Chapter 14
The technical role of government authorities in watershed management

14.1 Objectives and procedural outline

1) Purpose of this chapter as related to "participatory watershed management"

The participatory watershed management methodology introduced in this Extension Guideline is a "bottom-up" method where farmer groups participating in the project extend and expand land use management and watershed conservation activities through the initiative of the local inhabitants.

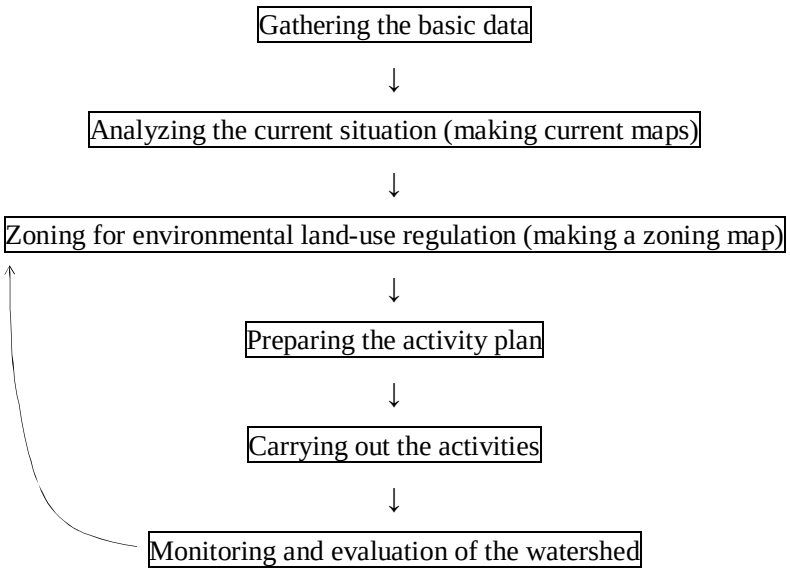
However, since this methodology is based on the horizontal development of conservation activities at the level of individual and group farms, even though such conservation activities may be achieved on the object farms, this methodology lacks the perspective of managing the watershed as a whole with a rational land use plan based on an evaluation of the entire region. Thus, in order for activities carried out by the inhabitants' own initiative to become an effective conservation method for the entire watershed, a system for managing the watershed as a whole is needed.

At present, ANAM has a National Plan for the Integrated Management of Water Resources (PNGIRH: Spanish acronym), and under this scheme it is creating an Environmental Land-Use Regulation Plan (POAT: Spanish acronym) and a Watershed Management Plan for priority watersheds. Three watershed management plans (one of which was created by CICH) can be seen in ANAM's website. Regarding the Environmental Land-Use Regulation Plans, the plan has been finished for 4 watersheds, and the plan will be made for 3 watersheds.

However, there appears to be a lack of a technical guideline for concretely guiding or managing each of the processes involved in creating such plans. Therefore, in this Chapter we present an example of a technical guide that can be used for creating an Environmental Land-Use Regulation Plan (POAT) and a Watershed Management Plan with a unified perspective that combines both the "bottom-up" (participatory) method and the "top-down" (government coordinated) method.

2) Process for creating an Environmental Land-Use Regulation Plan and a Watershed Management Plan

The general process for creating the Environmental Land-Use Regulation Plan and the Watershed Management Plan is shown below. (This Chapter focuses on presenting a technical guide for making said plans, therefore, it does not touch on the details of governmental procedures or the process for creating consensus among local inhabitants.)



Among all these topics, those discussed in this Chapter, and their contents, are shown in the table below.

Table 14-1 Topics and their contents presented in this chapter

Necessary Topics	Contents
Gathering the basic data	Selecting the data to be analyzed. Methods for obtaining the data.
Analyzing the current situation	Analyzing the collected information, such as “terrain” and “vegetation cover” etc. and creating their distribution maps.
Zoning for environmental land use regulation	Establishing the conservation criteria and the production criteria. Creating the conflict map. Zoning
Preparing the activity plan	Points to take into account when creating the activity plan: - Prioritize the zones. - Location and organization of the activities, and coordination of individual activities. - Consideration of land-possessor rights and land use rights.
Monitoring the watershed	The purpose and method for different types of monitoring.

