COMMUNITIES & WATERSHEDS

PROJECT

PE-3

ANNUAL REPORT 2005

CIAT
Centro Internacional de Agricultura Tropical
International Center for Tropical Agriculture

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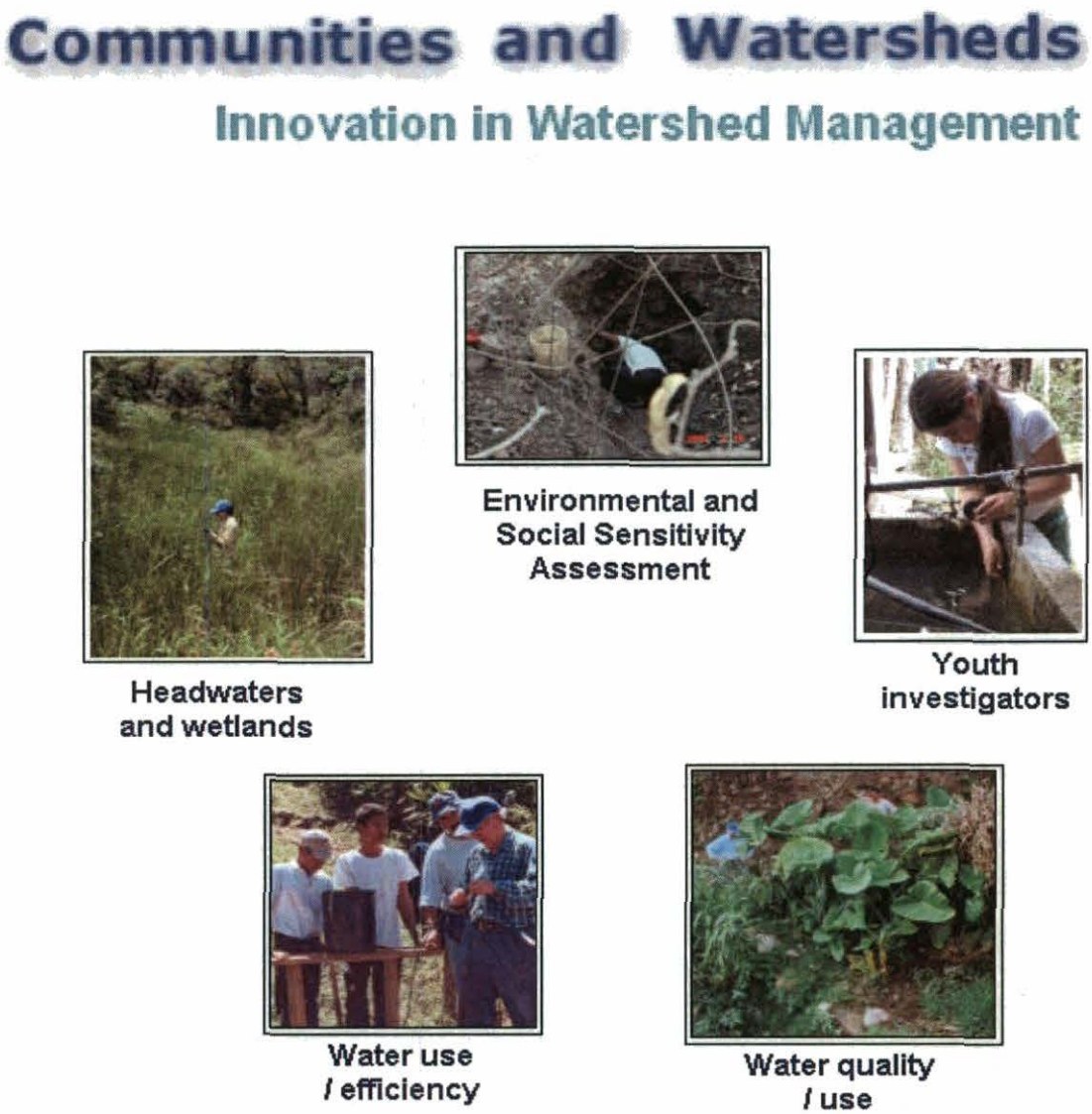
1. Introduction

1.1 Goal

To improve water, food, and environmental quality and services through research on land, water, and community interactions

1.2 Objective

To strengthen local processes of watershed management and sustainable agricultural development in tropical regions, based on experiences with NRM[1] in research watersheds



[1]For an explanation of the acronyms and abbreviations used in this report, see the list at the end of the report.

1.3 The Communities and Watersheds Project in 2005

Communities and Watersheds has made significant progress towards its scientific goals in 2005. Research highlights include:

Output 1:	
Watershed management and land-water interactions	Water-use assessment in Los Saínos, Colombia Assessment of water sources in Tascalpa, Honduras Environmental and social sensitivity analysis in Cálico, Nicaragua
Output 2 and 3:	
Highland-lowland water allocation and environmental services	Water availability in the headwaters of the Barbas River, Colombia Drip irrigation in Yorito, Honduras Economic evaluation of hydrologic services in the Jucuapa and Cálico watersheds, Nicaragua
Output 4:	
Community capacity	Youth and water science projects in Colombia, Bolivia, and Honduras Leadership skills for youth co-researchers CERES (regional educational center), El Dovio, Colombia
Output 5:	
Alliances, replication, and outreach	University of British Columbia, Canada IDEAM, Ministry for the Environment, Colombia Ministry for Education, Colombia INTA, Nicaragua POSAF, Nicaragua

Strategic alliances continue to be an important link for science and outreach, and several key partnerships have been established and/or strengthened. Outreach products produced in 2005 include a CD-ROM, entitled *Youth researchers: education, food security, and natural resources*, a poster series on youth and environmental research results, and a youth and water-science brochure.

Communities and Watersheds presented Central and South American interests on water and watershed management at several international meetings in 2005, including at Glochamore (Spain), United Nations University (Canada), 5th Inter-American Dialogue on Water Management (Jamaica), Water 2005 (Colombia), 1st International Conference on Climate Change (Bogotá), IV Congress of the INIA Systems of Ibero-America, III National Forum of Hydrographic Watersheds (RENOC, Nicaragua), and CATIE-FOCUENCAS Forum for Integrated Watershed Management in Honduras.

1.4 Milestones, 2005

Pilot watersheds

Monitoring networks and baseline surveys

- Water-monitoring networks were established within PE-3 watersheds on the Rivers Barbas (water availability) and Los Saínos (water quality) in Colombia, and Tascalapa (water quantity) in Honduras
- Links to regional and national monitoring networks for data interchange established with IDEAM (Colombia) and INTA (Nicaragua)
- Baseline surveys on levels of household use of water and resources—the surveys are designed, implemented, and analyzed within PE-3 watersheds in Los Saínos (water use), Tiquipaya in Bolivia (baseline), Tascalapa (baseline), and Cálico in Nicaragua (water use)

Integrated watershed management

- Image analysis of land use (high resolution imagery and ground-truthing) ongoing within Los Saínos, Barbas, and Cálico watersheds
- Water availability and wetlands hydrologic response research established in Barbas
- Riparian use and management studies initiated in Los Saínos
- Water-efficient technologies (drip irrigation) adapted and monitored in Yorito
- Best management practices (BMP) assessment in Los Saínos (water use and sand filter), Tascalapa (wetland filter), and Cálico (water harvesting)

Workshops and formal training

Watershed management

- Environmentally Sensitive Area workshop series completed by 2004 to support ongoing CIAT/GO "hot spot" analyses

Youth research and leadership

- Youth leadership workshops conducted in Colombia and Bolivia
- Joint UBC youth workshop conducted in Bolivia on baseline survey design and implementation

Students and interns

- 2 MSc theses completed in 2005: M. E. Baltodano on *Economic evaluation of hydric environmental services* and C. Roa on *Multiple uses of water*
- 3 ongoing student research activities supported: P. P. Orozco, M. C. Roa, and K. Tehelen
- Internship projects: georeferencing water sources in Tascalapa, and water-harvesting technologies for irrigation in Cálico

Publications and communications

IT

- C&W's Web site re-designed and updated
- CD-ROMs highlighting the Kellogg Project initiatives in Colombia and Project Youth Yorito completed
- CD-ROM on the ESA method in English and Spanish completed in 2004

Guides and brochures	▪ Brochure on *Youth and water science* ▪ Poster series on youth research results, Colombia
Articles, books, conferences	▪ 5 scientific papers written ▪ 13 scientific presentations

Fund raising

Special projects	▪ 20 special project proposals written and submitted ▪ Specific donor targets: Kellogg for Colombia and CIDA for Honduras and Nicaragua

1.5 Medium-Term Plan, 2006-2008

1.5.1 Project description

Goal

To improve the quality and services of water, food, and environment through research on land, water, and community interactions

Objective

To strengthen local processes of watershed management and sustainable agricultural development in tropical regions, based on experiences with NRM in research watersheds

Important assumptions

- Environmental, social, economic, and political conditions are maintained on a macro level
- Local and regional partners continue project-related activities
- Donors interested in and supportive of project objectives
- Institutional linkages maintained

Beneficiaries and end users

Primary clients:	local governments, local organizations, farmer groups, and water-user associations
Secondary clients:	research institutions, national governments, and NGOs
Final beneficiaries:	farmers and communities

Collaborators

CGIAR:	IWMI; Water and Food CP; CIP
Universities:	CATIE (Costa Rica), de la Paz (Costa Rica), UBC (Canada), National Agraria (Nicaragua and Honduras), CIRA-UNAN (Nicaragua), del Quindío (Colombia), CINARA-U. del Valle (Colombia), Tecnológica

	de Pereira (Colombia), INTEP (Colombia), Swiss College of Agriculture
NGOs:	CGIAB (Bolivia), Randi Randi (Ecuador), ASOBOLO (Colombia), CLODEST (Honduras), FIPAH (Honduras), CARE (Nicaragua and Honduras)
GOs:	CRQ, CVC, SENA (Colombia), INTA, MARENA (Nicaragua), Municipalities of El Dovio (Colombia), Yorito (Honduras), and San Dionisio (Nicaragua)
Local associations:	Herederos del Planeta (El Dovio, Colombia), Asociación Campos Verdes and CIALs (San Dionisio, Nicaragua)
National and regional associations:	*RENOC (Nicaragua)*, CONDESAN, CONCORD (Americas)
International research organizations:	INIA (Spain); United Nations University, UNU-INWEH
CIAT:	Soils (PE-2), Land Use (PE-4), Forages (IP-5), Agroenterprises (SN-1)

Explanation of project changes with respect to previous MTPs

Based on comments received from the BoT Program Committee, we have combined outputs 2 and 3 from our 2005-2007 log frame. Output 4 (previously output 5) has been modified to include implementation, documentation, and analysis as suggested, and the information dissemination component of output 3 has been moved to this section. Additional detail has been added to the output targets (previous milestones) to clarify the role of production systems and sustainable agriculture, and to include activities with partners as an output target for capacity building.

1.6 CIAT Project PE-3: Communities and Watersheds Project Log Frame (2006-2008)

Manager: José Ignacio Sanz

	Outputs	Intended users	Outcome	Impact
OUTPUT 1	Methodologies for developing (1) community-based systems of monitoring and management of watershed characteristics and (2) processes for improving land-water management (5-7 years)	Farmers and local organizations; Decision makers at the local and district levels; National research organizations	Improved watershed management based on knowledge of land-water interactions, production systems, and land use; Data used in national monitoring programs	Improved water quality management by communities at the local level and associated implications for human and ecosystem health
Output targets 2006	**Monitoring of fully established networks; Baseline surveys on the use of water, land, and resources conducted and analyzed in pilot watersheds**	Water-user associations; District government	Data on water quality available to water-user associations	
Output targets 2007	Continued monitoring of water quantity and quality in reference watersheds; Impact assessment of land use and production systems on water quantity and quality in pilot watersheds, including adaptation of UBC's ESA assessment method for Latin America	Water-user associations; District government; National monitoring agencies; National research and governmental institutions	Data on water quantity and quality supplied to local water-users and regional authorities	
Output targets 2008	Continued monitoring and assessment of production system sustainability with respect to water (quantity and quality); Continued evaluation of modified ESA method (initiated in 2007)	Decision makers at the district level; National research and governmental institutions	Data on water quantity and quality linked to national monitoring networks; "Hot spot" analyses, based on the ESSA method	

	Outputs	Intended users	Outcome	Impact
OUTPUT 2	Methodologies for increasing the equity of highland-lowland water allocation, including the provision of environmental services (7-10 years)	Water-user associations; Decision makers at municipal, national, and regional levels	More equitable allocation of highland-lowland resources (especially water), including the provision of environmental services	Enhanced livelihoods while preserving ecological flow as a result of education programs and implementation of water policies for equitable water allocation and use efficiency
Output targets 2006	Continued research on water availability and hydrologic response (initiated in 2005); Water use by sector measured; Water-efficient technologies monitored in 2005 assessed; Regulatory framework for water in pilot watersheds compiled	Water-user associations; Decision makers at municipal and regional levels; Strategic project partners	Options available for water-efficient technologies relevant to local conditions	
Output targets 2007	Completed assessment of wetland hydrometric response (Colombia); Collaboration mechanisms for water allocation evaluated; Regulatory impact on water use and allocation for Latin America assessed; Water-wise programs initiated	Water-user associations; Decision makers at municipal and regional levels; Local organizations; Regional project partners	Collaboration between water-user associations (small and large); Understanding of the implications of the regulatory (legal) framework for water use and allocation	
Output targets 2008	Assessment of headwater protection, rehabilitation, and management measures based on hydrometric and regulatory analyses (2007); Adoption and replication of water-efficient technologies and water-wise methods	Decision makers at municipal, regional, and national levels; Local organizations, NGOs, and research institutions	Improved headwater management; Improved decision making in water allocation; Structural and behavioral options for water use made available	

	Outputs	Intended users	Outcome	Impact
OUTPUT 3	Methodologies for strengthening community capacity to manage and allocate water resources (5-10 years)	Local organizations and institutions; Regional partners	Organizations strengthened by community and institutional capacity building	A mix of diversified, productive, and natural landscapes resulting from initiatives, decisions, and adaptations of strengthened local organizations and institutions
Output targets 2006	Workshops and training conducted to support research initiatives and internship projects	Local organizations and institutions; Water-user associations; Strategic project partners	Enhanced capacity at the local level; Multiple operational partnerships; Interinstitutional collaboration mechanisms implemented	
Output targets 2007	Joint workshops held with strategic partners and institutions in support of research	Local organizations and institutions; Water-user associations; Regional project partners	Enhanced capacity of multiple operational partnerships for water-resource management at local, national, and regional levels	
Output targets 2008	Comparative analysis of capacity of partners and institutions associated with the project versus comparable groups	National governments; National and international research institutions; Donors	Better collaboration between stakeholders (small to large); National and regional networks of comparable watersheds	

	Outputs	Intended users	Outcome	Impact
OUTPUT 4	Information systems available to various audiences in multi-formats	Regional project partners; Research institutions; NGOs	Reaching audiences beyond direct project sites and partners	Multiple watersheds with improved quality of water, food, and environment, as a consequence of replicating research results
Output targets 2006	Web sites, CD-ROMs, guides, and scientific papers of project results and methods in English and Spanish	Strategic project partners		
Output targets 2007	Updated Web sites and CD-ROMs of project activities and impacts; Scientific papers	Regional project partners; NGOs; National research institutions		
Output targets 2008	Updated and new project results disseminated, using ICTs; Scientific papers	Regional project partners; NGOs; National and international research institutions; GOs		

2. Pilot Watersheds

Communities and Watersheds' pilot watershed approach permits the team to engage in multiscale scientific research while maintaining local impact and regional relevance. Action-based research is implemented in specific watersheds to address regionally relevant topics.

In the Garrapatas watershed, El Dovio, Colombia, the project *Youth researchers: education, food security, and natural resources*, funded by the W. F. Kellogg Foundation, was implemented at three principal scales. Water and ecological issues are addressed at the microwatershed and watershed scales in Los Saínos and Quebrada Grande, while activities related to food security, environmental education, sustainable resource use, and leadership are undertaken in the larger catchment of the Garrapatas Canyon. At all three scales, the project contributes to C&W's *Output 1: Watershed monitoring and management*. Local researchers and youths were central to the project's implementation. An institutional platform has been developed to include the Municipality of El Dovio, the Ministry for Education, local schools, NGOs, small enterprise, the coffee growers' committee, advanced educational institutions, and the regional governmental corporation. By incorporating local actors, the project contributes to C&W's *Output 4: Strengthened community and institutional capacity* and the dissemination of research results.

In the Barbas watershed, situated in Colombia's Central Cordillera, research activities focus on water availability, quality, and use. Monitoring and research are concentrated in the headwaters with strong links to downstream water-user associations. Research activities are central to C&W's *Output 2: Equity of highland-lowland water allocation and water-efficient technologies*, focusing on the biophysical processes that influence water availability and the implications for downstream water users. The process-based approach will generate knowledge on the eco-hydrologic factors that are key to water balance and their relevance for local management activities. Water-holding capacity in headwater ecosystems is a regionally important theme, and research results from Barbas will assist in determining the importance of conservation and land-use impact.

The Tiquipaya watershed, Bolivia, exemplifies water allocation and access issues in Cochabamba. The headwaters incorporate the dry high-altitude tablelands or *puna*, used for extensive grazing and as the water source region for the downstream urban-rural centre. The C&W/UBC/CGIAB linkage project, *Youth Bolivia: alliance for water science and the future*, strives to build local capacity for youth involvement in integrated watershed management. The project contributes to C&W's *Output 1* through a baseline survey and site-specific assessments of water use and quality; to *Output 2* through activities related to mapping and distribution of water sources; and to *Output 4* through research and leadership activities led by youths.

In the Tascalapa River watershed, Yorito, Honduras, research activities correspond to:

(1) *Output 1*, establishing a baseline survey of water and resource use (including site-specific assessments of water use and quality), establishing monitoring networks for production systems, and collecting data for the climate network.

(2) *Output 2*, emphasizing drip irrigation systems installed and monitored. These activities, supported by the COSUDE project, strengthen the capacity of young researchers to manage water harvesting by managing drip irrigation in biointensive gardens.
(3) *Output 4* through research and leadership activities led by youths.

In the Cálico River watershed, San Dionisio, Nicaragua, for:

(1) *Output 1*, baseline activities were strengthened at the microwatershed level, emphasizing the theme of water and establishing climate networks (precipitation) and production systems.
(2) *Output 2*, water harvesting was begun through internship projects.
(3) *Output 3: Provision of environmental services: water*, through thesis field work, supervised together with CATIE, research activities were carried out on the *Economic evaluation of the offer of hydric environmental services*.

Comparative watershed studies have facilitated the transfer of lessons learned through projects to partner institutions. The environmental research techniques and leadership workshops addressing youth co-researchers and which were developed in Colombia were implemented in Bolivia and Honduras. Institutional platform techniques used in Nicaragua and Honduras to implement broader scale initiatives such as baseline surveys and "Environmentally and Socially Sensitive Area" (ESSA) assessments at the watershed scale are being adapted to relevant issues in Colombia. Adaptations include a consortium of water-user associations, learning alliances, and rural education programs. This institutional focus facilitates replication and broader application of the methods, techniques, and tools developed within pilot watersheds.

2.1 Output 1. Watershed Monitoring and Management: Land-Water Interactions

For output 1, Communities and Watersheds strives to improve watershed management, based on knowledge of land-water interactions, production systems, and land use. Quantifying the linkages between production systems, nutrient management, land use change, and water is a precursor to improving environmental management. Establishing monitoring networks, and baseline surveys on water, land, and resource use is fundamental to developing case-based methods of community monitoring and management of watershed characteristics and processes.

2.1.1 Water use, quality, and availability in the Los Saínos watershed, Colombia

Related milestones

Monitoring networks, primary data collection, baseline survey on water use, land-use assessment, watershed best-management practices

Introduction

Integrated watershed management by communities is of interest to the young people who live in the Los Saínos microwatershed. This watershed does not provide sufficient water in the dry season; the water is of poor quality for domestic use; and natural resource management in the

lower part of the watershed is poor. The principal water source for domestic use is in the upper valley, which has erosion problems. After the 1998 drought, a youth group, known as the "Herederos del Planeta" [*Heirs to the Planet*], initiated, with community support, an activity to restore two wetlands, aiming to recover the water source. However, problems of water availability and sedimentation continue.

Objectives

Watershed research in this area attempts to answer four questions:

(1) Can the wetlands be restored, thus improving water quantity and quality?
(2) What are the sources of water pollution?
(3) What is the relationship between use, quality, and availability of water?
(4) What are the options for improving water use?

Baseline survey

The first step in conducting research on the watershed was to design, implement, analyze, and present the findings of a baseline survey. The survey was designed with the community, the youths executed the survey (Figure 1), people in the field responded, the results were interpreted in a participatory manner, and feedback was given to the community. All 54 houses located in the watershed participated in the survey. Results included socioeconomic aspects, land use, crops, livestock activities, forests, riparian forests, water sources, water quantity and quality, and wastewater.

Figure 1. A youth conducts an interview.

Figure 2. Collecting water for domestic use.

Water sources: quantity and quality

Water sources are mainly water supply systems, with some springs for livestock and crops. A major water supply system, with its source in the upper valley (Figure 2), provides water to most of the houses in watershed. Half of the watershed inhabitants tell of their experiences with water shortages in June and August, and 25% of houses also suffer water shortages in January and February (Figure 3). People report that sediments are the main problem presented by the water in the water supply system. Most (90%) families boil their drinking water (Figure 4). While 77% have septic tanks, only 27% of farms do. Animals have access to streams and, in 27% of cases, wastewaters from the animals enter the stream directly.

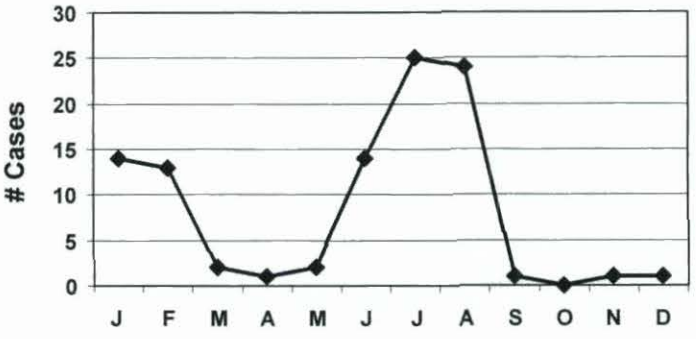


Figure 3. Water shortages in the Los Saínos microwatershed, Colombia.

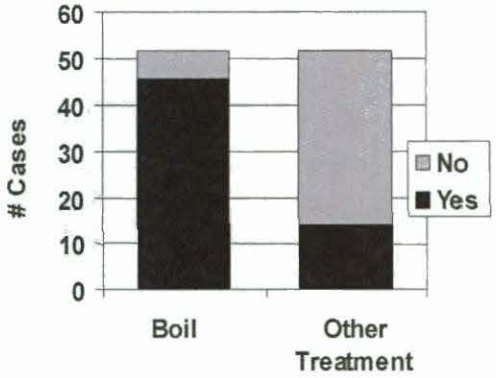


Figure 4. Water treatment for human consumption.

Rehabilitating water sources

After presenting the survey results to the community, people who live in the upper, central, and lower areas of the watershed decided to launch a program to rehabilitate the water sources in the upper area. The first step was constructing barriers to retain the sediments and the next step was conducting a reforestation day, when native trees were planted (Figures 5 and 6).

Figure 5. Gully rehabilitation work group, Los Saínos watershed, Colombia.

Figure 6. Constructing sediment barriers for erosion control.

Water consumption

To discover water demand and thus be able to compare it with the hydric offer, domestic and production consumption of water was measured on farms (Figure 7).

Figure 7. Measuring water consumption in the house.

Families in the microwatershed have regularly been prohibited from using water for activities such as irrigating crops or animal care, but the results showed that total consumption is double that of the domestic consumption normally required by urban dwellers (Figures 8 and 9).

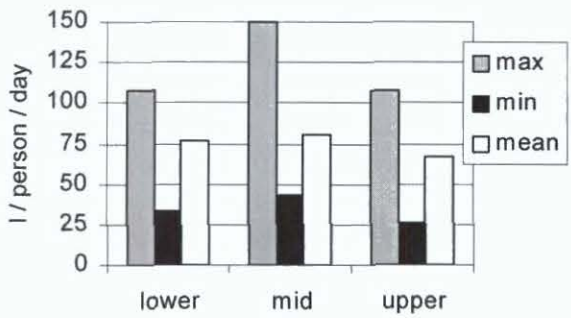


Figure 8. Daily domestic consumption.

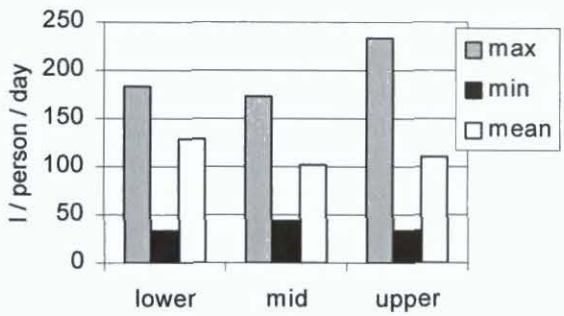


Figure 9. Daily domestic and production consumption.

Water quality

Recognizance sampling of water quality was conducted for the tributaries in the upper, central, and lower reaches of the watershed (Figures 10 and 11).

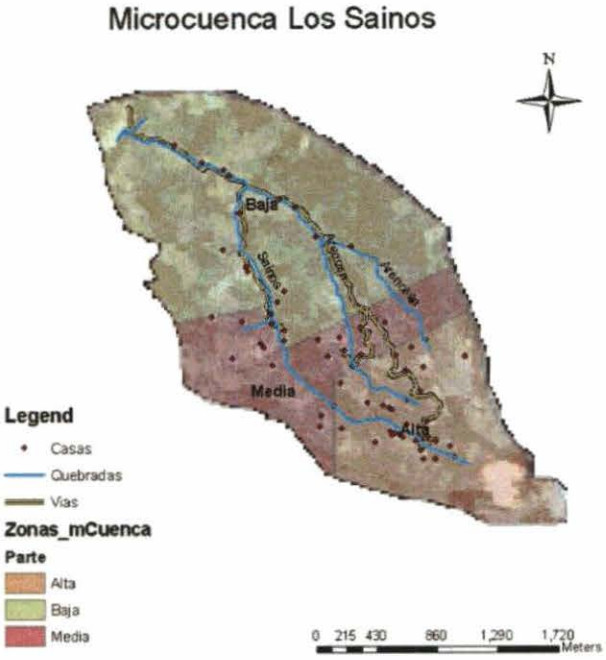


Figure 10. Los Saínos microwatershed, Colombia.

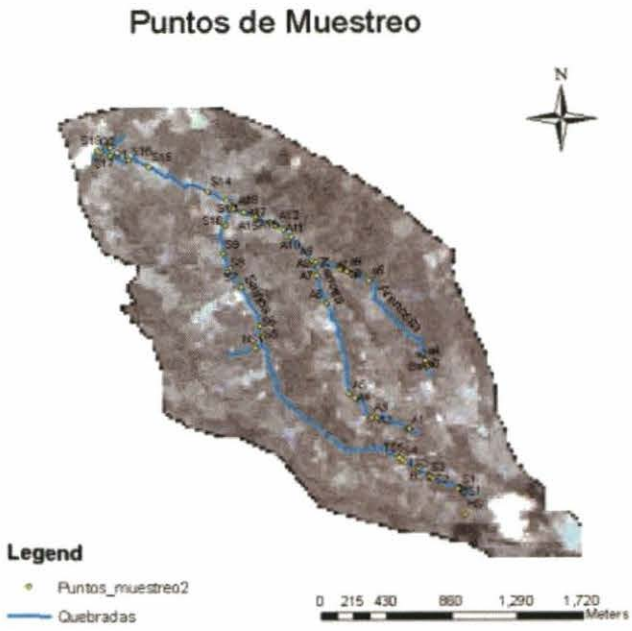


Figure 11. Water quality sampling sites.

Conductivity is a physical variable that expresses the capacity of water to transport an electric current and depends on the quantity of dissolved ionized substances. The sources of these substances may include soil with high content of calcareous stone, domestic or industrial discharge of wastewaters, crop runoff carrying fertilizers or pesticides, or erosion of loose soil. In the Los Saínos microwatershed, according to an exploratory sampling, conductivity increases from the upper watershed to the lower, with three observable jumps in values (Figure 12).

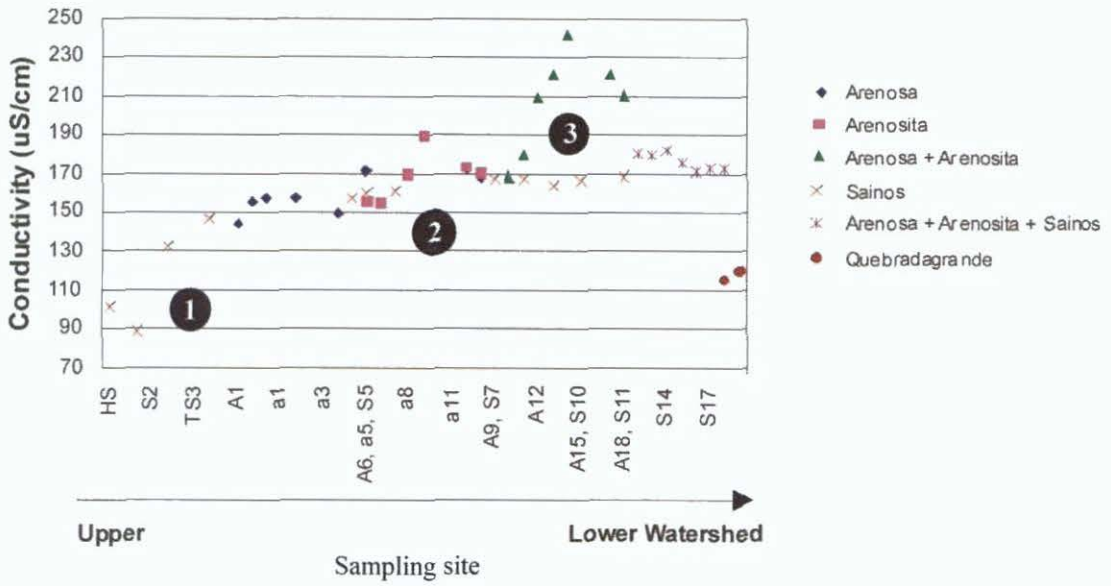


Figure 12. Conductivity of water in Los Saínos microwatershed, Colombia. Three jumps in values are indicated by numbers in circles.

In the upper watershed (1, Figure 12), there is an increase in conductivity because of the nature of the soil. This is demonstrated by a commensurate increase in chemical water hardness within a protected area (with no access to animals). In the Arenosita stream (2), the values of conductivity increase as a result of discharges of domestic wastewaters. In the Arenosa stream (3), the change in conductivity results from discharges of water used to clean pigsties.

Likewise, the number of fecal coliforms increases from the upper to the lower microwatershed (Figure 13). Even the more protected areas such as the wetlands and springs present levels from 80 to 240 cfu/100 mL. According to the World Health Organization, the number of colony-forming units should not be higher than 10.

