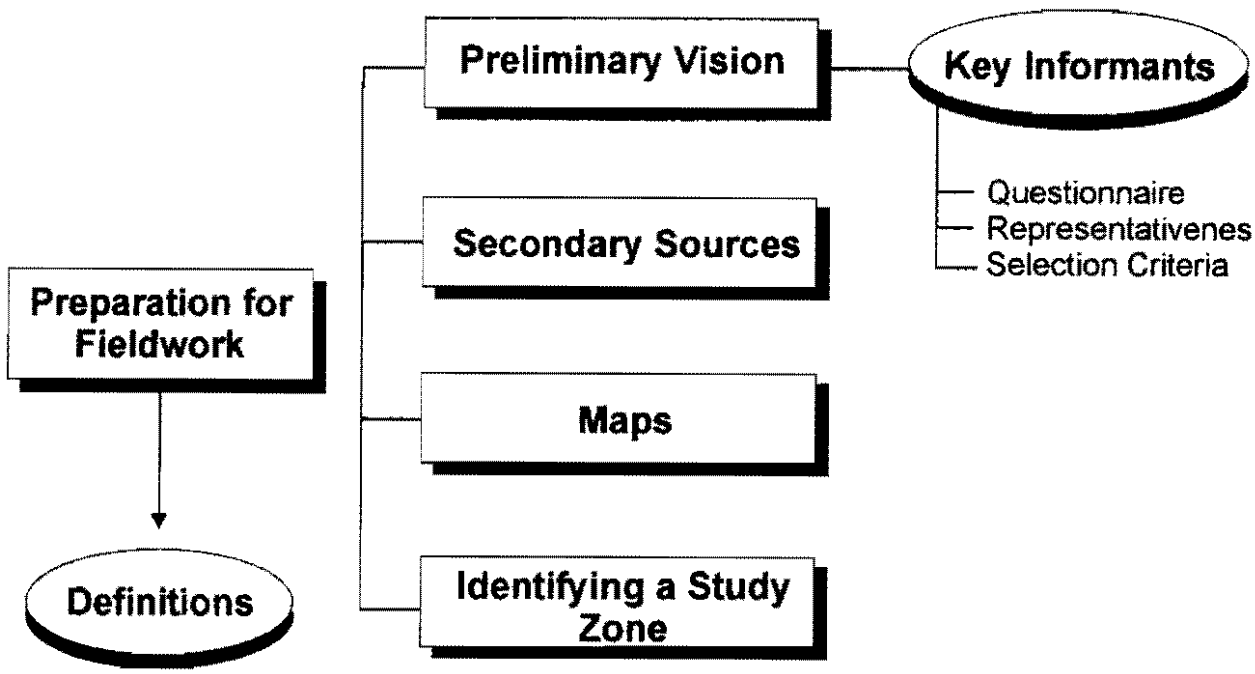
Section 1

Preparatory Steps for Fieldwork

Section 1. Preparatory Steps for Fieldwork

Page

Section Structure



Objective

- ✓ To prepare work, which will be developed in the field, with the support of secondary information, maps, and key local collaborators.

Guiding Questions

1. What information sources could you use to identify and delimit a study area?

2. How would you choose a group of people to collaborate in the process of selection, characterization, and analysis of a study area?

3. How would you take into account the perceptions and knowledge with different frequencies that men, women, old, and young have about their community and its natural resources?

1.1. Identifying a Study Area

Objective

✓ To identify a study area considering geographic, ecological, and socioeconomic aspects. The support of secondary information, key informants, and maps is required.

Introduction

You can select an area for studying natural resource management at watershed level with the support of secondary information, interviews with key informants, maps, and an exploratory workshop on natural resources.

Examples of secondary information are the reports or studies (e.g., thesis, papers) related with a particular zone or region, that include statistical data (e.g., population or agricultural censuses) and qualitative data helping obtain a first approach to a zone. Maps provide additional information about hydrography, infrastructure, topography, and vegetation or land use. The interviews with key informants of an area serve to update and correct the secondary information and widen or make more detailed the already available data.

The technical definitions of watershed that help delimit potential areas for the study can be used. With the aid of an orthophotomap or mosaic of aerial photos and a stereoscope, the limits of a watershed or that part of it known technically as the ridge can be indicated.

1.1.1. Watershed scale

A hydrographic watershed is an area drained by a stream or system of streams defined by the relief, whose waters converge to an exit point. An example in Nicaragua is the Grande River in Matagalpa.

Within the main watershed are smaller-scale systems with direct drainage to the main stream of the watershed. An example in Nicaragua is the Calico River, which flows into the Grande River of Matagalpa.

Even smaller-scale systems occur that drain directly into the main stream of a small-scale watershed. An example is the Fuente Azul Stream that flows into the Calico River.

1.1.2. Watershed: A broad and dynamic definition

The three technical definitions given above are of three scales of watershed. In these definitions, the flow of water conditions the definition of the study area. However, there are two additional key aspects for the study of natural resources at their levels.

1. Water is part of an agroecological and environmental system that is more extensive and dynamic. Taking the whole system into account makes for a better understanding of the spatial and temporal interdependencies of natural resources such as water, soil, flora, and fauna.

2. Water is also a part or component of a living space in which different social groups live and work that, in their turn, are characterized by interdependencies of a social, economic, and political nature. These interdependencies change over time and space and, further, often go beyond the technical limits defined by the flow of water. It is a space in which to coordinate and arrange actions, look for opportunities, and learn together.

This is a broader and more dynamic vision, that perceives the small-scale watershed primarily as a space of life and work that is proposed for the definition of the study area and can be called the "living microzone" (Figure 1.1.). In this Guide, the concepts of the small-scale watershed and the living microzone are synonymous.

Figure 1.1.The living microzone: A space for collective action.

1.2. Identifying Key Collaborators

Objective

✓ To identify a group of key collaborators to form a preliminary overall view of a watershed.

1.2.1. Key collaborators

To carry out the study of a watershed you need to choose a group of key collaborators or informants with a good knowledge of the zone, the community, and its history regarding the use of land, water, and forest, and the existing social and economic relationships. We recommend making one or several visits to the zone to contact local organizations that have information or that are developing relevant actions in the area. In these visits, look for support, explaining the study objective and dynamics and discussing ways of cooperation that need to be established.

To develop this activity we recommend that you have plenty of time available (e.g., a morning or an afternoon for each organization). When dealing with a small-scale watershed or community we estimate that the average time needed is a full day, taking into account the long distances and road conditions involved in travelling in rural zones.

For the interviewing, we suggest that you prepare a list with key questions such as:

1. What are the main uses of natural resources in the zone?
2. Who are the users of the natural resources?
3. What do the institutions and organizations responsible for natural resource management do (or not do)?
4. Are there problems of access, use, and management of natural resources?

The key informants may be the promoters of grass-roots organizations, among them, the members of Drinking Water Committees, or CIALs, or NGOs. In Nicaragua, for the fieldwork that served as a base for this Guide, we relied on the support of the promoters of the *Programa Campesino a Campesino* (Farmer-to-Farmer Program), the Indigenous Association of Matagalpa, the Organization of United Farmers of San Dionisio, and Assistant Mayors. Natural or religious leaders who, on the whole, know the study area well may also be included.

1.2.2. Different perspectives and complementary knowledge

For a wide perspective and to take into account different knowledge and opinions from the point of view of gender and age, we recommend that you include women, men, old, and young people in the group of key informants. The interviews can be done with mixed groups of informants or with homogeneous groups, that is, with a group of only women, or only old or young people.

Women's participation is highly important because they play lead roles in the use and management of natural resources in the field. They often know about the resources in the zone better than the men do.

Old people or "sages" are the historians and those who best know the communities. Their participation is therefore important, because they have observed the changes and can give a perspective from the past to the present.

Young people are the future, and often know their community very well because they work in the fields, carry firewood, collect water, and look for produce in the forest.

In short, the knowledge of different informants is complementary and allows for a more complete overall view of the zone.

Exercise 1.1. Identifying a Study Area: Jigsaw Puzzle

Objective

✓ To choose a study area by applying the concept of the three scales of watershed in a broad and dynamic sense using a living microzone approach.

Instructor's Guidelines

This exercise is carried out using the examples of a small-scale watershed and its subsidiaries, with a wide and dynamic perspective of the concept of watershed, taken from a study in Matagalpa Department, Nicaragua.

1. Before beginning the training, prepare the necessary jigsaw puzzles (one for every four participants) using the map model shown on page 1-14, widened to 0.70 x 1 m in size, so that groups can work comfortably. A map of the region where you wish the participants to focus their attention can also be used.

2. Divide participants into groups of four and ask them to appoint a representative (a narrator) to present the results of the exercise during a plenary session.

3. Give a jigsaw puzzle to each group. Ensure that each puzzle contains the 14 pieces that represent the living microzones of the small-scale watershed (in the case of Nicaragua, the Calico River).
A similar puzzle representing a local area familiar to the participants can be used in each region or country.

4. Ask the participants to assemble the puzzle, without telling them that it is the map of a small-scale watershed (Figure 1.2.). The puzzle should be stuck with adhesive tape to a piece of card. This is displayed where it can be easily seen.

5. The estimated time for assembling the puzzle is 20 minutes.

6. Ask the narrator of each group to present the assembled puzzle and the remarks of the group on the results of their work.

Figure 1.2. Group of participants assembling the jigsaw puzzle, San Dionisio, Nicaragua.

Resources needed

- A jigsaw puzzle for each group of four participants
- Thick card (250 g) for each group
- Adhesive tape (masking tape)
- Overhead transparency (acetate) of the map corresponding to the puzzle

Estimated time required: 45 minutes.

Exercise 1.1. Identifying a Study Area: Jigsaw Puzzle

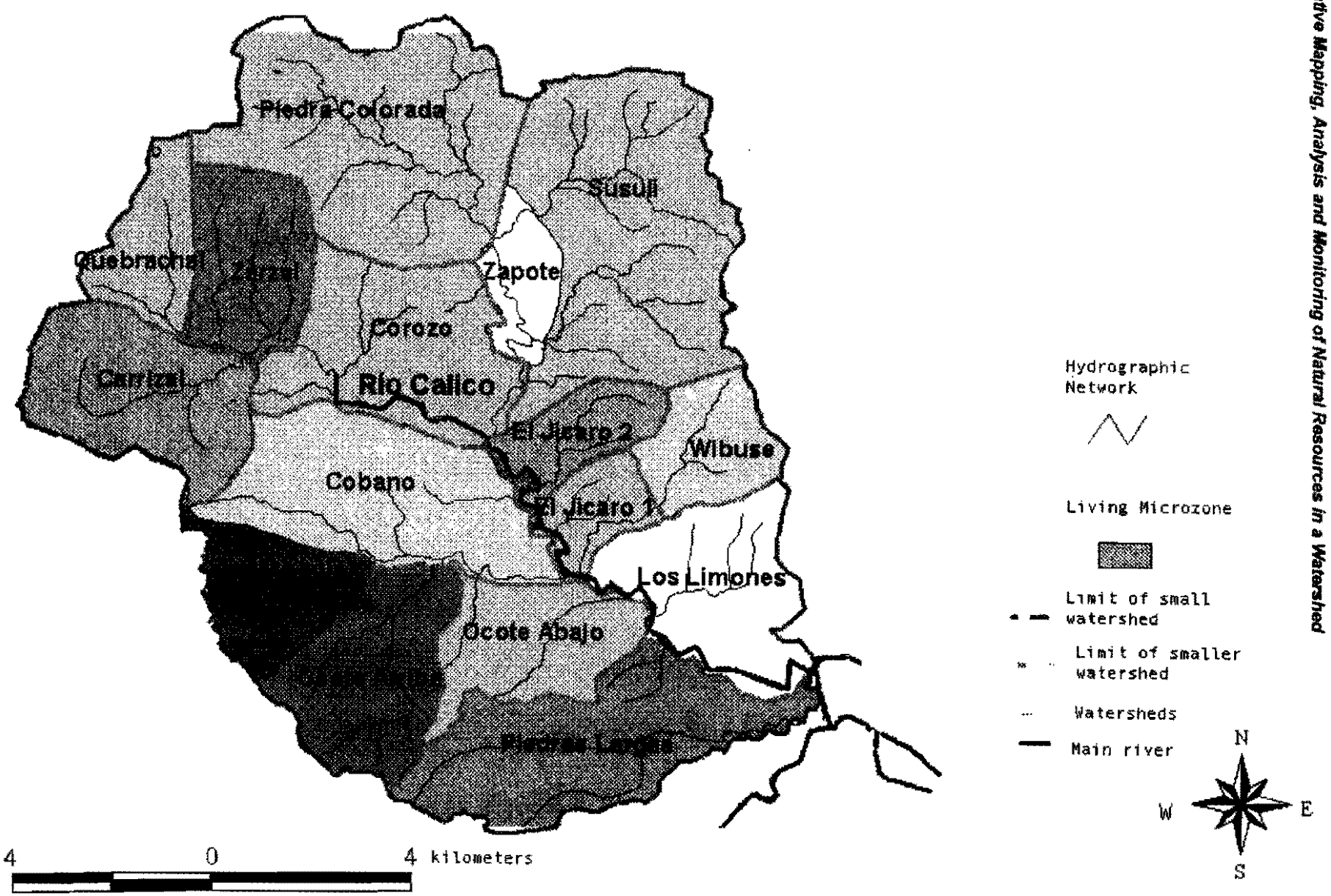
Objective

✓ To choose a study area by applying the concept of the three scales of watershed in a broad and dynamic sense using a living microzone approach.

Instructions for the Participants

- Following the instructor's guidelines, form groups of three. Appoint a narrator who will be in charge of presenting the results of the exercise in a plenary session.
- Each group will receive a jigsaw puzzle. Your task is to assemble it as quickly as possible.
- Once the jigsaw puzzle is assembled, you should stick it on card and put it on the wall where it can be easily seen.
- The group then writes down its interpretation of the jigsaw puzzle for the narrator to present in the plenary session following the exercise.
- Present your individual opinions and comments about the results obtained in this exercise.

Exercise 1.1Work Sheet for Identifying a Study Area: Jigsaw Puzzle



Exercise 1.1. Feedback on Identifying a Study Area: Jigsaw Puzzle

Instructor's Guidelines

Once the jigsaw puzzles are clearly displayed, the narrator of each group will give the results and comments on the exercise. The instructor will then:

1. Show with an overhead transparency the way in which the puzzle should be assembled, explaining that it represents the watershed of the Calico River and its 14 living microzones (or if an alternative is being used, the local watershed chosen).

2. Stress participants' remarks concerning the identification of the concept of three watershed scales and the living microzone, pointing out how these fit in the puzzle.

3. Review along with participants the concepts studied in Section 1.

4. Invite participants to answer the following question: What use is the recognition of a watershed scale?

5. Once the feedback session is finished, the instructor will collect the puzzles, putting them into an envelope and keeping them for later use.

Exercise 1.2. Identifying Key Collaborators

Objective

✓ To identify the steps and criteria for selecting key informants or collaborators for the mapping and analysis of natural resources in a watershed or living microzone.

Instructor's Guidelines

This exercise uses a real case of a small-scale watershed known by the participants or, if this is not possible, a case study can be used (see work sheet on page 1-18).

1. Divide participants into groups of four or five, preferably mixed (men and women, technicians and promoters) and ask them to appoint a narrator who will present the results of the exercise in a plenary session.

2. Explain to each group that they are members of a research team belonging to a research center interested in carrying out a study on the present state of natural resources and the changes that have occurred in their use and management over the last few years.

3. Ask each group to define the steps and criteria for the identification and selection of key collaborators who will help it obtain a detailed view of the state of natural resources in the watershed.

Allow 30 minutes to define the criteria and choose the key informants.

Resources needed

- Case study (optional)
- Cards for identifying criteria
- Markers

Estimated time required: 45 minutes.

Exercise 1.2. Identifying Key Collaborators

Objective

✓ To identify the steps and criteria for selecting key informants or collaborators for the mapping and analysis of natural resources in a watershed or living microzone.

Instructions for the Participants

1. The central task of this exercise consists of identifying a small group of key collaborators or informants, clarifying the criteria used in their selection. We recommend that you write the criteria and types of informants down on cards.

2. Following the instructor's guidelines, form a group of four or five and appoint a narrator who will be in charge of taking notes about the criteria and will present the results of the exercise in a plenary session.

3. Each group represents a research team of a center interested in carrying out a study of the present state of natural resources and the changes that have occurred in their use and management over the last few years.

4. Each group will identify a watershed known by all the participants. If this is not possible, the case study on the attached work sheet can be used.

5. The narrator will present the results of the group work in a plenary session.

Exercise 1.2. Work Sheet for Identifying Key Collaborators

Case Study

El Limon is a rural community 15 km from the municipality of Teustepe within the Timal River watershed. It is located in a hillsides zone, between 600 and 1100 m, with slopes greater than 30% in the middle and high areas. The community enjoys a drinking water service, thanks to a project initiated 4 years ago. Its access roads are in medium condition.

Its main crops are coffee in the higher areas (Limón No. 1), and basic grains in the middle area (Limón No. 2) and in the valley (Limón No. 3). Cattle farming is beginning to operate.

The area is divided into three big sectors. Limón No. 1 (highest area) is the major coffee producer. It is forested mainly with valuable timber and it supplies water for the other sectors. Most farms in this sector belong to landowners dedicated to coffee growing, which has provoked wood felling to increase the areas for this crop.

Small- and medium-scale farmers occupy the middle and lower parts. They mainly cultivate maize and beans with intensive use of agrochemicals and burning practices to prepare the land. In the last few years, these practices have increased, with some sites showing the effects of soil erosion represented by low yields of crops, increase in temperatures, and also poisoning symptoms in some farmers. The latter is worsened by using the water sources of fumigation pumps containing the remains of agrochemicals for washing.

Over the last 2 years a decrease in the flow of the main river has been observed, and also in the supply capacity of the drinking water project for the three sectors.

