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MID-TERM EVALUATION REPORT
OF GEF PROJECT (GF/1010-01-05)

"ARGENTINA-BOLIVIA: IMPLEMENTATION OF THE STRATEGIC ACTION PROGRAM FOR THE BERMEJO RIVER BINATIONAL BASIN"

Marcelo H. García

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1. INTRODUCTION

1.1. Bermejo River Basin and Sediment Related Issues

The binational basin of the Bermejo River covers an area of about 123,000 km². The river rises in the Andes Mountains in northwestern Argentina and southern Bolivia and flows for some 1,300 km across the vast Chaco Plains serving as an important ecological corridor linking the Andes Mountains with the Atlantic Ocean. The Upper Bermejo Basin (50,000 km²) is shared by Argentina and Bolivia while the Lower Bermejo Basin (73,000 km²) lies entirely within Argentina. The basin comprises three major features: the Eastern Cordillera of the Andes with altitudes of between 3,000 and 4,600 m above sea level; the Sub-Andean Ridge that runs north-south at altitudes of around 2,000 m; and, finally, the Chaco Plain lying between 200 and 400 m above mean sea level. The population of the basin is of the order of 1,200,000 inhabitants.

This river system contributes the largest amount of Andean sediments to the Paraguay-Parana-LaPlata River system and plays a major role in the ecological and morphological dynamics of the Parana River, including its floodplains and delta, and the La Plata River, which, on average, receives more than 100 million tonnes of sediment annually (Figure 1). Most of the suspended sediment reaching the estuary of the La Plata River and the Atlantic Ocean originates in the Bermejo River basin (Amsler and Prendes, 2000).

Figure 1. Satellite image of La Plata River Basin showing suspended sediments largely derived from the Bermejo River

Sediment loads contributed by the Bermejo River basin are among the largest in the world. Rivers can transport sediment in suspension, via turbulence, or as bedload along the bottom and stream banks (Garcia, 1999). The sediment transported in suspension consists of: (a) bed

material, mainly fine sand and silt resuspended from the bottom; and (b) fine material, mainly clay commonly known as "*washload*." The amount of fine sediment transported in suspension by a river as washload does not depend on the sediment transport capacity of the river but is rather a function of how much fine sediment a given watershed will yield. There is a strong correlation between watershed soil erosion and the washload conveyed by a river system. However, not all the sediment eroded in a watershed ends up in the river, so a distinction needs to be made between watershed sediment erosion and downstream sediment yield (Walling, 1989). In the case of the Bermejo River, the washload is extremely large (*to be exact* more than 100 million tonnes per year) and constitutes the main source of sediment to the Parana-La Plata River system (Alarcón *et al*., 2003). Even though the flow discharge of the Bermejo River is very small when compared with other rivers in the La Plata River Basin, its sediment load is several orders of magnitude larger than those of the Paraguay and Upper Parana Rivers. For example, in the Middle Parana River, the Bermejo River contributes only 5% of the liquid flow discharge but about 95% of the suspended sediment discharge (Alarcón *et al*., 2003). Every year, tens of millions of dollars go into dredging and maintenance of harbours and navigational waterways along the Paraná River. It should be clear that even a modest reduction on the amount of sediment produced and delivered by the Bermejo River basin could have a socio-economic impact on the Paraná-La Plata River system. Even if the erosion of sediment cannot be reduced in the upper watershed, sediment management along the Lower Bermejo, for instance with permeable dikes, could have a double benefit by making the course of the river more stable and reducing the amount of sediment delivered to the Paraguay river during floods.

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Many environmental and water management issues within the Bermejo River basin are also related to the dynamics of sediments, including erosion, transportation and deposition and the resulting river morphology and planform geometry. For example, in the Lower Bermejo Basin, close to the town of Laguna Yema in Formosa, Argentina, the lateral migration of the river channel makes it practically impossible to have a reliable continuous source of water for both human consumption and the irrigation of agricultural land. In the Upper Bermejo basin, the San Jacinto Reservoir near Tarija, Bolivia, is steadily filling up with sediments thus reducing its capacity for storing water, a fact that has motivated the Tolomosa and Mena River projects for sediment control. These two examples show the need to assess sedimentation processes within the Bermejo River basin for the benefit of sustainable water management and land use.

Understanding the hydrologic, sedimentologic and ecologic balance of the Bermejo River basin has the potential to provide more widespread benefits, such as in the case of the upcoming UNEP-OAS-GEF Plata River Basin Programme. Only the river basins of China and Nepal have rates of sediment erosion and yield comparable to those observed in the Bermejo River basin, making it a rather unique river system on the American continent.

There are two further aspects that make the Bermejo River basin different from those of similar river systems around the world. First, the population of the watershed is rather small and, second, the extent of environmental degradation can still be reduced or curtailed with the introduction of appropriate measures. Thus there is a unique opportunity for sustainable river basin management in the region, which in other parts of the world can no longer be achieved since the degree of environmental degradation has extended beyond critical levels (UNESCO, 1999).

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1.2. Implementation of the Strategic Action Plan (SAP)

In 1995, the governments of Argentina and Bolivia established the Binational Commission for the Development of the Bermejo and Tarija River Basins (COBINABE). With support from the GEF, UNEP, the OAS and a number of regional agencies, a Transboundary Diagnostic Analysis (TDA) was prepared as the basis for the formulation of a Strategic Action Programme (SAP). The first phase of the project comprised the formulation of the SAP and was undertaken between August 1997 and June 2000.

The TDA identified six priority areas relating to the conservation, rehabilitation and preservation of the basin's ecosystems:

I. Soil degradation, intense erosion and desertification;
II. Water shortages and limited availability;
III. Degradation of water quality;
IV. Habitat destruction, loss of biodiversity and the deterioration of terrestrial and aquatic resources;
V. Losses from flooding and other natural disasters; and
VI. Deteriorating living conditions among the inhabitants of the basin and the loss of cultural resources.

