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PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED GRANT FROM THE
GLOBAL ENVIRONMENT FACILITY TRUST FUND

IN THE AMOUNT OF USD {US$6.9} MILLION

TO THE

ANDEAN COMMUNITY OF NATIONS (CAN)

FOR A

ADAPTATION TO THE IMPACT OF RAPID GLACIER RETREAT IN THE TRPOPICAL ANDES PROJECT

{April 25, 2007}

CURRENCY EQUIVALENTS

(Exchange Rate Effective {Date})

Currency Unit	=	
	=	US$1
US$	=	SDR 1

FISCAL YEAR

January 1 – December 31

ABBREVIATIONS AND ACRONYMS

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ANDEAN COUNTRIES
Adaptation to the impact of rapid glacier retreat in the tropical Andes

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I. STRATEGIC CONTEXT AND RATIONALE

A. Country and sector issues

1. Climate change represents a global challenge and is caused by accelerated increases in greenhouse gas concentrations in the atmosphere. The Fourth Assessment Report, Summary for Policy Makers of the Intergovernmental Panel for Climate Change (IPCC-SPM 2007), concluded that the global average surface warming following a doubling of carbon dioxide concentrations over pre-industrial levels, is *likely* to be in the range of 2 to 4.5°C with a best estimate of about 3°C, and is *very unlikely* to be less than 1.5°C. A temperature increase of this magnitude is unprecedented. The report also indicates that current CO_2 concentration in the atmosphere in 2005 exceeded by far the natural range during the last 650,000 years. Doubling of CO_2 is now expected to occur within this century. The IPCC's Third Assessment Report summarizes the anticipated climate changes, including warmer temperatures, alterations of the hydrological cycle, drier soils, changes in weather extremes, rising sea levels, changes in agricultural productivity and ecosystem composition. Many of these changes will restrict access to natural resources and environmental goods and services, ultimately affecting both ecosystem stability, and human well-being.

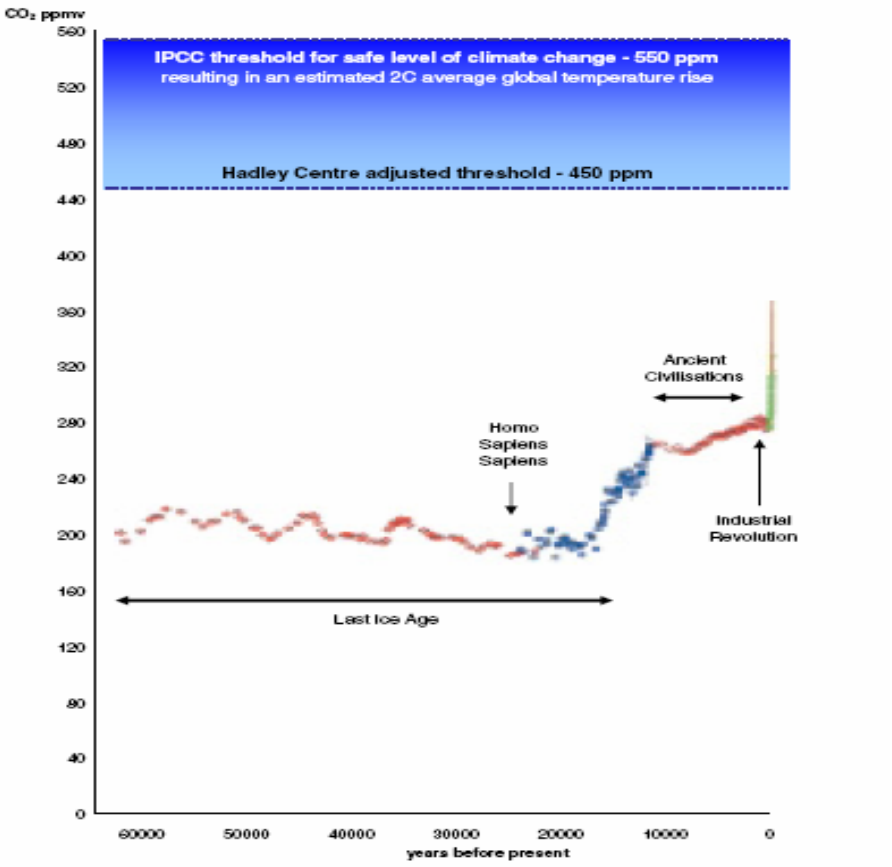
2. **Recent research shows that climate change will be even more pronounced in high-elevation mountain ranges** (Bradley et al. 2006). While much attention has been paid to climate change in the polar region, those mountains that extend into the troposphere have been warming faster than adjacent lowlands. Thus, heavily populated, high-elevation areas in the tropics, such as the tropical Andes, are now experiencing, and will likely continue to experience, dramatic changes in climate. In particular, global warming has been linked to the accelerated retreat of tropical glaciers in the Andes and to an increase in the weather variability and weather extremes affecting the Andean ecosystems with immense repercussions on ecosystem integrity and the welfare of local populations.

3. **Runoff from tropical glaciers plays a critical role in mountain ecosystem integrity and its reduction will have lasting and pervasive implications for water supply in the Andes.** In the Andes, runoff from glaciated basins is an important element of the regional water budget, and is essential to the integrity of mountain ecosystems. Many Andean valleys are seasonally dry and depend on glacier runoff to maintain extensive mountain biomes. Specifically, glaciers play an important role in freshwater regulation in associated watersheds, assuring year-round water flows for agriculture, potable water, power generation, and the stability of mountain biomes. Thus, glacier retreat in the Andes places in doubt the sustainability of current patterns of water use and ultimately the viability of the economies and ecologies of glaciated basins, and may also have wider impacts on the entire Andes region. The changes induced by tropical glacier retreat constitute an early case of the need for adaptation and therefore an example of the type and size of associated economic and social impacts caused by climate change.

4. **The threat of changes in water supply associated with tropical glacier retreat has only recently received attention.** Global projections rely on models which, due to their coarse resolution, are inadequate to resolve the steep topography of long and narrow mountain chains, such as the Andes. As a consequence, climate change in high tropical locales is not well

simulated in these models. Indeed, when considering the rate of warming in the free troposphere (e.g., Bradley et al. 2004, 2006) rather than at the surface, it becomes evident that warming in the tropical Andes is likely to be of similar magnitude as in the Arctic, and with consequences that may be felt much sooner and that will affect a much larger population.

Figure 1. Concentration of CO2 in the atmosphere during the last 650,000 years



Source: EMCT, 2007

5. **The pace of glacier retreat has accelerated and thus requires urgent actions to understand and address its implications**. Field observations and historical records have been used to document the reduction of tropical glaciers over the length of the Andes. This information shows that glacier retreat rates used to be moderate but have accelerated in recent decades. Glacier retreat in the Andes is consistent both with upward shifts in the freezing point isotherm and the Equilibrium Line Altitude (ELA), where glacier accumulation balances with ablation. Thus, although sensitivity to temperature for specific glaciers is dependent on local climate characteristics, this retreat coincides with an overall warming of the Andean troposphere. Recent work done in the process of formulation of the proposed project indicate that global warming will induce a very rapid glacier retreat in the tropical Andes region that will further exacerbate changes already measured..

Figure 2. Rapid glacier retreat (1995–2003) of Glacier 15 at Antisana, near Quito

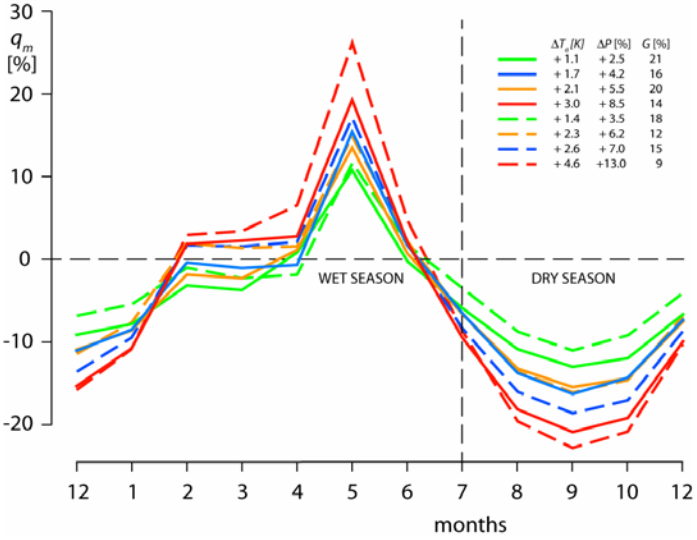
Source: Cartier 2007

6. Tropical glaciers in the Andes (those located between Bolivia and Venezuela) covered an area of over 2,940 km^2 in 1970 but declined to 2,758 km^2 in 1991 and to 2,493 km^2 by 2000. In Peru **alone**, glaciers covered an area of 2,041 km^2 in 1970 but had declined nearly 22 percent to 1,595 km^2 by 1997. The largest of these glaciers in the Cordillera Blanca have lost 15 percent of their glacier surface area in a period of 30 years. Many of the smaller glaciers in the Andes have already been heavily affected and others are likely to completely disappear within a generation. For example, the Chacaltaya glacier (located in Bolivia, see figure 5) has lost most of its surface area and may completely disappear by 2010 *(Francou et. Al., 2006)*.

7. Several glaciers in the region, such as Cotacachi in Ecuador, have already disappeared, providing an early glimpse of upcoming consequences. The area around Cotacachi has experienced a decline in agriculture and tourism and a loss of biodiversity. Waterless streams and a decrease in water levels have already led to water conflicts and these are expected to worsen with time.

8. **Glacier retreat will affect regional water supply.** Changes are expected in regional water supplies, including in areas that are already water short, placing millions of already economically and environmentally stressed ecosystems and inhabitants at further risk of inadequate supplies (Vergara et. al. 2007). Glacier retreat results in a temporary increase in runoff. Once glaciers, melt, water availability will be severely affected. For large urban centers such as Quito in Ecuador (pop. 2.0 million) where glaciers (Antisana and Cotopaxi in particular) supply one-third of Quito's drinking water, or La Paz and El Alto in Bolivia (pop. 2.3 million) where the glaciers of the Cordillera Real have until recently supplied 30–40 percent of potable water, the changing circumstances can affect costs of supply and ultimately the ability of urban centers to maintain vibrant economies.

Figure 3. Runoffs from Llanganuco Glacier for different climate scenarios



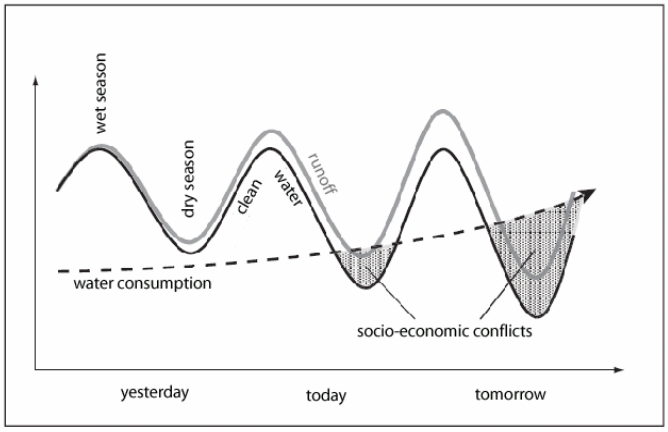
The graph highlights the water regulation function played by tropical glaciers in Los Andes under different scenarios..

Source: Juen et al., in press

9. **Glacier retreat and other climate changes will impact local agriculture**. Semiarid mountainous ecosystems in the region are highly vulnerable to disruption of local hydrological patterns, placing subsistence agriculture and consequently rural livelihoods at risk. Anticipated dramatic fluctuations in the hydrological cycle will exacerbate already stressed ecosystems and reduce biodiversity and productivity of highland agricultural lands because of unreliable water supply. The adaptive limitations of less-developed areas will likely increase the disparity in food production and food security in rural highlands. As much of the lowlands' basins depend on tributary streams coming from the Andes, impacts will also be felt downstream.

10. **Glaciers fed rivers are major source of hydro power in these countries**. The region relies on hydropower to cover most of its power requirements, and many rivers that are used to generate hydroelectricity are glacier- or mountain-lake fed. Indeed, most power generation in Peru (80 percent) and Ecuador (50 percent) is met through hydropower. Reduction in water flows will reduce the potential for power generation and directly induce a carbonization of the power sector (countries returning to thermal power plants to make up for reduced hydropower potential), therefore increasing the greenhouse gas emissions of these systems. Recent studies in Ecuador suggest that during the low-water period, the Paute Project (Paute River basin) would only be providing between 43 and 45 percent of average power capacity; this represents a deficit of about 27 percent compared to energy production under normal conditions.

Figure 4. Chart of water runoffs with and without glacier contribution and water demand



As glacier retreat accelerates, the water regulation function of the glacier disappears. Growing demand may outstrip supply during seasonal dry periods and lead to potential socio-economic conflicts unless measures are taken to adapt to the new situation.

Source: Vuille 2006

11. Although the Andean countries contribute little to the cause of this problem, they face potential social, ecological and economic costs from climate change induced impacts. To understand vulnerability, adaptive capacity and devise mechanisms to address these potential impacts, these countries have already initiated a number of activities, in particular:

PERU. The Government has formed the National Council on Climate Change (CNCC), a consultative technical group which is part of the Structural Framework of Environmental Management. The result of this effort is a National Climate Change Strategy, which is a basis for the formulation of a nationwide program on climate change, with an emphasis on adaptation to anticipated impacts. The strategy calls for: i) Strengthening of regional and national climate observation systems to facilitate their integration with worldwide networks; ii) Identification of a National Research Agenda; iii) Evaluation of the country's present and future vulnerability; Prioritized evaluation of specific ecosystems, for example, mountain ecosystems and the availability of glacier-fed water resources.

ECUADOR. The current Government has strengthened the planning process and initiated a national development plan for the period 2007–2015. In this context, the National Committee on Climate has begun a process aimed at having the National Government declare a national climate policy as an essential element for sustainable development. This policy is already drafted and is in the process of being discussed with different stakeholders. Various State agencies, as a result of studies and research associated with their specific areas of expertise (climate data generation, power generation, provision of drinking water, etc.) have generated guidelines related to water resources and climate change that have been incorporated, or are in the process of being incorporated, into the respective planning.

BOLIVIA. The Government has promoted a series of activities on climate change that include: i) Greenhouse gas reduction and carbon sequestration, in which the State participates as the owner of natural resources, in the generation of surpluses through certification, international

negotiation, fair and supportive sale and distribution of the benefits generated by marketing in international carbon bond markets; ii) Adaptation to global environmental climate changes; iii) Implementation of the international environmental agenda in Bolivia as an instrument to enable the country's economic and social development, promoting productive empowerment and transformation, and strengthening investment initiatives for sustainable development; iv) Consolidation of a National Strategy for Implementation of the Climate Change Convention, promoting climate change adaptation efforts that enable rural development and the generation of national skills to fight against the risks and impacts of climate change by including communities in a process that enables their socioeconomic development; v) promotion of the use of the Clean Development Mechanism.

B. Rationale for Bank involvement

12. The last full Country Assistance Strategy (CAS) for Perú was published in December 20, 2002. Recently, a Country partnership Strategy (CPS)[1] for Peru has been drafted which recognizes the country's vulnerability to both climate change and climate variability and the challenge posed to the Country by glacier retreat, which will impact the country's water supply, agricultural, health, and tourism sectors. This project contributes to the CPS' strategic focus on protection and conservation of strategic ecosystems, increasing their adaptive capacity with regard to GCC impacts. Adaptation activities are designed to strengthen local adaptive capacity, reducing risks and contributing to the adoption of sustainable practices within current programs. The CAS for Ecuador and Bolivia highlight the vulnerability of water resources to changing environmental conditions.

13. The World Bank has been involved in climate change mitigation and adaptation projects in the region, funded through the GEF and other sources, including the Colombia Integrated National Adaptation Project (INAP), which includes an activity in the central mountain range of the Colombian Andes. The Bank has also been managing different carbon funds of about US$1.6 billion. Carbon financed projects that are of relevance include the *Colombia Amoyá Environmental Services Project* which supports adaptation measures in mountain habitats.

14. The project would also coordinate activities with the TF-funded project "Strategies for Adaptation to the Environmental and Socioeconomic Impacts of El Niño for Rural Communities in Ecuador and Peru," which is currently aimed at identifying key vulnerabilities and specific capacity-building measures. El Niño events have become more frequent since 1976 with some devastating effects in particular on the economies of Ecuador and Peru and proposed SCCF-funded adaptation activities in Ecuador (see below)

15. **Complementarity with the Ecuador water management and development and integration of climate adaptation governance instruments in host government and practitioner protocols project.** In particular, efforts will be undertaken to ensure full coordination with a proposed national project in Ecuador for the SSCF, dealing with water impacts. The three major outcomes envisioned for this national project are: improved public

[1] Country Partnership Strategy for the Republic of Peru, FY07-FY11

policy and governance structures for effective water management, increased adaptive water management practices through capacity development and flexible financing mechanisms, and strengthened information and knowledge management on climate risks. Both projects—the Ecuador national project and the Andean regional project—have been designed in close collaboration to ensure that there will be no overlap but rather substantial complementarity. Both projects are expected to be submitted for consideration to the same council meeting.

16. The Ecuador project focuses strongly on water management adaptive governance instruments, and steers away from operational community pilots related to hydrology, thus providing a strong complementarity with regional project activities in the country. The project aims at strong coordination with this activity, involving implementing agencies through an informal coordination committee to ensure that the region's overall adaptive capacity is strengthened through complementary measures.

17. Key differences between the two initiatives in Ecuador are:

- The regional project focuses on the response to glacier retreat, the national project focuses on governance in the water sector.
- The regional project focuses on high mountain ecosystems and water supply, the national project focuses on agriculture and power generation. The national project focuses on coastal areas.
- In the regional project the water utility of the city of Quito plays a key role. The main stakeholder for the national project is Hidropaute (power utility) in the Paute river basin.

18. Key synergies are:

- Both projects will make use of similar tools to simulate future climate, with the regional project having access to the Earth Simulator and thus in a position to contribute to the analysis under the national project.
- Both projects will be led by the Ministry of Environment.
- Information generated by both initiatives will be shared.

19. **Complementarity with Perú Second National Communication.** While the second national communication analyzes the vulnerabilities of Peru to the impacts of climate change, the Regional Andes Adaptation Project seeks to demonstrate practically how to reduce a key vulnerability, to rapid glacier retreat, and will support specific measures to adapt to these changes. The experience with the implementation of adaptation measures will inform the overall process of adaptation to rapid glacier retreat throughout Peru, illustrating costs and benefits.

20. In the area of glacier retreat the communication is expected to contribute with (i) analysis of current glacier hydrology, including an update of previous glacier inventories, glacier variations, and record of glacier melt hazards and disasters; (ii) estimation of the availability of water resources due to glacier melt at the national level up to 2050; and (iii) evaluation of adaptation strategies in the management of hydro resources in the basins with a glacier component under climate change conditions. These outputs will guide the selection process of

priority adaptation measures and will strengthen their design. Additionally, the glacier monitoring effort under the regional project will benefit from the analysis under the communication.

C. Higher level objectives to which the project contributes

21. The project responds to UNFCCC guidance for the Special Climate Change Fund (SCCF). The scope of the SCCF is to finance activities, programs, and measures relating to climate change that are complementary to those funded by the resources allocated to the climate change focal area of the GEF and by bilateral and multilateral funding in the following areas: (i) adaptation; (ii) transfer of technologies; (iii) energy, transport, industry, agriculture, forestry, and waste management; and (iv) activities to assist developing countries in diversifying their economies. The project will look for implementation of adaptation activities to address the adverse impacts of climate change; it will complement traditional government interventions in the area of water resources management by explicitly including the impacts of warmer temperatures and glacial melt into planning processes with emphasis on water supply and irrigation in highland areas including mountain ecosystems.

22. Moreover, the proposed project will serve as a catalyst to leverage additional resources from bilateral and other multilateral sources. The activities to be funded under the proposed project are country driven, cost effective, and integrated into national priorities as expressed in the National Communications. While the assessment of future climate scenario impacts on key ecosystems has been conducted under the UNDP National Communications for Peru, the project will focus on filling the gap in the assessments for three countries, thus achieving the same analytical basis for all. The proposed regional project contributes with SCCF mandates and objectives in that it seeks the implementation of pilot adaptation measures to adjust for the loss of the environmental services that glaciers perform in the Andes region, specifically in Perú, Bolivia and Ecuador.

23. More importantly, while some glacier retreat is unavoidable, and is a direct consequence of the current thermal momentum in the troposphere, the project will pioneer adaptation activities designed to compensate the loss of glacier services and provide global lessons on how to deal with the related changes in ecology linked to tropical glaciers. **It will also contribute to raise awareness as to the tragic consequences of climate change in countries that contribute relatively little to the problem**. In addition, the proposed Project will help to address some Millennium Development Goals (MDG) targets (especially targets 9 and 10)[2].

24. The Project will, support the implementation of adaptation activities to address the adverse impacts of climate change; it will complement government traditional interventions in the area of water resources management with emphasis in water supply and irrigation in highland areas including mountain ecosystems. The proposed Project will serve as a catalyst to leverage additional resources from bilateral and other multilateral sources. The Activities to be funded

[2] Target 9: Integrate the principles of sustainable development into country policies and program and reverse the loss of environmental resources; Target 10: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation

under the proposed Project are country-driven, cost-effective and integrated into national priorities as expressed in the 1st National Communications.

II. PROJECT DESCRIPTION

A. Lending instrument

25. The project cost would be financed by a SCCF-GEF grant in the amount of US$6.9 million, with co-financing from (i) the Republics of Peru, Ecuador and Bolivia (US$7.2 million), (ii) the Swiss Development Corporation (SWF 5 million, US$5.5 million equivalent), (iii) a Climate Change Implementation Grant (US$0.9 million); (iv) NOAA (US$0.3 million), (v) the Meteorological Research Institute of Japan (US$1.0 million), (vi) EMAAP-Quito, the water utility serving Quito (US$4.7 million), (vii) The Andean Community of Nations (US$0.25 m) and other donors (US$1.9 million, to be confirmed) for a total of US$28.65 million. The SCCF requires that most of its resources be used toward the implementation of adaptation measures. Co-financing resources provide complementary funding.

26. The adaptation project is associated with four Bank investments in the region with a total cost of US$194 million, to which the project adds US$28.7 for a total of US$222.7 million. The Bank investments were designed in parallel but now with the contributions of the adaptation project will be able to incorporate a climate change overlay, specifically targeting the impacts of rapid glacier retreat. These investments and their linkage to the adaptation project are detailed in page 89 of the report.

B. Program objective and phases

N/A

C. Project development objective and key indicators

27. **The development objective of the proposed project is to implement adaptation measures to meet the anticipated consequences of the catastrophic glacier retreat induced by climate change.** This will be achieved by: a) supporting the detailed design of selected adaptation measures; b) implementing regional and strategic adaptation pilots to address key impacts from rapid glacier retreat on selected basins; and c) supporting continuing observation and assessment of glacier retreat and the associated impacts on the region (no GEF resources requested for this activity). The measures will be located in vulnerable highland glacial-dependent watersheds, other associated ecosystems, and regions of mutual interest to participating member countries, where the combined impacts of glacier retreat on global commons and on the prospects for local sustainable development are the highest.

Figure 5. The destruction of the Chacaltaya Glacier (near La Paz) between 1940 and 2005

Source: Ramirez 2007

28. **Key performance indicators:**

- Integration of glacier retreat impacts into local, regional, and country level planning, as measured by actions taken during the planning process to ensure such integration.

- Government institutions of Peru, Ecuador, and Bolivia will have the capability to document and disseminate information on the process and the impacts of rapid tropical glacier retreat in the Andes, as measured by technical reports and published papers.

- A sustainable glacier observation and monitoring network, as measured by continuity of records of previous 12 months and allocation of budget for its mid-term operations after the end of project.

- Increase in the global and regional awareness on the catastrophic impacts of rapid tropical glacier retreat as measured through mentions in written media of mass circulation.

D. Project components

Component 1. Detailed design of key selected adaptation measures (GEF contribution US$0.4 million; total cost US$5.25 million): the objective of this component is to complete the design of at least six strategic adaptation measures to be implemented under component 2. The objective will be achieved through the following activities:

Sub-component 1.1 – Design of Glacierized Basin Impacts Map: This sub-component will apply global climate circulation models developed and run by the Earth Simulator in Japan and use the data generated through project preparation funds to quantify impacts on glacier retreat, runoff availability, and water regulation at basin levels. Under this activity, participating countries will develop an impacts map for the selected glacierized basins. The basins were selected through a set of agreed criteria and in consultation with key stakeholders during project preparation. These criteria and consultation process is described in Annex 1 of this document.

Sub-component 1.2 – Detailed Design of Specific Adaptation Measures: The sub-component will overlay the impacts map designed under sub-component 1.1 on the existing and/or planned regional government programs and investments to adapt to glacier retreat impacts. This activity will support the detailed design of specific adaptation measures, already selected through a broad consultation with major stakeholder groups in each of the participating countries. Design of the pilot adaptation measures will also include a strong monitoring mechanisms to generate data (e.g., on costs) to feed into the overall M&E system of the project developed under component 3.

Sub-component 1.3 – Public outreach and dissemination of information:
This subcomponent has the following objectives: (i) to improve public knowledge of the actual and expected local impacts of climate change on tropical glaciers and how their recession will directly affect associated catchments' ecosystems and socioeconomic activities in the Andean region, (ii) to disseminate existing information on climate change, high mountain ecosystems and glacier retreat recession, and their impacts on: 1) water supply systems for human consumption and agricultural and livestock use, and the 2) energy sector; (iii) raise international awareness on the economic and social costs of tropical glacier retreat.

Outcomes of this component: Integration of the issue of glacier retreat in the regional/local planning of relevant glacierized basins.

29. **Component 2. Implementation of pilot adaptation measures (GEF contribution US$6.0 million; total cost US$20.10 million)**. The component includes two activities:,

Sub-component 2.1: Implementation of pilot adaptation measures in selected communities and sectors highly vulnerable to the effects of glacier retreat. The following pilot adaptation interventions for each country are under formulation and will be appraised prior to CEO endorsement:

ECUADOR

1. Adaptation to the impacts of glacier retreat in the water supply plan for Quito (US$ 2,000,000). The objective of this is to incorporate the impact of retreat of the Antizana glacier in the medium term (2010-2040) planning for water supply for the city of Quito. This is a period during which substantial glacier retreat is anticipated. The activity will support: (i) strengthening of existing water infrastructure (water supply pipes and water storage capacity) sufficient to maintain same level of water service with reduced glacier runoff contributions, (ii) speed up of the investments in development of new water sources to internalize water yield reduction and loss of water regulation caused by glacier retreat (through the inclusion of additional creeks in the water supply system to the city of Quito and the use of underground reservoirs); (iii) undertake demand management program to reduce water leaks in the distribution system to Quito to adapt to anticipated reduced water availability per capita.

2. Integrated Basin Management Plan in the wetlands of the Antisana Plateau to compensate for reduction of water regulation and water availability caused by glacier

retreat (US$ 1,000,000). The objective is to: (i) compensate for the decrease in water regulation of the Antizana catchment through the construction of water storage capacity and measures to increase water holding capacity in mountain wetlands; and (ii) minimize the potential negative effects on highly vulnerable local communities in the area, which in most cases live in extreme poverty conditions. The main activities include the development and adoption of a community base Catchment Management Plan including: (i) a revised land zoning (incorporating land forms, ecosystems and vegetations formations) that incorporate the concerns of reduced glacier runoffs, increased evaporation and generalized warming of mountain habitats; (ii) design and adoption of adapted land use practices that take into account anticipated climate changes in the Plateau; and (iii) design and implementation of a fire prevention/management plan and a reforestation program with native species to secure water retention and regulation lost though rapid glacier retreat and generalized warming.

BOLIVIA

1. Implementation of a Management Plan for the potable water supply systems in areas affected by the disappearance or reduction of glacier runoffs in the region of La Paz and El Alto (US$2,300,000). This activity seeks to include provisions that compensate for the retreat of the Huayna Potosí, Tuni, and Condoriri glaciers through: (i) study and design of government-planned reservoirs in the urban areas near the cities of La Paz and El Alto; and (ii) construction water supply system that incorporates loss of water regulation caused by glacier retreat, through the addition of water storage capacity (tanks and ponds), in the rural areas of Pucarani and Cohoni.

2. Integrated Pilot Catchment Management Plan in the Bolivian Plateau and High Valleys. (US$1,700,000) This will support activities to adapt agriculture and livestock activities to the loss of water regulation and supply caused by glacier runoff in the Bolivian Plateau and high valleys. Specific activities include: (i) build and operate small ponds in selected places where water scarcity induced by glacier retreat is projected to stress local economical activities; (ii) implement a reforestation and re-vegetation to decrease erosion rates, and promote infiltration; (iii) apply water conservation practices (drip irrigation and mulching, closed water tanks) for agricultural and livestock activities; (iv) implement a Water Management Plan with the help of local communities to make an efficient use of reduced water resources in their daily domestic activities (water recycling and adoption of rainfall collection tanks and spouts).

PERU

1. Implementation of a Water Management Plan aimed to: (i) improve water use practices in the agricultural and livestock sectors and (ii) improve water storage infrastructure at selected basin's head waters to address negative effects caused by temporary increase in runoff. (US$ 5,500,000). The activity seeks to improve water availability and its use for agricultural and livestock through the implementation of a Water Management Plan to (i) improve water use practices (systems for irrigation, improvement in efficiency of water use to compensate reduction in water regulation induced by glacier retreat ; (ii) improve infrastructure for water storage in selected areas to prevent negative impacts due to overflows caused by temporary increase in runoff caused by accelerated glacier melting;

and (iii) implement reforestation to promote water retention. It will also facilitate the creation of a protected natural area for the purpose of protecting and conserving the hydrological system of the Huaytapallana glacier and associated small lakes, as the principal source for the generation of water resources, biodiversity, and the scenic beauty of the upper zone of the Shullcas River basin.