14.2 Gathering the basic data

1) Selecting the data to be analyzed

The data that generally needs to be analyzed is shown in the following table. Every watershed has different characteristics, therefore, the topics for collecting data are selected, or more are added as needed, according to such characteristics. If too much data is collected it can complicate the analysis afterwards, and it will not necessarily make the results more precise. Therefore, always keep in mind that the purpose for collecting the data is the "zonation of the object watershed for the environmental regulation of its land use", and try to keep to a minimum the number of topics for which you collect the data.

Table 14-2 Selecting the data for analysis

Category		Topics
Data on natural resources and their use		
	Terrain	Slopes, drainage system (rivers and streams)
	Vegetation cover, Land use	Distribution of vegetation cover and land use. (Classification is explained further below.)
	Biodiversity	Valuable vegetation cover and the habitat of species in danger of extinction, etc. The study and selection of the vegetation covers and fauna are done for each object watershed.
	Protected areas	Location and type of restriction of the reserves, national parks, etc.
	Land ownership	Demarcation of the area by land ownerships (or land use rights).
Socioeconomic data		
	Population	Location of the urban zones and communities. Demographic distribution
	Culture	Location and type of cultural resources that should be preserved. Especially those that need to be preserved together with their surrounding environment. Distribution of native population.
	Important infrastructure and industries	Areas and constructions, such as roads, hydroelectric plants, tourism sites, manufacturing areas, etc. where there is a high possibility of significant socioeconomic consequences from disasters (drought, floods, landslides, etc.) caused by environmental degradation. The type of infrastructure and industry are decided upon and selected for each object watershed.
	Potential sources of pollution	Industrial sites, such as mining operations, large plants, large livestock farms, etc., which could be a source of environmental contamination if the necessary measures are not taken. The potential pollution sources are decided upon and selected for each object watershed.

Note: The selection of research topics was also explained In Chapter 5. However, in that chapter the purpose of the analysis was different from here, and therefore the data collected also differed.

2) Basic data

The methods used for obtaining the basic data are to review existing documents and to make on-site surveys. It is assumed that the area of a watershed would be extensive: therefore, the use of existing documents will be an effective method for collecting data. (The methods for collecting the basic data are also explained in Chapter 5.)

Terrain

Topographical maps generally show contour-lines and the location of the main rivers and streams. Information about the terrain, slopes, rivers and streams can be gathered from these maps. In Panama, there are topographical maps with a scale of 1:50,000, with the exception of certain areas. It would be convenient to use these maps as base maps for the 52 watersheds nationwide, and for their sub-watershed divisions. When the object area is a micro-watershed, it will be hard to learn the detail of the terrain with the 1:50,000 scale maps and another base-map will have to be used or created in accordance with the purpose of the study. If it is difficult to find a suitable topographical map, satellite images or aerial photos can be used for obtaining the information about the terrain, rivers and streams.

Vegetation cover and land use

The current situation of the watershed can be learned by studying existing documents (vegetation cover maps, aerial photos, etc.) or making on-site surveys. For determining the vegetation cover of extensive areas, it would be more effective to examine satellite images or aerial photos. If there are already vegetation maps or land use maps available, those can be used as well.

Biodiversity

Pertinent data (distribution and state of growth of valuable vegetation cover, and the condition and habitat of valuable fauna) are collected by analyzing existing documents and by interviewing research organizations and area inhabitants.

Protected areas

Information about the demarcations and the purpose of the protected areas, such as reserves and national parks, are gathered from ANAM and other public institutions that manage the protected areas.

Land ownership

Information about the owners or users of the land in the watershed is obtained from the Public Registry, MIDA, ANAM or other institutions that administer such land. Information about the large landowners within the watershed is especially important. Later, when planning and implementing concrete activities, information about the owners of the individual pieces of land will be needed.

Population

Information about population concentrations (urban zones and the main communities) can be obtained from existing topographic maps. Regarding the precise population figures of political areas, they can be obtained from census data or from the local authorities of the corresponding jurisdictions.

