

**REGIONAL ENVIRONMENTAL PROGRAM OF DANIDA
FOR CENTRAL AMERICA**

**POTENTIAL OF FOUR INTERNATIONAL
WATERSHEDS FOR DANIDA**

Final Report



**Danish International Development Assistance
DANIDA**

Tropical Agricultural Research and Higher Education Center

CATIE

**Turrialba, Costa Rica
July, 2001**

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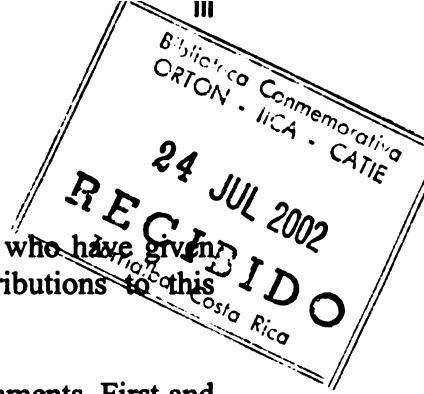
ACKNOWLEDGEMENTS

Special appreciation is extended to the many persons and institutions who have given generously of their time and efforts to provide us with the contributions to this consultancy work.

Many people have contributed their kind assistance and thoughtful comments. First and foremost, we would like to thank the stakeholders including local communities and NGOs that played an essential role providing social, ecological and economical concerns during the field studies.

We are especially grateful to Mario Moscoso and Viviana Sanchez in Guatemala, Mauricio Castro and Fabrizio Brutti in El Salvador, Allan Bendeck in Honduras and Victor Cedeño and Francisco Rodriguez in Nicaragua for preparing local and country information.

Finally, our sincere gratitude goes out to the colleagues who generously helped us with logistical assistance during our fields visits that have made it possible to accomplish this consultancy report.



ABBREVIATIONS

ADESCO	Asociaciones de Desarrollo Comunales
AFE-COHDEFOR	Administración Forestal del Estado
AMHON	Asociación de Municipios de Honduras
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza
CEL	Comisión Ejecutiva Hidroeléctrica del Río Lempa
CENTA	Centro Nacional de Tecnología Agrícola de El Salvador
COSUDE	Agencia Suiza para el Desarrollo y la Cooperación
COPECO	Comité Permanente de Contingencias
DANIDA	Danish International Development Assistance
DGRNR	Dirección General de Recursos Naturales Renovables
ESNACIFOR	Escuela Nacional de Ciencias Forestales
FOCUENCAS	Proyecto Fortalecimiento de la Capacidad Local en Manejo de Cuencas y Prevención de Desastres Naturales
FUNDEMUN	Fundación de Desarrollo Municipal
INTA	Instituto nacional de Tecnología Agrícola y Forestal
INIFOM	Instituto Nicaragüense de Fomento Municipal
ÍNTER	Instituto Nicaragüense de Estudios Territoriales
PASOLAC	Programa de Agricultura Sostenible en Laderas de América Central
POSAF	Programa Social Ambiental Forestal de Nicaragua
PROGOLFO	Proyecto Golfo de Fonseca
PROLEÑA	Proyecto Leña y Fuentes Energéticas
PRONADERS	Programa Nacional de Desarrollo Rural Sostenible
MAG	Ministerio de Agricultura y Ganadería
NITAPLAN	Oficina de Estudios Especiales Universidad Centroamericana
NGO	Non governmental Organization
GOs	Governmental Organization

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Second part

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General information

An extensive study was carried out concerning geographical boundaries on maps regarding the four selected international watersheds included in this preliminary study. A set of maps used is available on request. Maps depict watershed boundaries based largely on field delineation at the broadest level. All major descriptions are based on secondary information compiled from many sources, the most important of which are listed in the bibliography. Watershed form is described using the terminology and classification developed by Faustino (2000).

Executive summary

Internationally shared watersheds in Central America cover more than 40% of the region and have very similar characteristics, potentials and problems in a general context, but with specific characteristics according to the particular basin to which they belong: Pacific or Caribbean. Furthermore, there are major differences in the ways local actors and institutions are taking actions and decisions in regard to natural resources management in each country.

Water is a vital resource for development in the shared watersheds of the region. Management of water in an efficient way constitutes a priority challenge, taking into account the problems that its mismanagement is generating. Limited water availability during the year, in a tropical eco-system with a dry season of about six months, brings as a result environmental conflicts and a reduction of agricultural possibilities. Similarly water pollution is one of the more alarming problems, because it limits human and agriculture purposes and generates high costs for water treatment in order to avoid negative effects on human and animal health. In contrast, during the rainy season, poor forest cover and inadequate land use practices are to blame for serious environmental, economic and social problems caused by floods in low lands and coastal zones.

These are some of the more important aspects that must be taken into account in the analyses of the Rio Sumpul, Paz, Negro and upper watershed of Rio Coco. Diagnosis with emphasis on watershed management, shows that the main problems are: deforestation, floods, water pollution, water scarcity, use of non-sustainable technologies, low management capacity, low agricultural profitability, lack of coordination and need for local empowerment.

In this situation the necessity of re-establishing a forest cover, improving rational water management, applying sustainable technologies, facilitating the added-cost and commercialization, strengthening the capacity of management in local governments and their organizations, all stand out.

This study incorporates project profiles for each watershed that deal with the main problems in each case; these profiles focus on sustainable management of natural resources and their externalities (taking into consideration water as an integrating factor), the use of production technologies, vulnerability and the capacity of local management. Based on these analyses, the following selection of shared watersheds is recommended, in order of priority: 1st. Rio Paz watershed, 2nd Rio Negro watershed, 3rd Rio Coco upper watershed and 4th Rio Sumpul sub-watershed. The decision is based on the following considerations:

- a. Regional integration is effective in the Rio Paz and Negro watersheds; both have more extensive and functional communication systems year round.
- b. The Rio Paz watershed has already moved forward with important steps like the preparation of a Master Plan for Integrated Watershed Management and agreements between the two countries that consider the interests of both and facilitate new and immediate actions.

- c. **The externalities of the Rio Paz and Negro watersheds highlight important impacts and benefits from the social, ecological and economic points of view.**
- d. **Local actors of Rio Paz and Negro watersheds expressed more disposition, experience and motivation to initiate actions to improve water use and management.**
- e. **Sustainability, based on the application of environmental services, was identified as more feasible in the scenarios of the Rio Paz and Negro watersheds.**

The coordination of possible investments, government support and target populations willing to participate, are in favor of the Rio Paz and Rio Negro watersheds.

I. Introduction

The state of the environmental and natural resources in Central America constantly presents serious conflicts that affect living conditions of its inhabitants, creating as a consequence serious limitations for social and economic development. Problems like water scarcity and availability, water quality, impacts due to floods and droughts, lack of firewood, reservoir sedimentation and loss of biodiversity, lead to the need to analyze the importance to re-establishing and managing a forest cover on the typical volcanic soils on steep slopes, exposed to frequent high intensity precipitation. Also it is advisable to consider the application of sustainable technologies in agricultural, cattle, forest and agroforestry productive systems. However maybe the most important consideration is to relate these factors with the decisions, needs, attitudes and aptitudes of the different actors, such as local and national governments, who share responsibilities in regard to natural resources sustainability and human well-being.

In this context, water becomes a vital resource, that must be used in a very efficient way, making sure that it will be available in the right amount and with good quality, all year round and in every place where it is needed. These are key reasons that justify the necessity of adopting watershed management criteria to design conservation and production actions, integrating biophysical and socioeconomic elements. In order to guarantee water in the right amount and quality to all rural and urban areas, it is essential to manage the watershed as a system, ordering land use according to its capacity, with forest cover rehabilitation and management actions, introducing sustainable technologies (integrated pest management, agroforestry, organic agriculture, risk consideration) always having in mind water sources protection. All of these actions must have a participatory approach, with a leading participation of municipalities and the active involvement of community organizations in an integral effort to achieve sustainable development.

In the Central American isthmus, shared watersheds between two or more countries, cover more than 40% of the total area. In these watersheds we must face the challenge of coping with the conflicts and problems originated by hydrological imbalance (drought and floods with their consequences), lack of coordination, necessity of mutual agreements, building of mutual trust, etc. in order to ensure integrated watershed management.

The DANIDA Regional Environment Program for Central America, considers that it is important to work in the shared watersheds and hence organized an identification and selection process, leading to the preselection of 4 watersheds, with evident need for conservation and management of natural resources, with emphasis on water. The preselected watersheds belong to Guatemala, El Salvador, Honduras and Nicaragua. All of them are very important, with similar problems and needs but there are some outstanding differences that must be considered at the moment of decision taking. The proposed watershed management programs must be very practical, with a problem solving approach, with community organizations being empowered, generating the adoption of successful technologies in other similar regions of the involved countries and the isthmus in general.

II. Consultancy Objectives

To establish a sound technical base so that the evaluation mission of the Programme can take the necessary decisions regarding sub-component 3.A and be able to select the priority watersheds that

will finally be included in DANIDA's Regional Programme for Environmental Management and Sustainable Development in Central America.

In order to achieve this previous objective, the consultant will present a comprehensive report with a diagnosis document for each one of the four pre-selected shared watersheds, including project profiles and recommendations in regard to the possible incorporation of the watersheds in the Programme.

