

# Ten years of adaptation practice in mountain ecosystems in Latin America

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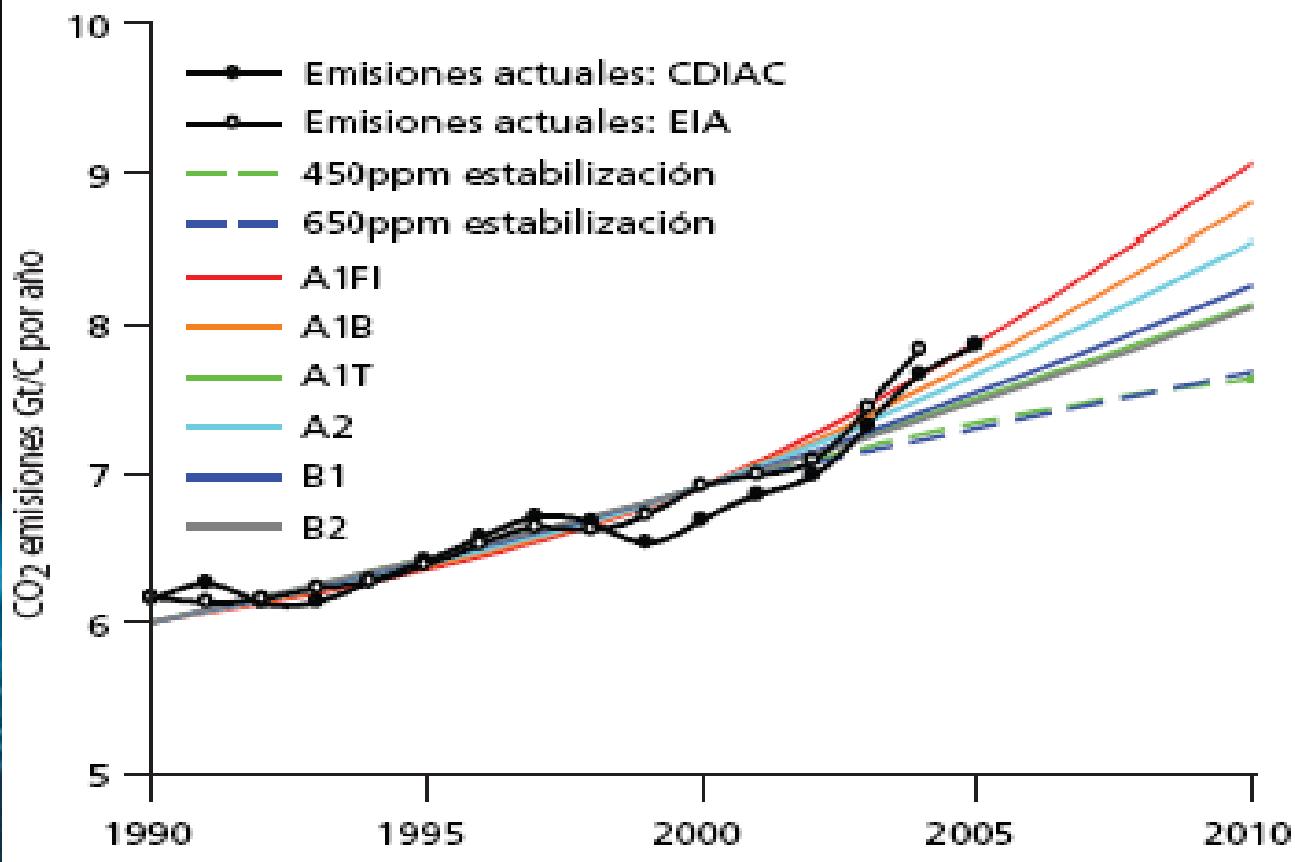
Glacier Hazard Workshop

# Key points discussed

- Large, at times, irreversible changes in mountain ecosystem services with economic and environmental implications
- Climate stress adds to already considerable burdens imposed by human activity on mountain ecosystems
- There is a need to document local mountain climate trends and visualize likely future conditions
- Costs and benefits of adaptation approaches are largely unknown. Need to define through practical on the ground examples.
- Adaptation process in mountain areas involves a gradual approach where pilot activities are tried and documented as a basis for scale up
- Current funding schemes are limited in scope and size, adaptation needs far surpass available resources

# Global GHG emissions are on track to surpass worst case IPCC scenario

Emisiones globales de CO<sub>2</sub> observadas comparadas con trayectorias de estabilización y emisiones proyectadas