On the basis of an extensive process of public consultation, a long-term action plan was prepared that was designed to not only to attack the fundamental causes of the critical environmental degradation affecting the basin, but also to promote sustainable development for communities in the region. This second phase was directed towards the implementation of the SAP and included four groups of priority activities that constitute the four components of the current project phase:

I. Institutional strengthening and the development of an effective legal and institutional framework for integrated planning and management of water resources;
II. Protection and rehabilitation of the environment;
III. Sustainable development of natural resources; and
IV. Promoting public awareness and participation and replicating project activities in other regions of the La Plata River basin.

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For each of these four broad components, there are a number of sub-projects (a total of 34) that are being implemented by various executing agencies, including consultants, universities, government agencies and NGOs. The SAP project coordination unit has offices in both countries (Tarija and Buenos Aires) and, on the Argentinean side, there is now a local office in the city of Salta. There are technical teams in each of the countries responsible for planning, outsourcing and supervising the execution of the sub-projects.

The Bermejo SAP project has an estimated cost of US $19.77 million[1] and a duration of about 4.5 years (June 2001 - November 2005), which means that the project is now well past its midpoint.

[1] Of which the GEF is contributing $11.04 million, the governments $8.43 million, and the UNEP and OAS the remaining $0.30 million.

This report presents the mid-term evaluation of the Bermejo River SAP Project as specified in the ProDoc.

2. MID-TERM EVALUATION PROCEDURE

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This mid-term evaluation follows the terms of reference (TOR) provided by UNEP, the guidance provided by the evaluation Team Leader, J Michael Bewers, and basic considerations agreed upon during the evaluators' meeting held in Brasilia in October 2004.

For the purposes of this mid-term evaluation, several documents were reviewed. These documents were provided by UNEP, OAS, GEF, the Regional Commission for the Rio Bermejo (COREBE) and the Binational Commission for the Development of the Upper Bermejo River and Grande de Tarija River Basins (COBINABE).

These documents included the following:

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- The Project Document (ProDoc) for the Bermejo Project;
- The Transboundary Diagnostic Analysis (TDA);
- The Strategic Action Program for the Bermejo River Basin (SAP);
- Financial Reports;
- Consultants´ Reports; and
- Documents from workshops (on topics such as risk management, hydrometeorological network, etc.)

In order to conduct a more effective mid-term evaluation, a field mission was undertaken to permit visits to several demonstration sites and to interview relevant actors involved in the activities developed within the project. The field mission took place from December 6 to December 17, 2004.

Several meetings with the technical teams and consultants from both countries took place in Buenos Aires, Salta and Tarija. A list of all the persons met during the mission is given in Annex 1.

More than 30 PowerPoint presentations were provided by technical teams, consultants, NGOs, and local groups (*e.g.,* Women of Tilcara).

Several field trips were conducted to observe directly the progress of different erosion and sediment control works at strategic points in the watershed as well as other projects being conducted within the framework of the SAP such as the Hydrometeorological Network.

These included visits to the following locations.

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1) Tilcara, Argentina: Plant Nursery, Piedmont Erosion Control Works, Land Management Plan, activities of the Women of Tilcara, etc. on the Huasamayo River.
2) Iruya, Argentina: Construction of River-Bed Control Structures, Bank-Erosion Protection Structures, Waste Treatment System, Rain Water Drainage System, Irrigation Canals, School, etc. on the Iruya River.
3) Hydrometeorological Stations on the Bermejo and Rio Grande de Tarija Rivers, Argentina-Bolivia.

4) Calderas, Bolivia: Sediment Control in the Santa Ana River basin.
5) Santa Ana, Bolivia: San Jacinto Reservoir and Irrigation System.
6) Churquis and Pampa Redonda, Bolivia: Sediment Control in Tolomosa-Mena River Basins.
7) Tarija, Bolivia: Construction of building for COBINABE.
8) San Lorenzo, Bolivia: Environmental Cleanup of the Guadalquivir River.

Two workshops were being conducted at the time of the field mission. The first workshop was given by consultants (EVARSA) at the COREBE office in the city of Salta to train technicians from government agencies in the operation of the Hydrometeorological Network implemented as part of the SAP. The second workshop, on Flood Risk Management, was held at the school of Iruya and was organized by the Civil Protection Division of the Province of Salta, under the auspices of the Bermejo SAP project. People participating in both workshops were informally interviewed to gather their opinions about the workshops in general as well as the quality of the presentations.

3. MAJOR PROVISIONS OF THE PROJECT DOCUMENT

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3.1. Project Goals

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The primary objectives of this GEF International Waters project are to assist the governments of Argentina and Bolivia in addressing the root causes of the principal environmental problems affecting the Bermejo River basin with a focus on their main transboundary manifestations - namely, sediment erosion, transport, and deposition - and to promote the sustainable development of the Bermejo River Binational Basin (BRBB).

Activities for the control of land degradation caused by agricultural activities, the prevention of erosion, and sediment control (including: the creation, restoration and protection of natural vegetated areas; the conservation of aquatic and terrestrial habitat; support for popular participation in the management of natural resources through improved access to information and enhancement of public awareness; and the control of water-borne contaminants) have been selected in order to catalyze the implementation of specific actions as recommended in the formulation of the SAP.

3.2. Project Components:

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The proposed project activities are designed to catalyze the implementation of actions necessary to address the root causes of priority transboundary problems identified during SAP formulation with primary focus on soil degradation and sediment transport. The project activities are designed to implement an integrated programme of river basin management in the BRBB and are concentrated in four principal components outlined below.

3.2.1. Component 1: Institutional Development and Strengthening for Integrated Water Resources Planning and Management

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This component was designed to provide a broadly-based, participatory and institutional framework. This includes developing and strengthening the legal basis underlying the regulation, planning, and environmental and social evaluation, environmental zoning, and economic and financial arrangements that are indispensable for effectively implementing

sustainable measures for prevention, restoration, planning, and development of the natural resources identified in the SAP.