Culture, Important infrastructure and industries, and potential sources of pollution

This information can be found in existing documents and from interviewing related governmental institutions, researchers and local inhabitants. Information about roads can be derived from topographic maps and aerial photos.

14.3 Understanding the current situation (making current maps)

An analysis of the current situation is done using the basic data collected above. Specifically, this means creating 3 types of current maps and organizing on each map the information pertaining to it. With the exception of situations where the necessary information already exists, the basic data can be analyzed in the manner indicated below.

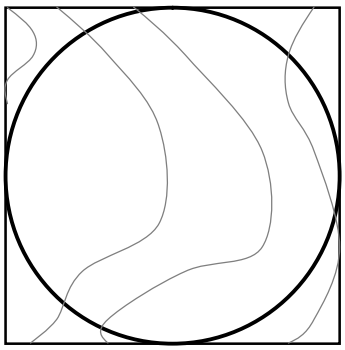
1) Topographic division map (Map Nº 1)

If a map with an adequate scale can be obtained, this can be used as the base map upon which the slopes, rivers and streams can be transposed.

Regarding the slope of the land, there are various ways to find the angle of a slope on a topographic map. The most common is to draw a circle that touches the edges of a grid square formed by the lines on the map. The number of contour lines inside the circle are counted and the average slope inside the grid square is calculated. The calculated slope angle is classified according to the slope types determined beforehand, and this is

recorded in the square together with the corresponding attributes. The slope types are decided according to the conservation criteria described below. The "minimum unit of area" for determining the degree of land undulation has not been established yet., however, for Panama's 52 watersheds and their divisions and sub-watersheds, it would be convenient to use the area of one grid square that is 1km × 1km or 500m × 500m (in a map with a scale of 1:50,000, it would be 2cm × 2cm or 1cm × 1cm, respectively).

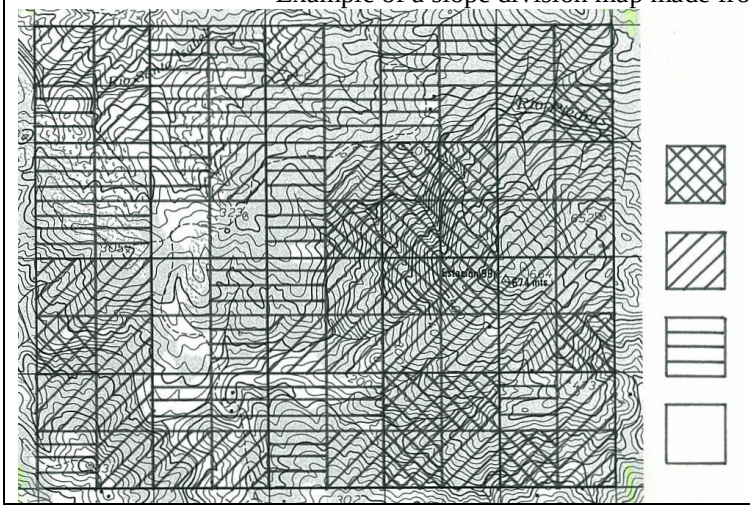
The 1:50,000 scale map has a grid with 1km × 1km squares printed on it (which measure 2cm × 2cm on the map) and these grid squares (or their quarter sized square) can be used for calculating the slope angles.



There are 3 contour lines in the circle.

Calculating the slope angle on a topographical map (using contour lines)
In the case of Panama's 1:50,000 scale topographical maps (which have a 20m interval between the contour lines), inside a 1cm diameter circle, when there are: 10 contour lines (500m : 200m) = then the slope is about 23° (around 40 %) 6 contour lines (500m : 120m) = then the slope is about 14° (around 24 %) 4 contour lines (500m : 80m) = then the slope is about 9° (around 16 %) 2 contour lines (500m : 40m) = then the slope is about 5° (around 8 %)

Example of a slope division map made from a topographical map:



LEGEND

No. of contour lines (slope in %)

Over 10 (over approx. 38%)

7 to 9 (approx. 26% to 38%)

5 to 6 (approx. 18% to 26%)

0 to 4 (under approx. 18%)

The main drainage channels (rivers and streams) can generally also be found on the topographical map. The smaller tributaries can be deduced from the shape of the contour lines and should be drawn on the topographical map. The smallest-sized tributaries that need to be recorded on the map should be decided beforehand based on the content of the watershed management plan and the conservation criteria.