Recently some landowners located in the higher area are negotiating a contract with a company for extracting valuable wood and they are approaching the Ministry of Natural Resources for the respective permission.

Because of this situation most of the inhabitants showed concern about protecting natural resources in their community. This encouraged them to form a Community Action Committee represented by community leaders, the municipal Mayor, and representatives of projects that work with the community in the conservation and protection of natural resources.

Exercise 1.2. Feedback on Identifying Key Collaborators

Instructor's Guidelines

Once the narrators have presented the results of the exercise, make a synthesis of the criteria, emphasizing the following points:

- No single formula or recipe exists for the selection of key collaborators. A lot depends upon the local situation.
- However, it is important that the selection of key collaborators is not biased; that is, only including a particular type of people. It should include men and women, producers running operations of various sizes, people living in different places within the same community, and members of various organizations.
- For the case study, the selection of key collaborators may include:
  - A landowner, in order to have his opinion on wood felling and the protection of water sources.
  - One or several small-scale producers to understand their perspective regarding intensive land use.
  - A member of the Community Action Committee to know the actions they expect to develop.
  - A delegate of the Ministry of Natural Resources to know the government point of view and existing laws.
- Further, it is important to have enough time to get to know the community and, later, know it in detail.

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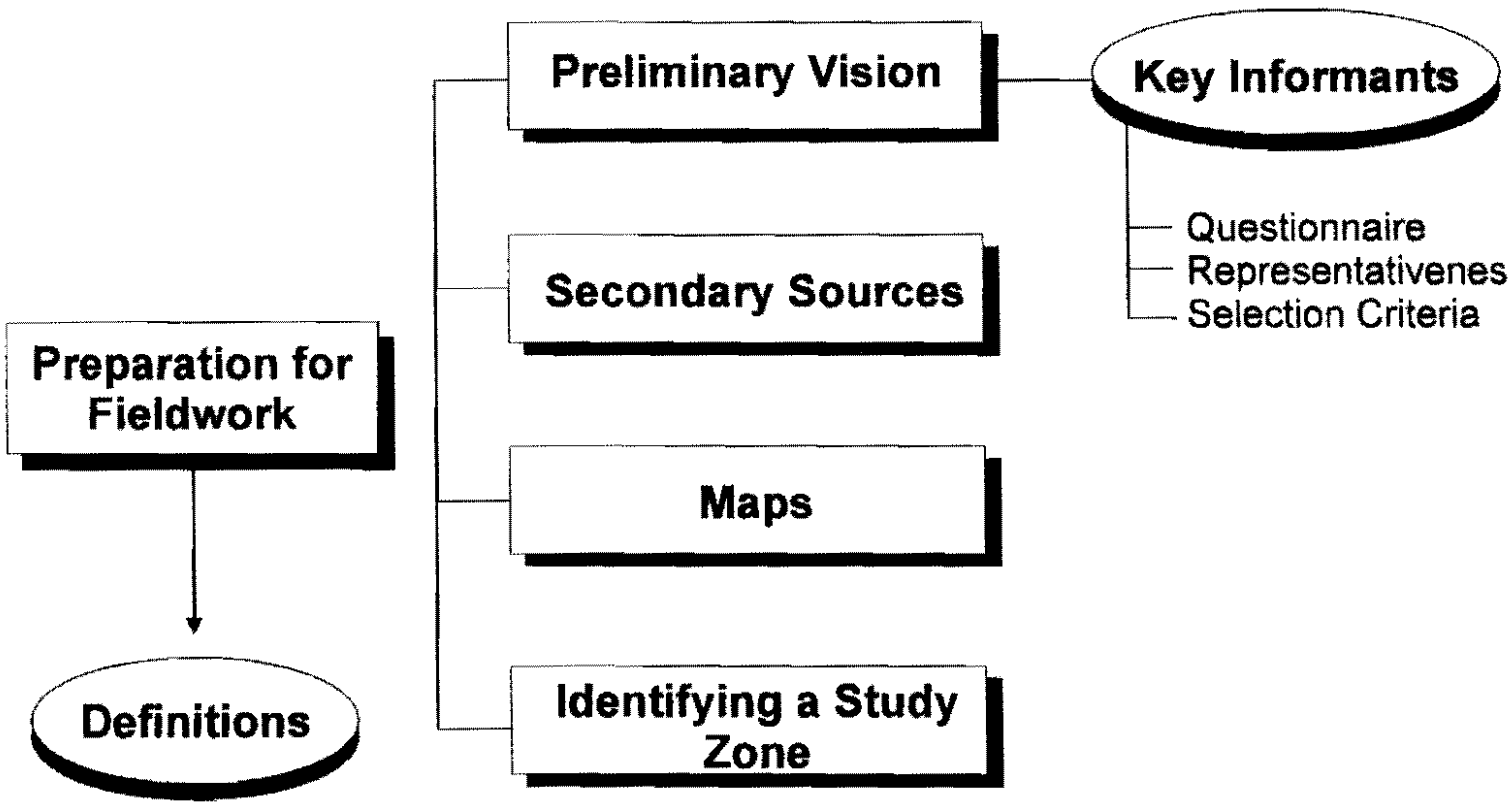
SECTION STRUCTURE



SECTION OBJECTIVE

- ✓ To prepare work, which will be developed in the field, with the support of secondary information, maps, and key local collaborators.

GUIDING QUESTIONS

1. What information sources could you use to identify and delimit a study area?

2. How would you choose a group of people to collaborate in the process of selection, characterization, and analysis of a study area?

3. How would you take into account the perceptions and knowledge with different frequencies that men, women, old, and young have about their community and its natural resources?

MICROZONE OF LIVING

It is a space:

- Where water is part of an agroecological and environmental system that permits us to better understand spatial and temporal interdependencies of natural resources (soil, flora and fauna)
- Of life in which
- To work, concert, and coordinate actions;
- Look for develop opportunities; and
- Learn together.

A SMALL-SCALE WATERSHED

Is a water-producing zone that drains directly to the main stream of the watershed. An example in Nicaragua is The Calico which flows in the River, of Grande Matagalpa.

EVEN SMALLER-SCALE WATERSHED

These smaller drain directly into the main stream of a small-scale watershed.
An example in Nicaragua is the Fuente Azul Stream tha flows into the Calico River.

IDENTOFYING A WATERSHED OR A SMALL-SACLE WATERSHED HELPS US TO:

- Identify the area or interest
- Have a clearer and more concret vision when we make decisions

CRITERIA FOR THE SELECTION OF KEY COLLABORATORS

No single formula or recipe exists for the selection of key collaborators.

It is important that the selection of collaborators is not biased.

It should include:

- Men and women
- Producers with farms of different size
- People living in different places in the community
- Members of different organizations

THE SELECTION OF KEY COLLABORATORS MAY INCLUDE :

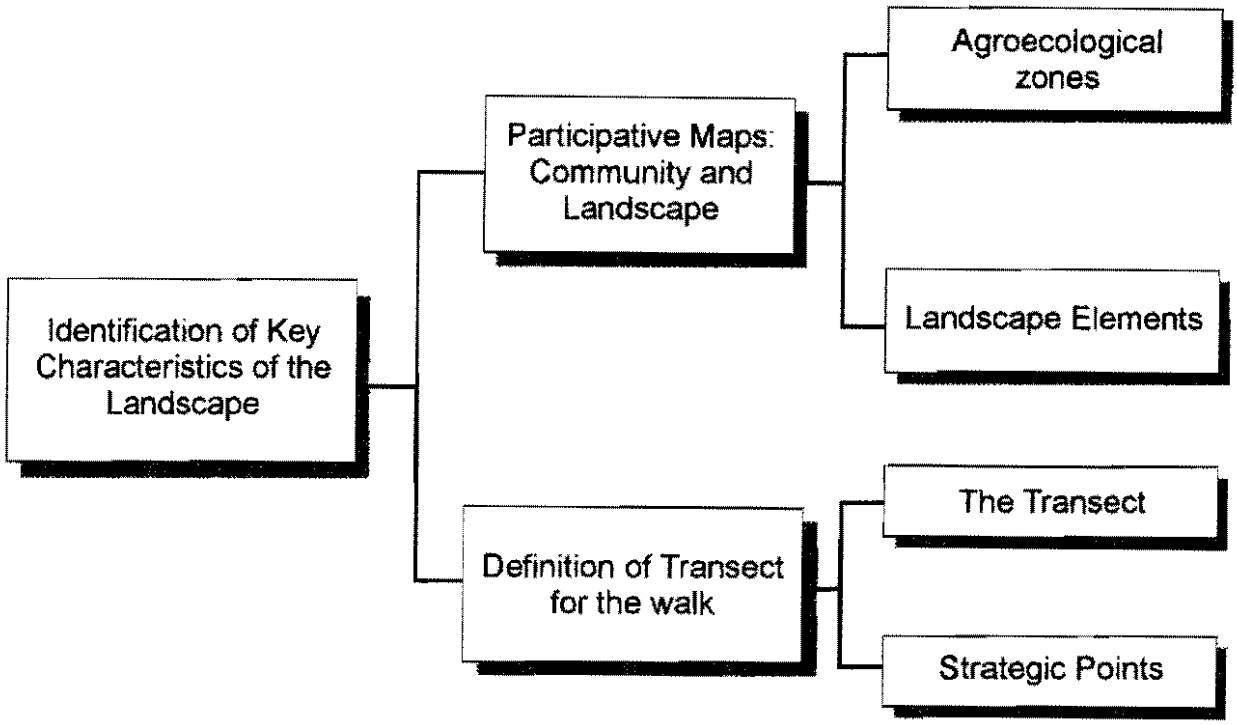
- A landowner
- Several small-scale producers
- A member of the Community Action Comittee
- A delegate of the Ministry of Natural Resources
  (to know the government point of view and existing laws)

Section2

Key Characteristics of the Landscape

Section 2. Key Characteristics of the Landscape

Section Structure



Objective

✓ To identify the key characteristics of the landscape through a traverse on foot or walk with the support of a participative map of the watershed and other available maps (e.g., orthophotomaps)

Guiding Questions

1. With what types of maps are you familiar and what type of information do they contain?

2. What uses may these maps have?

3. How could you visualize the knowledge that local inhabitants have about their environment?

2.1. Drawing a Participative Map of a Watershed

Objective

✓ To orient local inhabitants (key informants) in drawing a map of the watershed or living microzone.

2.1.1. Participative maps of the watershed and the landscape

Once the key informants have been chosen, the field visit is organized to elaborate the map of the watershed and its natural resources. The visit begins with the drawing of a map of the space of life and work defined as the "living microzone" (small-scale watershed), elaborated by the key collaborators or informants. The objective of this exercise is to specify on a diagram or drawing the ideas and knowledge that the inhabitants have about the space and resources. This is a time-consuming activity; therefore, we suggest keeping a whole morning or afternoon for its execution.

This practice requires the participation of various people, who together will build up the map (see Figure 2.1.). They discuss the location of parts of the landscape, asking one another, for example, where the borders of the zone or community are and how the main streams flow. In other words, they take an imaginary journey through the space of the chosen area.

Figure 2.1.Key informants elaborating the map of a living microzone.

However, it must be pointed out that often men can more easily make the traverse through the region and elaborate the community map (see next section). The reality also is that men mostly work as promoters, assistant mayors, and members of base committees. When women cannot be included in the traverse or directly in the diagnostic, then fieldwork results should be validated with them.

2.1.2. Agroecological zones

The drawing of a map allows us to know the space better and to help define, always with key informants' participation, whether the community or watershed has a single zone or different agroecological zones. This zoning allows the later determination of the transect to be made with key informants to observe on-site the landscape characteristics and the changes occurring, for example, from the highest to the lowest area of the zone.

2.1.3. Landscape elements

The drawing of a map begins with delimiting the zone according to local criteria. It also includes the hills or mountains, roads and paths, rivers and streams, schools, churches, health centers, coffee-producing areas, farms, the owners' names and the number of *manzanas* they own, the main production systemsbasic grains, coffee, livestock, vegetables, riceand perhaps an agroecological zoning. Those not owning farms are marked down as plot holders A key should be included with the map and geographic north indicated.

If you have access to an orthophotomap of the study area (see Figure 2.2.) it can be used as a reference guide because it shows a global view of the landscape, particularly in regard to elements of interest such as roads, forested areas, and farming plots.

You can repeat the drawing of a participative map over time to visualize the changes that have occurred caused by natural phenomena and man's intervention.

2.2. Selecting the Transect for Traversing

Objective

- ✓ That participants are able to choose the transect/s for a traverse across a small-scale watershed to observe, accompanied by local inhabitants, the state of natural resources.

2.2.1. Transect for the traverse

The transect, or path to be traversed on foot, across the zone is also identified on the map. The ideal transect should go through the different agroecological zones, from the highest to the lowest part and crossing through the different production systems or land uses. It also allows the characterization of each agroecological zone on a diagram (see Section 3).

1 mz (manzana) = 0.7 ha (80 m^2).

Figure 2.2. Part of an orthophotomap of the Calico River watershed, San Dionisio, Matagalpa (Nicaragua).

The transect that is chosen must go through key points of the landscape representing typical uses or problems of the area (Figure 2.3.). For example, a key point might be a place where coffee washing contaminates the community stream. Another example might be a place where latrines are situated near the community's source of drinking water.

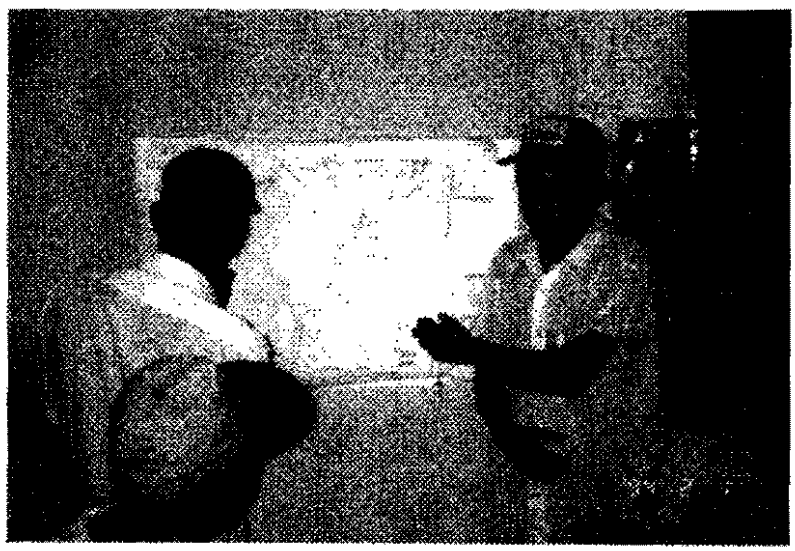


Figure 2.3.Transect drawing during a training workshop.

2.2.2. The strategic points

We further recommend that you include in the transect the strategic points from which a wide view of the zone is available. These points can also serve for the diagnostic (see Section 3). Usually, these key, strategic points are not necessarily near the main road or path.

If a particular interest in a natural resource exists (e.g., water), an additional transect can be drawn according to relevant criteria.

This will be the first time that many of the informants have drawn their living space. Thus they may pick up the pencil a little nervously, but experience has shown us that once they draw the first lines, they gain confidence and realize that they too can draw a map. We recommend that you do not pressure those doing the drawing, but encourage them, and if necessary, support them (e.g., helping them start the map).

Exercise 2.1. Facilitating the Drawing of a Participative Map

Objective

✓ To orient local inhabitants in drawing a watershed map in a participative way.

Instructor's Guidelines

1. Divide the participants into groups of four. Three of each group assume the role of key informants and the fourth is the facilitator. Preferably the groups should be mixed, with men and women.

2. Explain the objective of the exercise. Each group will draw a map of a community previously known by the informants. Ask each group to appoint someone to draw the map.

3. The map should show the roads and paths, rivers and streams, water sources, infrastructure (schools, health centers, churches, etc.), main crops, forested areas, and protected zones.

4. Ask the informants to also evaluate their facilitator's performance once the exercise is completed.

5. Delegate to the facilitator the tasks of explaining to the informants the aim in drawing the map and of facilitating that all participants in the group contribute. The facilitator is also asked to note informants' interactions.

6. When the maps are ready, display them where clearly visible for a later review by the participants. Each group can quickly present its map, pointing out the elements that they drew. If the maps are very different, we suggest you discuss the reasons for this.

7. Ask for remarks on the process to be presented, first by the facilitator and then by those who did the drawing.

8. Allow each group 1 hour for the exercise.

Resources needed

For each group

- A flip chart
- A set of markers of different colors
- A work table
- An example of a participative map (see Work Sheet)

Estimated time required: 1 hour 30 minutes

Exercise 2.1. Facilitating the Drawing of a Participative Map

Objective

✓ To orient local inhabitants in drawing a watershed map in a participative way.

Instructions for the Participants

1. For the key informants (also doing the drawings): to elaborate a participative map, choose a watershed well enough known by everyone in their work zone. If you cannot choose a real watershed, we suggest you first elaborate a brief profile of a fictitious watershed including elements such as the landscape (flat or hillside topography), roads and rivers, water sources, important constructions, and production systems. The key characteristics of this profile may be written down on a flip chart.

Next, draw the watershed according to the facilitator's instructions. It is also important to take notes about the facilitator's performance. These will be used in the evaluation of the facilitator's role once the map is completed.