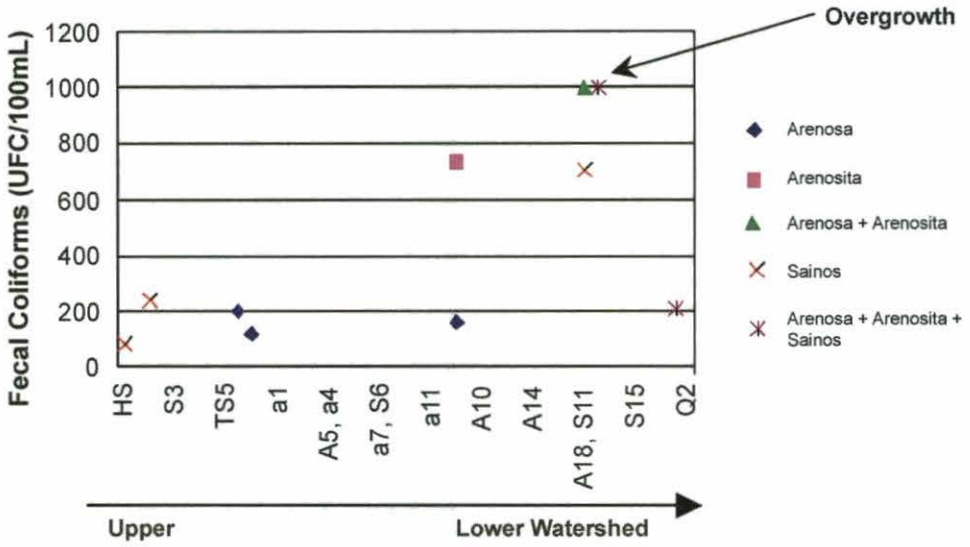


Figure 13. Levels of fecal coliforms found in the Los Saínos microwatershed, Colombia.

Actions

Some best-management practices are used in the watershed, including rainwater harvesting, installation of floats in storage tanks to stop overflow, use of water hose guns, and re-use of gray waters. A community meeting was held to discuss the results of the water use and quality study, and the following activities were agreed on for implementation:

(1) Installation of a sand filter at the school.
(2) Construction of fencing and reforestation in critical areas.

In addition, the landowner at a critical pollution point has agreed to install a biogas digester with the support of the project and the Municipality of El Dovio.

2.1.2 Food security: biointensive vegetable gardening in the Garrapatas River watershed, Colombia

Related milestones

Best-management practices

Background

This activity aimed to:

(1) Develop, through action-oriented research, leadership skills in seeking to improve food security and nutritional offer for the community, using technologies that contribute to the conservation and integrated watershed management.
(2) Establish a teaching-learning model that can be replicated in other areas, based on the lessons learned from this process.

Methodology and results

(1) Initial diagnosis (baseline survey; Figure 14): *composition of the* diet; presence of gardens; identification of products that are bought, produced, and exchanged; use of inputs for pest and disease management.

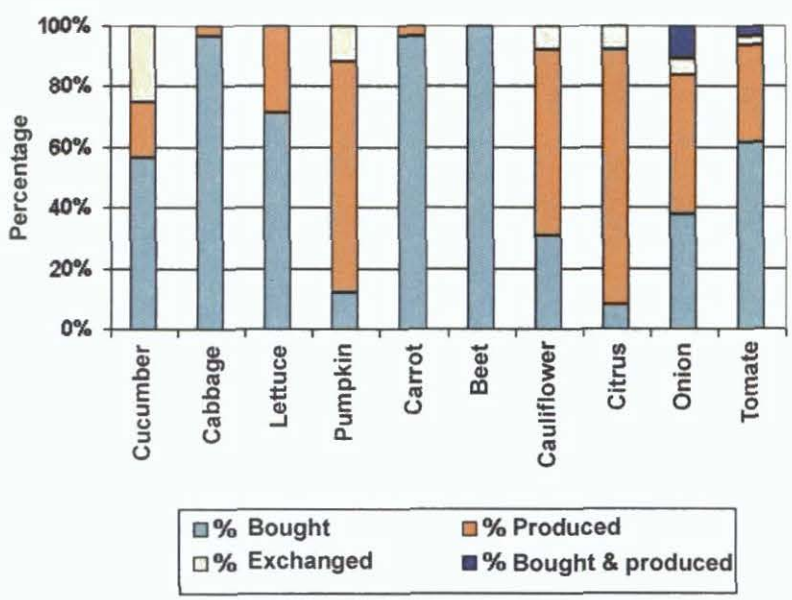
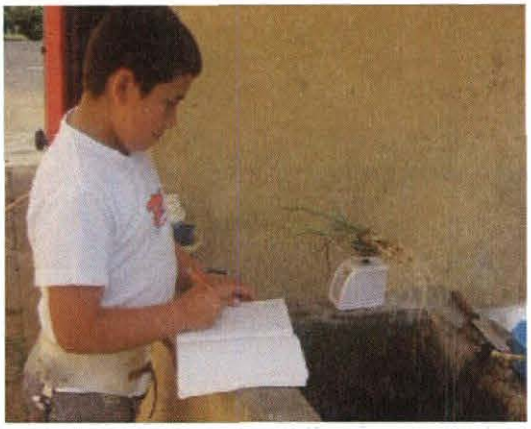


Figure 14.
A significant portion of the vegetables consumed is purchased, thus greatly motivating the community to implement biointensive vegetable gardens.

(1) Training in the construction and importance of gardens, promoting organic agriculture.
(2) Development of action-oriented research to improve the food security and nutritional offer for the area's families (Figure 15).



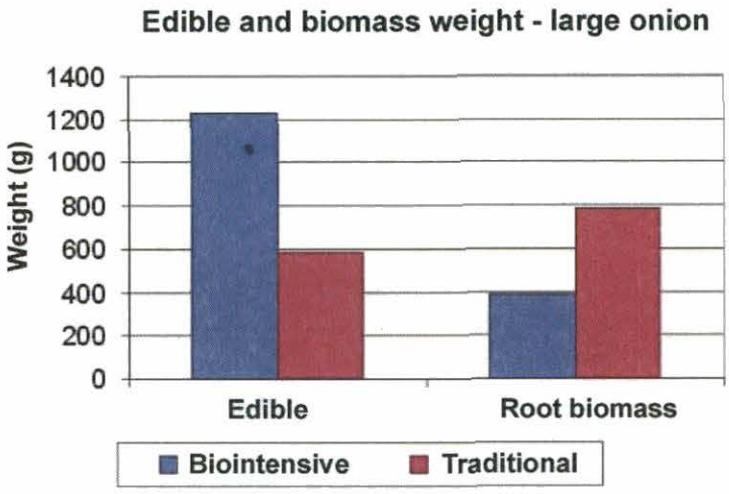


Figure 15. Measuring the edible and biomass weights of spring or green onion.

(3) Establishment of research trials, where comparisons of production were made between the traditional and biointensive systems Figure 16.

Figure 16.
The biointensive gardens permit better plant development, using resources more efficiently and producing a larger quantity of food.

(4) Identification of native seeds and exchange between villages to recover and promote these products of high nutritional value for cultivation in gardens.

(5) Adaptation and multiplication of local and native seeds (e.g., spinach, broccoli, peas, common beans, soybeans, maize, and cabbage) in the area, and designing two artisanal irrigation systems (drip and sprinkle) in which water consumption is quantified for each system.

(6) Workshops on nutrition and preparation of food from soybeans and vegetables to complement other related activities.

(7) Monitoring activities adopted in the biointensive gardens. This process was replicated through the UMATAs in other villages of El Dovio, where the entry point to these villages was the schools of the José María Falla College.

Conclusions and next steps

A major motivation for the community to implement biointensive gardens is to provide fresh nourishing food that contributes to family savings, marketing only the surpluses of basic grains, and giving away vegetables. Even so, some families were not encouraged and preferred to buy vegetables because they did not consider that what they would save on buying vegetables would be significant.

Families see that having biointensive gardens in their plots is highly useful, because farming in the region is predominately carried out by smallholders, and these systems can be implemented in small areas.

The participants highlighted the importance of research, seeing it as a good educational tool for their own integrated formation.

The community is interested in marketing its surpluses, and regard as important to continue engaging in this activity.

The production of organic inputs and vegetables for household consumption needs to be strengthened, using seeds from the area, for example, cabbage, squash, and spinach, which have high vitamin content but are little used.

2.1.3 Integrated animal production systems, Garrapatas River watershed, Colombia

Related milestones

Best-management practices

Background

As a component of the youth-led research project in the Garrapatas watershed, our research partner CIPAV developed, together with three groups of youth co-researchers, alternative animal production systems based on local resources and aimed at improving food security and making better use of abundant natural resources.

The decision to implement three rural livestock systems was made together with the project's beneficiaries:

(1) Rural pig raising. Feed comprises locally available forage resources.
(2) Rural chicken-range systems. Chickens receive supplements of forage and maize, and are used to clean plots of grasses.
(3) Rural fish farming. Small outputs, with low populations, and serving mainly to ensure food security.

Young researchers

For pig raising:

Sergio Rodríguez	José Iván Pineda	Jildardo Antonio Pineda
Emilce Cárdenas	Edward Espinoza	José Leonel Marulanda
Jorge Alexis Blandon		

For poultry farming:

Yerson Bernardo	Nallibi García	Paola Andrea Aristizábal
Diana Cristina	Mónica Manrique	Leidi Carolina Giraldo
Sandra Escudero	Maida Melo	María del Pilar Giraldo
Mónica Quintero	César Antonio Henao	
Sergio Antonio Zuleta		

For fish farming:

Hilver Agudelo	Wilder Agudelo	Erika Jhoana Sánchez
Yenny Rodríguez	Yuri Marcela Salazar	
Jaime Alonso López	Yeimer Leandro Muñoz	

CIPAV researchers:

Mauricio Trujillo	Edwin Caro	Elkin Pulido
César Cuartas		

Rural pig raising

Purpose: To analyze and evaluate the consumption of shrubby and herbaceous forages of primarily high protein value, such as nacedero (*Trichanthera gigantea*) and bore (*Xanthosoma serratifolium*), or of high energy value, such as sugarcane (*Saccharum officinarum*).

The forages were provided fresh during pre-fattening and at the start of fattening (30-70 kg), replacing about 60% of the diet in a traditional exploitation system (forage plot) and comparing it with a diet of 100% commercial concentrate (control plot) (Table 1).

Table 1. *Proposed treatments and feeding regimes.*

Diet	Control plot	Treatment plot
Commercial concentrate (%)	100	40
Quantity of forage	0	*Ad libitum*
Energy base	0	*Ad libitum*

To evaluate:

- Daily offer of forages and other feeds on a fresh weight basis (kg)
- Rejection of forages and other feeds on a fresh weight basis (kg)
- Daily weight gain (DWG), based on weekly weigh-ins

Results: The differences in DWG among plots with forages were not significant among the villages La Hondura (452 g/pig) and Maravélez (487 g/pig). However, the time the animals in these plots took to acquire total weight gain and appropriate sale weight was affected. For example, in Maravélez, pigs feeding on forage and sugarcane juice took 106 days (i.e., longer) to gain 51.6 kg. These results can be explained by two factors:

(1) The area's climatic conditions, especially temperature, limit swine production.
(2) In Maravélez, fresh cane juice was used to increase the energy base and so compensate for the losses in body temperature that the animals suffered.

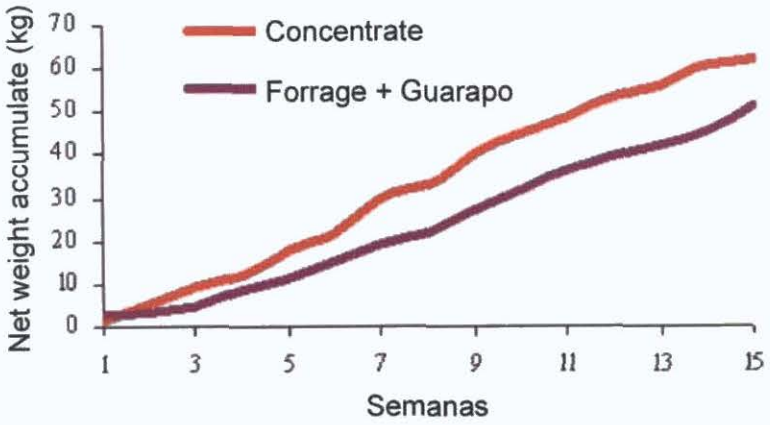


Figure 1. Weight gained by pigs raised on different feeds, Maravélez village, Colombia.

Labor costs for the treatment plots represented about 20% of total production costs. However, the costs saved from using concentrate were between 18% and 20%. Overall production costs with forages were higher than with concentrate because the distances involved in transport increased labor costs.

Rural chicken-range systems

Purpose: Observational trial with commercial lines of middle-weight chickens, associated with different crops: star grass (*Cynodon nlemfuensis*), signalgrass (*Brachiaria decumbens*), small banks of protein of nacedero, Mexican sunflower (*Tithonia diversifolia*), and tannia. These crops replaced 50% of concentrate and were supplemented with 20 g of maize per bird per day, and with free access to forages such as nacedero, tannia, and/or ramio (*Boehmeria nivea*). The lack of supply and/or suspension of supply of concentrate in the trial significantly affected egg-laying (Table 2, Figure 18).

Table 2. Egg-laying according to village.

Village	Beginning of laying period	Week at which laying begins	Eggs laid by week 40 (no./bird)
Bitaco	21/11/04	24	87.5
La Hondura	16/12/04	27	68.9
Balcanes Bajo	15/01/05	31	70.3
Maravélez	18/01/05	32	51.8

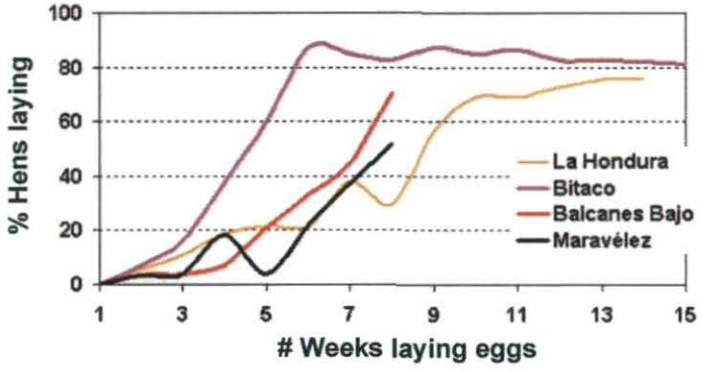


Figure 18. Percentage of hens laying, once egg-laying starts.

Figure 19. Weighing eggs.

Rural fish farming

Purpose: To evaluate the adaptability of a polyculture of mirror carp (*Cyprinus carpio*) and Nile tilapia (*Oreochromis niloticus niloticus*) under conditions of low-density rural fish farming, using feed from local resources (banana, maize, and rice), forages, and restricted concentrate.

The results showed the Nile tilapia to be the most appropriate type, for the following reasons:

- Lower mortality
- Possesses a greater range of adaptability to adverse climatic conditions
- Being omnivorous, it can use a larger number of local resources as feed
- Sexual maturity is reached in about one year in the tropics, thus easier to keep in ponds for longer periods

This type of trial was conducted in the area as an alternative for food security. Significant advantages exist in implementing this type of production system in terms of quantity and quality of water (Figure 20).

	Mortality (%)		Period of greatest
Village	Tilapia	Carp	mortality
Balcanes Alto	18	18	Days 2 to 5 after introduction
Balcanes Bajo	9	9	Days 3, 4, and 22 after introduction
La Hondura	26	26	Days 3 to 7 after introduction

Figure 20. Mortality of fish in the trial on integrated production systems.

For commercial production, mortality rates are expected to be as much as 25% after introducing the fingerlings. When the variability of day-to-night temperatures in the area is more than 10 °C, it increases the metabolic rate, which in its turn, represents an increase of biological oxygen demand (BOD). Excessive handling and maltreatment of fish during collection and packaging at the commercial farm is another factor of mortality.

Alternative feed resources used for fish:

Table 3. An alternative dietary resource used to feed fish is dung, with which the tanks are fertilized.

	Quantity of dung needed (kg)	
Source	12 m^2 tank	50 m^2 tank
Cow	0.84-1.44	3.5-6.0
Pig	0.72-1.56	3.0-6.5
Chicken	0.20-0.42	0.85-1.75

Based on the supply of local resources and their acceptability to fish, the young people emphasized as most important to supplement fish feed with the following local resources:

- Tannia leaves, as being the forage most consumed on a fresh weight basis
- Kitchen waste, especially rice
- Mature fruits such as guava and plantain
- Fresh or dried Californian red worm

		Number of fish		Weight (g)		Length (cm)	
Village	Date	Tilapia	Carp	Tilapia	Carp	Tilapia	Carp
Balcanes Alto	14/12/04	7	7	14.5	11.5	5.4	5.2
	22/12/04	4	5	37.5	16.0	14.7	6.4
	25/01/06	4	5	102.2	67.8	19.5	12.6
Balcanes Bajo	19/01/06	8	6	22.1	8.3	11.1	5.5
La Hondura	13/12/04	11	11	12.6	33.3	6.1	9.8
	25/01/05	9	9	22.1	74.2	8.1	12.2
	16/02/05	14	11	83.6	96.9	15.8	14.2

Figure 21. Fish measurements according to village.

2.1.4 Characterizing local forests for ecological restoration, Los Saínos, Colombia

Related milestones

Best-management practices

Researchers:

Youths: Julian Giraldo, Adriana Giraldo, Lina Giraldo, Jesús Antonio Castellanos
CIPAV researchers: Lorena Piedrahita, Zoraida Calle

Objectives

(1) To characterize the trees and shrubs of the villages of Bellavista and Los Saínos to identify useful species for initiating ecological restoration of the forest
(2) To characterize the botanical composition and physiognomy of forest fragments (Table 4)
(3) To discover what rural dwellers like about trees and shrubs and what they know about their use
(4) To identify useful trees and shrubs to initiate ecological restoration of forests in degraded lands and to enrich secondary forests (Figure 23)

Table 4. Inventory of forest relicts in the Los Saínos microwatershed, Colombia.

Village	Forest	Altitude (m above sea level)	Area (ha)	Uses
Bellavista	Q. Los Saínos	1830	3.7	Timber for posts
	Alto Bonito	1962	1.4	Extraction of orchids
	El Higuerón	1752	0.9	Research
	Las Palmas	1846	1.2	Firewood, posts, and poles
Los Saínos	Los Bedoya	1705	2.4	Firewood and posts
	Los Montoya	1686	1.1	Firewood and posts
	Don Delio	1742	5.2	Firewood and posts
	Don Ezaú	1793	1.3	Firewood and timber

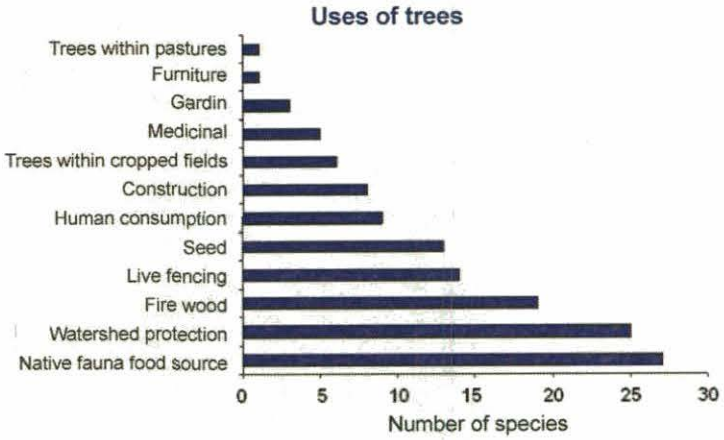


Figure 22. Community use of tree species

The most appropriate trees for restoration should have the following characteristics:

- Symbiosis with nitrogen-fixing bacteria
- Able to adapt to degraded soils
- Abundant regeneration
- Rapid growth
- Trunks and roots able to shoot
- High production of fruits and seeds
- Trees in danger of extinction
- Food source for native fauna
- Suitable for protecting microwatersheds
- Able to grow in landslides

Examples of appropriate trees for ecological restoration (Figures 23 and 24):

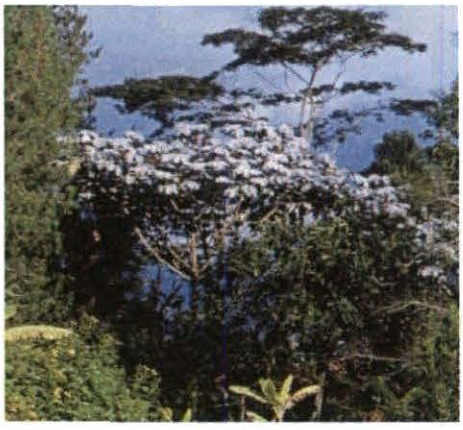


Figure 23. White yarumo (*Cecropia telealba*)
Rapid growth
High regeneration rate
Leaf litter decomposes rapidly
Wide canopy
Food source for native fauna
Protects water sources
Ornamental tree

Figure 24. Arboloco (*Montanoa quadrangularis*)

Rapid growth
Colonizes degraded areas
High capacity to shoot
High seed production
Good for construction

2.1.5 Evaluating the influence of the riparian giant bamboo (*Guadua angustifolia*) forest on the quality of the aquatic ecosystem and its water

Background

The watershed of the El Dovio River possesses extensions of riparian forest dominated by giant bamboo. This bamboo fulfills an important environmental service by protecting water quality of the watershed's hydric network. The biological, physical, and chemical characteristics of the rivers are integrating elements that help diagnose water quality and identify the consequences of watershed management practices. As a result, they are indicators that provide elements to support the formulation and execution of action plans.

Thus, the objectives of this study are to:

(1) Compare the river's physical, chemical, and biological characteristics between monitoring stations;
(2) Quantify biological, physical, and chemical indicators of water quality at monitoring stations whose riparian forests present different levels of forest management;
(3) Identify areas in the watershed where management action must be taken to conserve the forest and sources of water; and
(4) Develop a methodological proposal to write primers on the results obtained to provide support for environmental education on aquatic ecosystems and as possible support for the management of this forest ecosystem.

Materials and methods

The study was conducted in the watershed of the El Dovio River, which flows into the central valley of the Garrapatas River. The watershed is located in the western Andean ranges, in southwestern Colombia. It is part of the biogeographical region of Choco, a priority area for the country because of its high biodiversity.

Ten sampling stations were selected along the stream Los Saínos, which flows into the Quebrada Grande (*lit.* "Large Stream"). The stations were named Before, Within, and After the Tiberio Forest, itself located in the Ciprés Natural Reserve; New Bocatoma; Before, Within, and After the School Forest; and Before, Within, and After the Forest Crossings. Another three stations were selected along the Quebrada Grande and named Before, Within, and After Quebrada Grande. A final three were selected along the El Dovio River and named Before, Within, and After El Dovio River.

Samplings were carried out in "summer" (dry season) and "winter" (wet season), two samplings per season. Samples included benthic macroinvertebrates associated with different substrates of the streams. Physical and chemical measurements were also taken, such as conductivity, total dissolved solids (TDS), pH, dissolved oxygen, temperature, nitrates, phosphates, and turbidity.

Physical and chemical variables. The values for conductivity and TDS declined as the water passed through the riparian School Forest of Los Saínos, the Forest Crossings, and Quebrada Grande (Figure 25). This decline of concentrations may possibly have been a result of these forests acting as a filter, trapping pollutants and sediments and thus increasing the values of conductivity and TDS in the water.

This behavior was not observed between the station in the forest of the Ciprés Natural Reserve and the station located at New Bocatoma. The increase in conductivity and TDS at these stations is possibly a result of organic matter entering the river from agricultural and livestock activities very close to the sampling stations.

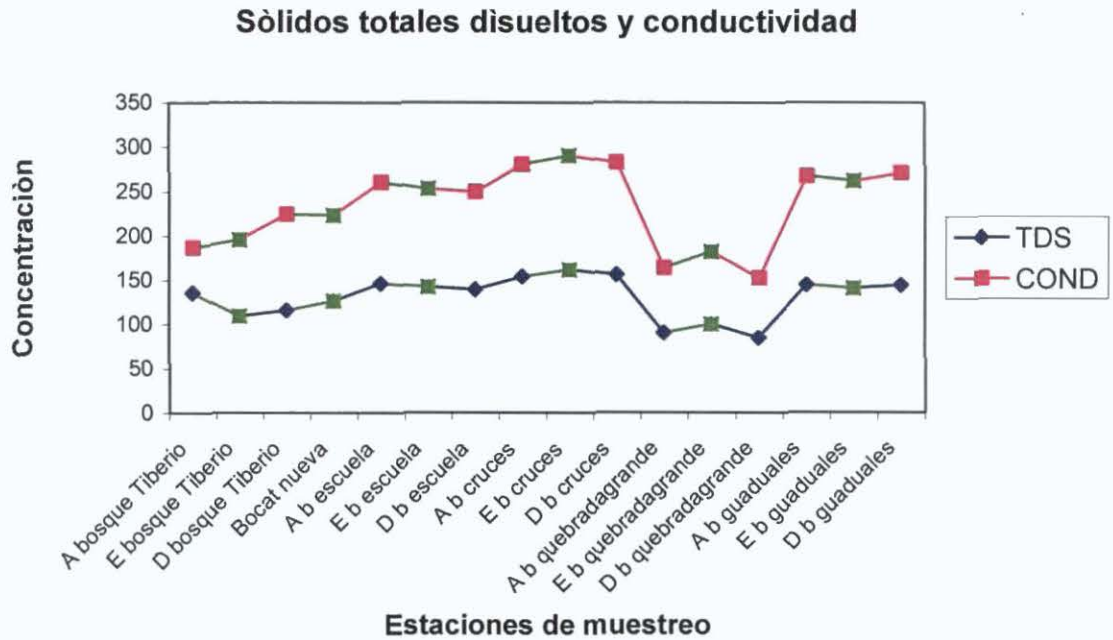
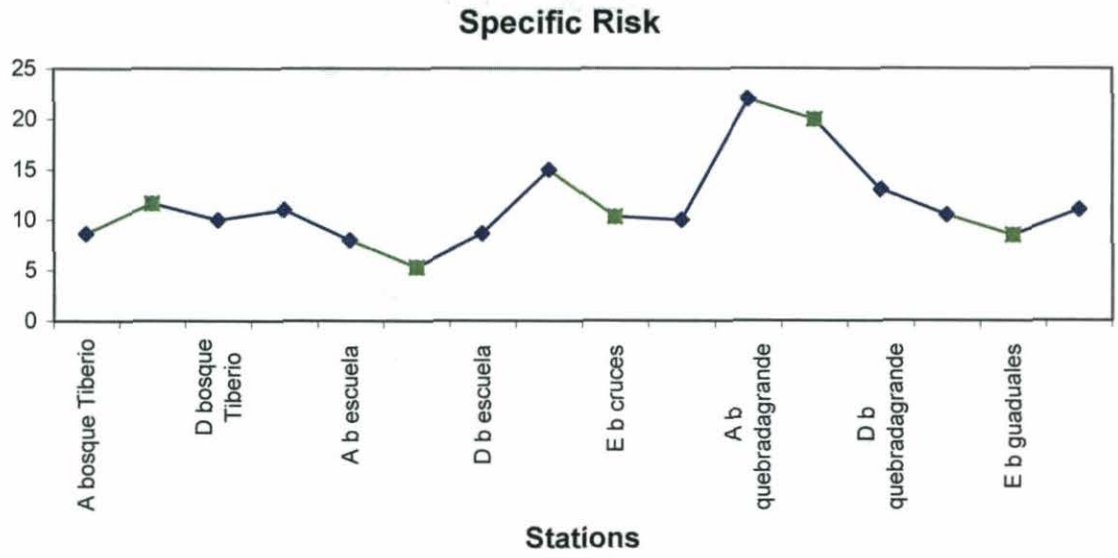


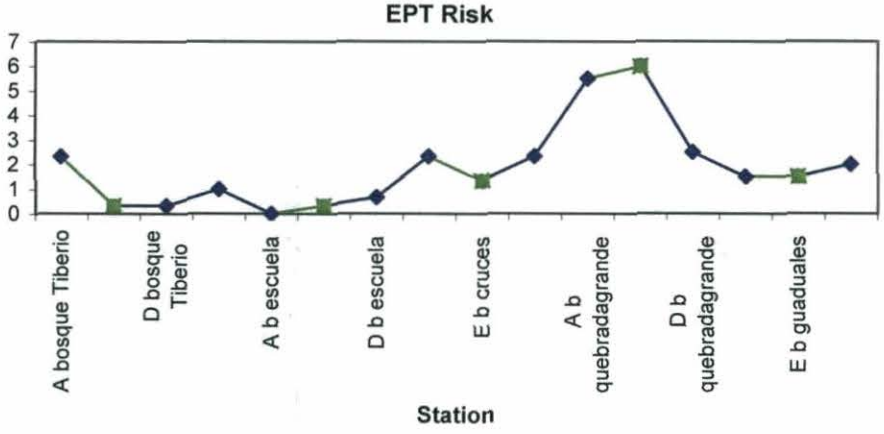
Figure 25. Spatial variation of total dissolved solids,TDS (mg/l) and conductivity, COND (µs/cm) in a study on the impact of riparian bamboo forests on water quality.

Biotic variables. The biotic indices, calculated as total species richness, EPT species richness, and diversity (Figure 26), can be clearly observed as increasing as the water moves away from the School Forest station, where the forest is characterized as being little disturbed, with very low levels of use, compared with the other stations.

(A)


Specific Risk
25
20
15
10
5
0
A bosque Tiberio
D bosque Tiberio
A b escuela
D b escuela
E b cruces
A b quebradagrande
D b quebradagrande
E b guaduales
Stations

(B)


EPT Risk
7
6
5
4
3
2
1
0
A bosque Tiberio
D bosque Tiberio
A b escuela
D b escuela
E b cruces
A b quebradagrande
D b quebradagrande
E b guaduales
Station

(C)

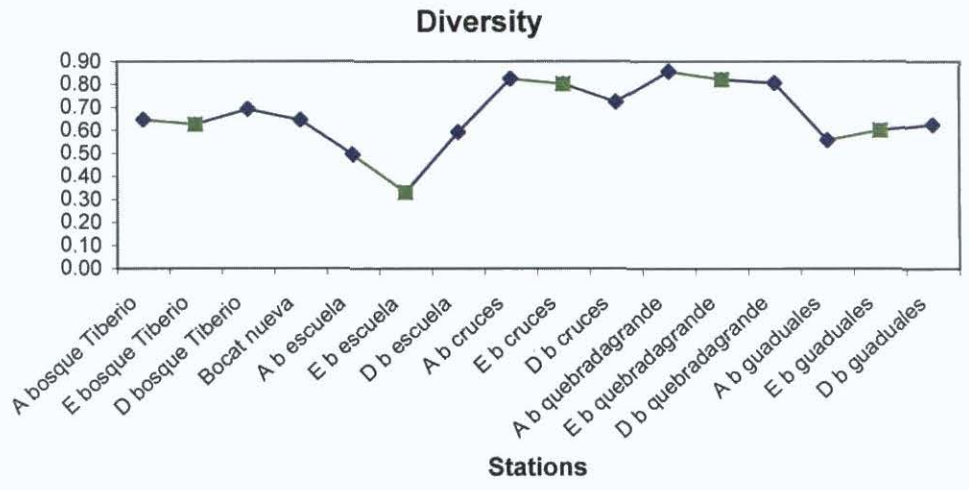


Figure 26. Spatial variation of biotic indices: species richness (A), EPT species richness (B), and diversity (C). For a study on the impact of riparian bamboo forests on water quality.

Overall, the Los Saínos stream begins being disturbed by agricultural and domestic activities a few kilometers from its source and, as it arrives at the station Within the School Forest, that forest fulfills an important filtering role, restoring the aquatic ecosystem to as far as the El Dovio River. There, because of the high rate of dumping from the urban area of the Municipality of El Dovio, which constitutes about 2000 inhabitants, the river deteriorates, as shown by its biotic indices.

Conclusions

Results on physical and chemical variables such as conductivity and TDS showed that these decline at some stations after the water has passed through the riparian forest. While the biotic indices did not show these changes in detail, similar results could be seen at the stations located after the riparian forests. Only one marked change was observed at the station Within the School Forest, which had the lowest degree of use in the study. Such a change indicates that physical and chemical variables undergo wide fluctuations and thus may give more accurate information on observed changes.

With the biotic indices, we saw no clear pattern of positive influence from the riparian forest on water quality, possibly because the pollutants that reached the river were not sufficient to destabilize the biological communities. In contrast, the physical and chemical variables were more fluctuating.

The principal critical points, from the watershed to the stations, were identified as being before the riparian forest facing the school in the Los Saínos stream, where waste arrived from pig raising; and at the stations on the El Dovio River, where a high pollution load was coming from dumpings from the urban area of this municipality. Hence, liaison with local entities is essential for executing action plans.