2. Implementation of an Agricultural Production Plan that compensates for reduction of water availability to the agricultural sector as a result of rapid glacier retreat. (US$ 1,480,000) This pilot will implement a Plan for the Diversification of agricultural production which will aim to improve competitiveness, food security, reduction of agricultural production losses and implementation of agricultural good practices adapted to the anticipated consequences of glacier retreat in the area. It would include the following actions: (i) identification and implementation of pilot plots of drought-resistant crops; (ii) facilitate purchase of seeds and inputs to promote drought resistant cultivars in the areas of Shullcas and Santa Teresa sub-basins; (iii) promote changes in agricultural exports to adapt to anticipated conditions and addressing the basic needs of financing for the purchase of seeds and inputs for production in the areas of Shullcas and Santa Teresa sub-basins; (iv) develop a program in the application of adapted agricultural practices; (v) develop a program for technology transfer to sustain adapted agricultural practices in the Mantaro Valley.

3. Implementation of an Integral Water Management Plan that incorporates reductions in glacier run off contributions in Huancayo. (US$ 600,000) **Objectives:** To improve the availability of water for human consumption by rationalizing the use of water and research on alternative sources of water supply. The following activities are contemplated: (i) implement improvements as required of the drinking water supply infrastructure (storage tanks and reservoirs and rain collection systems); (ii).implement a strategy for the planning of the use of drinking water and agricultural water; (iii) develop a Program with local communities in the rationalization and efficient use of water for human consumption (adoption of water saving practices and tools).

Key outcome of this component is the incorporation of glacier retreat impacts in the water, energy and agricultural sector policies and implications in the areas of intervention.

30. **Component 3. Monitoring of glacier retreat in the region. (No GEF contribution; total cost US$1.9 million).** The project would support, primarily with assistance from a Climate Change Implementation Grant and other technical and scientific institutions, the installation and operation of a monitoring network to measure the gradual process of glacier retreat in the region in order to enable better long-term planning for further adaptation policy and interventions. The program will be largely supported through a CCIG grant (no GEF contribution) as well as contributions from the Japanese Space Agency, NOAA and IRD.

The monitoring program has two sub-components:

Sub-component 3.1: Design and set up of field stations for monitoring of tropical glaciers of economic relevance**.** This component will finance the design, installation and operation of eight glacier monitoring stations, located at or near tropical glaciers of economic relevance.

Sub-component 3.2: Use of high precision remote sensing to monitor tropical glaciers and associated ecosystems through the use of the Japanese Space Agency ALOS satellite (Advanced Land Observing Satellite or DAICHI). This component will support the use of ALOS data for remote sensing of tropical glaciers. Specifically, the component will support: a) Data access from ALOS, b) data compilation and storage; c) data interpretation and use.

Outcomes of this component: Effective use of the information of the monitoring network as an input to the planning in glacierized basins and decisions taken to support its long term operation.

31. **Component 4:** Project management (Total $1.4 m GEF funding $0.5 m): This component will support the overall technical coordination of Project Activities (including the implementation of a technical monitoring system) as well as the administrative and financial management of the Project. It will include goods; consultancy services; travel; and operating costs undertaken by the Project Management. Specifically this component will finance the project coordinator, the procurement specialist, other required personnel for the project management, and the project external audits. Incremental GEF co-financing will be used for goods; consultancy services; travel; and operating costs.

E. Lessons learned and reflected in the project design

32. The successful operation and sustainability of adaptation measures rests on the generation of local benefits. Experience has indicated that to increase the sustainability of interventions the benefits generated have to induce the community to operate and maintain the Project, or that these who benefit guide the operating agency to allocate the resources required for effective implementation.

33. Experiences in the past have indicated that the implementation of a Regional Project is better carried out by a solid regional institution with: (i) a good institutional capacity with demonstrated experience in the field for which the Project is being implemented, (ii) regional presence through local offices or representations and (iii) a legal and financial autonomy. All these factors together will allow a more efficient and effective Project operation reducing excessive transaction costs and inefficient Project logistics.

34. **Monitoring natural resources and climate data collection is a long-term activity that demands long-term commitments**. The implementation of adaptation programs in the Caribbean (CPACC and MACC) highlight the need to ensure sustainability and local ownership of any monitoring and data collection activity and reliable methods to secure and compile the data collected. These aspects have been incorporated in the project.

35. **Climate change adaptation is a long-term venture.** As illustrated by the work in adaptation to climate change in the Caribbean and in Colombia, many years of continuous work are required to establish the basis for successful adaptation programs. The process in Colombia is being jump-started on the basis of an excellent diagnosis made through the National Communications and other vulnerability assessments. It is clear for all project agencies that the

project is the first step in a lengthy process and therefore that long-term commitments are required to meet the growing challenges of adaptation to climate change.

36. **Close coordination, clear management, and technical leadership are required for multifaceted projects**. Bank experience with multi-sector activities has shown the importance of having a clear, simple management structure. The project applies experience with project management in Colombia and uses a structure that combines clear coordination and technical leadership through specialized sector agencies.

F. Alternatives considered and reasons for rejection

37. The project gave **preference to practical, on-the-ground adaptation measures** over the more traditional approach of strengthening institutions and building enabling environments. The project will strengthen capacity only as it is required to implement well-defined adaptation measures, with high probability of success. The adaptation measures that will be implemented are the result of a comprehensive selection process that relied primarily on the impacts on biodiversity of global importance and included the following criteria: replicability, institutional capacity, high probability of success, cost effectiveness, and clear determination of additionality. Furthermore, the project selected a regional approach instead of a national project as a response to the ecosystem-wide character of the climate challenge in the region. Finally, the project is being implemented through a regional entity (CAN) as a response to the need for a common approach and quick internalization of lessons obtained in each country.

III. IMPLEMENTATION

A. Partnership arrangements

38. The project will be implemented in cooperation with several partnership arrangements:

- **Meteorological Research Institute (MRI) of Japan and Japan Frontier Research Institute (JAMSTEC).** Under an agreement reached with both institutions, support will be provided to CAN. Specifically, MRI and JAMSTEC will provide data from the Earth Simulator for use in the development of local climate scenarios and the selection of adaptation measures, training, and scientific exchanges.
- **Japanese Space Agency (JAXA-RESTEC).** JAXA-RESTEC will provide assistance to the project under the terms of a MOU agreement and as a contractor under the CC-IG grant. The support will be geared to glacier monitoring activities.
- **National Agency for Oceanic and Atmospheric Administration (NOAA).** NOAA will support activities under the monitoring component. Specifically, NOAA, under an agreement with the implementation agencies, will complement the resources provides for the installation and operation of field stations designed to complement the remote sensing monitoring of tropical glaciers.
- **Consortia of Glaciology Institutes.** A consortia composed of the Innsbruck Glaciology Institute (Austria), Institute pour le Recherche sur le Développement (France), the Global Monitoring Service, and the University of Massachusetts will provide technical assistance and capacity building, targeting the monitoring of tropical glaciers in the region.

- **Global Glacier Monitoring Service**. The service, based in Bern, Switzerland, will assist with the dissemination of information obtained through the project.

B. Institutional and implementation arrangements

39. **Implementation Period:** The Grant is expected to become effective by December 2007 for a five-year period. The expected project completion date is December 2012.

40. **General implementation arrangements:** The GEF grant beneficiary (the Beneficiaries) will be the Governments of Bolivia, Ecuador, and Peru. The grant recipient (the Recipient) will be CAN (Andean Community of Nations) for the benefit of the Beneficiary. The project will be executed by CAN. The **administrative and financial management of the project** will also be carried out by CAN. CANwill be in charge of the overall technical coordination of project activities.

41. **Technical implementation arrangements:**

- **Steering Committee.** The main responsibility of the Steering Committee involving representatives from the three governments and sector agencies will be to assure the attainment of the projects objectives and targets. The SC will also provide guidance on the implementation of the project and take high level decision regarding the project's development, technical difficulties and management issues. The SC will approve the Annual Operating Plans (AOP) of the project.
- The **National Coordination Units (NCU)** will be in charge of the operational coordination of the project activities in each participating country. The NCU will finalize the POA[3], assess the overall project progress. The NCU will ensure the financial, conceptual and methodological coherence among all activities and the integrity of the project. This will also include the provision of feed back to the component coordinators of the executing agencies
- **CAN** will carry out the administrative and financial management of the project

C. Monitoring and evaluation of outcomes/results

The NCU will be responsible for the overall monitoring and evaluation of the project at country level. A detailed monitoring and evaluation system and guidelines will be further developed in the project's operational manual which will be produced prior to effectiveness. The NCU will submit to the Bank biannual project progress reports demonstrating project development and financial and physical performance indicators. The Bank will conduct supervision missions to jointly review progress made with regard to objectives and performance indicators. Regular monitoring of project activities will be the responsibility of the NCU, which will prepare semiannual reports on implementation progress. Monitoring is

[3] The POA will include statement of specific objectives for the year, a description of the activities, expected outputs, monitoring indicators, detailed estimated budgets, a procurement plan, indicating the sources of financing in the budget.

key both for local purposes as well as for the documentation of global benefits. The project will have a complete Project Monitoring and evaluation system.

42. **Mid Term Review (MTR):** The Bank's supervision team, together with a team of external reviewers and key stakeholders, will conduct a midterm evaluation of project execution. It will be conducted no later than three years after the first disbursement. The external review will focus on: (i) progress in achieving project outcomes, (ii) institutional arrangements for project implementation, (iii) operational manual for payments, (iv) review of both the project implementation plan and general project operational manual. In preparation for the midterm review (MTR), the Steering Committee, together with the local implementing agencies, will prepare a working book containing the following information: (i) executive summary of the overall project status, (ii) up-to-date description of the overall components' development and indicators; and (iii) detailed description of the status of the proposed adaptation pilots by catchments.

D. Sustainability and Replicability

Sustainability

The sustainability of project impacts can be measured in four distinct manners:

- **Integration of climate change retreat impacts in governments' planned and ongoing investment activities**: The project will add on to these government activities by incorporating the consequences of rapid glacier retreat in planning, designing and implementing development plans, making these plans more sustainable. However, unless quick action is taken by resource intensive societies, glacier melt will only accelerate imposing a heavy burden in the development options of these areas.

- **Integration of the issue of glacier retreat in regional and local policies**: Adaptation measures implemented under this project will provide lessons that can be incorporated into regional and municipal government policies (water and energy use, for example) and into poverty alleviation policies and strategies.

- **Built monitoring and technical capacity**: The proposed project will support in implementing a monitoring network to measure the gradual process of glacier retreat in the region. The monitoring network will be equipped with state of the art equipment and field stations. The technical capacity of institutions involved in monitoring the climate change induced impacts, in general, and on glacier retreat, in particular, will be strengthened to enable better long-term planning for further adaptation policy and interventions.

- **Provision of tools and demonstrative pilots that can be replicated within the country, region and world**: The proposed project is a first of its kind in overlaying, in a pilot basis, the climate change induced impacts on the hydrological cycle of glacier basins. Lessons from the project interventions will be widely disseminated in other parts and sectors of these countries, region and the world.

Replicability

43. The implementation of adaptation pilots will be used to disseminate expertise and know-how. Project outcomes will provide substantive lessons observed and learned regarding climate impact and adaptive practices. Dissemination of lessons learned, public education and outreach initiatives, and transborder linkages will ensure the ongoing and effective exchange of accrued adaptive expertise. Projects will be used to disseminate adaptation knowledge. The outcome of activities in the glacierized basins will be of direct relevance in other regions of the world subject to the impacts caused by glacier retreat. The development of specific adaptation measures to face the impacts of glacier retreat, under this project is a "first of kind", that will inform on the cost and benefits of adaptation alternatives.

44. **Dissemination of results.** The results of this and other adaptation projects under implementation in the region will be the focus on the "First International Seminar of Adaptation Practices", which is scheduled to be held in Bogotá, next November, with wide participation of policy and decision makers in the region. Additional events are planned for later in the project cycle. Results from the work undertaken will be published in peer reviewed journals. As adaptation measures are successfully implemented, the results will be shared widely amongst practitioners in the region.

E. Critical risks and possible controversial aspects

Risk	Mitigation	Rating
Overarching macroeconomic/fiscal constraints remain a key risk in the region.	Project resources will be committed by executing agencies by time of appraisal. External resources will be committed by partners by time of appraisal.	Moderate
Given the long-term nature of adaptation measures, there is a risk that future administrations may not support the activities under the project.	Sustainability mechanisms and local ownership are criteria for the selection of adaptation measures and pilot sites. Local implementation arrangements will be considered for all measures. Pilot Project will be selected based on the local benefits it generates. Sustainability is enhanced if beneficiaries operate the Projects although. This is not always possible. Increased availability of information on climate change will facilitate integration of these issues in local strategic priorities.	High
Mainstreaming of climate change issues remains a concern given the multitude of challenges that the region is facing.	Incorporation of climate change perspective in the water supply, agriculture, and power development plans in affected regions is part of the project. Given the relevance and high visibility of glacier retreat in the region, policy makers are unlikely to ignore the issue.	Moderate
Allocation of national	Allocation of counterpart resources	Moderate

counterpart resources may delay implementation.	will be made prior to appraisal for the first year of project operation.	
Financial constraints may limit sustainability of adaptation measures.	Long-term co financing arrangements will be undertaken. Cost-benefit and financial analysis will provide information on the adaptation measures' viability and long-term benefits. Beneficiaries will be encouraged to manage and generate the pilot projects.	Moderate
Regional character may increase transaction costs and create difficulties for project management and implementation.	The governments of Bolivia, Ecuador, and Peru have committed to efficient coordination and administration. The executing agency will be empowered to coordinate across boundaries.	High

Overall risk assessment: **Moderate**

45. **Controversial aspects**:
There are no controversial aspects. The science of climate change has strongly established the linkage between rapid glacier retreat and the gradual warming of the troposphere.

F. Loan/credit conditions and covenants

G. APPRAISAL SUMMARY
IV.
A. Economic and financial analyses

46. An economic analysis of adaptation measures will be undertaken as part of the detailed design process of specific adaptation measures during the first year of implementation of the project. In the economic analysis consideration will be given to the long-term character of expected benefits and costs. An incremental cost analysis and an accounting of global and local benefits will also be included. A financial analysis will be conducted as part of the selection process for relevant adaptation measures. This analysis will guide the decision-making process for scaling up the selected measures. During project implementation, and as a subcomponent of the M&E system, data will be collected to assess actual benefits and measure costs. A sample economic analysis for the impacts of glacier retreat on water supply for Quito has already been completed (see Annex 9).

Cost effectiveness. The project will support adaptation measures that will be selected and formulated based on cost-effectiveness criteria. These criteria will be applied to all proposed activities; it will be necessary to submit data on unit costs and how the activities will aim to increase cost efficiency over time. Contracts for goods and services will be subject to Bank guidelines and will use open and internationally competitive practices. In addition, economic analysis will be applied as well as an incremental cost test, before funds are allocated.

B. Technical

47. The project seeks to better document climate, climate variability, and climate change and their impacts in glacier-dependent regions of the participating countries; this documentation is

required for the proper formulation and long-term monitoring of adaptation measures. In addition, the project will support national institutions and stakeholders in the formulation and implementation of adaptation programs and pilot measures. Preliminary adaptation programs and pilot measures include: (i) the development and implementation of a climate change adaptation strategy for water supply to the city of Quito and surrounding municipalities, (ii) the design and implementation of an Integrated Catchment Management Plan in the Antisana and on the Bolivian Plateau, (iii) the design of an Agricultural Production Plan and an agro-meteorological system to help increase food security in selected sub-basins in Peru, and (iv) the development of a climate observation network as an element of an early warning system for the occurrence of extreme climate events in the Mantaro River basin. The project will provide support for the design and implementation of the corresponding monitoring and evaluation systems to identify trends and assess the effectiveness of adopted measures. The project's technical design is based on technical studies implemented during project preparation, partially funded through a PDF-B grant.

The adaptation project will add the climate overlay to a number of projects in the Bank portfolio, with activities in a common area of influence. The links between both sets of activities is summarized in the table below and in Annex 15 of the PAD.

Country	Associated Bank investment	Associated Bank investment Project Cost	Adaptation Project link
Ecuador	Ecuador: Rural and Small Towns Water Supply and Sanitation Project II (PRAGUAS)	US$ 48 million	Pilot adaptation activities in rural communities in the Antizana Plateau will be considered for replication under PRAGUAS
Peru	Peru: Agricultural Research and Extension APL Phase 2	US$ 69 million	Adoption of agricultural practices in glacier-dependent watersheds will inform the agricultural research and extension activities under the APL phase two. Practices are expected to benefit from the results of the pilot.
	National Rural Water Supply, Sanitation and Health Project	US$ 50 million	Information from the pilot adaptation activities will be used to further strengthen community management abilities, and introduce new

			concepts to better cope with the impacts of rapid glacier retreat in communal economic and social activities under the National Rural Water Supply project.
Bolivia	Community-Based Land Distribution Project	US$ 17 million	In the Bolivian Plateau, the adaptation project will support activities to adapt agriculture and livestock activities to the loss of water regulation and supply caused by glacier runoff in the Bolivian Plateau. The data from these activities will be of direct benefit to actions under implementation by the land distribution project in the common area of influence of both initiatives.
Total		**US$194 million**	**US$28.7**

C. Fiduciary

48. **Financial management.** A Financial Management Assessment of the project funds administration entity will be carried out during the proposed project appraisal. CAN will enter into administrative and financial agreements with local agencies for the project's financial management arrangements.

49. **Auditing arrangements.** The financial audit of project expenditures will be carried out in accordance with terms of reference (TORs) prepared according to the Bank's audit policy in effect since July 1, 2003. The TORs and the appointment of the auditor are the responsibility of CAN. Operational, financial, and audit procedures will be detailed in the Operational Manual that will be sent for the Bank's no objection prior to project negotiations.

50. **Disbursement:** a project special account will be opened with the Bank's approval. The account will be managed by the executing entity which will be responsible for sending withdrawal applications together with adequate documentation in accordance with Bank disbursement procedures. The disbursements will be performed based on complete documentation of the expenditures reviewed by the Bank. The disbursement will be executed in accordance with statements of expenditures (SOEs). The executing entity and each implementing

agency will maintain the supporting documentation for the expenditures, clarifying their availability for review by the Bank and by independent auditors.

51. **Procurement:** The procurement arrangements and plans will be discussed during appraisal and will be included in the operational manual. CAN will be responsible and follow standard Bank procedures for all project procurement, and will ensure enforcement in procurement by beneficiaries. An 18-month procurement plan and all procurement procedures are included in the operational manual. Procurement will include consulting services, goods, civil works, and non-consulting services. Annex 8 provides more detail on procurement arrangements.

D. Social

52. The project is expected to trigger OP 4.10 (Indigenous Peoples). The project is likely to benefit farmers and rural communities in the three countries through the implementation of interventions such as reforestation, forestation, livestock management, water resource management, irrigation infrastructure, improved agriculture, etc. It is highly likely that some of these are indigenous communities, in which case the countries involved will prepare a social assessment and an Indigenous Peoples Plan in consultation with the beneficiaries if these are known before appraisal. If communities cannot be identified before appraisal the countries will prepare an Indigenous Peoples Planning Framework in compliance with OP 4.10.

53. A Social Assessment is being carried out which will provide detailed information about specific type of communities and farmers that will benefit from project interventions and mechanisms to involve all the major stakeholders in the project activities. Stakeholder participation is the key for the success of project impacts and is an integral part of the project. Consultations have been carried out in each participating countries where all the major stakeholder groups have participated in design of project. The design of adaptation measures and location of interventions will be considered in a consultative process taking into account the eligibility criteria developed during project preparation.

54. Public consultation and dissemination: As part of the formulation efforts, a consultation and participation process has been undertaken in the region, in the area of influence of the project. The results of the consultation process will be documented in the PAD and executive summary.

E. Environment

55. This is a category B project as no major adverse environmental impacts are anticipated. Minor environmental impacts may be expected from some on-the-ground investments. The project is designed to be entirely positive from an environmental point of view, particularly by protecting vulnerable ecosystems from the impact of GCC. Some expected direct positive impacts include: (i) reduced vulnerability of the high mountain ecosystems in the immediate vicinity of the pilot measures; (ii) reduced uncertainty of impacts of GCC; (iii) mitigation of impacts of unsustainable agricultural practices, and development and implementation of sustainable alternatives; (iv) reduced vulnerability of and planning and management of water

supply in selected urban areas; and (v) increased public awareness of adaptation needs and increased social and institutional capacity to manage the ecosystems. An Environmental Assessment will be performed as part of the preparation of the adaptation measures.

F. Safeguard policies

Safeguard Policies Triggered by the Project	Yes	No
Environmental Assessment (OP/BP 4.01)	[x]	[ ]
Natural Habitats (OP/BP 4.04)	[x]	[ ]
Pest Management (OP 4.09)	[x]	[ ]
Cultural Property (OPN 11.03, being revised as OP 4.11)	[ ]	[x]
Involuntary Resettlement (OP/BP 4.12)	[ ]	[x]
Indigenous Peoples (OP/BP 4.10)	[x]	[ ]
Forests (OP/BP 4.36)	[x]	[ ]
Safety of Dams (OP/BP 4.37)	[ ]	[x]
Projects in Disputed Areas (OP/BP 7.60)*	[ ]	[x]
Projects on International Waterways (OP/BP 7.50)	[ ]	[x]

G. Policy Exceptions and Readiness

56. No policy exceptions are required. The procurement plan for the first 18 months of operation will be ready by appraisal. The project implementation plan for the first year of operation will be ready by appraisal.

* *By supporting the proposed project, the Bank does not intend to prejudice the final determination of the parties' claims on the disputed areas.*

Annex 1: Country and Sector or Program Background

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

In the Andes, runoff from glaciated basins is an important element of the regional water budget, and is essential to the integrity of mountain ecosystems. Many Andean valleys are seasonally dry and depend on glacier runoff to maintain extensive mountain biomes. Specifically, glaciers play an important role in freshwater regulation in associated watersheds, assuring year-round water flows for agriculture, potable water, power generation and ecosystem integrity. Thus, glacier retreat in the Andes places in doubt the sustainability of current patterns of water use and ultimately the viability of the economies and ecologies of glaciated basins, and may also have wider impacts on the entire Andes region. The changes induced by tropical glacier retreat constitute an early case of the need for adaptation and therefore an example of the type and size of associated economic and social impacts caused by climate change.

Field observations and historical records have been used to document the reduction of tropical glaciers over the length of the Andes. This information shows that glacier retreat rates used to be moderate but have accelerated in recent decades *(1)*. Glacier retreat in the Andes is consistent both with upward shifts in the freezing point isotherm and the Equilibrium Line Altitude (ELA), where glacier accumulation balances with ablation. Thus, although sensitivity to temperature for specific glaciers is dependent on local climate characteristics, this retreat coincides with an overall warming of the Andean troposphere *(2)*. Modelling work and projections indicate that many of the lower altitude glaciers in the cordillera could completely disappear within a few decades.

Tropical glaciers in the Andes (those located between Bolivia and Venezuela) covered an area of over 2940 km^2 in 1970 but declined to 2,758 km^2 in 1991 *(5)* and to 2,493 km^2 by 2002 *(6)*. In Peru alone, glaciers covered an area of 2,041 km^2 in 1970 but had declined nearly 22 percent to 1,595 km^2 by 1997 *(5)*. The largest of these glaciers in the Cordillera Blanca have lost 15 percent of their glacier surface area in a period of 30 years *(7, 8)*. Many of the smaller glaciers in the Andes have already been heavily affected and others are likely to completely disappear within a generation. For example, the Chacaltaya glacier (located in Bolivia) has lost most of its surface area (82 percent) since 1982, and may completely melt by 2010 *(1)*. The rapid retreat has resulted in a temporary but unsustainable net increase in hydrological runoff, particularly in the most glacierized watersheds.

Several glaciers in the region, such as Cotacachi in Ecuador, have already disappeared, providing an early glimpse of upcoming consequences. The area around Cotacachi has experienced a decline in agriculture and tourism and loss of biodiversity *(9, 10)*. Waterless streams and a decrease in water levels have already led to water conflicts; these are expected to worsen with time.

1. PERU

Characterization of the study's catchments

1.1 Mantaro Basin

1.1.1 Description of the basin

1. The Mantaro River basin is located in central Peru, between parallels 10°34'30" and 13°35'30" south latitude, and meridians 73°55'00" and 76°40'30" west longitude. The basin partially encompasses territories in the Junín, Pasco, Huancavelica, and Ayacucho regions. The Mantaro is one of the most important rivers in Peru's Central Andes, and its volume depends on precipitation throughout the basin, from the level of Lake Junín and of the lagoons located at the foot of snow-covered mountains in the Cordillera Occidental and Mount Huaytapallana.

2. Due to the complexity and extent of the area encompassed by the Mantaro River basin, this basin can be classified in three zones: northern, central, and southern, taking into account aspects such as climate, physiography, hydrology, and socioeconomics. Several sub-basins can be identified in each zone; as a result of the workshop held in Huancayo and due to their relationship with the Huaytapallana glacier, two sub-basins were proposed: Achamayo and Shullcas, which are located in the central zone. The Shullcas sub-basin has the most information available and thus should be considered a pilot area for the PRAA.

3. The Shullcas River sub-basin is part of the Mantaro River basin and is a tributary along the left bank at the city of Huancayo. It is located in the Cordillera Oriental of Peru's Central Andes. The most prominent mountain is Huaytapallana at 5,557 masl. The sub-basin's principal lagoons are Chuspicocha, Lazo Huntay, and Huacracocha. There Shullcas River is the principal resource for several towns along its banks. The sub-basin forms part of the districts of Huancayo and El Tambo. It has a length of 35.9 km and a land area of 232.52 km^2.

4. Current water use in the Shullcas River sub-basin consists of drinking water for the city of Huancayo, 2,000 hectares of irrigation, 2 fish farms, and small power plants. There is a conflict between agricultural and drinking water uses, especially in times of low water, due mainly to the increase in areas under irrigation as well as population growth in the city of Huancayo.

1.1.2. Importance for the region and justification for selection

5. The Mantaro River basin is of great economic importance to the country because it generates approximately 35 percent of the country's energy. In addition, the valley's agricultural production provides food to Lima and the population involved totals 700,000. The population of the Mantaro River basin is vulnerable to various meteorological and geodynamic phenomena that constantly threaten its safety and well-being. Climate change may exacerbate these "natural" threats, especially those in which there is a certain degree of human participation. The principal threats that affect the Mantaro River basin are frost, droughts, aboveground geological dangers, landslides, torrential flows, soil erosion, and riverbed sedimentation.

6. With regard to the Shullcas River sub-basin, the key problems identified relate to the availability of surface and ground water, infrastructure for human water supply, volumes of maximum high waters, protection works, hydroelectric plants, infrastructure for waste water treatment, waste water drainage, and rain drainage.

7. According to INEI, in 2002 poverty in the Mantaro River basin totaled 62.6 percent and affected 790,000 inhabitants, among whom extreme poverty totaled 30 percent and affected 376,000 people. The total per capital expenditure according to poverty level was 140.8 new soles and for non-extreme poverty 387.1 new soles; the income of the extremely poor was 150.9 new soles and of the non-extremely poor 399.8 new soles. The national average for poverty level is 54.3 percent compared to 62.6 percent in Junín. In other words, there are more poor people in this region.

1.1.3. Preliminary analysis of the vulnerabilities present in the basin and associated with global warming

8. The socioeconomic vulnerability in the Mantaro River basin is increased by several factors such as the structural crisis in the agricultural sector, growing and disorderly urbanization, and displacement, migration, and conflicts over resources. This can be explained by the fact that the poor population lacks resources to relocate or take preventive measures against adverse environmental conditions. In addition, the low level of education, together with social exclusion, reduces access to infrastructure and social assistance services, thereby increasing the possibility of events that are harmful to health. The identified factors affect the spread of poverty which in turn is related to the population's low level of resistance.

9. Biophysical vulnerability in the face of frost, drought, and surface geology is present, especially because of their possible effect on agricultural and livestock production and on the generation of electricity (with moderate levels of vulnerability). In addition, seasonal conflicts are related to water use, due to the demand for human consumption, power generation, and agricultural use. Institutional vulnerability should also be mentioned; there are interinstitutional initiatives but these are still insufficient. Institutions and their relationships are still too weak to address the existing problems.

10. The Shullcas River sub-basin can be divided, from a geodynamic standpoint, into three zones: the upper part (within the area of direct influence of snow-covered Mount Huaytapallana and the Lazo Huntay and Chuspicocha lagoons), which is highly vulnerable; the middle part (from the point where the streams of the Ucushcancha and Ronda meet, to the locality of Vilcacoto), which is moderately vulnerable; and the lower part (mainly encompassing the urban area, including areas adjacent to the Huacacrocha lagoon), which has a low level of vulnerability.

11. With regard to vulnerability in critical areas of the Shullcas River sub-basin (in which environmental factors tend to have a negative influence on residents' lives), it has been identified that the greatest disasters affecting the population are mudslides (*huaycos*), such as the one that occurred in 1990 and caused major human and material losses. A second risk factor is flooding which favors the development of various diseases and infections, as well as personal and

material losses. In addition, landslides represent a considerable risk due to increased water filtration on hillsides, especially during rainy periods.

12. According to previous studies carried out in the area by IGP under the framework of CONAM's "Program to strengthen the national capacity to manage the impact of climate change–PROCLIM" (2005), the impacts of climate change are associated with a higher recurrence of frost, drought, and alteration of the water cycle. Thus, the decrease in precipitation is estimated at around 19 percent in the prioritized study area of the Mantaro River basin.

13. There is also considered to be a reduction of 5 km^2 in the Huaytapallana glacier which, as previously indicated, supplies water and energy to the study area. (See graph in Annex xxx.)