3.2.2. Component 2: Environmental Protection and Rehabilitation

This component was designed to extend the implementation of feasible measures of basin management identified during the formulation of the SAP. The activities programmed for this component address specific transboundary aspects identified in the TDA. In particular, planned actions focus on soil management and sediment transport control, either by means of feasible specific prevention and control measures or by preserving the natural landscape in critical, erosion–prone areas through the consolidation of protected areas. Complementary basic natural resource studies and the maintenance of the quality of the basin's water resources are parts are included in this component.

3.2.3. Component 3: Sustainable Development of Water Resources

This component encourages the implementation of alternative production modes that are environmentally friendly or that, at the least, minimize environmental degradation, especially land degradation and soil erosion, while at the same time providing greater economic opportunities for local populations in a context of integrated management of water resources and sustainable development planning for the basin as a whole.

3.2.4. Component 4: Public Awareness, Participation and Replication of the Project Activities

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This component embraces activities to identify and coordinate the interests of people and organizations with economic and/or institutional responsibilities in the basin, including those within the agricultural and private industrial sectors. A central theme of this component is to inform the citizenry, including corporate entities, within the basin through an integrated programme of environmental education, institutional transparency and the exchange of information among communities, organizations, and government agencies. In this component, actions are considered for sharing experience and promoting international and regional cooperation aimed at identifying mechanisms that will enhance positive synergies at the broader level within the Plata River basin.

4. CURRENT STATUS OF PROJECT

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This project was intended to be executed in 4.5 years with a commencement date of June 2001 and completion date of November 2005. Most of the project components have made steady progress towards meeting their goals and it is expected that the SAP implementation project can be completed as planned. However, because of the nature of some activities, a few sub-projects will most likely need more time to achieve their objectives. For instance, more time will be needed to observe and to monitor the performance and impact of certain activities. This is definitely true in the case of structural and non-structural approaches to erosion and sedimentation control because both hydrologic and sedimentological time scales are rather long when compared with the lifetime of the project.

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Basin stakeholders visualize this project as a "*short-term*" SAP that has the potential to serve as a catalyst for the preparation of a much larger "*long-term*" SAP for the Bermejo River Binational Basin. Because of the characteristics of the Bermejo River basin and its relevance to the region, it is apparent that the only way to establish an integrated and sustainable river

basin management programme will be over many years of work. The current implementation of the SAP provides a good foundation for the development of a longer-term SAP.

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5. PROJECT PERFORMANCE TO DATE

5.1. Evaluation of Project Components in the Context of the ProDoc Workplan

The mid-term evaluation for the project components in the context of the ProDoc are based on the information provided in Section 2 above. Each component of the project is evaluated separately for consistency with the ProDoc.

5.2. Evaluation of Project Components

5.2.1. Institutional Development and Strengthening

Institutional strengthening is one of the most important aspects of this project. Changes in government usually wreak havoc in programmes like this one, it is therefore important to ensure that, despite political changes, SAP implementation will continue to move forward. A good deal of effort has gone into the strengthening of the Comisión Binacional del Río Bermejo and Rio Grande de Tarija (COBINABE) and the Comisión Regional del Río Bermejo (COREBE).

Since January 2001, COBINABE has signed more than 30 agreements for collaboration with government agencies, universities and NGOs within the framework of the SAP. A list of all the agreements and the institutions and agencies involved is given in Annex 2.

A basin-wide Hydrometeorological Network (HN) has been implemented consisting of 12 sub-stations. The network will collect meteorological (precipitation, temperature, humidity, etc.) and river flow (discharge, water elevation) data on a continuous basis. It will have two operational centers, one in Tarija, Bolivia and the other in Oran, Salta.

COBINABE has now an office in the city of Salta and COREBE has representatives in all the provinces in the basin. This is an important initiative because it has augmented the operational capacity and has centralized many activities closer to the area where the sub-projects take place. The Salta office will house the database for the Hydrometeorological Network. It will also, in the future, serve as the centre from which the Civil Protection Division of Salta will issue flood warnings.

A new building is also being constructed in Tarija, Bolivia, for the Oficina Tecnica Nacional (OTN) that will be shared with the Pilcomayo River Basin Technical Office (PNUMA 2200). This is relevant as the Bermejo and Pilcomayo River Basins share many similarities making it possible to optimize the use of resources (computer centre, field equipment, demonstration projects, etc.). As stated above, one of the operational centers for the Hydrometereological Network will be located in the new OTN.

Two water quality laboratories have also been created, one in Chaco, Argentina, and the second in Tarija, Bolivia (PNUMA 2202). Given that water quality is a major issue, both laboratories will be providing a very important service to the inhabitants of the region while

generating an important benchmark database on water quality that will be very useful for future project evaluations.

The international nature of the SAP for the Bermejo has facilitated the interaction between the Governments of Argentina and Bolivia. There is evidence that Bermejo SAP project is being used to discuss the role of government and potential legislation to satisfy the goals of the SAP. The development of a Regional Coordination Committee, a Regional Steering Commission and an Inter Ministry Committee has strengthened the actions of the SAP and other organizations within the basin.

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Recently, the Governments of Argentina and Bolivia, motivated by trade negotiations about natural gas, have declared their mutual interest in going ahead with the construction of one three planned large dams near the border between both countries. This has created even more interest in the activities conducted within the project and has brought more visibility to COBINABE. However a word of caution is necessary here. Due to the high sediment loads in the Bermejo watershed the useful life of a reservoir can be drastically reduced, rendering the impoundment useless in just a few years of operation. Thus before an investment of such magnitude is made to construct a dam, a very thorough sedimentation analysis should be conducted to assess the potential sedimentation of the reservoir (Garcia, 1999).

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5.2.2. Environmental Protection and Rehabilitation

5.2.2.1. Soil Management and Erosion Control in Critical Areas

Sedimentation basins have been built to trap sediments in the watershed of the Santa Ana River, Bolivia (PNUMA 2208). They have been quite efficient in capturing substantial amounts of debris and sediment (see Figure 2). At the same time, these small impoundments have provided much-needed water to the local people for irrigation of crops and livestock. As the basins fill up with sediment, the local peasants use them as agricultural plots. This activity increases the protection of the soil against further erosion.