The indices applied in this study clearly show disturbance in the watershed's drainage network, even though only minimum changes are reflected because of the presence of the riparian forest. These indices have been applied in other studies conducted by the project. These should therefore be included as input into the methodological proposal for monitoring water quality in a microwatershed.

Developing a proposal for a methodology to support environmental education on aquatic ecosystems

During the research, five workshops were held with young people. At the beginning of the study, the proposal was generally described and the youths asked open questions on what "watershed" meant to them and what role forests growing on river banks played according to local knowledge. At the end, feedback was given. During sampling, the youths visited the monitoring stations to learn techniques of collecting research data. Later, indicators were identified according to the youths' local knowledge, and a priority matrix was made with these indicators so they could determine whether a river was heavily or moderately contaminated, or had little or no contamination. Thus, they learned to predict a river's level of contamination by using technical methodology.

With the inputs of these workshops and the lessons currently being learned, a methodological tool is being designed, so that young people can know a little more about aquatic ecosystems and be able to apply a methodology to monitor water quality in a microwatershed (Figure 27). One product expected from this process is an educational primer that is applicable to other sites.

Figure 27. Youths learning about aquatic ecosystems and techniques for monitoring water quality, El Dovio, Colombia.

2.1.6 Wetlands and water quality, Yorito, Honduras

Related milestones

Monitoring networks, primary data collection, best-management practices

Background

A basic function of wetlands is to help reduce levels of contamination in wastewaters. The urban zone of the Municipality of Yorito contributes grey waters from dwellings. These flow to La Pimienta stream. In 2003, the first bioenvironmental wetlands were constructed with young researchers from the San Pedro Institute of Education. The youths measured the water quality and their results were reported in the 2004 annual report. During 2005, the young researchers focused their management activities of the wetlands and implemented actions that improved infiltration and reduced contamination of the waters that reached the principal stream. For this purpose the wetlands are being redesigned to add other components such as placing gabions, planting *Valeriana officinalis* (garden valerian) or vetiver grass, entry channels, stone walls, rubbish-retention grills, and expanding the wetlands (Figure 28).

Figure 28. La Pimienta wetland, Yorito, Honduras (Left photo). Building the wetland stone wall (Right photo).

Biological evaluation

To measure the effect that the wetlands would have on water quality, the young researchers quantified the macroinvertebrates (tool for monitoring water quality) living in La Pimienta stream. The results, presented in Figure 29, indicate a high presence of macroinvertebrates that tolerate pollution, especially those of the Oligochaeta family, thus indicating high contamination of the stream.

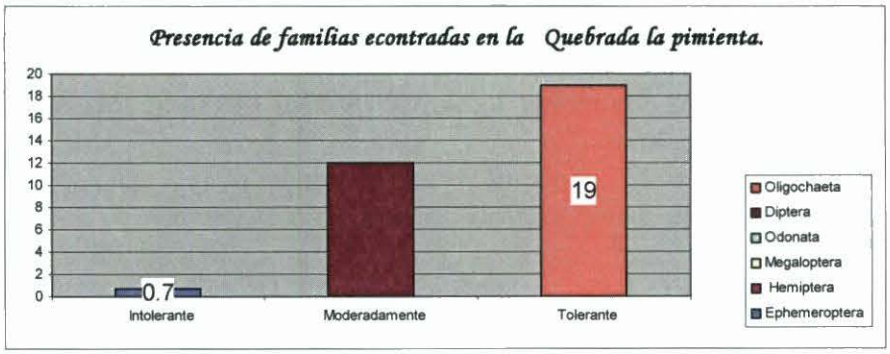


Figure 29. Families of macroinvertebrates found in La Pimienta stream, Yorito, Honduras.

Replication

As a result of this initial work, the Municipality of Yorito, through the Environmental Municipal Unit and with the support of the youths from the San Pedro Institute of Education, constructed more wetlands to filter the confluent waters of the Aguan River, as shown in Figure 30.

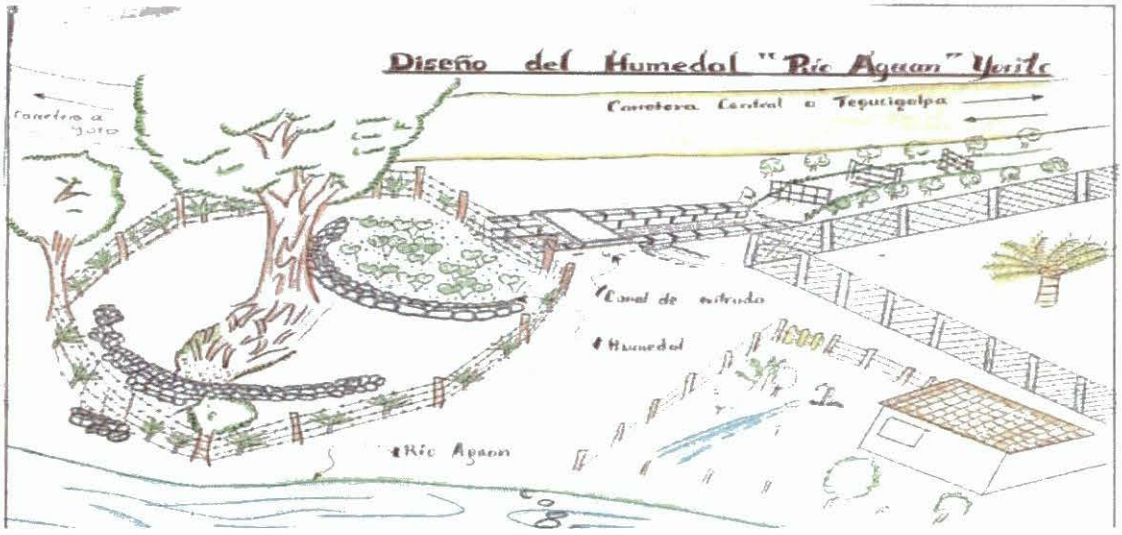


Figure 30. A design for the Aguan River wetlands, Yorito, Honduras.

The Aguan River is one of the largest in the country, draining to the Atlantic Ocean. It is of great importance for the production of banana, citrus fruits, African palm, basic grains, and livestock for the entire Aguan Valley, located in the Departments of Yoro and Colón.

Problems frequently identified in managing wetlands in Yorito

- In winter, the bioenvironmental La Pimienta wetlands are not able to filter all the rainwater that flows into it.

- As products of the rains, the wetlands are saturated with different types of sediments brought by the rains.
- The care given to the wetlands by local authorities is limited.
- Neighbors show little interest, continuing to throw rubbish in the streets and gutters whose waters drain into the wetlands.
- The forces of rainwater erode gullies in the El Aguan wetlands.
- The pressure of runoff causes water to flow to the main waterway without passing through the wetlands.

Actions

On finding these limitations and to improve the performance of the wetlands, the young researchers, with support from the San Pedro Institute of Education and the Municipality, will continue, in 2006, to:

(1) Monitor water quality, obtaining physical, chemical, and biological data; and
(2) Evaluate the wetlands' performance to continue making technical adjustments to increase their efficiency.

Recognition

The Municipality of Yorito, Honduras, awarded a certificate of recognition to CIAT for the Center's invaluable support in the Municipality's administration of its water, agricultural, and natural resources.

REPÚBLICA DE HONDURAS
MUNICIPIO DE YORITO
DEPARTAMENTO DE YORO

LA CORPORACION MUNICIPAL
DE YORITO, YORO

OTORGA EL PRESENTE DIPLOMA DE

Reconocimiento

A: CEAT

Por su invaluable apoyo en la gestión municipal 2002 - 2006

Yorito, Yoro 25 de enero de 2006

MANUEL DE JESUS CANTILLANO
ALCALDE MUNICIPAL

DANIA MENCIA
SECRETARIA

2.1.7 Water sources: their management and potential contamination, Yorito, Honduras

Related milestones

Baseline water survey

Background

Previous annual reports had presented results on the development of a general baseline survey with biophysical and socioeconomic indicators of integrated watershed management. These results have shown deficiencies in historical information both in quantity and quality of water, which prevented statistical analysis for identifying the highest risk zones for populations in terms of water use. The Land Use and Development Plan of the Municipality of Yorito, executed in 2003, established that water resources are facing costly deterioration, which is being reflected in reduced water quality and quantity. As a result, water management is a problem to solve at the watershed level, with particular attention to those areas producing potable water and are fundamental for the Municipality's well-being and socioeconomic development.

To help communities and local government supply basic information for developing plans on microwatershed management, this study is:

(1) Georeferencing and characterizing the area of irrigation-ditch construction;
(2) Georeferencing water-storage tanks;
(3) Georeferencing and characterizing the area of the potential permanent springs; and
(4) Updating and locating communities.

Baseline survey of water

In the watershed of the Tascalapa River live about 2022 families who represent about 13,200 people, grouped into 41 communities, which have 30 water boards for a total of 33 springs. About 140 potential and permanent springs were identified, their waters currently being used for agricultural crops, drinking troughs for livestock, and wells for houses and huts (Figure 31).

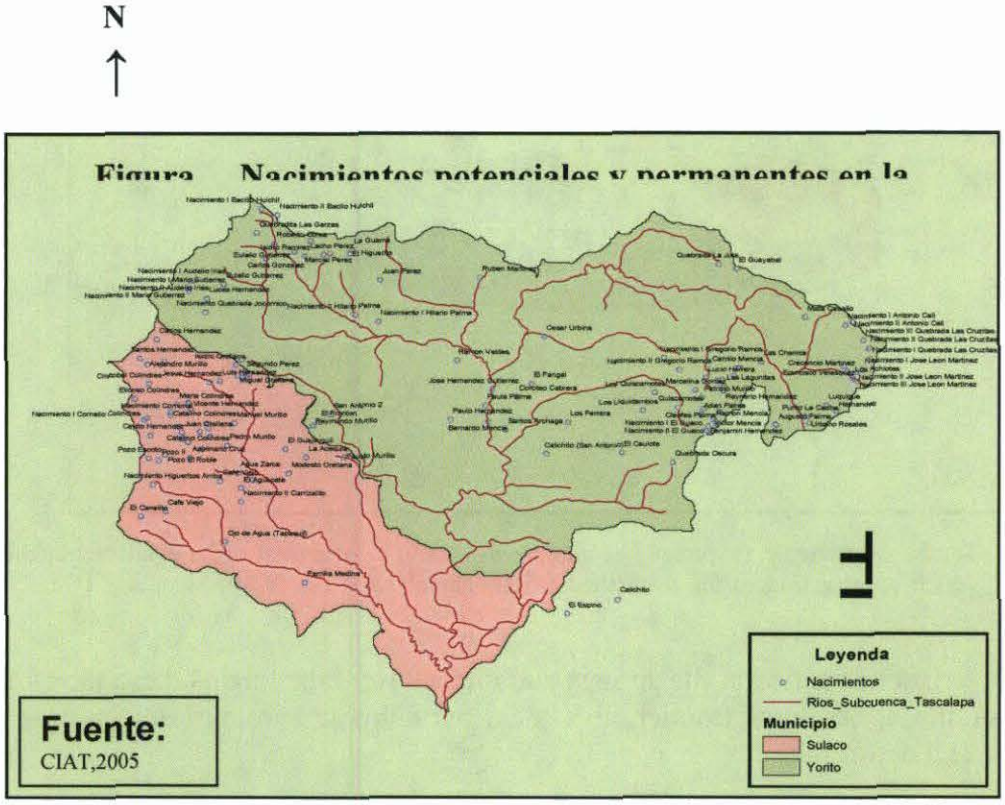


Figure 31. **Potential and permanent springs in the watershed of the Tascalapa River, Yorito, Honduras.**

Of the 38 irrigation ditches existing, 32 have their own water-storage tank. The others are directly connected or are public ditches. About 53% of the ditches were classified as being in a bad to regular state and 34% as being good. This evaluation took into account the state of the infrastructure, security, quality of maintenance, and area protected. For protected areas, 54% of ditches possessed minimal protected total area, that is, from zero to two *manzanas* (1mz = 0.64 ha). The highest level of protection observed was from four to six *manzanas* (15%), while another 31% of ditches had a total protected area of two to four *manzanas* (Figure 32). In the protected areas, 89 predominant forest species were identified, including the most frequent: *guama* (*Inga* sp.), *aguacatillo* (*Ocotea* aff. *jorge escobarii*), *cachimbo* (*Platymiscium dimorphandrum*), and oak (*Quercus skinneri*).

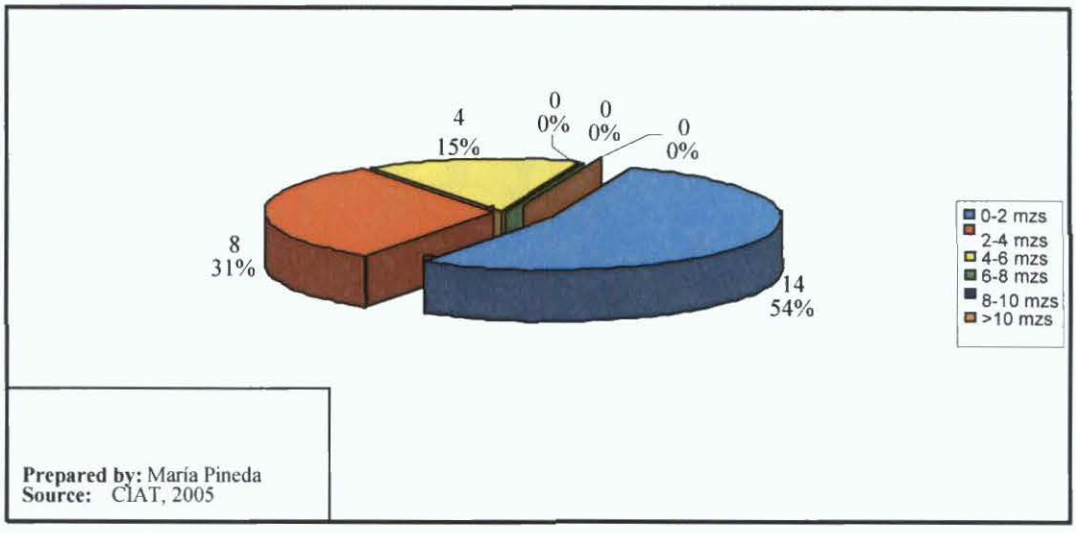


Figure 32. Total area protected (expressed as number of ha and % of a total of 26 evaluated ditches) in the areas of irrigation-ditch construction in the watershed of the Tascalapa River, Yoro, Honduras ("mzs" refers to *manzanas*)

Another characteristic identified at the springs and ditches were the threats these face, including the advance of the agricultural frontier, livestock, agricultural burnings, forest fires, use of agrochemicals, and deforestation.

Water quality

The Municipal Health Center is the entity responsible for monitoring water quality, especially at the household level. In some specific cases, other NGOs do the monitoring, but within the framework of projects or partnerships with international organizations. Quantifiable historical data of water quality in the watershed of the Tascalapa River are very limited. Currently, data on springs are available only for 1998, 1999, 2000, and 2003. Information for 2004 was provided by the Health Center, but could not be compared with the aforementioned data as they had been obtained at the household level and monitoring points were different.

According to the data, contamination levels have dropped but, because historical data are insufficient, water quality cannot be assumed to have improved. Of the 33 water boards, only that of Ojo de Agua has complained of the spring's water quality. Only two boards (Chagüitillo and Pacayal) had copies of results of analyses.

Quantity of water

Assessments of water quantity were carried out for 33 springs, prioritized according to the number of beneficiaries. Assessment method was governed by the infrastructure at each spring and conducted jointly with each water board (Lanza 2005). To analyze the information for both quantity and quality, comparisons between years were difficult because (1) not all springs had

been assessed historically; and (2) measuring methods varied from one institution to another, thus directly influencing the results.

As shown in Table 5, flows have diminished. An information gap exists between 2000 and 2005, indicating that, although values were available for some springs in 2004, the information was not enough to compare the cumulative flows. Overall, all the flows measured declined against the measure immediately before it. If gross values are taken, the cumulative total flow of 18 springs dropped by 60%. However, a monitoring process (4 × year) must be initiated to identify more precisely the springs' dynamics, as of the 33 springs, 16 have no records of assessments, even though beneficiaries exist. In some communities, alternative springs have been exhausted, thus leading to increased investments in water projects as water must be transported over long distances.

Water boards

The Marco Law for the potable water and sanitation sector (Presidency of the Republic 2003) gives functions to these local organizations to monitor water quality and quantity and to municipalities to socialize national environmental policies. The initiative begun in 2003 by the Municipality of Yoro in collaboration with the Health Center to form a local committee of water boards. However, it had to be dropped because these entities showed little interest in being organized. Hence, overall, water resources in the watershed of the Tascalapa River are being handled by communities, with no private entities involved. The water board members carry out their jobs on a volunteer basis, with only the plumber receiving payment to maintain and clean the tank. Results at the water board level indicate the following:

- Ignorance of the Marco Law for the potable water and sanitation sector.
- Coordination with the Health Center to establish a monitoring plan, with greater participation from the water boards.
- Training on assessing water quality and quantity so that a monitoring network is established and the boards can observe and discuss the dynamics of springs.
- Absence of meters mean that tariffs are not real and are collected in terms of quantity consumed. Beneficiaries pay a symbolic value (1-10 lempiras, i.e., about US$0.05-0.5 per month) for water.
- The water boards do not have a management plan that is established and functional.

Table 5. Comparing dry-season flows of springs in the watershed of the Tascalapa River, Honduras.

No.	Spring catchment	Community	Dry-season flow (gal/min)[a]					Benefi-ciaries[b]
			Q-98	Q-99	Q-00	Q-04	Q-05	
1	Los Anices	San Antonio	50	140	88.2	19.1	17.32	3600
2	La Lagunita	Luquigue	48.86	60	51.28	nd	21.4	1200
3	Piedra del Jamo	Carrizal	nd	nd	nd	nd	10	910
4	La Albardilla	Las Cañas	nd	nd	nd	nd	13	750
5	Piedra del Jamo	La Libertad	35.08	164	73.8	nd	10	702
6	Guichi	Vallecillos	nd	nd	nd	nd	5.83	576
7	Mina Honda	Mina Honda	nd	nd	nd	nd	1.32	510
8	La Fragosa	Las Minitas	38.9	32	38.21	nd	13	364
9	El Suyatal	La Sabana	nd	nd	nd	nd	13	275
10	El Cachimbo	Capiro	nd	nd	nd	nd	2.14	270

11	Los Rincones	Los Rincones	13.04	35	27.6	12	11.8	252
12	El Guarumal	Río Arriba	nd	nd	nd	nd	7.46	240
13	Loma Larga	Albardilla	7.95	11	12.6	13.3	17.84	240
14	Monte Galán #1	Monte Galán	nd	nd	nd	1.35	1.37	224
15	Chaguitillo	El Frontón	15.8	58	38.4	21.6	2.8	210
16	Mataguineo	Oropendula	nd	nd	nd	nd	0.23	200
17	El Caimito	Loma Larga	6.36	7.58	7.8	nd	17.84	189
18	Pajaritera	Campo 7	nd	nd	nd	nd	2.58	168
19	La Entrada	Entrada-Salida	nd	nd	nd	nd	1.16	114
20	El Salto	Guaco y Coroso	12	12	8.23	nd	12.84	140
21	Las Lagunas	Pichingo	10.9	3	28.57	nd	5.69	132
22	La Veguita	Coyol Dulce	3.53	22	7.43	nd	5.13	120
23	Ojo de Agua	Las Lajitas	1141	2129	2181.3	nd	568.06	115
24	Sombrerito	Los Planes	nd	nd	nd	nd	0.97	114
25	Sombrerito	Los Planes	0.63	1.5	1.78	nd	0.97	114
26	Plan de la Posa	Quebraditas	34.08	27.74	19.23	nd	10.22	95
27	Chaguitillo	Chaguitillo	nd	nd	nd	2.14	0.77	90
28	La Saca de Agua	Las Brisas	7.28	18.3	8.74	nd	13.67	90
29	Aguacatillo	El Pacayal	0.66	1.03	0.98	nd	0.81	56
30	Patojo	Patojo	2.91	1.5	0.65	nd	3.9	54
31	Jalapa	Jalapa	nd	nd	nd	nd	490.86	nd
32	Monte Galán #2	Monte Galán	nd	nd	nd	nd	0.16	nd
33	Cerro Bonito	Luquigue	nd	nd	nd	nd	10.92	nd
Total			**1394.6**	**2560.6**	**2521.9**		**734.1**	

a. Q refers to water quantity; nd refers to no data.

Actions

With support from IDRC (Canada) and to continue with the theme of water, an integrated strategy for the resource was developed jointly with the Municipality, water boards, and young rural researchers, covering producing water sources to after use by beneficiaries. Principal activities would be to:

- Evaluate water quality in three pilot sites at the source, collection tank, and dwellings (taps and containers) as beneficiaries of these springs.
- Determine the multiple uses of water and efficient use with respect to its availability (quality and quantity).
- Identify and evaluate practices for managing and disposing wastewaters and refuse carried out by the beneficiaries, and implement practices to improve water quality.
- Estimate the value of hydric services for the pilot sites (costs of maintaining the water systems) to initiate, with the Municipality, a scheme of payments for environmental services.

2.1.8 Managing water sources, San Dionisio, Nicaragua

Related milestones

Baseline water survey

Background

Several studies on water have been conducted in the watershed of the Cálico River, including by Espinoza (2003), Orozco et al. (2005), and Baltodano (2005). These studies indicate that the river's principal course maintains very little water in the dry season. Some farmers located in the central part of the watershed carry out small summer works, damming the river to irrigate grapevine and vegetable crops. This undrinkable water is contaminated mainly by wastewaters from coffee processing, agrochemicals (in surface runoff, which also carries erosion products), dead animals, solid wastes, animals bathing, detergents, and feces. The same occurs with streams and springs. Water for human consumption comes mainly from smaller natural sources such as springs and mini water supply systems located in high areas. Serious problems of water supply exist, especially in the dry season.

Water sources

In the watershed of the Cálico River (Figure 33), 106 sources are located, of which 61 are natural wells, 19 improved wells, and 26 are mini water supply systems. Except for those supplying an entire community or communities, each supplies a minimum of five families.

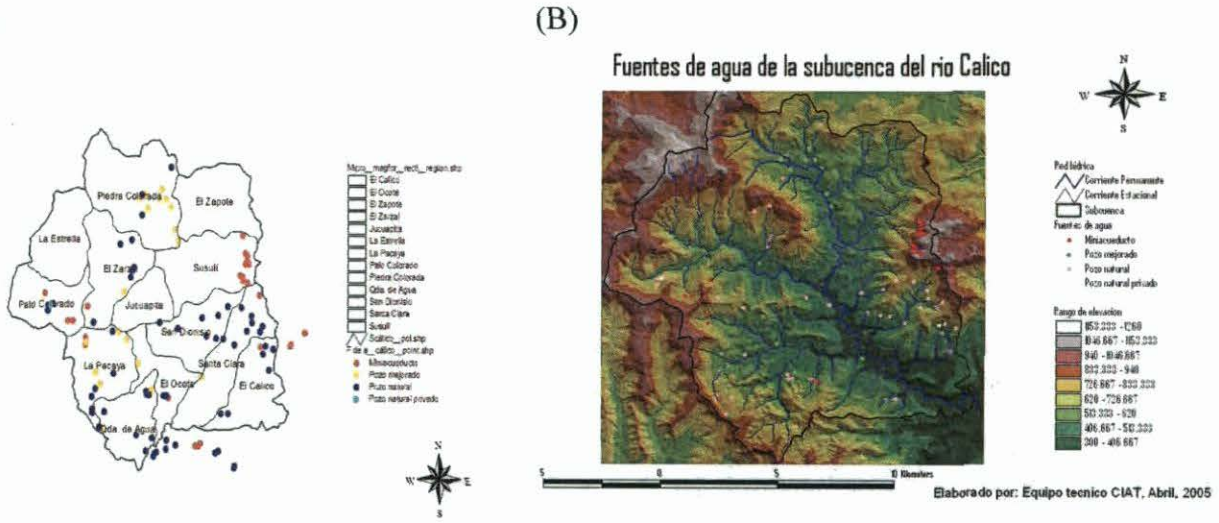


Figure 33. Water sources in the watershed of the Cálico River, Nicaragua. (A) Location of water sources in different zones of the watershed. (B) Water sources superimposed on a physical map of the watershed.

Table 6 indicates that 40.5% of water sources are well protected as a result of the sources being, for the most part, those that are in the upper part of the watershed and which supply the mini water supply systems, as in the case of the Susulí community, which relies on nine sources high in the mountains, with no cropping nearby, but only natural vegetation and trees. Likewise, Carrizal and Las Cuchillas are in similar situations. We point out that, taking all the water sources of the watershed together, they are found to benefit a significant number of consumers, including those that benefit a minimum of five families, and may or may not be protected. Those sources with the least protection (21%), and hence the most vulnerable, concentrate in the lower part of the watershed, including at the river.

Table 6. Classifying water sources according to type of plant cover and protection, watershed of the Cálico River, Nicaragua.

Community	Conditions of the source							Total
	No protection from trees and/or vegetation	Protected by trees and/or abundant vegetation	Little protection	No protection, crops nearby (GB, coffee)[a]	Protected but with crops nearby	Protected, but with paddocks nearby	No protection and with paddocks nearby	
Corozo	0	1	0	0	1	0	0	2
Carrizal	0	3[b]	4	0	1	0	0	8
El Cóbano	0	0	1	1	1	0	1	4
El Jícaro	1	2	4	0	0	0	0	7
El Zarzal	1	2	0	0	2	1	0	6
La Cañada	0	1	1	0	4	0	0	6
Las Cuchillas	0	5	2	0	0	0	3	10
Limones	0	4	0	1	1	1	2	9
Ocote Abajo	0	2	3	1	0	0	0	6
Ocote Arriba	0	4	5	0	0	0	0	9
Piedra Colorada	6	3	2	1	0	0	0	12
Piedra Largas	1	6	0	0	0	1	2	10
Susulí	0	9[c]	0	0	1	0	0	10
Wibuse	1	1	0	1	4	0	0	7
Total	**10**	**43**	**22**	**5**	**15**	**3**	**8**	**106**

a. GB refers to staple grains (In Spanish: Granos Básicos)
b. Benefits the urban area of the Cálico River watershed
c. Benefits three communities, together with Susulí.

The principal water sources that supply the communities are the Cálico River, streams, potable water, community wells, private wells, public water posts (supplied with washing places and public baths), mineral springs, and springs. Table 7 shows some families have more than one water source. In general, 50% of dwellings are supplied with potable water through pipes. However, for 16% of families, the piped water is insufficient and must therefore receive water from other sources. The microwatersheds of Piedra Colorada, Las Cuchillas, Ocote Abajo, Ocote Arriba, and El Junquillo are least accessible for this type of connection. We point out that 8% of families receive their water directly from the stream.

Table 7. Sources of water supply by microwatershed, Municipality of San Dionisio, Nicaragua, 2005.

Microwatershed	Dwellings (no.)	Potable water, piped		Improved well		Natural well		Stream	
		Own	Neighbor	Own	Neighbor	Own	Neighbor	Own	Neighbor
A	10	0	0	1	0	9	4	6	0
B	18	3	4	0	0	7	7	0	1
Carrizal	101	51	28	1	5	15	21	1	3
Cobano	519	425	25	13	173	7	34	8	35
Corozo	295	152	90	3	8	20	78	1	25
Cuchillas	127	22	11	8	19	35	38	10	8
Jicaro 2	199	83	71	4	4	12	45	1	7
Limones	117	38	21	1	4	18	66	3	12
Ocote Abajo	28	5	6	2	5	3	8	1	6
Ocote Arriba	94	4	8	4	5	20	64	2	2
Piedra Colorada	354	28	19	41	80	58	140	12	26
Quebrachal	153	121	29	0	0	3	9	0	0
Susulí	444	304	151	22	23	14	40	9	24
Wibuse-Jicaro	143	42	40	1	3	10	66	2	4
Zapote	346	180	133	10	22	22	115	13	24
Total	**2948**	**1458**	**636**	**111**	**351**	**253**	**735**	**69**	**177**

Local organizations

The watershed of the Cálico River has no Watershed Committee and most activities are co-managed with the Municipality through its Committee of Municipal Development (CDM). A local association brings together community organizations, which are present in all the communities. Their principal function is to manage small community projects. Cooperatives also exist, many of them for credit management.

The Committee for Potable Water is elected by the community and is formed by 4 or 5 volunteer members, who include a coordinator and a finance officer. Their principal function is to operate and maintain the water system (i.e., to ensure that the delivery system is operating adequately—installing pipes, protecting water sources, cleaning the collection tank, repairing pipes, and preparing and cleaning the places where the pipes pass through) and correctly manage the contributions made by beneficiary families to pay for the consumption of water from the system. The finance officer is trained to perform this function, as this person must organize the monthly collection of tariffs and constitute a fund for maintaining the water system, whether it is a well (either dug by hand or drilled), starter pump, or aqueduct (either gravity or electric pump).

However, work with the Committees for Potable Water (CAP) must be considered, as they may become important in the immediate future, in view of the serious problems with water scarcity and management. Water management in the communities is achieved through the CAPs existing in the watershed. These work on a voluntary basis, and do not provide the same level of management in all communities, thus continuing to limit the supply of piped water.

Economic valuation

Water rates are paid differently according to community. The highest tariffs are C$5.00 (US$0.30) and the smallest are C$2.00 (US$0.12) monthly as fixed payment, regardless the level of consumption. However, not all communities pay for the service, as it does not arrive to all. Inhabitants invest an estimated average of 35 minutes per day walking to the natural sources to obtain water for domestic consumption. A study by Johnson and Baltodano (1998) approximated the economic value of this time, taking cost of opportunity as half a day's work[2]. The study showed a total cost of US$42 per family per year for all families who reported having to bring water from the closest source for consumption (42%). This represented a total cost per year of US$36,268 to have water at home for all these families.

Actions

Because information on water quality and quantity in the watershed of the Cálico River is scattered, a monitoring network has been established jointly with the Ministry of Health (MINSA), the Mayor's Office of San Dionisio, and the CAPs to conduct periodic samplings over time.

[2] According to the IDB, half a day is used because it is the women and children who mainly bring water to the house. In the area, the wage price for that time was US$3.00.

2.1.9 Environmental and social sensitivity analysis (ESSA): a case study of the Cálico River watershed, Nicaragua

Related milestones

Land use assessment

Background

For its project activities in 2004, the INTA/UNA/CARE/CIAT Strategic Alliance gave emphasis to identifying criteria for determining environmental and social sensitivity. In 2005, an exercise was carried out to implement the methodology in the field in the Cálico River watershed, as described in Figure 34.