1.1.4. Gathering of existing basic information, identification of key actors and their specific action in the river basin

Existing Basic information

1. Integrated local evaluation of climate change for the Mantaro River basin (PROCLIM project). IGP–CONAM–SENAMHI.
2. Study of environmental conservation and integrated development of the Shullcas River sub-basin. ECSA INGENIEROS.
3. Natural resources database. INRENA.
4. Study of the municipality of Huancayo and INDECI
5. Hydrological study of inter-basin transfer. CORDEJUNIN.
6. Comprehensive studies. WATER FOR HUANCAYO TECHNICAL GROUP.
7. Study of water impoundment for human consumption. UNCP (Faculty of Forestry)–SEDAM HUANCAYO.
8. SEDAM HUANCAYO Master Plan.
9. Reinforcement of water resources. PRONAMACHS 1997.
10. Water balance and water resource management. IGP.
11. Records of mining concessions and environmental liabilities. MINEM REGIONAL BUREAU.
12. Map of environmental risks. INDECI.
13. Inventory of tourism resources in Junín. JUNÍN REGIONAL GOVERNMENT.
14. Competitiveness plan.
15. Joint regional development plan. JUNÍN REGIONAL GOVERNMENT.
16. Road infrastructure. MTC/PROVIAS RURAL/PROVINCIAL ROAD INSTITUTES.
17. INEI (CENAGRO).
18. Inventory of peasant communities. MINISTRY OF AGRICULTURE/PETT.
19. Cultural calendar. Inventory JUNÍN REGIONAL GOVERNMENT /DIRCETUR/INC.

Key actors

1. Junín Regional Government.
2. Junín Regional Agrarian Bureau.
3. IGP (Geophysical Institute of Peru).
4. SENAMHI. Junín Regional Bureau (National Meteorology and Hydrology Service).
5. SEDAM Huancayo (Municipal Drinking Water and Sewerage Service).

6. INIEA (National Agricultural Research and Extension Institute, of the Ministry of Agriculture).
7. UNCP (National University of Central Peru).
8. CONACS (National Council on South American Camelidae).
9. CIP Junín (Peruvian College of Engineers).
10. NGOs (CEAR, CEDEPAS).

1.1.4. Brief, non-quantitative description of the future climate scenario of interest

14. The results of statistical downscaling for the study of the Mantaro River's future vulnerability indicate an increase of 1.3° C and a decrease of 6 percent in relative humidity from December to February. Precipitation would decrease by 10 percent, 19 percent, and 14 percent in the northern zone, the middle basin, and the lower basin, respectively. The projected increase in air temperature is also consistent with observations; for example, Vuille and Bradley (2000) estimate a trend of approximately +0.2° C per decade (for the period from 1959 to 1998), while the trends observed in the basin are +0.24° C per decade.

1.2. Vilcanota–Urubamba Basin

1.2.1 Description of the selected basin

15. Two principal river basins may be identified in the Cusco region: the Apurimac basin and the Vilcanota–Urubamba basin. As a result of the workshop held in Cusco and in light of the information available as well its relationship with glaciers, its economic importance, and its valuable cultural and natural heritage, it was suggested that the project be focused on the Vilcanota–Urubamba basin. Besides being the site of the Machupicchu Historic Sanctuary, the department of Cusco has valuable assets including archeological parks, zones, sites, and monuments located in various provinces such as La Convención, Calca, Espinar, Quipichanchi, Urubamba, and the province of Cusco. As mentioned in the Master Plan of the Machupicchu Historic Sanctuary, the various studies indicate that Machupicchu should not be considered an isolated area but rather as part of the entire Sacred Valley, so that the protection of various Inca cities and towns would also include the Historic Sanctuary. Thus, there is a need to provide integrated protection to the entire Vilcanota–Urubamba River basin in order to ensure its sustainable development.

16. The Vilcanota–Urubamba River Basin extends from La Raya to Yanatile and has three main sections: the basin's headwaters, the middle basin, and the lower basin. It was proposed that the lower basin be used as a pilot area, with the commitment of linking the entire Vilcanota–Urubamba basin as part of an integrated project. The pilot area would specifically encompass zones adjacent to the Vilcanota, Sacsara, and Santa Teresa Rivers, associated with the snowcapped Mount Salcantay, and would be related to the municipalities of Santa Teresa, Machupicchu, and Aguas Calientes, as well as the Machupicchu hydroelectric plant (see map in Annex 3).

17. Another proposal that could be considered as an alternative for a pilot area is associated with the Quelccaya glacier cap, considered the world's largest tropical glacier cap; its most important glacier is Qori Kalis, located east of Sicuani in the Vilcanota Cordillera.

18. As a result of individual meetings held with relevant institutions such as the MERISS Plan (Small and Medium Irrigation Project), INRENA-Machupicchu, IMA (Water and Environmental Management Institute), and SANBASUR (Basic Sanitation in the Southern Sierra), agreement was reached on the formation of technical group with participation by these institutions as well as the Regional Government for the purpose of determining the specific area to be considered as a pilot area for the Andean Regional Project.

1.2.2. Importance for the region and justification of selection

19. The Cusco region's location is strategic both nationally and internationally. At national level, the southern macroregion has a special position with respect to neighboring regions: Madre de Dios, Puno, Apurimac, Ayacucho, Junín, and Ucayali. In an international context, it also has a strategic location with respect to Brazil, Bolivia, and Chile. It also has excellent possibilities for connection with the Pacific basin from the port of San Juan de Marcota, as well as its interconnection under the framework of the interoceanic highway, the principal route integrating the southern part of the country and its relationship with Brazil.

20. The total water supply in the Cusco region is 72 billion m^3 per year, of which 0.03 percent is used for human consumption and 0.3 percent for agriculture. Basically, the problem relates to distribution and access to water resources. This problem increases under conditions that affect water availability. These conditions include climate change as well as local-level problems such as deforestation and overgrazing, wasteful use of water (for example, irrigation efficiency in the region is 20 percent), water resource degradation (contamination from waste water, solid waste, tailings, and agricultural use), and the increased demand for water resources due to the region's growth. These conditions create conflicts regarding use and the environment, resulting in improper management of water resources.

21. There are also references to the process of significant of ice-melt from the Salcantay on the Aobamba and Sacsara streams, giving rise to high-risk hanging glaciers in a zone that is degraded and experiences seismic movements from potential flooding and landslides; for example, in 1998 a very large flood affected the Machupicchu power plant, and the cost of replacing this structure was around US$100 million, not counting the impact of indirect losses stemming from the loss of energy and the effect on economic activities that use this energy.

1.2.3. Preliminary analysis of the vulnerabilities present in the basin and associated with global warming

22. The vulnerabilities associated with the process of global warming relate to two basic conditions—the effect of temperatures and precipitation—that give rise to climate dangers such as droughts, intense precipitation followed by flooding, glacier melting which affects the availability of water resources, especially the increase in processes of erosion and soil loss, as

well as the increase in the number of days and the intensity of meteorological frosts (temperatures below 0ºC).

23. Likewise, the processes of degradation in the basins due to social phenomena associated with the overuse or improper use of natural resources in both basins are giving rise to higher losses of plant cover, degradation of resources, and environmental deterioration; these conditions increase the risk of landslides (*huaycos* and *llocllas* in the local language), the silting of streams, and the loss of soils (in several zones of the Vilcanota basin there are references that slopes are bare and show solid rock).

24. The limited perception, or lack thereof, of the problem hinders proper management of natural resources, including water resources, with limited access to water for irrigation and human consumption.

25. Despite significant traditional, ancestral knowledge, participatory mechanisms have not yet been put in place to promote the involvement of the various institutional and social actors to propose a mutual, systemic solution to the zone's social and environmental problems which give rise to severe economic impacts, ungovernability, and changes to the social structure. These problems will definitely be exacerbated under climate change conditions due to the increase in adverse climate conditions and unawareness of the opportunities that could stem from the new variability.

2. BOLIVIA

2.1 Characterization of the Study's Microcatchments

LA PAZ RIVER MICROCATCHMENT

2.1.1 Environmental Aspects

26. The La Paz River microcatchment is located in the Central Andes and encompasses the municipalities of La Paz (partially), Palca, and Mecapaca of the Department of La Paz, Bolivia. The microcatchment's estimated land area is 1,891 km².

27. Physiographically, the microcatchment belongs to the province of Cordillera Oriental, where Bolivia's principal snow-covered mountains are located. The most important of these are Mount Illimani (6,402 masl) and Mount Mururata (5,869 masl). The highest perpetual snow line is located at 5,300 meters.

28. Geologically, the microcatchment is included in the morphostructural unit of the Cordillera Oriental, which is formed by powerful packets of silico-clastic marine sediments corresponding to lutites, siltites, and sandstone from the Ordovicic to Devonic eras. There are interfolded coastal sediments from the Upper Paleozoic and Cretacic to tertiary continental sediments. The sediments have been strongly folded and faulted, and there are numerous small tertiary to recent intermontane basins that have become population and farming centers.

29. The microcatchment's waters drain into the Amazon River basin, with their sources in Mount Chacaltaya and the Choqueyapu River, later becoming the La Paz River and then the Beni River and forming the natural boundary with the Department of Beni.

30. The northern and northeastern region of the microcatchment (municipality of Palca) corresponds to perpetual snows and permanent glaciers, where there are no flora and fauna species exclusive to these altitudes. However, these are represented by various species of lower altitude thresholds, including various species of *Calamagrostis* and *Senecio, Anthocloa lepidula,* as well as various species of malvaceae and *Nototriche*, among others.

31. In this region, climate data indicate a cold, moist area with perpetual snow cover and glaciers, where low-lying mists are common. Average annual precipitation can reach 497 mm and the average annual temperature is -0.5ºC, according to data from the Chacaltaya station located at 5,220 m.

32. In the central and lengthwise part of the municipality of Palca, whose altitude is lower than the former, precipitation and temperature conditions are more benign, in conjunction with the existence of better soils that are suitable for farming and offer the possibility for agricultural activities.

2.1.2 Social Aspects

33. According to the latest Population and Housing Census in 2001, the microcatchment's population totaled 819,260, of whom 97 percent live in the city of La Paz, in the municipality of the same name. The annual rate of intercensus growth for the period between 1992 and 2001 was 1.67, with the greatest growth in the municipality of Mecacapa (2.25 percent).

34. For 2001, in the microcatchment area, 286,839 inhabitants (35 percent of the total population) were considered poor and 78,374 (10 percent of the total) were living in extreme poverty. In the municipality of Palca, 96 percent of inhabitants were living in poverty; of these, 80 percent were living in extreme poverty. In the municipality of Mecapaca, data show that nearly 80 percent of inhabitants are poor; of these, slightly more than half are living in extreme poverty.

35. Health indicators show that the average infant mortality rate in 2001 was 64.66; the municipality of Mecapaca had the highest index, 73.19. The percentage of diarrhea episodes in children under age five is 30.33 and the percentage of cases of acute respiratory infections in children under age five is 12.6 percent on average, with the highest rate in the municipality of Palca, 19.96 percent.

36. With regard to the basic services existing in homes within the microcatchment, statistical data from the 2001 National Population and Housing Census show that percentages of coverage are not comparable between the city of La Paz and the municipalities of Mecapaca and Palca; the average is a parameter that may not provide adequate data.

37. The city of La Paz, which is one of Bolivia's most important population centers, has service coverages of 91.59 percent for the provision of drinking and cooking water, and 95.35

percent for electricity in homes as of 2001. Gas, the fuel most often used for cooking, is supplied by means of pipes or bottles, with a coverage rate of 87.33 percent.

38. In turn, the municipalities of Palca and Mecapaca, as a whole, present the following data for 2001. With regard to water piped to homes, coverage totals nearly 50 percent; 45 percent of homes are supplied with electricity. In contrast to the city of La Paz, the fuel most often used for cooking is firewood.

39. In the microcatchment area in particular, and in the Department of La Paz in general, no ethnic groups or original peoples are identified.

2.1.3 Economic Aspects

40. The microcatchment area contains three municipalities, two of which have similar economic features (Palca and Mecapaca) and one dissimilar: that of La Paz (city of La Paz), because the population of the first two is distributed among towns with fewer than 2,000 inhabitants, classified as rural populations, while the population of the municipality of La Paz is concentrated in the city of the same name.

41. For the municipality of La Paz as whole in 2001, the most important economic activities[4] are agriculture, cattle raising, hunting, and forestry, and for the city of La Paz, manufacturing industries and commerce. In the municipalities of Palca and Mecapaca, agriculture and livestock raising are the principal activities.

2.1.4. Justification of the Selection of the La Paz River Microcatchment for PRAA-Bolivia

42. The importance and/or relevance of the La Paz River microcatchment for the Andean Regional Adaptation Project in particular and for the Department of La Paz and Bolivia in general is (are) based on the following:

a) There is reliable hydro-meteorological information in the microcatchment regarding its distribution in terms of space and time. There are records, in most stations for over 30 years, which would make it possible to calibrate the outputs of the *High-Resolution Climate Change Simulation Model* (Japanese Model).

   A comparison of the results of the Japanese Model, in the preliminary analyses performed, indicates a good representation of the behavior of current precipitation conditions, so that the future characterization could at least be acceptable to the PRAA's objectives in the microcatchment.

b) According to the latest National Population and Housing Census (2001), the population on the boundaries of the microcatchment totaled 819,260, corresponding to 35 percent of the department's population and nearly 10 percent of the Bolivian population; these populations contain a high percentage living in conditions of poverty and extreme poverty.

[4] The importance of economic activities is considered from the standpoint of employment, not of the contribution to the Gross Domestic Product, because this information is not available.

Due not only to the high population density of the city of La Paz but also to the high percentage of poor people in the microcatchment, especially in the lower part (the municipalities of Palca and Mecapaca), the social, economic, and environmental impacts of climate change and the receding of glaciers could be important from the perspective of the quantification of economic damages and the possible loss of human life, such as what has occurred in extreme climate events in the recent past.

c) The issue of climate change at national and governmental levels has been considered a national priority, ever since worldwide concerns began to emerge. Currently, in light of greater evidence of climate change, the priority is aimed at measures to adapt to climate change, especially in areas where the impact of climate change is estimated to be greater and where ecosystems are more vulnerable to it, as in the case of the La Paz River microcatchment.

   The microcatchment receives direct and indirect contributions of water resources from glaciers. The snowcapped Illimani and Mururata mountains directly contribute ice melt to the municipality of Palca. Indirect contributions come from the diversion of the El Alto microcatchment, also selected under the project, to provide and distribute water to homes in the city of La Paz.

d) The experiences of joint efforts by the municipality of La Paz, Palca, and Mecapaca, although on different issues of climate change, call for their participation and contribution in the various project stages, thus creating favorable conditions for the project's success.

43. Because there is a consolidated organization of municipal institutions that belong to the microcatchment, and because they have autonomy in managing their activities, it may be possible to obtain the necessary resources to finance measures to adapt to climate change and receding glaciers that the project could carry out.

2.2 DESCRIPTION OF PROJECT CONTEXT

44. The climate has been changing rapidly on a global scale; the emission of greenhouse gases, which accumulate in the atmosphere, is responsible for this change. Since the 19th century, the temperature of the earth's surface has been increasing one degree Celsius per century, with the majority of changes occurring in recent decades. With the continued emission of greenhouse gases, it is projected that the temperature of the planet's surface may increase by nearly 6º C, which would result in significant impacts on a global scale.

45. Recent research shows that climate change may be more pronounced in high-mountain regions, such as the Andes region, which could possibly experience particularly dramatic climate changes, especially with regard to the accelerated receding of glaciers. Such changes would have negative impacts on drinking water supply systems, water security for agricultural and livestock activities, and power generation.

46. Because of its location in the central Andes, Bolivia is vulnerable to the impacts of climate change and is the area of operation of the Andean Regional Adaptation Project (PRAA), because the country lies between 2,500 masl[5] in the lower sector at the foot of the Cordillera Oriental, and higher altitudes up to 6,000 masl. This cordillera contains major snow-covered mountains such as the Illimani (6,402 masl, Mururata (5,869 masl), and Huayna Potosí (6,088 masl).

47. PRAA's area of operation involves the La Paz and El Alto microcatchments, which may be considered ecosystems that are sensitive to climate change due to their social, economic, and environmental characteristics and their location in arid and semiarid zones of the Altiplano, and those of the Cordillera Oriental due to the altitude of this mountain chain.

48. In the two microcatchments selected, in 2001 the population totaled 1,514,713, representing 18 percent of the country's total population which consists of a high percentage of poor people: close to 50 percent of the population, of whom 30 percent may be considered to live in a state of extreme poverty. This composition, with a high number of poor people, gives the project study area a high level of social vulnerability.

49. Nearly 95 percent of the population lives in the cities of La Paz and El Alto, which depend on surface sources for their water supply, principally the water stored in reservoirs which are partially fed by glacier melt. Considering the population growth in both cities and estimates of the impact of climate change, the resources currently available are not expected to be sufficient to provide water, in terms of quality and quantity, to these cities in the future.

50. In addition, due to geological conditions, existing soil types, and the location of the cities of La Paz and El Alto on the slopes and plateau of the Cordillera Oriental mountain chain, these cities are very vulnerable to soil erosion which causes solid material to erode and the existing hydraulic works that channel the rivers crossing the city to lose their hydraulic efficiency. In lower sectors, this generates flooding and overflowing which have caused significant material losses and in some extreme events the loss of human lives. This phenomenon also affects the municipalities of Palca and Mecapaca, located downstream from the city of La Paz.

51. In turn, dryland farming is carried out in the El Alto microcatchment (located on the Altiplano) but is limited by the agro-climatic characteristics of the zone and by a small percentage of farmers who benefit from irrigation systems, most of which use ice melt from the Cordillera Real and rainwater. These make the systems vulnerable to climate change which is worsened by the modification of rainfall patterns, causing the region to be vulnerable to frost, droughts, and flooding; these in turn have led young people to migrate to cities in search of opportunities, creating poverty belts especially in the cities of La Paz and El Alto.

52. Although there are no hydroelectric plants in the microcatchment area, dependence on water resources stemming from glacier melt is considered important to generate electricity. This is evidenced by the first hydroelectric plants in the Valle de Zongo, which receive contributions of water (not yet quantified) from the snow-covered Huayna Potosí which lies within the El Alto microcatchment area.

[5] masl: meters above sea level

3. ECUADOR

3.1. Description of the selected study's catchments

53. In the context of the above background information, we have selected the sub-basins and microcatchments directly related to the glaciers of the Antisana volcano, which is part of the Cordillera Real and flows toward the country's Amazon region. These sub-basins and microcatchments are located in the northeast region of the Republic of Ecuador, between the provinces of Napo and Pichincha.

54. The microcatchments that receive waters directly from the Antisana glaciers correspond to the Papallacta, Jeringa, and Quijos Rivers (belonging to the Coca River sub-basin) and the Antisana River microcatchment (belonging to the Jatunyacu River sub-basin). In turn, these sub-basins form part of the Napo River basin, the country's largest.

55. These microcatchments are distributed around the Antisana and occupy an area whose extreme points correspond approximately to the following coordinates:

Extreme northern point:	9970000N	825000E
Extreme southern point:	9922000N	821000E
Extreme eastern point:	9955000N	837000E
Extreme western point:	9938000N	802000E

56. From the viewpoint of sufficient available glaciological and hydro-meteorological data, the microcatchments in question meet the basic requirements for consideration under the PRAA as beneficiaries of pilot adaptation programs, except in the case of the Quijos River microcatchment in which the difficulties of access and steep slopes have hindered the installation of stations in the zone.

57. In general terms, the predominant climate in the microcatchments corresponds to a uniform, cold, high-mountain climate (rain year-round and average temperature below 12°C); average annual precipitation totals 1,300 mm, and it is important to note that the low number of available stations in the study zone has until now hindered the estimation of rainfall distribution.

58. In the sub-basins and microcatchments included in the project, livestock, fishery, and tourism activities are carried out (especially in areas adjacent to and within the zone's principal town, Papallacta). The current uses of waters from the sub-basins considered under the project are drinking water for the city of Quito (with a population of over 2,000,000), hydroelectricity generated in various existing projects, drinking water for the small towns located there, and, in a considerable smaller proportion, for agriculture, fisheries, and tourism.

3.2. Importance for the region and justification for selection

59. In general terms, the microcatchments and basins considered for the formulation phase of PRAA/Ecuador meet the established selection criteria, i.e.:

- There is hydro-meteorological information, most of which has been generated by the National Institute of Meteorology and Hydrology (INAMHI) and by the Metropolitan Drinking Water and Sewerage Company of the city of Quito (EMAAP-Q). In addition, IRD keeps records and carries out various types of glaciological-hydrological research in glaciers 15 and Los Crespos of the Antisana volcano (directly associated with several of the selected microcatchments).

- Moreover, because important projects dealing with the provision of drinking water and the generation of hydroelectricity for the Quito Metropolitan District have been carried out and are expected to be carried out, economic, socio-environmental, and technical information associated with these projects, their zones of influence, and particularly the sub-basins in question exists and is available through EMAAP-Q.

- We feel that the impacts of climate change on glaciers and moorlands associated with the project can be identified and quantified based on existing technical and scientific information (IRD, National Polytechnic School, INAMHI) and on other information that may be obtained and collected during the PRAA formulation phase. In addition, the impacts on environmental, social, and economic dimensions may be evaluated because, for the region included in the project, there is a considerable amount of prior information that could be used as a baseline whose conditions may be compared with those resulting from climate scenarios in the coming months.

- With regard to socio-environmental aspects, it is very important to keep in mind the position presently expressed by the population living in the country's Amazon region, since the various objections to the use of water resources from the Napo River (of which the selected sub-basins and microcatchments are a part) include the lack of sufficient participation by communities potentially affected during infrastructure project design phases, and especially the high levels of uncertainty about the ecological consequences of impounding huge volumes of water at high elevations of the Antisana on the ecological volumes that should be preserved in the sub-basins' rivers, and about other direct and indirect environmental impacts that are commonly caused when such works are carried out in these zones. Another key aspect to keep in mind is that the selected sub-basins and microcatchments partially occupy the area of the Antisana ecological reserve.

- The water resources produced in the sub-basins involved with PRAA/Ecuador are currently of immense importance at local, provincial, and regional levels, because they account for over 60 percent of the total amount provided by EMAAP-Q to over two million people who currently live in the city of Quito and its surrounding areas, and in the future this importance could become even more significant because, with the expansion of the Papallacta and Mica–Southern Quito Projects and the materialization of the Eastern Rivers Project, it is estimated that the demand for drinking water for 3.7 inhabitants could be met, at least until 2055. In

addition, through the realization of these works, the installed capacity to produce electricity is expected to increase.

- With regard to PRAA's likelihood of success, we think there is a very strong possibility that EMAAP-Q will co-participate by offering information, technical and logistical support, and even economic resources, which constitute the foundation for ensuring successful management during PRAA's formulation and implementation phases. Moreover, there is evident scientific interest by IR and INAMHI in the Antisana glaciers; this translates into the availability of information and the willingness to work together on the execution of efforts aimed at identifying impacts on these glaciers and high-mountain zones, as well as on the design and implementation of measures to adapt to such impacts.

- Other actors that we expect to be interested in the project (from their particular viewpoint) are the National Water Resources Council (CNRH), the governments and civil society of towns in the area of influence, the Prefectures of the Provinces of Napo and Pichincha, the indigenous communities of the region, and various NGOs that traditionally deal with these issues. These actors are undoubtedly able to contribute information and interact for the purpose of overcoming the scientific uncertainty that currently exists on the eventual consequences of climate change and/or the use of large quantities of water resources.

3.3. Preliminary analysis of the vulnerabilities present in the basins, associated with global warming.

60. PRAA/Ecuador still lacks sufficient information on this issue to present in this document. The data and knowledge on this subject are expected to be complemented through studies/consultancies which, if carried out on an ongoing basis, will make it possible to obtain relevant information on possible environmental, socioeconomic, institutional, and other vulnerabilities.

3.4. Existing basic information on microcatchments, sub-basins, and related areas

61. As indicated in the previous sections, EMAAP-Q, INAMHI, and IRD, among others, have diverse information related to the microcatchments, sub-basins, and areas of influence of PRAA/Ecuador. Through consultancies, the integrity of existing information on this matter is expected to be inventoried, and a digital database will be formed to facilitate the consultation, processing, and use of information that exists to date and that will be generated with regard to the Antisana's glaciers, the high-mountain ecosystems, the directly related microcatchments and sub-basins, and in general the zones of influence and the populations and communities residing in them.

62. In general terms, the type of information available to date, especially that related to the microcatchments of the Antisana, Papallacta, and Jeringa Rivers, is presented below.

- Cartography and GIS at different scales.
- Digital elevation models.
- Historical series of hydro-meteorological data, in some cases for up to 30 years.

- Regional hydrological study.
- Regional geological and geotechnical study/assessment of dangers and risks of seismic, volcanic, and geodynamic origin.
- Studies of demographics, supply and demand of drinking water in the city of Quito.
- Technical studies of the infrastructure works that are planned to be implemented.
- Environmental Impact Studies.
- Monthly and seasonal relationships between hydro-meteorological information and the fusion of tropical glaciers on Mount Antisana (IRD–INAMHI–EPN).
- Studies of the balance of Mount Antisana's ablation zone and its correlations with local rainfall and global meteorological variables (IRD–INAMHI–EPN).
- Scenarios of water volume reduction in the Antisana's Humboldt basin (this refers to the Antisana River microcatchment).

3.5. Brief, non-quantitative description of the future climate scenario of interest

63. PRAA/Ecuador still does not have enough information on this issue to present in this document. The work of specialists of SENAMHI (Peru and Bolivia) and INAMHI (Ecuador) at the December 2006 workshop in Lima, as well as regional studies contracted on climate scenarios, will provide the opportunity to obtain sufficient data.

64. Despite the above, we include as an example the preliminary estimates resulting from research by IRD–INAMHI–EMAAP-Q, according to which, in the Antisana River microcatchment and under the hypothesis of stable precipitation, three scenarios are proposed, as shown in the following table:

Hypothesis	Scenario	Decrease in volume of flow at the mouth of the glacier	Decrease in the volume of flow in the entire microcatchment
Stability of precipitation	The glacier stabilizes at the current position	-42% to -63%	-13.5 to – 31%
	The glacier loses 25% of its area and stabilizes	-50% to -68%	-15% to -34%
	The glacier totally disappears	-73% to -83%	-20% to -42%

It is the Ecuadoran team's opinion that these and other associated studies should be considered in the study of scenarios to be carried out by IRD, UMASS, and Innsbruck.

Annex 2: Major Related Projects Financed by the Bank and/or other Agencies

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

Relationship to Other Bank Operations in Peru, Ecuador, and Bolivia. The Bank has a significant environmental portfolio of climate-related interventions, mostly related to environmental management. These have been summarized in the following tables:

Sector Issue	Project Name	Status	Implementation Process
Special Program on Adaptation in the Caribbean: SPAC Climate change vulnerability of coastal areas, availability of GCC impacts information	Dominica, St. Lucia, and St. Vincent & the Grenadines: Implementation of Pilot Adaptation Measures in coastal areas of Dominica, St. Lucia, and St. Vincent & the Grenadines (GEF)	In preparation	Satisfactory
Climate change vulnerability, Natural disaster management, Environmental policies and institutions, Vulnerability assessment and monitoring	The Caribbean: Mainstreaming Adaptation to Climate Change (GEF)	Ongoing	Moderately satisfactory
Renewable Energy, Climate Change vulnerability of high-mountain ecosystems and of water resources	Colombia: Amoyá Environmental Services Project	Ongoing	Moderately satisfactory
Climate change vulnerability assessment, adaptation planning and related capacity building	Caribbean Planning for Adaptation to Global Climate Change Project (GEF).	Closed	Satisfactory
Restoration of agricultural capacity	Guyana: El Niño Project (IBRD)	Ongoing	Satisfactory

in drought-stricken areas; vulnerability reduction measures; flood protection and restoration of water supplies in low-lying areas			
Climate change vulnerability, Flood protection, health	Colombia: Integrated National Adaptation Project, INAP	Ongoing	Satisfactory
Climate change, Vulnerability to rising sea level and increased frequency and intensity of hurricanes	Central America, Regional: Addressing impacts of Climate Change on the Caribbean coast of Central America	In preparation	
Climate change vulnerability of coastal areas, water, sanitation, and flood protection	Mexico: Adaptation to Climate Change in the coastal wetlands of the Gulf of Mexico	In preparation	

Peru, Sierra Rural Development Project: The proposed project will provide a platform to promote rural development initiatives, expand productive opportunities, create alliances between producers and other actors in the value chain, build social capital and food security, and strengthen local institutions. The Bank is well positioned to finance this project given its (i) strong track record in supporting rural development and decentralization in Peru through the Country Partnership Strategy (CPS) dialogue, (ii) extensive experience in promoting demand-driven rural productive alliances in Peru and in other countries (Argentina, Bolivia, Colombia, Ecuador, Guatemala, etc.), and (iii) past and current operations in the Sierra, including projects for Sierra Natural Resources Management and Poverty Alleviation (PRONAMACHCS), Rural Roads, Social Development Fund (FONCODES), Rural Education, Indigenous and Afro-Peruvian Peoples Development, Rural Water and Sanitation, Rural Electrification, Trade Adjustment and Competitiveness, Vilcanota Valley Rehabilitation and Management, and Agricultural Extension and Research (INCAGRO).

Annex 3: Results Framework and Monitoring

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

Results Framework

PDO	Project Outcome Indicators	Use of Project Outcome Information
To assist participanting governments to adopt measures to meet the anticipated consequences of the catastrophic glacier retreat induced by climate change.	Integration of glacier retreat impacts into local, regional, and country level planning, as measured by actions taken during the planning process to ensure such integration. Government institutions of Peru, Ecuador, and Bolivia will have the capability to document and disseminate information on the process and the impacts of rapid tropical glacier retreat in the Andes, as measured by technical reports and published papers. A sustainable glacier observation and monitoring network, as measured by continuity of records of previous 12 months and allocation of budget for its mid-term operations after the end of project. Increase in the global and regional awareness on the catastrophic impacts of rapid tropical glacier retreat as measured through mentions in written media of mass circulation.	The outcomes will be the basis for replication in other areas of Andean countries and for medium term adaptation measures planning for in those countries.
Intermediate Outcomes	Intermediate Outcome Indicators	Use of Intermediate Outcome Monitoring
Component 1: Detailed design of strategic	Local, regional, and national institutions of Peru, Ecuador,	The map will be the basis of designing adaptation measures

adaptation measures	and Bolivia have the capability to assess glacier retreat, runoff availability, and water regulation at basin levels for the selected glaciarized basins, as measured by impact map developed. At least 6 sets of adaptation measures designed for the selected basins. At least 10 dissemination notes to reach and raise awareness of local impacts of climate change.	for the selected basins. The adaptation measures will be the basis for the pilots implemented in Component 2.
Component 2: Implementation of pilot adaptation measures	Amount of water supply to be compensated / improved through the pilots in the selected microcatchments in the Antisana Plateau and for Quito City, as consequence of gradual glacier retreat up until 2015. Scope (ha, tons) of agricultural production to be compensated/improved through the pilots in, the selected microcatchments in the Mantaro, Cusco Basins, Peru. Amount of water supply to be compensated/improved through the pilots in the La Paz and El Alto microcatchments in the Altiplano, Bolivia	The outcomes will be used for cost benefit analysis of pilot measures.
Component 3: Monitoring of glacier retreat and associated impacts in the region	Six of glacier monitoring stations are established and capable of monitoring glacier	The outcomes will be used for better long-term planning for further adaptation policy and

	evolution, weather and hydrological conditions in the glacier basin on a sustainable basis, as measured by continuity of records and budget. Increased capacity, i.e., resolution, coverage, and frequency of provision of high precision remote sensing data, of the national institutes of meteorological sciences of the participating countries to monitor gradual process of glacier retreat and associated ecosystems in the region	interventions

Arrangements for results monitoring

Institutional issues:

1. Monitoring and evaluation of project outcomes/results (both intermediate and end-of-project) will be coordinated by the project staff in the Andean Community of Nations (CAN). The CAN project manager will be responsible for monitoring project performance with the assistance of the national coordination units.