For those areas where an appropriate topographical map cannot be obtained, you can make your own topographic division map by taking a regular map of the area and drawing in the rivers, streams and other topographical divisions (level area, gentle and steep slopes, etc.) deduced from aerial photos and satellite images, and from the results of on-site surveys.

2) Vegetation cover map (Map Nº 2)

The same topographical map used to create the topographical division map in section 1) above, or the topographical division map itself can be used as the base map. The vegetation covers are drawn directly on the base map, or they can be drawn on a semi-transparent sheet placed on top of the base map.

To find the vegetation cover of extensive areas, the most effective method is to use satellite images and aerial photos. However, if such images and photos are used to deduce the plant cover, the types of vegetation and land uses being indicated by the satellite and aerial information should always be confirmed on the ground. This is also true when doing a mechanical reading of digitalized satellite images to make the vegetation map. An exception can be made to the rule of always confirming the image information with reality on the ground, only when you are already fully knowledgeable of the vegetation cover and land use of the object area.

The classification of vegetation cover we used are based on the Final Report on the Results of Forest Cover and Land Use in the Republic of Panama: 1999-2000 (mature forest, mature secondary forest, homogeneous forest of cativo (prioria copaifera), mixed forest of cativo, homogeneous forest of orey (campnosperma panamensis), submergible mixed forest, mangrove, plantations, intervened forest, submergible low vegetation, scrubland and stubble, crop and livestock farming for subsistence, crop and livestock farming, saline land, inland waters, other uses) giving a total of 16 classes, which could be reduced to its half. The classes can be selected or added, according to the characteristics of the object watershed.

The minimum unit of area for indicating vegetation cover is 0.25km^2 (a 1cm × 1cm area on the 1:50,000 scale map) for the 52 watersheds nationwide. In the case of important classifications where conservation measures or land management is to be applied (residential area, mature forest, intervened forest, scrubland and stubble, etc.), smaller land use or cover divisions may be used. Also, when land use is more fragmented than the minimum unit of area mentioned above (for example: small, dispersed plots of crops inside a secondary forest), a classification that best expresses the real situation can be made, such as (in this case) "mixed area of secondary forest and crops".

These characteristics of the (vegetation cover and land use) classifications are organized according to their attributes as the map's legend.

Note 1: The vegetable cover and the topographical divisions mentioned above are important information when deciding on the appropriate use of the land, and therefore they should be depicted for the entire watershed. Sometimes there are "vegetation cover maps" or "land use maps" that only show the cover of interest and leave the rest of the area blank. The Environmental Land Use Regulation Plan is a land management plan for an entire watershed, therefore, there should not be any blank reas on the current vegetation cover map, which is the base document for this Plan.

Note 2: Strictly speaking, "vegetation cover" and "land use" are different concepts. For example, the classification for "pasture" in land use purposes means land that is mostly pasture, however, it could have areas of brush or bare soil in it. On the other hand, according to vegetation cover classifications, if a farmer is doing farmland rotation correctly, at the moment of the on-site study she would have areas of "crops", "pastures" and "scrubland" on her farm. However, from the perspective of land use, it would be better to classify all of these as "rotation farmland". The classifications for vegetation cover presented in this chapter are based on the real situation in Panama, which combines these two concepts of vegetation cover and land use.

3) Specific area map (Map Nº 3)

The same topographical map used to create the topographical division map in section 1) above, or the topographical division map itself can be used as the base map upon which the necessary information is added.

The information that is needed in addition to the topographic and vegetation cover maps is information that is specific to certain places (such as biodiversity distribution, protected areas, cultural areas, important

infrastructure and industries, and potential sources of contamination) and is depicted as points or lines on the map. All this information is drawn on top of the map (if there is too much information to be drawn on one map, the information can be divided by types and put on 2 or more maps). The attributes of each information (their detailed contents) are organized separately.