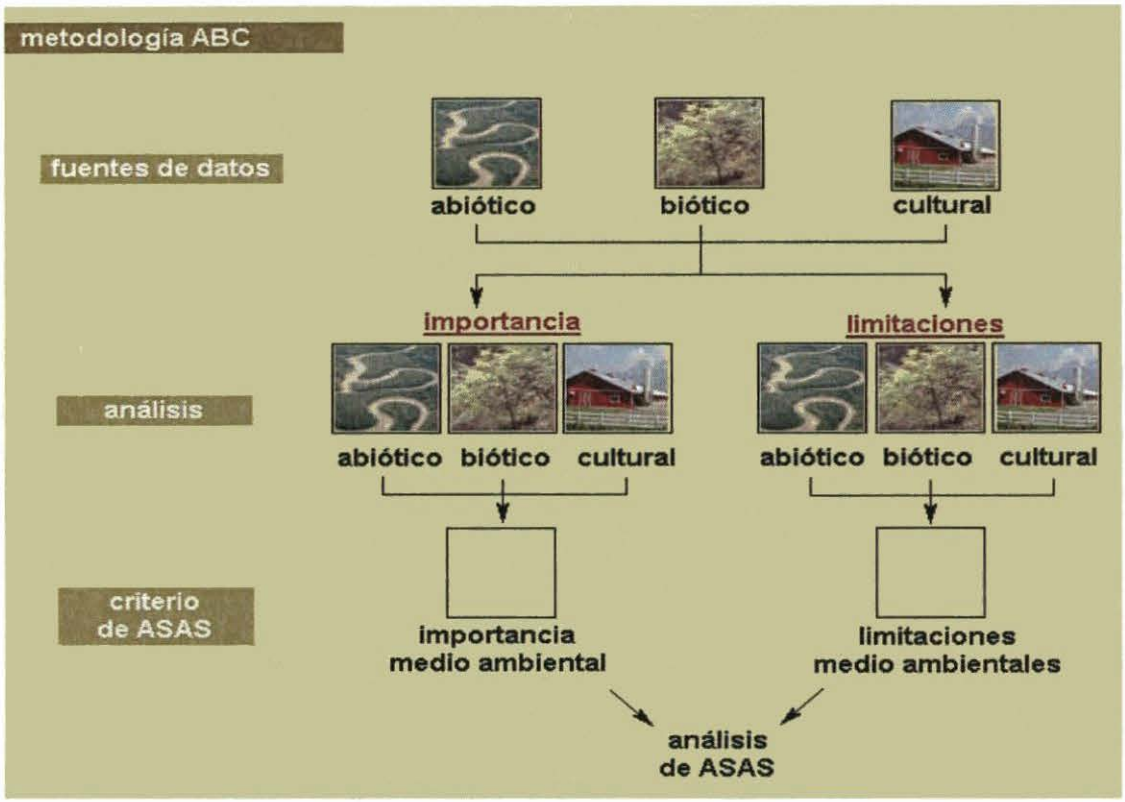


Figure 34. Abiotic, biotic, and cultural (ABC) methodology for developing criteria for conducting an Environmental and Social Sensitivity Analysis (ESSA) of a watershed.

Data inventory for ESSA analysis

Together with local partners in the Cálico River watershed, the Municipality of San Dionisio constructed an inventory of primary abiotic (topography, soils, contour intervals, and hydrologic network), biotic (forest cover, riparian forest, and biodiversity), and cultural or social data (water quality and quantity, tourist potential, land use and tenure, level of local organization, levels of

poverty and education, and health). This inventory permitted the generation of interpretive maps and analysis of the importance and limitations of the environment (Table 8).

Table 8. Data sources for the environmental and social sensitivity analysis (ESSA) of the Cálico River watershed.

Needs for data	Data sources	Map	Scale (year)	Measured as:
Land use	SIGMAT	Yes	1:20,000 (2004)	Hectares of land use, forest, and crops
Hydrologic network	SIGMAT	Yes	1:20,000 (2004)	Rivers (in km) per polygon or microwatershed
Topography	CIAT	Yes	1:50,000 (2003)	Slopes at <8%, 8%-30%, >30%
Road network	SIGMAT	Yes	1:20,000 (2004)	Roads (in km) per polygon or microwatershed Paths (in km) per polygon or microwatershed Source: SIGMAT
Contour lines	SIGMAT	Yes	20 m 1:50,000 (1988)	Maps established at 20, 50, and 100 m
Soil classification	CIAT/UNA	Yes	1:50,000 (1999)	Areas with types of soils
Land use conflicts	CIAT/UNA	Yes	1:50,000 (1999)	Areas with inappropriate use Comparisons of current use with potential
Poverty levels	CIAT	Yes	1:50,000 (1998)	Groups of well-being levels Families (no.) in each well-being group
Social information (education, health, population)	Municipal Committee for Development (MCD)	Yes	1:20,000 (2005)	People (no.) with <4 grade (illiteracy) per polygon or microwatershed People (no.) who read or not per polygon or microwatershed Health relationship between latrines and water pipes and diseases, health center data in each microwatershed on number of diseases related to bad water (for future)
Land tenure	MCD	No	(2000)	Topology of farmers and holdings Types: no land, with land but not enough, with land and enough Distribution or percentage of houses by type per polygon or microwatershed
Basic services (energy, water, latrines)	MCD	Yes	(2005)	Access to electricity, potable water, and latrines Baseline survey: latrines, water pipes, electricity
Water quality and quantity	CIAT	No	-	Fecal and total coliforms (counts/100 mL) Precipitation (mm/month) over various seasons Flow by season (minimum and maximum m^3/s) Demand by population (m^3/s)
Water sources—springs	CIAT	No	1:20,000 (2005)	Map of water sources for human use
Natural risks	COSUDE	Yes	1:50,000 (2002)	Areas and location of risks, floods, droughts, fires, and others

Classifying the criteria

An interinstitutional initiative defined ranges among specific criteria, and the value between different criteria to apply to the watershed under study. Table 9 indicates the classification system of criteria for Cálico River. Thus, this classification is ready to apply to different microwatersheds to determine high, medium, or low sensitivity.

Table 9. Criteria for indicating the environmental and social sensitivity of the Cálico River watershed.

		Sensitivity by indicator (range) 3 = highly important or greatest limitation[a]		
Indicator or criterion	Value	**3**	**2**	**1**
Water quality	3	Fecal coliforms > 100 units/ 100 mL	Fecal coliforms = 10-100 units/100 mL (average)	Fecal coliforms < 10 units/100 mL
Water quantity	3	<25 L per person per day	25-50 L per person per day	>50 L per person per day
Production systems	3	<2 crops per farm	3-4 crops per farm	>5 crops per farm
Population density	3	>10 people/km^2	5-10 people/km^2	<5 people/km^2
Basic services	3	No water pipes, latrines, or electricity	1 or 2 basic services	3 basic services
Land tenure	3	Most families have no land	Most families have land but not enough	Most families have enough land
Forest cover	3	Most cover is primary forest	Most cover is secondary forest	No cover
Riparian forests / connectivity	3	Exist and connected >75%	Exist but fragmented <75%	Exist and fragmented <25%
Health	2	>X[b] + 15%	Average	<X[b] - 15%
Level of community organization (CO)	2	Presence of CO for development (cooperative, associations, CIALs, ACV, watershed committee)	Presence of traditional COs (potable water, education, patronage)	No COs
Biodiversity	2	Species are common, exotic, or in danger of extinction	Common species	None
Conflicts on land use	2	Conflict on comparing current with potential use	Well used	Underused
Topography	2	>30%	8%-30%	<8%
Level of education	1	Cannot read	<4 grade	≥4 grade
Tourist potential	1	High	Medium	Low
Access	1	Cleared track	Road and path	Road, path, and highway

a. Score of 3 indicates an ESSA index of high sensitivity = 0.75.
Score of 2 indicates an ESSA index of medium sensitivity = 0.50-0.75.
Score of 1 indicates an ESSA index of low sensitivity <0.50.

b. X = average number of cases with gastrointestinal disease in the watershed. Possible maximum (8 × 3) + (5 × 2) + (3 × 1) = 37 * 3 = 111.

Management guidelines

With the information from the baseline survey on the microwatersheds of the Cálico River watershed map positions can be made and, with the collected field data, management guidelines can be developed.

The principal audiences for ESSA management guidelines for the Cálico River watershed include:

- Municipal Committee for Development (MCD)
- Interest groups from the microwatersheds
- Related interest groups (e.g., soil, youths, farmers, livestock producers)

The management guidelines include the themes:

- Natural resource management (soil, water, forests, animals)
- Management of production systems
- Tourism

Work plan for developing an ESSA for the watershed under study

Defining the responsibilities for each interest group
Meeting representatives of the interest groups
Conducting baseline surveys and/or developing indicators
Participatory mapping
Analyzing or interpreting the information
Selecting criteria
Presenting information
Identifying ESSA indices
Classifying and verifying ESSA indices
Taking action (applying guidelines)
Monitoring and evaluating

2.1.10 Water diagnosis, use, and quality in the Titiri/Totora and Tiquipaya watersheds, Bolivia

Related milestones

Baseline survey

Introduction

The Youth Bolivia alliance for water science strives to build local capacity of youths involved in integrated water management science. The project focuses on water use and access, working with youths from upstream and downstream communities. Youths participate as co-researchers to develop their capacity to analyze natural resource issues, improve communication skills, and build linkages with local organizations involved in water management.

Diagnosis

Two diagnostic workshops were conducted, one in Titiri and Totora (upper watershed) and the other for Tiquipaya (lower watershed), centred on three components: issues, research needs, and youth priorities. Diagnostic trees, grouping similar themes, were constructed. The youths discussed research needs in relation to the diagnostic trees, and the activities that they could undertake in relation to those themes. Results for the two workshop groups are summarized in Boxes 1 and 2.

Box 1
Results of diagnosis for Titiri and Totora (4090 m)

Themes:
Water quantity; Water quality; Access and water use; Food security

Activities:

Water quantity
- Source mapping
- Measuring rainfall
- Participatory mapping with elders to know change in climate and area of "bofedales" (meadow wetlands)
- Visioning for the future

Water quality
- Garbage: analysis of quantity and type
- Latrines: map houses with or without
- Animals: location in relation to water sources, streams, and canals
- Tourism: location and impact
- Fecal coliform levels

Access and water use
- Measuring water consumption by use
- Mapping distribution system
- Household access to water (e.g., rain, pipes, wells, no access)
- Compare with Tiquipaya

Food security
- Diet: dairy
- "Greenhouse": vegetable production with assistance from a local NGO with experience at high altitudes

Box 2
Results of diagnosis for Tiquipaya (2650 m)

Themes:
Water shortages (i.e., quantity); Water use; Water quality (i.e., contamination); Water rights and distribution

Activities:

Water quantity
- Measuring rainfall
- Water sources: volume over time
- Survey on water shortages, climate change, and the historical availability of water

Water use
- Measure water consumption for different uses (per family in 24 hours)
- Water meter data for houses

Water quality
- Identifying and mapping sources of contamination: erosion, garbage, animals, and houses with or without latrines

Water rights and distribution
- Surveys
- Workshops with users (water committees)
- Mapping canals and wells (mix of primary and secondary data collection)

Baseline survey and water-use training

A workshop was conducted to design a survey, using previous experience from CIAT's work in Colombia. Priority questions were designed and the youths practiced interviewing techniques. Household interviews were conducted and information was compiled on land tenure, access to basic services, land management and production systems, animal holdings, water sources, water shortages, water culture, and food security. Data analysis is ongoing and results will be presented to local communities in the coming months.

A workshop on water-consumption monitoring was held to train youth co-researchers in quantitative methods for measuring domestic and production water use. A series of methods was adapted from Colombia, including the use of graduated cylinders, volumetric measuring containers, chronometers, tank volume measurements, and tally measures. Domestic water uses being monitored include washing clothes, washing dishes, drinking and food preparation, personal hygiene, household cleaning, showers, and flush toilets. Production water uses include pigs, cattle, horses, pigs, chickens, rabbits, fish, sheep, llamas, dehydrated potatoes, irrigation, and *chuca.* Water use has been assessed on a preliminary basis, and measurements are being repeated to determine "typical" headwater and downstream water use for domestic and production uses.

Water quality

In the upper watershed, in the communities of Titiri and Totora, various springs and wetlands provide the principal sources of water for consumption and irrigation downstream for the Tiquipaya and Cochabamba communities. Youths and co-researchers from CGIAB were trained in the use of the Oxfam-DELAGUA water-testing kit to quantitatively determine coliforms in water. The samples analyzed were from the Cordillera, and the downstream communities of Montecillo, Sirpita, and Capachi (Figure 35).

Figure 35. Youth and co-researchers filtering and incubating water samples to determine fecal and total coliforms.

Cattle excrement was noted near streams, and canal structures may impede contamination as noted by the low coliform counts measured for canal samples. The highest bacteriological contamination was found in downstream untreated portions of the distribution system such as the Montecillo household (Table 10). In Sirpita and Capachi, water intake from wells is more common and is free of contamination, except for the last well measured (Ronald water tank). Septic system contamination is postulated but requires further study of cause and effect.

Table 10. Results for fecal and total coliforms, and turbidity, Bolivia.

Description of sampling site	Turbidity (NTU)	Fecal coliforms (no./100 mL)	Total coliforms (no./100 mL)
Cordillera			
SEMAPA energy canal (water for Cochabamba)	<5	10	310
Energy canal, after the lagoon	<5	0	20
Upslope, Ramiro Household	<5	0	10
Ramiro Household	<5	0	80
Montecillo			
Upslope, Khora River	<5	0	10
Water intake, Machu Mita	<5	0	50
Water treaty	<5	10	70
Montesillo Household with no treatment	50	40	510
Tiquipaya Household with treatment	<5	-	-
Sirpita			
Old network near water tank	<5	0	10
New network, Darwin well	<5	0	-
Household, Darwin well	<5	140	-
Household, Juan Carlos well	10	0	30
Capachi			
Oscar Household	<5	0	0
Oscar Well	<5	0	80
Household, Ronald water tank	<5	30	4080

2.2 Outputs 2 and 3: Equity of Highland-Lowland Water Allocation, and the Provision of Environmental Services

For outputs 2 and 3, Communities and Watersheds aims towards a more equitable allocation of resources between upper and lower watersheds, including the provision of environmental services, with a focus on water issues. Water resources are generated in upland watersheds, the "water towers". Improper management often results in supply and pollution problems to both upper watershed environments and downstream users. Wealthier farmers in well-endowed valleys anticipate sufficient water quality and quantity for increased productivity, while poorer upland farmers often have limited economic opportunities. Highland-lowland interactions, trade-off analysis, and quantification of environmental services are key to conflict resolution and the equitable allocation of resources, including water. The information obtained through water availability and hydrologic response research is fundamental to improving water allocation and administration. An economic evaluation of hydrological services is also required before developing retribution models.

2.2.1 The role of Andean wetlands in small-catchment hydrology, Barbas watershed, Colombia

Related milestones

Monitoring networks, primary data collection, land use (ecosystem), inventory, water availability

Hypothesis

This study's hypothesis was that wetlands located in the heads of watersheds regulate water balance and availability for users in lower parts.

Analyzing hydrologic response

Fluctuations in water levels of wetlands monitored in watersheds and major slopes suggest that the wetlands contribute to the regulation of water flow in surface outlets. Although peaks produced by rain storms rapidly become runoff, the water in wetlands appear to permit maintenance of the flow at outlets (Figure 36).

Monitoring network

To carry out this analysis, a network of hydrologic monitoring was designed and established with the components described in Figure 37.

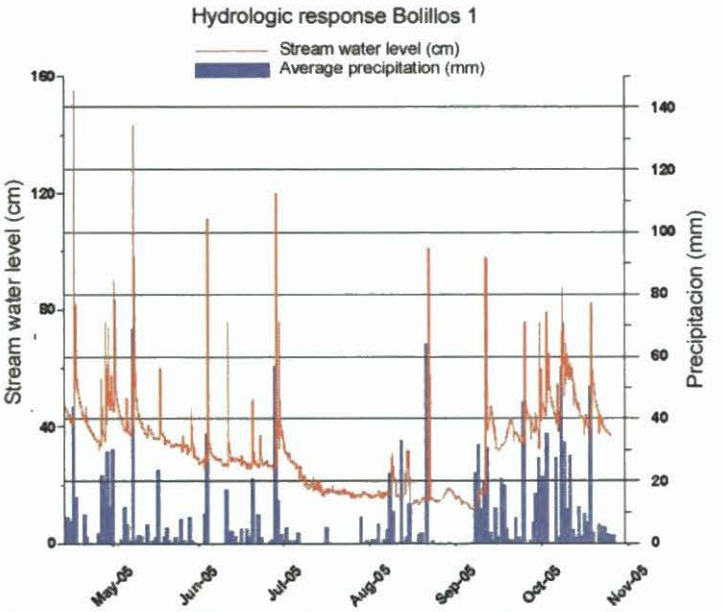


Figure 36. Hydrologic response at Bolillos 1, Barbas watershed, Colombia.

Figure 37. Network for collecting hydrological data in the Barbas watershed, Colombia.

Wetland inventory

To quantify their contribution as "buffers", an inventory of wetlands and their characteristics was carried out, making use of satellite imagery and field measurements. A preliminary inventory resulted in 59 wetlands distributed throughout three watersheds (Figure 38).

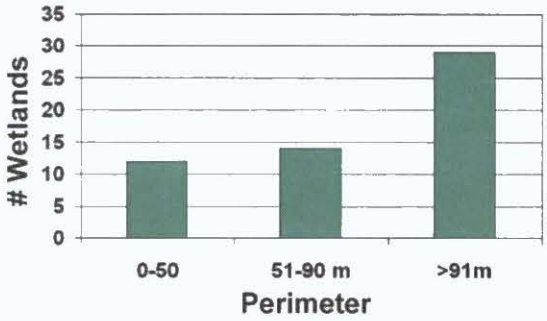


Figure 38. Number of wetlands and their perimeters in the Barbas wetlands, Colombia

Inventory of wetland plants

Plants' efficiency in using water is determined by their photosynthetic mechanism (C3 or C4 pathway). With the wetland plant inventory, we hope to determine the composition of current communities to determine their influence on the water balance in the wetlands (Figure 39). Thus, we can design options for managing the wetlands to conserve water.

Figure 39.
A wetland plant population containing 23 species, the dominant ones of which are *Juncus effuses* and *Hydrocotyle* sp., covering, respectively, 25% and 22% of the inner areas of the wetlands.

Organic matter decomposition and carbon accumulation

Twenty-four samples of three species previously weighed were buried 20 cm deep, 12 in an area of wetlands and 12 in a well-drained area. Decomposition rates were measured every 4 months (Table 11).

Table 11. Decomposition (%) after 4 months, Barbas watershed, Colombia.

Plant family	Wetlands	Well-drained area
Juncaceae	21	45
Poaceae	35	54
Cyperaceae	33	61

Integration and application

The components of this study will be used to construct the water balance to compare the availability of water with consumption by the population under different scenarios:

- Land use (comparing three watersheds)
- Variability of short-term annual precipitation
- Impact of climatic change on the vegetation (ecosystem's efficiency in using water)

2.2.2 Economic evaluation of the hydric environmental services on offer in the watersheds of the Cálico and Jucuapa Rivers, Nicaragua

Background

In 2005, an economic evaluation study on the offer of hydric environmental services (HES) was carried out. The two study areas were the Cálico River watershed, reference site for CIAT's C&W Project in Nicaragua, and the Jucuapa River watershed, study area of the CATIE-FOCUENCAS project and INTA. The study was based on the following assumptions:

- Water shortage in both areas is a sensitive problem, motivating the populations concerned to give priority to this resource
- The providers currently do not have sufficient incentive to adopt sustainable practices that would protect the HES
- In the rural areas of Cálico and most of Jucuapa, water is not paid for—a factor that probably encourages the lack of protection

Principal objective

To assess economically the costs of protecting water resources and thus increase the offer and be able to propose a payment plan for HES

Methodology

Both sites are very similar in terms of agroecological and biophysical conditions. Differences are in territory size, where Jucuapa measures 40 km^2 and Cálico 170 km^2. Moreover, Cálico has a population of 21,000 and Jucuapa 3705. The study involved the same methodology for both sites, as follows:

(1) Field diagnosis, for which three principal activities were carried out:
   (a)Collection of relevant socioeconomic and biophysical information from both sites
   (b)Selection and prioritization of critical and not-critical-but-significant areas for water supply
   (c)Characterization of farmers in these areas and potential providers of HES
(2) Economic analysis of the costs of changing practices and land use
(3) Determination of the required size of the compensation fund for farmers involved directly in protecting water resources
(4) Design and validation of compensation proposals as payment for HES

The prioritization of areas is a major intermediate product of the study. Prioritization was carried out on the assumption that hydric services are delivered from specific sites for specific users, meaning that areas of intervention must be carefully selected (Alpízar et al. 2005). The principal steps were:

- Georeferencing and characterizing the biophysical context of water sources (e.g., principal river, constructed and natural wells, water projects, or mini water-supply systems)
- Selection of areas with GIS, based on the criteria of slope and vegetation or forest cover, to generate a map of critical areas of water production and protection in both sites
- Final selection of areas by superimposing the information on water sources, according to their biophysical characteristics (protection, number of beneficiaries), over the map of critical areas, thus backing up the prioritization

Farmers living close to water sources were characterized to discover the socioeconomic status of possible providers of HES, and with whom negotiations would be made in case of implementing payment plans for HES.

The economic evaluation was carried out with methods of changes in productivity and opportunity cost, involving the following main steps:

(1) Selection of technologies for soil and water protection and areas for changes in land use, in consultation with experts and inhabitants of the areas.
(2) Individual evaluation of the costs of implementing techniques and changes from agricultural use to forest use. This change of use was assessed on the basis of opportunity cost for production and was proposed for 300 ha in Cálico and 150 ha in Jucuapa, both areas located along the principal rivers.
(3) Evaluation of costs of protection techniques combined in four scenarios, involving physical works and live covers for part of the prioritized areas.
(4) Evaluation of both proposals projected to 10 years to distribute the long-term costs and, knowing the maximum amounts per year, to plan a strategy of the most viable implementation from the economic viewpoint.

Results

According to the criteria defined in the study, the Cálico River watershed, measuring 17,000 ha, had 6000 ha designated as critical, that is, 35%; and in Jucuapa, with 4000 ha, had 620 ha, that is, 15%.

As shown in the map of Cálico (Figure 40), the critical areas are distributed throughout the entire watershed, but are more concentrated in the upper parts—the community of El Zapote and surroundings—and in the lower parts, around the communities of Ocote Arriba and Ocote Abajo.

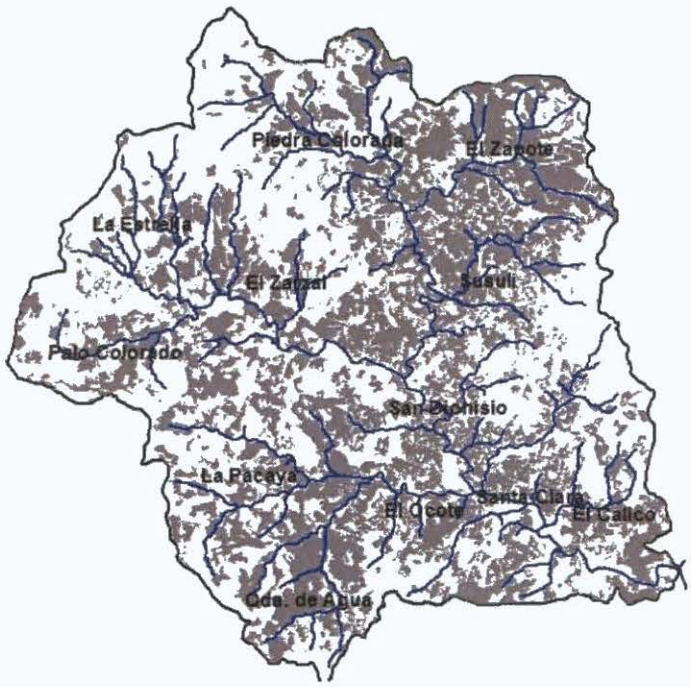


Figure 40. *Critical areas distribution in the Calico river watershed.*

To generate these maps, land use and contour maps were combined, establishing three categories through the combination. For example, slopes steeper than 30% with no cover of any type resulted in a critical area. Likewise, the same result would occur when the same slope is combined with the presence of agricultural crops with no management. Based on the same criteria, the rest of the two areas was distributed between **stable** and ***moderate*** areas. As a result, the number of water sources georeferenced was as follows:

(a) Cálico Number of sources georeferenced = 106 Number of priority HES suppliers = 23
(b) Jucuapa Number of sources georeferenced = 24 Number of priority HES suppliers = 17

The economic evaluation of both change in land use and implementation of technologies to protect soil and water was estimated at 10 years, working with 15 ha per year. The components of amount per year are the initial investment of 15 new hectares, plus the maintenance of the 15 ha from the previous year, plus the payment of opportunity costs for production. The principal values are shown in Table 12.

Table 12. Average annual costs of (a) changing land use and (b) using technologies to conserve soil and water in the Cálico and Jucuapa watersheds, Nicaragua.

	(a) Changing land use			(b) Using technologies (US$ per 15 ha per year, up to 470 ha)[a]		
Watershed	Year 1	Year 10	Maintenance (year 11+)	Year 1	Year 10	Maintenance (year 11+)
Cálico (300 ha) (US$ per 30 ha per year)	11,160	72,990	68,700	3,643	10,305	7,403
Jucuapa (150 ha) (US$ per 15 ha per year)	5,580	36,495	34,350	3,643	10,305	7,403

a. Four scenarios of different combinations of technologies were designed. The scenario presented here is the least expensive.

The individual costs of initial investment and annual maintenance of each protection technology are the proposed compensation sums for farmers directly involved in protecting the water resources.

The annual sums of changing land use imply 50% reforestation and 50% natural regeneration and include opportunity costs for production, that is, the compensation per farmer is payment for what is seen as no longer being produced—that is, the maize and beans system—by the land being protected. As can be seen, this factor increases the amounts, but from the economic viewpoint, it is a possible way of making a program of this type sustainable. The projection of costs at 10 years permitted proposing a strategy of implementation of 15 ha per year, taking into account fund availability and the presence of farmers who will participate in the program.

The proposals were validated in the area and, essentially, farmers in both sites were disposed to participate, provided they were compensated. However, for the Jucuapa River watershed, as shown by a preliminary survey with focus groups, implementing a payment scheme for HES is not yet possible because of the small number of beneficiaries who could maintain a fund to pay for the water. Moreover, institutional conditions are such that they cannot yet support such a scheme.

For Cálico, according to a previous study of disposition to pay for the water, the larger number of beneficiaries and the more favorable institutional conditions make implementing a payment scheme for HES possible. This conclusion has provided guidelines for proposing a project to discuss with the Municipality of Cálico and submit to financing organizations.

We point out that problems of infrastructure and water distribution exist that must be dealt with on a par with the proposals for protection. Otherwise, no payment system for HES would be viable, even if the people are so disposed. This implies that, from the beginning, the local water company must be included in the action.

2.2.3 Drip irrigation, biointensive vegetable production, and water efficiency in Yorito, Honduras

Related milestones

Water-efficient technologies

Introduction

For many years, work with family, community, and school gardens have emphasized crop diversification to improve the diet. Staying within this line of work, the project, with local partners, especially young researchers of the region, are setting up biointensive gardens as an innovative technique to increase food production by managing small areas, using the double excavation.

The biointensive garden technique permits crop management in areas that range between 3 and 16 m^2 per garden plot (or vegetable garden), built by double digging to a depth of 60 cm, and applying organic matter. Hence, soil texture and structure can be improved, water-retention capacity increased, soil temperature regulated, and the soil better aerated. Furthermore, biological reactions should contribute to a better assimilation of nutrients by the plants.

Establishing and managing biointensive gardens

In 2004, in Yorito, biointensive gardening began with a workshop for youth groups, focusing on:

- The double excavation
- Using organic fertilizer
- Installing a drip irrigation system
- Planting in staggered parallel rows
- Planting aromatic plants around garden edges

Improving the biointensive garden in the SOL

- *Arranging the first garden plots:* The slope of each bed constructed was adjusted to 2%, leaving a step-wise talus of 1.20 m. At the same time, a drain was made to prevent rain water discharging over the garden area.
- *Constructing new garden plots:* Eight new beds, each 1 × 12 m, were constructed against the slope, in a north-south direction. The area is 12 m^2 per bed, amounting to a total area of 96 m^2.
- *Preparing organic fertilizer and constructing seedling beds:* Two compost bins were prepared with local materials and two seedling beds constructed (Figure 41).

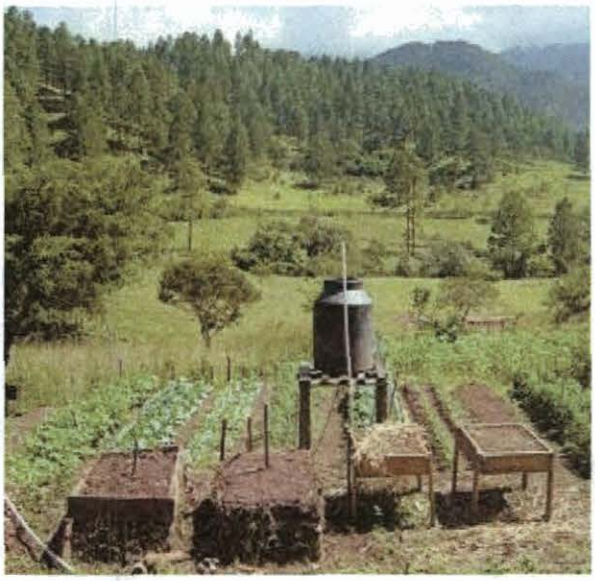


Figure 41. *Seedling beds*

Installing a rainwater catchment system

Gutters were installed and improved, together with a rainwater catchment tank and lead lines to distribution tanks. A RotoPlas tank was used in this system, as shown in Figure 42, and two distribution tanks made available. These tanks can be replaced with another, less expensive, type of container.

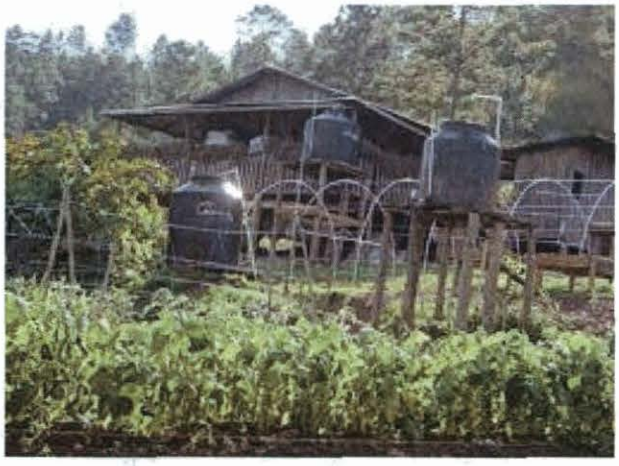


Figure 42. *RotoPlas tanks used in the system*

Installing drip irrigation systems

After testing several irrigation systems, the system with perforated droppers was determined as being the most adaptable for vegetable production, as it can be adjusted to the distance each crop requires (Figure 43). For small gardens (40 m²), 1 m is a sufficient height difference at which to stand the distribution tank.

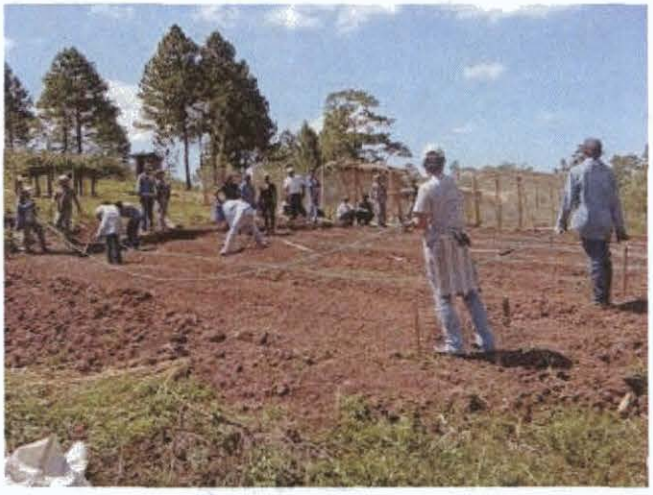


Figure 43. *Installation of the irrigation system*

Producing vegetables in the garden

The garden shown in Figure 44 is producing vegetables such as squash, Chile sweet onion, and cabbage under the principles of biointensive gardening. The fertilizer applied is based on organic matter, and pest-and-disease control on natural insecticides. In crops such as string bean and tomato, pest control is more difficult.