2. The project will be guided by semiannual learning reviews of project results to coincide with Bank supervision missions on which basis CAN and the Bank will identify specific measures to: (i) address any areas of implementation weakness, and (ii) adapt project design to ensure that objectives are met. These measures for improvement will be reflected in CAN's semiannual learning reports and its proposal for the forthcoming year's Annual Implementation Plan including project budget.

3. CAN will monitor financial and procurement management for the project. Financial information on inputs, outputs, budgeting, treasury, accounting, and audits will be monitored. The latter activity will be performed by an externally hired consultant. A budget specially allocated for this purpose was considered during the project design stage. The project will send to the Bank quarterly financial management and procurement reports. Monitoring and processing of procurement for services, goods, works, and subprojects will be carried out by CAN's project staff. The annual planning processes will be monitored with specific indicators on planning performance defined in the Results Framework. The project's physical implementation will be monitored based on the specific outputs and monitoring indicators for project components as defined in the Results Framework. Information from the monitoring system will be analyzed by project management and disseminated according to the project's communication strategy to

appropriate stakeholders. The project will provide the Bank with quarterly progress reports and an update on legal covenants compliance every six months.

4. The monitoring and evaluation process will function as a mechanism for assessing project impacts and as a day-to-day management tool. A baseline study will be carried out at inception, and follow-up evaluations at both midterm and project closing. Site-specific baseline studies will be performed before work begins in the pilot areas; baseline studies will be shared with local NGOs and other national institutions. The National Focal Points will collaborate in the process, assuring a free flow of information to project stakeholders. Specific project implementation monitoring data will be provided in agreed-upon report formats, included in the operational manual, and will be required for the twice-yearly supervision missions. CAN, with the help of the Steering Committee, will develop the project monitoring system that will record planning, physical implementation, performance of local technical assistance and development objective indicators from the project's Results Framework.

Data collection

5. National activities will be reported to CAN project management. CAN will be responsible for compiling data and reporting to the World Bank. Data used for regional modeling and post-downscaling activities under Subcomponent 1.2 comes from statistical reports developed by local institutions.

Semiannual evaluations

6. Semiannual discussions are planned to coincide with supervision missions to identify and discuss lessons learned during project implementation with project stakeholders and beneficiaries. Project staff will submit semiannual reports on lessons learned and plans for incorporating those lessons into future activities.

Midterm Evaluation

7. The Bank's supervision team, together with a team of external reviewers and key stakeholders, will conduct a midterm evaluation of project execution. It will be conducted no later than three years after the first disbursement. The external review will focus on: (i) progress in achieving project outcomes, (ii) institutional arrangements for project implementation, (iii) operational manual for payments, (iv) review of both the project implementation plan and general project operational manual. In preparation for the midterm review (MTR), the Steering Committee, together with the local implementing agencies, will prepare a working book containing the following information: (i) executive summary of the overall project status, (ii) up-to-date description of the overall components' development and indicators; and (iii) detailed description of the status of the proposed adaptation pilots by catchments.

Final Evaluation

8. A final evaluation will be conducted in the last semester of project execution. The key objectives of the final evaluation will be to: (i) assess attainment of the project's expected results, (ii) use the results to design a strategy for replication in future projects, and (iii) design a strategy for mainstreaming future adaptation activities in the participating countries.

Arrangements for results monitoring

		Target Values					Data Collection and Reporting		
Project Outcome Indicators	**Baseline**	**YR1**	**YR2**	**YR3**	**YR4**	**YR5**	**Frequency and Reports**	**Data Collection Instruments**	**Responsibility for Data Collection**
Integration of glacier retreat impacts into local, regional, and country level planning, as measured in concrete actions taken for such integration.	0	0 (To be measured at EOP)	0 (To be measured at EOP)	0 (To be measured at EOP)	0 (To be measured at EOP)	At least 6 concrete actions at different levels of planning	Completion Report	Final Evaluation	National Coordinators
Government institutions of Peru, Ecuador, and Bolivia will have the capability to document and disseminate in formation on the process and the impacts of rapid tropical glacier retreat in the Andes, as measured in technical reports and papers for publication.	0	0	0	0	0	5 technical report, 3 journals	Completion Report	Final Evaluation	National Coordinators
A sustainable glacier observation and monitoring, as measured in continuity of records of previous 12 months and allocation of budget for its mid-term operations after the end of project.	Record: None Budget: N/A	Record: 0 Budget: N/A	Record: 0 Budget: N/A	Record: 50% Budget: N/A	Record: 95% Budget: N/A	Record: 97% Budget: 100% at least for the following 2 years.	Annual Report	Annual Review	National Coordinators
At least 30 policy makers from local, regional, national planning institutions increased their awareness and knowledge on the impacts of rapid tropical	0	0 (To be measured at EOP)	0 (To be measured at EOP)	0 (To be measured at EOP)	0 (To be measured at EOP)	At least 30	Completion Report	Survey	National Coordinators

glacier retreat.									
Intermediate Outcome Indicators									
Component 1: Identification, selection, and formulation of adaptation measures									
Local, regional, and national institutions of Peru, Ecuador, and Bolivia have the capability to assess glacier retreat, runoff availability, and water regulation at basin levels for the selected glaciarized basins, as measured by impact map developed.	No map	Draft impact map created	Final impact map completed	-	-	-	Annual Report	Annual Review	National Coordinators
Sets of adaptation measures designed for the selected basins.	0	0	At least 2 sets of strategic adaptation measures	At least 4 sets of strategic adaptation measures	At least 5 sets of strategic adaptation measures	At least 6 sets of strategic adaptation measures	Annual Report	Annual Review	National Coordinators
At least 10 dissemination notes to reach and raise awareness of local impacts of climate change.	0	6	7	8	9	10	Annual Report	Annual Review	National Coordinators
Component 2: Implementation of pilot adaptation measures.									
Amount of water supply to be compensated/improved through the pilots in the selected microcatchments in the Antisana Plateau and for Quito City.	0	0	0	TBD (as a result of PDF-B)		TBD (as a result of PDF-B)	Annual Report	Annual Review	National Coordinators
Scope (# ha, # tons) of agricultural production to be compensated/improved through the pilots in,the selected microcatchments in the Mantaro, Cusco Basins,	0	0	0	200,000 ha		400,000 ha	Annual Report	Annual Review	National Coordinators

Peru.									
Amount of water supply to be compensated/improved through the pilots in the La Paz and El Alto microcatchments in the Altiplano, Bolivia	0	0	0	TBD (as a result of PDF-B)		TBD (as a result of PDF-B)	Annual Report	Annual Review	CAN
Component 3: Monitoring of glacier retreat and associated impacts in the region.									
6 of glacier monitoring stations that are established and capable of monitoring glacier evolution, weather and hydrological conditions in the glacier basin on a sustainable basis.	0	0	0	6 (Bolivia, Ecuador, and Peru)		6 (Bolivia, Ecuador, and Peru) And 2 additional as part of network (Colombia)	Annual Report	Annual Review	CAN
Increased capacity, i.e., quality, coverage, and frequency of provision of high precision remote sensing data, of the national institutes of meteorological sciences of the participating countries to monitor gradual process of glacier retreat and associated ecosystems in the region	Quality: 20 x 20 km resolution Coverage: 1 basin Frequency: N/A	Quality: less than 10 x 10 km resolution Coverage: 3 basins Frequency: Annually	Quality: less than 5 x 5 km resolution, basin basis Coverage: 6 basins Frequency: Semiannually			Quality: less than 5 x 5 km resolution, basin basis Coverage: 6 basins Frequency: Quarterly	Semiannual Report	Semiannual Review	CAN

Annex 4: Detailed Project Description

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

1. The development objective of the proposed project is to implement adaptation measures to meet the anticipated consequences of the catastrophic glacier retreat induced by climate change. Priority will be given to pilots from vulnerable glacial-dependent highland watersheds, other associated ecosystems, and regions of mutual interest to participating member countries, where the combined impacts on global commons and on the prospects for local sustainable development are the highest. The description of the components is presented in the next paragraphs.

Components Description

2. **Component 1. Detailed design of key selected adaptation measures (GEF contribution US$0.4 million; total cost US$5.25 million)**: the objective of this component is to complete the design at least six strategic adaptation measures to be implemented under component 2. The objective will be achieved through two specific sets of activities:

Sub-component 1.1 – Design of Glacierized Basin Impacts Map: This sub-component will apply global climate circulation models developed and run by the Earth Simulator in Japan and use the data generated through project preparation funds to quantify impacts on glacier retreat, runoff availability, and water regulation at basin levels. Under this activity, participating countries will develop an impacts map for the selected glacierized basins. The basins were selected through a set of agreed criteria and in consultation with key stakeholders during project preparation. These criteria and consultation process is described in Annex 1 of this document.

Sub-component 1.2 – Detailed Design of Specific Adaptation Measures: The sub-component will overlay the impacts map designed under sub-component 1.1 on the existing and/or planned regional government programs and investments to adapt to glacier retreat impacts. This activity will support the detailed design of specific adaptation measures, already selected through a broad consultation with major stakeholder groups in each of the participating countries. Design of the pilot adaptation measures will also include a strong monitoring mechanisms to generate data (e.g., on costs) to feed into the overall M&E system of the project developed under component 3.

Sub-component 1.3 – Public outreach and dissemination of information:
This subcomponent has the following objectives: (i) to improve public knowledge of the actual and expected local impacts of climate change on tropical glaciers and how their recession will directly affect associated catchments' ecosystems and socioeconomic activities in the Andean region, (ii) to disseminate existing information on climate change and glacier retreat recession, and their impacts on: 1) water supply systems for human consumption and

agricultural and livestock use, and the 2) energy sector; (iii) raise international awareness on the economic and social costs of tropical glacier retreat.

3. While some regional modeling at a 20 km by 20 km resolution has been developed by local institutions in countries such as Peru, it is still necessary to use downscaling techniques to bring down this initial coarse regional resolution to the project-specific selected sites. The proposed project will assist countries in the downscaling to pilot project resolution, so that they can use this information during the pilots' project implementation phase. The proposed project will focus on the assessments for Peru, Ecuador, and Bolivia, thus achieving the same analytical basis for the three countries. The project will build analytical capacity for policy and project evaluation that can be expanded subsequently to include other sectors. Likely areas for immediate intervention include watersheds, and consequent impacts on hazards to life and property, watershed ecology and desertification, water availability for hydropower, human consumption, and productive uses such as irrigation, agricultural productivity/fisheries, and food security.

Outcomes of this component: Integration of the issue of glacier retreat in the regional/local planning of relevant glacierized basins.

4. **Component 2. Implementation of pilot adaptation measures (GEF contribution US$6.5 million; total cost US$20.10 million)**. This component builds on the detailed blueprints produced under component 1 and its main objective is to successfully implement feasible and replicable adaptation pilot measures in country specific selected basins. The component consists of two sub-components,

Sub-component 2.1: Implementation of pilot adaptation measures in selected communities and sectors highly vulnerable to the effects of glacier retreat. The following pilot adaptation interventions for each country are under formulation and will be appraised prior to CEO endorsement:

List of preliminary indicative adaptation interventions by country

ECUADOR

5. **Selected catchments**: Microcatchments that receive water from the Antisana volcano: Papallacta, Jeringa, Quijos, and Antisana Rivers.

Statement of Expected Climate Change Impacts

- Rapid glacier retreat (observed). Since the recent onset of accelerated glacier retreat (around 1980), downstream water development projects have enjoyed increased availability of water resources, in an unsustainable process. As glaciers are brought close to extinction or a new equilibrium is reached, water availability will be drastically reduced. Estimates for the Antisana glacier, near Quito, indicate potential reduction of its water yield of up to 50 percent.

- Confirmed trend toward reduced precipitation (yearly, high confidence). Global circulation models and historical records show a well-defined trend to a future with less precipitation in the highlands around Quito. It should be noted that the impact of reduced precipitation has an amplified impact on runoff, especially when climate trends also show increasing rates of evapo-transpiration, as in the case of watersheds draining from the Antisana volcano.
- Increased number of high-intensity precipitation events (likely). Regional information, as well as projections based on global circulation models, indicate that the number of severe storms is likely to increase. From a water resources viewpoint, this trend implies greater runoff variability, or reduced reliability in the available/usable water yield.

  For the city of Quito's inhabitants, as well as for the population living in the foothills of the Antisana volcano, climate change is already affecting their lives and threatens their future. Climate change is resulting in water yield reduction, increased runoff variability, and reduced reliability of usable.

6. Proposed Actions

Indicative Pilot Project 1: Assurance of water availability. US$2,000,000

Objective: To develop and implement a CC adaptation strategy for water supply for the city of Quito and surrounding municipalities.

Never before have city planners, engineers, and city officials confronted the problem of planning the expansion of water supply (among other uses of water resources) under the conditions of uncertainty that climate change implies. At the core of this adaptation project is the question of how to incorporate cc threats to planning and operating water supply systems. The following general categories of interventions are being considered. A combination of all options is the most likely outcome (minimum cost). Project participants will begin the lengthy process of adapting to impacts of global warming. The following categories of interventions will be considered in detail:

Main scheduled activities:

1. Strengthening of existing water infrastructure to maintain the same level of service. This category of possible interventions includes: (i) adjustments to existing infrastructure, such as larger intake structures, water supply pipes, increased reservoirs, and improved storage facilities sufficient to maintain same level of water service with reduced glacier runoff contributions; and (ii) changes in system operations to increase the usability of the water resources collected, i.e., the adoption of new operating strategies to maximize the volume of water actually delivered to consumers.
2. Speeding up the development of new water sources to cope with (i) demand growth; and, (ii) water yield reduction. Under this category of interventions city planners and engineers seek to implement identified expansions plans sooner than initially thought (e.g. the inclusion of additional creeks in the water supply system to the city of Quito and the use of underground reservoirs). This option is reflected in the cost analysis presented

in Annex 9. Clearly, such a situation will have important implications for the finances of the water utility and for consumers.

3. Implement demand management options to reduce per capita water consumption/usage. Better use could be made of the water supplied to consumers. All users and all sectors could make efforts to reduce water wastage, and public officials have the responsibility of guiding actions and programs to achieve a "voluntary" reduction in water consumption. Public outreach programs, adoption of new standards for water fixtures, new operating policies, and economic signals are part of the arsenal of tools available to planners and city managers.

Indicative Pilot Project 2: Integrated Catchment Management Plan on the Antisana Plateau to compensate for reduction of water regulation and water availability caused by glacier retreat. US$1,000,000

Objectives: (i) To compensate the decrease in water storage capacity of selected catchments. (ii) To minimize the potential negative effects on highly vulnerable local communities in the area, which in most cases live in extreme poverty conditions.

Main scheduled activities:

1. Facilitating a participatory process to develop and adopt a community-bases Catchment Management Plan including: (i) zoning of land forms, ecosystems, and vegetation formations that incorporate the concerns of reduced glacier runoffs, increased evaporation and generalized warming of mountain habitats; (ii) adoption of adapted land use practices that take into account anticipated climate changes in the Plateau; (iii) implementation of high-priority interventions to secure water retention and regulation lost through rapid glacier retreat and generalized warming (fire prevention/management plans, reforestation with native species);

BOLIVIA

7. **Selected catchments:** La Paz and El Alto Microcatchments

Statement of Climate Change Impacts

- Precipitation shows a decreasing trend (high confidence). Global circulation models are indicating a generalized trend toward lower precipitation regimes in the Andean highlands. This trend will be critical to the already semiarid high plateaus bordering Lake Titicaca. Although global warming is normally associated with increased atmospheric activities, in the basins of interest the trend is opposite. This presents a major challenge to the already impoverished communities settled in the area.
- Increased number of large-scale precipitation events (medium confidence). A regional trend has been observed, supported by GCM, indicating an increase in the number of precipitation events above some thresholds. The possible implication of this observation is added stress to ecosystems, because erosion is closely related to extreme precipitation events, and drought conditions could develop as the periods between precipitation events

increase. Crops, native vegetation, and fauna in general will have to adapt to such new conditions.

- Surface water, the main source of irrigation, is fed from retreating glaciers (observed). Diverting surface runoff waters for water supply and irrigation is an ancestral practice known for centuries before the arrival of the first Europeans. As with all glaciated basins in the Andes, creeks and streams have undergone a process of increased water availability, the result of glacier retreat which is coming to an end for low-altitude glaciers. In the medium term water availability is expected to decrease as glaciers disappear and the water regulating function of glaciers (storing water during the cold months and releasing it during the warm months) will diminish or disappear altogether.
- Temperature increases will be more pronounced at high elevations, fostering increased evapo-transpiration, changes (possibly increases in) crop yields, and increased risks of pest infestation.

8. Proposed Actions

Climate change will compound the difficulties of promoting well-being from agricultural practices in the small, impoverished communities of the Andean highlands. Although the project will concentrate on improving the expected impacts of climate change, a broader perspective will be maintained to ensure that other barriers and market failures are incorporated in the analysis and in the interventions sought. The project will complement programs and projects already being considered by the national and local authorities. The indicative activities are presented below,

<u>Indicative Pilot Project 1</u>: Implementation of a management plan for potable water supply systems in areas affected by the disappearance or reduction of glacier runoffs in the region of La Paz and El Alto. US$2,300,000

Objectives: To include provisions against climate change risks in the, construction, and management of water supply systems. More specifically, (i) the construction and management of water supply systems in the urban areas of La Paz and El Alto and (ii) to construct, and improve the operations of water supply systems in rural areas, specifically Pucarani and Cohoni.

Main scheduled activities:

1. Generating climate scenarios supported by historical data and the use of regional climate models which will give policy makers enough tools to take the necessary steps for those areas most affected by climate change.
2. Providing technical assistance for the study and design of government-planned reservoirs in urban areas near the cities of La Paz and El Alto.
3. Carrying out an assessment of vulnerability to climate change in the rural areas of Pucarani and Cohoni.
4. Implementing adaptation measures that increase resilience to climate change in potable water supply systems for the areas of Pucarani and Cohoni.

<u>Indicative Pilot Project 2</u>: Integrated Pilot Catchment Management Plan in the Bolivian Plateau and High Valleys to compensate for loss of water availability caused by glacier retreat. US$1,700,000

Objectives: To support activities to adapt agriculture and livestock activities to the loss of water regulation and supply caused by glacier runoff through the design of an Integrated Pilot Catchment Management Plan in the Bolivian Plateau and High Valleys.

Main scheduled activities:

1. Building and operating ponds in selected sites where water scarcity is expected to put stress on local economical activities.
2. Implementing a reforestation and revegetation plan to reduce surface water runoff, decrease erosion rates, and promote infiltration
3. Applying water conservation good practices for agricultural and livestock activities.
4. Implementing a water management plan with the help of local communities to make efficient use of water resources in their daily domestic activities (water recycling and adoption of rainfall collection tanks and spouts).

PERU

9. **Catchments selected:** Mantaro River basin (*Shullcas River Microcatchment)* and the Vilcanota–Urubamba (Cusco) River Basin

Statement of Climate Change Impacts

Peru contains roughly 71 percent of the world's tropical glaciers. Recent measurements show catastrophic declines in glacier volumes which are likely to result in substantial impacts on water flows to Andean valleys. For instance, since the early 1980s Peruvian glaciers have lost about 22 percent of their surface (500 km2), equivalent to 7,000 million cubic meters of water (about ten years of water supply for Lima). Peru also has over 12,000 lakes and ponds that could be destabilized by glacier melt.

At lower mountain altitutes, observed climate changes include deterioration of watersheds and depletion of water recharge capacities, increased likelihood of flash fires, and biotic changes in ecosystem thresholds and composition. Moreover, there is substantial risk of glacial lakes causing flash floods and placing large downstream populations and infrastructure at risk. These dramatic hydrological and ecological changes will likely result in a loss of global biodiversity, in addition to losses in ecosystem-dependent goods and services, especially potable and agricultural water supply, and associated hydropower potential, including the loss of traditional water management and agricultural practices and techniques.

Furthermore, the combined impacts of global warming (El Niño Southern Oscillation) and extreme weather events on mountain hydrology are likely to diminish the water flow used by

populations downstream, and to have devastating impacts on highland and associated downstream ecosystems, altering the ecology and livelihoods of millions of people.

The results of statistical downscaling for the study of the Mantaro River's future vulnerability indicate an increase of 1.3°C and a decrease of 6 percent in relative humidity from December to February. The projected increase in air temperature is also consistent with observations; precipitation would decrease by 10 percent, 19 percent, and 14 percent in the northern zone, the middle basin, and the lower basin, respectively.

The principal threats that affect the Mantaro River basin are frost, droughts, aboveground geological dangers, landslides, torrential flows, soil erosion, and riverbed sedimentation. With regard to the Shullcas River sub-basin, the key problems identified relate to the availability of surface and ground water, infrastructure for human water supply, volumes of maximum high waters, protection works, hydroelectric plants, and infrastructure for waste water treatment, waste water drainage, and rain drainage.

In the Cusco region, the problem relates to distribution of and access to water resources. This problem increases under conditions that affect water availability. These conditions include climate change as well as local-level problems such as deforestation and overgrazing, wasteful use of water (for example, irrigation efficiency in the region is 20 percent), water resource degradation (contamination from waste water, solid waste, tailings, and agricultural use), and the increased demand for water resources due to the region's growth. These conditions create conflicts regarding use and the environment, resulting in improper management of water resources.

10. Proposed Actions

The project seeks to address the impacts of climate change on agriculture, energy generation, and basic sanitation in two river basins that have been selected based on the high degree of nearby glacier retreat and the speed at which these climate change-related phenomena occur.

The selected Mantaro River basin is of great economic importance to the country because it generates approximately 35 percent of the country's energy. In addition, the valley's agricultural production provides food to Lima and the population involved totals 700,000. In the Cusco region the total water supply is 72 billion m^3 per year, of which 0.03 percent is used for human consumption and 0.3 percent for agriculture.

In the **agriculture and water** sectors the project seeks to address the water deficit caused by climate change through the efficient use of water in irrigation. In addition the project will support the consideration of more climate-resilient crops and promote crop diversification. The indicative adaptation measures to be sought include:

Indicative Pilot Project 1: **Implementation of a water management plan aimed at: (i) improve water use practices in the agricultural and livestock sectors, and (ii) improve**

water storage infrastructure at selected basins' head waters to address negative effects caused by temporary increase in runoff. US$5,500,000

Objectives:
1) To improve water availability and its use for agriculture and livestock through the design of a water management plan to: (i) improve water use practices (systems for irrigation, improvement in efficiency of water use to compensate reduction in water regulation induced by glacier retreat, and (ii) strengthening storage capacity in selected areas.
2) To implement reforestation to promote water retention. This will be achieved by facilitating the creation of a protected natural area for the purpose of protecting and conserving the hydrological system of snow-covered Mount Huaytapallana and associated small lakes, as the principal source for the generation of water resources, biodiversity, and the scenic beauty of the upper zone of the Shullcas River basin.

Main scheduled activities:

1. Implementing a water management plan with the aid of local communities in the areas of Huancayo, El Tambo (Shullcas), and Santa Teresa, which can help to identify and apply water conservation good practices for agricultural and livestock activities including the optimization of irrigation practices through: (ii) the improvement and expansion of irrigation infrastructure, and (ii) a proposal for institutional arrangements.
2. Carrying out a diagnostic through topographic and geotechnical studies to evaluate storage capacity in the areas of the Lazo Huntay and Chuspicocha ponds in the Mantaro Valley.
3. Building and operating ponds to improve storage capacity in selected locations in the areas of the Lazo Huntay and Chuspicocha ponds in the Mantaro Valley.
4. Developing an institutional strengthening plan for the management and maintenance of ponds in the areas of the Lazo Huntay and Chuspicocha ponds in the Mantaro Valley.
5. Developing a reforestation program at the basin headwaters in Shullcas (Mantaro Valley, Junín) and Santa Teresa (Vilcanota–Urubamba Valley, Cusco), which may include the following activities:

    5.1 Preparing plants in nurseries for the reforestation of 1,200 hectares at the basin headwaters in Shullcas and reforestation of 800 hectares in Santa Teresa.
    5.2 Developing and implementing a forestry management plan and training sessions for its execution by local communities.

6. Developing a protection plan for natural areas as a mechanism to propose the Peru's National System of Protected Areas (SINAMPE) for categorizing the hydrological system of snow-covered Mount Huaytapallana and its associated ponds as a protected natural area.
7. Facilitating the generation of specific projects that are in line with development, and research, aimed at the conservation of the area's natural resources

<u>Indicative Pilot Project 2</u>: **Implementation of an Agricultural Production Plan that compensates for reduction of water availability to the agricultural sector as a result of rapid glacier retreat. US$1,480,000**

Objectives: To implement a plan for the diversification of agricultural production aimed at improving competitiveness and food security, reducing agricultural production losses, and implementing agricultural good practices adapted to the anticipated consequences of glacier retreat in the area.

Main scheduled activities:

1. To identify and implementation of pilot plots of drought-resistant crops.
2. Facilitate purchase of seeds and inputs to promote drought resistant cultivars in the areas of the Shullcas and Santa Teresa sub-basins.
3. To promote changes in agricultural exports to adapt to anticipated conditions and addressing the basic needs of financing for the purchase of seeds and inputs for production in the areas of the Shullcas and Santa Teresa sub-basins.
4. Developing a program in the application of adapted agricultural practices.
5. Developing a program for technology transfer to sustain adapted agricultural practices in the Mantaro Valley.

<u>Indicative Pilot Project 3</u>: **Implementation of an integrated water management plan that incorporates reductions in glacier run-off contributions in Huancayo. US$600,000**

Objectives: To improve the availability of water for human consumption by rationalizing the use of water and research on alternative sources of water supply.

Main scheduled activities:

1. Implementing a plan for improvement, as required, of the drinking water supply infrastructure.
2. Implementing a strategy to plan the use of drinking water and agriculture water.
3. Developing a program with local communities on the rationalization and efficient use of water for human consumption.

The measures in the **energy sector** will be implemented in the Vilcanota–Urubamba riverbed due to the direct impact on the Machupicchu hydroelectric plant. The indicative adaptation measures seek to reduce climate change impacts through the following activities:

- Improvement of water storage and collection capacity in the Santa Teresa watershed through a reforestation program;
- Strengthening of lagoons that depend on the Salcantay glacier in the area of influence of the Santa Teresa watershed;
- Improvement of the collection and conduction infrastructure for the energy generation system.

Outcomes of this component: Incorporation of glacier retreat impacts in the water, energy and agricultural sector policies and implications in the areas of intervention.

11. **Component 3. Monitoring of glacier retreat in the region. (No GEF contribution; total cost US$1.9 million).** The project would support, primarily with assistance from a Climate Change Implementation Grant and other technical and scientific institutions, the installation and operation of a monitoring network to measure the gradual process of glacier retreat in the region in order to enable better long-term planning for further adaptation policy and interventions. The program will be largely supported through a CCIG grant (no GEF contribution) as well as contributions from the Japanese Space Agency, NOAA and IRD.

The monitoring program has two sub-components:

Sub-component 3.1: Design and set up of field stations for monitoring of tropical glaciers of economic relevance**.** This component will finance the design, installation and operation of eight glacier monitoring stations, located at or near tropical glaciers of economic relevance. The component will support the design and the acquisition of the required scientific and monitoring equipment for a total of eight high-altitude stations. The stations will monitor glacier evolution, weather and hydrological conditions in the glacier basin. Two stations each will be located in Peru, Ecuador, and Bolivia which form part of the Regional Andes Climate Change Adaptation Project. Two stations will also be installed in Colombia as part of the network. The stations will generate information and data to inform the process of adaptation to their rapid retreat.

Sub-component 3.2: Use of high precision remote sensing to monitor tropical glaciers and associated ecosystems through the use of the Japanese Space Agency ALOS satellite (Advanced Land Observing Satellite or DAICHI). This component will support the use of ALOS data for remote sensing of tropical glaciers. Specifically, the component will support: a) Data access from ALOS, b) data compilation and storage; c) data interpretation and use. Data from ALOS will be used to monitor glacier evolution and changes during the current period of rapid retreat. This information will be combined with field stations to project glacier evolution and plan for adaptation measures. ALOS data will be complemented with photogrammetry for specific glaciers.

Outcomes of this component: Effective use of the information of the monitoring network as an input to the planning in glacierized basins and decisions taken to support its long term operation.

12. **Component 4:** Project management (Total $1.4 m GEF funding $0.5 m): This component will support the overall technical coordination of Project Activities (including the implementation of a technical monitoring system) as well as the administrative and financial management of the Project. It will include goods; consultancy services; travel; and operating costs undertaken by the Project Management. Specifically this component will finance the project coordinator, the procurement specialist, other required personnel for the project

management, and the project external audits. Incremental GEF co-financing will be used for goods; consultancy services; travel; and operating costs.