III. Methodology

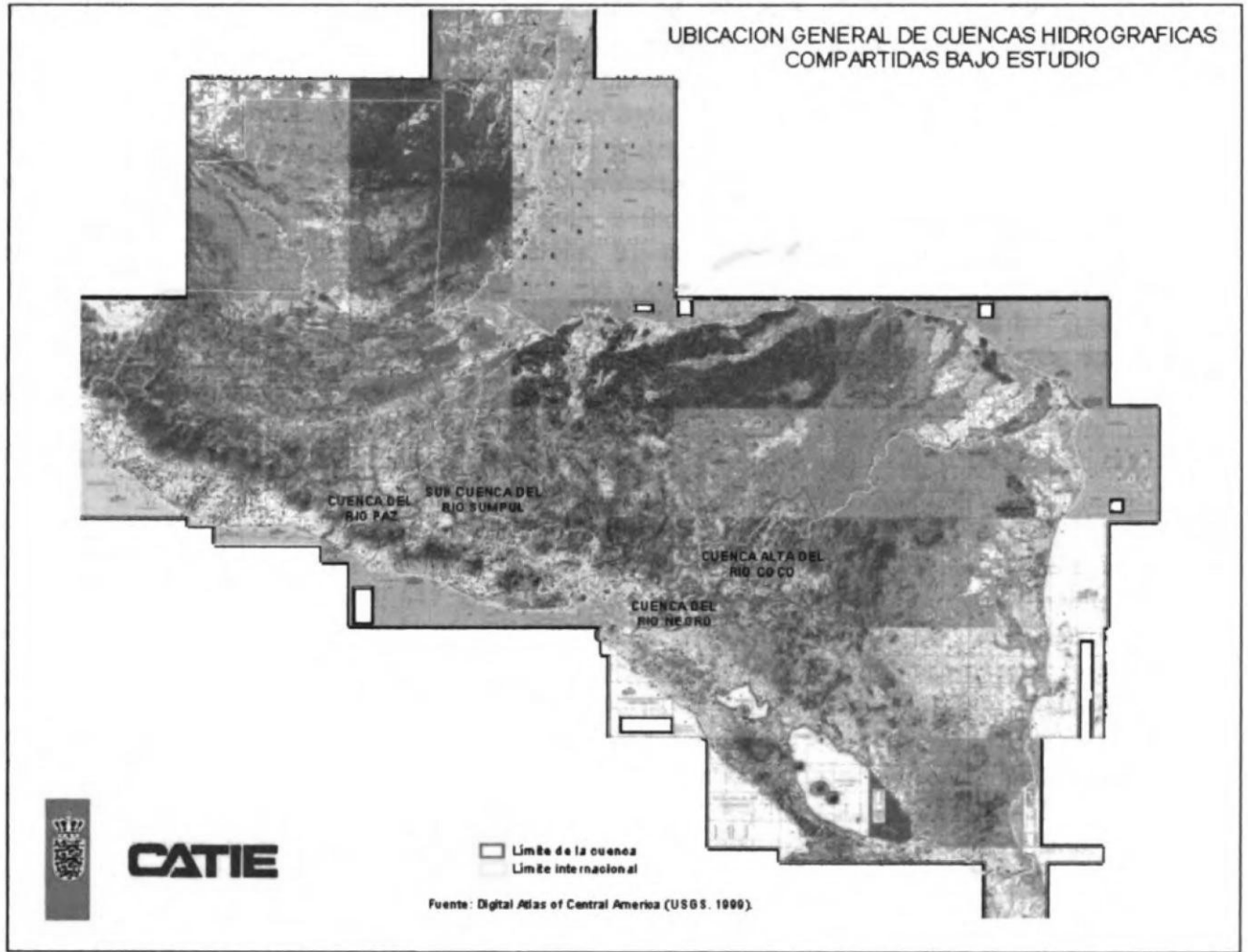
The methodology considered each one of the tasks indicated in the terms of reference and the technical offer, taking the following steps: a) focus on the concepts of watershed management and organization to achieve the expected results; b) collection of technical and institutional secondary information and maps for the watersheds; c) interviews with leaders and technical staff of the government offices; d) reconnaissance field trips, accompanied by key local actors for a preliminary evaluation of problems, production systems and potential activities; e) interviews and dialogues with important local actors (municipalities, local committees, farmers and common inhabitants of the watershed); f) analysis of the available information (maps, data) and g) discussion, design and elaboration of the final technical report.

For the diagnosis, the system approach was applied, relating the biophysical and socioeconomic components, to find out how the watershed is functioning, what are the relations between the upper and the lower watershed and its surroundings and identifying the impact of activities on the water system. The actors' roles was very important in the analyses as well as in the problem identification and definition of potential use, considering causes and consequences. The vocation of the watershed and the externalities were emphasized in each diagnosis. This part of the study was based on secondary information, field reconnaissance, similar studies, contact with local actors, existing data bases and technical experience of the consultants.

The project profile elaboration is based on the matrix of problems, in which solutions are proposed to overcome the causes, and to take advantage of the potential of the watershed. Each group of solutions generate a project profile, which make up the base for the management of the watershed, emphasizing water sustainability and the associated socioeconomic factors. In this part of the study, secondary information and rapid identification of needs and opportunities by local actors is complemented by the analyses of the consultant team.

Recommendations are based on the previous relevant elements, considering the terms of reference. A comparative box is used to show the advantages of every particular watershed.

Map 1. General location of four watersheds included in the study area



IV. Diagnosis of the Shared Watersheds

The characterization and analysis was based on the biophysical, technological, productive, institutional, social and economic components, and the available information considered adequate for the level of this study. The diagnosis presents the vocation of the watershed, the problems and the externalities that justify the implementation of a watershed management project.

There is no doubt that the implementation of a watershed management programme must have a social basis, associated with economic and ecological elements, flood losses, water pollution, seasonal availability of water, etc. These are key externalities that support watershed management. Starting from a land use plan, it is possible to harmonize the offer of water resources and the demand of local actors, leading to a proper use of agricultural, forest and pasture lands leading to sustainable rural development. In the absence of watershed management, negative effects would persist and continue to grow, and the lack of protection in the upper watershed would lead to increasing structural measures in the low lands, without the possibility of attenuation. Besides, protection of water sources and critical areas, by means of reforestation, would have as a consequence an improvement in water quality and a consequent reduction in health problems and expenses, and the hydrologic cycle would be partially rehabilitated. Finally it must be remembered that a strategy of land use planning and municipal development must consider a watershed management approach.

IV.1. River Paz watershed diagnosis (Guatemala and El Salvador)

a) General watershed characteristics

The area of the watershed is 2,647 km² with a current population of 498,800 inhabitants, 28 municipalities and 56 microwatersheds. The rainy season, which starts in May and lasts until the end of October, provides 94% of the total annual precipitation. The Guatemalan sector has a mean annual precipitation of 1400 mm, while the Salvadorian sector receives 1700 mm. Annual surface runoff amounts to 886 million m³, corresponding to a mean annual discharge of 28.1 m³/s, which is reduced to 10.5 m³/s during the dry season. Soils have a volcanic origin and 60% of the total area has more than 15% slope; 21% of the territory has slopes ranging from 30 to 50%. The system of land transportation is relatively extensive and functional, especially in the Salvador side, all year round.

b) Problems of the watershed

Water availability for different uses is a problem during the dry season. There is a contrast of deficit and excess of water, leading to droughts and floods, influenced by deforestation and inadequate land use. All of the irrigation schemes are subject to droughts and the extreme precipitation events produce floods along the last 8 km (the final sector of the river), provoking between \$0.4 and 1.6 millions losses in agriculture per year.

On the other hand, water quality is affected by fecal contamination, coffee processing plants, industries and the Ahuachapan Geo-thermic Central, on El Salvador side. Erosion is moderate to severe, and is associated with deforestation and a lack of soil conservation practices in the production systems. Forest cover has been drastically reduced on the Salvador side, but on the Guatemala side, there is more than 300 km² of forest cover. 76% of the whole watershed is dedicated to pasture, basic grains and coffee. Fires contribute to natural resources degradation.

Population density varies from 98 persons/km² in Guatemala to 299 persons/km² in El Salvador, predominantly rural. Migration varies as a function of season and destination. Primary education has a good cover, but in the rural areas 31% of children under 10 years old are illiterate. Land tenure is well defined in coffee plantations, but in general, legal rights are not properly established. Extreme poverty is high on both sectors, being more critical on the Guatemala side (64%), and manpower is dedicated mainly to agriculture. Diarrhea and respiratory diseases are to a large degree responsible for high mortality rates. There is a good level of local organization, especially on El Salvador side; for example, the Association of Coffee Growers, Association of Sugar Cane Growers and Cooperatives. There are 215 community associations, with at least 25 members each. In every municipality there is a Local Development Committee. There is not, however, an strategic plan for coordinating watershed development, and there is a lack of an institution responsible for the coordination and integration of all the efforts to achieve sustainable development is apparent.

c) Watershed vocation

The río Paz watershed has a varied development potential, due to the variety of agro-ecological classes. The watershed is degraded, but not to an extreme level, and it is not irreversible. Efficient crop and cattle development are possible because of the availability of soils of class I, II and III, adequate for intensive agricultural use. Besides, there is a good availability of water for irrigation purposes. In fact, base discharge, during the dry season, could permit the irrigation of about 8000 ha. (3% of the area). The majority of the watershed, however, has to face a 6 months drought, producing environmental problems, reduction of production, poverty and migration. There are extensive lands belonging to classes VII and VIII, with forest vocation, which could be used for timber and firewood production and eco-tourist projects. These forest projects, normally in the upper watersheds, have a positive impact by reducing runoff and erosion, and hence reducing vulnerability of flood prone areas. This watershed also has a hydro-electric potential. CEL has undertaken specific studies in this direction. At present, several institutions work in this watershed, with normally separated efforts and partial success. In this way, general watershed development is not achieved, and the preparation and application of a master plan is indispensable.

d) Why should this watershed be managed?