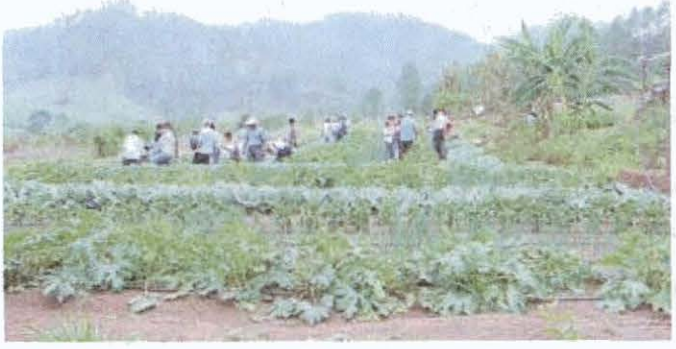
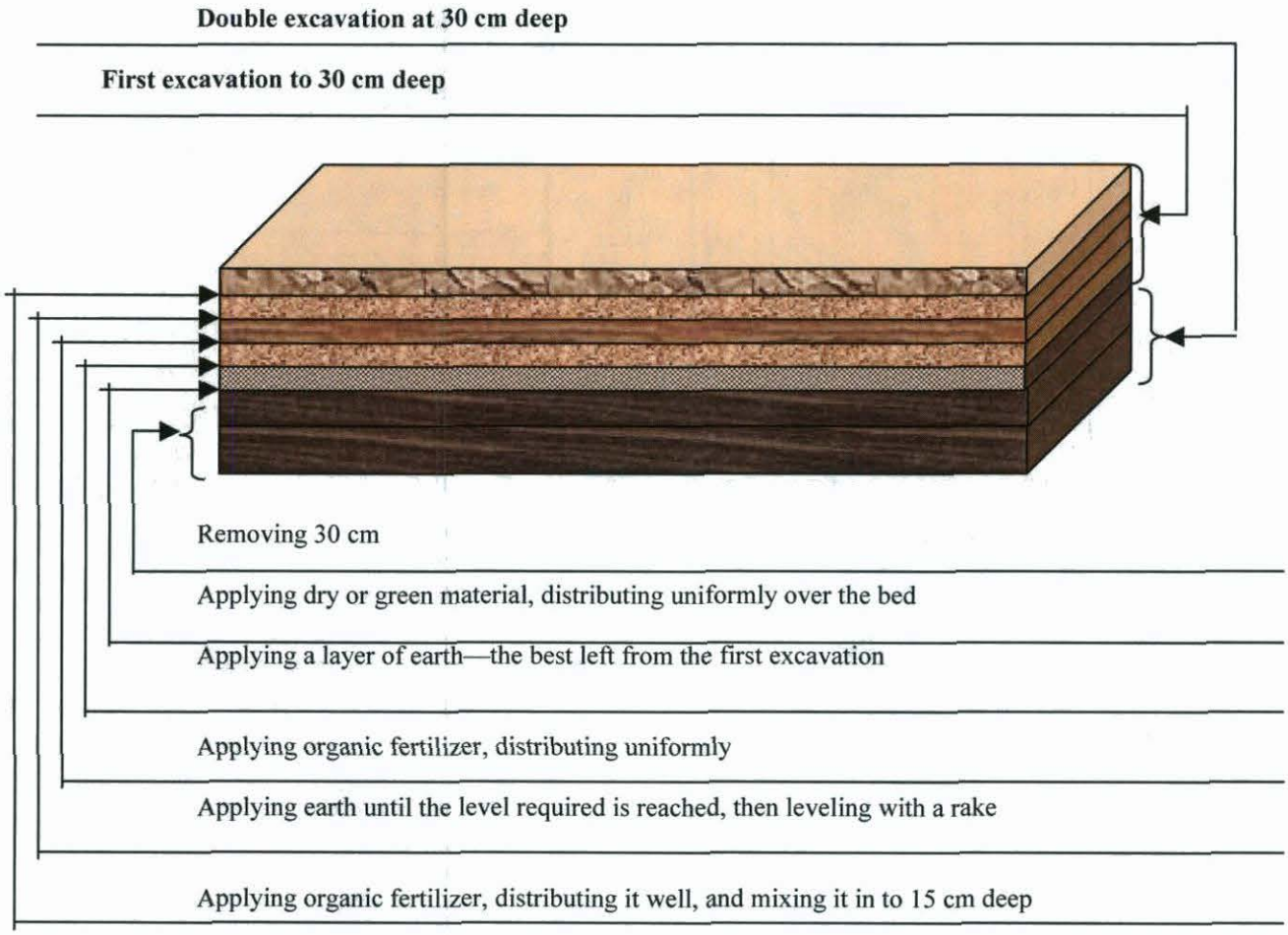


Figure 44. ***Producing vegetables in biointensive gardens***

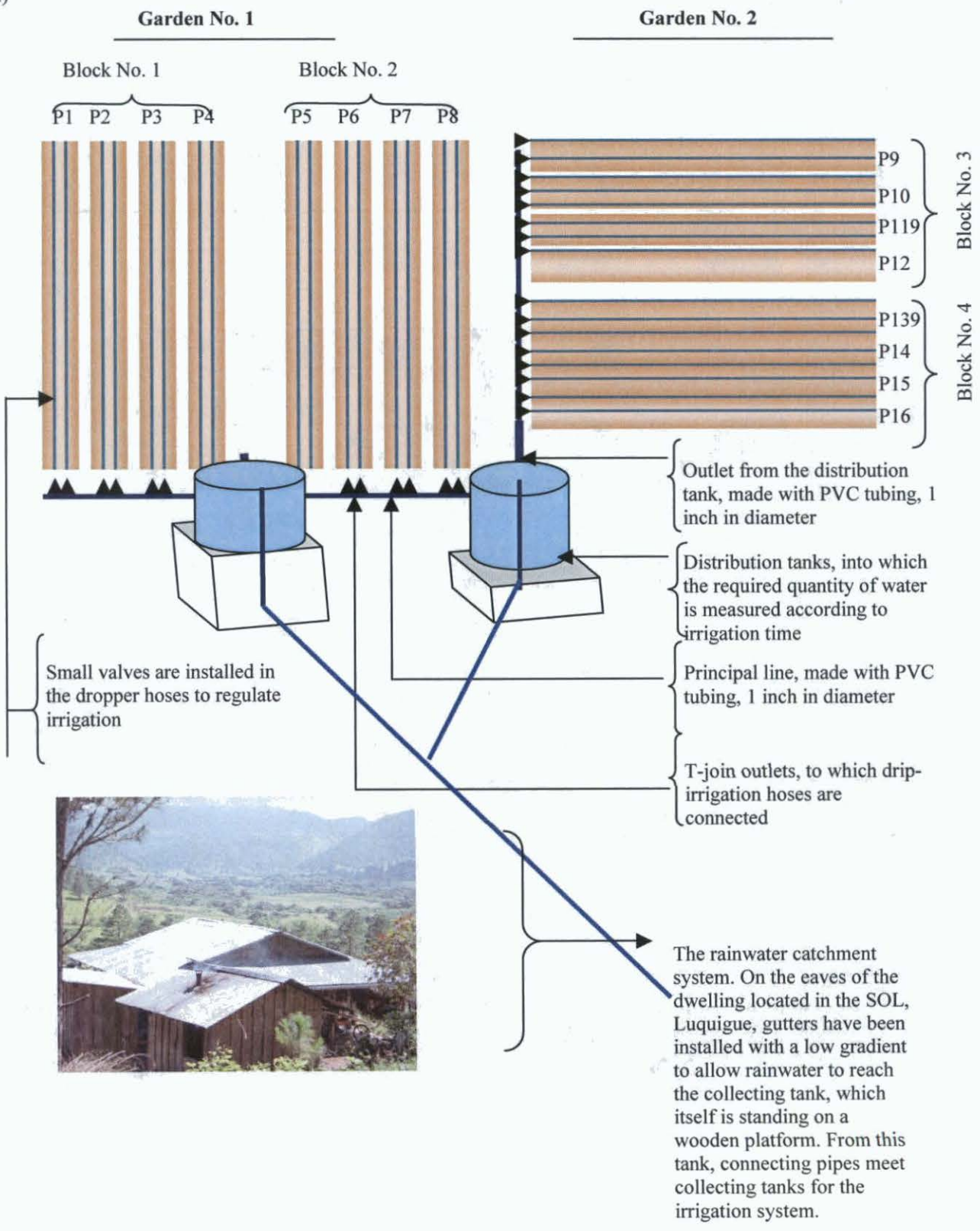
Designing double-excavation beds



Establishing an irrigation system in the garden

A drip irrigation system has been designed to adapt to the requirements of each crop. In this sense, the system is installed with a PVC outlet, 1 inch in diameter, from the distribution tank. The outlet is connected to the principal distribution line through T joins and stops directed at each row of crops. The principal line is connected to hoses with droppers designed at planting distance but between plants, as shown in Figure 45:

(A)


Garden No. 1
Garden No. 2
Block No. 1
Block No. 2
P1 P2 P3 P4
P5 P6 P7 P8
P9
P10
P119
P12
Block No. 3
P139
P14
P15
P16
Block No. 4
Outlet from the distribution tank, made with PVC tubing, 1 inch in diameter
Distribution tanks, into which the required quantity of water is measured according to irrigation time
Small valves are installed in the dropper hoses to regulate irrigation
Principal line, made with PVC tubing, 1 inch in diameter
T-join outlets, to which drip-irrigation hoses are connected
The rainwater catchment system. On the eaves of the dwelling located in the SOL, Luquigue, gutters have been installed with a low gradient to allow rainwater to reach the collecting tank, which itself is standing on a wooden platform. From this tank, connecting pipes meet collecting tanks for the irrigation system.

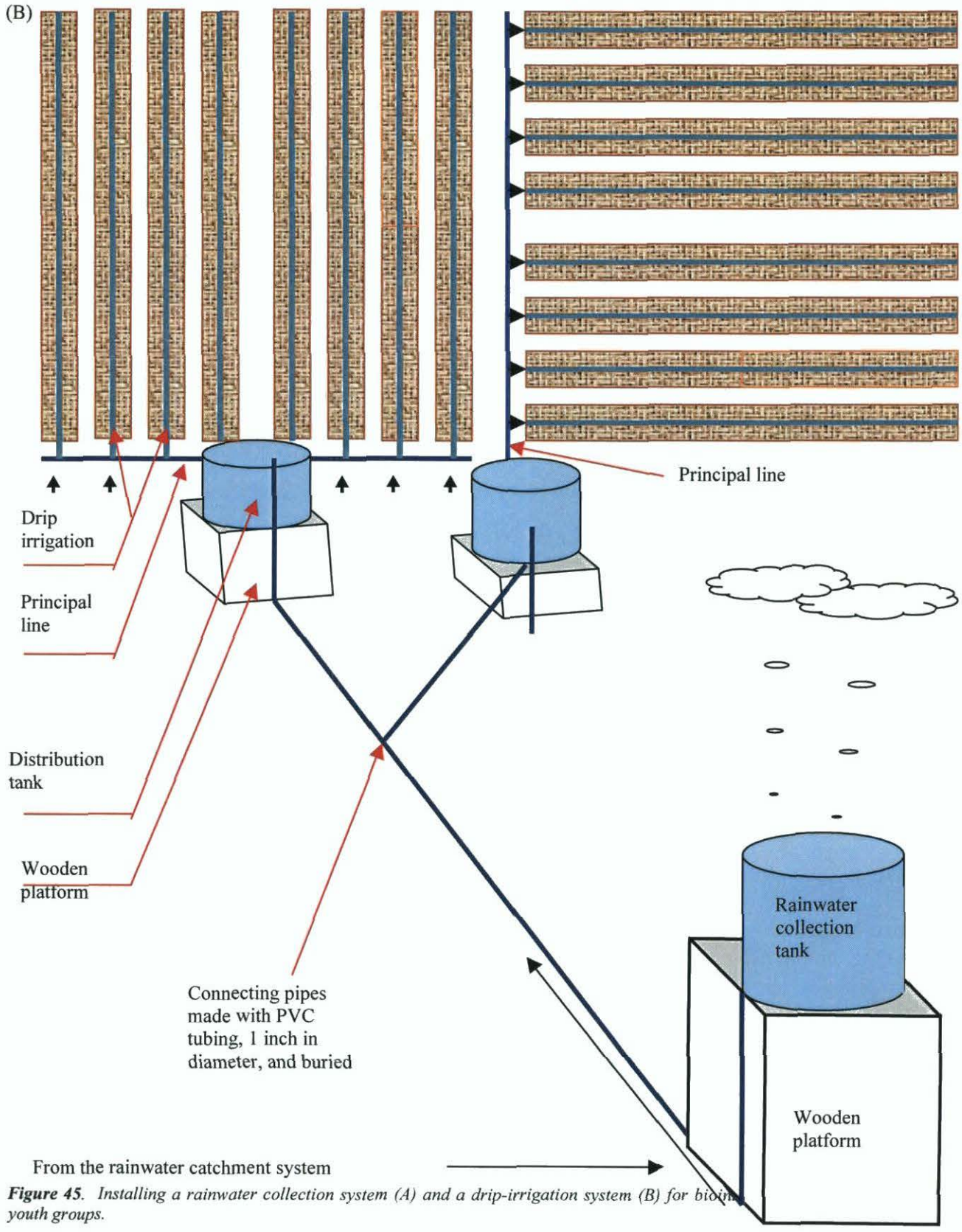


Figure 45. *Installing a rainwater collection system (A) and a drip-irrigation system (B) for bioin youth groups.*

Managing biointensive gardens with youth groups in the Tascalapa River watershed, Honduras

Table 13. Youth groups with biointensive gardens, Honduras.

Group no.	CIAL[a]	Area of the garden
1	Jalapa	Four beds = 48 m^2
2	Wisilka	Four beds = 48 m^2
3	El Destino	Three beds = 36 m^2
4	La Sabana	Three beds = 36 m^2
5	ISP 1	Two beds = 36 m^2
6	ISP 2	Four beds = 40 m^2

a. ISP = San Pedro Institute of Education.

Figure 46 shows youth groups from the San Pedro Institute of Education (ISP) digging to install biointensive gardens. The ISP leads two youth groups, integrating the students into the research process.

(A)

(B)

Figure 46. Youth groups from the San Pedro Institute of Education (ISP): (A) installing and (B) managing biointensive gardens.

Actions

During 2006, with COSUDE's support, youth groups focused their activities on installing and managing biointensive gardens (Table 13), together with market studies and the definition of high-value crops. They also worked on rainwater catchment systems that permit efficient water use. These activities will strengthen the youths' capacity for research to better manage water harvesting, linked with drip irrigation in biointensive gardens.

Recognition

The San Pedro Institute of Education, Yorito, Honduras, awarded CIAT a certificate of recognition for its work with youths on food security and natural resource management.

Republica de Honduras
Secretaría de Educación
Dirección Departamental de Educación
Instituto "San Pedro"
Estudio - Cultura - Civismo
Yorito, Yoro

Otorga

Reconocimiento

A: Centro Internacional de Agricultura Tropical (CIAT)

Por su decidido apoyo en las actividades ejecutadas con el Proyecto de Investigación Participativa con Jóvenes en Seguridad Alimentaria y manejo de Recursos Naturales y el fortalecimiento del Bachillerato en Ecología y Medio Ambiente.

Yorito, Yoro 20 de noviembre de 2005

INSTITUTO "SAN PEDRO" DIRECCIÓN Yorito, Yoro

Profa. Dilcia Suyapa Martínez
Directora

NAZ

2.3 Output 4: Strengthened Community and Institutional Capacity

For output 4, Communities and Watersheds seeks to strengthen organizations at local and national levels to build capacity for watershed resource management and allocation. Workshops and training are conducted to support research initiatives and enhance capacity at the local level. Interinstitutional collaboration mechanisms are used to build multiple operational partnerships and facilitate the dissemination of research results. Methods and case-based examples are developed to illustrate capacity-building techniques that are specific to water and watershed management, and which integrate rural communities into research relevant to development issues.

2.3.1 *Rural Youth in the Management of Natural Resources and Food Security*, project in the Garrapatas Canyon, Colombia: the lessons learned

Related milestones

Completion of Phase I of the W. F. Kellogg Foundation project

The project

The goal of the project *The rural youth in the management of natural resources and food security* is to develop an educational model based on research on themes that are of priority to Latin American rural areas, that is, managing natural resources and food security. Our objectives are to:

- Promote the development of juvenile rural leaders through practicing leadership skills and participating in research processes.
- Develop research on natural resources through partnerships with research centers, universities, companies, and local organizations.
- Facilitate (1) the development of a youth company for the sustainable and profitable use of abundant local natural resources, and (2) the generation of mechanisms whereby youths finance their own companies and studies.
- Incorporate the project's processes into local, national, or regional networks through partnerships, thus expanding the project's impact.

In the project's three years, several complementary activities were carried out to achieve these goals, including the (1) construction of a baseline for the region on which the project is carried out, (2) development of institutional alliances that will give sustainability to the changes initiated, and (3) attainment of additional resources.

The breadth of this project's goals demanded the formation of a wide network of national, international, and local institutions to cover different aspects of the project. The network has generated large synergies in the use of limited resources and generation of new ideas, and has enabled the maintenance of social dynamics in the area to implement the project. Figure 47 shows the partners and alliances who participate in this project and their relationships with it.

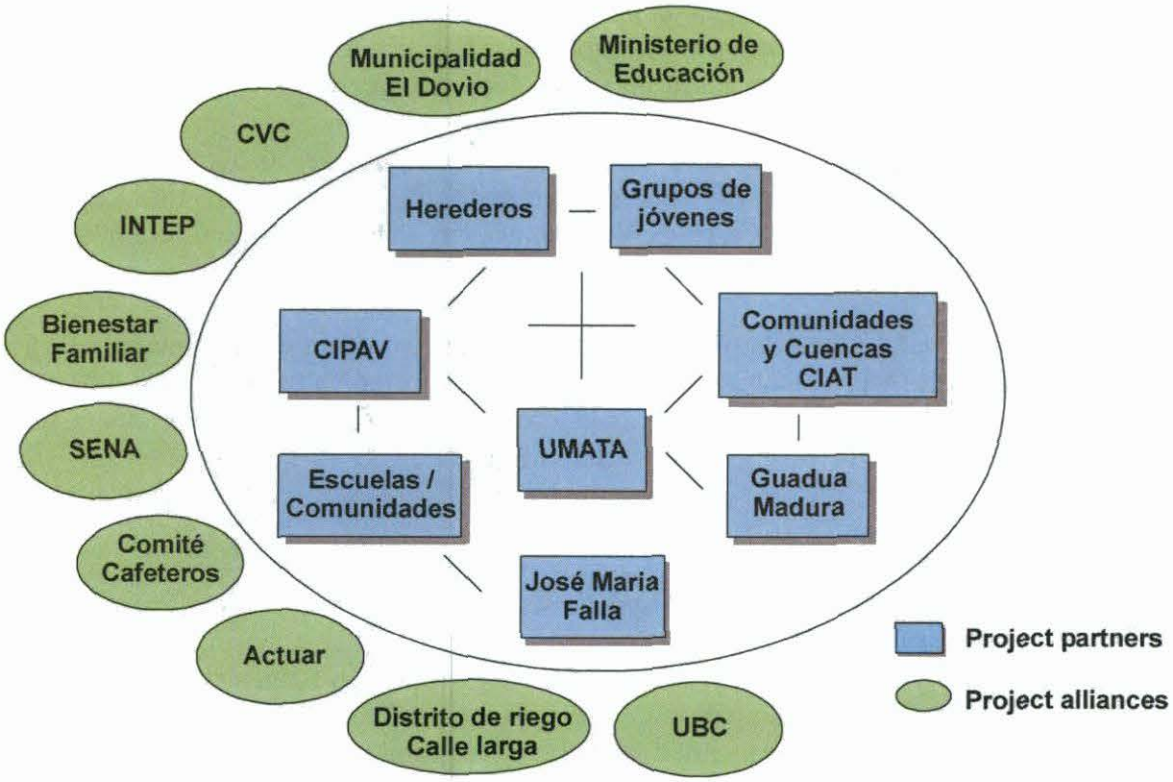


Figure 47. Partners and alliances that participate in the project and their relationships within it.

Lessons learned

The marginalization of rural areas strongly affects the opportunities young people have to develop their human potential. Ongoing activities to develop leadership skills in young people to constructively influence their families, educational centers, and communities have an enormous impact on rural youths who had never been exposed to such tools and dynamics.

Monitoring the youths' progress in terms of their leadership skills is important for establishing the effectiveness of these tools. Hence, links must be made with teachers who show great individual commitment and with the educational institutions where they work.

In the course of the project, we saw that leadership tools could often make young people more capable than their teachers and parents, generating conflicts. Hence, we learned that the educational community of marginalized areas should be a target group for projects aiming to have impact on young people. For El Dovio, particularly its rural areas, teachers have had few opportunities to be educated and have serious limitations in guiding young people in the processes of personal development or research.

When working with partners we learned the importance of having local institutional and regional actors who, through permanent accompaniment, can appropriate the process on behalf of the institutions and rural communities. Locating people within institutions who are prepared to work

in teams is essential, and is achieved by recognizing their affinities with one or another of the project's objectives. In this case, we saw how key people within the UMATA and the Mayor's Office of El Dovio undertook activities, based on the project's research ideas and activities. For example, from the creation of capacity to process *guadua* (building or giant bamboo) and the evaluations of the environmental impact of this bamboo on water resources, the UMATA initiated the planting of 18 hectares of this species with the resources of the Regional Autonomous Corporation of Valle del Cauca (CVC), an activity that will continue in 2006 with another 18 ha.

Based on this work with partner institutions and strategic alliances within the framework of this project, additional resources were obtained, represented in kind to the value of US$189,082 and in dollars to $12,500, totaling $201,582. The resources contributed by project partners and collaborators have had considerable impact on achieving the objectives because, not only did investments in project activities increase, but also the dynamics of searching for resources were created by local organizations and youth groups.

With communities, we corroborated on the hypothesis that the participation of youths was important in discussions of problems and creation of alternatives for the communities. For example, from the research on water quality and availability in the Los Saínos microwatershed, which was carried out with the participation of five young people in the area, a process of improving water treatment systems was started, based on that same community's initiative. The project created a very small fund to transfer knowledge on constructing sand filters, and the community contributed additional funds to construct new filters and water decontamination systems. Likewise, resources were also obtained to isolate riparian areas and protect water sources.

Teamwork with local institutions guarantees the step from research findings to impact on development. For example, activities that started as research on the management of building bamboo as promising resource in the project's area of influence, when carried out jointly with the Mayor's Office and enterprising young people, generated a company that processed and marketed products of building bamboo and which has participated in 10 handcrafts fairs in nearby cities and has managed to sell products to a value of almost US$1400.

2.3.2 Interinstitutional alliances and strengthening organizations in the Municipality of El Dovio, Colombia

Background

A need that was recognized at the project's start was strengthening the local organizational process in the C&W's site of reference, El Dovio (Valle) so that the project with the rural youth had a network of support institutions.

A technical limitation has been the lack of coordination among governmental and nongovernmental agencies, and grass-roots communities involved in the El Dovio region. This lack of coordination has led to a lack of articulation among policies, programs, and interests of the rural population. Another weakness has been the little participation of local organizations in terms of decision making, often because of a lack of sufficient and timely information.

Organizational strengthening

To begin this process, the Mayor of El Dovio, representatives of the Municipal Unit of Technical Assistance (UMATA, its Spanish acronym), and the field technicians of CIAT's project on rural youth exchanged experiences by visiting another CIAT reference site in the Tascalapa River watershed in Yorito, Honduras. Within the component of interinstitutional coordination, they examined indicators for integrated watershed management and work with young people in natural resource management.

A product of this exchange, on the Municipality's initiative, was a workshop held to strengthen the Municipal Council for Rural Development (CMDR). The results of this workshop were as follows:

Participation and representation. With the workshop participants, an inventory of organizations and groups active in the community was made, identifying for the Municipality of El Dovio, 11 governmental institutions, 7 NGOs, and 24 local organizations. Of these 42, 20 were invited to the workshop (i.e., 48%). Great effort was made to convene local community organizations, who, in their turn, all participated.

Activities of the organizations (organizational analysis). Using as criterion "activities carried out", the organizations were grouped according to their thematic interest: (1) community organization and environmental education, (2) natural resource management (forests, soils, and water), (3) marketing, and rural agroindustry, and education (Table 14).

Table 14. Local organizations/institutions and their activities in the Municipality of El Dovio, Colombia.

Local organizations/institutions	Activities
	Production
Rural youth	Diverse exploitations emphasizing organic agriculture
Young researchers from La Hondura	Biointensive gardens
Farmers' association of La Peña	Emphasis on managing the integrated farm
Farmers of Puerto Nuevo	Diversified production (chili pepper, passion fruit, tomato, bell pepper,
Irrigation district "Calle Larga"	onion)

UMATA Coffee Growers' Committee CIAT	Focus on summer production Isolating forests, animal health Diversification, technical assistance
Community action boards UMATA Rural youth CIAT	Natural resource management Reforestation of microwatersheds; conserve, recover, and strengthen ecological resources CVC Green Plan, isolations, reforestation, purchase of protection areas Methodologies for integrated watershed management
ASOGUADUA CIAT	Processing and marketing Processing giant bamboo
José María Falla Institute of Education Rural Juvenile Home UMATA ICBF CIAT	Community organization and environmental education Education integrated with an agricultural modality School program for youths to include agroecological education Group organization Work methodology, focusing on youths
Saint Lucía Hospital Rural Juvenile Home	**Health** Programs of health services and prevention Health services

Baseline preparation. Indicators for integrated watershed management are being established through the CMDR. This activity permits greater integration among local actors in that, through institutional agreement, the indicators are prioritized. Likewise, it permits data systematization and processing, and preparation of projects to support the population in a more integrated fashion. About 40% of this baseline has so far been constructed.

An operational bylaw has been prepared and promulgated, containing principles, vision, mission, and residence of (a) objectives and functions, (b) equity, (c) the CMDR members, (d) organization and operation, (e) community participation, and (f) logistics. This bylaw aims to obtain formal commitment from institutions present in the Municipality before the CMDR.

Leadership at the municipal level: the UMATA. The UMATA leads in matters of interinstitutional coordination. The immediate opportunities in the area for this type of support work are as follows:

(1) With the baseline finalized, we will have a reference by which to process and systematize data according to indicators for integrated watershed management.
(2) Analysis of more precise and reliable data for the Municipality, with information available to all interested actors.
(3) Information that serves for more specific studies and for preparing integrated projects to support the population.

2.3.2.1. Preparing baseline indicators for the Garrapatas River watershed, Colombia

Related milestones

Baseline survey

Context

The baseline survey was carried out as part of an alliance with local institutions in the framework of the Municipal Council for Rural Development (CMDR), particularly with the Municipality of El Dovio, to establish a starting point for the project. The objective of this activity was to monitor the progress made by the project and its alliances.

Activities were carried out in the central part of the Garrapatas River watershed, which is part of the biogeographical region of Chocó. The watershed lies in southwestern Colombia, northern Department of Valle del Cauca in the Municipality of El Dovio. This area lies under the influence of the mountain range Serranía de los Paraguas in the Colombian western cordillera. Geographically, the area of interest lies between 4°6' and 4°30' S, and 76°30' and 76°40' W. To the west, the Municipality of El Dovio borders with the magistracy of Quebrada Larga, La Unión, and Roldanillo; to the west, with the Department of Chocó; to the north, with Versalles; and to the south, with the Municipality of Bolívar (Figure 48). The territory extends 383 km^2, distributed as 3600 properties, of which 1538 are urban and 2062 rural. The annual average temperature is 20 °C, and its altitude is 1434 m above sea level.

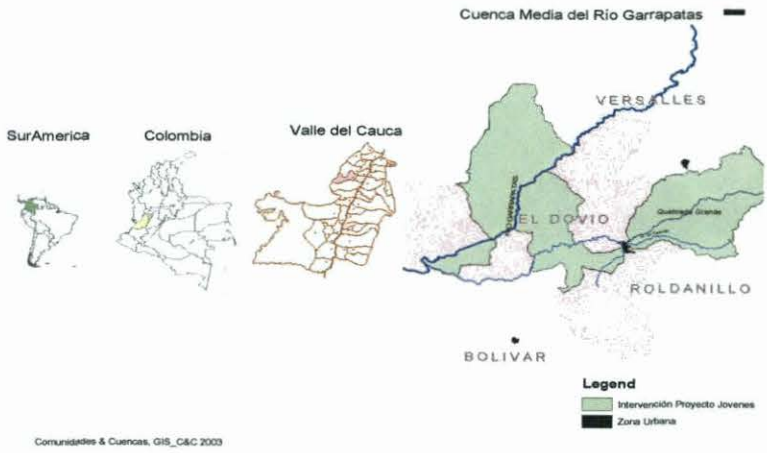


Figure 48. Location of the study area, central watershed of the Garrapatas River, Municipality of El Dovio, Colombia.

In contrast to other municipalities, 70% of El Dovio inhabitants own their land (INCIVA 2001). However, many of these landowners have reduced holdings. Specifically, in the Municipality, predominant land use is natural forest and stubble, followed by pastures. Income from agricultural activities has declined, with extensive livestock prevailing as the main source and

possibly generating heavy social impact, because its demand for labor is low and because livestock is "raw material", that is, exported for processing outside the territory. Most inhabitants of El Dovio are therefore farmers, followed by the unemployed people and home keepers (INCIVA 2001; *Plan de desarrollo municipal* 2004). Although the predominant land use is livestock production, this activity generates very low employment, confirming that extensive livestock offers few opportunities of employment to the population.

The Municipality suffers high emigration. The population of 2004 is much smaller, compared with that of 1999 (SISBEN 2004). The behavior of the Municipality's female and male population shows that the working population—category 20 to 40 years—is reduced in the Municipality (Figure 49), probably because of the high migration, encouraged by violence and the few employment opportunities available in the Municipality.

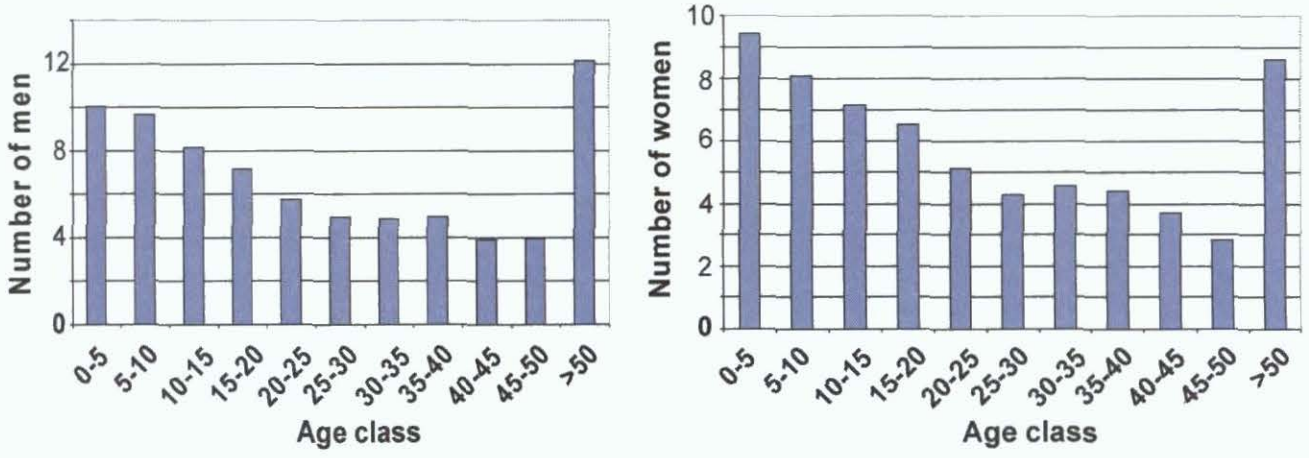


Figure 49. Average number of males and females by age classes in the Municipality of El Dovio, Colombia.

For this reason, the local population gives high importance to projects that promote development of the region (SISBEN 2004). On comparing the leading causes of emigration from the Municipality of El Dovio with other nearby municipalities, the principal reason is violence, caused by the presence of illegal crops and armed groups in the region (INCIVA 2001).

In terms of education, human settlements in El Dovio present in a higher percentage at primary school level, followed by people who have not been to school (INCIVA 2001). For secondary schooling, El Dovio compares less favorably with other municipalities, having smaller coverage (Figure 50).