In the Tolomosa (Mena sub-basin) River Basin, a number of low-head dams have been built with gabions having the goal of curtailing sediment erosion and preventing the silting of the San Jacinto Reservoir (PNUMA 2207). During an intense rainfall event that took place during the site visit, the dams were observed to perform quite well. The water impounded by the dams is also being used for irrigation of crops in areas were water is extremely scarce.

Figure 2. Sedimentation Basin in the Santa Ana River Basin, Calderas, Bolivia

Figure 3. Sedimentation Basin in the Santa Ana River Basin, Calderas, Bolivia

The rates of soil erosion in this region are amongst the highest in the world. Accordingly, the sediment erosion control measures implemented so far can be considered a success.

Several activities are also underway in the Iruya River basin as part of the SAP implementation (PNUMA 2209). Here the situation is more complicated because erosion by the Milmahuasi River is endangering a large number of houses perched atop of one of its margins (Figure 4). The city of Iruya is located at the confluence of the Milmahuasi and the Colanzuli Rivers. Taking advantage of a geological hardpoint (fulcrum), a control structure (rock water fall) is being built to prevent further lowering of the riverbed along the Milmahuasi. Riverbed sills and streambank protection structures have also been built along the Colanzuli River following the recommendations of an Italian expert (Filippi-Gilli, 2002). While the activities conducted under the SAP project are helping, it is clear that a lot more

work is needed in Iruya before the situation can be considered under control. For instance, the drainage of rainwater from houses and streets in the city promotes the erosion of soil where the city stands. This needs immediate attention before matters get worse. A large portion of the city, previously used for agricultural land, has already been scoured away by the combined erosive action of the Milmahuasi and Colanzuli Rivers. This erosive process will continue its course, eventually endangering the whole town of Iruya and its people.

Fig. 4. Upstream view of Milmahuasi River (Iruya). Notice houses perched atop the right margin of the river

The city of Tilcara, Jujuy, has erosion and sedimentation problems as a consequence of its location on an alluvial fan. It sits at the confluence of the Grande and Huasamayo Rivers. As part of the SAP project, several erosion prevention measures have been implemented. They include reforestation of eroded areas and construction of erosion control structures (see Figure 5). While the structures have been built correctly, population growth has been such that in the case of an extreme hydrologic event, these structures will capture sediment but flooding will be unavoidable because people have been building houses right next to, or downstream of, the erosion control installations.

Urban planning is a major issue in Tilcara with many conflicting interests at play. Land use should go hand-in-hand with soil erosion and flood control measures given that the city is located on an alluvial fan. To make matters worse, the bed of the Huasamayo River is progressively aggrading so that, before too long, the mean ground elevation of some areas in Tilcara could very well be below the riverbed elevation. This could be a disaster during a major flood and the topic needs immediate attention as the number of tourists as well as the local population continues to increase. Several land use plans have been made by universities and NGOs. However no consensus seems to be within reach. Local grass roots efforts (*e.g.,* by the Women of Tilcara) seem to be the most effective way to get input and help from the local population (PNUMA 2202).

One of the most positive activities taking place within the project in Tilcara is the tree and plant nursery project (PNUMA 2210). This project involves the participation of several members of the community and has a very important educational component. The plants and

trees are transplanted and used to reduce soil erosion in Tilcara, Iruya, and at other locations throughout the watershed. Produce from the vegetable garden is used to feed low-income families and more than one hundred children every day at the dining rooms tended for by women volunteers adjacent to the nursery.

Figure 5. Piedmont erosion control structures in Tilcara, Jujuy.

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5.2.2.2. Consolidating Protected Areas and Protecting Biodiversity

The consolidation of the Ecologic Corridor Tariquia-Baritu-Tariquia can be considered as one of the main milestones of SAP-Bermejo project (PNUMA 2214). This is a high visibility project that allows for the participation of government agencies, local communities and NGOs.

Ecotourism is being explored along the piedmont of the National Parks of Calilegua and El Rey (PNUMA 2211). Questions remain as to the infrastructure requirements for such a growing industry. Excellent progress has also been made with the Yungas project in the provinces of Salta and Jujuy as well as the Biological Reserve of Sama in Bolivia (PNUMA 2215). The biodiversity of these areas is globally unique and they must be protected at all costs. The Yungas project has already attracted financial help from several national and international agencies, including the French Government. The fact that the ProYungas Foundation has worked in the area for more than a decade has had an important positive influence on this SAP project component.

The Presidents of Argentina and Bolivia have expressed their full support for the Transboundary Biological Reserve of the Yungas (PNUMA 2214) and have declared this project of binational importance.

A plan for the preservation and management of the Biological Reserve of Sama, Bolivia, has been formulated and approved (PNUMA 2215). A study of biodiversity on the Bolivian side of the Bermejo River basin is also making steady progress (PNUMA 2213). A demonstration project on the fixation of carbon in the sub-Andean region is its design phase (PNUMA 2212).

5.2.2.3. Protection and Restoration of Water Quality

Pilot water treatment plants have been installed in rural communities near the town of Tomatitas, Bolivia, with the goal of cleaning-up the Guadalquivir River (PNUMA 2218). The water treatment system includes a system of trenches in the ground coupled with irrigation canals. So far, the clean-up effort has been very effective. The Guadalquivir River affords many recreational opportunities to the citizens of Tarija and its surroundings. This environmental clean-up effort has great potential for replication in many small rural communities throughout the Bermejo River basin.

There is a clear need for the project to finalize the assessment and design phase and to move ahead with the construction of water pollution control facilities in the area of the Bermejo Triangle, where currently all the waste water, both human and industrial, goes into the Bermejo and Rio Grande de Tarija Rivers without undergoing any type of treatment (PNUMA 2219).

The city of Iruya has successfully implemented a solid waste treatment system just outside the town that indirectly helps in improving water quality in the town (PNUMA 2209). The town has its own small water treatment system for treating water prior to its release to the Colanzuli River. No chlorination of the treated water seems to be taking place at this time so there still remains some level of biological contamination. This could pose risks to small communities downstream of Iruya that may be using river water for human consumption.