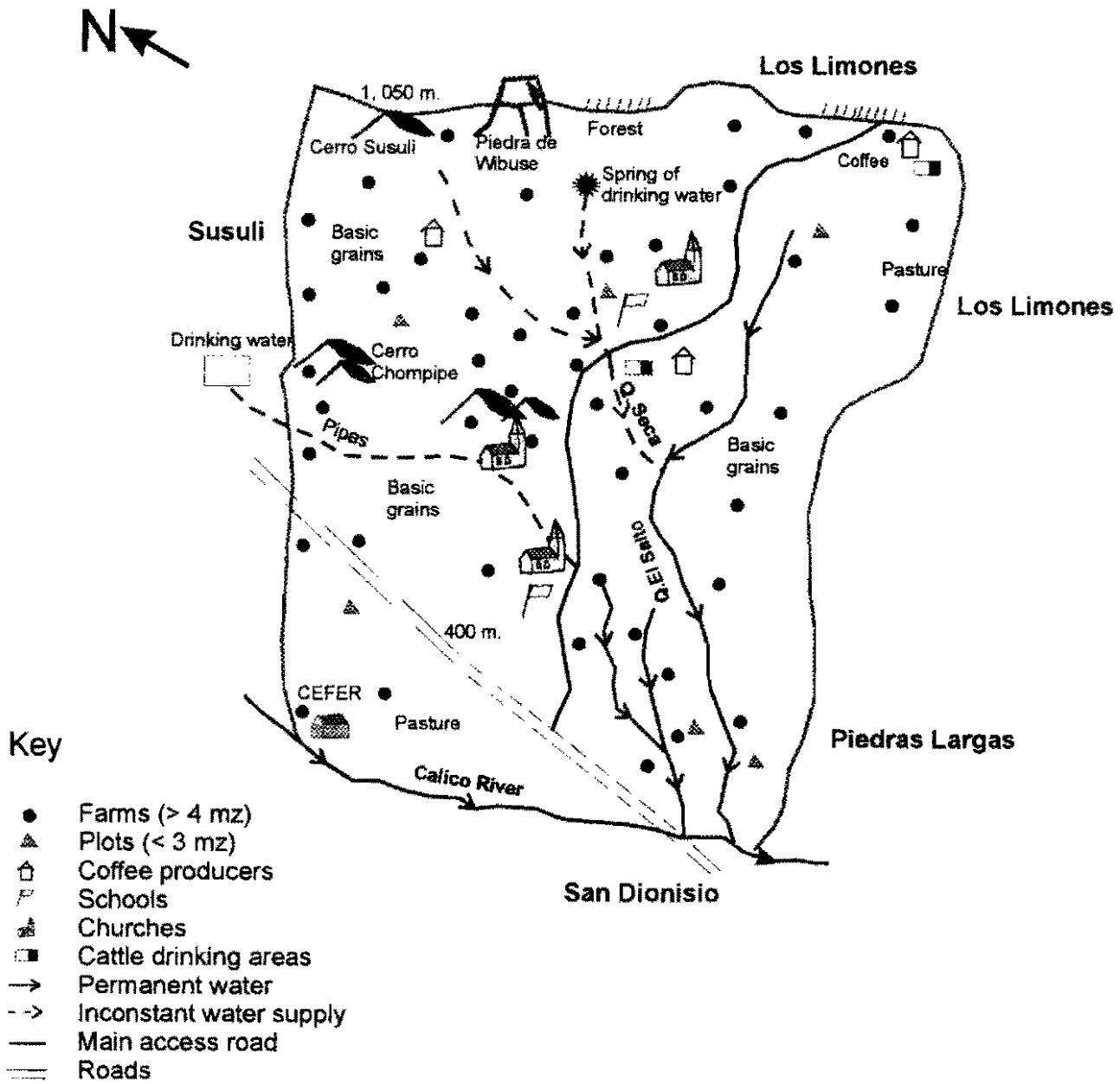
2. For the facilitator: explain to the key informants the objective of the activity and help in drawing the participative map, which should include the most important components of the landscape, the infrastructure, and the production systems.

Note down the times you consider necessary to support those drawing indicating the reason for your intervention.

3. Present the participative map and remarks in a plenary session.

Exercise 2.1. Work Sheet for Facilitating the Drawing of a Participative Map

Participative Mapping of Wibuse-El Jicaro, San Dionisio, Matagalpa, Nicaragua.



Exercise 2.1. Feedback on Facilitating the Drawing of a Participative Map

Instructor's Guidelines

As previously indicated, the instructor shares with participants the remarks about the exercise results, making reference to the maps and the interactive process used in their drawing. The instructor can also use the participative map example elaborated in Nicaragua (see Work Sheet). This map represents one of the 14 microzones of the Calico River watershed (see also Exercise 1.1.).

- Check that all the key elements were identified in the participative mappings. If one or more elements were omitted, the reasons for this should be discussed.

- Review with the group the following points that represent situations that can arise in the drawing of a map, and that require the facilitator's intervention:

  - The participants feel very insecure at the beginning of the session and do not want to take the initiative. In this case, the facilitator explains that each participant can draw a part of the map and the person who can draw the best should begin this task.

  - The participants do not know how to begin the map. The facilitator explains that they can start by drawing the rivers, roads, or the community borders in order to outline the map.

  - Not everyone is participating in the exercise. The facilitator asks that the markers be given to the person who is not participating. Also, participation may be encouraged with questions addressed to the quieter participants.

  - Participants go into great detail to make a highly detailed map. The facilitator asks them to concentrate only on the key or essential characteristics.

- Remember that the map drawing is an activity of the group of informants and not of just a single person.

Exercise 2.2. Drawing a Transect

Objective

✓ To define and draw a transect for the traverse through the community.

Instructor's Guidelines

We suggest you carry out this exercise with small groups (four participants). The participative map of Wibuse El Jícaro can be used.

1. Explain to informants that the task consists of defining and drawing, with the facilitator's support, one or several transects on the community map, previously elaborated.

2. The selection criteria of each transect should be explained. They may be noted down on a separate sheet or card.

3. Explain that the ideal transect should go through the different agroecological zones, starting from the highest to the lowest part and crossing through the different systems of exploitation or land use.

4. Give the facilitator the task of explaining to informants the objective of drawing the transect and of facilitating that all participants contribute to the exercise.

5. In addition, ask the facilitator to take note of the informants' interactions.

6. Remember that this is an activity of the informants' group carried out with the facilitator's support and not the work of just a single person.

7. When the transects are ready, put the maps back on display where they can be clearly seen and review them with the participants.

8. Ask each group to quickly present its transect, pointing out the selection criteria. If there are any doubts, clarify them with the whole group.

9. Also ask for remarks on the process, first by the facilitator and second by those who did the drawings.

Resources needed

For each group

- A map
- Markers
- Cards or a flip chart
- Onionskin paper
- Participative map Wibuse-El Jícaro as model

Estimated time required: 1 hour 30 minutes

Exercise 2.2. Drawing a Transect

Objective

✓ To define and draw a transect for the traverse through the community.

Instructions for the Participants

1. Following the instructor's guidelines, form mixed groups of men and women, professionals and promoters.

2. In each group, appoint someone to draw the transect on the map. Appoint someone else to note down the criteria that will be used for the drawing and that will be presented in a plenary session. Appoint a third person to observe exercise dynamics and present remarks in the plenary session.

3. Each group will work with the participative map, previously elaborated in Exercise 2.1. or with the participative map of Wibuse-El Jícaro.

4. Take a sheet of onionskin paper to draw the transect. Quickly review if the map shows the main roads, rivers and streams, water sources, main constructions (e.g., church, school), and the production systems.

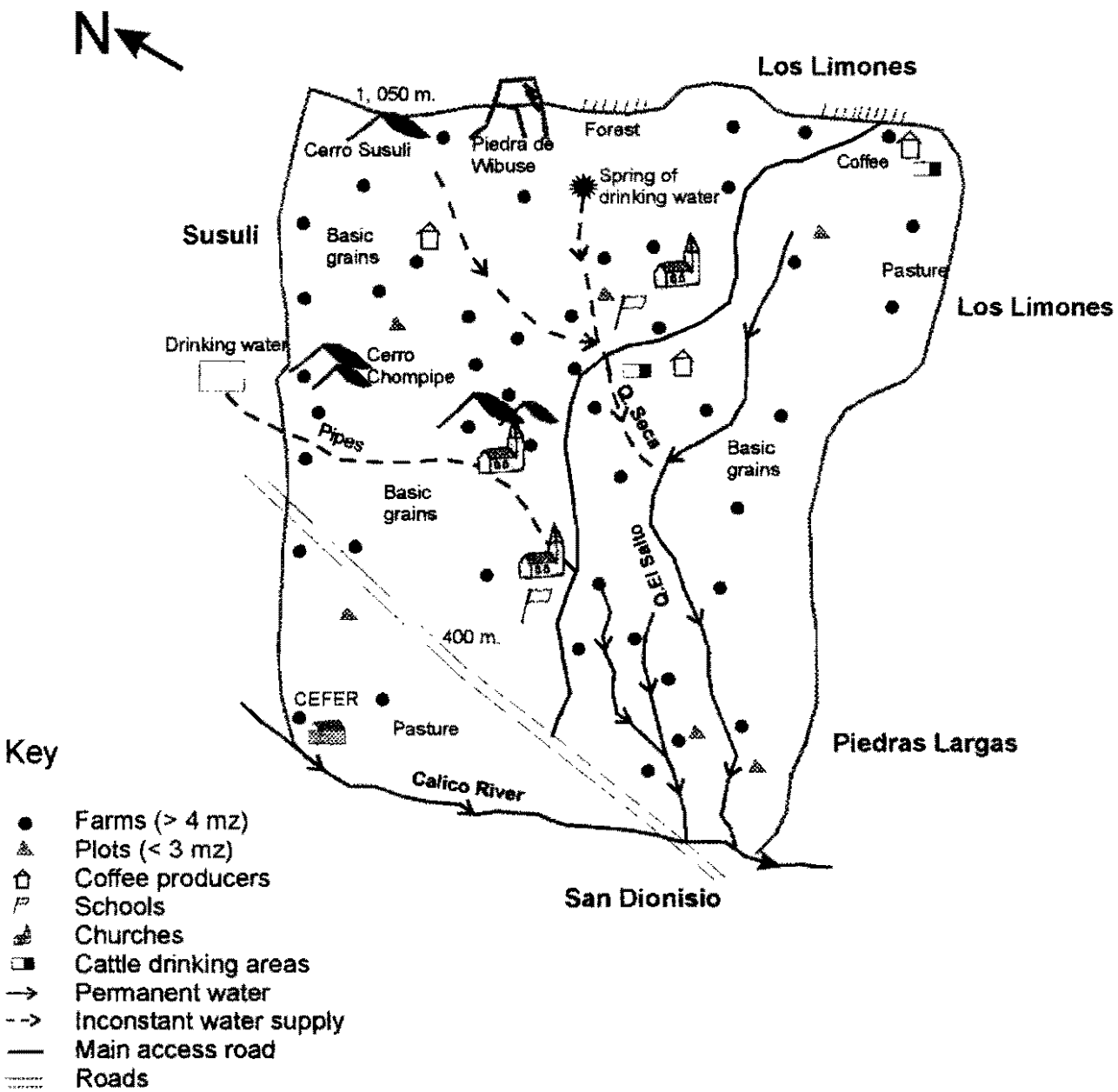
5. Each group will interview the key informants again. Your task is to define, with their participation, the criteria for the drawing of a transect across the watershed. Later, the transect may be used for making a traverse and a diagnostic about the state of the watershed's natural resources. Draw the transect on the onion-paper sheet and, lastly, return with the group to the plenary session.

6. In the plenary session, the narrator of each group will present the map, the transect, and the criteria used for its drawing.

Exercise 2.2. Work Sheet for Drawing a Transect

Participative Map of Wibuse with an identified transect: El Jícaro village, Municipality of San Dionisio, Matagalpa Department, Nicaragua

The transect begins at the top of the watershed passing through areas of forest and coffee cropscoffee washing is also donehere the streams have their sources and there is an important source of drinking water. Next the transect crosses the middle part characterized by plots and small-scale farms producing basic grains. At the bottom the transect crosses a zone of pastures reaching as far as the Calico River.



Exercise 2.2. Feedback on Drawing a Transect

Instructor's Guidelines

As previously mentioned, the instructor shares with the participants the remarks about the exercise results, particularly the criteria used for the transect selection. Also referred to is the interactive process carried out in drawing the transect.

- Verify that the transects include all key elements of a watershed that have been identified on the map. If one or more elements were omitted, the reasons for this should be discussed.

- Once more review with the group the following points that represent situations that can arise in the transect drawing and that may require the facilitator's intervention:

  - The participants do not know where to begin the transect. The facilitator explains that it can be started at the highest point of the community.

  - Not all the participants take part in the exercise. The facilitator may ask questions addressed to those not participating.

  - The participants become involved in long discussions about transect details. The facilitator should intervene and ask them to concentrate only on the key or essential characteristics of the map to define the transect. Another alternative is for the facilitator to propose drawing two transects and enumerating the criteria for both.

- Make remarks on the dynamics of the exercise, referring to the interaction between key informants and the group, the participation, and the decision making on the criteria chosen.

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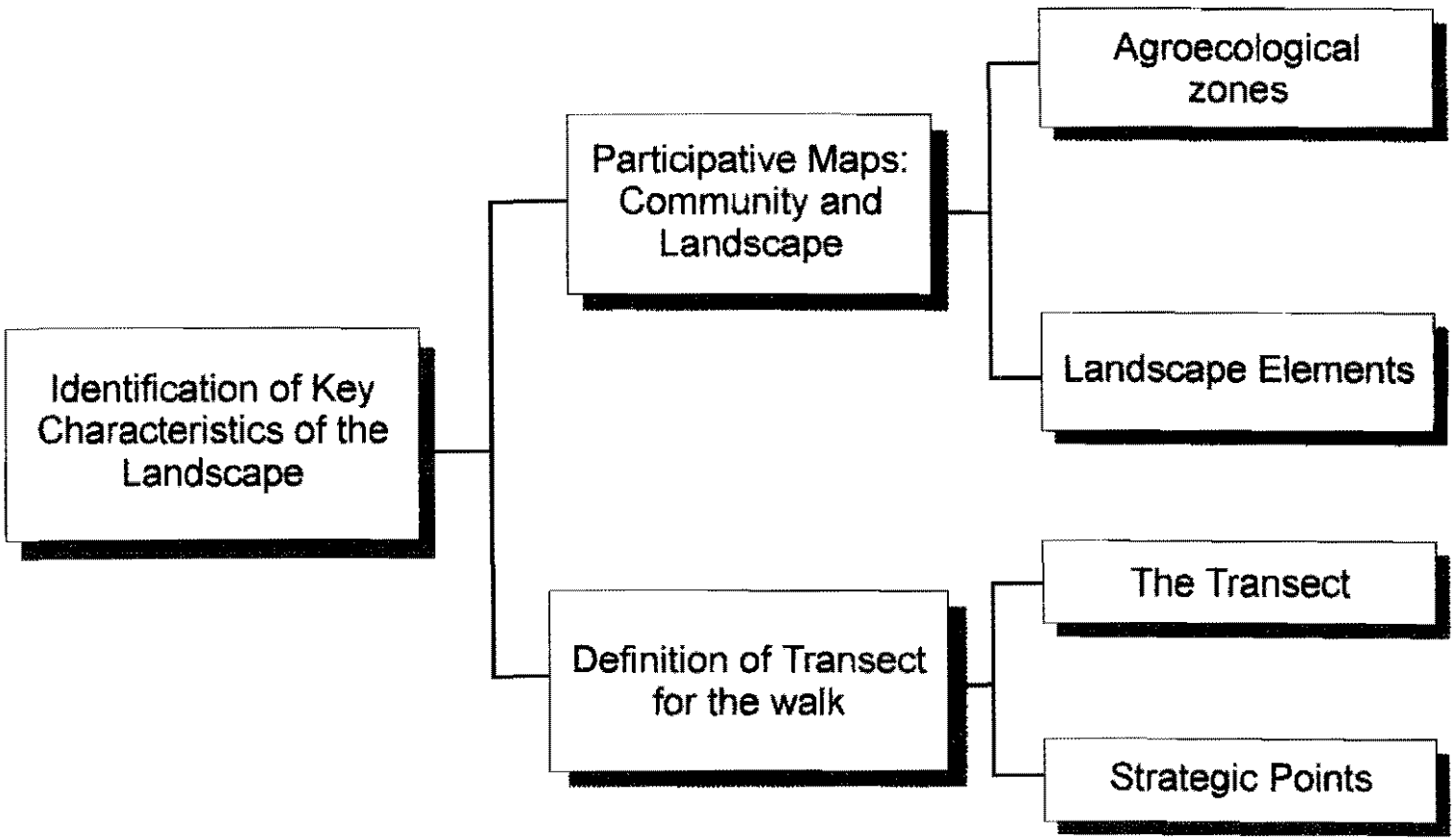
SECTION STRUCTURE



OBJECTIVE

To identify the key characteristics of the landscape through a traverse on foot or walk with thw support of a participative map of the watershed and other available maps. (E.g. Orthophotomaps)

GUIDING QUESTIONS

1. With what types of maps are you familiar and what type of information do they contain?

2. What uses may these maps have?

3. How could you visualize yhe knowledge that local inhabitants have about their environment?

FREQUENT SITUATIONS OCCURRING IN THE DESING OF A PARTICIPATIVE MAP

- Not everyone participates in the exercise.
- Partcipants feel very insecure at the beginning and do not want to take the initiative.
- Participants do not know hao to begin the map.
- Participants go into great detail to make a highly detailed map.

FREQUENT SITUATIONS OCCURRING IN THE DESIGN OF A TRANSECT

- Participants do not know where to begin the transect.
- Not all participants take part in the exercise.
- Participants become involved in long discussions about transect details.