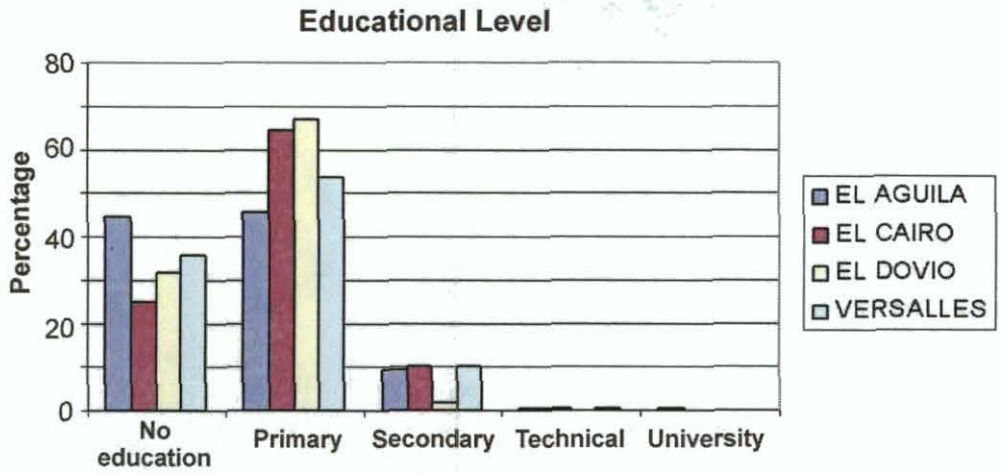


Figure 50. Status of education in El Dovio, compared with neighboring municipalities, Colombia (INCIVA 2001).

In terms of general morbidity, intestinal parasites comprise the third major cause of disease in the Municipality, possibly from consumption of polluted water. Thus, this fact is an important component for carrying out works related to water quality, disease prevention, and management of treated water in village water-supply systems.

The best public utilities in the Municipality are, in descending order, education, telephone, and electric lighting (INCIVA 2001). Although the Municipality is well supplied with electric lighting, firewood is most used for cooking. This aspect must be taken into account as, most probably, strong pressure exists on the natural forest (*Planeación municipal* 2004).

Thus, by knowing the general state of the region, then we can see it is a highly critical area that deserves more attention from the departmental government of Valle del Cauca. This information, which has supported decision making and prioritization of actions to take, is described in this report.

2.3.3 Youth leadership in the Garrapatas River watershed: challenges, objectives, and abilities

Related milestones

Leadership

Background

By developing their leadership skills, young people will have tools to become researchers of local problems, to be critical and inquisitive about the processes in which their educational centers and their communities are involved, and to liaise between their own communities and research processes. Furthermore, juvenile leadership would make it possible to increase the potential for impact and the speed with which new knowledge of natural resource management is assimilated. The participation of young people in research activities related to natural resource management can offer them a source of income, guarantee the immediate use of research findings, and the will of parents to support and promote research activities in their watersheds and communities. Leadership skills will give adolescents a voice in the decision-making processes that affect their lives.

We define leaders as those individuals who can think for themselves, use their personal strengths, communicate their thinking and feelings to others, influence and motivate others to follow a common cause, and work collectively to achieve results. They have high standards of achievement. Leadership is a set of skills and attitudes that can be learned and developed. After 3 years of working in research projects with youth groups, we designed a series of workshops on juvenile leadership under the assumption that all people have potential to become leaders and that the most critical skills for effective leadership, including the capacity to understand and interact with others, are developed predominantly in adolescence and early adulthood. This program takes into account both transactional leadership (through which leaders trade promises of rewards and benefits in exchange for support from subordinates) and transformational leadership (through which leaders help others to also become leaders).

The workshops still need more precise development. So far, the workshops held to date have provided guidelines, and have shown the enormous potential that exists in developing these skills to transform young people. These skills can increase the self-esteem and security with which young people express themselves, and make interacting with others easier for them. The contents of the workshops have been designed, based on the knowledge of CIAT team members, some teachers involved with the project, and various documents.

The limitations we have had with this component lie in (1) designing and using verifiable indicators of leadership skills developed by young people and (2) guaranteeing the sustainability of the workshops through training teachers in educational centers. Accordingly, our next steps will be:

- The methodological development of workshops on leadership skills that will support rural youths involved in learning and research processes.
- Development of verifiable indicators of the impact of leadership skills on young people, their academic performance, and their relationships with their families and communities.
- Development of a training system for teachers with the capacity to provide accompaniment for these processes on a local scale.

The attendance of young people at leadership workshops already shows features of initiative, as many young people must overcome barriers of distances, lack of funds for transport, and parental opposition to activities that remove them from work or study. This is one reason why monitoring leadership skills in young people and the impact on their communities are difficult to quantify.

The content of workshops already developed varies according to the level of the young participants, but encompasses the following aspects:

- *Knowledge of themselves*: To give the youths tools for understanding themselves and developing self-esteem and confidence
- *Communication skills*: Theory and practice of effective public presentations; facilitation abilities; and corporal conscience
- *Teamwork*
- *Participatory video*: A tool for diffusing the experiences and results of research and development

2.3.4 Rural enterprise for the management, processing, and marketing of giant bamboo, Garrapatas River watershed, Colombia

Related milestones

Best-management practices, strengthened organizations

Background

In seeking new income alternatives for family sustenance and the development of the El Dovio region, institutions such as the Mayor's Office, CIAT's C&W Project, and Actuar Quindío have jointly made a significant effort to implement the first phase of a training process on the use and processing of *guadua* (giant or building bamboo) to create handcrafts and furniture. The course has a strong component of business management and criteria for the sustainable management and use of resources.

Objective

To carry out an environmentally and economically sustainable but integrated management of giant bamboo and associated resources (e.g., water, soils, and biodiversity) in the central part of the Garrapatas River watershed.

Activities

One-year training with Actuar Famiempresas of Quindío and the Colombian Laboratory of Design. Training components are, in order:

Administration. The beneficiaries of the project were provided with administrative tools needed to properly and efficiently manage all of the company's or association's resources.

Technical and production development. This component is executed in all stages of giant bamboo production, starting from planting, through use and treatment, to processing into crafted pieces. To obtain works of excellent quality it was vitally important that the artisans had precise knowledge of different aspects of managing stands of giant bamboo and the techniques appropriate for their use. Hence, a support strategy was proposed that was developed by the National Center for the Study of Guadua Bamboo, Municipality of Córdoba. This strategy was carried out through nine training modules.

Technical assistance. Training was complemented with group visits of technical assistants (i.e., two groups of 20 people each), which were carried out during training workshops or in an agreed-upon site with the community.

Marketing and commercialization. This component aimed to seek market niches that would make possible the placing of crafted products in local, regional, national, and even international markets. The group of young artisans attended local, regional, and national fairs.

Results

- Association of Giant Bamboo Artisans of El Dovio, Valle "Guadua Madura" (28 associates) (Figure 51).
- Association belonging to the Marco Agreement on competitiveness of the giant bamboo production chain in Colombia.
- Catalog of over 50 designs of handcrafts marketed.
- Warehouse of handcrafts in El Dovio.
- Group highly trained to produce high-quality handcrafts in giant bamboo, as well as furniture and construction.
- Group strengthened in leadership skills such as teamwork, commitment, and group strengthening.
- The group's craft workshop totally provided with heavy industrial machinery for handcraft manufacture.
- Participation and penetration into markets through craft fairs, including the CIAT fair, local fairs, and the Coffee Belt Fair in Bogotá.
- Local strategic alliances established with UMATA, Mayor's Office of El Dovio, CVC, SENA, Actuar, Colombian Laboratory of Design, and CARITAS International.
- Written and approved proposals for funding the process: the Proposal of a Three-year Plan of Action (PAT) with the CVC, involving 36 ha for right of use, planting, and managing giant bamboo stands; and Col$14 million for machinery and inputs from CARITAS International.

Lessons learned

- The group that formed as an association required the participation of new institutions to contribute training and machinery (CVC, SENA, and CARITAS).
- Young people still do not have the level of developed commitment to mount rural agrobusinesses, and need more institutional accompaniment and monitoring of activities.
- Armed conflict in the area has hindered the participation and permanence of young people in the project.

Figure 51.
The Association "Guadua Madura" display their handcrafts in a community hall.

2.3.5 Youth news: communicating project results to the local community, Garrapatas River watershed, Colombia

Related milestones

Leadership, publications, dissemination of information

Background

The young people of the Garrapatas Canyon are affected by the lack of communication media in the area. The great distances that stretch between villages prevent the adequate flow of information on happenings in villages generally and on activities of young people in particular. Each village community and school wants to report to the urban community of El Dovio, its events, achievements, culture, outstanding persons, and, above all, the progress made in projects of institutions that support young people. Thus, a need exists to generate a communications medium between villages that will publicize important events to the urban area. Two issues to be handled were:

- How to communicate and disseminate information on research projects and activities among the young people of the Garrapatas Canyon?
- How would a communications medium help develop leadership skills in the young people of the area and encourage them to resort to research?

Objectives

- To create and produce a youth magazine
- To develop, with and for young people, a medium through which they can manifest and express their experiences, reflections, knowledge, etc.
- To develop communication channels that will permit the integration of young people from different villages and schools throughout the entire watershed of the Garrapatas River
- To promote community organization and integration
- To encourage young people to reflect on the process they are experiencing to develop the project
- To enhance the knowledge of young people in information technology, reading and writing, and oral expression

Activities

- Call a meeting to create the production team for the youth magazine with educational institutions and communities of the area.
- Hold a workshop to determine committee roles and positions for the production team for the magazine's first edition.

- Training in communications media: How to construct a vehicle for news, interviews, and entertainment?
- Training in information technology for the magazine's entire production team: introduction to the computer environment, PowerPoint, Word, Publisher
- Reading and writing workshops with CIAT's Communications Unit
- Tour of the newspaper *El Pais*
- Production, publication, and sale of copies

Results

- A group of five young people was formed to develop the production of the area's youth magazine.
- Established a methodology for learning and publication.
- Four copies published and sold within the community, reporting on different activities and events (news) of educational institutions and characteristics of young people (Figure 52).
- Fund to continue producing more copies.
- Recognition of the leadership skills in the young people who participated in the magazine's production such as commitment, committee leadership, capacity to manage, and teamwork.

Next steps

To promote the management and accompaniment of local institutions that support such activities to ensure their permanence and sustainability.

Figure 52.
Front page of the youth magazine published in the Garrapatas watershed, Colombia

2.3.6 Designing a model for replication: CERES, El Dovio, Colombia

Related milestones

Strengthened organizations, dissemination of information

Background

Over the last three years, we identified a key factor to maintaining the project's dynamics in the area and being able to replicate it in other scenarios. This was partnership with institutions and people dedicated to youth education. For this reason, we saw the convocation made by the Colombian Ministry of Education to cofinance regional centers for higher education (CERES, the Spanish acronym) as a great opportunity to initiate a partnership that would enable us to consolidate the results we have so far obtained, rely on the support of institutions interested in rural youth, and support our results on a broader scale.

Neither El Dovio nor Versalles have higher education programs and young people who remain in the area become involved in the production sector with knowledge acquired from practice, but without access to innovative technologies or knowledge that would permit the development of businesses or maintain natural resources as the production base.

The production sector in these municipalities requires professional technicians in the sciences related to the management of sustainable and profitable use of natural resources, involving the use of modern technologies for designing, processing, and marketing their products and for adequately managing or creating production organizations.

Because young people can access, without leaving the area, higher education through the virtual education programs offered by CERES, they can maintain their production activities and continue to generate income that, in most cases, is fundamental to their families' economy. The community would benefit from young people staying with their families while finishing their studies and then becoming involved, or strengthening or creating local businesses. Companies and production associations would have trained technical personnel able to create opportunities to improve the production base, manage the natural resources on which depend the watersheds' production and quality of life, create opportunities for business, and administer these.

The need to strengthen higher education in Colombia becomes evident in its low cover. Despite the growth attained during the last decade, the country continues having figures below those of international standards (Figures 53 to 55).

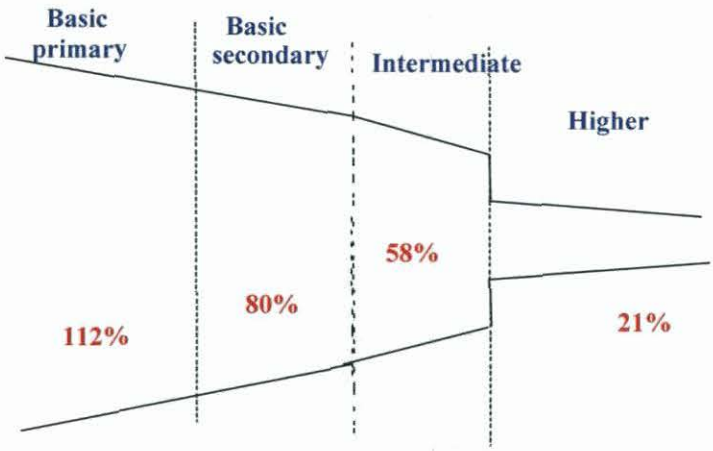


Figure 53. Educational coverage in Colombia.

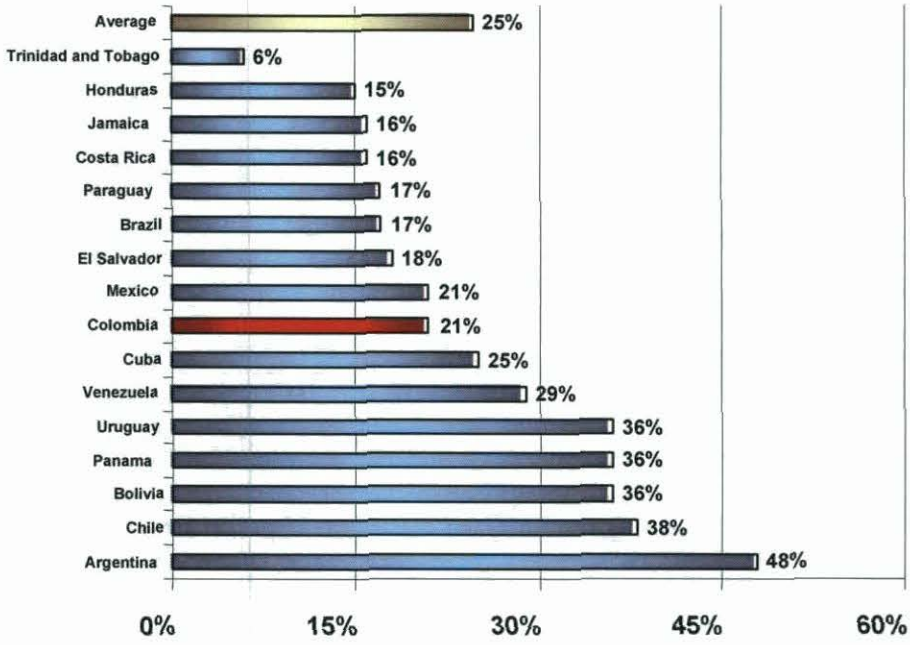


Figure 54. Higher education in Latin America.

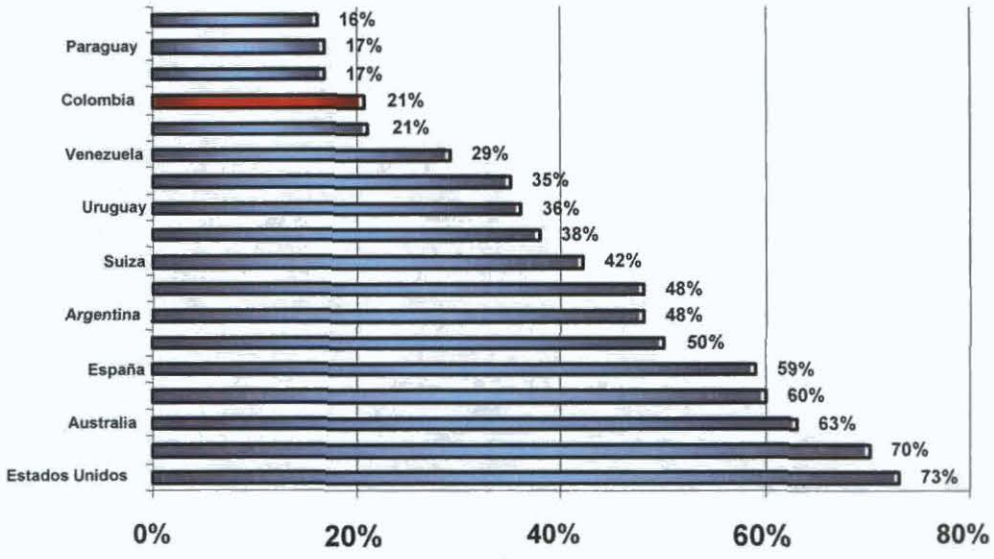


Figure 55. Higher education in the global context.

The offer of higher education is concentrated in the major cities (Figure 56), and young people from other regions must be displaced to access programs, which implies that only those with resources can do it.

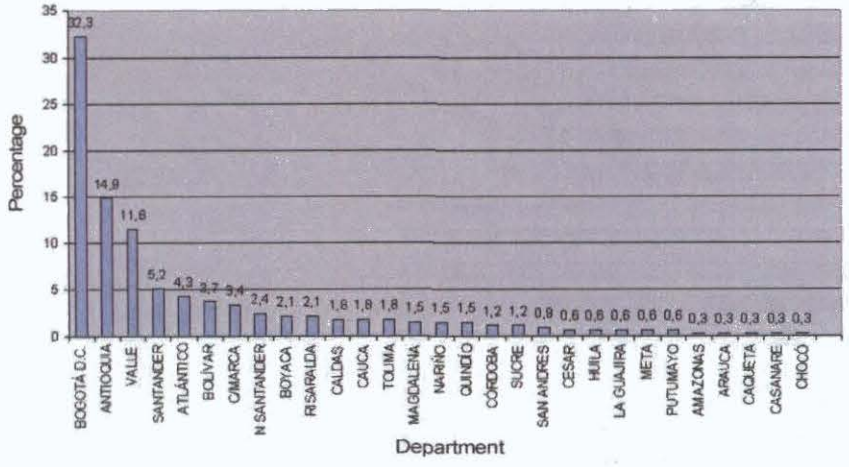


Figure 56. Geographical distribution of higher education institutions in Colombian departments.

The inequity of the system has increased. In 1993, 3.5% of the population in the two low-income quintiles attended a higher education institution, compared with 36% in the higher quintiles. For 1997, the distance between these two groups had increased: where only 9% of the low-income young people had access to higher education, 65% of high-income population had access.

The relevance of some higher education programs is questionable, as well as the preference of university education over technique and technology in both student demand and institutional offer. A common element in the different diagnoses on the subject is that, in Colombia, the tertiary formation pyramid is inverted: that is, an inverse proportion exists between professionals and technical personnel. Of the 981,458 students who enrolled in 2002, 82% attended universities and university institutions and only 18% studied technical careers.

The Colombian experience suggests that the higher education system is not responding adequately to the country's labor and production needs. Problems of relevance and consistency exist among academic content, learning, and demand for labor.

Faced with the above-mentioned problems, the CERES program is a strategy to expand cover by taking higher education to the country's marginalized populations. This new model stems from dialog and the regions' cultural pools, focusing on the offer of programs that are relevant to the areas' production vocations, and promoting distance and virtual education and interinstitutional alliances that enable the shared use of resources, both human and infrastructure, and connectivity.

The CERES are conceived as an alliance in which the government, civil society, and the academe participate with a common objective: to create opportunities for the social and economic development of marginalized communities. The national government acts as promoter and facilitator, and contributes resources; the local governments and representatives of the civil society and of the production sector channel community realities and create production projects explicitly for the area and its requirements; and the academe puts its knowledge to service the region's development.

A CERES is created as a place provided with very good technological infrastructure for information and communication, through which the community can access programs of higher education, whether professional, technical, or university. These programs are offered by different higher education institutions, using shared resources.

The academic offer is defined as responding to the analysis that the alliance had made of the production vocation and specific requirements of the area of influence. They must be pertinent and consonant with the labor market to motivate young people to remain in their place of origin. Preferably, the programs work with distance methodology and have a major connectivity component.

Higher education institutions will find an opportunity to reach marginalized communities through a CERES, which will make shared resources available and reduce the costs of offer. It is important that the interested higher education institutions are willing to offer virtual education with connectivity, using, to the utmost, information and communication technologies that will facilitate and reduce the cost of taking programs to remote communities.

For its daily operation, a CERES will rely on the academic and technical support of an "operating" institution. This higher education institution will administer the Center to facilitate

learning and the offer of programs that both the operating institution itself and other higher education institutions will have developed with the CERES resources that they share. It will give students access to CERES during the schedules and modalities agreed upon by all the institutions; offer induction and support for academic work; allot times; maintain facilities, infrastructure, and information and communication technology in a perfect state for learning; monitor good use, and offer technical support to students using technology and installations.

2.3.7 Youth Bolivia: an alliance for water science and the future

Related milestones

Strengthened organizations, leadership

Introduction

Youth Bolivia is a partner for water science in the CGIAR/CIDA linkage fund collaborative project, which helps broaden the CIAT/UBC research alliance through the exchange of researchers and researcher collaboration with CGIAB. CIAT brings extensive experience in youth involvement in natural resource management research to the alliance, UBC a strong foundation in water science and innovation, and CGIAB extensive experience in water rights.

Researcher exchange

The exchange of scientists from CIAT, UBC, and CGIAB has helped enhance collaboration and exchange of lessons learned, develop youth capacity, and compile scientific baseline information on water issues for the Tiquipaya watershed. Scientific exchange has included joint workshops on baseline survey techniques, leadership, water consumption, and water quality. Workshops focused on the transfer of techniques and tools from CIAT and UBC to CGIAB. The adaptation of those tools for Bolivia by CGIAB facilitated improved application by UBC and CIAT. The workshops significantly contributed to the building of youth capacity through specific skills such as diagnostic trees, questionnaire design, interviewing techniques, water-use monitoring techniques, water-quality monitoring procedures, data analysis, and presentation skills.

Leadership training for youth co-researchers

The objective of youth leadership training relative to water science is to facilitate the development of youth leaders who think independently, can use their strengths, communicate their thoughts, influence and motivate others for a common cause, work collectively to produce concrete results, and have high work standards. Youth leadership experience in Colombia has resulted in a sequence of development modules. A level-one workshop was conducted in Bolivia, focusing on self-knowledge, teamwork, and public speaking.

Because this was the first workshop, and it combined two youth groups (upper and lower watershed), activities included integration and the creation of an atmosphere for feedback. Self-awareness activities included the creation of graphic profiles and flags that reflected dreams, abilities, strengths, weaknesses, culture, and gender. Public-speaking skills involved practice in small and large groups, presenting the results of individual and team work, and a discussion session reflecting on the lessons learned after each activity. Teamwork exercises stressed coordination, cooperation, common goals, delegation, mutual respect, conflict management, and communication. Activities such as "crater hopping", "rope walking", "pyramids of glass", "rope

swing", and "the square" challenged youths to understand and develop teamwork skills in a non-threatening environment.

The leadership workshop was a positive first step towards developing youth capacity within the project and was a challenge for many participants who had limited exposure to public speaking, teamwork, or self-expression and/or self-awareness (Figure 57).

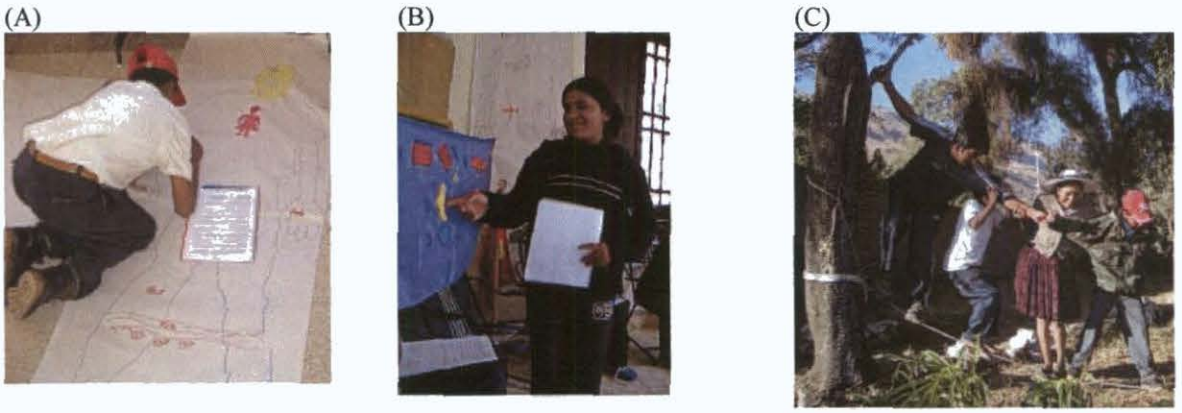


Figure 57. Activities during a leadership workshop. (A) Drawing a self-profile. (B) Presenting the flag. (C) Doing a teamwork exercise.

The exchange between the youth groups from Titiri and Totora (upper watershed) and Tiquipaya (lower watershed) also provided opportunities for the youths from the two zones to present their work on water resources, and discuss common interests and differing perspectives.

2.3.8 Conflict and stakeholder analysis: the case of the Tiquipaya watershed, Bolivia[3]

The Tiquipaya watershed in Bolivia represents an interesting case of conflict and collaboration over water. It embodies struggles and negotiation over water resources between upstream and downstream rural communities and between irrigation farmers and urban interests. At the same time, part of the Tiquipaya watershed is situated in a national park created to protect water resources, but making the watershed part of a larger conflict in the entire Tunari region between rural communities and illegal settlers on the one hand and departmental and national park authorities on the other. Moreover, Tiquipaya has been a focal area of organization against the privatization of water supply and resources in Cochabamba (often referred to as the "Cochabamba Water War"), defending customary rights and access to water (*usos y costumbres*). The development of an Andean vision for water management was partly elaborated in Tiquipaya. Finally, Tiquipaya comprises urban, peri-urban (semi-agricultural), and rural communities with different forms of managing water resources. While these groups are interdependent both biophysically and socially, they obviously have different interests and access to and control over water resources. All this makes Tiquipaya a relevant and appealing case for studying conflict and collaboration in transboundary water-resources management.

The field of water management in Tiquipaya is divided into several subfields with a range of stakeholders. Different stakeholders often have an interest in one or more interrelated subfields because of the transboundary nature of water and biophysical interdependencies. Four of these subfields are described below.

Irrigation usos y costumbres *versus upstream tenure rights and social claims*

User rights to lake water resources are based on a mix of centuries-old customary law termed *usos y costumbres* and contemporary tenure rights. Irrigation farmers in the valley have gained rights to lake water resources through land ownership and have maintained their rights through further development and maintenance of the systems. This has partly excluded others, such as the upstream Totora and Cruzani farmers, creating increasing tension. However, respect for and acceptance of *usos y costumbres* is still strong. Relationships, both economic and social, between upstream farmers and irrigation farmers, date back to the Incas and their irrigation systems. Today, many upstream farmers also have land downstream. Friendships, intermarriage, and godfather relationships are maintained and enhanced by common events and activities. Moreover, upstream farmers are, for the first time, represented in the municipal government, together with irrigation farmers organized in ASIRITIC. Also unifying all communities, upstream or downstream, is their organization into agrarian syndicates, which, at the watershed level, often belong to the same regional syndicates.

The most important challenge to this inter-Andean relationship is that the norms and values involved are increasingly being confronted by modern and external factors, particularly

[3] This section forms part of a PhD dissertation on water access, negotiation, and power, using the Tiquipaya watershed as a case study.

urbanization and commercialization, affecting water resources. Urbanization, which claims large shares of water resources, is one reason why irrigation farmers are forced to increase storage capacity in the upstream lakes to maintain their level of agricultural production. The growing demand for compensation by upstream farmers may be explained as a result of their increasing consciousness about the value of land—which, again, is a result of commercialization.

Upstream farmers are exposed to huge temptations by public and private actors to sell land around lakes for irrigation, industrial production, and electricity production. The opening of concession rights to water has initiated a change of attitude (*sensación de propiedad*), and resourceful external actors have tempted community leaders into selling land around water sources, sometimes without their communities' knowledge. Thus, upstream farmers and their structures and institutions are in a process of transition with one foot in traditional *usos y costumbres* and the other foot in modern processes of commercialization and privatization. This, in reality, may also cause conflict between upstream and downstream farmers, as well as within communities.

In other areas of Cochabamba, this kind of conflict is more evident, for example, in the Colomi Region between the Aguirre community and the Punata Valley farmers. According to one farmer from Aguirre, *Para nosotros que el agua quede en el territorio y si ellos dicen 'usos y costumbres' pues, ya se ha pagado con los años que ellos llevan el agua, y según la ley nos corresponde a Aguirre – la descentralización nos favorece* (28 Feb 2004). [For us, the water stays in the territory and if they claim *usos y costumbres*, well, this has already been paid with the years over which they took the water and, according to the law, it (*the water*) corresponds to us, to Aguirre—decentralization favors us.]

This farmer has pitched the law on popular participation against the customary *usos y costumbres*, thus touching on the discussion of legal pluralism, for example, overlapping rights between formal and informal laws, which stakeholders may use according to their interests.

In contrast to the Totora farmers, Cruzani farmers cannot use tenure rights to claim access to lake water resources. They use other strategies and social relationships to gain access to water for irrigation, taking advantage of the shorter distances between their community and the valley irrigation associations.

According to Appolin (1993), more informal practices of acquiring water or "stealing" is common among farmers living close to the canals and is often negotiated through social relationships with the holders of water rights or with water guards or water judges. One irrigation farmer from the community of Montecillo expressed this practice in this colorful way: *"Ouh, pues, roban unos 40 litros / segundo, tal vez hasta 50. Esta noche, eso me ha sucedido. Puta, yo he entregado 10 de la noche. Pucha que barbaridad, yo tengo marca, yo veo con mi linterna; ha rebajado. Tengo que salir justamente arriba en Gagendora. Pucha, como es mi familia, él es familiar de mi mujer, caray! Tengo que rascar mi cabeza y punto..."*(Appolin et al., 1993, p.206). [Oh, well, they steal about 40 litres/second, maybe as much as 50. Tonight this happened to me. F..., I had delivered 10 (*L/s*) of the night (*supply*). Bummer, what barbarity! I've got a marker, I saw it with my lantern, it had dropped. (*Today*) I have to go up there to Gagendora.

Bummer, as it's my family, he's my wife's family, man, far out! I can only scratch my head and that's it!"]

Rural versus urban access and control over water resources

Another rural-urban conflict involves traditional irrigation farming versus growing urban needs. The ongoing conflict over the sanitation and water supply project in the Municipalities of Tiquipaya and Colcapirhua is an example of this. Because of rapid urbanization in the semi-urban zones of Tiquipaya, the Municipality of Tiquipaya, in collaboration with the neighboring Municipality of Colcapirhua, designed a sanitation project (termed MACOTI). The project later included water supply to existing independent potable-water committees. The municipal authorities planned the project without sharing much information and with less participation from citizens and their organizations.

The potable-water committee and the irrigation federation protested against the project for different reasons. The potable-water committee inevitably would lose control over water infrastructure and supply, which previously had been their mandate, independently of the municipalities. Community leaders argued that the communities/neighborhoods would lose autonomy, thus prejudicing their participation in and decision-making about water use and management. The irrigation association (ASIRITIC), on the other hand, saw the project as a threat to their livelihood because of accelerating urbanization. At the same time, their exclusion from the project pointed to a municipality prioritizing urban needs at the expense of rural needs (even though no other civic groups were included in the project either). Finally, ASIRITIC thought the project would open up a future takeover of their water resources in the lakes in the high plains. A citizens' protest succeeded in paralyzing the project and opened up an opportunity for negotiation (multiple stakeholder platform), facilitated by the project NEGOWAT. However, no final agreements have been reached.

Settlement and land tenure rights versus water resource protection in Tunari National Park

Another conflict involving water resources relates to the Tunari National Park. On the one hand, local and national authorities and environmental NGOs are interested in the national park mainly to protect water resources and, on the other hand, local communities and illegal settlers want to access the land.

Local communities oppose the Park, mostly because of ambiguity between the law on national parks and Article 2 in the Law for Tunari National Park, which created considerable insecurity among farmers within the Park. Although the communities are not against sustainable management of the Park per se, they are concerned about their legal rights to use the land and, in particular, their children's right to manage the land and natural resources. Likewise, they protest (although not in an organized way) against their exclusion from decision making about the Park and demand authority in the Park's management.