Annex 5: Project Costs

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

Project Cost By Component and/or Activity	Local US$ million	Foreign US$ million	GEF US$ million	Total US$ million
C 1: Detailed design of key selected adaptation measures				
Sub C1-1: Design of Glaciarized Basin Impacts Map	2.05	0.5	0	2.55
Sub C1-2: Detailed Design of Specific Adaptation Measures	1.0	1.3	0.3	2.6
Sub C1-3 Public outreach and dissemination of information	0.0	0.0	0.1	0.1
C2: Implementation of pilot adaptation measures				
Sub C2-1: Implementation of pilot adaptation projects in selected communities and sectors highly vulnerable to the effects of glacier retreat	7.95	6.15	6.0	20.1
C-3: Monitoring of glacier retreat and associated impacts in the region	0.8	1.1	0	1.9
C-4: Project Management budget/cost	0.4	0.5	0.5	1.4
Total Baseline Cost	12.20	9.55	6.9	**28.65**
Physical and Price Contingencies (included in baseline costs)				
Total Project Costs[1]				
Interest during construction				
Front-end Fee				
Total Financing Required				

[1]Identifiable taxes and duties are US$m ___, and the total project cost, net of taxes, is US$m___. Therefore, the share of project cost net of taxes is ___ percent.

Associated Bank Investments

Country	Associated Bank investment	Associated Bank investment Project Cost	Adaptation Project link
Ecuador	Ecuador: Rural and Small Towns Water Supply and Sanitation Project II (PRAGUAS)	US$ 48 million	Pilot adaptation activities in rural communities in the Antizana Plateau will be considered for replication under PRAGUAS
Peru	Peru: Agricultural Research and Extension APL Phase 2	US$ 69 million	Adoption of agricultural practices in glacier-dependent watersheds will inform the agricultural research and extension activities under the APL phase two. Practices are expected to benefit from the results of the pilot.
	National Rural Water Supply, Sanitation and Health Project	US$ 50 million	Information from the pilot adaptation activities will be used to further strengthen community management abilities, and introduce new concepts to better cope with the impacts of rapid glacier retreat in communal economic and social activities under the National Rural Water Supply project.
Bolivia	Community-Based Land Distribution Project	US$ 17 million	In the Bolivian Plateau, the adaptation project will support activities to adapt agriculture and livestock activities to the loss of water regulation and supply caused by glacier runoff in the Bolivian Plateau. The data from these

			activities will be of direct benefit to actions under implementation by the land distribution project in the common area of influence of both initiatives.
Total		**US$194 million**	**US$28.7**

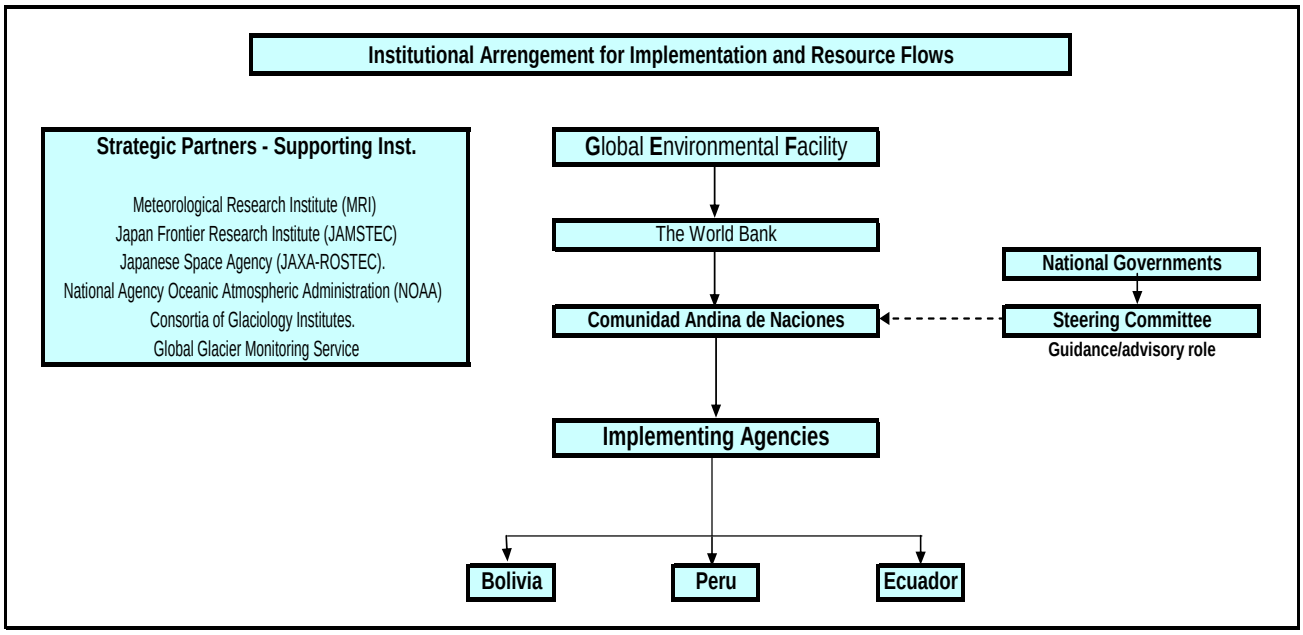
Annex 6: Implementation Arrangements

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

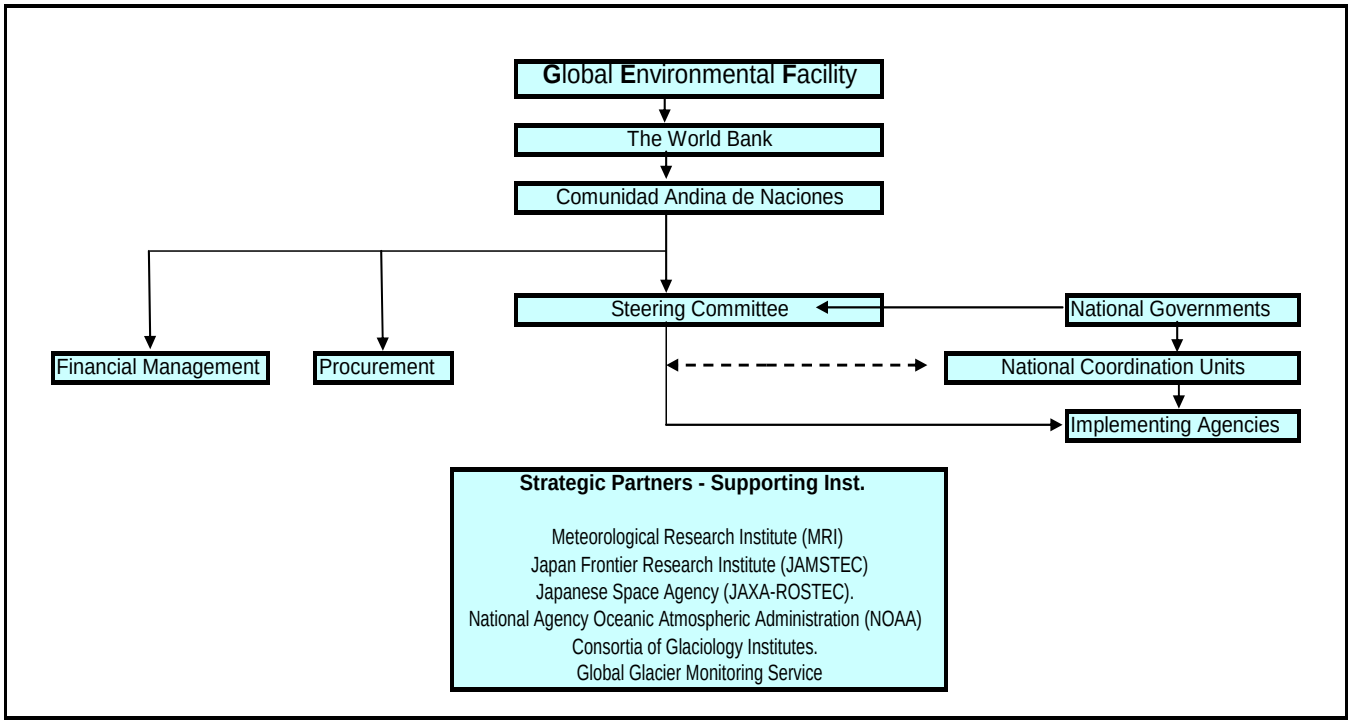
1. General implementation arrangements: The GEF grant recipient will be the Governments of Bolivia, Ecuador, and Peru. The Andean Community of Nations (CAN) will manage the grant resources as executing agency on behalf of the governments. CAN is a subregional organization with international legal status. It is formed by Bolivia, Colombia, Ecuador, and Peru and by the agencies and institutions of the Andean System of Integration (SAI). SAI is the set of agencies and institutions that work together and whose actions are aimed at achieving the objectives of furthering Andean subregional integration, promoting its external projection, and strengthening efforts related to the integration process.

2. The Andean Environmental Agenda contains both short- and medium-term subregional actions that add value to national efforts and help strengthen the capacities of the member countries with regard to environmental and sustainable development issues, including climate change. The 2006–2010 Andean Environmental Agenda for Climate Change provides for the formulation and organization of the Andean Strategy on Climate Change–EACC and its corresponding Action Plan, so that they can serve as a basis for subregional coordination on the priority issues of the countries and of the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

3. **The administrative and financial management** of the project will be undertaken through CAN as the recipient of the GEF grant. CAN will enter into subsidiary agreements with regional implementation agencies. The following chart shows the project's institutional arrangements for implementation and flow of funds. There will be a steering committee created and directed by the national governments of the participating countries, which will maintain a continuous relationship with CAN and will play an advisory role during project implementation.



4. The following chart shows the working structure for the project's technical implementation. CAN will coordinate operational and logistical activities on a continuous basis with the steering committee (SC), the financial management team, and the procurement team during project implementation. The SC will provide technical and institutional guidance to the project as required and will assure that the project is being implemented in accordance with the project development goals and activities as expressed in the Grant Agreement. For this purpose it will have the direct coordination of the national governments, which will be also in continuous communication with the National Coordination Units (GEF focal points). These focal points will maintain a flow of information to the project and will play a coordinating role with both the SC and the local implementing agencies.



Annex 7: Financial Management and Disbursement Arrangements

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

1. [This section is under construction. The Andean Community of Nations will be the Implementing Agency as has been presented before. Currently the Bank's routine financial and procurement assessments are being developed and will be ready for project appraisal. The financial management assessment will be undertaken in accordance with OP/BP 10.02 and the Guidelines for Assessment of Financial Management Arrangements in World Bank-Financed Projects, in order to determine whether the Beneficiary has or will have in place acceptable financial management arrangements prior to effectiveness, capable of providing with reasonable assurance, accurate and timely information on the status of the project in agreed reporting formats.]

Annex 8: Procurement Arrangements

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures
(Recommended length 2-4 pages)

[This section is under construction and will be completed once the Bank's routine Procurement Assessment on CAN is completed. The annex will be completed before project appraisal.]

A. General

1. Procurement for the proposed project will be carried out in accordance with the World Bank's "Guidelines: Procurement under IBRD Loans and IDA Credits," dated May 2004, "Guidelines: Selection and Employment of Consultants by World Bank Borrowers," dated May 2004, and the provisions stipulated in the Legal Agreement. The various items under different expenditure categories are described in general below. For each contract to be financed by the Loan/Credit, the different procurement methods or consultant selection methods, the need for pre-qualification, estimated costs, prior review requirements, and timeframe are agreed between the Borrower and the Bank in the Procurement Plan. The Procurement Plan will be updated at least annually or as required to reflect the actual project implementation needs and improvements in institutional capacity.

2. **Procurement of Works**: Works procured under this project will include: small civil works such as remodeling water and sewer capturing management works (e.g., ponds). Procurement will be done using the Bank's Standard Bidding Documents (SBD) for all ICB and National SBD agreed with or satisfactory to the Bank. [*Indicate any special requirements specific to the project.*] [*If the project involves procurement carried out by communities, indicate where details can be found in the Project Implementation Manual or similar documents.*]

3. **Procurement of Goods:** Goods procured under this project will include: [Describe *the types of goods*]. Procurement will be done using the Bank's SBD for all ICB and National SBD agreed with or satisfactory to the Bank. [*Indicate any special requirements specific to the project.*]

4. **Procurement of non-consulting services: [***Provide a general description of non-consulting services to be procured under the project and information on the bidding documents to be used for the procurement.*]

5. **Selection of Consultants:** [*Provide a general description of the consulting services from firms and individuals required for the project.*] Short lists of consultants for services estimated to cost less than $_____equivalent per contract may be composed entirely of national consultants in accordance with the provisions of paragraph 2.7 of the Consultant Guidelines. [*If applicable, provide any information regarding engaging universities, government research institutions, public training institutions, NGOs, or any special organizations.*]

6. **Operating Costs:** [*Describe the operating costs which would be financed by the project and procured using the implementing agency's administrative procedures which were reviewed and found acceptable to the Bank.*]

7. **Others**: [*Describe if any special arrangements for scholarships, grants etc*.]

8. The procurement procedures and Sods to be used for each procurement method, as well as model contracts for works and goods procured, are presented in the [*name the Project Implementation Manual or the equivalent documents.*].

B. Assessment of the agency's capacity to implement procurement

9. Procurement activities will be carried out by [*name of the Implementing Agency*]. The agency is staffed by [*describe the key staff positions*], and the procurement function is staffed by [*describe the staff who will handle procurement*].

10. An assessment of the capacity of the Implementing Agency to implement procurement actions for the project has been carried out by [*name of the procurement staff*] on [*date*]. The assessment reviewed the organizational structure for implementing the project and the interaction between the project's staff responsible for procurement Officer and the Ministry's relevant central unit for administration and finance.

11. The key issues and risks concerning procurement for implementation of the project have been identified and include [*describe the risks/issues*]. The corrective measures which have been agreed are [*Describe the corrective measures*].

12. The overall project risk for procurement is [*give the risk rating*].

C. Procurement Plan

13. The Borrower, at appraisal, developed a procurement plan for project implementation which provides the basis for the procurement methods. This plan has been agreed between the Borrower and the Project Team on [*date*] and is available at [*provide the office name and location*]. It will also be available in the project's database and in the Bank's external website. The Procurement Plan will be updated in agreement with the Project Team annually or as required to reflect the actual project implementation needs and improvements in institutional capacity.

D. Frequency of Procurement Supervision

14. In addition to the prior review supervision to be carried out from Bank offices, the capacity assessment of the Implementing Agency has recommended [*frequency*] supervision missions to visit the field to carry out post review of procurement actions.

E. Details of the Procurement Arrangements Involving International Competition

1. Goods, Works, and Non-Consulting Services

(a) List of contract packages to be procured following ICB and direct contracting:

1	2	3	4	5	6	7	8	9
Ref. No.	**Contract (Description)**	**Estimated Cost**	**Procurement Method**	**P-Q**	**Domestic Preference (yes/no)**	**Review by Bank (Prior/Post)**	**Expected Bid-Opening Date**	**Comments**

(b) ICB contracts estimated to cost above [*fill in threshold amount*] per contract and all direct contracting will be subject to prior review by the Bank.

2. Consulting Services

(a) List of consulting assignments with short-list of international firms.

1	2	3	4	5	6	7
Ref. No.	**Description of Assignment**	**Estimated Cost**	**Selection Method**	**Review by Bank (Prior/Post)**	**Expected Proposals Submission Date**	**Comments**

(b) Consultancy services estimated to cost above [*fill in threshold amount*] per contract and single source selection of consultants (firms) for assignments estimated to cost above [*fill in threshold amount*] will be subject to prior review by the Bank.

(c) Short lists composed entirely of national consultants: Short lists of consultants for services estimated to cost less than [*fill in threshold amount*] equivalent per contract, may be composed entirely of national consultants in accordance with the provisions of paragraph 2.7 of the Consultant Guidelines.

Annex 9: Economic and Financial Analysis

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

Assessing the Costs of Climate Change: The Case of Water Supply in Quito, Ecuador

1. The metropolitan area of Quito, the capital city of Ecuador, has a competent water utility (EMAAP-Quito) that serves 96 percent of nearly 2 million inhabitants through 7 water systems. The latest expansion of the water supply system is the La Mica project in the foothills of the Antisana volcano-glacier. EMAAP-Quito is proud to have a long-term expansion plan that is estimated to guide future water supply needs for the next 50 years or more. The main water supply component in this expansion plan is the Ríos Orientales project, which also captures waters draining the Antisana and Cotopaxi volcano-glaciers. A plant view of the projects is presented in Figure No.1. The long-term sustainability of the existing water sources, as well as the water yield from the Ríos Orientales, has been recently questioned as more information is made available on the rapid changes observed in the Antisana glacier driven by climate change. Early estimates indicate that glacier melt represents up to 50 percent of the surface runoff measured. Recent analysis confirmed the presence of horizontal precipitation and reduced the estimate to the range of 25 to 35 percent.

La Mica System

2. This is the first major investment made by Quito to obtain waters from the Antisana. The water sources are located 70 km southeast of Quito, and are conveyed by means of a long pipeline. The project's main feature is a reservoir (La Mica) and a series of intake structures capturing water from creeks draining from the Antisana. The La Mica system could tap 3, 5, or 8 creeks, as described in Table 1.

Table 1. La Mica natural water yields under present and future conditions without reservoir

(a) Project: La Mica–Quito Sur	Yield with melting (m^3/s)	Yield without melting (m^3/s)
Alternative 1: 3 creeks	1,722	1,119
Alternative 2: 5 creeks	1,868	1,214
Alternative 3: 8 creeks	2,175	1,414
(b) Project: La Mica Sur with reservoir (43 million cubic meters) (95% reliability)		
Alternative 1: 3 creeks	1,500	0,975
Alternative 2: 5 creeks	1,630	1,060
Alternative 3: 8 creeks	1,820	1,185

3. These data show that even if Alternative 3 is selected it will not provide Quito with a future reliable water yield similar to the smaller Alternative 1 under existing conditions. Based on historical records and hydrologic (static) analysis, the project could yield, with 95 percent reliability, the discharges indicated. When climate change considerations are brought into the

analysis, the potential yields are severely reduced, as indicated. As global warming takes its toll on the glaciers, the city of Quito will experience a dramatic shortfall in its ability to capture all the water it requires.

4. A more detailed depiction of the relationship between reliable yield and reservoir size is found in Table 2 at the end of this annex. To make the two alternatives similar, the comparison must include changes in reservoir size. For example, equivalent alternatives, with a reliable water yield (95 percent) of 1.20 m^3/s, are:

Existing conditions: Alternative 1; 3 creeks and reservoir volume of 4.3 Mm^3
Future conditions: Alternative 3; 8 creeks and reservoir volume of 49 Mm^3

5. The hydrological analyses indicate that under a climate change scenario without glacier melting the La Mica project will be severely affected. To maintain a water yield of 1,200 lps from the La Mica system, under existing condition it is necessary to tap 3 creeks and build a small reservoir of 4.3 Mm^3. Under the climate change scenario the same yield would require tapping the same 3 creeks, adding 5 more creeks, and increasing the reservoir capacity to 49 Mm^3. Otherwise Quito will be forced to look for other alternatives to cope with its growing water demand.

Ríos Orientales

6. This project will serve the city of Quito once the demand for water approaches existing capacity. As one might expect, it will divert water resources located further away from the demand center. Ríos Orientales will take waters from the Amazon basin through a very long pipeline system. The project is designed to grow as demand requires. Initially, some creeks will be diverted to the tunnel intake, and the system will grow by adding more pipelines, more intake structures, reservoirs, and operating and maintenance infrastructure. To bring waters from the Amazon basin to the Pacific basin a 20 km tunnel is required. The system is complemented by water treatment facilities and connected to the expanded distribution grid. Table 2 summarizes the expected water yield for hydrological conditions without and with climate change considerations. Under the climate change scenario the city of Quito will have to build its water infrastructure at an accelerated pace.

Table 2. Water yields in Ríos Orientales Project, with and without climate change

Ríos Orientales Main creek system	**Yield with melting (m^3/s)**	**Yield without melting (m^3/s)**
1. Papallacta–Tumiguina	1,975	1,167
2. Chapi	1,885	1,225
3. Blanco Grande	0,410	0,267
4. Quiljos	0,324	0,211
5. Azufrado–Pucalpa	1,760	1,144
6. Cosanga	0,891	0,579
7. Antisana–Tambo	1,256	0,816
8. Reservoirs and minor creeks	2,479	1,611

As the water yield decreases, resulting from the glacier's disappearance, more creeks will need to be diverted to provide the same level of service as previously done with fewer components.

Estimating the costs of climate change

7. The above information, as well as cost data, could be used to estimate the costs of the global warming phenomenon, from the standpoint of infrastructure development. The results are indicated in Table 3. In the case of the La Mica project, the investment for diverting eight creeks with climate change would yield the same water availability as La Mica with just three creeks without global warming. The investment cost differential is the additional cost Quito must incur, attributable to climate change.

8. A similar exercise is presented for the Ríos Orientales project. In this case, given the design flexibility of adding more creeks as demands grows, the accelerated pace of investment would force the city of Quito to increase its water supply investment needs at the expense of other societal needs. The investment needs, presented in Table 4, are used to estimate the corresponding net present value of the impact on Quito's water supply due to climate change.

Table 4. Investment needs: Ríos Orientales with and without climate change

Year	Existing conditions Creek systems diverted	Investment	Expected conditions Creek systems diverted	Investment
01	Papallacta, Chalpi,	110.00	All creek systems are	143.00
02	Blanco Grande,	110.00	required	143.00
03	Quiljos, Azufrado	112.65		144.00
12	Casanga	10.00	Reservoirs and	39.00
13		11.23	minor creeks	40.27
17	Antisana–Cosanga	22.00		
18		22.28		

Under existing conditions the net present value of the required investments is:

Existing conditions: $298 million
Future conditions: $391 million

In the particular case of Quito and its water supply, global warming increases investment needs by 31.3 percent.

Analysis

9. The data presented are indicative of the costs of climate change in water supply, but they do not capture all the complexity of climate–water interactions. Although there is evidence that precipitation is slowly decreasing with time, and global circulation models indicate that this trend will continue and accelerate in the future, no additional provision was made. Similarly, evapo-transpiration will surely increase with time as temperature increases, but it has not been incorporated in the calculations. The gradual pace at which climate change takes place has not been incorporated. There is considerable agreement on the scenarios used, but the pace at which this will occur is yet uncertain.

PROYECTO MICA-QUITO SUR. EMAP-Q

Cuadro No. 31

VOLUMEN UTIL (millones de m3) PARA REGULAR LOS CAUDALES DE LAS FUENTES DEL PROYECTO EN FUNCION DEL CAUDAL NOMINAL Y DE LA GARANTIA DEL SUMINISTRO

Caudal nominal m3/s	ALTERNATIVA 1. (3 RIOS) GARANTIA 99%	97%	95%	90%	85%	ALTERNATIVA 2. (5 RIOS) GARANTIA 99%	97%	95%	90%	85%	ALTERNATIVA 3. (8 RIOS) GARANTIA 99%	97%	95%	90%	85%
2.100														88.7	58.9
2.050												164.2	112.5	61.6	41.7
2.000											201.2	119.1	84.7	48.3	31.8
1.950											144.3	82.1	63.5	35.7	23.2
1.900											96.0	63.5	49.0	26.5	15.9
1.850											78.1	53.6	40.4	20.5	11.9
1.800									92.1	57.6	62.9	42.4	30.4	15.2	7.0
1.750							161.1	112.8	59.3	40.9	51.6	33.1	23.2	9.9	4.5
1.700						175.0	103.6	73.7	42.0	27.6	42.4	25.8	17.2	6.0	2.0
1.650			138.6	69.3	46.4	125.5	71.4	55.3	31.1	20.1	35.7	20.5	12.6	3.5	0.7
1.600		127.9	85.3	46.9	31.4	79.4	53.5	40.9	21.9	12.7	29.8	16.5	9.3	1.3	0.5
1.550	134.3	74.6	57.6	33.0	21.3	61.6	42.0	31.7	16.1	8.6	24.5	11.9	5.3	1.0	0.4
1.500	88.5	57.6	44.2	24.0	14.9	48.9	32.8	23.0	10.9	4.6	19.2	7.9	3.3	0.8	0.2
1.450	62.9	43.2	32.5	17.1	9.6	39.7	25.3	16.7	6.9	2.3	14.6	5.0	1.3	0.5	0.0
1.400	48.5	32.5	22.9	11.2	5.3	31.7	18.4	11.5	3.5	1.2	11.3	2.6	0.9	0.3	
1.350	38.4	24.5	16.5	6.9	2.7	25.9	13.8	8.1	1.2	0.6	7.9	1.3	0.4	0.0	
1.300	30.4	17.6	11.2	3.2	1.1	20.1	9.2	4.6	0.6	0.4	5.3	0.7	0.0		
1.250	24.2	13.0	7.0	1.5	0.8	15.6	6.0	2.5	0.4	0.2	3.3	0.0			
1.200	18.7	8.5	4.3	0.5	0.6	12.1	3.5	1.2	0.2	0.0	0.7				
1.150	14.2	6.8	1.7	0.4	0.3	8.2	2.0	0.6	0.0		0.0				
1.100	10.1	2.7	1.2	0.2	0.0	5.2	1.0	0.0							
1.050	6.6	1.3	0.6	0.0		3.0	0.0								
1.000	4.2	0.0	0.0			0.0									
0.950	0.0														
Q. medio de las fuentes	1.722 m3/s					1.868 m3/s					2.175 m3/s				
Q. medio captable	1.690 m3/s					1.825 m3/s					2.099 m3/s				

Nota: El caudal medio captable es inferior al caudal medio de las fuentes por cuanto las tomas no pueden captar las crecidas altas.

Table 2. Hydrological reliability analysis: Water yield and reservoir size

Annex 10: Safeguard Policy Issues

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

Social Safeguard Policies

The project is preliminarily expected to trigger the following safeguard policies:

Environmental Assessment (OP/BP 4.01)
Natural Habitats (OP/BP 4.04)
Indigenous Peoples (OP 4.10/BP 4.10)
Forests (OP/BP 4.36)
Pest Management (OP/BP 4.09)

1. **Environmental Assessment (OP/BP 4.01):** The project will build analytical capacity for policy and project evaluation that can be expanded subsequently to include other sectors. Likely areas for immediate intervention include watersheds and consequent impacts on hazards to life and property, watershed ecology and desertification, water availability for hydropower, human consumption and productive use (e.g., irrigation, agricultural productivity/fisheries and food security). A Regional EA will be developed to set forth the major issues, impacts, and mitigation measures (e.g., criteria for selecting pilot sites and determining the need for additional environmental work). This EA will be also used as a planning tool for the regional adaptation strategy.

2. Natural Habitats (OP/BP 4.04): Project adaptation measures may include activities such as improved streamside conservation and management, and improved management of glacier buffer zones. A Regional EA will be developed to set forth the major issues, impacts, and mitigation measures (e.g., criteria for selecting pilot sites and determining the need for additional environmental work).

3. **Indigenous Peoples (OP 4.10/BP 4.10):** The project is likely to benefit farmers and rural communities in the three countries through the implementation of interventions such as reforestation, forestation, livestock management, water resource management, irrigation infrastructure, improved agriculture, etc. It is highly possible that some of these are indigenous communities, in which case the countries involved will prepare a social assessment and an Indigenous Peoples Plan in consultation with the beneficiaries if these are known before appraisal. If communities cannot be identified before appraisal, the countries will prepare an Indigenous Peoples Planning Framework in compliance with OP 4.10.

4. At this stage, the three countries have identified the general areas of intervention but have not yet carried out a social assessment of these areas. Therefore, there is no information on the type of communities and farmers who will benefit from project interventions.

5. The areas selected for project implementation that are more likely to have indigenous peoples are the following:

- In Bolivia: Aymara indigenous communities located in the rural municipalities of Batallas, Pucarani and Palca, as well as herders in El Alto.
- In Ecuador: communities located in the lower parts of the Antisana glaciers and the Napo River in the Amazon basin that may be affected by project interventions in the upper areas.
- In Peru: communities living in the Vilcanota–Urubamba basin. Most of these rural communities are populated by Quechua indigenous peoples.

6. **Forests (OP/BP 4.36):** Forestry activities are aimed at reducing deforestation, enhancing the contribution of forested areas, promoting afforestation, and reducing the vulnerability of neighboring communities to GCC impacts. Some of the indicative pilot projects under Component 2 consider the implementation of reforestation plans for specific catchments. Therefore, as a precautionary measure this safeguard will be highlighted during project preparation and implementation to minimize the risks of unintended negative impacts on national parks and World Nature Heritage sites. Special emphasis will be placed on forest issues during EIA preparation to assure a positive contribution to the resilience of these ecosystems.

7. **Pest Management (OP/BP 4.09)**: Project activities are not expected to lead to an expansion of the area under agricultural production nor will the project finance the procurement of pesticides or pesticide-application equipment. Nevertheless, a Regional EA will study the possibility of the project triggering this safeguard. If this safeguard is triggered a pesticide management plan will be developed for use during project development.

Annex 11: Project Preparation and Supervision

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

	Planned	Actual
PCN review	07/09/2005	07/09/2005
Initial PID to PIC	06/02/2006	
Initial ISDS to PIC	06/02/2006	
Appraisal	04/09/2007	
Negotiations	04/23/2007	
Board/RVP approval	05/29/2007	
Planned date of effectiveness		
Planned date of mid-term review		
Planned closing date		

Key institutions responsible for project preparation:

Bank staff and consultants who worked on the project included:

Name	Title	Unit
Walter Vergara	Task Manager/Lead Chemical Engineer and Environmental Specialist	LCSEN
Alejandro Deeb	Hydrologist	LCSEN
Alonso Zarzar	Social Scientist	LCSEO
Alfred Grünwaldt	Engineer	LCSEN
Seraphine Haeussling	Economist	LCSEN
Keiko Ashida		
Evelyn Villatoro	Procurement Specialist	
Luis Schwarz	Financial Management Specialist	
Counsel	Jorge Kamine	LEGLA

Bank funds expended to date on project preparation:

1. Bank resources: None
2. Trust funds: GEF PDF-B
3. Total: US$590,000

Estimated approval and supervision costs:

1. Remaining costs to approval:
2. Estimated annual supervision cost:

Annex 12: Documents in the Project File

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

Latin America and Caribbean Region: Sustainable Development Working Paper 25: Adapting to Climate Change, Lessons Learned, Work in Progress and Proposed Next Steps for the World Bank in Latin America, October 2005, by Walter Vergara.

Climate change in the tropical Andes–Impacts and consequences for glaciation and water resources, Part 1: The scientific basis, Mathias Vuille, University of Massachusetts, Climate System Research Center.