THE TRAVERSE

Includes:

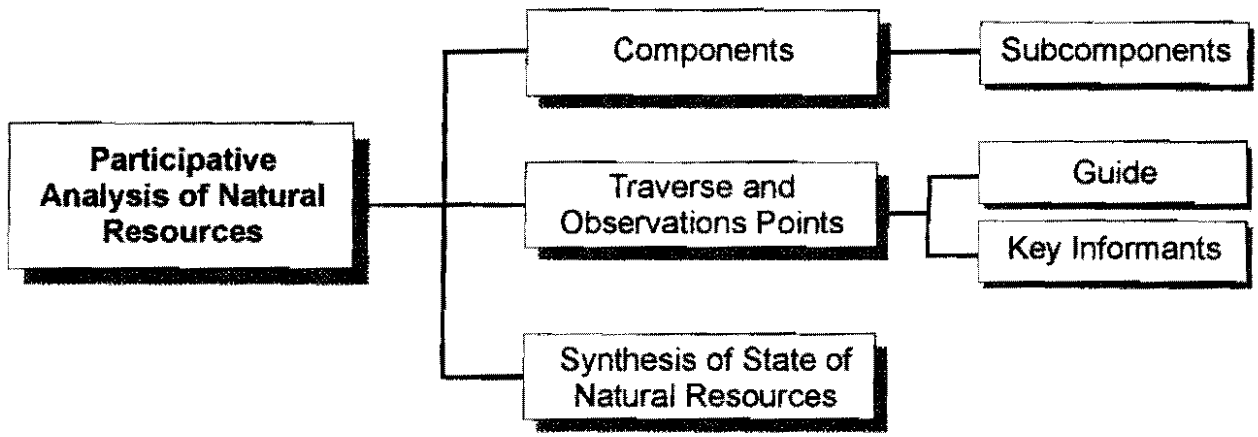
- On-site observations
- Local knowledge
- Diagnostics of each natural resource
- Participative mappings
- Air Photos
- Maps on details such as altitudes, topography, and types of soil.

Section 3

Participative Analysis of Natural Resources

Section 3. Participative Analysis of Natural Resources

Section Structure



Objective

✓ That participants be able to carry out an analysis of the natural resources of a watershed using a set of biophysical and socioeconomic components.

Guiding Questions

1. What are the most important natural resources in the watershed?
2. How can you tell the state of the natural resources in a watershed?
3. What factors influence the present state of natural resources?

3.1. Participative Analysis of Natural Resources

Objective

- ✓ To identify a set of components representing the problematics of access, use, and management of natural resources in a watershed.

Introduction

The watershed map, the maps produced by GIS tools, the data, and the traverse provide an overall view of the community and its natural resources, and permit the identification of agroecological zones within the area. Above all, these data facilitate knowledge of the landscape and the resources.

This overall view needs to be complemented with a qualitative diagnostic of natural resources that allows a thorough knowledge of the state of each, individually or jointly. This diagnostic is carried out as part of a traverse through the watershed or study area.

For this qualitative diagnostic a general framework or perspective of natural resources and their use needs to be elaborated, covering all the larger-scale watershed to which the smaller-scale watershed or living microzone belongs. Although this framework may be different by region, we present here an example of a set of components for the participative diagnostic considered relevant in different regions: water, forest, crops, yields, soils, wild and domestic animals, pastures, advantages and limitations, land ownership, presence of organizations, programs or projects, and conflicts.

According to the local conditions, additional components may be defined or those considered irrelevant eliminated. (The most important point is to have available a set of components that represent the state of natural resources at local level).

At the same time, this set of components facilitates comparison among communities and watersheds.

3.2. Guide for the Analysis of Natural Resources

Objective

✓ With the support of the information collected in the participative mappings and the traverse across the watershed, to carry out a participative analysis making use of the set of components identified.

For the analysis, answers need to be found for a series of questions about the present condition of the resource and about the changes observed over time. It is of interest to gather and document the knowledge and remarks of key informants. You also need to have available concrete data, both of quantitative and qualitative type. With this aim, the guide may include a combination of open and directed questions. In addition, it may include a series of questions with predefined answers, in the form of a sampling. An example of a guide for the sampling on natural resources is found in Dvorak and Jimenez (1997).

It is important that the guide is structured in a detailed and clear way to avoid confusion about the subcomponents and the questions asked. Above all, it should be a guide that allows the standardization of the information.

3.2.1. Components and subcomponents

- **Water**

Identify and record the rivers, streams, small lakes, water sources (springs, wells), and the drinking water systems existing in the zone (Figure 3.1.). For each family, describe the different uses of water: domestic, irrigation, for animals and coffee washing, the quality (color, taste); the availability per inhabitant or family; distribution and its problems. If fishing is an important activity, identify the technological characteristics: type of fish, number of families involved in fishing, and the impact of this activity on the environment.

- **Forest**

Identify the forested zones and, if possible, determine their total surface. If no forested zones exist, find out the reasons for their disappearance; also, find out if any reforestation projects are being developed. Identify the most common tree species (native or introduced), the missing species, and those in the process of extinction. Identify forest species for medicinal use and how they are used, their quantity and quality. Find out the quantity and quality of firewood available for the zone's inhabitants and, if the forest is exploited for commercial and domestic purposes, note down the type of wood exploited and the quantities.

- **Land use**

Take down information about access and types of land ownership, and the amount of exploitation per family or home, indicating whether lands are national, state, communal, indigenous, or private. Identify land quality.

Figure 3.1.Informants checking on a water source.

- **Crops**

Identify the main crops of the area, their location, and the total area planted as a percentage of the total cultivated area. Also identify crops of minor importance and those new or recently introduced, with their area and condition. If no native varieties are found, ask the reasons for their disappearance.

- **Animals**

Identify types of animals and productivity, especially bovines, poultry, pigs, ducks, and all animals found on the farm; also identify the presence of wild animals. If the latter have disappeared, find out why. Identify the types of products provided by the animals (milk, meat, eggs, etc.) and their contribution to family income.

- **Pastures**

Identify the area and type of pastures in existence and their present state. Estimate the average number of animals per unit area (*manzana* or hectare). Identify the improved pastures and their use. If they are in poor state, find out the causes of their degradation.

- **Soils**

The soil is a main resource for food production (Figure 3.2.). To know the actual fertility of soils in detail, we recommend consulting the list of indicators of soil quality (Technical Annex 7.1., list adapted from Burpee and Turcios (1997).

Figure 3.2.Informants taking soil samples.

- **Yields**

The yields per unit area of the main crops (maize, bean, sorghum, and coffee) are useful indicators for knowing the soil's present state. Find out the actual averages of the yields and the averages of 5 or 10 years ago to know if any changes have occurred. If significant changes are observed, find out the causes, for example, if the use of agricultural inputs or seeds type and quality have changed.

- **Presence of organizations, projects, or programs**

Being aware of community organizations, NGOs and government entities present in the zone is important. It is also useful to know what type of initiatives they develop, if a means of coordination exists, and how inhabitants are involved in these activities.

- **Conflicts**

The problems of access, distribution, and use of natural resources may give rise to conflicts among communities, groups within a community, or the community and municipal or government authorities. It is important to know if this type of conflict exists. However, it must be pointed out that in a diagnostic carried out with the support of several people it is not always possible to discover if conflicts exist. The key informants may prefer not to mention these issues. Thus other methodological techniques are needed to find out and discuss this issue (see for example, Guide No. 4 of this series, Methodology of Analysis of Groups of Interest for the Collective Management of a Watershed.

- **Limitations**

Every agroecological zone has advantages and disadvantages or limitations. In each identified zone, find out the difficulties the producers face with crops. Limitations may be biophysical (access, climate, precipitation), economic (markets, credit, lack of farming land), social (migration of young people to cities), or political (presence of armed groups). If possible, quantify the number of people or families affected. In the case of several limitations, we suggest you prioritize them to know the problem most affecting the population.

- **Advantages**

Advantages may also be biophysical, economic, social, or political in nature. In each case identify the existing opportunities.

The results obtained from the analysis of the components, together with the information of secondary sources (reports, maps, etc.), allow the identification of indicators for each element. These indicators can be used for monitoring both the natural resources and the impact of concrete actions that purport to improve resource management. Further, the indicators allow us to compare the state of natural resources in different watersheds or living microzones.

Section 4 presents the topic of indicators.

3.3. The Traverse and Observation Points in the Watershed

Objective

- ✓ To identify on site the representative places of natural resources' use, the associated problems, and the existing opportunities.

The traverse by the transect across the watershed and the different agroecological zones, allows us to observe the resources' uses on-site, the associated problems, and the existing opportunities. At the key points of the landscape already defined on the transect, specific aspects can be discussed with the informants, validating their knowledge of the landscape, asking about the situation in the past and how it could be in the future. Here the facilitator plays an active role in constructing the diagnostic.

These observation points are located on the map to complete the landscape view. If you have access to an altimeter or a global positioning system (GPS), the correct altitude and geographic coordinates may be noted down (latitude and longitude).

3.3.1. The photographs

You can also take pictures of the landscape that may serve for making comparisons between the present and future state of natural resources and serve, in addition, as points of reference for monitoring the changes over time. Later, the photographs can be used as teaching material in training events. A "Polaroid"-type camera facilitates immediate use and analysis of photos. Note down the places of where pictures are taken and the characteristics of each place.

During the traverse, soil samples can also be taken at representative points that can be analyzed on-site with the help of a list of indicators of soil fertility (Annex 7.1.). Also, samples may be sent to the laboratory for a more detailed analysis of fertility.

3.3.2. Listening to key informants' impressions

The traverses on foot are useful for knowing a community or watershed in detail, both for the facilitators and the informants.

Probably this will be the first time that many of the informants walk across a transect of the zone where they live and work, discovering new elements in the landscape, and observing interdependencies among the different parts or microzones. We recommend that you take note of informants' impressions about the traverse in order to know how they perceive it and if they have learned anything new.

Also, during the traverse the diagnostic of natural resources is carried out with the study guide for support.

Exercise 3.1. The Traverse and the Participative Diagnostic of Natural Resources in a Watershed

Objective

✓ Following a transect through the watershed, to recognize and analyze in the company of key informants the present state of natural resources.

Instructor's Guidelines

A. Preparation prior to the practical

1. Select two small-scale watersheds that permit a global diagnostic of natural resources.

2. Identify a small group of key informants or collaborators for each of the communities or microzones that are willing to facilitate the field practical of the participants.

3. Train the informants about their role in the field practical.

4. Inform other members of the watersheds about the practical that will be carried out as part of the training.

5. Agree on a suitable date and hour for the practical.

6. Agree on a place to meet with the participants for the start of the practical.

7. Request the required permissions for visits to producers' farms.

B. Preparation for the traverse

1. Divide the group of participants into two groups, preferably of mixed nature (men and women).

2. Ask each group to appoint a coordinator and an observer. The coordinator will be responsible for explaining the practical's objectives to informants, supervising its steps, and controlling the time spent. The observer will take note of group dynamics, that is, the interactions between informants and participants and the way they all participate in the practice.

3. Explain practice objectives, including:

- The elaboration, with informants' support, of a participative map of the community or microzone and the design of a transect for the traverse.
- The participative diagnostic of natural resources, with the aid of the guide presented in Section 3.2.

4. Each group will have at its disposal the drawing of the participative map and will choose with the informants the place to begin the practical.

A schedule suggested for the traverse is the following:

Time (a.m.)	*Activity*
7.00	Meeting in the field.
8.00 9.30	Introducing the group to the informants and the drawing of the map and the transect.
9.30 3.30	Traverse and diagnostic, including lunch in the field.
3.30 4.00	Review of results and thanking informants.

The review of results is carried out in a plenary session to present participants' information and perceptions in the practical.

Resources needed

For each group

- A thick sheet of cardboard (250 g)
- A set of colored markers
- A notebook
- A support table or flip chart
- A Polaroid-type camera (if possible)
- Copies of the diagnostic guide for each participant
- A sheet of paper to write down details about the photos
- Lunch in the field and plenty of water at participants' disposal

Estimated time required: 1 day

Exercise 3.1. The Traverse and the Participative Diagnostic of Natural Resources in a Watershed

Objective

✓ Following a transect across the watershed, to recognize and analyze along with the key informants, the actual state of natural resources.

Instructions for the Participants

1. Following the instructor's guidelines, join one of the two work groups.

2. In each group, appoint a person to be responsible for the practical's coordination, another person to answer the questions of the Guide for Natural Resources' Diagnostic, and another to write down the answers. Nonetheless, we suggest that all participants take notes on the diagnostic.

3. Also, appoint a person to observe the dynamics of the practical. This person should observe how the group and informants interact, in particular paying attention to whether people are participating or not in the discussions, how questions are asked, and how answers are noted down. This person will also carry a camera to take photos.

4. The guide should be reviewed so everyone is aware of its components and questions.

5. During the traverse, carefully observe the most outstanding characteristics of the landscape and make, with key informants' support, natural resources' diagnostic in a representative place of the zone.

6. If possible, take photos of the places considered of importance for the diagnostic and write down where they were taken and why (e.g., Picture 1 = secondary wood sprouting after burnings).

7. At the end of the traverse and the diagnostic, return to the meeting place and appoint three people to prepare a presentation of the results, including the remarks on the work dynamics.

Exercise 3.1. Feedback on the Traverse and the Participative Diagnostic of Natural Resources in a Watershed

Instructor Guidelines

Once the groups have presented results of the practicals, stress the following points:

1. The traverse is an intensive and dynamic practical. During it, good communication with the key collaborators or informants is important.

2. This communication may be encouraged with direct questions during the traverse.

3. Also you may stop in strategic places to observe, take photos, and ask about the characteristics of the landscape.

4. Only one or two of the informants may present explanations. Thus we suggest you walk next to the people who are talking less and interact more actively with them.

5. During the traverse lots of information may be learned and collected. The data must be accurately recorded, such as the places where pictures and data were taken and the knowledge of key informants gathered.

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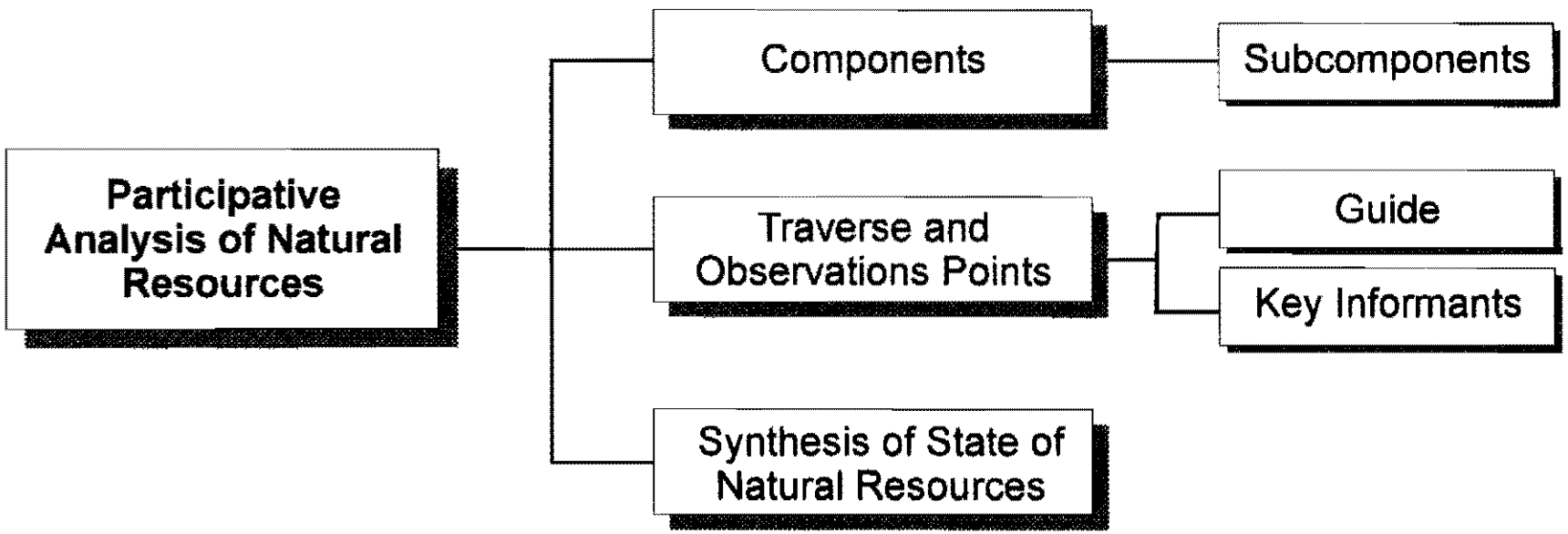
Originals for Transparencies

SECTION STRUCTURE



SECTION OBJECTIVE

That participants be able to carry out an analysis of the natural resources of a watershed using a set of biophysical and socioeconomic components.