5.2.3. Sustainable Development of Natural Resources

5.2.3.1. Implementation of Planning Framework for Integrated Water Resource Management and Sustainable Development

Formulation and development of an Integrated Water Resource Management and Sustainable Development Plan (IWRMP) constitutes one of the biggest challenges for the SAP project. While progress has been made in terms of information gathering and dissemination, studies, analyses, sharing of experience and demonstrations, it is fair to say that the implementation of an IWRMP in the Bermejo River is still in its early stages. The implementation of such an important framework for decision-making should be given high priority at this stage. However, this undertaking hinges on the development of most of the activities under the SAP project, particularly institutional strengthening, so it can be expected that an integral plan might not be produced prior to the completion of the project.

5.2.3.2. Sustainable Practices for Rehabilitation of Degraded Areas in the Chaco and Yungas Regions

The ProYungas Foundation has leveraged the support from the SAP project (PNUMA 2222) and from other programmes to develop a project geared towards: a) strengthening community organizations (*e.g.,* mothers clubs and producers groups); b) sustainable agricultural production (community plant nurseries, fruit cultivation, irrigation systems, apiculture, forestation, etc.); c) production and commercialization of local artwork (*i.e.,* artesanias); and d) participation of local and native communities.

A great deal of effort has also gone into helping rural communities, including the Wichi Indians, along the Chaco region of Salta (PNUMA 2224). This area presents some unique challenges but progress is being made mainly through the education of children at Technical School No 29 "*Justo Pastor Santa Cruz*". The main objective here is to improve the living conditions of the native people and to ensure that these remote communities can become self-sustaining through sustainable agricultural practices, including swine production and the exploitation of unique forest products such as the Algarrobo that yields one of the most popular woods for furniture making. Harsh climatic conditions make working conditions very difficult in this region of the Bermejo River Basin. Water is a precious commodity here and, when it rains, sediment erosion is exacerbated by the lack of vegetative cover.

5.2.3.3. Community Extension Programmes for Sustainable Production and Natural Resource Management

This is an area where progress is being made by encouraging families in various communities to get involved in different activities. For instance, the ProYungas Foundation (PNUMA 2222) reports that, in the field of agricultural production, the degree of family participation is comparatively high (Lipeo 100%, Baritú 100%, Los Toldos 37%, Los Naranjos 100%, San Andrés 15%).

5.2.3.4. Sustainable Agriculture and Soil Conservation Practices along the San Jacinto Project Area

The design phase of this component has been completed (PNUMA 2225). Irrigation canals, as well as erosion control structures, will be built. Demonstration projects will be set up in 5-hectare land parcels. Local communities are very enthused with this project since it gives them an opportunity to become self-sufficient.

5.2.3.5. Securing Financial Resources for Bermejo River Basin Management

Non-reimbursable loans from the Comision Andina de Fomento (CAF) have been negotiated by COBINABE. The ProYungas Foundation has obtained additional support for its activities within the framework of the SAP from the French Government.

The Prefecture of Tarija will invest U$S 12,000,000 in infrastructure for the environmental cleanup of the Guadalquivir River (PNUMA 2218). The Prefecture has also expressed interest in supporting other projects within the SAP. There are several other projects (*e.g.,* irrigation of calderas and flood protection of Tarija) that have a good chance of receiving additional financial support.

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5.2.4. Public Awareness, Participation and Replication of Activities

Public awareness has been a trademark of the project since the very formulation of the Bermejo SAP project. This continues to be the case with the assistance of workshops, seminars and presentations (PNUMA 2228). A sticker with the legend "*Soy tu rio* (Bermejo), *cuidame*" helps the COBINABE in spreading the word about the Bermejo River and its relevance to the inhabitants of the basin.

A programme of Environmental Education has been designed in collaboration with the University "*Juan Misael Saracho*" in Bolivia (PNUMA 2227). When approved by the Ministry of Education, this will be the first programme of its kind in Bolivia.

An excellent teaching manual for elementary school teachers about the Bermejo River watershed was also produced under the implementation of the SAP project (PNUMA 2227). This publication is unique for it introduces young readers to water management issues within the Bermejo River Basin. More than 3,000 copies have been distributed.

The educational component of the Bermejo SAP project has great potential for replication in other watersheds of Latin America. It should become a model of how to generate environmental awareness among people of all ages (PNUMA 2228).

A school has been built in Colanzuli, with partial support from the SAP project. This construction includes a water supply system that is shared with local agricultural producers.

The implementation of the Hydrometerorological Network, consisting of pluviometers and streamflow gauges, among other instruments, has been completed (PNUMA 2231). An alert system for flooding is currently undergoing testing. This network forms part of a basin-wide information system for water resources management being implemented as part of the project.

5.3. Project Enhancement Beyond ProDoc Provisions

An interesting initiative between Argentina, Bolivia and Paraguay has added a new dimension to the Bermejo project that was not considered in the ProDoc provisions. This is the Yrendá-Toba-Tarijeño Aquifer, which covers an area of about 300,000 square kilometers. Until recently, most of the efforts were focused only on surface water resources. With this new initiative, groundwater resources will also receive much needed attention. At the same time, the global benefits of the Bermejo SAP project will become more apparent as the neighboring Pilcomayo River basin shares similar issues. Resources will now be shared more equitably between COBINABE and the Trinational Comisión of the Pilcomayo River thanks to the attention to the Acuífero Yrendá-Toba-Tarijeño. The European Union is also involved in this undertaking. Both groups will be housed in the same building currently under construction in Tarija, Bolivia.No other obvious enhancements beyond those stipulated in the ProDoc were observed as part of the MidTerm review.

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6. SUMMARY OF ACHIEVEMENTS AND PROGRESS TOWARDS OVERALL PROJECT OBJECTIVES

Achievements and progress towards overall project objectives can be summarized for each project component as follows.

6.1. Institutional Development and Strengthening

The development of a Regional Coordination Committee, a Regional Steering Commission and an Inter-Ministry Committee has strengthened the actions of the SAP project and organizations within the basin.