The main reason to manage the river Paz watershed is the cyclical occurrence of flooding disasters in the low lands which are precisely the most suitable lands for agricultural and urban development. The impact of floods has retarded the process of sustainable development of the watershed in both countries. Structural and nonstructural measures must be implemented in the whole watershed in order to reduce to an acceptable level the economic losses in crops and properties. The structural measures focus on the immediate reduction of the risk of flooding such as dikes, river channel alignment and enlargement, gavions, slope control, etc., in order to limit the affected area. Non structural measures focus on the medium and long term solutions, such as reforestation, soil conservation interventions, land use planning of the floodplains, early alarm systems, etc, in order to reduce the discharge and/or the economical and human losses, and to avoid a future worsening of the situation, if sedimentation of the channel continues to occur. Additionally, the high quality of the extensive arable low lands could permit intensive agricultural production, if irrigation schemes counter-act droughts during the prolonged dry season. The base flow, during the dry season, is sufficient to support a lot of small low cost irrigation systems. Small and successful irrigation schemes are also feasible in the small valleys of the mountainous areas, where poor people struggle

for survival. Watershed management would contribute to the reduction of floods, erosion and sedimentation during the rainy season, to the increase of base flow during the dry season and to the organization of the population for implementing the necessary measures. Water use, in general, for agricultural, industrial or direct human use, is threatened by an alarming increase of water pollution, originated mainly from soil erosion, wastes from coffee processing plants, improper use of agrochemicals and sewage disposal. This is why this watershed must be managed: all of these problems demand an integral and immediate watershed management. The whole watershed is contributing to flooding and low water quality. Effective solutions will need that all of the watershed population, in a participatory way, participate fully in watershed management.

Map 2. Rio Paz watershed

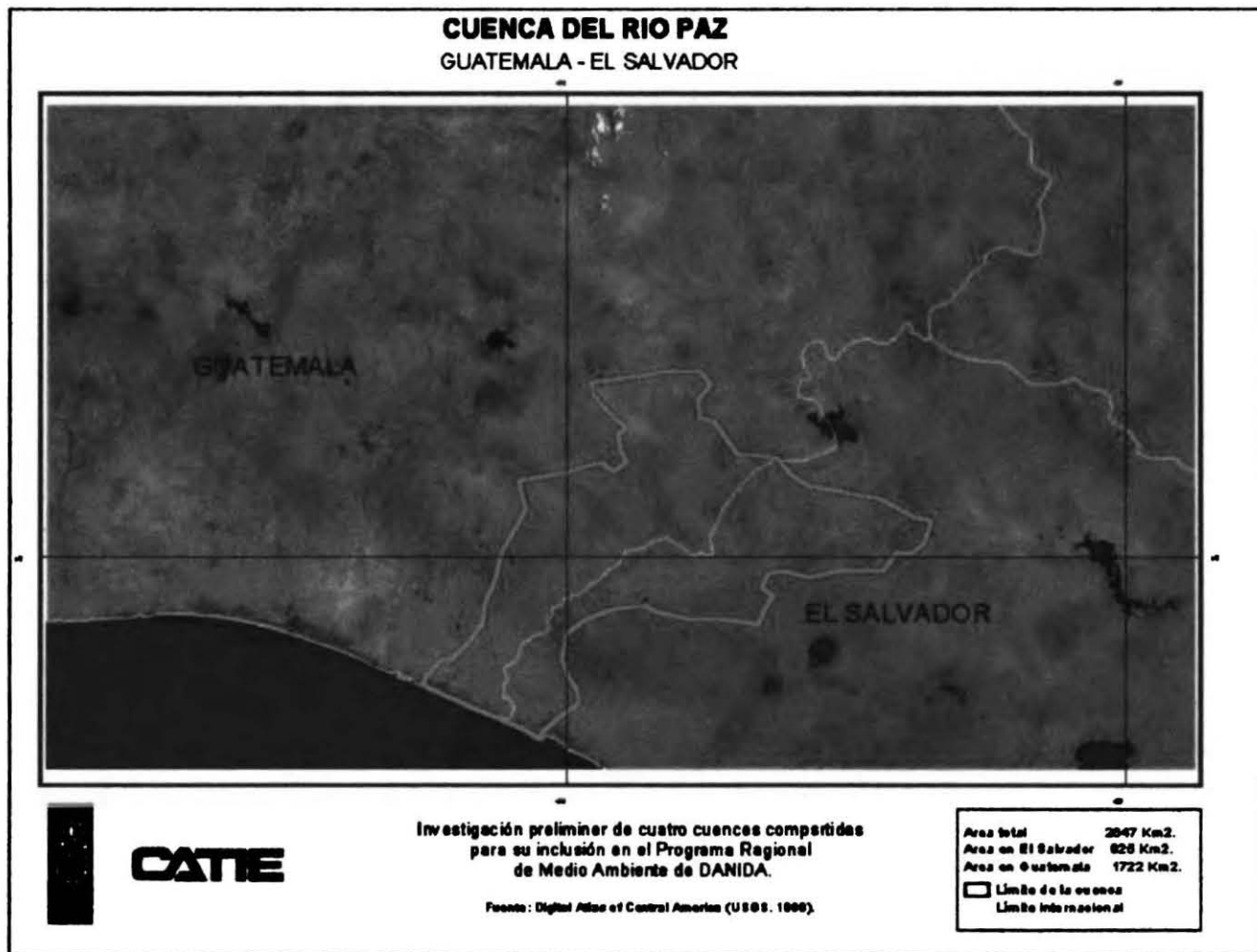


Table 1. Synthesis of diagnosis: Rio Paz watershed

<p>Floods in the last 8 km of the river in the lowlands.</p>	<p>Deforestation, land overuse, reduction of river hydraulic capacity, inadequate land use in flood prone areas, institutional weakness.</p>	<p>Agricultural losses caused by floods, ranging from \$0.4 to 1.6 millions per year, human life losses, damages to infrastructure, interruption of services and communications.</p>	<p>Non structural: Reforestation, use of sustainable practices, land use planning, institutional strengthening. Structural: Hydrological and hydraulic modeling, river improvement..</p>
<p>Insufficient water supply and irrigation during the dry season, low water quality all year round.</p>	<p>Precipitation deficit during the dry season, inadequate distribution system, inefficient water use, water cycle alteration caused by inadequate land use changes, lack of protection of water sources and recharge zones.</p>	<p>Reduction of quality of life, economic losses for manual transportation of water, increased cost of supply, reduced agricultural production, fewer economic options for women.</p>	<p>Water source and recharge zone protection, improved supply systems, adequate land use, implementation of small irrigation schemes, training in irrigation.</p>
<p>Low water quality in springs, wells and rivers, caused by sewage discharges, and wastes from coffee processing .</p>	<p>Inadequate sewage water and solid waste management, soil erosion, improper pesticide and fertilizer use, institutional weakness.</p>	<p>Water related diseases, reduction of multiple water productive use, increase in treatment costs, biodiversity reduction.</p>	<p>Water treatment, point and diffuse source pollution identification and control, soil conservation, integrated pest control, law enforcement, institutional strengthening</p>
<p>Forest cover loss (87%), biodiversity loss and soil degradation.</p>	<p>Land use conflicts, timber and firewood demand, forest fires, inadequate agricultural practices, inadequate agrochemical use, subsistence agriculture, institutional weakness.</p>	<p>Increase of erosion, loss of fertility, infiltration reduction, runoff increase, droughts, increase of landslide hazard, limited environmental services.</p>	<p>Agroforestry systems, reforestation, soil conservation, land use planning, organic agriculture, institutional strengthening.</p>
<p>Insufficient coordination of local actors.</p>	<p>Lack of implementation of a master plan of watershed development, non existence of a watershed organization, institutional weakness.</p>	<p>Duplication of efforts, development without a proper orientation, individual actions of local actors, weak impact of investments.</p>	<p>Institutional strengthening of local governments, definition of strategic plans for investments. Creation of a watershed management organism.</p>

IV.2. River Sumpul sub-watershed diagnosis (El Salvador y Honduras)

a) General watershed characteristics

The area of the watershed is 867 km², a population of 52703 inhabitants and 23 municipalities. The rainy season, in which is concentrated 95% of the total annual precipitation, starts in May and lasts until the end of October. The Salvadorian sector has a mean annual precipitation of 2095 mm. Surface annual runoff amounts 658 million m³, corresponding to a mean annual discharge of 21.16 m³/s, which is reduced to 4.64 m³/s during the dry season. Soils have volcanic origin and steep slopes. The system of land transportation is relatively functional only during the dry season, with predominantly dirt roads that are in very bad conditions during the rainy season.

b) Problems of the watershed

Water availability for different uses is a problem during the dry season. There is a contrast of deficit and excess of water, leading to droughts and floods, influenced by deforestation and inadequate land use, mainly in the upper watershed. All of the region is subject to droughts.

On the other hand, water quality is affected by fecal contamination, inadequate agro-chemical use, industries and sediments due to soil erosion. Erosion is moderate to severe, and is associated with deforestation and a lack of soil conservation practices in the production systems. Forest cover has been drastically reduced on the Salvadorian side, leaving 97 km² of forests, equivalent to less than 30% of the watershed. In contrast, 202 km², corresponding to 62% of the total area in El Salvador is dedicated to pasture and basic grains. Fires contribute to natural resources degradation.