GUIDING QUESTIONS

1. What are the most important natural resources in the watershed?

2. How can you tell the state of the natural resources in a watershed?

3. What factors influence the present state of natural resources?

COMPONENTS THAT MAY BE TAKEN INTO ACCOUNT FOR NATURAL RESOURCE ANALYSIS

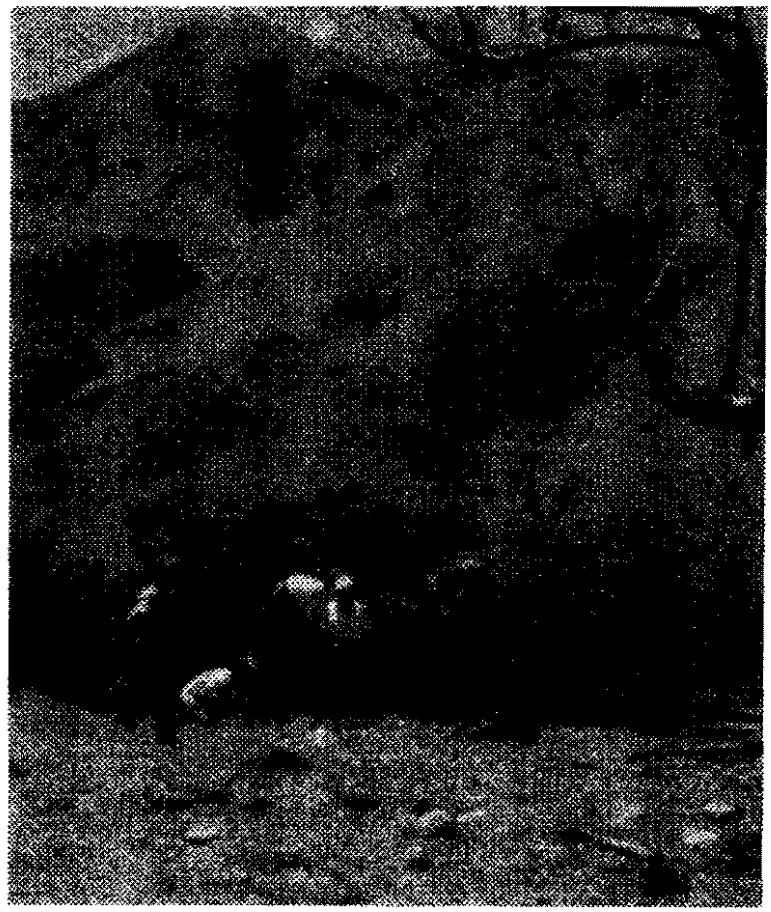
- ✓ Water
- ✓ Forest
- ✓ Crops
- ✓ Soils
- ✓ Animals
- ✓ Pastures

- ✓ Yields
- ✓ Limitations
- ✓ Advantages
- ✓ Conflicts

- ✓ Presence of organizations (NGOs)
- ✓ Projects
- ✓ Land Use

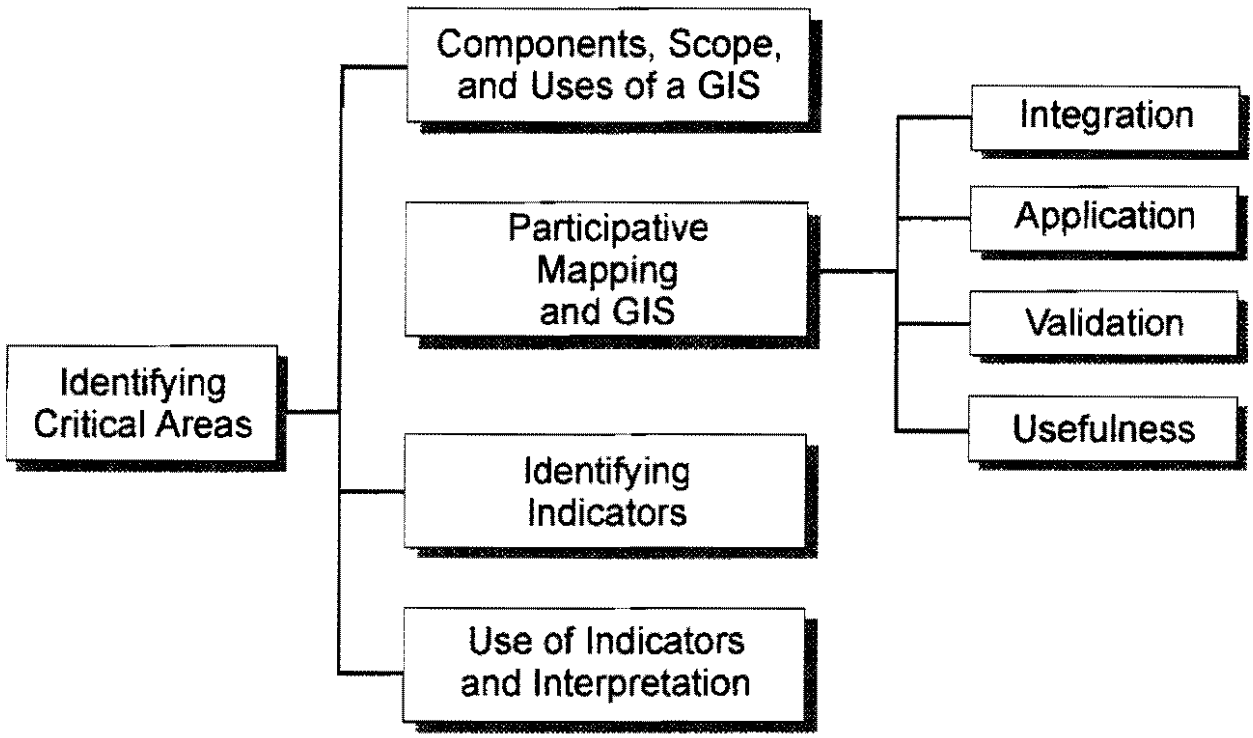
Section 4

Identifying and Monitoring Watersheds in the Process of Degradation



Section 4. Identifying and Monitoring Watersheds in the Process of Degradation

Section Structure



Objective

✓ To identify, using a list of indicators of natural resources' quality, the watersheds (or critical areas therein) in the process of degradation.

Guiding Questions

1. How can you measure the condition or quality of natural resources in a small-scale watershed?

2. How can you classify the different states or the quality of natural resources in a watershed?

3. How can you compare the state of natural resources in the different watersheds found in a study area?

Introduction

The execution of sections 1, 2, and 3 has generated a great deal of information about the state of natural resources. In this final section we proceed to:

1. Map and analyze this information, using Geographic Information Systems (GIS) as a tool, and
2. Define indicators of the quality of natural resources that allow us to recognize zones in the process of degradation and to give recommendations about decision making for intervening.

For both cases, there is insufficient space here to discuss GIS and indicators and analyze them in detail.

4.1. Definition of GIS

Geographic information systems group together a set of principles, methods, information tools, and spatial reference data used to collect, save, analyze, model, transform, and map information about land. The end purpose of these systems is to produce significant information and facilitate decision making. They require the integration of other elements, such as, knowledge about cartography, geodesy, remote sensing, informatics, agriculture, environment, and municipal management.

4.4.1. Use of GIS

The reasons for using GIS are numerous. An overall reason for their use is the need to handle, locate, and integrate in a single context a large amount of data of different types and formats.

This demand can be satisfied thanks to GIS, which offer traditional and sophisticated instruments of acquisition, analysis, and diffusion of spatial reference data.

The end objective in using GIS in this way is to support all those people and institutions involved in land management and decision making. For these purposes, GIS should allow the organization and analysis of pertinent information to answer problems of land use.

4.1.2. GIS components

Geographic Information Systems can be grouped into four large areas: data, human resources, technologies, and management procedures.

- **Data**

Data may be descriptive and geometric and may be used in different contexts such as land classification, prioritization of work places, and the follow-up of previous decisions taken.

- **Human resources**

For the elaboration of GIS several specialties should be gathered together, including informatics and the collection of data and thematic areas about agriculture, the environment, and municipal management.

- **Technologies**

We refer especially to technologies regarding the collection, analysis, and diffusion of spatial reference data. The main methods for collecting these data are surveying, the elevation of global positioning systems (GPSs), the use of manual photo and stereoscopic interpretation, optical sweeping and vectorization, and remote sensing (Figure 4.1.).

Figure 4.1.Identifying landscape elements on an orthophotomap.

- **Management Procedures**

Management procedures are essential for maintaining all information systems. The different processes involved are updating, standardization, and diffusion of data. Frequently, technologies and data eclipse this facet of information systems, but it is a most important process for its strategic, budgetary, and operational impacts.

4.2. Participative Mapping and GIS

Objectives

- To integrate participative mappings to GIS.
- To identify GIS characteristics at the local level.

4.2.1. Need to integrate data to GIS

Most projects working at local level generate strategic knowledge that contributes to improving decision making. This knowledge can be obtained through studies of the soil and water, maps of natural resources, socioeconomic analysis, and participative maps (or mappings). When this knowledge is of a descriptive nature or of spatial reference, its integration into a single database is essential for a wide and complete vision of the work zone. Also, such knowledge permits the analysis of the relations between two, or among several, entities of the territory that are evolving at different levels (e.g., soils, water, health, and forestry).

4.2.2. GIS application at local level

Both at national and local level GIS are defined as sets of tools, both traditional and sophisticated, that permit the acquisition, analysis, and diffusion of spatial reference data (Figure 4.2.). At local level, fewer GIS tools are available, but the activities carried out are the same, although their degree of complexity is different. The characteristics of local GIS may be the following:

- Most users of GIS utilize (do not produce) GIS results (in numerical format or on paper) such as orthophotomaps, satellite images, spatial reference data, and data taken with a GPS.

- Users mainly produce descriptive data that habitually do not have spatial reference. The collection of these data is mainly made through fieldwork that generates information about water, soils, forestry, and housing. To integrate these data to GIS, you must use a GPS, air photos, orthophotomaps, or any other map that may provide spatial reference.

- The access to technologies is different for all technicians, thus several information diffusion methods should be available so that every user can have access to the data required.

The integration of the data collected to GIS, as well as the updating of those available in numerical format, is made basically through a GIS program, type "ArcView" or "Idrisi". These programs are based on the capacity to introduce the geographic dimension of a phenomenon. Other basic points of GIS programs are their functions of editing, processing, and analyzing information.

Product diffusion can be carried out through:

- Printed maps that may take the form of an atlas on paper or slides.
- An atlas that regroups the maps available for the work zone.
- Numerical data available on diskette or magnetic tape.
- Numerical data available through Internet.

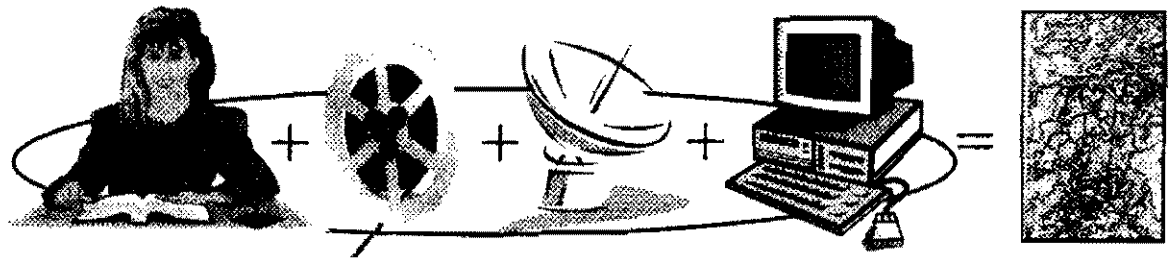


Figure 4.2.Combination of geographic information instruments.

4.2.1. Integration of participative maps to GIS

The integration of participative maps to GIS is managed with a program of this same system that has a digitalization module. Every program of participative mapping elaborated on paper is digitized on a special table or on screen on the basis of a coverage (e.g., hydrographic map, and orthophotomap) that has spatial reference and permits its location through landscape elements.

4.2.2. Validation of participative maps

As previously explained, the participative maps represent the perceptions that local informants have about their living zones. Thus, the elements identified may possibly be located in a wrong form in the georeferential sense.

The next step then is the validation and, if necessary, the correction of the elements contained in the participative maps. The GIS products available on the zone serve as a complement to participative mapping, because they permit a validation of the location of the various components (streams, woods, roads) and, if necessary, permit a correction of the information presented in the participative maps. Also, because of the dynamic nature of the information contained in these maps, they must be kept in numerical format to update and feedback the information and so have a more complete and updated vision of the territory.

The two main results to be presented to the community are the integral participative maps or mappings and the improved participative mappings in numerical format. The first represent the participative mappings performed in each transect. The second are the results of an iterative process of validation.

This validation continues until a GIS product is obtained that:

- Integrates the elements identified by people with a spatial reference,
- Corrects errors of location of the elements identified by people, and
- Permits a relation with other types of spatial reference data.

4.2.1. Usefulness of participative mappings in numerical format

Participative mappings allow us to obtain information that no other technology, traditional or sophisticated, permits quantifying. That is, the perception people have of their living zone. This information is complemented with available information that generally describes a territory's social and biophysical state.

Having the participative maps in numerical format allows the updating of the information they contain, facilitating diffusion, relating the maps with other information (topography, soils, land use), carrying out spatial analysis, and thus making better decisions (Figure 4.3.).

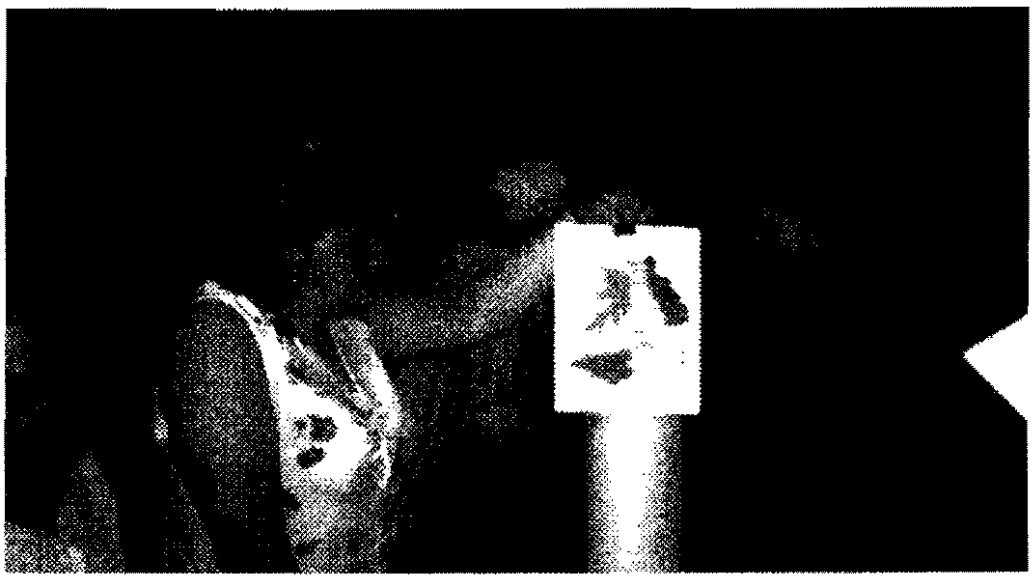


Figure 4.3.A geographic information systems (GIS) product for a better knowledge of the environment.

However, spatial analysis requires, among others, knowledge of pertinent information, the data sets with regard to their contents and accuracy, the relations existing between entities and the objectives proposed.

The main types of spatial analysis are:

Adjacency: Two or several elements sharing a same border or common space (proximity).

Connection: Two or several segments connecting with one another to form a defined entity (e.g., road or hydrographic network).

Inclusion/Exclusion: Part of an entity or a whole entity, contained within the limits of an entity/ any other entity located outside the limits of another entity.

Superposition: Analysis of the relations between two or several entities of the territory, evolving at two different levels (e.g., soils, drainage, and forest).

Modeling: Evolution of one or several phenomena with spatial reference according to different problematics.

4.3. Identifying Indicators of the Quality of Natural Resources

Objective

- ✓ To define a set of indicators and their respective values, taking as a basis the analysis of natural resources' state and quality.

The information obtained through participative maps and diagnostics is the main input for defining watersheds or living microzones that are degrading or of critical areas whose state demands decision making by local inhabitants, representatives of institutions, or project and program managers operating in the zone or planning to initiate works therein.

To facilitate the identification of critical areas, a set of indicators is elaborated of the quality of natural resources at watershed level, taking as a basis the results obtained in the participative mapping and analysis of all the watersheds.

An indicator is a value that serves to evaluate the variables used in the analysis, therefore it should be measurable, understandable, applicable to watershed scale, and be pertinent for decision making at local level. For every indicator, whether its measurement will be objective or subjective should be defined, and how it will be carried out. The degree of reliability of the measurements must also be clarified.

4.3.1. Elaboration of indicators

It is important to find out if the defined indicators correspond to the needs and concerns of the groups of interest existing in a zone. Different needs or concerns may exist depending on gender, age, ethnicity, or social class. If differences are identified, we recommend mediating with the different groups to reach an agreement about the indicators, their measurement, and use. In this sense, it is advisable to view the indicators as a result of a discussion process and, if necessary, negotiation.

A set of indicators may be elaborated with the participation of a small group of key collaborators. This set can be validated and reviewed in a workshop with the participation of all collaborators and other inhabitants of the watersheds. An alternative is to elaborate a first set of indicators without their participation and then validate and review it in a workshop or a series of workshops with their participation and that of some local inhabitants.

To define indicators, analyze the diagnostics' results for each component, particularly by subcomponents. The indicators are deduced from the set of results, that is, taking into account all the diagnostics that have been completed.

The guiding questions for identifying an indicator are:

What is the present state of the natural resource?
How can we identify if the resource is improving or in process of degradation?

Example:

Component:	water
Subcomponent:	water availability
Indicator:	water availability in the dry season
Subcomponent:	water quality
Indicator:	sources of pollution

4.3.2. Values of indicators

All indicators must have a series of values that reflect quality parameters with the same scale and therefore permit their use in a joint and combined fashion. It is also important to distinguish the indicators that only measure a background condition permanent or out of human control such as the monthly rainfall or the slope of a hillside, and indicators measuring a changeable or provisional condition. To use the indicators as a monitoring instrument you should take into account that the most relevant are those measuring changeable or transitory conditions at short- or medium-term. This requires, in its turn, that these indicators' values be within reach and be desirable, acceptable or not.

We propose the use of the categories poor, medium, and good to reflect quality measures. Consequently each indicator will have three values that express a good, a medium, and a poor state. These categories need to be described for each indicator in a clear, accurate, and exclusive form.

Examples of indicators with their respective values:

a. Water

Water availability in the dry season
- In this season, all streams and springs dry up.
- Streams and springs have little water.
- Streams do not dry up and water shortage does not occur.

Sources of pollution:
- Several sources of pollution affect the whole community.
- Only one source of pollution affects a part of the community.
- No sources of pollution exist.

- Forest

Forested Areas
- The community has no forested areas.
- A few forested areas exist.
- The community has extensive forested areas.

Diversity of tree species:
- The zone has only a few tree species.
- A great variety of species exists, but some of them are disappearing.
- A great diversity of tree species exists.

The list of indicators serves as a field tool for measuring and monitoring the state of natural resources. Its purpose is to provide rural communities with a simple and practical method for knowing the state of forest, water, soils, animals, pastures, and crops at a determined moment. It also allows the observation and measurement of changes in the state of these resources over time. The list of indicators will give an approximation, or relative estimation, of the quality of natural resources.

We suggest that you use the list at the small-scale watershed level, checking the state of the natural resources at a determined moment. If a watershed presents different agroecological zones (e.g., a coffee-growing zone and a zone producing basic grains or devoted to cattle raising) we recommend you use the list at the level of the agroecological zone.