14.4 Zoning to regulate land use

The 3 current maps, the attributes of each one, the conservation criteria and the production criteria are used to create zones in the object watershed for regulating the land use. The basic concept for the deciding on the activities to be implemented in each zone is the same as that explained in Chapter 7. However there are two big differences here: first, in this case the object area is much larger (than the group farmland), and second, commercial activities need to be taken into account besides farming activities.

1) Establishing the conservation criteria and production criteria

The conservation criteria for each watershed are chosen based on the characteristics of the watershed. An example of conservation criteria is shown in the following table. These criteria are a modified version of the conservation criteria that were selected in compliance with the Forest Law and the Chagres National Park Management Plan and used in making the Farmland Use Plans (for the activities of Alhajuela Project as explained in Chapter 7). (In this example, the land divisions are made under the concept that the existing forests, or the original environmental condition, should be preserved, and trees should be planted in other areas to recover the forest cover.

Table 14-3 Example of conservation criteria

Type of terrain	Conservation Criteria	
(Topographic Division)		
Slope (S = grade of slope)	S > 40% (23º)	Should be preserved without any activity.
	40% (23º) > S > 25% (14º)	Only agroforestry activity is permitted
	25% (14º) > S > 15% (9º)	Agroforestry and cattle farming are permitted.
	15% (9º) > S	Agroforestry, cattle and agricultural farming are permitted
Both sides of rivers and streams	A border as wide as the river on both the right and left riverbank. (However, the border shall not be less than 10 meters wide.)	
Surrounding a water source	(On hills)	A radius of 200 meters.
	(On level ground)	A radius of 100 meters.
(Vegetation Cover)		
Forest	A group of trees more than 15 years old with a closed crown. (Mature forest and with an area of secondary forest)	
(Specific Areas)		
Biodiversity	Area with valuable habitat cover or with species in danger of extinction.	
Population	Areas upstream from population concentrations.	
Culture	Cultural resources that should be preserved (especially those that need to be preserved together with their surrounding environment) and land around them (the size of the area should be decided upon according to each case.)	
Important infrastructure and industries	Land that should be preserved (the size of the area is decided according to each case) in order to protect the operation of the important infrastructure and industries (such as the watershed for a hydroelectric plant, the area upstream from tourist points or manufacturing areas, etc.) that were identified in the analysis of the current situation.	

The production criteria are created as a guideline for regulating the adequate use of the land outside the land selected for applying the conservation criteria mentioned above.

In Chapter 7 there is an example of production criteria (farming criteria) that are applied to farming areas. Besides such criteria, others (specific activity criteria) need to be selected for establishing the areas that are tolerant of production activities that cause pollution, which could have impact on the environment of large industries or large cattle farms. Regarding the farming criteria, the recommended farming activities should be decided upon based on an area's topography and vegetation cover. For specific activity criteria, the distance from population concentrations, from sources of drinking water, farming areas, tourist facilities, etc. also needs to be taken into consideration when choosing these criteria.

2) Identification of Critical Areas and making a Conflict Map

Using the current maps and the above criteria, the areas with "non-desirable land use and production activities" are identified as "critical areas", as explained below, and a conflict map is made from this information.

Critical Areas:

(1) Areas that fall under the conservation criteria, but that currently do not have forests or the original cover. The 3 current maps and the conservation criteria are used to identify this type of area.
(2) Inside production areas that are not under conservation criteria, those areas where the farming activities are inadequate and incongruent with environmental conservation. The current maps (topographical map and vegetation cover map) and the farming criteria are used to identify this type of area.
(3) Pollutant sources that could impact the environment, which are inside areas where activities are not permitted, according to the specific activity criteria. These are identified using the 3 current maps and the specific activity criteria.