Project Development Facility: Request for Pipeline Entry and PDF-B Block B Approval: Design and Implementation of Pilot Climate Change Adaptation Measures in the Andean Region aiming at climate resilient sustainable development, January 2006.

Annex 13: Statement of Loans and credits

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

			Original Amount in US$ Millions						Difference between expected and actual disbursements	
Project ID	FY	Purpose	IBRD	IDA	SF	GEF	Cancel.	Undisb.	Orig.	Frm. Rev'd
		Total:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ANDEAN COUNTRIES
STATEMENT OF IFC's
Held and Disbursed Portfolio
In Millions of US Dollars

		Committed				Disbursed			
		IFC				IFC			
FY Approval	Company	Loan	Equity	Quasi	Partic.	Loan	Equity	Quasi	Partic.
	Total portfolio:	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		Approvals Pending Commitment			
FY Approval	Company	Loan	Equity	Quasi	Partic.
	Total pending commitment:	0.00	0.00	0.00	0.00

Annex 14: Other Projects in the Region

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

1. This proposed project is complementary and will not overlap with the work supported by the Second National Communication in Peru, which is being funded as an enabling activity. The enabling activity project will allow Peru to obtain important information regarding climate change and its impacts in two main river basins and in four prioritized sectors (agriculture, energy, transportation, and water) and includes an assessment of water availability. This will help to identify adaptation measures to be included in the Adaptation Strategy under the National Communication. The strategy will be the basis for the selection of specific pilot activities under the proposed project. Close coordination and frequent reporting on both activities is envisaged as part of the formulation and implementation of the adaptation project.

2. Specifically, the river basins prioritized in the Second National Communication are the Santa River Basin (glacier fed) and the Alto Mayo River Basin (tropical rainforest) which feeds into the Amazon River Basin. The integrated local assessments under the Second National Communication will be complementary to previous works performed under the framework of the Peruvian Program on Climate Change–PROCLIM. This local initiative has worked in the Piura (Andean and northern desert coast) and Mantaro River Basins (Andean Central Highlands, near Lima, Peru's capital city). Information developed under PROCLIM and the Second National Communication will provide the basis for the formulation of specific adaptation measures and options and further develop detailed implementation plans. The design and implementation of selected measures will be supported by this Regional Project, which will also help to share experiences and methodologies with other Andean countries such as Bolivia and Ecuador.

3. The French Institute for Research and Development (IRD), together with research institutions in Bolivia, Peru, and Ecuador, is conducting an Andean Glacier Monitoring Program: A Tool to Analyze Global Climate Change in South America. The glaciers of the tropical Andes from Bolivia to Ecuador account for about 10 percent of all Andean glaciers, but their high vulnerability to climate change makes them a fundamental tool to study variability and climate change. This emerging research should be utilized in project analysis of climate and hydrological impacts. The Tropical Glaciology Group in Austria has been conducting reviews of glacier morphology and dynamic balances and would also cooperate in the project.

4. In addition to its formal endorsement of this proposed regional project, Bolivia's groundbreaking climate change projects provide an enabling environment within which to synergistically develop this Regional Project further. Support for Bolivia's projects is being provided by different international agencies already working with the National Program on Climate Change. This national adaptation program encourages civil society engagement in climate adaptation, promotes high-level dialogue in support of long-term public policies on climate change, and conducts case studies related to social adaptation and resilience of productive and subsistence regimes. These popular climate change program models will serve as useful examples of how to proceed at the grassroots level.

5. In Peru, the PROCLIM Project uses an integrated approach (mitigation and adaptation) to climate change, and is responsible for implementing the National Strategy on Climate Change, as well as the National Program: Let's Clean the Air. Additionally, there are currently 6 institutions, which are dedicated to the theme of local integrated assessments of vulnerability and adaptation in two Peruvian watersheds, and at least 25 additional agencies are involved.

6. Collaboration with other SPA-funded projects in the region will be sought through a memorandum of understanding between executing agencies (IDEAM for the INAP project in Colombia and the CCCC for the SPACC project in the Caribbean). The agreement seeks to further the exchange of information, prevent duplication of activities, and contribute to the value added of specific activities in terms of their global learning potential.

7. **Complementarity with the Ecuador water management and development and integration of climate adaptation governance instruments in host government and practitioner protocols project.** In particular, efforts will be undertaken to ensure full coordination with a proposed national project in Ecuador for the SSCF, dealing with water impacts. This national project's primary objectives are to assess future climate risks and work with stakeholders on national policies that increase the flexibility and resilience of managed water resources. Special attention will be given to innovative approaches to adaptation through revised water rights allocations, strengthened water authorities, and accessible adaptive water-saving technologies. The three major outcomes envisioned for this national project are: improved public policy and governance structures for effective water management, increased adaptive water management practices through capacity development and flexible financing mechanisms, and strengthened information and knowledge management on climate risks. Both projects—the Ecuador national project and the Andean regional project—have been designed in close collaboration to ensure that there will be no overlap but rather substantial complementarity. Both projects are expected to be submitted for consideration to the same council meeting.

8. Further, as indicated above, the national proposal for Ecuador focuses on water management and climate adaptation governance instruments. Project inputs and outputs link the water sector and risk management (adaptive) policy and management framework priorities. This distinguishes but complements the Andean Regional Adaptation Proposal. The Ecuador project focuses strongly on water management adaptive governance instruments, and steers away from operational community pilots related to hydrology, thus providing a strong complementarity with regional project activities in the country. The project aims at strong coordination with this activity, involving implementing agencies through an informal coordination committee to ensure that the region's overall adaptive capacity is strengthened through complementary measures.

9. A series of meetings have been held with the Government of Ecuador and UNDP to ensure coordination and cross fertilization. The following table presents a summary of the activities to be developed in each project and how these are coordinated for a perfect complementarity of results.

World Bank Regional Andes Adaptation Project	Ecuador Water Governance Project	Coordination of activities
Component 1. Detailed design of key selected adaptation measures	**Outcome 3.** Provincial and local planning and community action demonstrate adaptation to climate change	Adaptation measures designed under the WP Regional Project will be directly applied by provincial and community planning groups.
Component 2. Implementation of pilot adaptation measures **Indicative Pilot Project 1**: Assurance of water availability. **Indicative Pilot Project 2**: Integrated Catchment Management Plan on the Antisana Plateau to compensate for reduction of water regulation and water availability caused by glacier retreat	**Outcome 1.** Improved systemic capacity supports effective water management under conditions of climate change.	CNRH will be coordinating both efforts. The Ecuador project focuses strongly on water management adaptive governance instruments, and steers away from operational community pilots related to hydrology, thus providing a strong complementarity with regional project activities in the country. The project aims at strong coordination with this activity, involving implementing agencies through an informal coordination committee to ensure that the region's overall adaptive capacity is strengthened through complementary measures.
Component 3. Monitoring of glacier retreat in the region	**Outcome 2**. Institutional capacity to manage climate change risks on water resources developed through improved information and knowledge management.	INAMHI is executing both activities. INAMHI will apply lessons and information obtained in the WB-Project

9. **Bank Portfolio of Projects Supporting the Proposed Interventions**.

In the last two decades the Bank has assisted Bolivia, Peru and Ecuador with a number of projects relevant to the rural sector as well as to key urban centers. (See table below). Most recently, since 2002, the Bank program in the participating countries has had three main components: (a) to create conditions to increase economic competitiveness and productivity; (b) to improve social wellbeing and social policy efficiency; and, (c) to create a modern, decentralized, efficient state at the service of the people. All operations have a strong focus on poverty alleviation. Adaptation to climate change impacts is the creation or strengthening of capabilities to deal with the expected impacts of climate change by anticipating its occurrence and planning and implementing coping strategies. Adaptation is a local process. Adaptation is more effective if the community is being well governed, the more responsive government is to community needs, the presence of mechanisms to voice needs and expectation, the occurrence of well designed and maintained infrastructure. These emphases of the Bank portfolio are supportive and conductive to the proposed pilots on addressing the consequences of climate change and rapid glacier retreat. Pilots' selection was conducted through community participatory processes in each of the selected glaciered basins.

Ecuador portfolio of relevant Bank projects supportative of Adaptation measures

PROJECT ID	PROJECT NAME	COUNTRY	SECTOR BOARD	APPROVAL DATE	TOTAL AMT	IMP AGENCY	SECTOR
P063644	Power and Communications Sectors Modernization and Rural Services Project (PROMEC)	Ecuador	Energy and Mining	20-Nov-01	23	STATE MODERNIZATION COUNCIL	Central government administration
P066752	National System of Protected Areas	Ecuador	Environment	26-Nov-02	0	MINISTRY OF ENVIRONMENT AND FONDO AMBIENTAL NACIONAL (FAN)	General agriculture, fishing and forestry sector
P080093	ECUADOR - Umbrella of Hydro Projects	Ecuador	Environment	16-Dec-04	0	HIDRELGEN	Renewable energy
P095555	Rural and Small Towns Water Supply and Sanitation Project II (PRAGUAS)	Ecuador	Water Supply and Sanitation	25-Jul-06	48	MINISTRY OF URBAN DEVELOPMENT, HOUSING AND BASIC SANITATION	Water supply
P094784	Ecuador Chimborazo Development Project	Ecuador	Rural Sector	26-Jun-07	15	MINISTRY OF FINANCE	General agriculture, fishing and forestry sector
P086626	Agricultural Competitiveness and Sustainable Rural Development (CADERS)	Ecuador	Rural Sector	12-Jul-07	20.9	MINISTRY OF AGRICULTURE	Agricultural extension and research
P037051	Water Resources Management	Ecuador	Environment	13-Jul-07	20	MINISTRY OF AGRICULTURE	General water, sanitation and flood protection sector
P100532	Second Rural Poverty Alleviation and Local Development Project	Ecuador	Rural Sector	11-Sep-07	30	MINISTRY OF PUBLIC WELFARE, LOCAL LEVEL INSTITUTIONS	General agriculture, fishing and forestry sector
P105550	Chimborazo Natural Resources Management Project	Ecuador	Environment	18-Mar-08	0	GOVERNMENT OF THE PROVINCE OF CHIMBORAZO	General agriculture, fishing and forestry sector

10. In Ecuador the Bank portfolio includes: (a) the **Rural and Small Towns Water Supply and Sanitation Project II** (PRAGUAS) (P095555, $48.0 million). Its objective for phase 2 of the APL program is to (i) provide sustainable WSS infrastructure for approximately 500,000 rural beneficiaries; (ii) delegation of water/sanitation and/or solid waste services to autonomous operators in cantonal capitals and extend the coverage and quality of these services; and (iii) promote performance-based investment financing and strengthening sector institutions at the national and local level. (b) **The Chimborazo Development Project "*MINGA* FOR LIFE"** (P094784, $15.0 million) seeks to increase production and market access of 20,000 rural families living in Chambo and Chanchan-Chimbo river basins, through investments in irrigation, roads improvement and conservation of water sources. (c) **Power and Communications Sectors and Modernization and Rural Services Project** which aims to support the Government's efforts to improve prospects for increased efficiency, quality, access, and long-term viability of telecommunications and electricity services. The Project will support the government with the development of sound regulatory frameworks, private participation, extension of services to low income groups, and programs for efficient use and conservation of energy. (d) **Second Rural Poverty Alleviation and Local Development Project,** PROLOCAL II, to support local empowerment, improve quality of local services, and increase access to productive assets to improve the well-being of poor households. As with PROLOCAL I, the strategy to achieve this objective would rest on three pillars: (i) social capital development based on the strengthening of local organizational capacity and empowerment of local-level institutions, (ii) human capital formation based on promotion of networks of local service providers and certification of capacity to support local development planning processes and services, and (iii) access to productive assets based on investments intended to create employment, diversify production, and increase income.

Perú portfolio of relevant Bank projects supportative of Adaptation measures

PROJECT ID	PROJECT NAME	COUNTRY	SECTOR BOARD	APPROVAL DATE	TOTAL AMT	IMP AGENCY	SECTOR
P008037	Irrigation Subsector Project	Peru	Rural Sector	25-Jul-96	85	MINISTRY OF AGRICULTURE	Irrigation and drainage
P065256	NATIONAL RURAL WATER SUPPLY AND SANITATION PROJECT	Peru	Water Supply and Sanitation	29-Aug-02	50	VICE MINISTRY OF CONSTRUCTION AND WATER;	Sanitation
P082625	Vilcanota Valley Rehabilitation and Management Project	Peru	Urban Development	14-Sep-04	4.98	MINISTERIO DE COMERCIO EXTERIOR Y TURISMO	Other social services
P082588	Agricultural Research and Extension APL Phase 2	Peru	Rural Sector	31-Mar-05	25	MINISTRY OF AGRICULTURE	Agricultural extension and research
P094152	Peru Irrigation Sub-Sector Supplemental Project	Peru	Rural Sector	14-Jun-05	10.26	MINISTRY OF AGRICULTURE	Irrigation and drainage
P078894	REAL PROPERTY RIGHTS CONSOLIDATION PROJECT	Peru	Public Sector Governance	14-Mar-06	25	COFOPRI-SUNARP	Sub-national government administration
P079165	PE Sierra Rural Development Project	Peru	Rural Sector	24-Apr-07	20	MINISTRY OF SOCIAL DEVELOPMENT	General agriculture, fishing and forestry sector
P104760	Peru Irrigation Subsector in the Sierra and Water Resources Management Modernization Project	Peru	Environment	20-Nov-07	30	MINISTRY OF AGRICULTURE THROUGH UC-PSI AND IRENA	Irrigation and drainage
P095424	Strengthening Biodiversity Conservation through the National Protected Areas	Peru	Environment	30-Jan-08	0	NATIONAL INSTITUTE OF NATURAL RESOURCES - INRENA	Sub-national government administration
P104350	PE El Nino Disaster Vulnerability Reduction Project	Peru	Urban Development	08-Jul-08	100		Flood protection
P101431	PE Water Sector Modernization	Peru	Water Supply and Sanitation	18-Jul-08	120	TBD	Water supply
P066514	INDIGENOUS PEOPLE PROJECT	Peru	Social Development	21-Dec-08	20	PROMUDEH	General agriculture, fishing and forestry sector
P066158	PE - Environment Mgmt.	Peru	Environment	18-Jan-09	15		General agriculture, fishing and forestry sector

11. In Perú the Bank portfolio is more diverse than in the other two participating countries. The same portfolio addresses the same issues highlighted: (a) to create enabling conditions for increased economic competitiveness and productivity; (b) to improve social policy efficiency; and, (c) to foster an efficient state at the service of the people. This emphasis is exemplified but the following operations: (a) **Peru Irrigation Sub-Sector Supplemental Project**, which seeks to contribute to increase the production and productivity of irrigated agriculture in the Peru's Coast in order to improve the farmer's well-being and to contribute to poverty alleviation. To achieve this objective, the project will promote the development of the Water Users Organizations financing and management capacity, the improvement in the use of the water resource and the increase in the soil use efficiency. (b) **Real Property Rights Consolidation Project**: Building on the achievements of previous operations, the UPRP, the Project will: (i) generate comprehensive real property rights policies through diagnostic studies, strategic partnerships, and legal and regulatory reform proposals; (ii) address the remnant demand for property formalization, through a national strategy, municipal strengthening and tailor-made formalization plans; (iii) establish a National Real Property system based on a unified registry integrated with a national cadastre; and (iv) support property investment and credit promotion initiatives to empower the poor and facilitate the use of the Poor's property rights in a formal economy. (c) **Peru-National Rural Water Supply, Sanitation and Health Project.** The project seeks to increase the sustainable use of new and rehabilitated water supply and sanitation

facilities in rural areas and small towns while improving hygiene practices. More specifically it aims at:(i) implementing demand-responsive and sustainable basic water and/or sanitation services for approximately 1.5 million people in rural communities through the construction and/or rehabilitation of water points, piped systems, and sanitation facilities;(ii) strengthening local communities' capacity to manage services. (iii) strengthening municipal district level capacity to plan and deliver water and sanitation services to rural communities in a sustainable and cost effective way, including the use of private sector participation; and, (iv) strengthening central government capacity to develop sector policies, legislation, and regulatory frameworks, especially those related to the provision of water and sanitation services to the poor in rural and small towns. (d) **Agricultural Research and Extension APL Phase 2**. Phase 2 is contributing to the expansion, strengthening, and institutional development of the rural agricultural technology and innovation system so it is pluralistic, decentralized, demand driven, and led by the private sector. During Phase 2 the project will establish a unit responsible for policy formulation and coordination of public investments, which will contribute to the sustainability of the agricultural innovation system.

12. In addition to the projects mentioned above, the Second National Communication of Perú to the UNFCCC is also an important effort that the country is carrying out to fight climate change. Both projects, The Regional Andes Adaptation project and the Second National Communication have marked differences and are intended to complement each other through their scope of work. The table below presents a general overview of said differences. Additionally it provides an insight on their complementarity.

UNDP Project Document Government of Peru United Nations Development Program Second National Communication of Peru to the UNFCCC	**Adaptation to the impact of rapid glacier retreat in the tropical Andes – Peru**
Differences	
This project is an **enabling activity** that allows Peru to obtain important **information** regarding climate change and its impacts in two main river basins and in four prioritized sectors (agriculture, energy, transportation, and water) and includes an assessment of water availability. This will help to identify adaptation measures to be included in the Adaptation Strategy under the National Communication.	The proposed project will support the implementation of **specific adaptation measures.** It benefits from the information generated under the second national communication in order to select priority adaptation measures. However, the Andes project's focus lies on implementation. It doesn't support any studies but seeks to show how adaptation works practically.
Synergies	
Both projects are complementary to each other. While the second national communication analyzes the vulnerabilities of Peru to the impacts of climate change, the GEF Andes project seeks to demonstrate practically how to reduce a key vulnerability, to rapid glacier retreat, and will provide options on how to adapt to these changes.	In turn the experience with the implementation of adaptation measures will inform the overall process of adaptation to rapid glacier retreat throughout Peru, illustrating costs and benefits.

Specifically, the second national communication intends to determine the relationship between climate change, glaciers retreat, and the impacts on water availability in Peru. Expected outputs in that area are the (i) analysis of current glacier hydrology, including an update of previous glacier inventories, glacier variations, and record of glacier melt hazards and disasters; (ii) estimation of the availability of water resources due to glacier melt at the national level up to 2050; and (iii) evaluation of adaptation strategies in the management of hydro resources in the basins with a glacier component under climate change conditions. These outputs will guide the selection process of priority adaptation measures and will strengthen their design.	

Bolivia portfolio of relevant Bank projects supportative of Adaptation measures

PROJECT ID	PROJECT NAME	COUNTRY	SECTOR BOARD	APPROVAL DATE	TOTAL AMT	IMP AGENCY	SECTOR
P073367	Decentralized Infrastructure for Rural Transformation	Bolivia	Energy and Mining	17-Jun-03	20	SERVICES AND PUBLIC WORKS	Renewable energy
P083050	BO Support to Rural Development Strategy	Bolivia	Rural Sector	30-Jun-03	0		General agriculture, fishing and forestry sector
P083979	Bolivia Urban Infrastructure Project	Bolivia	Urban Development	21-Nov-06	30	MUNI LA PAZ, MUNI EL ALTO, SAGUAPAC	Flood protection
P104714	Strengthening Aid Coordination & Management Capacity for Effective Monitoring of Official Dev Assistance	Bolivia	Public Sector Governance	01-Mar-07	0	VIPFE - VICE MINISTRO INVERSION PUBLICA	Central government administration
P087925	Bolivia Land for Agricultural Development Project.	Bolivia	Rural Sector	26-Apr-07	15	MINISTRY OF SUSTAINABLE DEVELOPMENT	General agriculture, fishing and forestry sector
P101298	BO Participatory Rural Investment II	Bolivia	Rural Sector	26-Jun-07	17	FONDO DE INVERSION PRODUCTIVA Y SOCIAL AND OTHERS TBD	Irrigation and drainage
P101426	Lake Titicaca Local Sustainable Development	Bolivia	Urban Development	15-Nov-07	20	TBD	Other industry
P096267	Towards an Integrated Management of the National System of Protected Areas	Bolivia	Environment	27-Mar-08	0	SERVICIO NACIONAL DE AREAS PROTEGIDAS-SERNAP	Central government administration

13. The following projects are illustrative of the Bank portfolio in Bolivia: (a) **Community-Based Land Distribution Project:** the project seeks to establish a decentralized beneficiary driven mechanism that allows organized landless or poor farmers to acquire suitable agricultural lands and implement investment subprojects which puts them on a sustainable, higher-income pathway. At this point, it is estimated the proposed project would benefit between 1,500 and 3,000 poor rural families. (b) **Urban Infrastructure Project**: The Project aims to improve the access to basic services to the urban poor in Bolivia's major cities through targeted infrastructure

investments and the provision of technical assistance to municipalities in the planning, expansion and sustainability of urban service delivery. Specifically, the project is working: (i) to achieve sustainable improvements in the urban infrastructure and living standards in the poorest neighborhoods of La Paz through comprehensive urban upgrading and neighborhood participation in project implementation; (ii) to enhance mobility in the city of El Alto, removing infrastructure bottlenecks and introducing measures to modernize public transport services and urban transport management; (iii) to expand sewerage coverage in poor areas of Santa Cruz de la Sierra. (c) **Decentralized Energy and Information and Communication Technology for Rural Transformation**. The project objective is to expand and improve delivery of electricity and ICT services through private-sector led mechanisms as a catalyst for the development of rural areas in Bolivia. Phase I includes the following specific interventions in the identified project areas: (i) increasing access to rural electricity and ICT services by using innovative, output-based, decentralized service delivery models with increased private-sector participation and community involvement; (ii) defining and implementing improvements in policy, regulatory and institutional frameworks, and strengthening the respective key institutions; (iii) identifying and developing applications for the productive and social uses of electricity and ICT; (iv) intensively promoting the new services, including market development and training of local users, service providers and authorities; and (v) implementing rigorous monitoring and evaluation programs.

Annex 15: Additionality Analysis

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

Overview

The **development objective** of the proposed project is to implement adaptation measures to meet the anticipated impacts from the catastrophic glacier retreat induced by climate change. This will be achieved by: a) identifying ongoing or planned government interventions with outcomes highly vulnerable to rapid glacier retreat and assessing measures and policy options to adapt to the anticipated effects; b) implementing regional and strategic adaptation pilots to address key climate impacts on their economies; and c) supporting continuing observation and assessment of glacier retreat and the associated impacts in the region. Priority will be given to pilots from vulnerable highland glacial-dependent watersheds, other associated ecosystems, and regions of mutual interest to participating member countries, where the combined impacts on global commons and the prospects for local sustainable development are the highest.

Sector Issues Addressed by the Project

Runoff from tropical glaciers plays a critical role in the water regulation function (storing water during the cold months and releasing it during the warm months), and its reduction would have lasting and pervasive implications for water supply in the Andes. The runoff will be more concentrated in the rainy season due to the loss of water regulation function from glacier retreat, leaving the dry season even drier. In the medium term, water availability is expected to decrease due to glacier melting which is a significant portion of the final watershed runoff, even if glaciers represent only a small fraction of the total watershed.[6] Estimates for the Antisana glacier, near Quito, show a potential reduction of up to 50 percent in its water yield.

Increased number of large precipitation events: A regional trend has been observed, supported by GCM, indicating an increase in the number of precipitation events above some thresholds. The possible implication of this observation is added stress to ecosystems, because erosion is closely related to extreme precipitation events, and drought conditions may develop as the period between precipitation events increase. Crops, native vegetation, and fauna in general will have to adapt to these new conditions.

Temperature increases would be more pronounced at high elevations, fostering increased evapo-transpiration, changes (possibly decreases in) crop yields and increased risks of pest infestation.

With glaciers and *páramos* continuing to shrink at an alarming rate, the hydrological cycles across the Andean region will be permanently compromised without some sort of adaptive coping and risk management mechanisms for biodiversity, land degradation, and economic activities. These climate-induced changes would mean a dramatic reduction in biodiversity and increased ecosystem deterioration, significant degradation in agriculture productivity and food

[6] Vergara, et al. 2006. "The Economic Impacts of Rapid Glacier Retreat in the Andes."

security, risk to human health, and potential damage to public and community utility infrastructure.

The project addresses the vulnerability of highland communities and economic activity (water and power supply) to the impacts induced by rapid glacier retreat. The project also addresses the need for better information on glacier evolution. The project contributes to mainstreaming of glacier retreat concerns into water, power, and agricultural development plans in affected regions.

The vulnerability of water supply to Andean cities will be addressed through the implementation of a pilot measure to counteract the anticipated loss of water regulation and water supply to the city of Quito, caused by the retreat of the Antisana glacier. If successful, this measure will provide invaluable information for the development of water supply strategies for cities throughout the region, affected not only by rapid glacier retreat but also by the warming of other mountain ecosystems, such as moorlands.

The vulnerability of power systems in the Andes that depend on water runoffs from glaciated basins will be addressed through the implementation of a pilot measure that would counteract the seasonal loss in water flows caused by the retreat of glaciers in the Urubamba–Vilcanota valley.

Project Areas

Ecuador: Papallacta, Jeringa, Quijos, and Antisana Rivers

The project locations are the microcatchments of the Papallacta, Jeringa, and Quijos Rivers which belong to the Coca River sub-basin and the Antisana River which belongs to the Jatunyacu River sub-basin. In these areas, livestock, fisheries, and tourism activities are the main economic activities, especially in areas adjacent to and within the zone's principal town, Papallacta. The current uses of waters from the sub-basins are: 1) drinking water for the city of Quito which is inhabited by two million people; 2) hydroelectricity generated in various existing projects; 3) drinking water for other small towns located in the area, and 4) agriculture, fisheries, and tourism in a smaller proportion. The water resources produced in these sub-basins are of immense importance at local, provincial, and regional levels, because they account for over 60 percent of the total amount provided by the Metropolitan Drinking Water and Sewerage Company of the city of Quito (EMAAP-Q) to the over 2 million people living in the city and its surrounding areas.

Peru: Urubamba–Vilcanota and Mantaro Basins

The main use of water in the Mantaro basin is for drinking water for the 431,000 inhabitants of the city of Huancayo, capital of the Junín Region, for irrigation of 2,000 hectares, and for two fish farms and small hydroelectric plants. There has been a conflict between water uses for agricultural purposes and drinking water, especially in the drier season, due mainly to the increase of irrigated areas in recent years as well as the growing population of the city of Huancayo. Low water flows in summer are anticipated and already occurring as a result of warmer temperatures.

Bolivia: La Paz and El Alto microcatchments

The La Paz and El Alto microcatchments encompass the municipalities of La Paz, El Alto, Palca, Mecapaca, Batallas and Pucarani. The entire population of these areas is about 1,515,000 habitants (18 percent of Bolivia's total population), of whom 95 percent live in the city of La Paz and El Alto. Fifty percent of those inhabitants are considered poor and 30 percent live in extreme poverty. The annual rate of population growth for the period between 1992 and 2001 was 2.29, with the greatest growth in the municipality of El Alto (2.25 percent). The city of La Paz, which is one of the most important population centers in Bolivia, had a service coverage of 91.59 percent for the provision of drinking and cooking water, and 95.32 percent for electricity in homes according to the Census that was implemented in 2001. In the municipalities of Palca and Mecapaca, the coverage of water service is nearly 50 percent, and 45 percent of homes are supplied with electricity. In the municipalities of Batallas and Pucarani, the coverage of water service is 25 percent in average and 35 percent of homes are supplied with electricity. In addition to drinking water, water is used for agriculture and livestock which is collected from rivers, sides and others.

Due to changing climate, regional water supplies will not be the same for the areas impacted by accelerated glacier melting, placing millions of already economically and environmentally stressed ecosystems and inhabitants at further risk of inadequate potable water. Furthermore, climate-induced glacial melt will likely precipitate the migration of human populations and mega-faunal animals affected by extreme events. Thus, an average change in the distribution of water, hydrological, and agricultural resources will precipitate hydrological stressors that will likely cause a sharp rise in intraregional and country-scale inequities, and a possible risk of political instability and conflicts.

Semiarid mountainous ecosystems in the region are highly vulnerable to disruption of local hydrological patterns, placing subsistence agriculture and consequently rural livelihoods at risk. Anticipated dramatic fluctuations in the hydrological cycle will exacerbate already stressed ecosystems and reduce the biodiversity and productivity of highland agricultural lands because of unreliable water supply. Furthermore, poor land use practices exacerbate already compromised and destabilized watersheds, root retention structures, and ecosystems. Much of the current research suggests yield decreases in the Andean highlands as a consequence of effects on the water cycle and higher soil surface temperatures if no adaptation options are considered. The adaptive limitations of less-developed subregions will likely increase the disparity in food production and food security in rural highlands. It is also important to consider that much of the lowland basins strongly depend on the tributary streams coming from the mountain regions; therefore, impacts will also be felt downstream.

The region relies on hydropower to cover most of its power requirements, and many rivers that are used to generate hydroelectricity are glacier- or mountain lake-fed. Indeed, most power generation in Peru (80 percent) and Ecuador (50 percent) is met through hydropower. Reduction in water flows will reduce the potential for power generation and directly induce a carbonization of the power sector (countries returning to thermal power plants to make up for reduced hydropower potential), thus increasing these system's greenhouse gas emissions. Recent studies in Ecuador suggest that during the low-water period, the Paute Project (Paute River basin) would

only provide between 43 and 45 percent of average power capacity, which represents a deficit of about 27 percent compared to energy production under normal conditions.

Baseline Scenario

The proposed Regional Andes Adaptation Project baseline is represented by a scenario in which the adoption of specific measures to address the impacts caused by glacier retreat will not take place. This is due to critical but progressive needs which compete with immediate economic development requirements. It is unlikely that similar adaptation project design and development funding would be made available under a business-as-usual scenario, in which other multiple local and regional challenges demand all available technical and financial resources. Without SCCF involvement, a regional approach, i.e., one that supports climate change adaptation activities which generate benefits by alleviating barriers to development caused by the effects of climate change and which may be primarily local benefits, seems very unlikely. Moreover, SCCF resources will have a strong leveraging effect that will help generate additional financial resources.