Appendix 7.2. is an example of a list developed and used in a study in Nicaragua.

4.3. Use of the Indicators and Interpretation of Results

Objective

- ✓ To identify, with key informants' collaboration and using the list of indicators, small-scale watersheds or areas in the process of degradation.

4.4.1. Scoring system

As explained in the previous section, each indicator can be qualified by three categories (options). To interpret the categories obtained in a particular case you need to have available a systematic means that serves to organize and combine the indicators, draw conclusions on the present conditions of the ecosystem, and on the people interacting with it at watershed level. We suggest you score the quality categories (poor = 1, medium = 2, and good = 3).

If these scores are similarly applied for all the indicators, values should be used without weighing. Also, a weighing can be given to every indicator or group of indicators (e.g., those related with water) if this indicator or group of indicators is estimated to have a stronger role within the overall group.

Adding all the scores, you can calculate the total of the state of resources at a determined moment. This total reveals:

a. The overall state of natural resources in an agroecological zone and in a watershed. If two or more agroecological zones exist, an average of the total score can be calculated or the score by zone adhered to and each zone considered individually.

b. The overall state of resources in a watershed compared to the state of resources in another watershed (in this case the same indicators should be used).

c. Further, if the list is used consecutively (e.g., 6 months after the first measurement) you can estimate the difference in the total score, which will give an idea about the direction of resource management, either its improvement (highest score) or deterioration (lowest score).

The usefulness of this list can be compared with the functioning of a barometer.

4.4.2. Graphic presentation of scores

The total of the scores can be represented graphically, by components or by their total, to visualize the diagnostic results and the use of indicators. For example, for a watershed, time can be represented along the ***x***-axis and the score along the ***y***-axis. The figure may also indicate the ranges of total scores considered as poor, medium, and adequate state.

The ranges of total scores considered as critical can also be indicated because these ranges are moving downwards, that is, either from adequate to medium, or from medium to poor.

Another alternative is to represent the total of the scores of the modifiable indicators on the ***x***-axis and those of the permanent indicators on the ***y***-axis. This representation will help focus attention on those indicators that could be modified in the short- or medium-term by means of some actions.

4.4.3. Next steps

As mentioned in the introduction of this section, identifying the critical areas is the final step of the methodological process of this Guide. However, it may also be the first step of a process of collective actions at watershed level that includes, for example, a process of community organization and tests at landscape level to resolve problems affecting all or most of the inhabitants.

Here we refer in particular to two Guides of this series that facilitate the new steps leading towards collective action:

1. Guide No. 4, Methodology for analyzing groups of interest for collective management of natural resources in watersheds.

2. Guide No. 9, Developing organizative processes at local level for collective management of natural resources.

Exercise 4.1. Integration of GIS Products in the Management of a Small-Scale Watershed

Objectives

- ✓ To identify the characteristics of the watersheds represented in the participative mappings by means of GIS products available in transparencies.
- ✓ To identify the two types of analysis that can be done with GIS products available on transparencies.

Instructor's Guidelines

This exercise is carried out using the example of participative mapping of the Calico River watershed that identifies 14 smaller-scale watersheds within it.

1. Before beginning, prepare a sheet of paper identifying the zones (small-scale watersheds) that each group is to characterize and the sets of transparencies needed (one for every three participants) using the model maps shown in the Work Sheets. You can also use maps of the region where participants are expected to concentrate their attention.

2. Divide participants into groups of three and ask them to appoint a representative or narrator to present the exercise results in a plenary session.

3. Give each group a set of transparencies. Ensure that each set contains the six transparencies representing in this case different GIS products of the Calico River watershed.

Note: In every region or country where this exercise is carried out, similar transparencies can be made available representing a local area familiar to participants.

4. Allow 30 minutes for the work.

5. Ask the narrator of each group to make a presentation of the results in a plenary session.

Necessary Resources

For each group:

- A set of transparencies (the originals of the six colored transparencies are on the attached Work Sheet).
- Two colored markers for transparencies.
- A thick piece of card (250 g).
- A white sheet of paper to make the drawings on the transparencies clear.

Estimated time required: 1 hour

Exercise 4.1. Integration of GIS Products in the Management of a Small-Scale Watershed

Objectives

- ✓ To identify the characteristics of the watersheds represented in the participative mappings by means of GIS products available on transparencies.
- ✓ To identify the two types of analysis that can be done with GIS products available on transparencies.

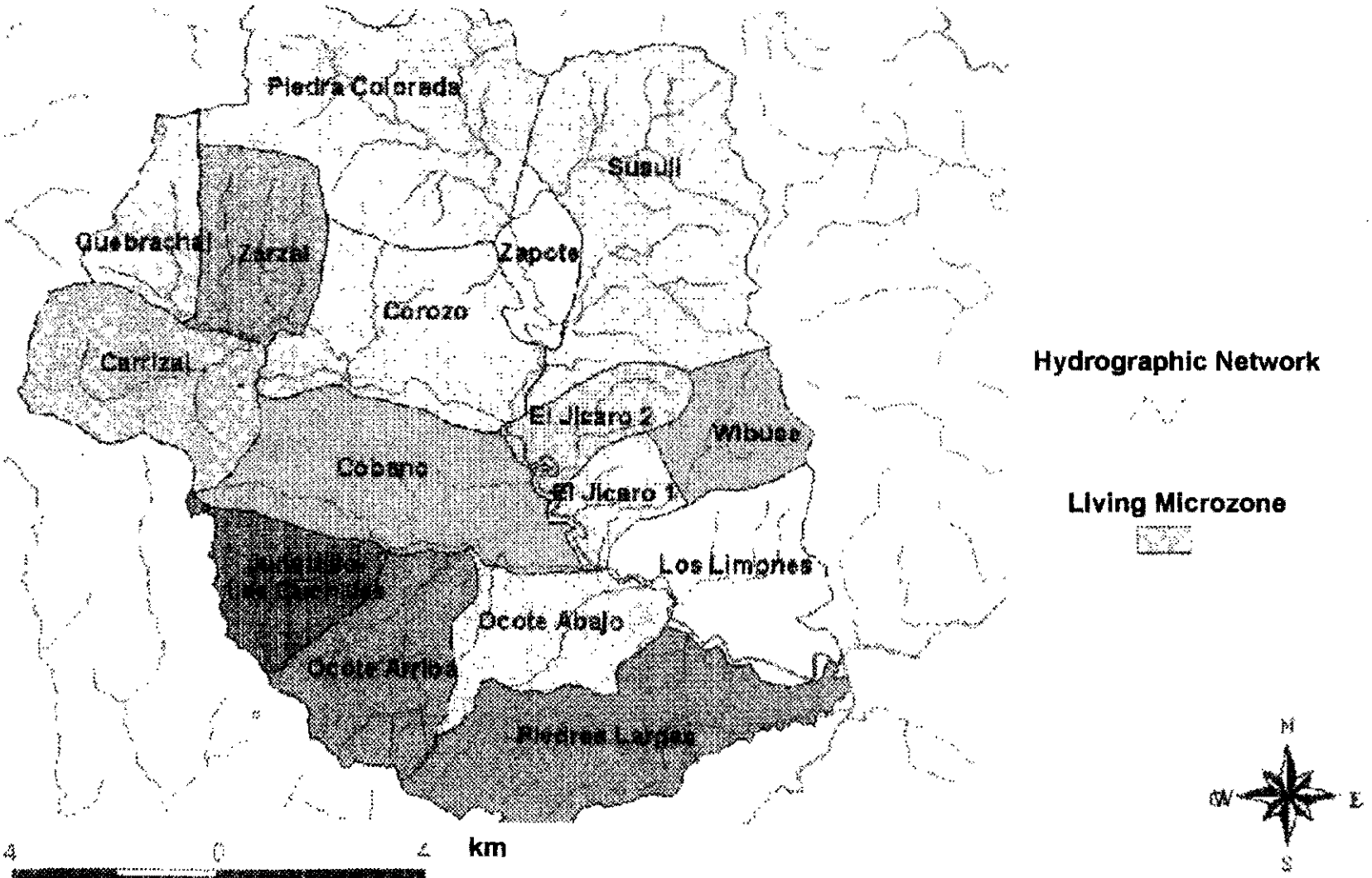
Instructions for the Participants

1. Following the instructor's guidelines, form a group with two other participants. Appoint a narrator who will be in charge of presenting the exercise results in a plenary session.

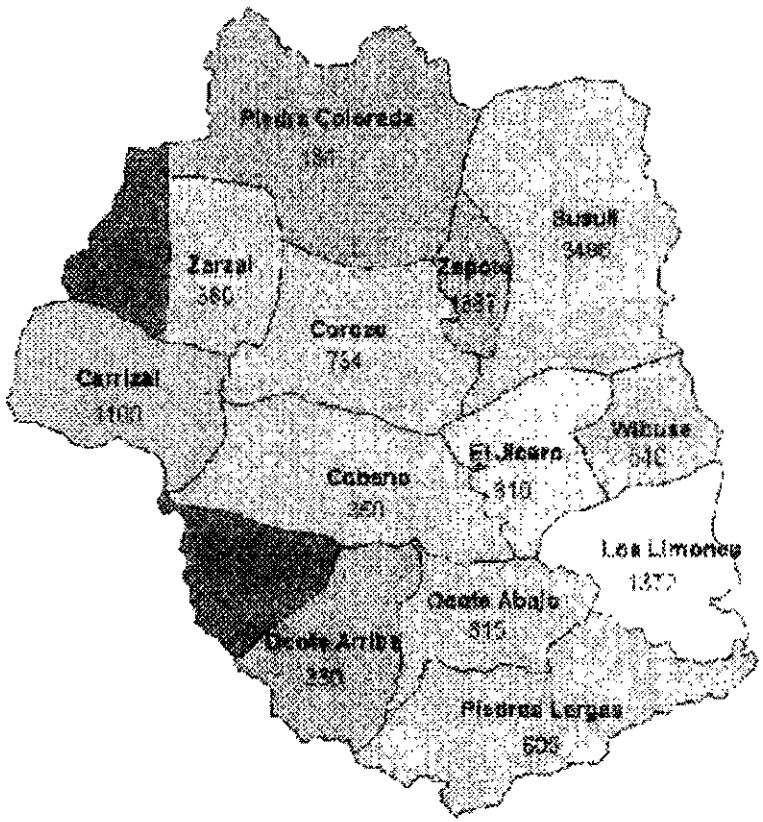
2. Each group will receive a package including a page that identifies the areas to be characterized, acetates, a card, and pencils.

3. Each group writes the results on a transparency so that the narrator using an overhead projector can present them in the plenary session to be held immediately after this exercise.

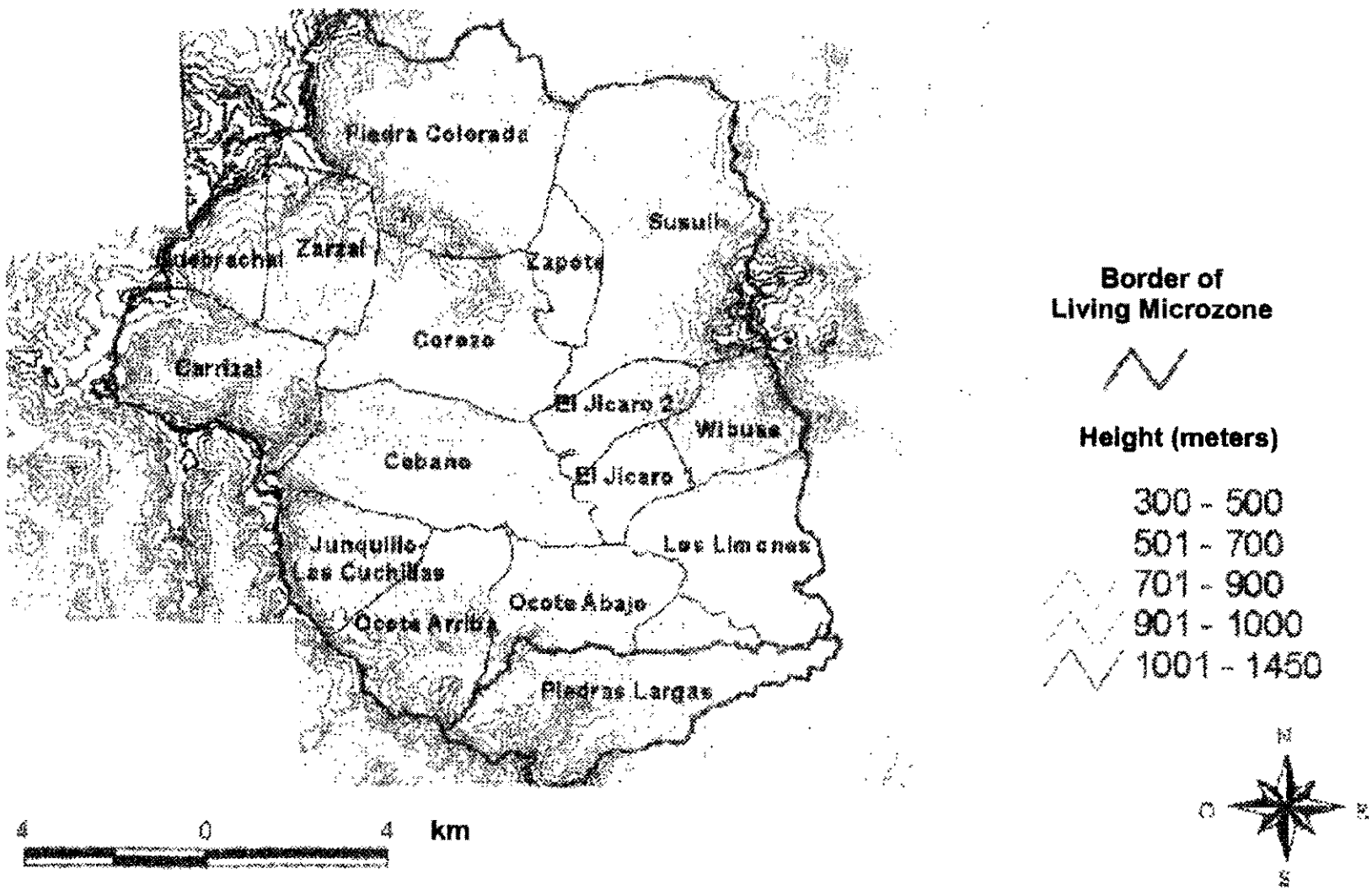
Exercise 4.1.Integration of GIS Products in the Management of a Small-Scale Watershed Work Sheet No. 1.



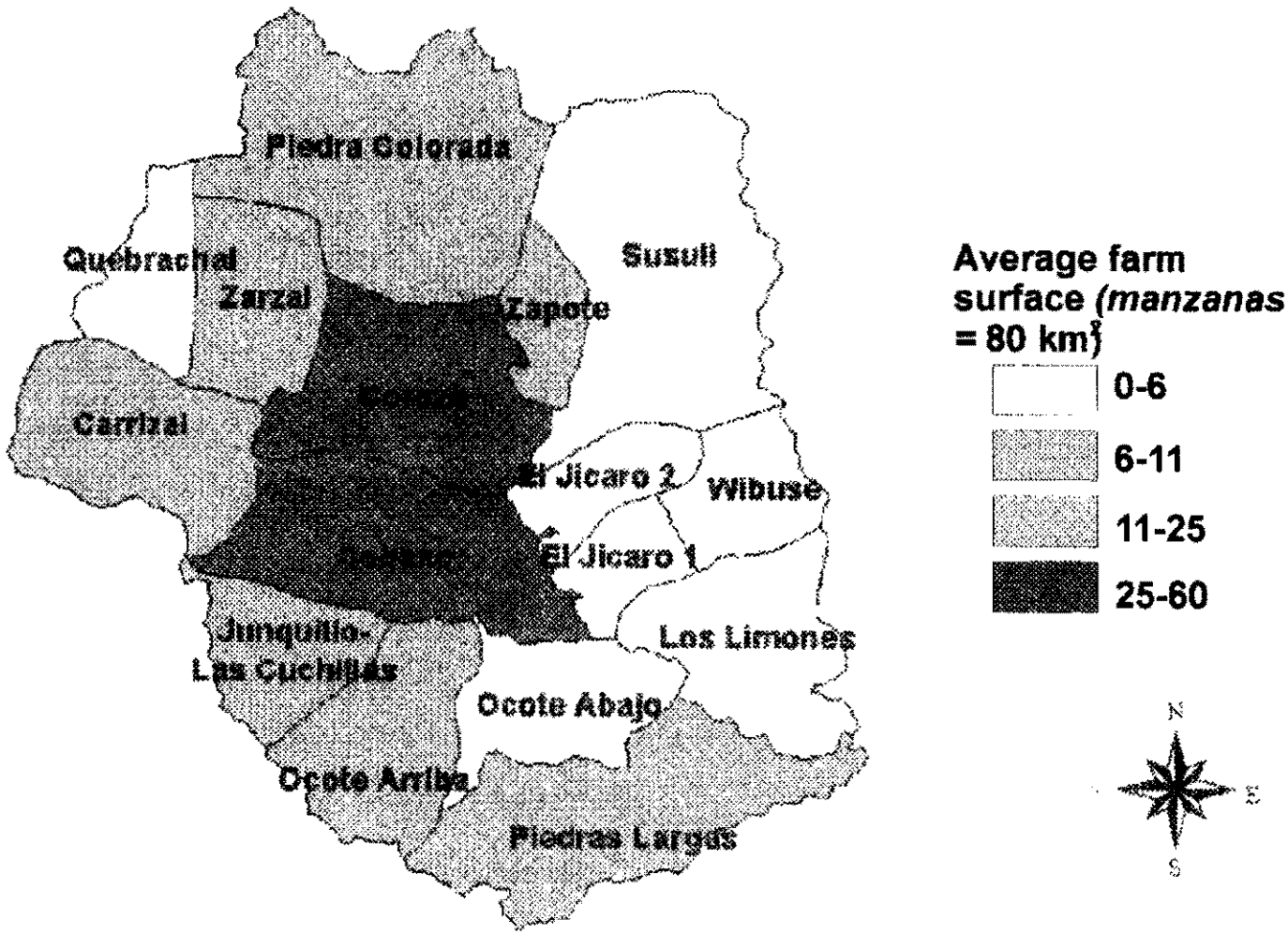
Exercise 4.1.Integration of GIS Products in the Management of a Small-Scale Watershed
Work Sheet No. 2