Population density varies from 51 persons/km² in Honduras to 77 persons/km² in El Salvador, predominantly rural (75%). Migration varies as a function of season and destination. Primary education has a poor cover (in Honduras 52% of the population are illiterate). Land tenure is well defined, but in general, legal rights are not properly established. Extreme poverty is high on both sectors, being more critical on the Honduras side (72.5% of rural population), and 45.4% in El Salvador side. Manpower is dedicated mainly to agriculture. Diarrhea and respiratory diseases are to a large degree responsible for high mortality rates. There is a good level of local organization, especially on El Salvador side; for example, the Association of Municipalities, Education Boards, Water Boards, Cooperatives and workshops. In every municipality there is a Local Development Committee. There is not, however, an strategic plan for coordinating watershed development, and the lack of an institution responsible for the coordination and integration of all the efforts to achieve sustainable development is apparent.

c) Watershed vocation

The río Sumpul subwatershed has a hydrologic and forest vocation, and a limited potential for agricultural development because the deficit of agroecological classes I, II and III. The watershed has steep slopes, high intensity precipitation and poor forest cover, leading to accelerated degradation. It can be mentioned that 81.5% of the watershed has a forest agroecologic recommended use, while actual use indicates a 61.8% under subsistence agriculture. There is a valuable water resource, but local conditions limit the productive use. In fact, the hydrological potential should be oriented to hydro-electricity and eco-tourism. Irrigation projects have a limited

potential, with the exception of small schemes in some flat valleys, due to the general scarcity of agricultural lands.

The majority of the watershed, however, has to face a 6 months drought, producing environmental problems, reduction of production, poverty and migration. There are extensive lands belonging to classes VII and VIII, with forest vocation, which could be used for timber and firewood production and eco-tourist projects. These forest projects, normally placed in the upper watersheds, have a positive impact by reducing runoff and erosion, and hence reducing landslide hazard. CEL has built two large hydroelectric reservoirs (5 of November and 15 of September), downstream of the junction of the Sumpul and Lempa rivers. The hydroelectric importance of the Sumpul river is limited because it joins the Rio Lempa river downstream of the Cerron Grande reservoir, the largest in El Salvador. There is however the possibility of developing small hydroelectric projects, taking advantage of the mean annual discharge of 21 m³/s and the average slope of 4%. The watershed has natural beauties, especially in the protected area El Pital, and ecotourism projects could take advantage of this situation. At present, several institutions work in this watershed, with normally separated efforts and partial success. In this way, general watershed development is not achieved, and the preparation and application of a master plan is indispensable.

d) Why should this watershed be managed?

The main reason to manage the river Sumpul watershed is the excessive surface runoff due to a number of local conditions such as steep slopes, very intensive rainfall and deforestation affecting negatively its main potential (hydropower production). As an inevitable consequence, the rate of sheet, gully and river erosion increases dramatically, and the energy of the river reaches such a high level that it threatens the stability of the river banks, leading to landslides and more fluvial erosion, reducing water quality and increasing river and reservoir sedimentation. This last issue is particularly important for hydroelectric production in El Salvador. In fact, two large reservoirs in the river Lempa (15 de setiembre and 5 de noviembre), located downstream of the junction of the Lempa and the Sumpul rivers, receive and retain a large amount of the sediments originated in the Sumpul river watershed. Obviously the capacity of the reservoir has been reduced and will continue to drop if proper watershed management is not implemented as soon as possible. The inevitable consequence is a reduction of the hydroelectric productivity and of the flood control capacity of the reservoir through the process of flood routing. Another watershed activity should be eco-tourism, based on the natural beauty of the mountainous landscape, with conifer and broad leaf forests. This activity could lead to the preservation and expansion of the surviving resources. These objectives could be achieved by implementing forestry and agroforestry projects, soil conservation interventions and by fostering the organization of the population. The Sumpul watershed has a variety of organized local groups, as an inheritance of the civil war, which can be the basis for an integral watershed organization. This is a compulsory condition for undertaking the necessary actions with a watershed perspective. Erosion originates on steep slopes, reducing their fertility, and is deposited in the low lands, provoking sedimentation problems. The solutions require a comprehensive understanding of the complex hydrological situation. The solution of these problems will require an active participation of the population of the watershed.

Map 3. Rio Sumpul Subatershed

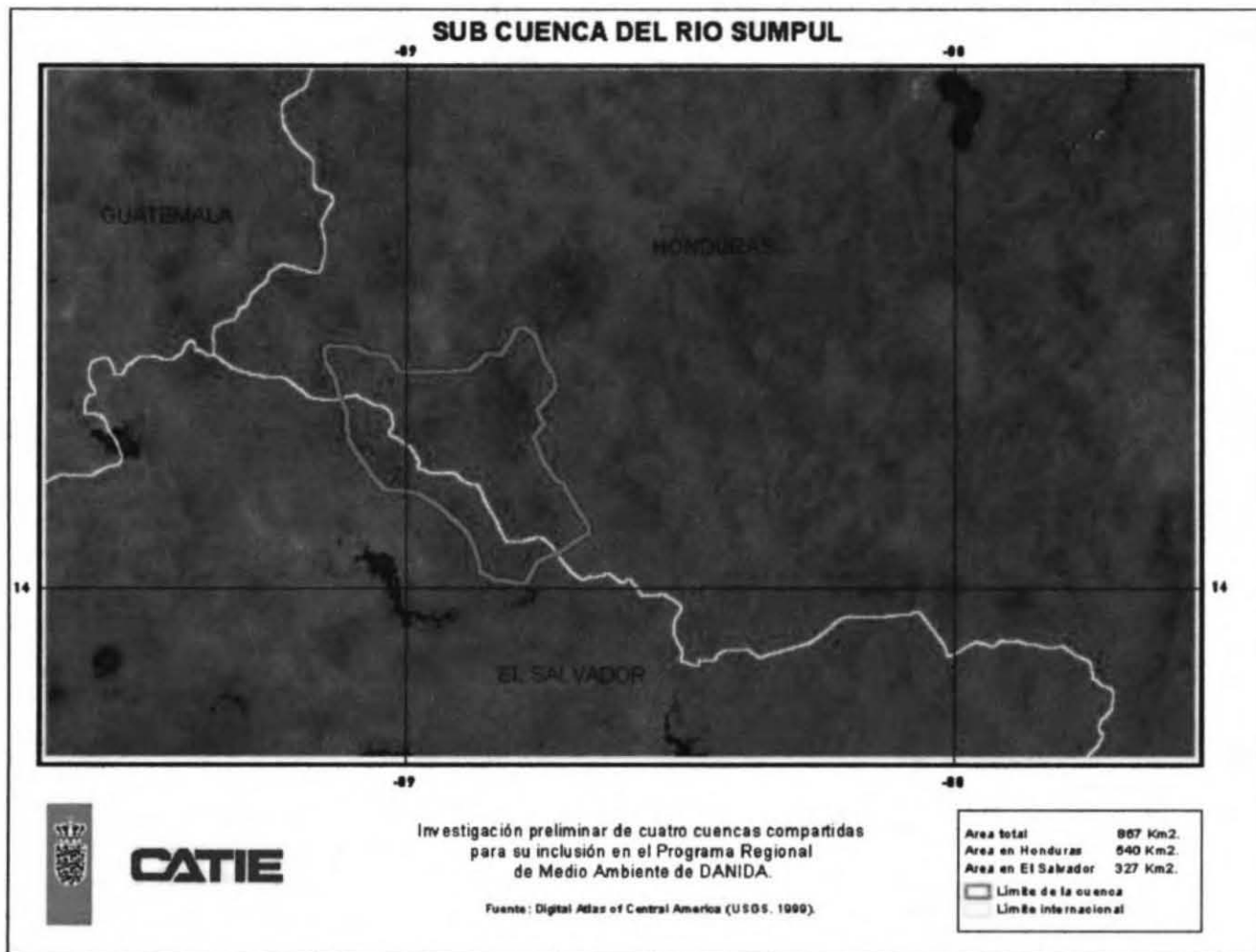


Table 2. Synthesis of diagnosis: Rio Sumpul watershed

Excessive sheet and fluvial erosion, and subsequent river and reservoir sedimentation	Loss of forest cover, land use conflicts, timber and firewood demand, forest fires, inadequate agricultural practices, inadequate agrochemical use, subsistence agriculture, institutional weakness.	Increase of erosion, loss of fertility, infiltration reduction, runoff increase, droughts, increase of landslide hazard, limited environmental services, loss of biodiversity.	Agroforestry, reforestation, soil conservation, torrent control, land use planning, organic agriculture, institutional strengthening, law reinforcement.
Insufficient water supply during the dry season, low water quality all year round.	Precipitation deficit during the dry season, inadequate distribution system, inefficient water use, water cycle alteration caused by inadequate land use changes, lack of protection of water sources and recharge zones.	Reduction of quality of life, economic losses for manual transportation of water, increased cost of supply, fewer economic options for women.	Water source and recharge zone protection, improved supply systems, adequate land use, institutional strengthening.
Low water quality in springs, wells and rivers, caused by sewage discharges, and water from coffee processing plants.	Inadequate sewage water and solid waste management, soil erosion, improper pesticide and fertilizer use, institutional weakness.	Water related diseases, reduction of multiple water productive use, increase in treatment costs, biodiversity reduction.	Water treatment, point source pollution identification and control, soil conservation, integrated pest control, law reinforcement institutional strengthening.
Insufficient coordination of local actors.	Lack of implementation of a master plan of watershed development, non existence of a watershed organization, institutional weakness.	Duplication of effort, development without a proper orientation, individual actions of local actors, weak impact of investments.	Institutional strengthening of local governments, definition of strategic plans for investments. Creation of a watershed management organism.
Insufficient transportation network	Very irregular geomorphology, adverse climatic conditions due to heavy rainfall, high landslide hazard. Low government investment.	Serious difficulties and delays for people and product transportation. High cost of construction and maintenance. Isolation during the rainy season.	Road design taking into consideration natural disaster risk, re-establishment of forest cover, torrent control.