The following projects have been identified as the baseline scenario in the three participating countries:

Ecuador: Rural and Small Towns Water Supply and Sanitation Project II (PRAGUAS)
This innovative US$ 48 million World Bank operation addresses the main shortcomings identified for the WSS sector in Ecuador. The second phase seeks to promote better service in 25 intermediate towns by strengthening and empowering local authorities to delegate WSS services to autonomous operators. The selected approach will improve water service provision, but will do so by concentrating efforts in the short to medium term.
How do activities under the Regional Andes Adaptation Project add to the baseline scenario in Ecuador?
The proposed Adaptation pilot will focus in the area of Antizana glacier, including rural communities and will explore, within the scope of existing good practices and government programs, options to cope with the consequences of rapid glacier retreat. Emphasis will be given to adaptive planning (planning based on climate projections) as well as on water conflict resolution alternatives, as it is expected than in the future water scarcity has the potential to trigger social and economic tensions. Lessons learned would be replicated in other towns sited in glacierized basins that could be sponsored through the baseline project.

Peru: Agricultural Research and Extension APL Phase 2
This US$ 69 million World Bank project will contribute to the expansion, strengthening, and institutional development of the rural agricultural technology and innovation system so it is pluralistic, decentralized, demand driven, and led by the private sector. It will advance a decentralized market for professional services for agricultural innovation. It will strengthen producer organizations as clients of quality services, and improve entrepreneurial capacity of private service providers. It will also strengthen agricultural research and technological development for innovation in strategic areas of national importance, and to strengthen institutional and professional competence through “centers of excellence”

How do activities under the Regional Andes Adaptation Project add to the baseline scenario in Perú?

Activities to be developed under the proposed Regional Adaptation Project do present a very good example of synergies between adaptation and development projects. Although the proposed adaptation project does not include an agriculture research component, it is clear that farmers confronted with the impacts of rapid glacier retreat will have to adjust their production practices and products to future water availability. Research into drought resistant species and new species suitable to future conditions is needed. The proposed SCCF project will provide the guidance required to define priorities and will create the appropriate environment for readily acceptance of new varieties.

Peru-National Rural Water Supply, Sanitation and Health Project

This World Bank US$ 50 million project aims to increase the sustainable use of new and rehabilitated water supply and sanitation facilities in rural areas and small towns while improving hygiene practices. More specific objectives:(a) implementing demand-responsive and sustainable basic water and/or sanitation services for approximately 1.5 million people in rural communities through the construction and/or rehabilitation of water points, piped systems, and sanitation facilities;(b) strengthening local communities' capacity to manage services, by (i) supporting an effective community participation process during the entire project cycle; (ii) introducing sound financial and economic principles to value water and sanitation services; and (iii) forming and training community-based water committees (JASSs).

How do activities under the Regional Andes Adaptation Project add to the baseline scenario in Perú?

The National Rural Water Supply, Sanitation and Health Project started in 2002 and its implementation is satisfactory to date. The proposed Regional Adaptation Project will build upon the results of this project to superimpose the climate change issues. The proposed Integrated Water Management Plan will work within communities that are sensitized to express their need and build consensus on their priorities. Also these communities would have had training to manage their water services. The Adaptation pilot seeks to integrate climate change consideration in their decision making process, further strengthen their community management abilities, and introduce new concepts to better cope with the impacts of rapid glacier retreat in their economic and social activities.

Bolivia Community-Based Land Distribution Project

The objective of this World Bank US$ 17 million Project is to establish a decentralized beneficiary driven mechanism that allows organized landless or poor farmers to acquire suitable agricultural lands and implement investment subprojects which puts them on a sustainable, higher-income pathway. It is estimated that this project would benefit between 1,500 and 3,000 poor rural families.

How do activities under the Regional Andes Adaptation Project add to the baseline scenario in Bolivia?

The Regional Andes Adaptation Project will collaborate closely with the implementation of the Bank funded project In particular the **Integrated Pilot Catchment Management Plan in the Bolivian Plateau.** (US$1,600,000) will support activities to adapt agriculture and livestock activities to the loss of water regulation and supply caused by glacier runoff in the

Bolivian Plateau. Both project seek to promote sustainability, the Regional Andes Adaptation project will incorporate the climate change perspective, and the concepts of adaptive management into the Community-based Land Distribution Project.

Additional Activities

The project seeks to finance the costs of analytical work and specific investment pilots that are necessitated by climate change and specifically by the warming of the higher catchments, glacial melt, and subsequent changes in the amount and seasonality of river flows. These components of the work would not be needed in the absence of climate change. The analytical work will be integrated into ongoing national planning processes such as the Peruvian Program on Climate Change (PROCLIM) and Ecuador's Water Management and Development and Integration of Climate Adaptation Governance Instruments Project which are funded through other sources.

The project seeks the funding of US$6.9 million from the SCCF to finance one-third of the US$28.65 million project cost. The SCCF financing has served as a catalyst to leverage additional resources from other financiers. The project would be cofinanced by (i) the Republics of Peru, Ecuador and Bolivia (US$7.2 million), (ii) the Swiss Development Corporation (SWF 5 million, US$5.5 million equivalent), (iii) a Climate Change Implementation Grant (US$0.9 million); (iv) NOAA (US$0.3 million), (v) the Meteorological Research Institute of Japan (US$1.0 million), (vi) EMAAP-Quito, the water utility serving Quito (US$4.7 million), (vii) The Andean Community of Nations (US$0.25 m) and other donors (US$1.9 million, to be confirmed) for a total of US$28.65 million. The SCCF requires that most of its resources be used toward the implementation of adaptation measures. Co-financing resources provide complementary funding.

The project would address the additional activities required to achieve climate-resilient sustainable development imposed on vulnerable countries in Andes by the impacts of climate change. The project would provide an enabling environment for regional efforts to address the ravages attributed to climate variability and extremes in Pacific-based highland and coastal-dependent watersheds and human settlements. It would help address primarily local impacts as well as downstream impacts on water supply, agriculture, and energy generation, which are of common interest and importance to the sustainable development of the three countries.

City planners, engineers, and city officials have never before confronted the problem of planning the expansion of water supply (among other uses of water resources) under the conditions of uncertainty that climate change implies. The challenge is how best to incorporate the threats of climate change if planning and operating water supply systems are at the core of this adaptation project. The following general categories of interventions are being considered:

- Strengthening existing infrastructure to maintain the same level of service. This category of possible interventions includes: (i) adjustments to existing infrastructure, such as larger intake structures, increased reservoirs, and improved storage facilities; and (ii) changes in system operations to increase the usability of the water resources collected, i.e., the

adoption of new operating strategies to maximize the volume of water actually delivered to consumers.

- Speeding up the development of new water sources to cope with (i) demand growth, and (ii) water yield reduction. Under this category of interventions city planners and engineers seek to implement identified expansion plans sooner than initially thought. This option is reflected in the cost analysis presented in Annex 9. Clearly, such a situation will have important implications for the finances of the water utility and for consumers.

- Implementing demand management options to reduce per capita water consumption/usage. Better use could be made of the water supplied to the consumer. All users and all sectors could make efforts to reduce water wastage, and public officials have the responsibility to guide actions and programs to achieve a "voluntary" reduction in water consumption. Public outreach programs, adoption of new standards for water fixtures, new operating policies, and economic signals are part of the arsenal of tools available to planners and city managers.

Climate change will compound the difficulties of promoting well-being from agricultural practices in the small and impoverished communities of the Andean highlands. Although the project will concentrate on improving the expected impacts of climate change, a broader perspective will be maintained to ensure that other barriers and market failures are incorporated in the analysis and in the interventions sought. The project will complement programs and projects already being considered by the national and local authorities.

The general categories of possible interventions are:

- Strengthening and complementing existing infrastructure. If climate change affects water availability at a particular site, one solution is to increase the infrastructure, if feasible, to compensate for the loss of water yield. Specific actions may include increasing diversion structures, building or increasing reservoir capacity, improving—through investment in civil works—the efficiency of the existing water systems, improving farm water delivery systems, etc.

- Providing additional infrastructure (more ponds and reservoirs, additional irrigation schemes). Infrastructure could be complemented and/or expanded. More creeks could be diverted and reservoirs built; pumping stations and transbasin systems may be considered.

- Enhancing the sustainable management of available resources. Water resources management may be adjusted to better incorporate scarcity values, improve maintenance, and increase the production of high-value crops. District -level integrated water management should be pursued, and new crop practices should be introduced at farm level.

- Developing new options: new crops or crop varieties, new agricultural practices attuned to climate variability and climate change, and exploration of other land uses. In the

medium term it should be expected that agricultural practices will be subjected to sweeping changes. New crop varieties should be developed to adapt to the expected future climate, practices will need to be modified, and in general strategic decisions will need to be made in order to guide agricultural change toward a new and more sustainable paradigm.

The proposed project specifically aims to carry out the following activities:

- Implementing pilot adaptation activities to address vulnerabilities to rapid glacier retreat, including:
    - Partial substitution of the loss of water regulation caused by the effects of the Antisana glacier's retreat on the water supply for the city of Quito in Ecuador.
    - Reduced vulnerability to loss of glacier runoffs with regard to the ability to generate power in the Urubamba–Vilcanota Basin.
    - Adaptation program designed and incorporated in regional development plans for the area of the Altiplano in Bolivia, taking into account the loss of glacier surface and glacier runoff in the region.
    - Incorporation of glacier retreat impacts on development plans in the following glaciated basins:
        - Bolivia: La Paz River microcatchment and El Alto microcatchment
        - Ecuador: Microcatchments receiving a direct water contribution from the Antisana glacier. These are: the Papallacta, Jeringa, Quijos, and Antisana Rivers.
        - Peru: Mantaro and Cusco Basins.

- Strengthening capacity to produce and disseminate relevant information on the process and the impacts of warming and rapid tropical glacier retreat in the Andes.

- Designing and operating a glacier observation and monitoring network combining six field stations and remote sensing through use of the Advanced Land Observation Satellite of Japan.

This project would produce significant local benefits in the development sectors of agriculture, water, and energy which are being pushed further under changing climate conditions. These benefits include partial substitution of the loss of water supply from glacier runoffs, the communities' preparedness and management with regard to the impacts of glacier retreat, and improved capacity of the glacier observation and monitoring network.

The proposed project follows the guidance defined by the UNFCCC for the SCCF. It will seek the implementation of adaptation activities to address the adverse impacts of climate change. It will also complement traditional government interventions in the area of water resources management by explicitly including the impacts of warmer temperatures and glacial melt into planning processes with emphasis on water supply and irrigation in highland areas, including mountain ecosystems. Moreover, the proposed project will serve as a catalyst to leverage additional resources from bilateral and other multilateral sources. The activities to be funded under the proposed project are country-driven, cost-effective, and integrated into national

priorities as expressed in the National Communications. While the assessment of future climate scenario impacts on key ecosystems has been conducted under the UNDP National Communications for Peru, the project will focus on filling the gap in assessments for the three countries, thus achieving the same analytical basis for all countries.

Annex 16: STAP Roster Review

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

Recommendations

The following comments and suggestions may help to focus and strengthen the project proposal:

1. The project, although very deserving, is somewhat ambitious, given the tasks identified, the limited GEF budget (US$6.9 million), and the local skills capacity for such an undertaking. The approach taken appears to be a piecemeal one, given the costs and the urgency of the problem. However, the project proposal can be strengthened by placing greater priority on the pressing infrastructure upgrades that are required to address future water resources availability following rapid glacier retreat under climate change conditions.

***Response**: The problem is enormous and growing. There is an urgent need to illustrate in a few well-selected basins the potential adaptation strategies. In these basins, the project will invest close to US$30 million at a very local scale. Allocated resources are judged sufficient to initiate the process of adaptation in these locations. The document does not claim that the problem will be solved with this one intervention. Although the GEF grant is for US$6.9 million, the entire project costs are estimated at US$28 million. Nevertheless, these adaptation funds are not enough to cope with the impacts of climate change, reducing the scope of the project to selected pilots. We have paid attention to the fragmentation indicated by the reviewer, and have concentrated resources on more strategic interventions. Although the countries have made detailed analyses of possible interventions, the final determination of the pilot adaptation interventions has been postponed to give recently elected governments the time to define priorities and investments in their portfolio for climate change adaptation.*

The overriding concerns are the consequences of rapid glacier retreat. These differ in different basins so that no single response is valid everywhere. Thus, tailored responses are required.

2. The document contains a number of broad, sweeping statements relating to rapid glacier retreat, automatically ascribing it to climate change without providing sufficient proof or evidence. For instance, the document claims that GCM project shows lower precipitation for the Andean region covering Bolivia, Ecuador, and Peru, unlike the results of the IPCC TAR. This may very well be the case since different GCMs using different climate forcings give contradictory results. It would also have been judicious to include sample stations' data on temperature and precipitation (including the fraction as snowfall) for the study area. Moreover, the tone of the document assumes that GHG climate change and its impacts are inevitable, which may well be the case, but caution must be exercised in such assumptions because of the high uncertainty, stemming from the level of GHG forcing, spatial issues, and climate models imperfections. Furthermore, the project supposedly attempts to undertake monitoring of glacier retreat in the future and less effort is focused

on glacier mass balance modeling using future climate scenarios which are critical in the design of the planned infrastructure works for the future. Besides, governments are more frequently being asked to integrate climate change issues into Environmental Impact Assessments.

***Response**: There is no doubt that rapid glacier retreat as experienced during the last quarter of the last century is directly linked to warming of the troposphere. Additional work performed recently shows that mountain habitats are warming faster than lower altitudes. There is in fact overwhelming evidence of the direct effect of global warming on the catastrophic decline of tropical glaciers worldwide. There is scientific consensus on this point and it should not be debated*

During project preparation we obtained data confirming the climate trends announced by the GCM. In addition, the recent publication of the Fourth Assessment Report by the IPCC reiterates the anthropogenic origin of global warming. The conclusions are now clear: even with the utmost efforts climate change will continue as the earth seeks a new thermal equilibrium to the high concentration of GHG in the atmosphere. This equilibrium will be reached; it is estimated, in centuries, much more time than the expected life of many Andean glaciers. In the new version of the project document we have included a state-of-the-art account of the understanding of tropical glacier retreat.

3. The sectors that are targeted as the focus of the study, i.e., water resources, hydropower generation, biodiversity, agriculture, drainage and flood protection, and lowland infrastructure and peoples are critical for the well-being of Bolivia, Ecuador, and Peru. However, the document does not provide adequate information in terms of institutions and capacity for undertaking the engineering and impact studies in these sectors and there is a lack of details relating to the precise methodologies that are to be used to undertake the assessments of rapid glacier retreat in the tropical Andes. Furthermore, although there are some identified timelines and targets, the planning of the project would seem to evolve as it progresses.

***Response**: Engineering capabilities are not lacking in the Andean countries, although due consideration is given to the need for international expertise. The reviewer's comment of the adaptive nature of planning is correct. It is considered a project's strength to have the flexibility to adjust interventions as new information becomes available and knowledge is increased. The project will be implemented by the Andean Community of Nations, an international institution, in cooperation with local and regional agencies in the targeted basins and with the ministries of environment and offices of climate change.*

4. The document provides details of budget allocations for the three activity components, i.e., *Identification, Selection, and Formulation of Adaptation Measure; Implementation of Pilot Adaptation Measures; and Monitoring of Glacier Retreat and Associated Impacts in the Region* for the GEF project proposal. However, there is no mention of guarantees to sustain the project beyond the five-year timeline and this is a concern.

Response: *The reviewer poses a very important consideration: long-term sustainability. This will depend on the specific pilots selected. If the criterion is to select (during the implementation of component 1) pilots with high local benefits, as is expected, then the expected benefits of the intervention should maintain the communities and governments' interest in its sustainability. This sustainability consideration will be incorporated in the criteria for the final selection of pilot interventions.*

Moreover, the problem is increasing with time and the measures are being developed with regional and local agencies facing a growing crisis with regard to time. There are strong incentives to continue this work in the long term. The GEF project needs to be seen as the necessary first step of a continuum of actions forced by the growing impacts of climate change.

5. It would appear from the project proposal to the GEF, that a good part of the research and funding will be handled by foreign consultants, since the tasks call for highly specialized expertise and equipment in mapping and glacier/hydrological modeling. This raises the issue of capacity building and in-house expertise. Besides, once foreign consultants are done with a project, follow-up and local ownership become issues.

Response: *This is not true. The local glaciology and engineering capabilities are being fully deployed for project implementation. Local institutions are managing the design and implementation of all activities. Where needed, critical inputs from overseas institutions are being used but most of the activities are implemented locally by local institutions. The project has a large component dealing with training and technology transfer. With additional resources from grants local scientists and development practitioners will continue to be trained in the use of data from new satellites and from global circulation models, including the art of downscaling. Local scientists have been and will continue to be involved in glacier retreat monitoring. Commitments are being sought for meteorological agencies to secure station maintenance and data collection for at least a period of 10 years.*

6. The identification of critical risks and possible controversial aspects (native land claims) are to be commended. However, it is stated that there are no controversial aspects related to the project. This statement is very strong and must be justified, especially in view of the fact that major native settlements are located within or in the vicinity of the project area. Also, the fact that social and environmental impacts of the project are considered is also highly commendable.

Response: *All safeguards have been closely studied and defined for the type of interventions sought. In this regard there are no controversial issues to report. The project proponents are working with local communities and their leaders to assure ownership of the pilot projects. This is a criterion for final project selection. No controversial political, social, or environmental issues have been identified.*

7. There is also the issue of supervision and control of the project. The executing agency is CONAM, an affiliate of the Peruvian Government. Also, the geographic size and populations of the three participating countries vary. This provides the potential for disagreements in terms of budget allocations and adaptation measures implemented.

Response: *This has changed. The implementing agency is CAN which represents all three participating governments. Local activities will be implemented by local agencies. The implementing agency has been selected by consensus among the participating countries, and a well-designed and -worded agreement has been signed, defining rights and responsibilities as well as conflict resolution procedures.*

8. There are a number of syntax and grammatical errors that need to be corrected to improve the quality of the project proposal. Furthermore, the document is too long and replete with repetition of information presented.

Response*: The project document has been edited to improve the reading quality of the document.*

9. A number of abbreviations and acronyms that are mentioned in the project document are not defined (CONAM for instance). It is recommended that a list of Abbreviations and Acronyms be inserted in the project proposal.

Response*: A table with abbreviations and acronyms will be inserted in the final document.*

10. The project document has a few incomprehensible and incomplete sections (Table 2, p, 64 and Maps, p. 81), which should be addressed in order to ensure a complete and comprehensive evaluation of the proposal.

Response*: The project document has been edited to improve the reading quality of the document.*

In spite of the above observations and comments, The Implementation of Adaptation Measures to Rapid Glacier Retreat in the Andes Project fits into the criteria of projects eligible for GEF funding for adaptation activities through the Special Climate Change Fund. Moreover, the project addresses a number of very pressing and critical issues relating to climate change impacts and adaptation for water resources management, hydropower generation, flood and drainage control, tropical mountain biodiversity, agriculture, tourism, health, the livelihoods of people, and the sustainable development of Bolivia, Ecuador, and Peru.

Although the project in its present form needs some improvements, it is well founded and justified and therefore GEF funding is highly recommended.

Bhawan Singh

Annex 17: Glaciers Monitoring Network

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

1. **Development Objectives:** To assist in the quantification of economic impacts caused by the rapid retreat of tropical glaciers in the Central Andes as a result of climate change.

2. Expected Key Performance Indicators of the Grant: Design and implementation of a monitoring network of high-altitude mountain stations linked to glaciers of economic relevance in the region. Quantification of economic impacts in agriculture and water supply caused by rapid glacier retreat.

Description of the Grant Components

3. **Component A:** Design and set-up of field stations for monitoring tropical glaciers of economic relevance. (Estimated cost: US$340,000)

> **Detailed Component Description:** This component will finance the design, installation, and operation of eight glacier monitoring stations, located at or near tropical glaciers of economic relevance. Two stations each will be located in Peru, Ecuador, and Bolivia which are part of the Regional Andes Climate Change Adaptation Project. Two stations will also be installed in Colombia as part of the network. The stations will generate information and data to inform the process of adaptation to the rapid retreat of glaciers.
>
> The component will support the design and the acquisition of required scientific and monitoring equipment for a total of eight high-altitude stations. The stations will monitor glacier evolution, weather, and hydrological conditions in the glacier basin.

4. **Deliverables/Outputs:** eight high-altitude stations designed by year one and in operation by year two.

5. **Responsible Implementation Unit/Agency:** The Andean Community of Nations (CAN) with assistance from NOAA (US). CAN is a subregional organization with international legal status and considerable experience in managing resources for the implementation of development projects. It is formed by Bolivia, Colombia, Ecuador, and Peru and by the agencies and institutions of the Andean System of Integration (SAI). SAI is the set of agencies and institutions that work together and whose actions are aimed at achieving the objectives of strengthening Andean subregional integration, promoting its external projection, and strengthening efforts to the integration process. CAN was formed in 1969 and began operating in August 1997. The World Bank is currently preparing an institutional assessment to evaluate CAN's internal financial management and procurement procedures to ensure that it fulfills all requirements for implementation of Bank-assisted operations. Details of these assessments will be archived in the project files.

Summary Description of Grant Agreement:

- Provision of consultant services for the design, installation, and operation of eight glacier monitoring stations.
- Goods and services for the construction of the stations.

6. **Component B:** Remote sensing of tropical glaciers through the use of the Japanese Space Agency ALOS satellite (Advanced Land Observing Satellite or DAICHI). (Estimated cost: US$300,000)

Detailed Component Description: This component will support the use of ALOS data for remote sensing of tropical glaciers. Specifically, the component will support: a) data access from ALOS, b) data compilation and storage, and c) data interpretation and use.

Data from ALOS will be used to monitor glacier evolution and changes during the current period of rapid retreat. This information will be combined with field stations to project glacier evolution and plan for adaptation measures. ALOS data will be complemented with photogrammetry for specific glaciers

Deliverables/Outputs: 1) Historical detection radar maps of tropical glaciers in the Andes covering two years of ALOS operation. 2) Assessment of glacier retreat process.

Responsible Unit/Counterpart: CAN with assistance from RESTEC (Japan)

Summary Description of Grant Agreement:
Provision of consultant services for: a) data access from ALOS, b) data compilation and storage, and c) data interpretation and use.

7. **Component C:** Training and economic assessment of implications from rapid glacier retreat. (Estimated cost: US$225,000)

Detailed Component Description: The component will support training for use of information gathered under components (a) and (b), as well as an economic assessment of the implications of rapid glacier retreat in the region's vulnerable glaciated basins.
The training will be provided to staff from CAN and other meteorological institutions in the region as well as to specialized staff in the climate offices.
The component will also support the economic assessment of implications of rapid glacier retreat in agriculture, water supply for urban mountain populations, including large cities such as Quito and Lima, and power generation.

Deliverables/Outputs: Report on the economic impacts of rapid glacier retreat.

Responsible Unit/Counterpart: CAN

Summary Description of Grant Agreement: Training in support of components (a) and (b) and consultant services for economic assessment of impacts from glacier retreat.

Annex 18: The Andean Community of Nations, CAN

ANDEAN COUNTRIES: Design and Implementation of
Pilot Climate Change Adaptation Measures

The Andean Community of Nations, CAN is a subregional organization with international legal status. It is formed by Bolivia, Colombia, Ecuador, and Peru and by the agencies and institutions of the Andean System of Integration (SAI). SAI is the set of agencies and institutions that work together and whose actions are aimed at achieving the objectives of furthering Andean subregional integration, promoting its external projection, and strengthening efforts related to the integration process.

The Andean Environmental Agenda contains both short- and medium-term subregional actions that add value to national efforts and help strengthen the capacities of the member countries with regard to environmental and sustainable development issues, including climate change. The formulation and structuring of the Andean Strategy on Climatic Change - EACC and their corresponding Plan of Action are contemplated in the Andean Environmental Agenda 2006-2010 in order that they serve as foundation for the subregional coordination in the high-priority subjects of the countries and the Marco Convention of the Nations United on Climatic Change and of the Protocol of Kyoto. Also regional high-priority sectors are contemplated the generation of capacities to evaluate the effects of the climatic change in subjects/, and the agreement of joint positions before the international forums of negotiation in the matter of Climatic Change and the fortification of the participation of the national delegates.

Area of Integration

- The CAN has carried out a Commercial Integration characterized by: Zone of Free Commerce, Common External Tariff, Norms of Origin, Competition, Practical standards, Sanitary Norms, Customs Instruments, Strips of Prices, Automotive Sector and Liberalization of Comercio de Servicios.
- In the field of the External Relations, the CAN maintains: negotiations with the MERCOSUR, with Panama, with Central America and the CARICOM; Relations with the European Union, Canada and the U.S.A.; It participates in the ALCA and the OMC; and all the countries members have a Common Foreign policy.
- Also, this organism has made concerted efforts to obtain a Physical and Border Integration in the matter of transport, infrastructure, border development and telecommunications, and also a Cultural, Educative and Social Integration.
- A Common Market, the CAN makes tasks of: Coordination of Macroeconomic Policies, Intellectual, Investments, Purchases of the Common Farming Sector Public and Political Property.

At the moment the Andean Community groups to five countries with a population superior to the 105 million inhabitants, a surface of 4.7 million square kilometers and a Gross Inner Product of the order of 285,000 million dollars. It is a subregion, within South America, with an own profile and a common destiny.

Annex 19: Climate change in the tropical Andes: Impacts and consequences for glaciation and water resources

ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

REDUCTION OF VULNERABILITY FROM RAPID TROPICAL GLACIER RETREAT IN THE ANDES PROJECT

1. Observations on the extent of glaciers in Venezuela, Colombia, Ecuador, Peru, and Bolivia provide a detailed and unequivocal account of rapid shrinkage of tropical Andean glaciers since the Little Ice Age (LIA). The retreat appears to have been non-uniform throughout the 20th century with periods of stronger recession interrupted by phases of more stable conditions or even minor re-advances such as in the 1970s and at the end of the 20th century. In general, however, there is clear evidence of ongoing shrinkage since the mid-1970s. Many smaller, low-lying glaciers are completely out of balance with the current climate and may disappear within a few decades. Mass balance records from Bolivia and Ecuador similarly show a very coherent picture, with a generally negative mass balance, which appears to be driven by the same background forcing throughout the region. Superimposed on this negative trend are interannual variations with occasional periods of balanced or even positive mass balance, in particular during prolonged La Niña events, such as between 1999 and 2001.

2. Glaciers grow or shrink as a reaction to changes in their mass balance, an obvious reaction being the advance or retreat of their tongues. The mass balance describes where and how a glacier is gaining or losing mass due the predominance of accumulation or ablation processes, which in turn are determined by climatic variables such as temperature, precipitation, solar radiation, humidity, etc. Because of the lack of a pronounced thermal seasonality but a clear differentiation between dry and wet seasons, tropical glacier mass balance and its sensitivity to climate change are fundamentally different from mid- and high-latitude glaciers. Inner tropical glaciers have a very negative mass balance below their Equilibrium Line Altitude (ELA) due to the ablation zone's exposure to melt and sublimation 365 days per year. In the subtropics ablation is greatly reduced, mostly because sublimation dominates over melt due to generally low humidity. Because of these characteristics the ELA is generally close to the 0°C line in the inner tropics and thus the ELA will react sensitively to changes in temperature. In the outer tropics the ELA is usually located considerably above the 0°C line, and a temperature increase will not have such an immediate effect. The ELA instead is more sensitive to changes in precipitation and humidity, which determines the ratio of melting to sublimation.

3. In general the glacier mass balance in the outer tropics reflects the variability in wet season accumulation and ablation, while mass turnover is minor during the dry season. In the inner tropics, on the other hand, mass net ablation remains quite constant throughout the year. The most dominant forcing factor on interannual timescales is associated with ENSO. During El Niño years subtropical glaciers experience reduced accumulation, a lowered albedo, combined with an increase in incoming shortwave radiation due to reduced cloud cover. All these factors contribute to a very negative mass balance. In the inner tropics the glacier response to ENSO is very similar but for different reasons. Here the impact of El Niño is through increased air

temperature which favors rain over snowfall, and to a lesser degree due to sporadic snowfall, insufficient to maintain a high glacier albedo, low wind speeds which limit the transfer of energy from melting to sublimation, and reduced cloud cover which increases the incoming shortwave radiation.

4. Several terms of the energy balance, show pronounced seasonality with very different behavior during dry and wet seasons. In the outer tropics both mass loss and runoff show a marked seasonality, which cannot be explained by sensitive heat transfer, and shows little seasonality and is generally small. Instead, net radiation and the latent heat flux dominate the energy balance. Incoming energy is quite constant throughout the year and instead it is the partitioning of this energy into melt and sublimation, controlled by humidity, which causes the much higher mass loss during the wet season. When humidity is high (wet season), the available energy is directly consumed by melting, while the enhanced vapor pressure gradient during the dry season favors sublimation, which is energetically inefficient and therefore leads to reduced mass loss. These peculiarities of the energy balance make subtropical glaciers highly sensitive to (a) changes in atmospheric humidity, which governs sublimation, (b) precipitation, whose variability, particularly during the rainy season induces a positive feedback on albedo, and (c) cloudiness, which controls the incoming long-wave radiation.

5. In the inner tropics the absence of thermal seasonality exposes the ablation zone to oscillations of the 0°C isotherm throughout the year. These small fluctuations in temperature determine the rain–snow line in the ablation zone and thus have a major impact on the albedo. As a result, air temperature significantly influences the energy balance in the inner tropics, although not through the sensitive heat flux as commonly thought, but indirectly through changes in albedo and net radiation receipts.

6. The high sensitivity of tropical glacier mass and energy balance to climate change, which is under way and well documented, leaves little room for doubt that the observed glacier retreat is occurring in response to a changing climate. Temperature in the Andes has increased by approximately 0.1°C per decade, since 1939, with the bulk of the warming occurring over the last two decades. Since the mid-1970s the rate of warming almost tripled to 0.3°C per decade. The eastern slopes show a much subdued warming, while the warming on the Pacific side is strongest. Higher elevations have experienced an intermediate but still significant warming. On average about 50–70 percent of the observed temperature change in the Andes can be attributed to a temperature increase in the tropical Pacific. Observations suggest that precipitation slightly increased in the second half of the 20th century in the inner tropics and decreased in the outer tropics. However, trends at individual stations are weak and mostly insignificant. Nonetheless, the general pattern of moistening in the inner tropics and drying in the subtropical Andes is dynamically consistent with observed changes in the large-scale circulation. Both satellite information and reanalysis data seem to suggest a strengthening of tropical atmospheric circulation. Changes in the inner tropics are characterized by enhanced low-level convergence, upper-level divergence, and as a result enhanced upward motion, increased convective activity, and more humid conditions. In the subtropics the opposite trends prevail, with increased subsidence and reduced convective activity leading to potentially drier conditions.