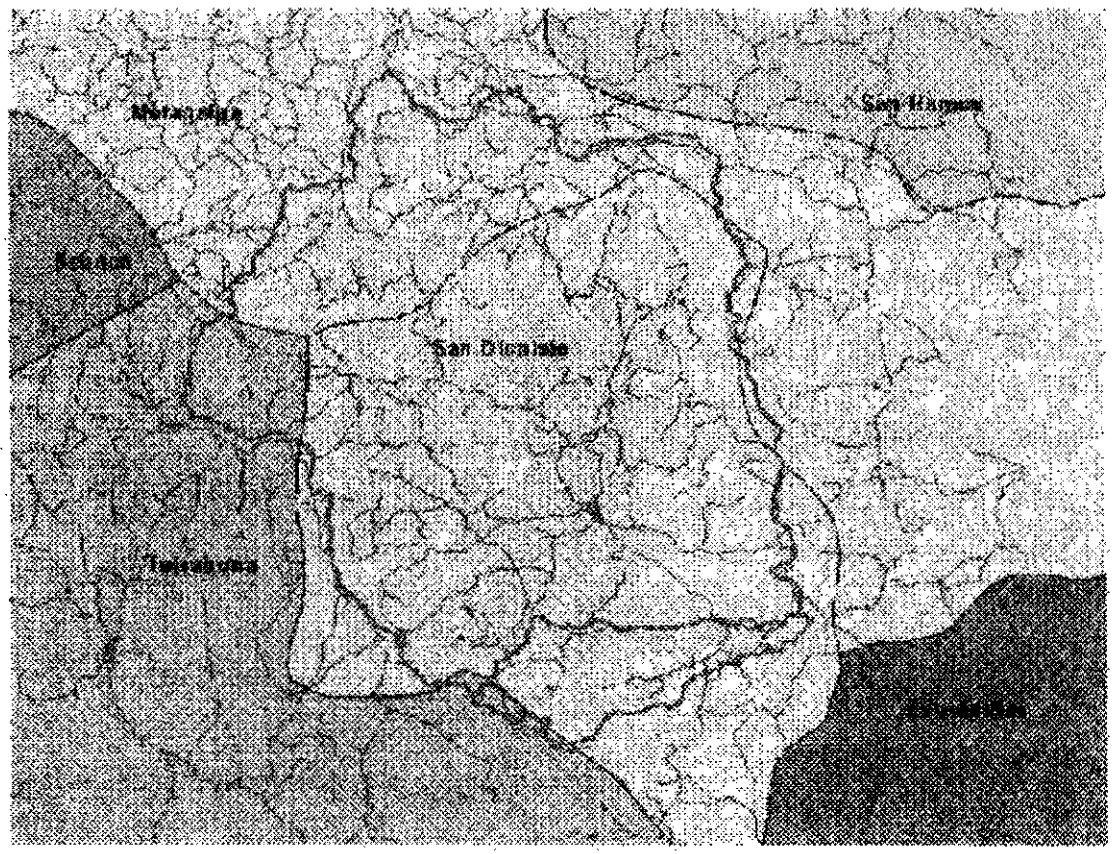
Exercise 4.1.Integration of GIS Products in the Management of a Small-Scale Watershed Work Sheet No. 3.



Exercise 4.1.Integration of GIS Products in the Management of a Small-Scale Watershed
Work Sheet No. 4.

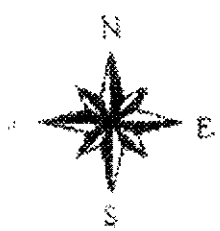


Exercise 4.1.Integration of GIS Products in the Management of a Small-Scale Watershed Work Sheet No. 5.

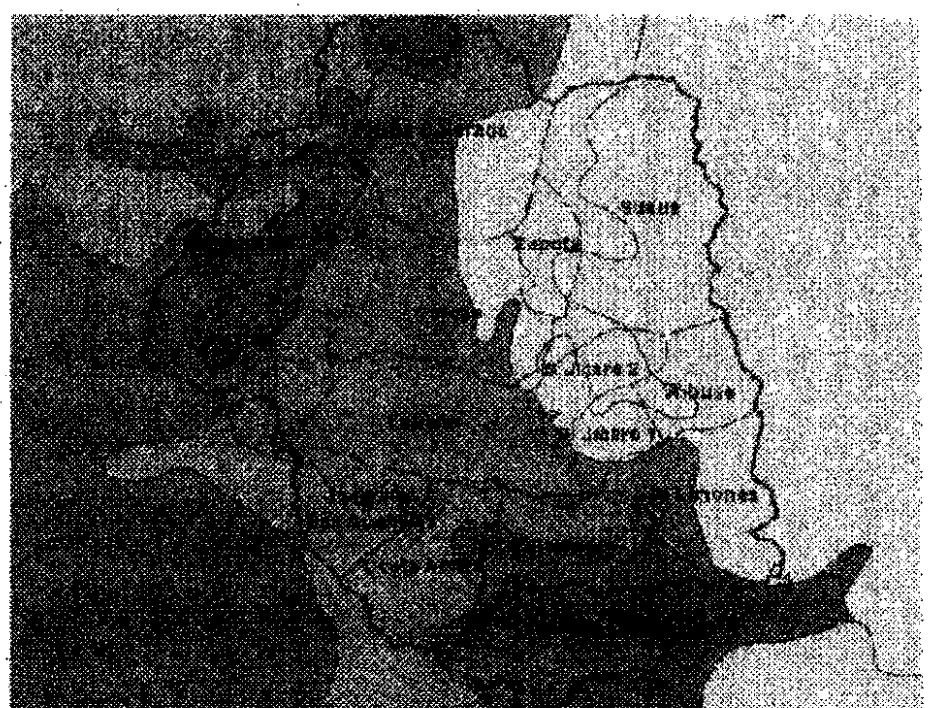


Border of a Living Microzone

Roads



Exercise 4.1.Integration of GIS Products in the Management of a Small-Scale Watershed Work Sheet No. 6.

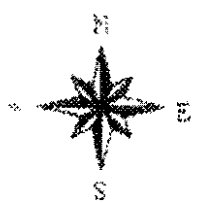


4 0 4 km

Border of a Living Microzone

Soil Classes

- AD-4
- AE-4
- AE-5
- EC-5
- ME-4
- ME-5
- MH-4



Exercise 4.1. Integration of GIS Products in the Management of a Small-Scale Watershed Work Sheet No. 7

Description of Soil Classes (CRIES Project)

1. AD-4:
   Order: Alfisols
   Subgroup: typic tropudalf
   Slope phase: 30% 40%
   Characteristics: old, clayey soils, relatively poor in organic matter.

2. AE4:
   Order: Alfisols
   Subgroup: ultic tropudalf
   Slope phase: 30% 40%
   Characteristics: old, clayey soils, relatively poor in organic matter.

3. AE5:
   Order: Alfisols
   Subgroup: typic tropudalf
   Slope phase: 50% 75%
   Characteristics: old, clayey soils, relatively poor in organic matter.

4. EC5:
   Order: Entisols
   Subgroup: typic ustorments
   Slope phase: 50% 75%
   Characteristics: young soils, rich in alluvial deposits, generally sandy.

5. ME4:
   Order: Molisols
   Subgroup: udic haplustols
   Slope phase: 30% 50%
   Characteristics: loamy texture, rich in organic matter, high fertility.

6. Me5:
   Order: Molisols
   Subgroup: udic haplustols
   Slope phase: 50% 75%
   Characteristics: loamy texture, rich in organic matter, high fertility.

7. Mh5:
   Order: Molisols
   Subgroup: udic arglustols
   Slope phase: 30% 50%
   Characteristics: loamy texture, rich in organic matter, high fertility.

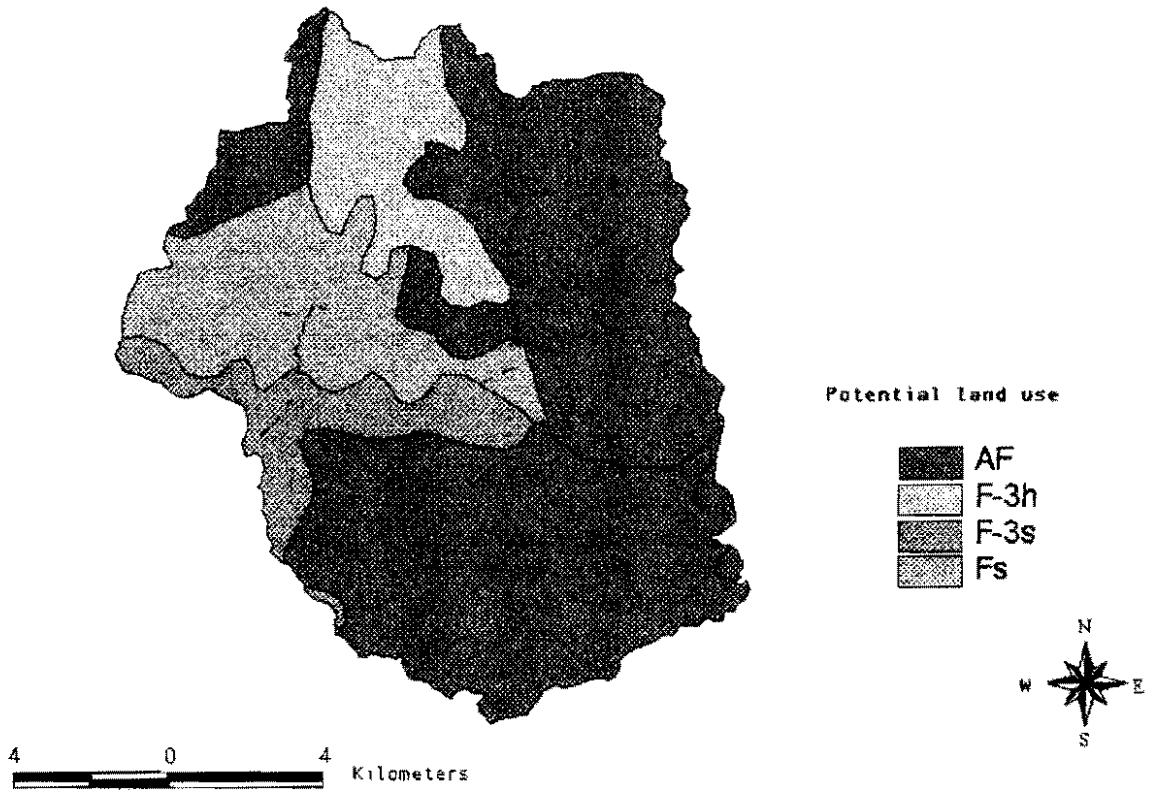


Figure 1.Potential land use.

Key to Interpretation of Potential Land Use Agroecological Map 1:250,000

Symbol	Classes of Land Use	ha	%
A	**Potential Agricultural Use** Land suitable for annual crops (basic grains, potato, linseed, *manzanilla*, cold-climate vegetables), semiperennial (sugar cane, pineapple, banana); perennial (coffee, citrus, cocoa); livestock: meat and/or milk, and/or forest production. In soils with slopes <15%, and high-altitude climatic conditions and without hot dry spell (700 - 1000 m).	176,860	1.5
A – 1	Lands suitable for annual crops (cotton, soybean, sesame, peanut, maize, sorghum, rice; semiperennial (sugar cane, Musaceae); perennial (citrus and fruit); livestock for meat and/or forest production. In soils with slopes <15%, hot climate, and defined mild dry spell).	359,135	3.0
A – 2	Lands for yearly crops (sorghum, sesame, pastures), perennial, cashew, tamarind; fattening livestock; forestry for energy supply. Soils < 15%, under conditions of warm climate with dry spell from mild to severe (< 500 m).	291,770	2.4
A - 3	Lands suitable for perennial crops of wooded habitat (coffee, cardamom, citrus and other fruit); livestock for meat and/or milk, and/or forest production. In soils with a slope of 15%-30%, properties of high and medium humid tropics.	553,425	4.5
Total Potential Agricultural Use		**1,381,190**	**11.4**
P	**Potential Livestock** Intensive grazing; rice, sugar cane and melon with irrigation in soils with slopes < 5% (vertic vertisols) under any climatic condition.	679,125	5.1
P – 1	Extensive grazing on superficial soils, rocky on the surface and/or on the contours, and/or severe erosion, on slopes of 15%-30%, under any climatic condition.	16,890	0.1
P – 2	Lands suitable for extensive livestock rearing with forest-grazing management and/or forest restoration, in soils with slopes of 15% – 30% (60% pastures and 40% forest), in conditions of dry, medium, and low tropics.	94,600	0.8
P – 3	Lands suitable for extensive livestock rearing with forest-grazing management and/or forest restoration, in soils with slopes of 15% – 30% (60% pastures and 40% forest), in conditions of high, medium, and low humid tropics.	36,245	0.3
P – 4	Lands suitable for extensive livestock rearing with forest-grazing management and/or forest restoration, in soils with slopes of 15% – 30% (60% pastures and 40% forest), in conditions of high, medium, and low humid tropics.	290,825	2.4
P – 5	Lands for highly extensive livestock rearing with forest-grazing management, in soils with slopes less than 15%, superficial and/or rocky, under any climatic condition.	0	0.0
P – 6	Lands for extensive livestock rearing, in soils with problems of salinity and under any climatic condition.	0	0.0
Total Potential Livestock		**1,057,685**	**8.7**

Key to Interpretation of Potential Land Use Agroecological Map 1:250,000. **Continued.**

Symbol	Classes of land use	ha	%
ASP	**Potential Forest** Lands suitable for forest production and/or extensive livestock with agriculture/forest/grazing management (agricultural border); in soils with slopes <15%, in association with adequate pastures, semiperennial and/or perennial crops (cocoa, rubber, oil palm, semiperennial citrus, vanilla and Musaceae; typical of humid tropics).	1,951,355	16.1
SP – 1	Lands suitable for forest production and/or extensive livestock with forest/grazing management, in soils with slopes <15%, with obstructed acid drainage, typical of low humid tropics (40% pastures and 60% forest).	1,278,360	10.5
SP – 2	Lands suitable for forest production and/or extensive livestock with forest/grazing management, in soils with slopes <5%, acidic and typical of low humid tropics (40% pastures and 60% forest).	220,190	1.8
Fs	Lands suitable for forest production (dry forest), in soils with slopes of 30% - 50%, under conditions of medium and low dry tropics.	2,071,135	17.1
Fh	Lands suitable for forest production (humid forest), in soils with slopes of 30% – 50%; under conditions of low humid tropics and/or medium and low dry tropics.	962,250	7.9
F – 1	Conifer-producing forest (pine forest), with slopes <30%, in conditions of warm humid subtropics.	315,080	2.6
F – 2	Lands suitable for biodiversity protection, in conditions of rainforest (> 4000 mm/year).	425,405	3.8
F – 3s	Lands suitable for protecting hydrographic watersheds and wild life, in soils with slopes >50% in conditions of medium and low dry tropics.	240,260	2.0
F – 3h	Lands suitable for protecting hydrographic watersheds and wild life, in soils with slopes >50% in conditions of high, medium, and low humid tropics. Medium and low dry period.	1,089,705	9.0
Total Potential Forest		**8,553,740**	**42.0**
AC	**Areas of Wildlife Conservation** Humid Atlantic coast (shrimps, traditional fishing); Pacific estuaries and mangrove swamps (salt industries and shrimp farming); volcanic lavas and cones (ecotourism)	1,149,850	9.5
Total Areas of Conservation		**1,149,850**	**9.5**
Grand Total		**12,141,650**	**100.0**

Exercise 4.1. Feedback on Integration of GIS Products in the Management of a Small-Scale Watershed

Instructor's Guidelines

After each narrator presents the results of his group, the instructor:

1. Presents own results.

2. Emphasizes participants' results and remarks in the sense of identifying concepts dealt with in the theory.

3. Invites participants to answer the following question:

Of what use are the different GIS products in watershed management?

4. Once the feedback information session has finished, the instructor collects the transparencies used in Exercise 4.1. and puts them into an envelope to keep them for later use in future workshops.

Exercise 4.2. Selecting Indicators

Objective

✓ To define a list of indicators of natural resources' quality, taking as a basis the watersheds' diagnostics.

Instructor's Guidelines

This exercise is carried out taking as an example a case study of a research project carried out in Matagalpa Department, Nicaragua, and presented on the attached Work Sheet. The study includes the results of three diagnostics of watersheds.

1. Before beginning be sure to have enough copies of the diagnostics results (case study) for each group.

2. Divide participants into groups of five and ask them to appoint a representative (narrator) to present the exercise results in a plenary session.

3. Give each group copies of the diagnostics' results with which the exercise will be carried out.

4. Each group will work with the diagnostics' results corresponding to two components. For example, the first group is assigned the components of water and forest, the second group is assigned the components of crops and wild animals, and so on.

5. Ask the participants to define, with the support of the case study, a series of indicators of the quality of natural resources with their respective values.

6. Ask each group of participants to explain how the indicators will be measured in the field.

7. Allow about 45 minutes for the definition of indicators and their respective values.

8. Ask the narrator of each group to give a presentation and commentary of the work carried out in a plenary session.

Resources needed

- Case study (see Worksheet for this exercise)
- A flip chart for each group
- Markers

Estimated time required: 1 hour

Exercise 4.2. Selecting Indicators

Objective

✓ To define a list of indicators of natural resources' quality, taking as a basis the watersheds' diagnostics.