IV.3. Rio Negro watershed diagnosis (Honduras y Nicaragua)

a) General watershed characteristics

The area of the watershed is 2,276 km², 55% in Nicaragua and 45% in Honduras, with an estimated population of 126,000 inhabitants (65% in Honduras), in 14 municipalities. The rainy season, which starts in May and lasts until the end of October, provides 95% of the total annual precipitation. The mean annual precipitation is 1600 mm. Annual surface runoff amounts to 1028 million m³, and an estimated infiltration of 546 million m³. Soils have a volcanic origin and 12.5% of the total area has less than 15% slope; the territory with slopes ranging from 30 to 50% is found above 1,600 masl. Temperature ranges from 24 to 28°C and relative humidity is 75% during the dry season. The lowlands physiography presents estuaries close to the mouth in the Fonseca Gulf. The system of land transportation is relatively extensive and functional, all year round.

b) Problems of the watershed

Deforestation in the upper watershed and inadequate land use is generating serious impacts in the lowlands, negatively affecting the international coast zones in the Fonseca Gulf. Floods have occurred in the lower parts. During the Mitch hurricane disaster, sedimentation of the river bed caused a change in the river's course towards the Nicaragua side (Guasaule and Palo Grande towns). This change of the river has reduced to a minimum the discharge arriving to San Bernardo estuary, leading to an increase of salinity, which is affecting shrimp production. Besides with the new river conditions, some areas are now prone to flooding, like the town of Somotillo. 40% of land cover conflicts with recommended use, and in spite of having 40% forest cover, this forest is affected by overexploitation, forest fires and pests. Conifer forests have not been properly managed and are currently under the threat of a pest (*Dendroctonus frontalis*). Landslide and gully formation are deteriorating the upper watershed in the Nicaraguan sector (Municipality of Limay).

Dispersion of the rural population in Honduras is high (60%), since the majority is living in very small villages (500 people). In contrast, in Nicaragua the majority is urban (approximately 60 %). The percentage of illiteracy is 29 % in Nicaragua and 20 % in Honduras. A good cover of primary education exists in both countries. Land tenure is well defined, but in general, legal rights are not properly established. In the lowlands, there are large farms and few owners; in the medium hilly watershed, farms are normally smaller than 5 ha.; in the upper watershed, land is concentrated in cattle and forest farms.

Extreme poverty is very high on both sectors, being more critical in Nicaragua (70 %), and manpower is dedicated to agriculture, business, shrimp production, fishing and illegal commercial activities (smuggling). There is a deficit of medical centers and medical staff, but the majority of the population has access to general medicine. Specialists are available only in the capital of the departments. It is estimated that only 50 % of the population have access to potable water. There is an important organizational process, associated with decentralization and municipal strengthening. In Honduras the following organizations are present: Environmental Municipal Units, Municipal Development Councils, Local Development Committees and Water Boards. In Nicaragua, there are projects like FOMENTA/COSUDE, PASOLAC, PROLEÑA, NICAMBIENTAL, NITAPLAN. There is not, however, a strategic plan for coordinating watershed development, and the lack of an

institution responsible for the coordination and integration of all the efforts to achieve sustainable development is apparent.

c) Watershed Vocation

Watershed management is justified not only to ensure the well-being of the population, but also to keep the hydrologic and environmental equilibrium in the Fonseca Gulf. In the middle and upper watersheds, deforestation is destroying the forest cover, together with forest fires, overgrazing and hillside cultivation without soil conservation practices, leading to erosion and degradation. Hurricane Mitch damaged the steeper areas of the watershed, and the resulting landslides and gullies are still visible.

The water resource is affected in its quantity and its quality. In fact, soil erosion, agrochemical, sludge, liquids from coffee processing plants, etc. is deteriorating water quality. Polluted water finally gets to the estuaries, in the Fonseca Gulf, negatively affecting the environmental equilibrium, shrimp and fishing activities.

Considering these dynamic and the complex processes, it is important that the watershed must be taken as a planning unit, considering an integral development, avoiding isolated actions. This type of planning is rather new, and it must be introduced gradually, in a participatory way, so that the population can actively participate in the decision taking, which can be beneficial or not to them.

While watershed actors do not plan in a participatory way, reaching agreements about the more important decisions and coordinated actions, there is the risk that the projects do not have a positive impact on the well-being of the population and the improvement of environmental conditions, and will finally end as failures. For these reasons, it is important to have an integral plan for the watershed development and this plan must be executed under orientation and coordination of a watershed organization.

d) Why should this watershed be managed?

The main reason to manage the Negro watershed is the growing pollution of the Fonseca Gulf, affecting negatively its main potential: aquatic production, especially shrimp production. The productivity and quality of this type of aquatic industry depends largely on water quality. It is well known that increasing water pollution from erosion, agrochemicals, wastes from coffee processing plants and sewage disposal is reducing dramatically water quality in the Gulf, especially in the estuaries, negatively modifying natural conditions for shrimp reproduction and development, particularly in their early stages.

Natural resources in general in the Negro watershed, as in the majority of the Pacific watersheds of Honduras and Nicaragua, has suffered a marked deterioration. In particular, forest cover has been systematically cleared all over the watershed. Impact is particularly severe in this case due to deforestation of areas with forest vocation, steep slopes and very fragile soils that have been exposed to the harmful effects of rainfall impact and runoff, resulting in a massive erosion that is, at the end of the day, deposited in the rivers and in their final destination: the Gulf of Fonseca. This critical situation is worsened by forest and pasture fires, overgrazing and agricultural practices without soil conservation measures. Hurricane Mitch exacerbated all these problems. Enormous landslides added thousands of tons of sediments to the rivers, and activated instable areas all over

the watershed. A very particular effect of hurricane Mitch is that the main river channel of the river Negro changed its course at its mouth. As a consequence, some areas of the Gulf have suffered a change in the salinity levels, increased in some areas where less fresh water is arriving, and reduced where more fresh water is arriving. These changes negatively affect the very sensitive forms of aquatic life. These problems are additional to changes in water turbidity, caused by dissolved sediments, which alter light penetration, photosynthesis and temperature of the shallow brackish Gulf waters. The arrival of soluble toxic material worsens even more an already dangerous situation. This is why this watershed must be managed: all of these problems demand an integral and immediate watershed management. Upper, medium and lower watersheds have a shared responsibility in the pollution of the Fonseca Gulf. Effective solutions will not become reality until the watershed population, in a participatory way, get fully involved in watershed management.

Map 4. Rio Negro watershed



Table 3. Synthesis of diagnosis: Rio Negro watershed

<p>Growing level of pollution in the Fonseca Gulf</p>	<p>Deforestation, inadequate sewage water and solid waste management, improper pesticide and fertilizer use, institutional weakness.</p>	<p>Water related diseases, reduction of multiple water productive use, reduction of shrimp production, biodiversity reduction.</p>	<p>Water treatment, point and disperse source pollution identification and control, soil conservation, integrated pest control, law enforcement, institutional strengthening</p>
<p>Floods in lower river course and main tributaries</p>	<p>Deforestation rate in critical zones, land over use, insufficient soil conservation practices, reduction of hydraulic river capacity, inadequate use of flood plains, lack of early alarm systems, institutional weakness</p>	<p>Human life losses, damages to structures and crops, interruption of communication systems and water supplies, water pollution, estuary sedimentation.</p>	<p>Reforestation and forest management, soil conservation practices, agroforestry systems, implementation of early alarm systems, land use planning.</p>
<p>Insufficient water supply during the dry season, low water quality all year round</p>	<p>Precipitation deficit during the dry season, inadequate distribution system, inefficient water use, water cycle alteration caused by inadequate land use changes, sediments in suspension, inappropriate use of agrochemicals, lack of protection of water sources and recharge zones, lack of sewage network systems, institutional weakness.</p>	<p>Reduction of quality of life, economic losses due to manual transportation of water, water related diseases, reduction of multiple water use, increased cost of supply, increased cost of treatment, fewer economic options for women.</p>	<p>Water source and recharge zone protection, improved supply systems, adequate land use, rational pesticide and fertilizer use, reforestation, aquifer recharge, community organization, environmental education.</p>
<p>Deforestation, loss of biodiversity, soil degradation.</p>	<p>Lack of land use planning, subsistence agriculture, expansion of agricultural and pasture border, timber and firewood demand, land tenure problems, inadequate use of agrochemicals, fires, institutional weakness.</p>	<p>Erosion, drought and flood increment, landslides, flora and fauna extinction, reduction of water quality in the Fonseca Gulf, loss of tourist value.</p>	<p>Land use planning (ordenamiento territorial), reforestation, agroforestry systems, integrated pest management, management of protected areas, soil conservation, sustainable farming.</p>
<p>Insufficient coordination of local actors.</p>	<p>Lack of implementation of a master plan of watershed development, non existence of a watershed organization, low local management capacity, institutional weakness.</p>	<p>Duplication of effort, development without a proper orientation, individual actions of local actors, weak participatory initiatives, weak motivation of local actors.</p>	<p>Preparation of a watershed management plan, institutional strengthening of local governments, effective participation of local actors, creation of a watershed management organism.</p>
<p>Low level of commerce capacity and added-value.</p>	<p>Small and poor farmers and cattle raisers with low technological level, lack of technical assistance, low level of knowledge of market, low diversification of production, inadequate transportation network, lack of credit.</p>	<p>Low quality of products, unbalance between offer and demand, postcrop losses, monocultivation risks, migration due to employment scarcity.</p>	<p>Strengthening of management capacity, support to local organizations, increase of technical level of production, crop diversification based on market analysis.</p>

IV.4 Coco river upper watershed diagnosis (Honduras and Nicaragua)

a) General watershed characteristics.