COBINABE has signed more than 30 agreements for collaboration with government agencies, universities and NGOs within the framework of the project.

COBINABE has now an office in the city of Salta and COREBE has representatives in all provinces in the basin.

A new building is almost finished in Tarija, Bolivia, for the OTN, which will be shared with the Pilcomayo River Basin Technical Office.

A basin-wide Hydrometeorological Network (HN) has been created that consists of 12 substations and will have operational centres in Oran, Salta and Tarija.

Water quality laboratories have been created, one in Chaco, Argentina, and the second in Tarija, Bolivia

6.2. Environmental Protection and Rehabilitation

Sedimentation basins built to trap sediments in the watershed of the Santa Ana River, Bolivia, have been quite efficient in capturing substantial amounts of debris and sediment. Local farmers are benefiting from this basins as they provide both water for cattle as wells as new plots of land to grow vegetables.

Several low-head dams have been built in the Tolomosa River Basin, Bolivia, with the goal of curtailing sediment erosion and preventing the siltation of the San Jacinto Reservoir.

A control structure has been built to prevent further lowering of the riverbed along the Milmahuasi River in Iruya, Salta. Riverbed sills and streambank protection structures have also been built along the Colanzuli River. **More work is needed here to prevent further damage to the city since the current activities are not be enough to control the lateral migration of the river towards the city. The city of Iruya and its people are in imminent danger.**

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In the City of Tilcara, Jujuy, which sits at the confluence of the Grande and Huasamayo Rivers, several sediment erosion prevention measures have been implemented. They include reforestation of eroded areas and construction of erosion control structures to reduce sediment transport during extreme hydrologic events. A land use plan accepted by all the stakeholders needs to be developed. As explained above the city is located in an alluvial fan, making it vulnerable to mudflows and floods.

The plant and tree nursery in Tilcara has both involved the local community and provided much needed vegetation to protect areas at risk of severe erosion.

The consolidation of the Ecologic Corridor Calilegua-Baritu-Tariquia is one of the main achievements of the SAP-Bermejo project. This is a high visibility activity that allows for the participation of government agencies, local communities and NGOs.

Ecotourism is being explored along the piedmont of the National Parks of Calilegua and El Rey. This is a promising undertaking since it could bring much needed investment for infrastructure to the region.

The Presidents of Argentina and Bolivia have expressed their full support for the Transboundary Biological Reserve of the Yungas and have declared this project of binational interest. Developments in this area should be followed closely in the context of energy issues (i.e. natural gas) in the region.

A plan for the preservation and management of the Biological Reserve of Sama in Bolivia, has been formulated and approved by the Bolivian Government. This is important given the political instabilities observed in the government.

Pilot water treatment plants have been installed in rural communities near the town of Tomatitas, Bolivia, with the goal of cleaning-up the Guadalquivir River. These plants will serve as models for other remote communities in the region, which currently lack water treatment facilities.

The city of Iruya has successfully implemented a solid waste treatment system just outside of the town that indirectly helps in improving water quality in the town. Other communities in the area (e.g. San Isidro) might follow the example of Iruya and build similar infrastructure.

6.3. Sustainable Development of Natural Resources

The ProYungas Foundation has leveraged the support from the SAP with support from other organizations to develop a program geared towards: a) strengthening of community organizations; b) sustainable agricultural production; c) production and commercialization of local artwork; and d) participation of local and native communities. Of all the projects reviewed this is the one that clearly shows success in terms of attracting support from a number of national and international organizations. It is important to recognize that the ProYungas Foundation activities predate the SAP project.

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A substantial effort has gone into helping rural communities, including the Wichi Indians, improve their living conditions though sustainable development in the Chaco region of Salta. This project needs more financial support since the funding they are receiving does not commensurate with the magnitude of the water and sanitary problems of these Indian communities.

Non-reimbursable loans from the Comision Andina de Fomento (CAF) have been negotiated by COBINABE to support sustainable development. However is not clear how successful these negotiations have been and what project within the SAP will benefit form such loans.

The Prefecture of Tarija will invest several million dollars in infrastructure for the environmental clean up of the Guadalquivir River, a major recreational resource for Tarija and its suburbs. There are several other projects (*e.g.,* irrigation of Calderas and flood protection of Tarija) that have a good chance of receiving financial support. In addition, a portfolio has been prepared with a list of projects for support by potential donors. This initiative by the Bolivian office of COBINABE could be emulated by it Argentinean counterpart.

6.4. Public Awareness, Participation, and Replication of Activities

Public awareness has been a hallmark of the project since the formulation of the Bermejo SAP. This continues to be the case through the medium of workshops, seminars, and presentations.

A program on Environmental Education has been designed, which is the first of its kind in Bolivia. It is pending approval by the Ministry of Education.

An excellent Teaching Manual for elementary schools teachers about the Bermejo River watershed was also produced under the implementation of the SAP. This publication is special since it introduces young readers into water management issues within the context of the Bermejo River basin. This activity adds an element of replicability that is very important for global benefits.

The educational component of the Bermejo project has great potential for replication in other watersheds of Latin America. It should become a model of how to generate environmental awareness among people of all ages.

6.5. Additional Benefits

At the time of the MidTerm evaluation it is not easy to identify additional benefits not considered in the ProDoc.

7. OVERALL CONCLUSIONS AND RECOMMENDATIONS

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Overall, project implementation is making steady progress towards satisfying its objectives. The underlying issue that permeates all the activities of the Bermejo SAP project is sediment erosion, transport and deposition. Sediment dynamics in the watershed constraints land use development and reduces the lifetime of infrastructure such as roads, bridges and water supply reservoirs. This does not mean that there are no other important problems (*e.g.,* sustainable development), but the fact is that excess sediment is the most pervasive characteristic of the Bermejo River and its tributaries. Dealing with this sediment management problem head on will result in local as well as global benefits. It then becomes necessary to examine the sediment problem in a global context in order to assess the potential benefits of the Bermejo River SAP.