3) Zoning

In watershed management "zoning" is a basic tool for identifying the desirable land uses for the entire object watershed, and to regulate the land use to achieve the desirable uses. The land zoning procedure is as follows:

(1) The above-mentioned three critical areas (or points, to indicate the location) are drawn on the map. These will be known as the zones in the watershed that will require the most energetic measures to be taken.
(2) In the remaining area, the currently forested areas that fall under the conservation criteria are drawn on the map. These zones are for the conservation and maintenance of the forest cover.
(3) Another zone is marked for the areas that have forests, but that are not part of the previous two zones. This zone follows zone (2), above, for maintaining the forest cover.
(4) The areas not included in the above 3 zones are marked as zones in accordance to their characteristics (areas where the farming activities are adequate). Basically, these are zones where the current condition should be maintained.

The table below is a summary of the zones (the names of the zones are only a suggestion). The zoning map shows the desirable land use for the entire object watershed and, therefore, should not have any blank areas (land that is not in any zone). If the land use classification is very detailed, and mixed land uses are found, a

zone with such characteristics can be created and given a name. Each zone is divided by region and by sub-watershed and a number is assigned to each zone. The activities for each zone are decided upon. It would be better not to make the zones too detailed in order to facilitate the planning of the activities.

Table 14-4 Zoning example

Area	Current Situation	Zone Name	Measures, activities permitted
Inside the conservation criteria area	Area without forest (Critical area 1)	Forest Recovery Zone	Plant trees to recover the forest or the original cover.
	Area with forest	Forest Preservation Zone 1	Preserve the forest. Vigilance and monitoring for any tree cutting and land clearing. The use of forest resources may be permitted at a level that does not affect the function of the forest, according to the situation.
Outside the conservation criteria area	(Farming Criteria Area)		
	Area with inadequate farming activity (Critical area 2)	Farming Activity Improvement Zone	Change to environmentally friendly farming.
	Area with adequate farming activity	Adequate Farming Zone	Oriented toward maintaining the current activity.
	With forest	Forest Preservation Zone 2	Maintaining the current situation is recommended. The use of forest resources may be permitted at a level that does not affect the function of the forest.
	Other (canal grass, etc.)	Function Recuperation Zone	Change the cover to one that functions better in soil conservation. Agricultural activity may be permitted if adequate techniques are used.
	(Specific Criteria Area)		
	Activity points inside an area where activities are not permitted. (Critical area 3)	Pollution Elimination Point or Zone	Oriented toward stopping and changing such activities.
	Activity points besides those above	Pollution Watch Point or Zone	Vigilance and monitoring of activities.

14.5 Creating an activity plan

Once the zoning for land use regulation has been finished, next, an activity plan needs to be made to change the situation in each zone in the desired direction. The time period of the plan can be decided according to the situation of each watershed management plan. The activities to be carried out in the zones are varied, including

the preservation of the current vegetation cover, tree-planting to recover forest cover, orientation to change to adequate farming activities and restriction and vigilance of the current situation. In this section we explain the issues that should be taken into account when making the activity plan.

1) Prioritization of the zones

The implementation of activities is generally restricted by budget and personnel, therefore, it is nearly impossible to carry out all the activities needed in a given watershed at the same time. In face of this reality, one option would be to implement activities uniformly throughout all the zones within the limits of budget and personnel, but this could lack effectiveness. Another option would be to prioritize the zones and carry out activities in order of their priority. From the perspective of the entire watershed, the critical areas will have greatest priority, followed by the other zones. Areas within a zone should also be prioritized for the same reasons given above. Thus, in each watershed the activities are implemented in the order of their priority. The box below shows some indicators that can be used for deciding on the order of priority for the activities.

Priority zones for implementing activities:

- Zones with severe environmental degradation.
- Zones with environmental degradation that is worse than other zones.
- Zones with greater population that would be affected by environmental degradation.
- Zones with economic activities that could be more affected by environmental degradation.

2) Locating and organizing activities, and coordinating individual activities

One of the functions that the management plan should fulfill is to locate and adequately organize the activities in the watershed, and to coordinate the connection between activities. In Panama, besides government projects there are many activities being done by NGO's, but there is no coordination for placing those activities appropriately. The result is that a needed activity is not always placed in the needed area. (There at least needs to be a system for evaluating if the placement of an activity is adequate or not and to make the necessary adjustments if needed.) It is important to coordinate the adequate placement of the project activities based on zoning and according to the scale and type of the activities.