The total area of the watershed is of 9,384 km², 8,437 km² (90%) in Nicaragua and 927 km² (10%) in Honduras, with a total population of 135,968 people, 93,681 people (69%) in Nicaragua and 42,287 (31%) in Honduras. It can be seen that the Honduran component of the watershed is very small compared to the Nicaraguan sector, but population density is much higher on the Honduran side. The watershed comprises 35 municipalities, but only two of them belong to Honduras. The watershed has a great variety of climates. The rainy season starts in May and ends in October, with 85 % of the total annual rainfall. Rainfall records vary from a minimum of 722 to a maximum of 1429 mm per year; September is the rainiest month.

The Coco River has seven tributaries on the Nicaragua side and only one in Honduras. Topography changes from undulating to scarp areas with slopes from 30 to over 50 %. In upper parts there are fertile valleys. 54 % of the area has a forest potential and 36 % an agriculture one. The upper part of the Coco River watershed is bordered by two large protected areas; the Patuca National Park and the Bosawas Protected Area. Road access is limited, mainly during the rainy season, especially in lower parts of the watershed.

b) Problems of the watershed

Water availability throughout the watershed is generally adequate, but some areas have an insufficient water supply, especially towns and communities in the upper parts of the watershed because sources dry up during the dry season. This deficit has increased over the years. This situation becomes more critical in areas with good agricultural potential but having a shortage of water for irrigation. There are more than 25,000 ha. with irrigation potential. The main threats for water availability and quality are: deforestation and erosion, improper use of agrochemicals in agriculture and industries, mine pollution and disposal of sewage water from towns. Conflicts for land use show 36 % overuse, mainly in areas of good soil quality for forestry use. Coniferous forests predominate above 800 meters above sea level (associated with oak trees and shrub species). In the dry forest, broad leaf species are dominant and sometimes are found in association with coffee plantations. The riparian forest is not more than 0.5 %. Actually pine plantations are being affected by the plague caused by *Dendroctonus frontalis* and by deforestation. Consequently soils are eroded, get more compacted and become less productive. In different places throughout the watershed, areas exposed to landslides, overflows and burning are found.

Rural population accounts for up to 60 % and they live in the valleys, close to the Pan American highway. Population density is low compared to the other watersheds. 58 % of the total population is related to agricultural activities. Families are migrating into this region, searching for arable lands, both in Honduras and Nicaragua. Poverty levels affect 70 % of the population and the development human index is 0.575 in Honduras. Health and sanitary services in Nicaragua cover near to 80 % of the population but only 50 % in Honduras. In rural areas, there is a poor electricity supply and 45 % of the people do not have access to safe drinkable water. In regard to local organization, there is a promising process of decentralization and municipal strengthening, with an outstanding participation of Councils of Municipal Development, water committees and municipality environmental units. However it is also important to insist on the creation of a

watershed management organism. It is estimated that presently there are more than 12 agricultural and environmental projects in the watershed with a budget of over 125 millions of dollars, but these investments do not follow an overall development plan and their coordination is too weak.

c) Watershed vocation

The upper watershed of the Coco river has a forest and agricultural vocation. Valleys, with high potential agricultural lands, need the implementation of irrigation schemes, in order to satisfy the internal food demand and also considering international markets. Very often, very ambitious irrigation project proposals are discarded because of their high investment need. There is always, however, the possibility of implementing numerous small and non expensive irrigation systems, which would finally have a significant impact on the local economy and well-being.

Climatic and topographic conditions have permitted the development of an important and growing cattle activity. Coffee plantations are also important and have a promising future if international prices for coffee improve.

Despite deterioration of the natural resources, due to an inadequate and unplanned utilization of the watershed, it must be stated that it has not reached the level of damage found in the river Paz or Negro watersheds. Consequently it should be possible to reverse relatively easily much of the damage, if adequate rehabilitation projects are undertaken.

d) Why should this watershed be managed?

The main reason to manage the river Coco watershed is to manage the expansion of the agricultural frontier, due to clearing of mainly deciduous forests without a proper development plan, based on recommended land use. The watershed has not been badly deteriorated, but the tendency is in that direction. Important environmental damage has occurred and the remaining natural resources, such as forests and rivers, are under threat. This watershed has limits with two protection areas; the Patuca National Park and the Bosawas Biological Reservation. In the buffer zone of these areas, indigenous tribes sustain the natural equilibrium. However, if the area is colonized by newcomers without a proper education and development plan, the future of the protected areas will be in danger. It can also be concluded that these ethnic groups face disruptive invasion of their habitat. This watershed presents opportunities for a variety of environmental services: water, eco-tourism, recreation, buffering of protected areas, disaster management, bio-diversity, diversification of production (e.g. horticulture) and sustainable forest use.

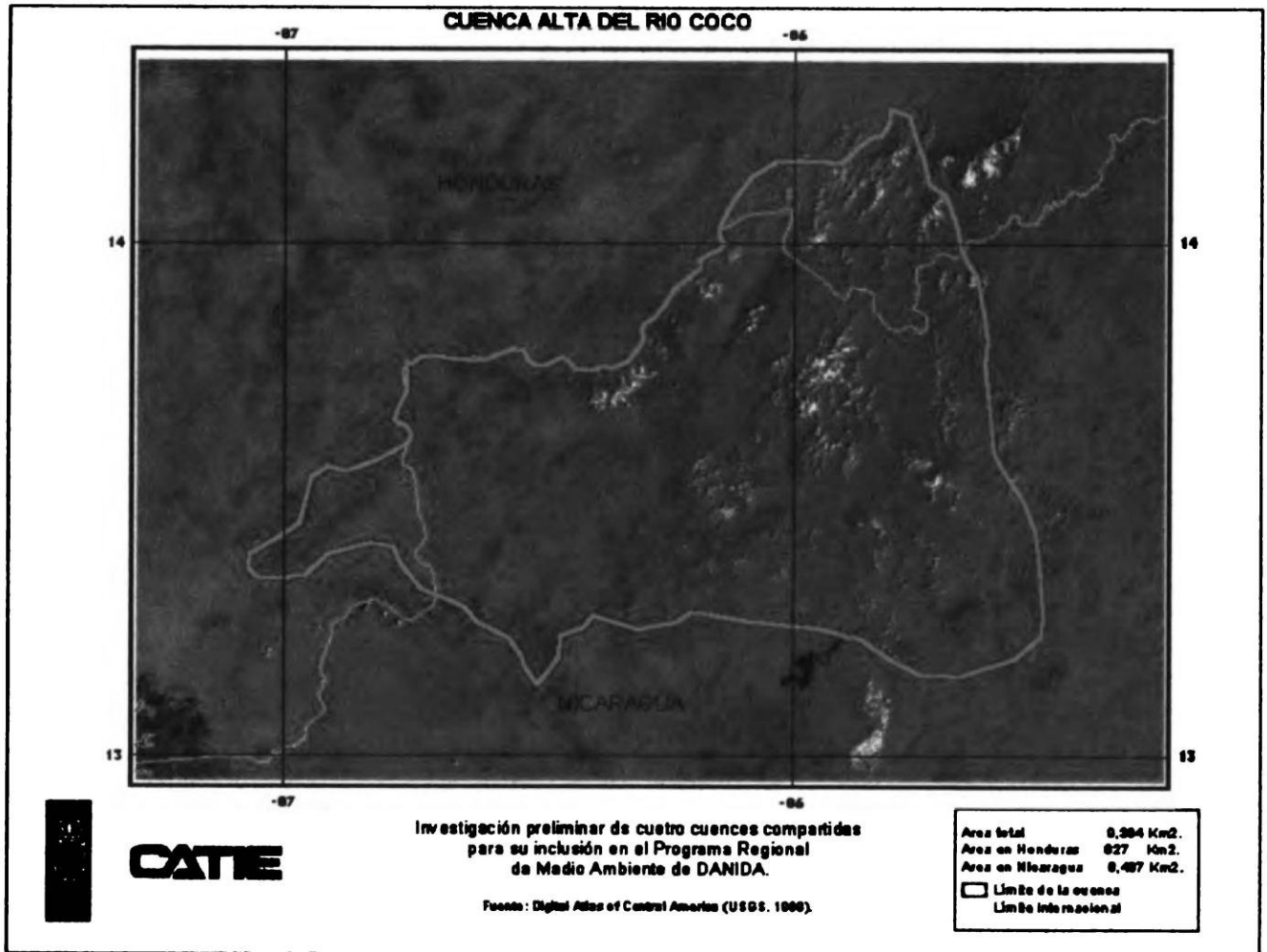
The following possibilities are identified: natural landscapes, waterfalls, canoeing, tours to protected areas, agro-tourism, hotel/recreation centers, tours to historic monuments, mountain tourism, fishing, etc.

Hurricane Mitch badly affected this region. In fact, massive landslides have led to serious instability processes that will affect erosion, water quality and flooding in the coming years. These processes must be controlled as soon as possible.

These opportunities could be properly realized through investment and planned activities focused on watershed management, with an integral vision based on participatory processes to promote local responsibilities with possibilities of sustainability based on the externalities. If these objectives are not achieved, degradation and other environmental conflicts will result in problems for the population and for the central government.

Watershed management in this case would have a preventive objective, before further damage is inflicted to these very important but fragile ecosystems. This is why this watershed needs integral and participatory management.