Instructions for the Participants

1. Following the instructor's guidelines, form groups of five. Appoint a narrator who will be in charge of presenting the exercise results in a plenary session.

2. Each group will receive a copy of the case study for each participant (three results of the diagnostic on a watershed).

3. Your task is to define a series of indicators and their respective values according to the results of a real case study taken from a research project located in Matagalpa, Nicaragua. The case study includes the data of three participative diagnostics on the natural resources carried out in three watersheds.

4. Each group will work with only two components of each diagnostic. For example, water and forest, crops and wild animals, etc.

5. For each defined indicator you should mention if its measure is objective or subjective and how the measure will be taken in the field.

6. The narrator of each group will present the results and remarks about the work in a plenary session.

7. Each group has 45 minutes to carry out the exercise.

Exercise 4.2. Selecting Indicators Work Sheet No. 1.

Susulí watershed

Height: 600 - 1000 m.

Component	Upper Area
Water	Three main water sources supply the drinking water service for the three sectors of Susulí, the community of El Zapote, and El Jícaro No. 1. There is a main stream (Susulí), and other streams of lesser flow that dry up in the dry season. The water of these streams is used for coffee washing, drinking troughs for livestock, and other domestic needs. At present, the Susulí project presents supply problems because the level or flow has dropped (sources' capacity). Users pay C$1.00 monthly per family. This project was created between 1970 and 1982. The water is of good quality and tastes good.
Forest	Some forested areas serve as shade for coffee crops. Forest has been cut to be replaced by coffee. The zone bordering with the communities of El Chile, Pueblo Viejo, and Wibuse are the most forested. Some reforestation projects are beginning to be implemented. Firewood is available. Trees of avocado, cinnamon, *mico* avocado, guava, citrus, *ojoche*, *papayón*, *arenillo*, *majagua*, and mountain guava prevail, among others.
Crops	• Coffee (var. Caturra and Catimor). • Citrus. • Musaceae. • Some vegetables.
Limitations	• Zone not suitable for crops of basic grains, because of the unfavorable temperatures and the slope of the land. • Pests in coffee crops. • Bad condition of access roads. • '*Despales*' (pruning) for coffee sowing.
Advantages	• Fertile soils. • Better quality production. • A cooler, more rainy zone.
Yields	Coffee: 30 qq/mz[a]. Yields are estimated to have decreased a little in the last few years.
Animals	Few animals of Brahman and Pardo Zuizo breeds, very few families have horses and lesser species. There are wild animals such as howler monkeys, *cusucos*, squirrels, foxes, *guardiolas*, wildcats, and rabbits. Most families have chickens and pigs.
Pastures	The native pastures are Jaraguá, zacate estrella. The area with pastures in this zone is reduced and mismanaged.
Organizations and Projects	Proyecto de Desarrollo de San Dionisio (PRODESA), UNICAFE-MAX, Organización de Desarrollo Sostenible Agrícola (ODESAR), Community Action Plans (CAPs), school sponsorship.

Susulí watershed. Continued.

Component	Upper Area
Conflicts	Water resource problems because of the supplying capacity of the water source for the community of El Jícaro. Deforestation in areas near the sources.
Water	No natural water sources exist. This zone is supplied with a drinking water service of good quality by the community in the upper reaches. Water from streams is of poor quality and does not taste good. The Susulí stream is used for animals and recreation, and for some domestic uses.
Forest	Small areas or remains of dispersed trees are used for extracting firewood, which is scarce. The area has no reforestation projects; the advance of the agricultural border has been notable. Trees of *guácimo*, *juñocuabo*, *muñeco*, *guanacaste* , *carao*, *jícaro*, mango, tamarind, guava, *chilamate*, *mamón*, *cenizaro*, *madero negro*, *sarguayán*, *matapalo*, cedar, and *pochotes* (the two last in danger of extinction) prevail.
Crops	Maize (NB-6, white hybrid), beans (DOR), sorghum, rice, vegetables. The native varieties have disappeared. Intensive use of agrochemicals.
Limitations	• Poor quality of soil. • Lack of credit. • Lack of water. • Lack of land, drought. • Pests.
Advantages	Zone accessible for trading of production and of moderate relief, which facilitates farm work.
Yields (qq/mz[a])	• 5 years ago At present • Maize: 45 20-30 • Beans: 25 15-18
Animals	In the upper area, cattle of Brahman and Pardo Suizo breeds are used for double purpose. The milk produced is mostly sold out of the community (in San Ramón). The major producer owns 50 animals. Most families have chickens and a few families have pigs to improve their incomes. A few wild creatures exist such as rabbits, squirrels, *cusucos*, *mapachines*, foxes, snakes, and toads.
Pasture	Estrella and Jaraguá. The areas of pasture are in bad state (mismanagement) Little use of cutting pasture.
Conflicts	None.
Organizations and Projects	Cooperative for American Remittances Everywhere (CARE), Ministerio de Acción Social (MAS), Proyecto de Desarrollo de San Dionisio (PRODESSA), Union de Campesinos Organizados de San Dionisio (UCOSD), INICAFE, CAPs, school sponsorships.

a. qq = quintals (100 kg); mz = manzanas (80 m^2).

Exercise 4.2. Selecting Indicators Work Sheet No. 2.

El Jícaro No. 2 watershed

Height: 420 500 m.

Components	Analysis
Water	There is only one stream with two tributaries that disappear in the dry season. It belongs to the community of upper Susulí. Some families use water for domestic consumption. Two artesian wells have water throughout the year. The network of drinking water service that comes from upper Susulí benefits only a part of the community (20 families). Water supply or its restriction is unequal. About 20 years ago there was water in the stream and all the community benefited from it. Water quality is medium. Sometimes drinking water comes with some sediment.
Forest	A narrow strip of forest runs beside the stream. In the rest of the area only small patches of dispersed trees and bushes are observed. A very dense forest existed 30 years ago. As the agricultural border (basic grains and livestock) moves forward, the forest is disappearing. A few families are reforesting with introduced trees; common ones are: *aripin*, mahogany, *melina*, eucalyptus, coffee, and fruit trees such as avocado, mango, and citrus. The timber-yielding trees are: *madero negro*, *cenizaro*, *guanacaste*, *jiñocuabo*, laurel, *guava montero*, *madroño*, *miliguiste*, *coyote*, *zapote*, *ojocheo jobo*, *huevo de burro*. Trees such as cedar and *pochote* are disappearing. Firewood is scarce.
Crops	Beans: var. DOR (new variety introduced 2 years ago); Honduras (introduced 10 years ago); Canadian (6 years ago). Maize: H-5, NB-6. Millet White Letter (new variety) and big millet (traditional variety). Pineapple, Musaceae, and cassava for home consumption.
Limitations	Lack of land for cultivation and for credit. Some zones have soils of low fertility. High production costs. Difficulties in getting seed. Some plots without windbreaks in the upper areas.
Advantages	Good crops in the lower zone. Easy access for sale of products.
Yields (qq/mz)[a]	10 years ago: Maize = 60, bean: 8, millet = 60. At present: Maize = 20-30, bean: 3, millet = 20.
Animals	There are few cattle, the prevailing breeds are: Holstein and Pardo Suizo. Milk is sold to cheese industries of San Ramón. Cattle graze in another community. Most families keep lesser species (poultry). Very few families raise pigs. Most families have chickens. Among the wild animals howler monkeys (*congo*), squirrels, rabbits, and parrots are frequently observed.
Pastures	Pastures are in very poor state, overgrazing being observed. Existing pastures: Jaraguá and Taiwan.
Conflicts	With the community of Susulí for the water source. Currently the documents of the ownership of this source are being registered. There are problems because of wood felling by the community of Susulí.

a.qq = quintals (100 kg); mz = manzanas (80 m^2).

Exercise 4.2. Selecting Indicators Work Sheet No. 3.

Los Limones watershed

Height: 400-700 m.

Los Limones	Analysis
Water	There is a drinking water system. Three projects supply the lower parts of the community. Families living in the upper areas are supplied from wells. There are three Drinking Water Committees; monthly each family pays C$2 for maintenance. Also, there are three main streams, two flow into the Viejo River and the other into the Calico River, but only one has water in the dry season. Water quality is good and chlorine is applied monthly. In the upper areas, cattle drink water from streams and wells. In the dry season water is always available. Water for the project comes from the community.
Forest	A few forested areas exist, mostly on La Suana hill. Forest has been seriously affected by felling for wood extraction. There are trees of *madero negro, cenizaro, carao, jiñocuabo*. In the higher areas are cedar, *pochote,* and avocado. Little timber is available for construction. Firewood is scarce and there are no reforestation projects.
Crops	Beans, maize, millet, rice, cassava, coffee, *quequisque*, and citrus.
Limitations	Lack of land, and some families exploit lands when leasing. Lack of credit and presence of pests. Labor is highly expensive. Lengthy droughts. Soil has become degraded. Traditionally only maize or beans are sown and crops are not rotated.
Advantages	Traditional sowing lowers production costs. Crops are for home consumption; most families do not have to buy basic grains.
Yields (qq/mz)[a]	5 years ago: Maize = 60–70, beans = 32. At present: Maize = 50-30; beans = 24–10.
Animals	There are about 80 head of cattle of Brahman, Holstein, and Pardo Suizo breeds. Milk is sold in Esquipulas. Most families have horses for their transportation. Among wild animals are deer, rabbits, wildcat, howler monkey (*congo*), squirrels, *garrobos*, chameleons, snakes, and *guardiolas*. Wild birds are scarce.
Pastures	They are in medium condition; cutting pasture is scarce. In some zones pastures are mismanaged (*'tacotales'*).
Conflicts	Taking of land from the cooperatives by the resistance (1994). Drinking water does not reach the lower zone.
Organizations Projects	CAPs: Running water Committees. The Indigenous Association of Matagalpa. CEPAD: Conservation of soils, training on organic agriculture, support to children's dining room. UCOSD: Credit for basic grains, farm Improvement, coffee, storage bank of basic grains. Land Bank.

b.qq = quintals (100 kg); mz = manzanas (80 m^2).

Exercise 4.2. Feedback Information on Selecting Indicators

Instructor's Guidelines

After narrators have presented the results and remarks of the exercise, the instructor:

1. Shows on transparencies and explains to participants how to choose indicators and their respective values. Take, for example, the component 'local organization', with three indicators selected and their scores (Use transparency Pmam T.4.5).

2. Stress the participants' remarks about measuring indicators, their applicability at watershed scale, and their relevance for decision making at local level.

3. Invite participants to verify if the measurement of every indicator will be carried out objectively or subjectively. Likewise, the values of every indicator may be:

- Representing measures of quality, in which case the same scale is used therefore permitting its joint and combined use.
- Measuring a background condition (permanent or out of human control), or a variable or temporary condition.

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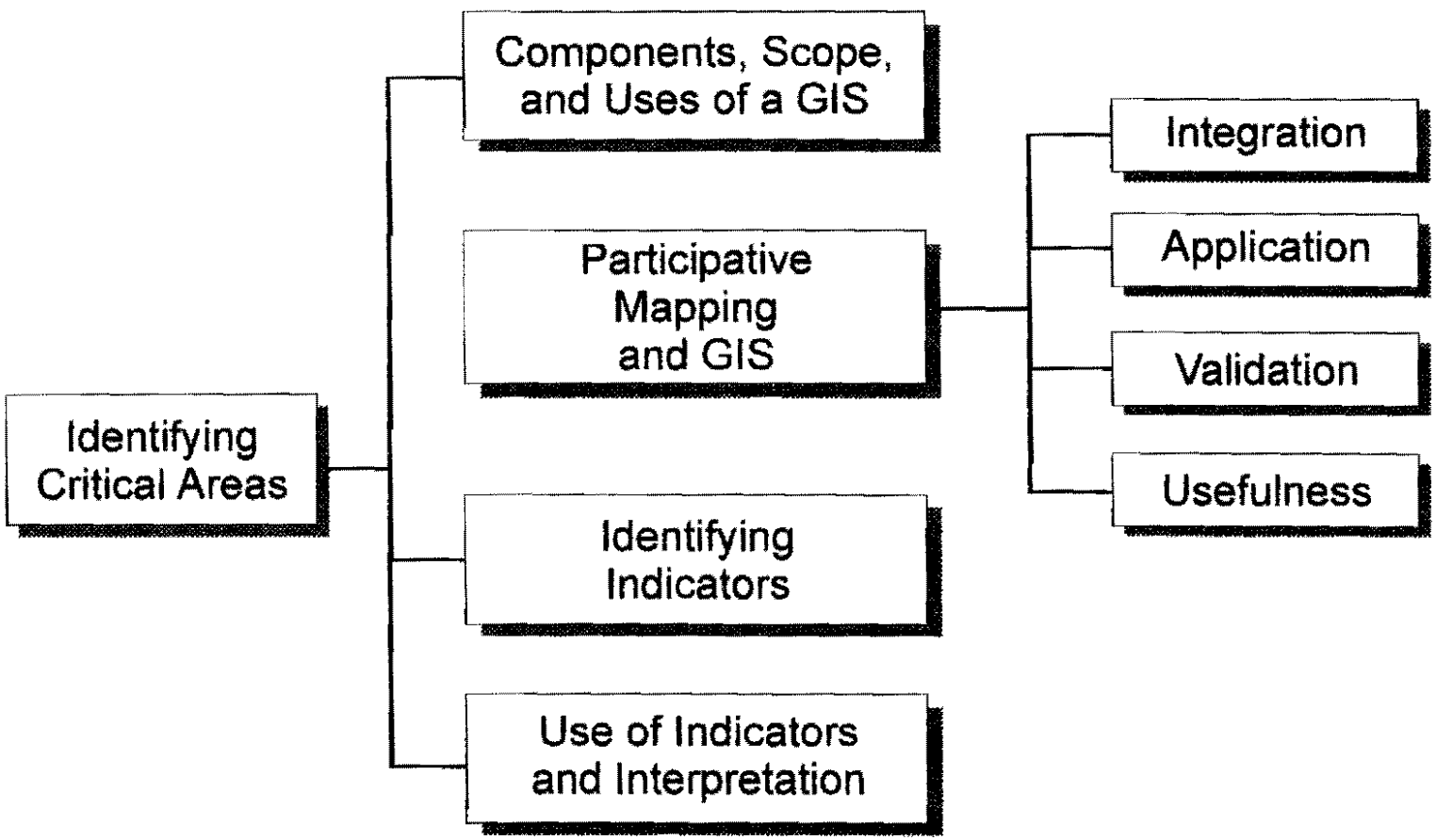
Originals for Transparencies

SECTION STRUCTURE



SECTION OBJECTIVE

Identify, using a table of indicators of natural resources' quality, the watersheds (or critical areas therein) in the process of degradation.

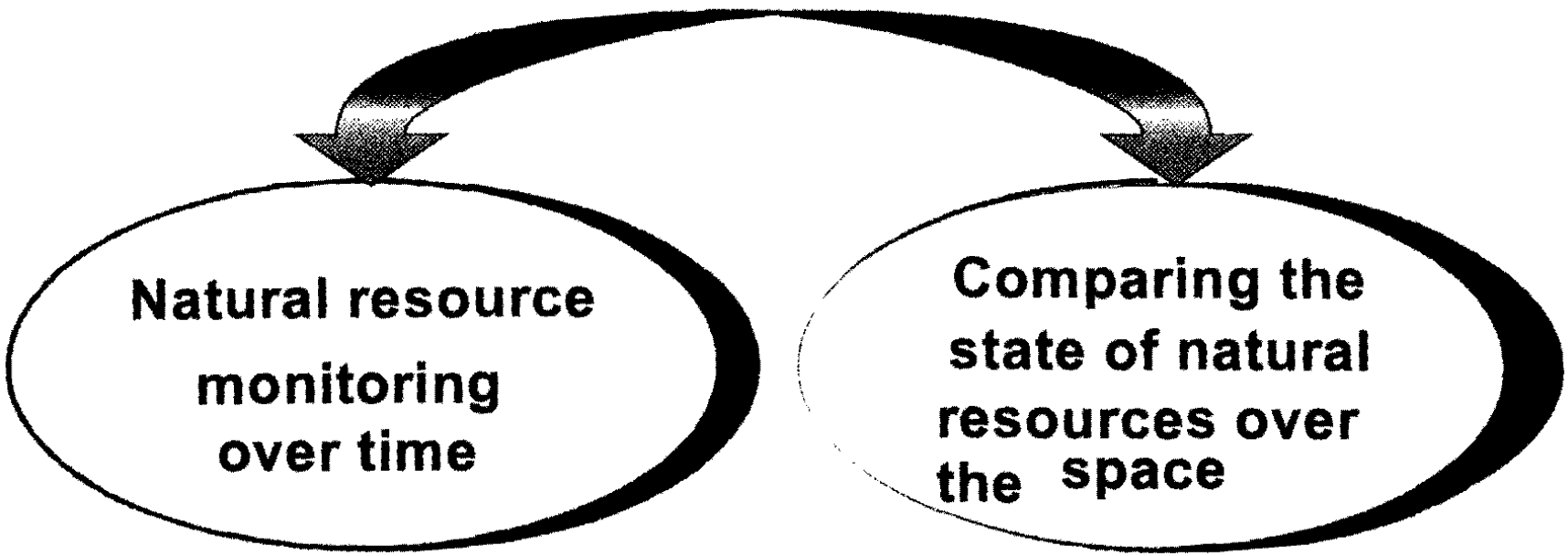
GUIDING QUESTIONS

1. How can you measure the condition or quality of natural resources in a small-scale watershed?

2. How can you classify the different states or the quality of natural resources in a watershed?

3. How can you compare the state of natural resources in the different watersheds found in a study area?

Use of Indicators



INDICATORS OF LOCAL ORGANIZATIONS

Degrees of Action:

- No community groups are carring out conservation practices for natural resources
- Only a small group of people or families in the watershed are carring out conservation practices.
- Most families or people in the watershed are carring out activities for the conservation of natural resources.