Furthermore, the promotion or relocation of NGO activities by establishing special zones should also be considered. Economic incentives, or the restriction of activities, could be set up to organize such activities in special zones thus making for a more effective watershed management.

3) Consideration of property rights and land use rights

The problem of land rights is different for each region. Often the owner and user of a property are not the same. For example, in the case of a national park, according to the law the land belongs to the State, however, there are inhabitants inside the park who have property rights due to the fact that they have lived and farmed the land from before the park was made. You will not be able to effectively carry out activities with them, without taking into account whether they have the right to farm the land (land use rights). When preparing the activity plan, you will need to clearly establish who are the owners and users of the object areas.

14.6 Monitoring the watershed

In the monitoring of the Environmental Land-Use Regulation Plan and the Watershed Management Plan, there are 3 types of monitoring, namely: "wide monitoring" of land uses and changes in vegetation cover over the entire watershed, "point monitoring" of specific sources or representative areas, and "project monitoring" of the development of each project in the watershed.

Wide monitoring

The purpose of wide monitoring is to observe the land use and changes in vegetation cover for the entire watershed. This monitoring focuses especially on the changes and their causes in high priority zones to verify the effectiveness of implementing the activity plan. When monitoring an extensive area, using remote sensing with satellite images and aerial photos is an effective method. When the area is limited, on-site surveys and aerial observation by helicopter are effective methods.

Regarding the frequency of monitoring, the zones with many changes are monitored once a year, and zones with less changes (especially with less environmental degradation), for example mature forests further inland, can be monitored with a frequency of once every 2 to 5 years.

Point Monitoring

This is the continuous observation of a specific place; it can be to measure specific sources or a representative point that has characteristics similar to other areas..

The observation point is decided upon and the periodic measurement of the observed object (for example: air or water pollutants, water volume, soil erosion, etc.) is carried out, and the changes are monitored and their causes analyzed. When positive changes in environmental quality are not observed (or when there are negative changes), or when the cause of the change is not the same as that assumed at the beginning of the activity plan, the plan should be revised to obtain the desired environmental change.

Monitoring the development of individual projects

This is the individual monitoring of a project according to the project's purpose. In Chapter 12, we present the monitoring method used for Alhajuela Project.

14.7 Other points to consider

1) Use of GIS

The GIS is an efficient tool for organizing and effectively analyzing a great volume of information. However, even when using the GIS to just analyze the current situation or to create a plan, you will have to collect information as explained in the previous section, and the information will have to be inputted (digitalized). In other words, the information may be digitalized, but it is human beings who have to make the decision about what information is needed or what is the quality of the information.

Also, the people in charge of making each plan are the ones who have to analyze the layers of information produced by the GIS and make an adequate zoning for managing the watershed. It is important to keep always in mind that the GIS is a tool to help the process of analysis and that it does not automatically do the analysis or planning. The use of the GIS is also explained in Chapter 7: Farmland use plan.

2) Dissemination of information, participation and awareness creation of inhabitants

Even when creating a management plan that is to be implemented by governmental authorities, it is still very important to have the participation of the area's inhabitants, to disseminate the information among them and to secure their consensus in order to guarantee the rational implementation of such a plan. This means to adequately disseminate the information among the inhabitants and promote their participation in each process of making, implementing and monitoring the management plan. Also, activities need to be held opportunely to

increase the awareness of inhabitants regarding watershed management and environmental conservation. The methods to use for such purposes are covered in other chapters of this Guidebook.

14.8 Inputs needed

The process of making an Environmental Land-Use Regulation Plan and a Watershed Management Plan does not involve just the technical inputs explained in this Chapter, but also requires procedures with governmental authorities and creating consensus among the local inhabitants. Therefore, it is difficult to state exactly all the inputs that will be necessary in the whole process of making such plans. Even just the technical investments, the content and quantity of the techniques that need to be invested will differ according to the extension of the object watershed and the methods that will be used. Therefore, the needed inputs cannot be generalized. They will have to be decided upon case by case according to the object watershed and the methods to be used.