Map 5. Rio Coco upper watershed



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Table 4. Synthesis of diagnosis: Rio Coco upper watershed

PROBLEMS		CAUSES		CONSEQUENCES	
Uncontrolled expansion of the agricultural frontier.	Lack of land use planning, subsistence agriculture, wood and firewood demand, land insecurity, degradation of previous farming land, lack of forest management plans, legal and institutional weakness.	Deforestation, erosion, increases of floods and droughts, landslides, loss of flora and fauna, destruction of ecosystems, reduction in water quality, reduction of soil fertility, loss of tourist value	Territorial arrangement, reforestation, application of agroforestry systems and management of protected areas, soil conservation and sustainable farms, law reinforcement, institutional strengthening.		
Floods in the floodplains	Deforestation, land use conflicts, inadequate agriculture practices, river capacity reduction, lack of alert systems, lack of land order, institutional weakness	Loss of human lives, destruction of towns and cultivations, disruption of water and energy supply, water pollution, danger of diseases and changes in the river course.	Forest management, soil conservation and agro-forestry practices; land use planning, institutional strengthening.		
Scarcity of drinkable water in summer and poor quality due to water pollution	Low rainfall during the dry season, lack of protection of water sources, inefficient use of water, alteration of hydrologic cycle, dispersion of towns, social conflicts for water use, inadequate management of sewage, excessive use of agrochemicals, lack of regulations.	Reduction of life quality and biodiversity; increase in transportation costs; reduction in water quality, multiple use of water and opportunities for women; loss of environmental services; increases in water treatment costs.	Water sources protection, water quality monitoring, rational use of agrochemicals and Integrated Pest Management, reforestation, water conservation, aquifer recharge, application of technical norms, community organization and environmental education.		
Insufficient coordination of local stakeholders	Lack of a watershed institution that coordinates the different activities of the different institutions, lack of a master plan, lack of laws and regulations, low local negotiation capacity and legal weakness.	Duplication of efforts, project implementation without adequate knowledge of the problem, very few participatory processes and limited motivation for local people.	Watershed management plan, increase of local negotiation capacity, creation of a watershed organization, community participation, integration of local participants and governments in watershed management negotiations.		
Problems with marketing and added value	Small producers with low technological practices, lack of technical assistance, lack on information on marketing, insufficient crop diversification, bad roads and low credit and finance availability.	Low product quality, unbalanced offer and demand, post harvest losses, higher risks because of monocultures, migration due to poor employment availability, low profitability.	Strengthening of negotiation capacity, support local and productive organizations, increase of the technical level in the processes of production, diversification of production based on marketing studies.		

V. Project profile proposal for each shared watershed

The set of project proposals for each watershed focuses on the problems of managing natural resources, emphasizing water management; it is not a matter of adding up projects, but of integrating and complementing them, and making alliances. Above all, they are directed to provide benefits and externalities for the target groups. Once the causes of the problems are determined, project profiles should be proposed. Key topics for watershed management are identified and articulated to cross cutting issues such as: gender, community participation, local governments (municipalities), vulnerability and sustainability. A detailed description of the project profiles can be found in part two of this report.

a) The point of view of the target groups

The target groups who make the decisions (farmers, rural families, local authorities, NGOs, GOs, projects, etc.) are many and diverse. During field appraisal, persons interviewed emphasized short-term alternatives. Externalities and environmental services are not satisfactorily visualized. They consider the use of improved seed to increase production rapidly and the application of chemicals instead of organic manure is frequently preferred. Agroforestry systems associated with fruit trees are accepted. Irrigation, water supply for the community and very practical training and support for community organization to reach a legal status are needed. Their priorities include improvement of roads and bridges, basic services and bank loans. In regard to project administration, a closer relationship with community organizations and a facilitating, supervising and supportive role from the local governments (municipalities), GOs and NGO's are requested.

b) Technical analysis

The technical analysis first identifies the problems and needs of the population. It integrates the watershed dimensions, and states long-term approaches. In this case, it is based on a rapid appraisal at the field level which includes community surveys, consultation of secondary information, experiences from similar projects implemented in the area, and consultation with other specialists. The technical analysis also evaluates training, immediate benefits, improvement in profitability, the introduction of promising activities and the possibility of incorporating environmental services.

In terms of project implementation and administration, technical staff mentioned organizational weaknesses and limited operational capacity and the need for training and strengthening managerial and administrative capacities of the Municipalities and community organizations, in order to increase their responsibilities in the mid-term.

It is important to point out that due to the large size of the area and the variety of problems encountered, project activities will be strategically focused on critical areas which will be identified through participatory processes and applying criteria such as: i) areas with higher degradation, ii) erosion-risk areas, iii) deforested areas, iv) areas that will eventually contribute to floods and land slides, v) areas with low quality water and vi) areas where the negative impacts are still reversible.

c) Key managerial strategies

Coordination is a key element, which must lead to new attitudes and visible results. Another important point relates the knowledge of the different activities and projects already completed or under implementation and the formation of working teams to gather available information on the watershed, such as studies, diagnosis, thesis, reports, etc.

The other set of tasks is the preparation of a watershed management plan or to promote any other kind of tool leading to development of the area, integrated into the municipal plans or related media. Finally, a very important element is to inform the community, incorporate the representatives of the target groups and disseminate the achievements. Rights for watershed management from the legal and institutional point of view will be another aspect of concern.

V.1 Project profiles for the Paz river watershed

Project profiles for the Paz river watershed focus on the solution of its main problems and seek to foster its main potential: i.e. flood and low water quality problems, and irrigation potential, respectively. Some of the solutions can be very expensive, especially if structural solutions are proposed, but there is always the possibility of implementing nonstructural solutions, normally much cheaper and at the end of the day probably more effective. For example, one way of fostering irrigation, is by reforestation that promotes infiltration and increases base flow quantity and quality. Some of the reforestation and agroforestry projects should be located in the riparian zones of the rivers, in order to contribute to the reduction of sediments reaching the water.

The following interventions are emphasized: reforestation to re-establish plant cover; introduction of efficient, low cost irrigation schemes; wise use of agro-chemicals, including IPM technologies and organic agriculture; protection of water sources and decontamination; the application of sustainable technologies such as agroforestry systems and soil conservation; community and municipal organization and participation; micro-enterprise development and environmental training and education.

With the aim of considering project operation, an implementing unit has been suggested. The projects indicated in Table 5 (below) are described in detail in the annexes (second part of the report).

Table 5. Investment needs for the Rio Paz watershed

Non structural flood control by implementation of agroforestry systems and reforestation, flood plain delineation by hydrologic and hydraulic modeling.	1,711,000	CENTA, MAG, CEL, MARN
Soil conservation and multiple use of water, demonstrative irrigation schemes.	755,000	CENTA, DGRNR
Water source protection and decontamination	834,000	Municipalities
Strengthening the managerial capacity of the local governments and community organizations, law reinforcement.	600,000	Municipalities, ADESCOS
Micro-enterprise development, commercialization and agro-industry	400,000	Municipalities, ADESCOS, Cooperatives
Environmental training and education	450,000	Municipalities, Ministry of Education
Implementing Unit	500,000	Open/to be selected
Total	5,250,000	

V.2 Project profiles for the Sumpul river sub-watershed

Project profiles for the Sumpul river watershed correspond to the solution of the main problems and seek to foster its main potential: i.e. excessive runoff/erosion problems and hydroelectric potential, respectively. In this case, the same solutions that could contribute to reduce erosion could simultaneously improve the hydroelectric capacity of the rivers, by reducing sedimentation and increasing base flow. Efficient production of hydroelectric energy is an environmental service that must be fairly paid to the people who are implementing watershed management projects in the upper watershed.

The natural landscape beauty and presence of protected areas should be the base for the implementation of eco-tourism projects that could provide new jobs, and promote the protection and rehabilitation of natural resources like forests and water courses.

The projects indicated in Table 6 (below) are described in detail in the annexes (second part of the report).

Table 6. Investment needs for the Sumpul river watershed

Erosion and sedimentation control by means of agroforestry systems and reforestation	1,780,000	CENTA, DGRNR, AFE-COHDEFOR, CEL
Soil and water conservation, torrent control and vulnerability	900,000	CENTA, DGRNR, PRONADERS
Water source protection	792,000	Municipality, Water Administration Association
Consolidation of managerial capacity of local governments and community organizations.	612,000	Municipalities, AMHON, FUNDAMUNI, Association of Municipalities of Southern Lempira
Eco-tourism development and management of protected areas.	280,000	SERNA, MARN, Municipalities
Implementing Unit	500,000	Open/to be selected
Total	5,524,000	

V.3 Project profiles for the Negro river watershed

Project profiles for the Negro watershed are orientated to contribute to the solution of its main problem (pollution of the Fonseca Gulf), and to materialize its main potential: aqua-culture projects. In order to achieve these objectives, it is necessary to reestablish the original hydrologic cycle, with lower rates of runoff and erosion during heavy rainfall. Local governments should enforce environmental legislation to ensure the protection of the water that finally arrives in the gulf. Some of the interventions should be located in riparian zones, in order to protect water courses from erosion.

A few decades ago, the river Negro upper watershed had an impressive coniferous forest cover, that should be recovered by means of reforestation projects. This can be the base, in combination with the beauty of the Fonseca gulf, for the implementation of eco-tourism projects.

The projects indicated in Table 7 (below) are described in detail in the annexes (second part of the report).

Table 7. Investment needs for the Negro river watershed

Fonseca Gulf water quality improvement by reforestation and agroforestry systems of critical areas, especially in riparian zones.	675,000	Municipalities, POSAF, AFE-COHDEFOR
Water quality control of the Fonseca Gulf by strengthening of environmental management units at local level, law reinforcement and monitoring.	412,000	Municipalities, PROGOLFO, AMHON, INIFOM, SERNA
Promotion of soil and water conservation	646,000	PRONADERS, INTA, PASOLAC
Sustainable management of forests and community energy plantations	729,000	POSAF, AFE-COHDEFOR, Municipalities, Forest Private Owners
Rehabilitation and construction works to face vulnerability and natural risks.	705,000	Municipalities, COPECO, INETER
Environmental training and education	569,000	Municipalities, Ministry of Education, PROGOLFO, ESNACIFOR
Implementing Unit	724,000	Open/to be selected
Total	4.460,000	

V.4 Project profiles for the Coco river upper watershed

Project profiles for the Coco river watershed are focussed on the solution of its main problem (expansion of the agricultural border), and to optimize its main potential: forest and agricultural resources . The current invasion of this watershed is leading to massive deforestation, increasing erosion rates, decreasing water quality and a reduction of bio-diversity. This negative process can and should be reverted. Rehabilitation interventions should be concentrated in degraded areas, and fragile forest areas should be protected from deforestation. Local institutions must be strengthened so that an integral watershed management plan becomes the guide for the development process.