In a book written by Eckholm (1976) contended "*excess sediment is the major form of human-induced water pollution in the world today and exacts a heavier cost…possibly more than all other pollutants combined*." Similar sentiments have been used to emphasize the importance of problems of loss of reservoir storage due to sedimentation (*e.g.,* Mahmood, 1987), the off-farm impact of eroded sediment (Clark *et al*., 1985), the role of sediments in the transport of contaminants (Novotny and Chesters, 1982), and various other environmental and operational problems associated with enhanced suspended sediment transport in rivers. These include biological and recreational impacts, as well as the sedimentation of navigational channels and harbors. These problems have a very significant economic dimension; for example, Clark *et al*. (1985) estimated that the annual economic cost of off-farm sediment problems in the United States was of the order of US$ 6.1 billion at 1980 prices and similar calculations undertaken in South Africa by Braune and Looser (1989) have estimated the cost of off-site damage caused by soil erosion to be of the order of US$ 36 million. Both of these estimates exclude less tangible environmental damage and degradation, which as in the case of the Bermejo River Basin is extremely difficult to quantify. They therefore are likely to be underestimates of the true cost of soil erosion. While

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is true that most of the erosion in the Upper Bermejo River basin is due to the geologic and climatic characteristics of the region, in some areas of the watershed human activities have accelerated the process of soil erosion and land degradation. Such is the case of the Iruya River, which constitutes the major contributor of sediment to the Bermejo River (Rafaelli, 2003). Originally the Iruya River flowed into the Blanco River, but the inhabitants of Oran, Salta, afraid of damaging floods changed the course of the Iruya River connecting it to the Pescado River with a makeshift channel around 1860. The present situation can be observed in Figure 1, where also the Blanco River and Oran are seen. The exact date of the works remains unknown but by the first flood in 1865 the Iruya River already flowed into the Pescado River instead of the Blanco River. As a result, the Iruya River started flowing into a lower level downstream, triggering a process of riverbed degradation that started traveling upstream as the river attempted to adjust its bottom gradient. Such degradational process has not reached an equilibrium slope to this date and is the cause of many of the problems the city of Iruya has today as mentioned above. This is an example of a local "river engineering" project that has impacted the dynamics of sediment in the Bermejo River for more than a century and will continue to do so unless it receives attention (Perez-Ayala et al., 1998).

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The Bermejo River Basin constitutes a "natural laboratory" where much can be learned about erosion and sedimentation at the watershed scale as well as within a global context as presented above. As explained in the introduction to this report, the sediment erosion rates observed in the Bermejo River Basin are among the highest in the world, so much so that the basin exports more than 100 million tons a year into the Parana-La Plata River system. It is clear that a sediment management program could have a positive impact both at the local level, where most of the SAP erosion control measurements are implemented (i.e. Iruya, Tilcara, San Jacinto, etc) and lateral channel migration damages roads and leaves water intakes high and dry (i.e. Lower Bermejo), and at the global level where the Bermejo River sediments have a definitive impact as well (i.e. La Plata River, Atlantic Ocean). It is important to realize that the Bermejo sediments also play a very important role in the ecosystem and floodplain dynamics along the Parana River in their journey towards the Atlantic Ocean. Sediment transport during extreme hydrologic events, such as the debris flows and mud floods commonly observed in Iruya and Tilcara, also has an impact on important infrastructure such as water intakes, bridges, highways, and pipelines. (Brea and Spalletti, 2003).

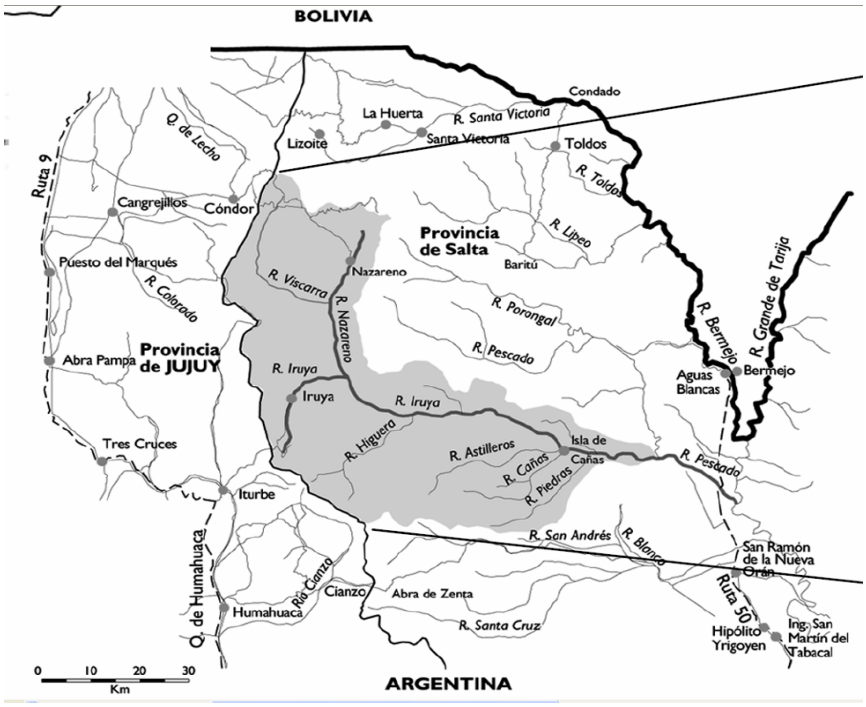

Figure 1: Detail of Upper Bermejo basin focusing on Iruya River (Rafaelli, 2003).

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The main recommendations resulting from this mid-term evaluation are the following:

1) All the activities conducted under the SAP framework should continue to receive financial support, as they are all very relevant to the success of this project. All the project components are making good progress and are contributing to the overall objectives of the project.

2) Project coordination should be improved so that progress can be made in all fronts of this challenging undertaking. Measures should be implemented (*e.g.,* timely release of funds, progress reports, etc.) to ensure that steady progress is made in all the sub-projects so that the project can be completed in a timely fashion. Quarterly meetings should be implemented to integrate all the subprojects and to ensure that progress is being made accordingly. A website listing all the SAP projects and their ongoing activities should be developed. This will also facilitate the work of future review missions.