7. Model projections of future climate change in the tropical Andes indicate a continued warming of the tropical troposphere throughout the 21st century, with a temperature increase that is enhanced at higher elevations. By the end of the 21st century, following the SRES A2 emission scenario, the tropical Andes may experience a massive warming on the order of 4.5°–5°C. The Special Report on Emission Scenarios (SRES) A1B scenario reaches about 80–90 percent of the warming displayed in the SRES A2 scenario at the end of the century, while the more moderate SRES B1 path displays only about half of the warming of SRES A2. All emission paths tend to show the same pattern of warming, but they differ in amplitude. Predicted changes in precipitation include an increase in precipitation during the wet season and a decrease during the dry season, which would effectively enhance the seasonal hydrological cycle in the tropical Andes.

8. If tropical glaciers continue to retreat and eventually disappear from certain catchments, the change in stream flow, due to the lack of a glacial buffer during the dry season, will significantly affect the availability of drinking water and of water for hydropower production, mining, and irrigation. In the tropical Andes the problem is exacerbated when compared with mid-latitude mountain ranges because ablation and accumulation seasons coincide; this precludes the development of a long-lasting seasonal snow cover outside the glaciated areas. Glaciers are therefore the only major seasonally changing water reservoir in the tropical Andes. Tropical Andean catchments show a high correlation between their capacity to store precipitation and their percentage of glaciated area. As glaciers retreat and lose mass, they add to a temporary increase in runoff. Downstream users will quickly adapt to this temporary increase in water supply, which raises serious sustainability concerns.

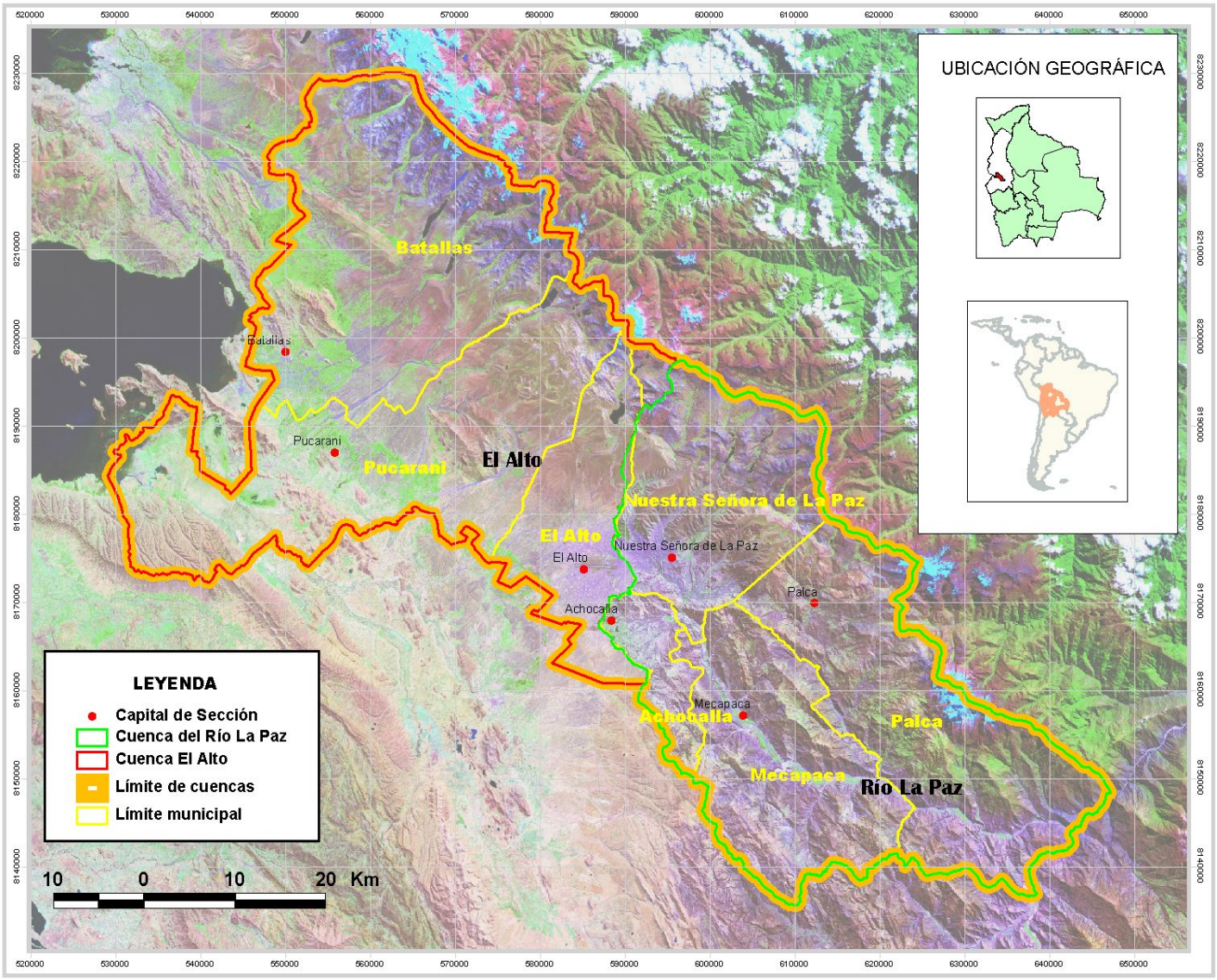
9. In the Cordillera Blanca at least 10 percent, and potentially as much as 20 percent, of the annual discharge stems from volume loss of stored glacier ice. Simulations based on different IPCC scenarios for 2050 and 2080 indicate that glacier volume in the Cordillera Blanca will be significantly lowered, but glaciers in most catchments do not completely disappear. Simulations further suggest that the overall discharge may not change very much, but that the seasonality intensifies significantly. Dry-season runoff is reduced, in particular in the A2 scenario, but during the wet season discharge is higher, since the larger glacier-free area leads to enhanced direct runoff. In general the results of the A2 scenario are much more dramatic in 2050 than they are 30 years later in 2080 under the more moderate B1 scenario. These results illustrate how uncertain the future extent of glaciation and therefore the changes in runoff really are; they clearly depend on which emission path we will ultimately follow.

10. In order to improve our knowledge and to enhance our understanding to a level where useful decisions regarding adaptation and mitigation can be made, a number of scientific and institutional improvements are necessary. These include a better equipped and denser on-site monitoring network, enhanced use of available remote sensing and GIS technologies, more adequate modeling studies which take into account the topographic and climatic peculiarities of the tropical Andes, better collaboration among the scientists and institutions involved, and better dissemination of results to local stakeholders and decision makers.

Annex 20: MAPS

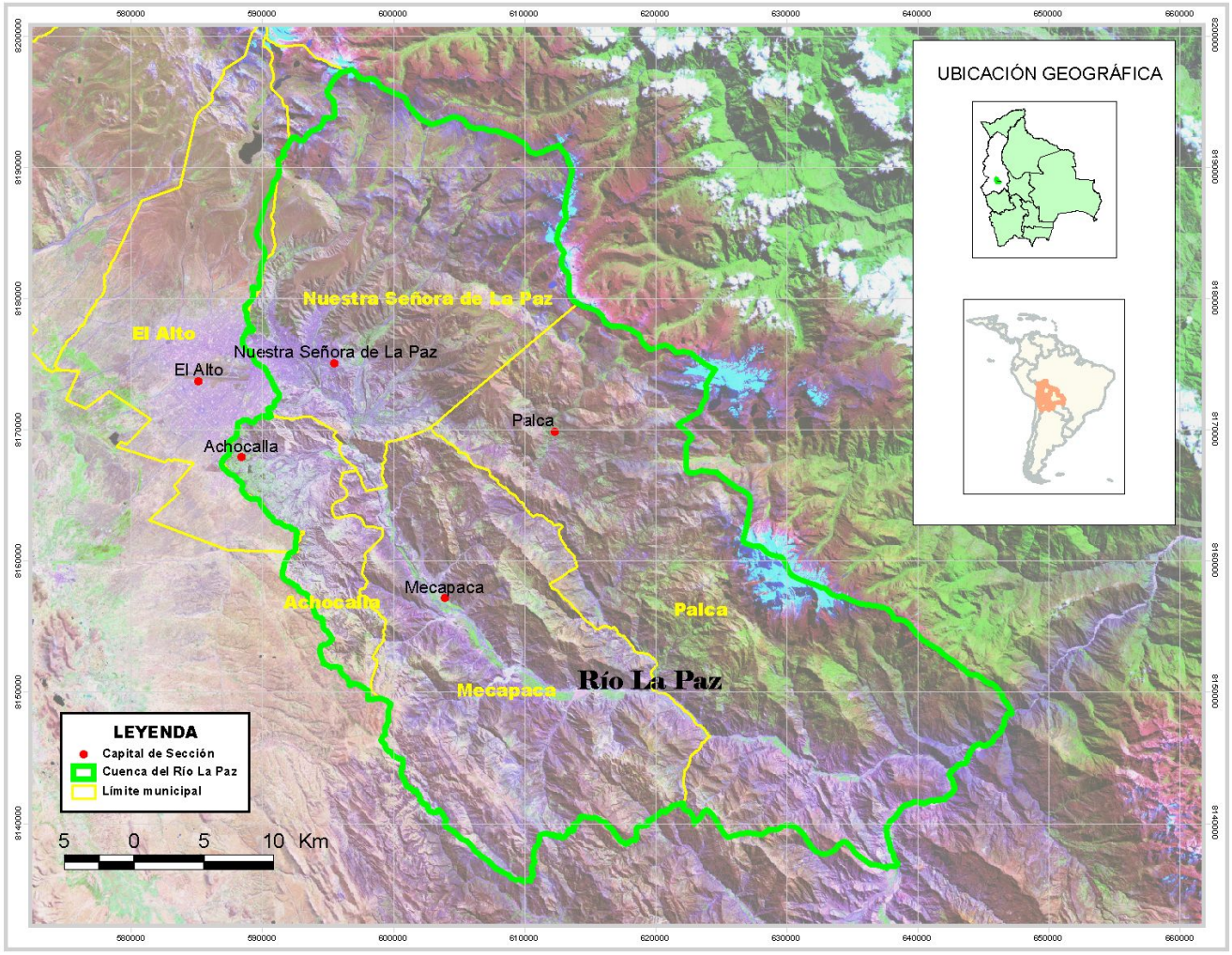
ANDEAN COUNTRIES: Design and Implementation of Pilot Climate Change Adaptation Measures

MAP 1. Bolivia: selected microcatchments–La Paz and El Alto



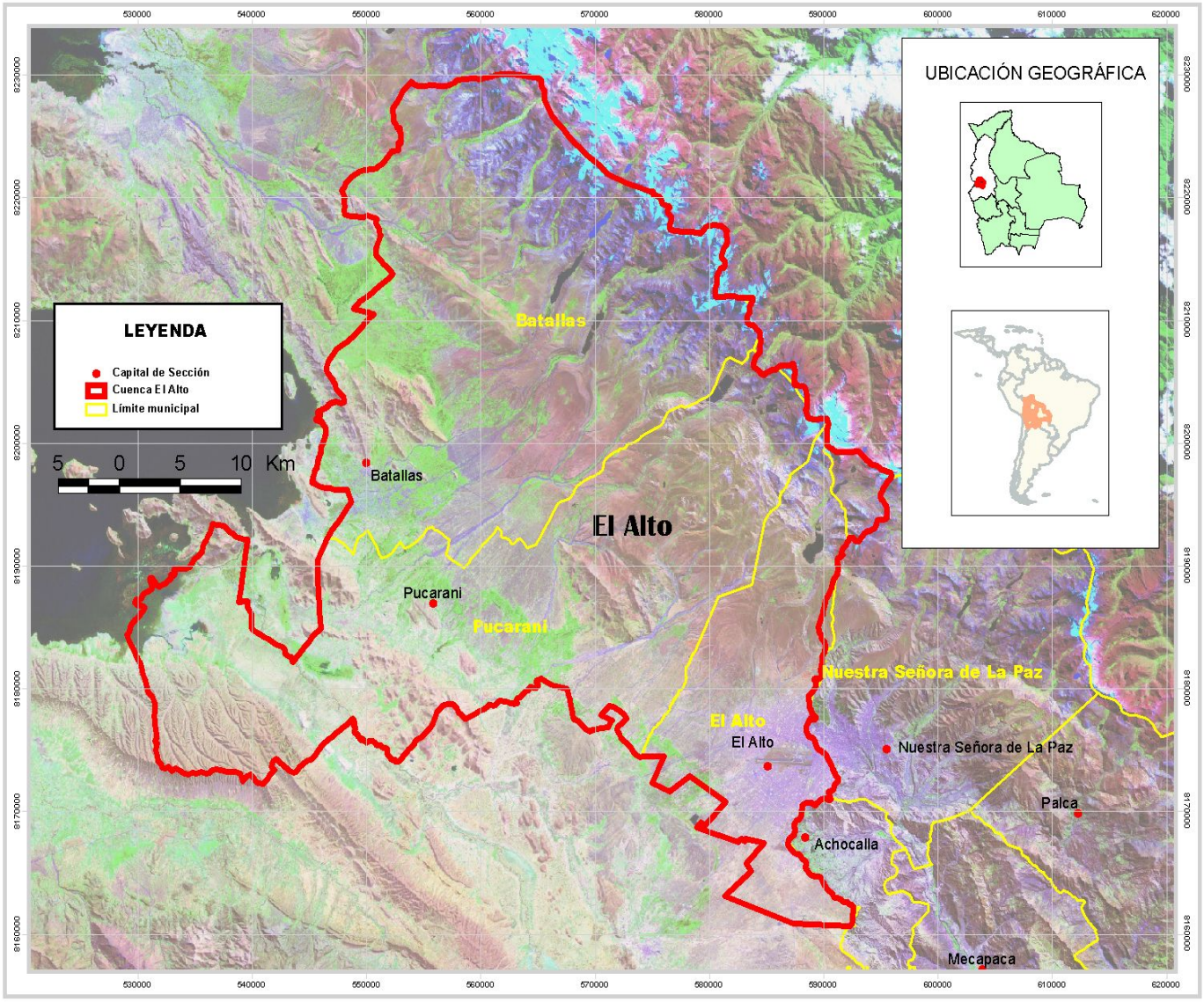
This map shows the La Paz River and El Alto River microcatchments, which have been selected by Bolivia for the implementation of proposed adaptation measures.

MAP 2. La Paz River Microcatchment



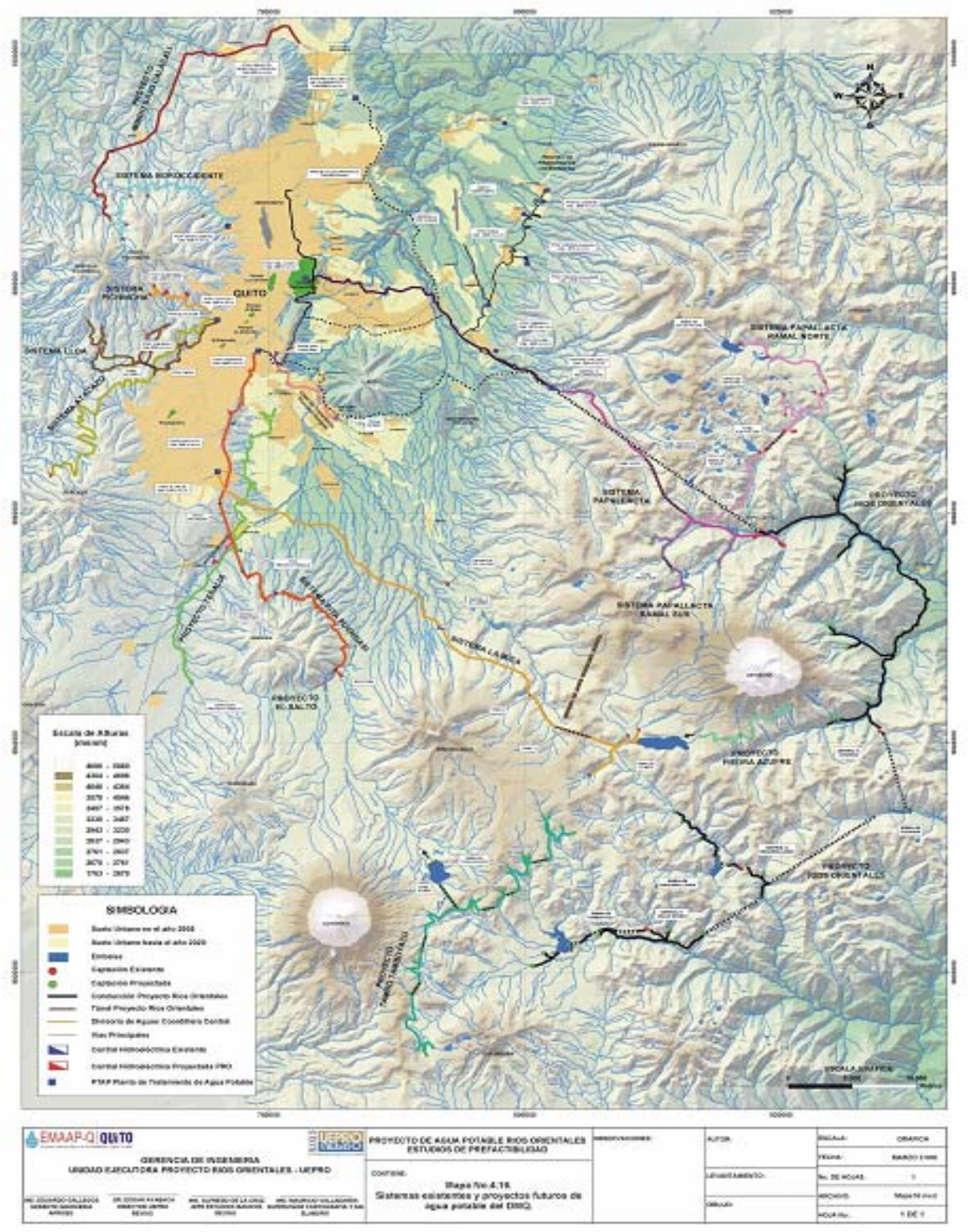
This map shows the La Paz River Microcatchment. It has an area of 1,891 square kilometers, and encompasses the municipalities of La Paz, Palca, and Mecapaca. The microcatchment provides environmental services to a population of approximately 819,000 inhabitants, of whom 10 percent live in extreme poverty, according to the 2001 intercensus.

MAP 3. El Alto River Microcatchment

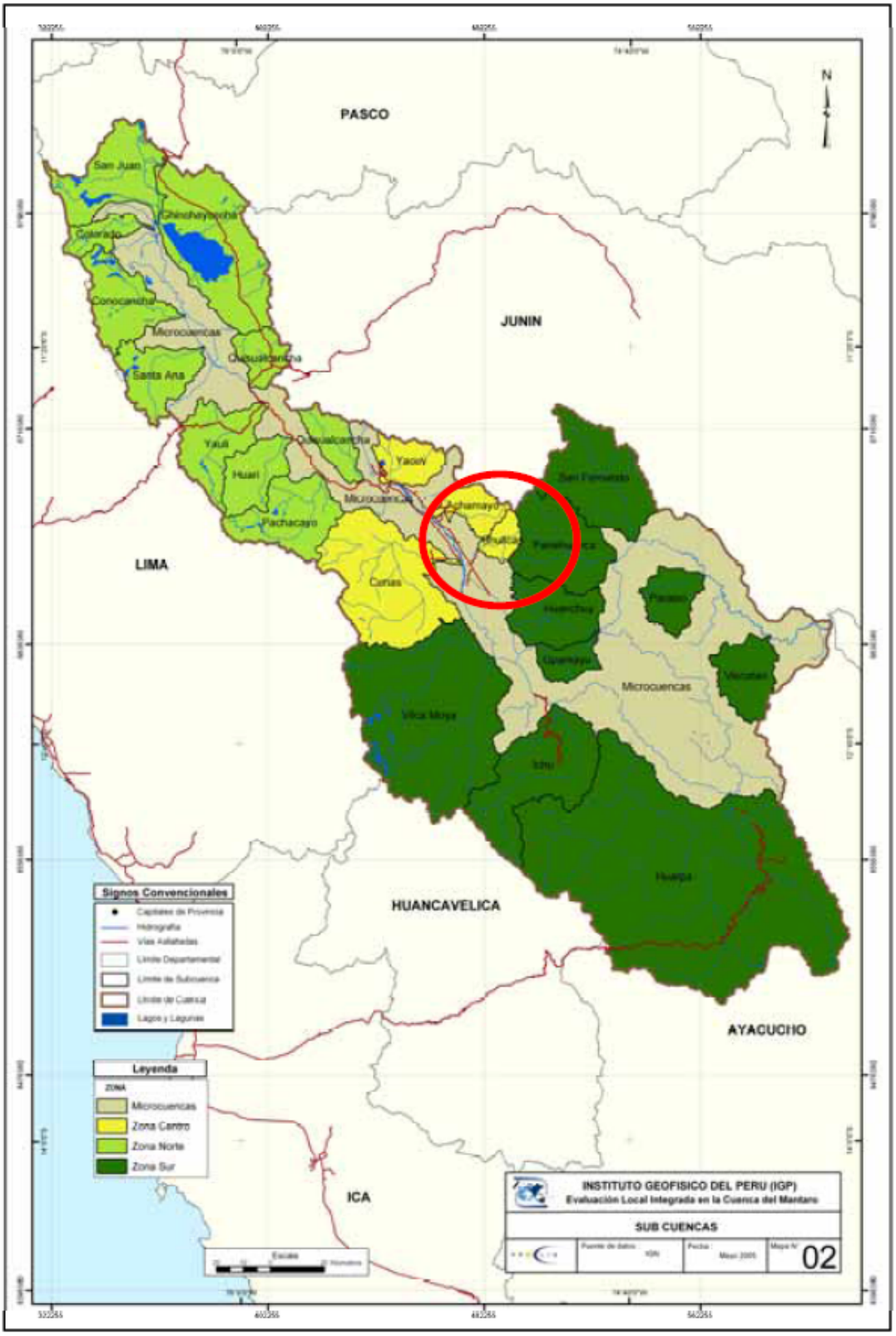


This map shows the El Alto River Microcatchment. It has an area of 2,265 square kilometers, and encompasses the municipalities of El Alto, Pucarani, and Batallas. The microcatchment provides environmental services to a population of approximately 695,000 inhabitants, of whom 30 percent live in extreme poverty, according to the 2001 intercensus.

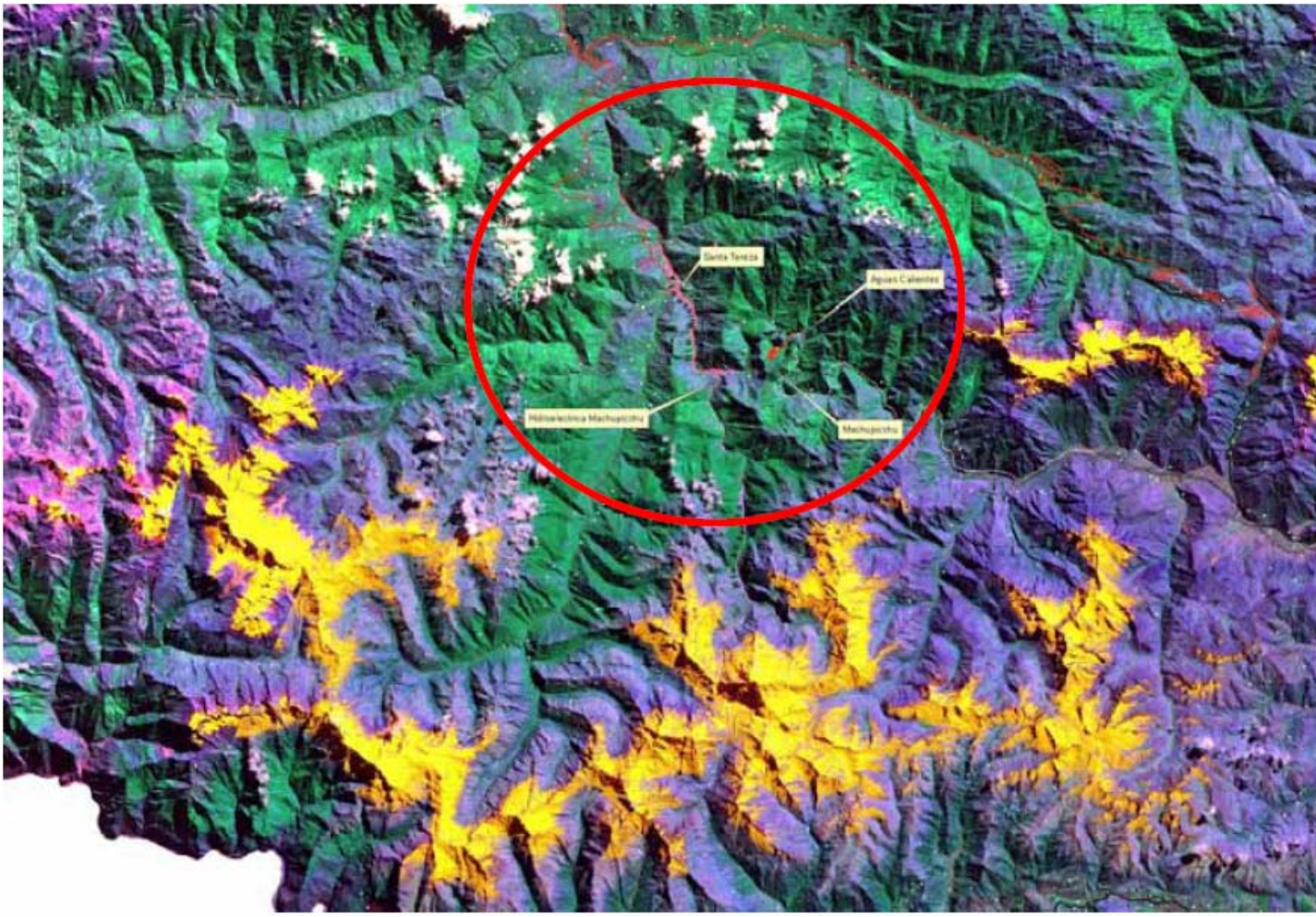
MAP 4. ECUADOR: Selected microcatchments that receive water from the Antisana volcano: Papallacta, Jeringa, Quijos, and Antisana Rivers.



MAP 5. PERU: Mantaro River basin

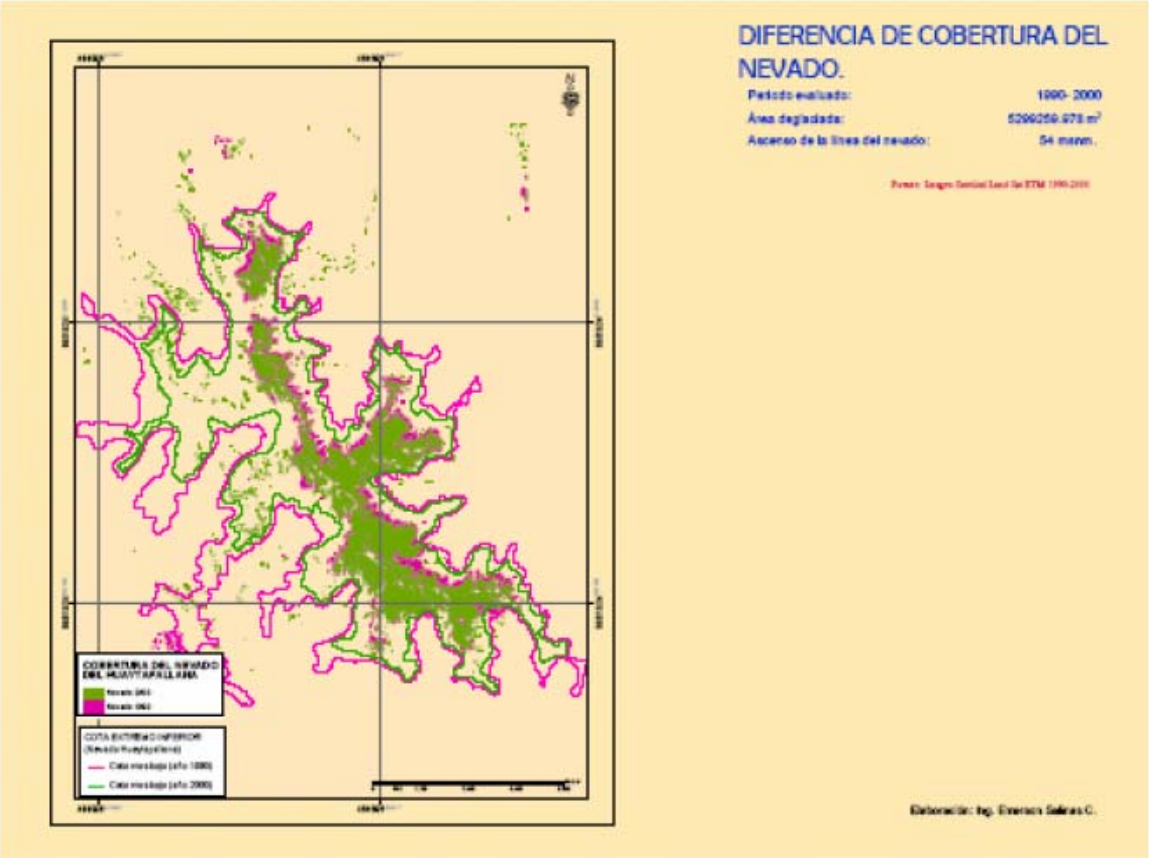


MAP 6. PERU: Vilcanota–Urubamba River Basin



The yellow areas correspond to glaciers.

MAP 7. PERU: Huaytapallana, glacier retreat between 1990 and 2000



Red lines correspond to the glacier's extension in the year of 1990 and green lines correspond to the glacier's retreat in year 2000.