This watershed, belonging to the Caribbean basin, can be affected by periodical hurricanes, as happened with the catastrophic hurricane Mitch. Vulnerability of the interventions must be seriously considered in the design of projects in this area.

The projects indicated in Table 8 (below) are described in detail in the annexes (second part of the report).

Table 8. Investment needs for the Coco river watershed

Land use planning to control agricultural frontier expansion, sustainable management of natural resources.	1.195,000	POSAF, AFE-COHDEFOR, Municipalities
Reforestation of critical areas and energy plantations in community micro-watersheds	1.350,000	Municipalities, Water Administration Associations, AFE-COHDEFOR, POSAF
Promotion of water and soil conservation	1.060,000	PRONADERS, INTA, FOCUENCAS
Strengthening of environmental management at the municipality and community levels.	595,000	Municipalities, AMHON, INIFOM,
Rehabilitation and construction works to face vulnerability and natural risks.	770,000	Municipalities, COPECO, INETER
Environmental training and education	699,000	Municipalities, Ministry of Education,
Implementing Unit	724,000	Open to be selected
Total	6.393,000	

VI. Recommendations on possible priority shared watersheds

VI.1 Key factor analysis

In a regional context, where all the watersheds evaluated have very similar characteristics and problems, it is very difficult to establish priorities in an integral way. Nevertheless a general decision can be made based on the following factors:

a) Current biophysical and socioeconomic conditions

Current conditions, in all the watersheds, reflect significant human intervention. From the biophysical point of view, this has resulted in severe degradation of the natural resources, mainly due to deforestation and related problems. The watersheds with higher forest protection are the Coco upper watershed and the Sumpul sub-watershed. From the socioeconomic point of view, greater importance has been given to the Negro river due to its economic impact, which depends on watershed functioning; that is, constant water quantity and quality in the lower part of the watershed which has many uses including shrimp production. The Paz watershed has the highest population density and, as a logical consequence, more intensive exploitation of natural resources.

b) Relevance of the factor water

Any watershed management project must look for the rehabilitation of the hydrologic cycle, both quantitatively and qualitatively. This is particularly valid for the Negro and Paz watersheds. Both cases have severe problems of excess and deficit of water, during the contrasting rainy and dry seasons, alternatively provoking floods and draughts. Thus, greater attention must be given to reforestation or other activities which provide plant cover, such as agroforestry systems, designed to improve the hydrologic conditions of the watershed, as well as to alleviate poverty. In spite of the tropical position of the study area, droughts constitute a very serious natural disaster due to cyclic long periods of absence of significant precipitation. As a consequence, it is important to consider complementary irrigation, and to study the dry periods which limit water availability in the rural areas. Torrential rainfall, on the other hand, provokes floods that threatens towns, agricultural areas and communications means. And something must be done here too. Finally, the impact of water pollution levels in human health and economic growth is critical and increases during the dry periods. The Paz river has the highest level of water pollution due to coffee processing wastes, and the Fonseca Gulf is very vulnerable to water quality deterioration. .

c) Coordination and complementation

There is almost no coordination between existing projects; consequently, it will be important to establish internal liaison mechanisms, in order to make the information of each project available and to look for reciprocal support, thus leading to the strengthening of these projects and other existing interventions in the watershed. The only case in which progress can be observed with this factor is in the Paz watershed, where a master plan and formal governmental agreements exist. This is a key and crucial advantage.

d) Interest of target groups and central government

The Negro and Paz River watersheds are the most populated, and are the areas where the target groups showed most interest in detailed information on the topics discussed in this report. There is great local interest in the management of these watersheds. During the appraisal, a good level of local community organization was found in all watersheds visited, although formal constitution of these local organizations was not a constant. Furthermore, top ranking government officials considered the Paz and Negro watersheds their first priority.

e) Contribution to problem resolution

Conflicts and problems are associated with increasing human populations. In order to face this situation, participatory processes and agreement must be developed, and a certain degree of basic reflection is needed in order to obtain support for selected priorities. The Paz watershed has more advantages than the other watersheds, since consultation and determination of the most feasible projects have been included in the follow-up process to the master plan.

f) Production and conservation

Agricultural capacities and potential land use should influence priorities. However, acceptance of these priorities by the target groups has to be obtained. Watershed management would definitely be a good alternative to promote conciliation. There are good productive lands in the Paz and Coco watersheds (e.g. mountain valleys), but water is a constant limitation. The lower parts of the Negro watershed also have an economic potential for shrimp production.

g) Externalities and sustainability

The watersheds showing the best perspectives for environmental services are the Negro, Paz and Coco. In regard to externalities, the most immediate ones have been mentioned above. Multiple externalities, especially for the Coco river, potentially exist (water, biodiversity, recreation, tourism). It will be very important to identify, evaluate and recognize environmental services, since they constitute a mid- to long-term source for financing for watershed investments; the municipalities must be ready to achieve this objective.

h) Disaster management at the local level

This is a major weakness in most of the watersheds. Development plans (or similar) usually do not exist. After Hurricane Mitch, many projects and initiatives have made this factor part of their components. It is important to develop experience and to evaluate the lessons learnt. Local managerial capacity is weak, but some progress is evident in the Paz watershed.

i) Local organization and experiences

Information on similar experiences in terms of watershed management does not exist but due to activities developed by other projects, processes have just started on managerial capacity strengthening and community participation. There are many organizations that can be used as a basis for the formation of water committees and related modalities; the watersheds in Nicaragua and El Salvador have very good potential in this respect. However, this requires definition of legal rights and support to institutionalize watershed management.

j) Other important elements (size, management plans, agreements, regional integration, information, country border development, legal aspects)

In terms of size, the Coco upper watershed is the largest; the Negro and Paz watershed have very similar and smaller surface areas. Only the Paz River has a master plan. For the Nicaraguan watersheds, a study was elaborated including part of the Negro and Coco watersheds. Some municipality managerial development plans and watershed management plans exist, such as the "Plan Rector de Producción y Conservación de Coco y Somoto" [Governmental Production and Conservation Plan for Coco and Somoto] for the upper part of the Coco watershed. Only the Paz river has agreements at the highest level of authority in both countries; for the Sumpul sub-watershed, agreements exist at the border municipality level. Regionalization of activities through shared watersheds, to allow the possibility of involving the four countries, could be achieved by selecting the Paz and Negro or the Paz and Coco rivers. There is a large variability between

countries in terms of norms and laws related to watershed management, and the definition of rights for the use of the water resources on borders lacks definition (CCAD is making efforts on this sense).

Regarding border development, the importance of projects of this kind is clearly recognized. These regions have been neglected and the difficulty to reach agreements between countries has prevented progress in these areas.

Table 9 attempts a comparison of the watersheds; the importance of some of the above factors has been valued (scale of importance from 0 to 5; i.e. from none to very high). The results give similar values. The Paz and Negro watersheds score 38 and 34, while the Sumpul and Coco sub-watershed score 32 and 29 points.

Table 9. Comparative synthesis for decision making on priority watersheds

Watershed	Problem	Potential use	Principal externalities	Water importance	Natural risks	Social capacities	View	Government level
Paz	Very high: deforestation, floods, water pollution (5)	High: hydric and agricultural (coffee) (4)	Very high: quantity and quality water (5)	Very high: irrigation potential (5)	Very high: floods, pollution, droughts and fires (5)	High: working organizations (4)	Very high: economic and environmental point of view (5)	Very high: at local government level (5)
Sumpul	High: landslides (4)	High: hydric (4)	High: quantity water (4)	High: guarantee storage (4)	High: landslides, seismic activity and fires (4)	Very high: organizations with important capacities (5)	High: environmental point of view (4)	High: at the level of neighboring municipalities (4)
Negro	Very high: deforestation, floods, erosion and pollution (5)	High: hydric, livestock and fishing (4)	Very high: quantity and quality water (5)	Very high: salinity problems in the Gulf (5)	Very high: floods, drought and pollution (5)	Very high: experienced organizations (5)	Very high: economic and environmental point of view (5)	None (0)
Coco	High: deforestation, water availability and landslides (4)	High: hydric, livestock and fishing (4)	Very high: water, tourism, diversification and conservation (5)	High: irrigation possibility (4)	High: droughts, landslides, floods in the mountain valleys (4)	High: presence of organizations (4)	High: environmental and social point of view (4)	None (0)

VI.2 Conclusions

Based on the results presented, the following priority order is recommended to implement activities in the shared watersheds: 1° Paz watershed, 2° Negro watershed, 3° Sumpul sub-watershed and 4° Coco upper-watershed. The following aspects are among the reasons for the given order:

- a) Regional integration is more practical with the Paz and Negro watersheds; both have more extensive and functional communication systems all year round.
- b) Important progress has been made in the Paz watershed; e.g. a management plan and agreements between countries (the interests of both parties can be supported and immediate action can be taken).
- c) Externalities of the Paz and Negro rivers lead to important impacts and benefits from the social, ecological and economic point of view.
- d) The target groups of the Paz and Negro watersheds showed higher willingness, experience and motivation to integrate activities leading to improved water use and management.
- e) Sustainability, based on the application of environmental services, was identified as a more immediate objective in the Paz and Negro watersheds.
- f) Coordination of possible investments, governmental support and a target population willing to participate favor the Paz and Negro river watersheds.

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