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3) An analysis should be conducted of the environmental and socio-economic impacts of erosion and sedimentation management for both the watershed scale (*i.e.,* the Bermejo River basin) and the global scale (*i.e.,* LaPlata River basin). The La Plata River basin covers 3,170,000 square kilometers in five countries and is the fifth largest in the world (Danilevsky, 1987). Something remarkable is that the Bermejo River basin covers only 123,000 km² (to be accurate only 3.9% of the La Plata River basin surface area) yet it contributes 95% of the total suspended sediment load that reaches the mouth of the La Plata River. It should be clear that the Bermejo River does have an global impact in term of sediment fluxes to the oceans (UNESCO, 1999; Syvitski et al, 2003).

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4) The Cities of Iruya, Salta, and Tilcara, Jujuy, could benefit from an in-depth alluvial fan and river morphodynamic analyses with the goal of increasing the level of protection against

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the existing risk of catastrophic erosion and flooding. This should be done sooner rather than later as the situation is quite critical in both cases, despite the positive measures that have already been taken, or are under development, within the rubric of the Bermejo project.

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5) A hydro-sedimentologic model for the prediction of the erosion, transport and fate of sediment in the Bermejo River basin should be developed, calibrated and validated with the observations made with the recently installed hydrometeorological network as well as existing historical data. Such a model would provide a management tool to assess sediment dynamics within the basin and predict the effect of potential erosion control measures in the upper watershed (*i.e.,* sedimentation reservoirs) as well as on the river morphodynamics (*i.e.,* meandering, lateral migration and channel avulsion) in the lower watershed. The hydro-sedimentological model should also account for mass sediment transport phenomena such as debris flows and mud floods that are commonly observed in the upper watershed of the Bermejo River (Brea and Spalletti, 2003).

6) A GIS-based "*Sediment Yield Map*" should be developed for the Bermejo River basin, similar to the one produced for Southern Africa by Roseboom and Lotriet (1992). Such a map would greatly facilitate sediment erosion control and management as well as land use planning and soil conservation. Much of the data and information needed to develop a map are already available (e.g. Rafaelli, 2003).

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8. LIST OF ANNEXES

Annex 1: Persons Interviewed During the December 2004 Field Mission

Annex 2: Institutional Agreements made by COBINABE

9. RATING OF PROJECT SUCCESS TO DATE

As requested in the TOR, the midterm evaluation needs to include ratings of several aspects of the SAP Bermejo. Following the guidelines provided in the TOR and based on the material presented above, the following ratings are given in table format for the overall SAP project to date:

Project Aspect	Rating
Timeliness	2
Achievement of Results and Objectives	1.5
Attainment of Outputs	1.5
Completion of Activities	1.5
Project Executed within Budget	1.5
Impact Created by the Project	1
Sustainability	1.5
Stakeholder Participation/Public Involvement	1
Monitoring and Evaluation	2
Overall Rating	**1.5**

10. SUSTAINABILITY

For a project to be sustainable it has to work along with nature. There are several components of the SAP Bermejo project that meet this condition. For instance, the "Tariquia-Baritu-Calilegua Ecological Corridor" and the Biological Reserve of Sama in Bolivia" are both candidates for the sustainable development of ecotourism. On the other hand, activities associated with sediment management will facilitate development and the longevity of infrastructure such water supply reservoirs, roads, water intakes, and gas pipelines but will, most likely, not be sustainable since it will be a constant battle with the nature.

11. REPLICABILITY

Most of the components of this project can be replicated along the Andes region since the problems and challenges with water/sediment management are very similar. The educational component of the Bermejo project should be used as a model of how to educate and engage communities on watershed management issues throughout Latin America.

12. OVERALL EFFECTIVENESS OF PROJECT COORDINATION AND MANAGEMENT

The overall effectiveness of the project coordination and management was found to be excellent in Bolivia. On the other hand, the much larger geographic area covered by projects that are coordinated from two different technical offices located both in Salta and in Buenos Aires, makes the project coordination and management much more difficult and consequently

less effective in Argentina. A field office in the Lower Bermejo area could help in this regard since there would be more opportunity for direct contact with the people working in remote areas. Recommendation 2 above gives some suggestions about additional measures that could be taken to improve the overall effectiveness of the project management.

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13. APPROPRIATENESS OF PROJECT MANAGEMENT/COORDINATION COSTS IN RELATION TO THE COST OF SUBSTANTIVE ACTIVITIES

The cost associated with project management and coordination in relation to the cost of the rest of the activities seems adequate. However there are several small projects in Argentina that could use more financial support and perhaps this could be accomplished, for instance, by reducing some of the administrative costs associated with the two technical offices as mentioned above. It seems that the people working in remote areas of the watershed, where the largest impact of the SAP substantive activities can be expected, could use more guidance and support.

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ANNEX 1

Persons and Groups Interviewed During December 2005 Mission

Argentina
Amb. Julio San Millan
Edgardo Sosa
Carlos Brieva
Daniel Brea
Claudio Daniele
Rita Jordan

Marta Odriozola
Graciela Adan
Adolfo Larran
Oscar Dean
Elisa Cozzi
Rafael Lopez Diaz
Mario Montero
Edgardo Castellanos
Jorge Pilar
Carlos Diez San Millan
Susana Chalabe
Patricia Lopez Saenz
Maria Ester Altube
Alejandro Brown
Hugo Infante
Fernando Carbone
Women of Tilcara (grassroots organization)
Mayor of Tilcara
School Teacher and Students, Iruya, Salta
School Teachers in Colanzuli, Salta
Risk Management Workshop Instructors and Participants in Iruya, Salta
Hydrometeorological Network Workshop Participants in City of Salta
ProYungas Foundation Members
EVARSA Consultants

Bolivia
Gabriel Gaite
Alfonso Vacaflores
Amado Montes
Mario Solis
Humberto Alzerreca
Daniel Canedo
Remy Kilibarda
Ronald Pasig
DHV Consultants
AGROSIG Consultants
COTED Consultants