Those rural communities established within the Park live in much more uncertainty, as their legal rights are ambiguously defined in Article 2. Some communities above the 2750 *meters* park

boundary have gained legal property rights by having been established before the law on the Tunari National Park was promulgated or by the political and economic pressures they were able to put on municipal authorities. Urban settlers, particularly poor immigrants from other parts of the country, remain illegal and live precarious lives without basic infrastructure like roads, potable water, or waste collection. However, few attempts have been made to remove these settlements and most municipalities recognize that an efficient and sustainable management of the Tunari National Park will almost certainly include a solution to illegal settlement and its accompanying problems.

The Andean Cosmo vision of water versus the modern liberal vision of water as a commodity and/or private property

A final subfield of water management is related to two (or more) fundamental different views on water. On the one hand, water is increasingly recognized as an economic good that should be managed according to principles of full cost recovery. This principle has often been associated with and accompanied by an increased commercialization and privatization of water resources and supply, although full cost recovery principles can also be applied to other models of water management such as cooperative or public water management. The economics of water management are often linked to formal and powerful authorities like governments and international financial organizations. On the other hand, a growing number of less formal civic organizations such as indigenous organizations, NGOs, and universities argue with the perception of water as a human right, to be free for all (although not necessarily open to access).

The Cochabamba water war is a highly illustrative case of this conflict. For further details, see Westermann (2004)[4].

[4] Westermann O. 2004. Privatisation of water and environmental conflict: a case study of the Cochabamba "Water Riot". In: Ravnborg HM, ed. Water conflict: conflict prevention and mitigation in water resource management. DIIS Report. 2.

2.3.9 Multiscaling baselines in Nicaragua

Related milestones

Baseline survey, strengthened organizations

Background

A strategic alliance between INTA-UNA-CARE-CIAT created to strengthen the institutional capacity of INTA and its partners in Nicaragua agreed on following an integrated watershed management approach through the synergetic use of knowledge and the integration of activities and extension during 2005. As a result of this, INTA produced baselines and management indicators for integrated management of prioritized watersheds in the country. Scientists from INTA who received training within the alliance and developed the above products in the prioritized watersheds of Río Viejo, Ochomogo and Tecomapa presented three separate products of their results at the "III Foro Nacional de Cuencas Hidrográficas" on November 8 and 9 of 2005 and organized every year by the "Red Nacional de Organizaciones de Cuencas of Nicaragua, RENOC". These three works respectively received the price as the first, second and third best works presented on methodology and municipal strengthening (please see attachments). INTA (Ariel Espinoza, responsible for the watersheds program) is going to start a second phase of this initiative, which is a result of the alliance and consists of the replication of these experiences in 11 more watersheds prioritized by INTA in Nicaragua. This new phase is linked to CIDA's Nicaragua Integrated Watersheds Project, which in turn has incorporated the ESSA Methodology from the UBC-CIAT alliance.

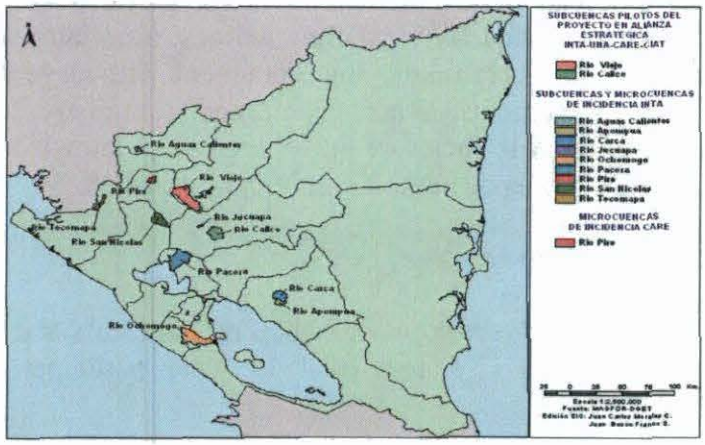


Figure 58. Location of the pilot watersheds involved in the Strategic Alliance's project and of the watersheds of intervention by INTA and CARE, Nicaragua, 2005.

Baseline 1: Microwatersheds of the upper catchment of the River Viejo, San Rafael del Norte and La Concordia, Jinotega[5]

Summary. The area of influence of the project of the INTA/UNA/CARE/CIAT Strategic Alliance in the Department of Jinotega encompassed the Municipalities of San Rafael del Norte and La Concordia, which are located 24 and 32 km, respectively, from the departmental capital of Jinotega. Jinotega itself is 160 km north of the country's capital Managua. San Rafael del Norte lies at 13°12' N and 86°06' W, and La Concordia at 13°11' N and 86°10' W.

This research was carried out to determine indicators, which were later agreed upon by local actors. The review of secondary information, which took place during March to December 2004, was carried out in local institutions that intervene in the study area. The search for primary information was funded by PRONORCEN, permitting surveys to be undertaken in the municipalities to obtain information on the proposed indicators.

This paper, which summarizes the baseline document on the microwatersheds of the upper River Viejo, is therefore only a reference to the work carried out. The indicators are classified according to aspects based on culture, biophysical features, socioeconomics, soil, water, biodiversity, land use and production, and, finally, community management. At the same time, each aspect is measured according to the consensus of local actors with respect to the proposed indicators.

Introduction. INTA, starting with preparing the Institutional Strategic Plan 2003-2007, is transforming itself so that its new line of agricultural and forest extension work involves the integrated watershed management approach. Hence, the Institute would be perceived to protect and preserve natural resources and help guarantee food security for rural families who dwell in such geographic areas. With the new approach of integrated watershed management, INTA aims to help the Municipalities of San Rafael del Norte and La Concordia strengthen their institutional capacities by encouraging different local actors to actively participate in various activities that would help conserve and rehabilitate natural resources, particularly soils and water. Thus, various benefits would be generated for local communities, especially small and medium-sized ones, in terms of production. Accordingly, this document will serve as platform or baseline material for municipal governments, other governmental entities, NGOs, and community organizations. These entities will therefore have increased knowledge and more effective intervention in their areas of influence in the River Viejo watershed.

Methodology used to conduct the baseline

Preparing a minimum set of indicators. A workshop on indicators and baselines was first held in UNAN, Matagalpa, from 9 to 12 March 2004, in which participated staff members of the

[5] Manuel Bucardo et al. Paper presented by INTA at the III National Forum on Hydrographic Watersheds (organized by RENOC), Managua, 9-10 November 2005. It received the award for the best methodology paper on municipal strengthening.

institutions in the INTA/UNA/CARE/CIAT Strategic Alliance and local partners such as the Mayor's Offices of La Concordia, San Rafael del Norte, Yalí, and San Dionisio, and UNAN of Matagalpa. The participants agreed on a minimum set of 50 indicators, representing different aspects such as culture (4), biophysical features (6), socioeconomics (12), soils (3), water (5), biodiversity (5), land use and production (12), and community management (3).

Socializing the set of indicators with the principal local actors of the area for intervention (San Rafael del Norte and La Concordia). Once the minimum set of measurable indicators was prepared (through the Matagalpa workshop), different local actors were convened. These actors included farmers, community organizations, farmer associations, municipal governments, state entities, and NGOs who operate in the Municipalities of San Rafael del Norte and La Concordia. The idea was to socialize, analyze, and obtain consensus on the indicators, whether to incorporate or eliminate each one and determine its importance in preparing the baseline. As a result of the socializing, the participating institutions and organizations committed themselves to make available all information that they had generated during their institutional duties, as a way of contributing to the documentation of the current state of the areas for intervention falling within the project of the INTA/UNA/CARE/CIAT Strategic Alliance.

Collecting primary and secondary information. From preparing and socializing the minimum set of measurable indicators, the next step was to acquire primary and secondary information to structure the baseline. Institutions were visited, key informants interviewed, released documents reviewed, and a survey conducted by the respective local governments of San Rafael del Norte and La Concordia.

What still remains to be done

- Include in this study the urban areas of San Rafael del Norte and La Concordia, as these exert great pressure on the microwatersheds' natural resources.
- Build a database of maps on a scale of 1:20,000 that provide greater details of the study area's characteristics and thus permit effective land-use planning.
- Establish a timetable for measuring variables or indicators such as soil fertility, erosion, water quantity and quality, and deforestation to permit measuring impact on the projects being carried out.
- Determine and georeference environmentally and socially sensitive zones in the area according to the microwatershed inhabitants' determinant criteria.
- Georeference the most significant pollutants on the basis of hydric sources to analyze consequences according to altitudinal floors in the microwatersheds.
- Achieve consensus between the Municipalities of San Rafael del Norte and La Concordia on the legality of their watershed committee and so accelerate the management of economic and social resources for working on integrated watershed management.

Baseline 2: Watershed of the Ochomogo River[6]

Summary. This paper was prepared to provide a qualitative and quantitative framework, and a comprehensive view of the potential and limitations that would permit analyzing changes and impact at biophysical and socioeconomic levels on the Ochomogo River watershed. Taking into account that these changes and impact occur on a medium to long-term basis, the study attempts to become a planning tool in adequately approaching integrated watershed management, to monitor technology generation and transfer, strengthen decision-making mechanisms, and adjust strategies and methods of public extension to ensure expected results.

The methodology used was that proposed by the project of the INTA/UNA/CIAT Strategic Alliance, which includes the collection of primary and secondary information from the field and from public and private-sector institutions. The field methodology involved working with focus groups and key informants, and using surveys structured on the basis of indicators agreed upon and socialized with local actors.

Results showed that in the Ochomogo River watershed, 60% of land is currently used for extensive and intensive agriculture, 4% for forest fallow, 10% for open broadleaved forests, 1% for dense broadleaved forests, 14% for pastures, and 11% for herbaceous and shrubby vegetation. Potentially, 13% of the land could be used for agriculture, 53% for livestock, and 34% for forest. The current state of this watershed's natural resources suggests that 41% are being adequately used, 25% underused, 31% overused, and 3% inappropriately used.

Baseline 3: Microwatersheds of the River Tecomapa catchment, Somotillo, Nicaragua[7]

In the Tecomapa watershed, poor management of natural resources has led to serious difficulties with water quality and availability, as well as with reduced crop production, lack of food, and deteriorated economic conditions of the population. Such deterioration increases with the lack of coordination between institutions, agencies, and local government and weak community organization. This watershed has a population of 4014.

The River Tecomapa is an important affluent of the bi-national watershed of the River Negro. For this reason, INTA initiated action in 2004 to facilitate in organizational processes and in the integration of actors, conduct diagnostic and intervention activities to attain the integrated management of the said watershed. Meetings to increase awareness and consensus-building were held with the Municipality and local actors. Participatory workshops were conducted to review

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[6] Víctor Hugo Arana Meza, Specialist, Integrated Watershed Management, INTA-South Pacific. Paper presented by INTA at the III National Forum on Hydrographic Watersheds (organized by RENOC), Managua, 9-10 November 2005. It received the award for the third best methodology paper on municipal strengthening.

[7] Ana Lucía Lorío Berríos and Amelia Gutiérrez Grio, Manager and Specialist, respectively, Extension Office-North Pacific, Nicaraguan Institute for Agricultural and Livestock Technology (INTA). Paper presented by INTA at the III National Forum on Hydrographic Watersheds (organized by RENOC), Managua, 9-10 November 2005. It received the award for the second best methodology paper on municipal strengthening.

diagnostic information and form watershed committees. Surveys were made and secondary information collected. After one year, the Tecomapa watershed now has a baseline, one municipal and 8 community watershed committees, and is publishing a baseline document. Although the task of making the Municipality feel the main actor in these activities was difficult, it is now being incorporated into the process.

In coordination with the institutions that make up the National Network of Watershed Organizations (RENOC, its Spanish acronym), INTA is working strategically, promoting and integrating activities into national policies that will improve natural resources and, thus, the country's socioeconomic status.

3. Other Projects and Collaborators

As C&W becomes more integrated with both outside and CIAT partners, our work with them appears as an integral part of our MTP and is therefore included within the activities of the Project reported above. In this brief section, we report other activities that represent early initiatives or the completing of past commitments.

3.1 Small seed enterprise development course, Haiti

This activity aims to fulfill the objective of developing a strategy to satisfy farmers' demand for maize seed (15 MT) and their anticipated demand for seeds of other crops such as sorghum, cassava, and beans (output 2.2). The project is entitled *Enhancing Food Security in Haiti: Grains, Roots, and Forages for Sustainable Rural Livelihoods.*

The first training session for World Vision staff on Artisanal Seed Multiplication has started in Port-au-Prince. Another on knowledge management methodologies has already been programmed for the fourth week of May with WV officers.

This course, delivered by Juan Bosco Franco, CIAT-Nicaragua, with support from Levael Eugene and V. Zapata, was attended by 16 professionals (most of whom were field personnel from Word Vision, Save the Children, and Catholic Relief Services), who rated it as very good or excellent (Table 15). Alternated translation was used throughout the course without difficulty. Practical activities captured enormous interest from the participants. All evaluation and validation forms were translated into French by Levael Eugene (working long nights) to help participants comprehend. Table 15 also summarizes the participants' final evaluation of the course, where 0 represents poor and 3 excellent:

Table 15. Participants' rating of the course on developing small seed enterprises, Haiti.

		Score			
Evaluated item		0	1	2	3
1.1	Objectives were at the level of institutional and personal expectations			8	8
1.2	Objectives were accomplished			4	12
2.0	Contents covered responded to knowledge needs			4	12
3.1	Presentations made by instructor			8	8
3.2	Work group			8	8
3.3	Quality of the training manual				16
3.4	Plenary sessions		4	4	8
3.5	Audiovisual aids			12	4
4.0	Contents presented were applicable to my job		4	4	8
5.1	Previous communications about the course			12	4
5.2	Schedules were kept			8	8
5.3	The program was run as expected			4	12
5.4	The group was wisely conducted			4	12
5.5	Activities were well led			8	8
5.6	Logistic support was adequate			8	8
6.0	Length of course vis-à-vis intended objectives			16	
7.1	Lodging		4	8	4
7.2	Board			12	4
7.3	Classroom			12	4

3.2 Rural Innovation Institute

The two main collaborative activities with CIAT's Rural Innovation Institute are:

(1) Supporting the project in Nicaragua on natural resource management and emphasizing integrated watershed management. Financed by the IDB, it is entitled *The community gets organized to do research.* The project is executed by MARENA-POSAF, with the principal goal of increasing the capacity of homogeneous groups to undertake their own "research and development". Thus, they can initiate technical changes in forest and agricultural production that will lead to a more effective implementation of the Project and to the sustainability of activities promoted by the Program of the Ministry for the Environment. Major results included:

- Training of 25 technicians from eight NGOs of Nicaragua (POLDES, UNAG, APRODER, FIDER, MOPAFMA, APRODESA, CUCULMECA, and UNICAFE) and CARE on participatory research, group formation, participatory diagnosis, planning and establishment of trials, and methods of participatory evaluation.
- Formation of 54 farmer groups as Local Agricultural Research Committees (CIALs, their Spanish acronym) by trained technicians who work in the watersheds of Esteli, Nueva Segovia, Jinotega, Matagalpa, and Managua.
- Evaluation of trials on common beans, maize, pastures, and potato.

(2) Participation in the development of methodologies for the *Comparative analyses of brief accounts of innovation with the theme 'small seed businesses' (SSBs): an innovative approach to improve the competitiveness of hillside products in dynamic markets.* This work experience developed in Central America after Hurricane Mitch. The concept of the innovation of small seed businesses was introduced into the process of seed production. Introduced changes and innovations have made this model successful in Honduras, Nicaragua, and Haiti.

3.3 IMAT-RDC to improve agroecosystem management in the tropics

3.3.1 Goal

To improve food security, economic productivity, agroecosystems, and human health in the tropics while ensuring the provision of global environmental goods and services

3.3.2 Objective

To contribute with technical, institutional, and policy innovations towards the improved management of tropical agroecosystems to benefit poor communities and the local and global environment

3.3.3 Communities and Watersheds' involvement

C&W has been very active within IMAT-RDC this year. C&W leads IMAT's *Output 3: Methodologies developed to improve watershed management based on community-based monitoring systems and management of watershed characteristics and processes*. The Project has helped identify opportunities and prepare several proposals. A small proposal led by C&W with IDEAM in Colombia, also involving scientists from CIAT's Soils and Impact Assessment Projects, was approved at the end of the year and may receive larger funds in the near future. C&W's Project Manager is personally involved and is chairing IMAT's developments towards the forthcoming CCER in 2006.

3.4. Consorcio para el Desarrollo Sostenible de la Ecorregión Andina (CONDESAN)

PE-3's Project Manager continued as a member of the Comité Técnico (CT) of CONDESAN during 2005 and has been invited to the meetings of the Consejo Directivo (CD) as a representative of the CT.

During 2005 the approval and implementation of the "Carta de Navegación" (navegation chart) of CONDESAN was at the center of the Consortium. The Carta de Navegación of CONDESAN is the equivalent of the CGIAR MTP. The document presented was considered as very good and only minor changes were suggested. The CD was emphatic to ask the Unidad de Coordinación (UC) to dedicate all their effort on the two "Áreas Temáticas" of the "Carta de Navegación":

a. Integrated water resources management at the level of watersheds, ecosystems and political units.
b. Innovations on agrarian systems aiming to increase value to the richness of the diversity of the Andes.

Four Concept Notes aimed at implementing the new Carta de Navegación were prepared and will soon be submitted to selected donors for possible funding.

The CD members have expressed their sympathy with the new developments both in the CGIAR and particularly in the two Centers present in the Andean region and closer to CONDESAN. CIP and CIAT MTPs were seen as complementary and capable to fulfill the three conditions necessary for development to take place which are: research, learning, and innovation. The UC was encouraged by the CD to further explore active collaboration with CG Centers particularly with CIP and CIAT.

3.5. Central American Think Tank Group on Integrated Watershed Management

The Central American Think Tank Group on Integrated Watershed Management was created with the purpose of fostering the regional dialogue on IWM. This group is made up of professionals from diverse disciplinary backgrounds and with broad experience and knowledge on both natural resources and the environment. These professionals belong to an equally broad group of institutions made up by UICN, CRRN, GWP, UPAZ, CIAT, POSAF, BID, ACDI, UCR, INCAE, FUNDACIÓN NATURA, and CATIE. This group will be analyzing the focus

and strategies needed in order to advance in the sustainable and participatory management of watersheds in Central America, and will also facilitate the process to consolidate a "Central American School of Thinking".

Some specific actions that are planned for this group are:

- Serve as a forum for consultation and analysis of trends on different approaches both at territorial and landscape levels, with the purpose of achieving greater integration, complementarities, and efficiency in the integrated management of watersheds, natural resources, and the environment in the Central American region.
- Suggest and develop directions, strategies and actions for the consolidation of a "Central American School of Thinking" on integrated watershed management.
- Analyze results and partial progress of CATIE's Focuencas II project in terms of its central elements or impact basis.
- Recommend on the steps needed to establish strategic alliances and collaborative efforts with other regional and international organizations.
- Collaborate with strategic publications aimed at reaching decision makers as well as the regional and international community.

4. Publications and Communications

The Communities and Watersheds' communication strategy reflects our philosophy of disseminating research results for increased impact. To ensure that the information generated by C&W is accessible to different users, we have started using a range of approaches, including Web-based information communication technologies (ICTs), comparative studies, alliances, regional networks, multi-media CD-ROMs, conferences, and traditional paper-based media.

4.1 Information Communication Technologies

4.1.1 Web site for the Communities and Watersheds Project

The principal objective of updating the Project's Web page is to make it an informative tool for our clients, partners, and donors, as well as for CIAT, its Board of Directors, and Science Council. This will be achieved by structuring the Web page around the last Medium-Term Plan (MTP) that was approved, ensuring that we report according to the "outputs" and, specifically, to the annual "output targets" agreed on. The site is being designed to take into account:

- C&W's "Research areas", as detailed in the "Logical Framework" of the MTP
- The resulting "Products" of the work, as framed in our "Research areas"
- Publications
- Description of the Project, its personnel, partners, and donors in the section "About Us"

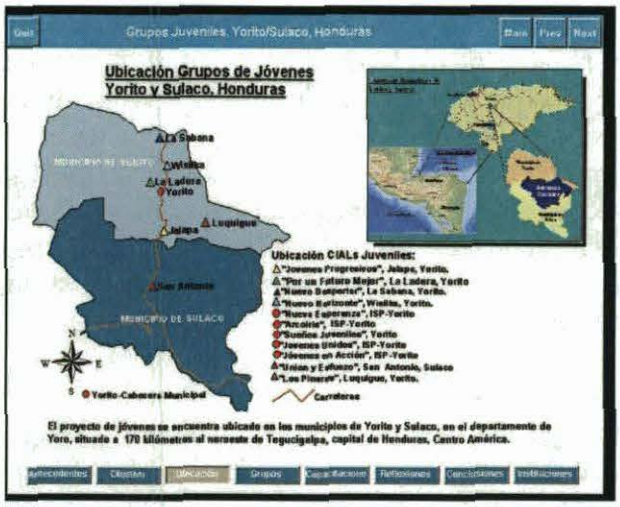
The section "Research areas" emphasizes the work C&W carries out on the management of watersheds and water. It also has a last part that makes information on the process available to different users.

The section "Products" currently includes work on natural resource management and food security with young people in Yorito (Honduras) and El Dovio (Colombia). Likewise, it includes the work resulting from the baseline survey on the Municipality of Yorito.

4.1.2 CD-ROMs

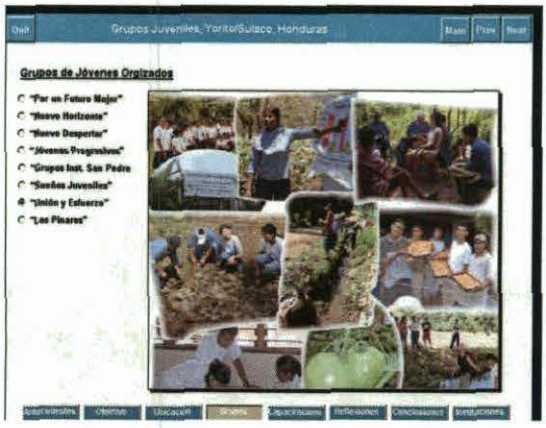
CD-ROM: Youth researchers, CIAT-Honduras

As a part of documenting the activities and results of the Youth Project in the Municipalities of Yorito and Sulaco, in Yoro, Honduras, a CD was prepared with information on the groups created, their operation, and the results obtained during the Project's first and second phases.



The Project began in 2001 by training facilitators to organize and lead youth groups, which were then formed. The Project lasted for 3 years until March 2004. The executing institutions (CIAT, FIPAH, the San Pedro Institute of Education, the University of Guelph, and the UBC) and the groups formed have since been continuing the activity. In February 2003, these groups received specific support from the Canadian Fund for Local Initiatives in Honduras, which enabled them to buy equipment and furniture for training.

During these first phases, 8 groups were formed that included students and young leaders from the communities or villages of Yorito and Sulaco. The San Pedro Institute also created 3 more groups to explore research topics in specific areas.



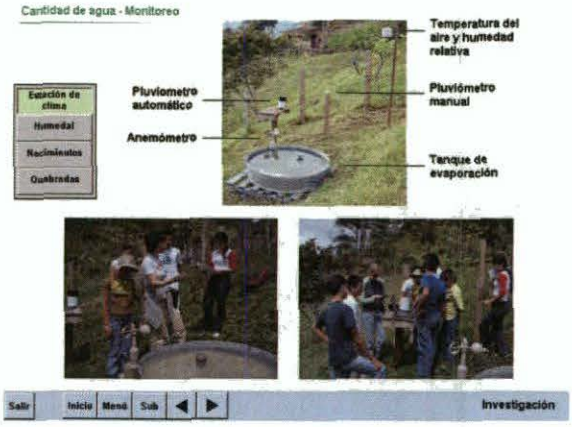
In the CD, information on these groups is summarized as follows:

- Background
- Objectives
- Location
- Description of each organized group and its community.
- Capacities acquired by the young people
- Reflections and conclusions
- Participating institutions

CD-ROM: Youth researchers: education, food security, and natural resources, CIAT-Colombia

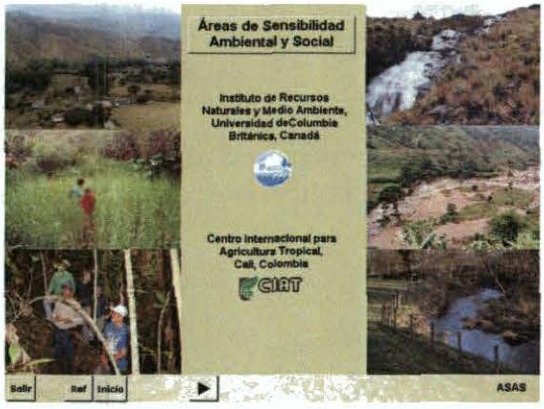
A multi-media CD-ROM summarizes the outputs and lessons learned from the project *Youth Researchers: Education, Food Security, and Natural Resources*, sponsored by the W. F. Kellogg Foundation. The CD was produced to systematize information from all the project's components and to facilitate the dissemination of results to a wide audience in an interactive format. The CD is in self-executable format and contains more than 140 interactive "pages" of maps, graphs, text, photos, and video. Compared with a traditional paper-based format, the CD is inexpensive to distribute and is significantly more graphic in nature. The CD contains principal sections dealing with research objectives, background, leadership, research projects, sustainable development of small enterprises, a model for replication, and retro-information.

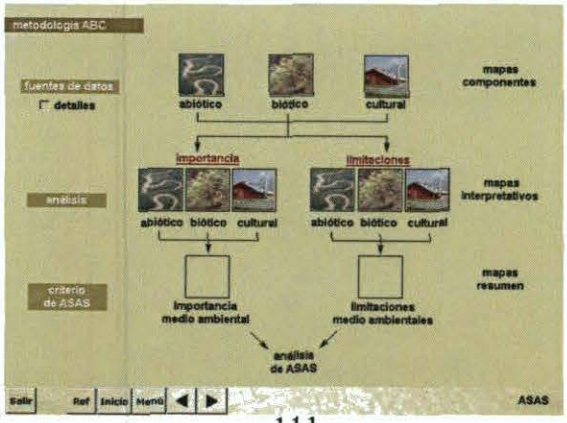
The leadership section focuses on workshops and concrete activities to develop leadership skills relevant to rural youth, including self-awareness, communication skills, team work, participatory video, networking, and local news production. The research section contains youth-led research on food security, water use, water quality and quantity, animal husbandry (poultry, pigs, and fish farming), and ecological restoration. Sustainability includes the development of a small bamboo enterprise (business, technical production, marketing, and environmental sustainability), and a self-regenerating seed-fund to support local initiatives. The model for replication includes a rural center for higher education (CERES), jointly led with a local technical institution and the municipality, and supported by Internet connectivity. The retro-information section contains lessons learned and feedback from project participants aimed at assisting other groups with similar interest.



CD-ROM: Environmentally and Socially Sensitive Area Assessment, CIAT-UBC

A CD-ROM on Environmentally Sensitive Area assessment techniques was produced in both English and Spanish as an output of the CIAT-INTA collaborative watershed management project in Nicaragua. The UBC's ESA method was adapted for Latin America to incorporate social assessment components, becoming ESSA. The method documented in this CD covers general concepts, the ABC method, examples, and discussions of pros, cons, and application.





The ESSA method integrates physical, biological, and cultural information of a watershed to support proactive land-use planning. Natural resource mapping provides the basis for assessment. Criteria are developed by watershed stakeholders to assess, in a transparent process, the relative importance of features. Land units are ranked according to the set criteria and assigned an ESSA class. Examples of ESSA types include water sources, riparian buffer zones, diversified agriculture, and geologic/erosion hazard.

Public participation in the designation of ESSAs is critical to success and contributes valuable knowledge about the watershed. ESSA maps are useful for developing a comprehensive community plan, identifying conservation areas and strategies, and establishing specific management guidelines. The method is flexible and easily adjusted to local conditions. The CD outlines the method for ESSA assessment, and contains concrete examples that permit interested groups to develop an approach assessment for their needs.

4.2 Posters

A series of posters on the results of youth research projects in the Garrapatas River watershed of Colombia was produced to disseminate information locally. Youth researchers worked in small teams to design their posters, highlighting the objectives, specific aims, methods, observations, results, and recommendations and conclusions. The posters included:

- Relationships between water use, water quality, and land use
- Monitoring the availability and temporal variability of water
- Ecological restoration
- Sustainable artisanal work in bamboo
- Food security: biointensive vegetable gardens and basic grains
- Integrated animal production systems: poultry, pigs, and fish farming

The posters were invaluable in communicating results at the local level. Presentations to the community and interested stakeholders were led by the local youth. Copies of the posters remain in local education centers and with the municipal environmental office for reference. In addition, the posters have been extremely useful for the Project to demonstrate specific examples of youth-led research projects.

4.3 Journal Articles, Books, Conferences, Technical Reports, and Others

4.3.1 Refereed journals

Brown S; Kennedy G. 2005. A case study of cash cropping in Nepal: poverty alleviation or inequity. Agric Human Values 22:105-116.

Brown S; Merz J; Shrestha B; Von Westarp S. Submitted. The need to incorporate gender in sustainability: women, water and workloads, a case study from Nepal. Water International.

4.3.2 Chapters in books

Brown S; Schreier H. In Press. Introducing innovations to watershed management. In: Price M, ed. UNESCO; MAB.

Brydon J; Roa MC; Brown SJ; Schreier H. Integrating wetlands into watershed management: effectiveness of constructed wetlands to reduce impacts from urban stormwater. In: Wetlands. Kluwer Acad Publ, (NATO Science Series.). 11pp. In Press

Zandbergen P; Brown S; Schreier H. 2005. Watershed management education and training CD-ROMs. In: France R, ed. Facilitating watershed management: fostering awareness and

stewardship. Rowman & Littlefied Publ, Oxford, UK. pp 129-141. (A Web-enhanced book.)

4.3.3 Theses

Baltodano ME. 2005. Economic evaluation of the offer of hydric environmental services in the sub-watersheds of the Jucuapa and Cálico Rivers, Nicaragua. MSc in Environmental Socioeconomics. CATIE, Costa Rica. 117 pp.

Lanza MG. 2005. A network analysis of the Barbas watershed: non-material environmental flows, Colombia. MSc in Environmental Sciences. Wageningen University, Netherlands. 83 pp.

Roa C. 2005. Relationships between water availability, multiple uses of water, and land use in the micro-watershed Los Saínos. MSc thesis in Sanitary and Environmental Engineering. Faculty of Engineering, Universidad del Valle, Cali, Colombia. 84 pp + appendixes.

4.3.4 Workshop and conference papers

Arana V. Línea base subcuenca del Río Ochomogo. Paper presented at the III National Forum on Hydrographic Watersheds (organized by RENOC), Managua, 9-10 November 2005. 9 pp.

Baltodano ME; Alpízar F; Madrigal R. Valoración económica de la oferta del servicio ambiental hídrico en las subcuencas de los Ríos Jucuapa y Cálico, Matagalpa, Nicaragua. Paper presented at the III Foro Nacional de Cuencas Hidrográficas (RENOC), held 9-10 November 2005, Managua, Nicaragua.

Brown S. Allocating mountain water: uncertainty and impacts. Paper presented at the Glochamore 3rd thematic workshop on Sustainable land use and natural resource management in mountain regions, held 14-17 March 2005, Sierra Nevada, Spain. (Organized by Centre for Mountain Studies, UHI Millennium Institute, Perth, UK. UNESCO-MAB.)

Brown S. Water in the Andes: conservation and human use. Paper presented at the UNU-INWEH/UNESCO-MAB-IHP International Workshop on Water resources management in diverse ecosystems and providing for human needs, held 14-16 June, Hamilton, Canada.

Bucardo M; Torres C; Navarrete R; Mairena LM; Montenegro N; Arauz N; Franco J. Línea base, microcuencas de la parte alta de la subcuenca del río Viejo, San Rafael del Norte y la Concordia, Jinotega. Paper presented at the III National Forum on Hydrographic Watersheds (organized by RENOC), Managua, 9-10 November 2005. 9 pp.

Espinoza N. Percepción de los habitantes de la subcuenca del río Cálico sobre el uso y manejo del recurso agua, San Dionisio, Matagalpa, Nicaragua. Paper presented by Diego Gómez

at the III Foro Nacional de Cuencas Hidrográficas (RENOC), held 9-10 November 2005, Managua, Nicaragua.

Giraldo G; Beltrán JA; Franco JB; Sanz JI. Pequeñas empresas de semilla – PES: Un innovador enfoque para mejorar la competitividad de los productores de las laderas en mercados dinámicos; Proyecto Comunidades y Cuencas-CIAT. Document available at www.ciat.cgiar.org/iir/recuentos.)

Lorio AL; Gutiérrez A. Línea base: Enfoque de cuencas en la subcuenca del río Tecomapa, Somotillo. Paper presented at the III National Forum on Hydrographic Watersheds (organized by RENOC), Managua, 9-10 November 2005.12 pp.

Orozco PP; Piccand V; Zanelli S; Beltrán JA. Estrategia de involucramiento de actores locales en la generación de datos para línea base con indicadores mínimos en manejo integral de cuenca: Estudio de caso microcuenca Wibuse / Jicaro, subcuenca del río Cálico, San Dionisio, Matagalpa. Paper presented at the III Foro Nacional de Cuencas Hidrográficas (RENOC), held 9-10 November 2005, Managua, Nicaragua.

Roa MC; Brown S. Variabilidad en la capacidad de almacenamineto de agua en la cuenca alta del río Barbas. Paper presented at the International Conference on Climate Change: Impacto en los sistemas de alta montaña, held 21-23 November 2005, Bogotá, Colombia.

Sanz JI. Actuación del CIAT con los INIAs en América. Paper prepared on invitation of INIA-Spain for presentation at the IV Encuentro del Sistema de INIAs de Ibero-América, held 30 May–3 June 2005, Rio de Janeiro, Brazil.

Sanz JI. Communities and Watersheds: an integral approach to water and ecosystem management (a). Paper presented during the Side Event on Integrated Water and Ecosystem Management, in response to an invitation by the Unidad de Recursos Naturales del Programa de las Naciones Unidas para el Medio Ambiente, Oficina Regional para América Latina y el Caribe, held 9-14 October 2005, Montego Bay, Jamaica

Sanz JI. Communities and Watersheds: an integral approach to water and ecosystem management (b). Paper on the conceptual framework of CIAT's Communities and Watersheds Project, prepared at the request of OAS to complement the presentation for the Side Event on Integrated Water and Ecosystem Management. Presented at the Fifth Inter-American Dialogue on Water Management, held 9-14 October 2005, Montego Bay, Jamaica.

4.3.5 Technical reports and others

Amaya JE. Investigando y promoviendo la instalación y manejo de huertos biointensivos en la subcuenca del río Tascalapa, Municipio de Yorito, Yoro, Honduras. Internal CIAT report, CIAT, Honduras. 22 pp.

Brown S; Cordero E. Youth Bolivia: alliance for water-science and the future. Annual report for the CGIAR-CIDA Canada Linkage Fund. CIAT; UBC; CGIAB, Bolivia. 15 pp.

Lanza GM. Evaluación de la cantidad y calidad del recurso hídrico en la subcuenca del río Tascalapa, Yoro, Honduras. Consultancy conducted for the CIAT Communities and Watersheds Project, Tegucigalpa, Honduras. 84 pp.

Orozco PP; Gómez D; Beltrán JA; Piccand V; Zanelli S. Línea base subcuenca río Calico, cuenca del río Grande de Matagalpa. Internal CIAT report, CIAT, San Dionisio, Matagalpa, Nicaragua. 24 pp.

Pineda M. Georeferenciación y caracterización de las obras toma (Bocatomas) en la subcuenca del rio Tascalapa, Yorito, Yoro, Honduras. Internship paper presented to the CIAT Communities and Watersheds Project, Tegucigalpa, Honduras. 75 pp.

Roa MC; Sanz JI; Brown S; Dossman S. The role of youth in natural resource management and food security: improving education for rural development; final report to the Kellogg Foundation. CIAT; ACERG; CIPAV; Herederos del Planeta, Colombia. 37 pp.

Stauble M. Tecnologías de cosecha de agua para propósitos de micro-irrigación: Recopilación de tecnologías sobre cosecha y almacenamiento de agua de bajo costo y bajo impacto ambiental que fortalezcan los sistemas de micro-irrigación; Evaluación del sistema de riego por goteo en huerto biointensivo en la subcuenca del río Calico. Internship paper presented to the CIAT Communities and Watersheds Project, Managua, Nicaragua. 61 pp.

5. Fund Raising

(A) Restricted projects confirmed

Description	Donor	Total budget (US$)	Start date	End date
Youth researchers, Colombia	W. F. Kellogg	300,000	Jun 2002	Feb 2006
Youth and water science, Bolivia	CIDA	35,170	Apr 2004	July 2007
Youth researchers, Honduras	SDC–COSUDE	30,000	July 2005	Jun 2006
Farmer experiences in Nicaraguan watersheds	POSAF-BID	108,250	Apr 2005	Oct 2006
Strengthening INTA microwatersheds, Nicaragua	FUNICA	75,429	March 2004	April 2005
FAO, Honduras	FAO	52,929	May 2004	April 2005
Water and carbon cycles, Colombia	IDEAM	48,000	Jan 2005	May 2005
Isotopes, Colombia (CGIAR/USAID/U. Idaho Linkage)	USAID	12,000	Jan 2005	Dec 2005

(B) Proposals submitted or being considered by donors

Description	Donor	Total budget (US$)	Prob. of funding (%)	Status
Youth researchers, phase II, Colombia	W. F. Kellogg	198,000	75	Submitted
Market oriented, Nicaragua, USAID	ARD	450,000	33	Submitted
Market oriented, Nicaragua	PRAGMA	690,000	33	Submitted
Nicaragua, Integrated Watershed Management Project, CARE (Canada)	CIDA	500,000	50	Submitted
Isotopes, Hydrology, Colombia Andes	IFS	12,000	25	Submitted
Use and integrated management of water resources, EXPERCO, CATIE	CIDA	2.000.000	50	Submitted
Systematization of information with indicators, Nicaragua	Chorlaví Group	19,830	-	Rejected
Water-use efficiency, Colombia	RFPP	63,600	-	Rejected
Water use and quality, Colombia	WFCP (Small Grant)	70,000	-	Rejected
Water harvesting, Nicaragua	WFCP (Small Grant)	69,600	-	Rejected
Headwater use conflicts, Colombia	Swiss ReSource	50,000	-	Rejected
Management and administration of water, Colombia	Ford	180,000	-	Rejected
Integrated watershed management, Colombia, CINARA	COLCIENCIAS	390,000		Rejected
Giant bamboo environmental services, Colombia	COLCIENCIAS	42,700		Rejected
Sustainable and equitable watersheds, Ecuador, Cornell	SANREM-CRSP	120,000	-	Rejected
Water demand management, Colombia	World Bank Development Marketplace	75,000		Rejected

(C) Proposals being developed

Description	Donor	Status
Integrated water use and administration, Honduras	UNDP/CIDA	Concept
Innovation in water management, Central and South America	INIA	Concept
Land degradation, Nicaragua, IMAT/RDC	CIDA	Concept
Youth leadership and research, Central and South America	AECI	Concept

C-sequestration, Phase II	Coop. Holandesa	Drafting
Learning Alliance, South and Central America	SNV	Concept
CERES Transformation	Colombian Min. of Education	Concept
Improved water administration in the Andes	CONDESAN	Concept
Water and carbon protocol implementation	IDEAM	Concept

5.1 Special Projects Submitted in 2005

5.1.7 Watershed management with young researchers in the Tascalapa River watershed, Yorito, Yoro, Honduras

This project aims to:

(1) Strengthen the capacity of young people to conduct research in the management of water harvesting, linked with drip irrigation in biointensive gardens
(2) Establish the ability of local youth groups to analyze the quality of potable water (monitoring fecal coliforms and constructing wetlands)
(3) Strengthen leadership skills (communication skills, teamwork and self-esteem, computation, and data analysis)
(4) Help improve the education of young people, based on local and current demands with a vision of the microwatershed as an integrated development project

This proposal was submitted to COSUDE at the request of the Resident Adjunct Director for Honduras, after visiting the region. The budget requested was US$30,000. It was approved and execution began in July 2005.

5.1.8 *The Community Gets Organized to Do Research* on natural resource management, emphasizing integrated watershed management

This project will increase communities' capacity to conduct their own research and development and to undertake technical changes in forest and agricultural production that would lead to greater productivity, higher income, and less environmental degradation in six watersheds of the Socioenvironmental Program and Forest Development (POSAF, its Spanish acronym) of the Ministry for the Environment and Natural Resources (MARENA). This project is carried out jointly by C&W and IPRA. Its total budget is US$108,000. It was approved and execution began in March 2005.

5.1.9 How to reduce water pollution? Developing, with young rural researchers, an integrated strategy from water sources to post-use by beneficiaries

This project will generate alternative systems of managing water resources in the upper parts of watersheds through participatory research with rural young people in the upper watershed of the Tascalapa River. It will be carried out jointly with the Municipality and the San Pedro Institute of Education. The proposal was submitted to IDRC (Canada) for a value of US$29,705. It was approved and execution will begin in February of 2006.

5.1.10 Use and integrated management of water resources in the Bañaderos–Lancetilla and Tocoa River watersheds on the northern coast of Honduras

The project is to improve living conditions for the rural and urban populations of the Municipalities of Tocoa and Tela by increasing coverage of potable water services and sanitation, improving water quality, sustainable use and management of land and water, and the strengthening of responsible organizations and institutions. The proposal was submitted as a partnership between EXPERCO, CATIE, and CIAT to UNDP-Honduras, to be financed by the Canadian Agency for Cooperation in International Development (CIDA). The funds requested were US$2,000,000. Approval is pending.

5.1.11 More competitive, market-oriented private enterprises, and improved environmental management in Nicaragua (a)
[Request for Proposal (RFP) No. 524-05-004]

Based on CIAT's experience with BDS provision in rural communities, the assessment will encompass not only formal organizations providing services but also farmer organizations with the potential capacity to offer BDS services in a more cost-effective fashion. Other themes include watersheds. The funds requested were US$450,000. This proposal was submitted by ARD to USAID. In January 2006, we were informed of cuts in resources for Nicaragua, resulting in this initiative being discarded.

5.1.12 More competitive, market-oriented private enterprises, and improved environmental management in Nicaragua (b)
[Request for Proposal (RFP) No. 524-05-004]

This proposal was based on environmental management model(s) for: (1) highlands and forested areas (mountain tops of watersheds); (2) the agricultural frontier (hillsides cultivated with crops and areas bordering forests within watersheds); (3) primary agricultural lands. The funds requested were US$690,000. This proposal was submitted by PRAGMA to USAID. In January 2006, we were informed of cuts in resources for Nicaragua, resulting in this initiative being discarded.

5.1.7 Information systematization with minimum indicators for managing watersheds

An experiment with local governments and communities in watershed management in Honduras, Nicaragua, and Colombia.

The project was to systematize information at watershed level, using social, economic, and environmental indicators to improve the decision-making of local governments, institutions, community organizations, and communities in the watersheds of the Tascalapa (Honduras) and Cálico (Nicaragua) Rivers. The proposal was submitted to the Chorlaví Group for a budget of US$19,830, but was not approved.

5.1.8 Strategy for collecting rainwater to enhance water availability during the dry season, Nicaragua, Central America

The project was to validate several water-harvesting technologies associated with soil conservation practices. Excess water, runoff, and rainwater were to be collected and stored in simple and inexpensive collectors that were large enough to satisfy farmers' individual needs. These structures would respond to a wide range of soil conservation practices, water retention capacity, and availability. Because water storage is focused on the watershed area, the farmers would not have to make significant investments in building the water collectors. Water balance or soil moisture would also be used to determine demand and availability of water for agricultural purposes. The proposal was submitted to the WFCP Small Grants Program for a budget of US$63,600, but was rejected.

5.1.9 Protocol for characterizing carbon and water cycles in high mountain ecosystems

The carbon and water cycle protocol proposal for Colombia will design a monitoring program for high mountain ecosystems to understand the impact of climate change and land use on ecosystems' capacity to regulate hydrologic flows and carbon accumulation. Specifically, the project will (1) formulate a conceptual model for the water and carbon cycles specific to glacier, alpine, and Andean forest ecosystems; (2) define protocols to characterize and monitor these systems; and (3) identify the key variables that determine the capacity of these ecosystems to monitor water flow and accumulate carbon. The proposal was submitted to IDEAM for a budget of US$48,000, and was approved.

5.1.10 Applying isotope technology to small headwater catchments in Colombia

This proposal aims to initiate collaborative research between C&W and the College of Natural Resources of the University of Idaho. The project will facilitate the use of innovative isotope technology to better understand hydrologic residency time in headwater catchments of Colombia. The results generated will help us better understand the water-holding capacity and hydrologic buffering capacity of headwater ecosystems, which are relevant to both the scientific community and local water-user associations dependent on these water sources. The proposal was submitted to the USAID/CGIAR/U.S. universities linkage fund for a budget of US$12,000 and was approved.

5.1.11 Youth leadership and research: improving rural education for development

To improve the quality of rural education, this project would support programs offered by Community Centers of Higher Education (CCES, its Spanish acronym) with methods to strengthen youths in leadership skills and capacity to conduct participatory research on local natural resources. The project provides three CCES centers with leadership methods and tools; participatory research methods for rural youth, focusing on watersheds and local natural resources; and develops ICTs and GIS methods to integrate biophysical and socioeconomic information from youth-led research projects. The proposal was submitted to the W. F. Kellogg Foundation for a budget of US$198,000, and is being considered.

5.1.12 The effects of water-use efficiency by the plant community and climate change on headwater wetlands for water storage and water availability in the Colombian Andes

To understand the current relationship between water-use efficiency of wetland plants and water-storage capacity of headwater wetlands, this project was to (1) analyze transpiration rates and wetland water balances, and (2) compare current with past plant-community compositions in relation to climate change in two headwater catchments in the Colombian Andes. The project partners were from the Earth Sciences Section and the Department of Geology and Paleontology at the University of Geneva led by Professor Georges Gorin. Professor Gorin has extensive research experience in paleo-environmental change, limnogeology, and sedimentation and tectonics in Andean Colombia. The proposal was submitted to RFPP for a budget of US$63,600, but was rejected.

5.1.13 Rural youths as leaders in water use, quality and allocation: Bolivia and Colombia

This project was to extend the CIAT/CGIAB youth leadership and water-science initiatives in South and Central America to assess the potential of working with local rural youths to build linkages between water productivity and development impact. Focusing on water use, quality and allocation, the project aimed to demonstrate the role of local youth leaders in identifying and implementing locally relevant strategies. The proposal was submitted to the Water for Food Challenge Program Small Grants competition for a budget of US$70,000, but was rejected.

5.1.14 Bonding biophysical research and rural communities for integrated watershed management

This proposal aimed to measure and compare the impact of land use on the quantity and quality of water resources in the upper watersheds of the Barbas River. The idea was to raise awareness of these relationships and implement alternatives to reduce risks to water users through participatory processes involving local communities. The project partners were CIAT, Tribunas Córcega (a local water supplier), and Cartón de Colombia (a multinational forest and packaging enterprise). This combination of science, community group, and multinational corporation provides a unique opportunity for communities and stakeholder groups to understand, on a scientific basis, the interactions existing between land use in upper watersheds, and the quantity and quality of water resources for improved management and decision making. The proposal was submitted to Swiss ReSource Award for a budget of US$50,000, but was rejected.

5.1.15 Isotope analysis for small-catchment hydrology in the Colombian Andes

This study hypothesizes that protecting areas with large water-holding capacity in catchments will produce catchment hydrographs that are characterized by higher base flows and lower storm flows. That is, areas with large water-holding capacity or "green reservoirs", mainly wetlands, will produce a buffer effect in the regulation of water flow. Isotope analysis of these catchments will provide information on the response of catchments to rain events. It will also determine differences in the source of the stream flow during dry and wet seasons, rain events, and no-rain

periods. Comparisons of water-storage capacity will be possible. The proposal was submitted to International Science Foundation for a budget of US$12,000, and is being reviewed.

5.1.16 Integrated watershed management project, Nicaragua

CARE (Canada) is leading an initiative on integrated watershed management in Nicaragua. The initiative has three principal priority themes: water and sanitation relative to public health, governance and institutional strengthening at the municipal level, and watershed management. The project operates in five microwatersheds in the headwater regions of the Rivers Viejo, Coco, and Estero Real in the semi-arid northern highlands of Nicaragua. In Canada, CARE is partnered by the Institute for Resources, Environment and Sustainability; the University of British Columbia (CIAT's Strategic Alliance partner); and the Tecsult International Limited. In Nicaragua, its partners are INTA (CIAT's Strategic Alliance partner), POSAF, and other local stakeholders. The proposal was submitted to CIDA. CIAT's estimated budget involvement is US$500,000, to be determined at project implementation phase.

5.1.17 Strategies for the integrated management of hydrologic resources for sustainable human development: managing water quality in the watersheds of southwestern Colombia

CINARA is leading an initiative to contribute to sustainable human development through the integrated management of hydrologic resources to facilitate improved water quality in Colombia. Specifically, the proposal is to dynamically model the factors of perturbation and recuperation of water quality; develop options for improved water quality, based on knowledge of land-water interactions, production systems, land use, and climate change; develop a conceptual model of integrated water services; develop a social understanding of watershed planning; and formulate environmental communication and education strategies. The proposal was submitted by CINARA, CIAT, Universidad del Valle, Eidenar, Universidad del Cauca, University Autónoma del Occidente, Institute for Coastal and Marine Research, CVC, and IDEAM to COLCIENCIAS, for a budget of US$390,000, but was rejected.

5.1.18 Sustainable management and use of giant bamboo in the central watershed of the Garrapatas River

This project strives to contribute to the institutional strengthening of the artisanal group "Guadua Madura" and to the sustainable use of bamboo forests in the Municipality of El Dovio, Valle del Cauca, Colombia. Specifically to (1) strengthen leadership and administration capacity within the association, (2) quantify the economic benefits of the sustainable use of bamboo for the community, (3) evaluate different technologies for processing the bamboo, and (4) create strategic alliances with other sector enterprises to increase the number of marketing channels. The proposal was submitted to COLCIENCIAS for a budget of US$42,700.

5.1.19 Designing and implementing institutions, investments, and incentives for sustainable and equitable watershed management

This proposal for the SANREM-CRSP long-term research award was to conduct comparative, integrated, gendered watershed analyses, ranging from assessments of payments for environmental services programs, through spatially distributed watershed models, to community-based natural resource management and participatory research to facilitate social and collective learning on improved water management. The project was to be led by the University of Cornell, Grupo Randi Randi, and ICRAF in association with CIAT, SANA, EARPO, ESPE, CIP, the University of Nairobi, and JKUAT. The proposal was submitted to SANREM-CRSP for a budget for CIAT at US$120,000, but was rejected.

5.1.20 Demand management and conservation strategies to alleviate water poverty in rural multiple-use water-supply systems of Colombia

The project was to combine hard and soft measures (structural/biophysical and educational/behavioral changes) to improve water availability in multiple-use systems for low-income households in rural Colombia. The project proposed to implement environmental and water-use conservation measures, targeting low-income households and based on understanding current use patterns, relevant options, and cost implications for service providers and water users. The proposal was submitted jointly with CINARA to the World Bank Development Marketplace for a budget of US$74,350, but was rejected.

6. Personnel

Colombia	
Jóse Ignacio Sanz	PhD Soil Science, Project Manager
Jorge Alonso Beltrán	MSc Agronomy, Associate Scientist (since Oct. 2005)
Sandra Brown (50%)	PhD Resource Management, Senior Staff, UBC/CIAT Alliance
María Cecilia Roa	PhD Candidate, Water Resources, UBC-Associate Researcher
Olaf Westermann	PhD Candidate, Collective Action, Roskilde University, Denmark
Sandra Dossman	BSc Graphic Designer, Communications Assistant
Adriana Domínguez	BSc Finances, Administrative Assistant
Lina Andrea García	MSc Watershed Management, Assistant Researcher
Pedro Lorenzo Burgos	BSc Agronomy, Research Assistant*
Katerine Tehelen	MSc Student/Assistant
Wilson Celemin	Officer
Gustavo Duque	Worker
Luis Enrique Exheverri	Worker
Mauricio Henao	Worker
Daniel Giraldo	Worker
María Gracia Lanza	MSc Student, Environmental Economics, Wageningen University, Netherlands
Clara Roa	MSc Student, Sanitation and Water Resources, Universidad del Valle

* Left during 2005

CIAT/CONDESAN, Colombia	
Rubén Darío Estrada	MSc Economist, Leader, Policy Analysis
Ernesto Girón	BSc Topographic Engineer, Research Expert
Ximena Pernett	BSc Agricultural Engineer, Research Assistant

Honduras	
Juan Evangelista Amaya	BSc Forest Engineering, Research Assistant
Villa Escober (50%)	BSc Journalist, Administrative Assistant
Guillermo Giraldo	MSc Agronomy, Consultant, Seed Systems*
Gilman Palma	Technician, Production Systems, Field Assistant
Rosalio Mencía	Paratechnician, Field Assistant, Yorito
Justa Mérida Barahona	High School Ecology and Environment, Local Youth Project Coordinator*
María Gracia Lanza	MSc Environmental Economics, Consultant, Water Resources, Yorito
María del Carmen Brizzo	High School Ecology and Environment, Local Youth Project Coordinator*
Melvin López	Primary Education, Local Youth Project Coordinator
María Pineda	BSc Student, Universidad de La Paz, Costa Rica, Water Quality and Quantity

* Left during 2005

Nicaragua	
Jorge Alonso Beltrán	MSc Agronomy, Liaison Officer (up to Oct. 2005)
Diego Gómez	MA Environmental Socioeconomics, C&W Liaison Officer (since Oct. 2005)
Pedro Pablo Orozco	MSc Student, Soils and Watersheds, CATIE / Research Assistant in Production Systems
Juan Bosco Franco	BSc Agronomic Engineer, Research Assistant
María Eugenia Baltadano	MA Student, Environmental Economics, CATIE / Research Assistant
Elvis Cayetano Chavarria	Field Assistant, San Dionisio
Michael Stauble	BSc Student, Water Harvesting, Swiss College of Agriculture

7. Acronyms and Abbreviations Used in the Text

7.1 Organizations and projects

ACERG	Asociación de Centros Educativos del Cañón del Río Garrapatas, Colombia
AECI	Agencia Española de Cooperación Internacional, Spain
Actuar	A local NGO, Colombia (*"actuar" is Spanish for "to act"*)
APRODER	Asociación de Profesionales en Pro del Desarrollo Rural, Nicaragua
APRODESA	Asociación de Profesionales para el Desarrollo Agropecuario, Nicaragua
ARD	Associates in Rural Development, Inc., USA
ASIRITIC	Asociación de Sistemas de Riego de Tiquipaya y Colcapirhua, Bolivia
ASOBOLO	Asociación de Usarios del Río Bolo, Colombia
ASOGUADUA	Asociación de Productores de Guadua del Valle, Colombia
BoT	Board of Trustees, CIAT
CARE	Cooperative for Assistance and Relief Everywhere, Inc., USA
CARITAS	A Catholic agency for overseas aid and development (*"caritas" is Latin for "love, charity, and compassion"*)
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza, Costa Rica
CCER	Center-Commissioned External Review, CGIAR
CGIAB	Comisión para la Gestión Integral del Agua en Bolivia
CGIAR	Consultative Group on International Agricultural Research
CIDA	Canadian International Development Agency
CIGMAT	Centro de Información Geográfica del Territorio de Matagalpa, Nicaragua
CINARA	*also* Instituto CINARA; Instituto de Investigación y Desarrollo en Abastecimiento de Agua, Saneamiento Ambiental y Conservación del Recurso Hídrico, Universidad del Valle, Colombia
CIP	Centro Internacional de la Papa
CIPAV	Fundación del Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria, Colombia
CIRA	Centro para la Investigación en Recursos Acuáticos de Nicaragua, UNAN
CLODEST	Comité Local para el Desarrollo Sostenible de la Cuenca del Río Tascalapa, Honduras
COLCIENCIAS	Instituto Colombiano para el Desarrollo de la Ciencia y la Tecnología "Francisco José de Caldas"
CONCORD	Climate Change – Organizing the Science for the American Cordillera
CONDESAN	Consorcio para el Desarrollo Sostenible de la Ecorregión Andina, Peru
COSUDE	Coordinating Office of Swiss Development Cooperation
CRQ	Corporación Autonóma Regional del Quindío, Colombia
CRRN	Caribbean Rice Research Network
CUCULMECA	"Asociación de Educación y Comunicación", Nicaragua
CVC	Corporación Autonóma Regional del Valle del Cauca, Colombia
DIIS	Danish Institute for International Studies
EARPO	Eastern Africa Regional Programme Office of the World Wide Fund for Nature (*i.e., WWF*)

Eidenar	Escuela de Ingeniería de Recursos Naturales y del Ambiente, Universidad del Valle, Colombia
ESPE	Escuela Politécnica del Ejército, Ecuador
Experco	Experco International Ltd, Canada (*a consulting engineering firm*)
FAO	Food and Agriculture Organization of the United Nations
FIDER	Fundación de Investigación y Desarrollo Rural, Nicaragua
FIPAH	Fundación para la Investigación Participativa con Agricultores de Honduras
FOCUENCAS	Proyecto de Fortalecimiento de la Capacidad Local para el Manejo de las Cuencas y la Prevención de Desastres Naturales, CATIE
FUNICA	Fundación para el Desarrollo Tecnológico Agropecuario y Forestal, Nicaragua
GWP	Global Warner Partnership
ICBF	Instituto Colombiano de Bienestar Familiar
ICRAF	International Centre for Research in Agroforestry
IDB	Inter-American Development Bank
IDEAM	Instituto de Hidrología, Meteorología y Estudios Ambientales, Colombia
IDR	Instituto de Desarrollo Rural, Nicaragua
IDRC	International Development Research Centre, Canada
IFS	International Foundation for Science, Sweden
IHP	International Hydrological Programme, UNESCO
INCAE	INCAE Business School
INCIVA	Instituto para la Investigación y la Preservación del Patrimonio Cultural y Natural del Valle del Cauca, Colombia
INIA	Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, Spain
INTA	Instituto Nicaragüense de Tecnología Agropecuaria
INTEP	Instituto de Educación Técnica Profesional, Colombia
INWEH	International Network on Water, Environment and Health, UNU, Canada
IP-5	Project IP-5: Tropical Grasses and Legumes: Optimizing Genetic Diversity for Multipurpose Use, CIAT
IPRA	*also* IPRA Project; Investigación Participativa en Agricultura/Participatory Research in Agriculture, CIAT
ISP	Instituto "San Pedro", Honduras (*an educational entity*)
IUCN	The World Conservation Union
IWMI	International Water Management Institute
JKUAT	Jomo Kenyatta University of Agriculture and Technology, Kenya
MACOTI	Mancomunidad Colcapirhua-Tiquipaya, Bolivia
MARENA	Ministerio del Ambiente y Recursos Naturales, Nicaragua
MINSA	Ministerio de Salud, Nicaragua
MOPAFMA	Movimiento por la Paz y la Acción Forestal y el Medio Ambiente, Nicaragua
NATO	North Atlantic Treaty Organisation
NEGOWAT	Negotiating Peri-Urban Water Conflicts Project (*of EU, DFID, and ASPA-Brazil*)
OAS	Organization of American States
Oxfam	Oxford Committee for Famine Relief, UK

PE-2	Project PE-2: Tropical Soil Biology Fertility Institute/Overcoming Soil Degradation, CIAT
PE-3	Project PE-3: Communities and Watersheds, CIAT
PE-4	Project PE-4: Land Use in Latin America, CIAT
POLDES	Polos de Desarrollo, IDR, Nicaragua
POSAF	Programa Socio-Ambiental y de Desarrollo Forestal, MARENA
Pragma	The Pragma Corporation, USA (*an international development firm*)
PRONORCEN	Proyecto de Desarrollo Económico y Social en la Zona Norte Central de Nicaragua, IDR
RENOC	Red Nacional de Organísmos de Cuencas, Nicaragua
RFPP	Research Fellow Partnership Programme for Agriculture, Forestry and Natural Resources, Swiss Federal Institute of Technology (ETH), Switzerland
SANA	Sustainable Approaches to Nutrition in Africa Project, USAID
SANREM-CRSP	Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program, USA
SDC	Swiss Agency for Development and Cooperation
SEMAPA	La Empresa de Servicio Municipal de Agua Potable y Alcantarillado de Cochabamba, Bolivia
SENA	Servicio Nacional de Aprendizaje, Colombia
SISBEN	Sistema de Selección de Beneficiarios para Programas Sociales, Costa Rica
SN-1	Project SN-1: Rural Innovation Institute: Agroenterprises Development, CIAT
SNV	SNV Netherlands Development Organisation
Swiss Re	A global reinsurer with interests in climate change and water resources
UBC	University of British Columbia, Canada
UCR	Universidad de Costa Rica
UNA	Universidad Nacional Agraria, Nicaragua
UNAG	Unión Nacional de Agricultores y Ganaderos, Nicaragua
UNAN	Universidad Nacional Autónoma de Nicaragua
UNDP	United Nations Development Programme
UNESCO-MAB	Man and the Biosphere Programme of the United Nations Educational, Scientific, and Cultural Organization
UNICAFE	Unión Nicaragüense de Cafetaleros
UNU	United Nations University
UPAZ	Universidad de la Paz, Costa Rica
USAID	United States Agency for International Development
WFCP	Water and Food Challenge Program, CGIAR
WV	Word Vision

7.2 Other acronyms and abbreviations

ABC methodology	Abiotic, biotic, and cultural methodology for ESSA analysis
ACV	Asociación Campos Verdes, Nicaragua
BDS	Business development services
BMP	Best-management practices
BOD	Biochemical oxygen demand
C_3	*also* C_3 cycle or Calvin cycle; a series of biochemical reactions that regulates photosynthesis in plants
C_4	*also* C_4 cycle or Hatch–Slack cycle; another series of biochemical reactions that regulates photosynthesis in plants
CAP	Comité de agua potable, Nicaragua
CCES	Centro comunitario de educación superior, Colombia
CD-ROM	Compact disk-read only memory
CDM	Comité de desarrollo municipal, Nicaragua
CERES	Centro regional de educación superior, Bolivia
CIAL	Comité de investigación agrícola local, Colombia
CMDR	Consejo municipal de desarrollo rural, Colombia
CO	Community organization
COND	Conductivity in water
CP	Challenge program, CGIAR
DWG	Daily weight gain (*of livestock*)
EPT	*also* EPT species richness; Ephemeroptera, Plecoptera, and Trichoptera species richness in river basins
ESA	Environmental sensitivity analysis
ESSA	Environmental and social sensitivity analysis
GIS	Geographic information system
GO	Governmental organization
HES	Hydric environmental services
ICT	Information and communication technology
IMAT-RDC	Improving Management of Agroecosystems in the Tropics Research for Development Challenge (*a research approach*)
INIAs	Instituciones nacionales de investigación agropecuaria
IT	Information technology
MCD	Municipal committee for development, Nicaragua
MTP	Medium-Term Plan, CIAT
mz	Manzana (*Latin American land measure of 0.64 hectares*)
NGO	Nongovernmental organization
NRM	Natural resource management
NTU	Nephelometric turbidity unit (*a measure of a liquid's transparency*)
PAT	Plan de Acción Trienial, Colombia
PES	Pequeña empresa de semillas (*Spanish for SSB*)
PVC	Polyvinyl chloride, often used to make water pipes
RFP	Request for proposal
SIGMAP	A mapping software (*Spanish version of GISMAP*)

SOL	Supermercado de Opciones para Laderas, CGIAR
SSB	Small seed business (*English for PES*)
TDS	Total dissolved solids
U.	University
UMATA	Unidad municipal de asistencia técnica agropecuaria, Colombia
U.S.	United States (*used as an adjective*)