End of century temperature  
Anomaly up to 8 Celcius

# Climate Hot-Spots in Latin America

<i>Climate Hotspot</i>	<i>Direct effect</i>	<i>Immediacy</i>	<i>Irreversibility</i>	<i>Magnitude of Physical Impacts</i>	<i>Economic consequence</i>
Coral Biome in the Caribbean	Bleaching and mass mortality of corals	Now	Complete	Total collapse of ecosystem and wide-ranging extinction of associated species.	Impacts on fisheries, tourism, increased vulnerability of coastal areas
Mountain ecosystems in the Andes	Warming	Now	Complete	Disappearance of glaciers, drying up of mountain wetlands, extinction of cold-climate endemic species	Impacts on water and power supply, dislocation of current agriculture
Wetlands in the Gulf of Mexico	Subsidence and salinization; increased exposure to extreme weather	This century	Complete	Disappearance of coastal wetlands, dislocation and extinction of local and migratory species	Impacts on coastal infrastructure, fisheries and agriculture
Amazon basin	Forest dieback	This century	Complete	Drastic change to the ecosystem leading to potential savannah	Impacts on the global water circulation patterns, impacts on agriculture, water and power supply at a continental scale

# Glacier area in the Andes is under fast retreat

- Andean glaciers retreat:
  - Impacts from loss of water regulation would affect human water supply, agriculture, power generation and ecosystem integrity



# Temperature increase and fire events in the central range (Las Brisas)

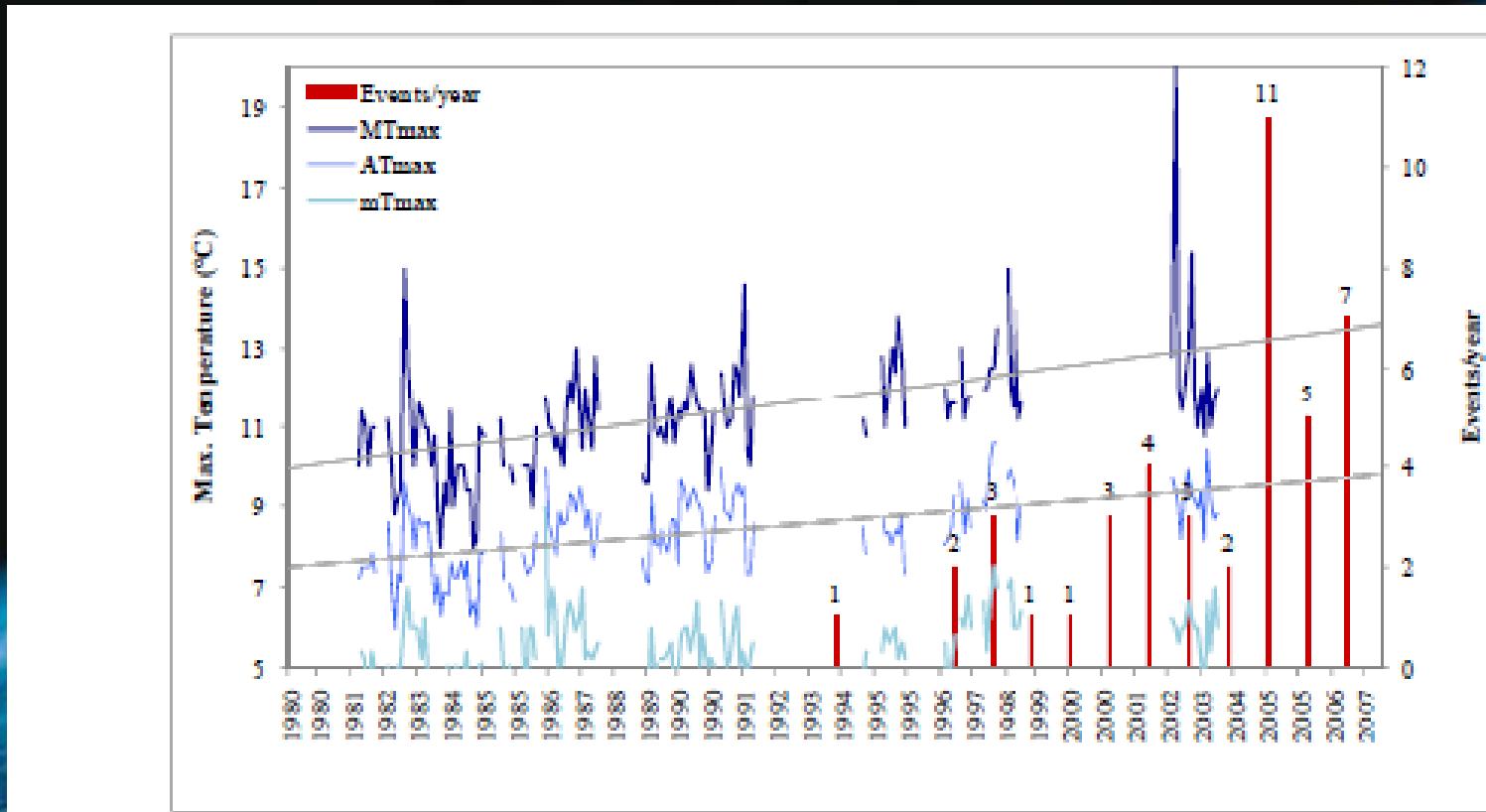
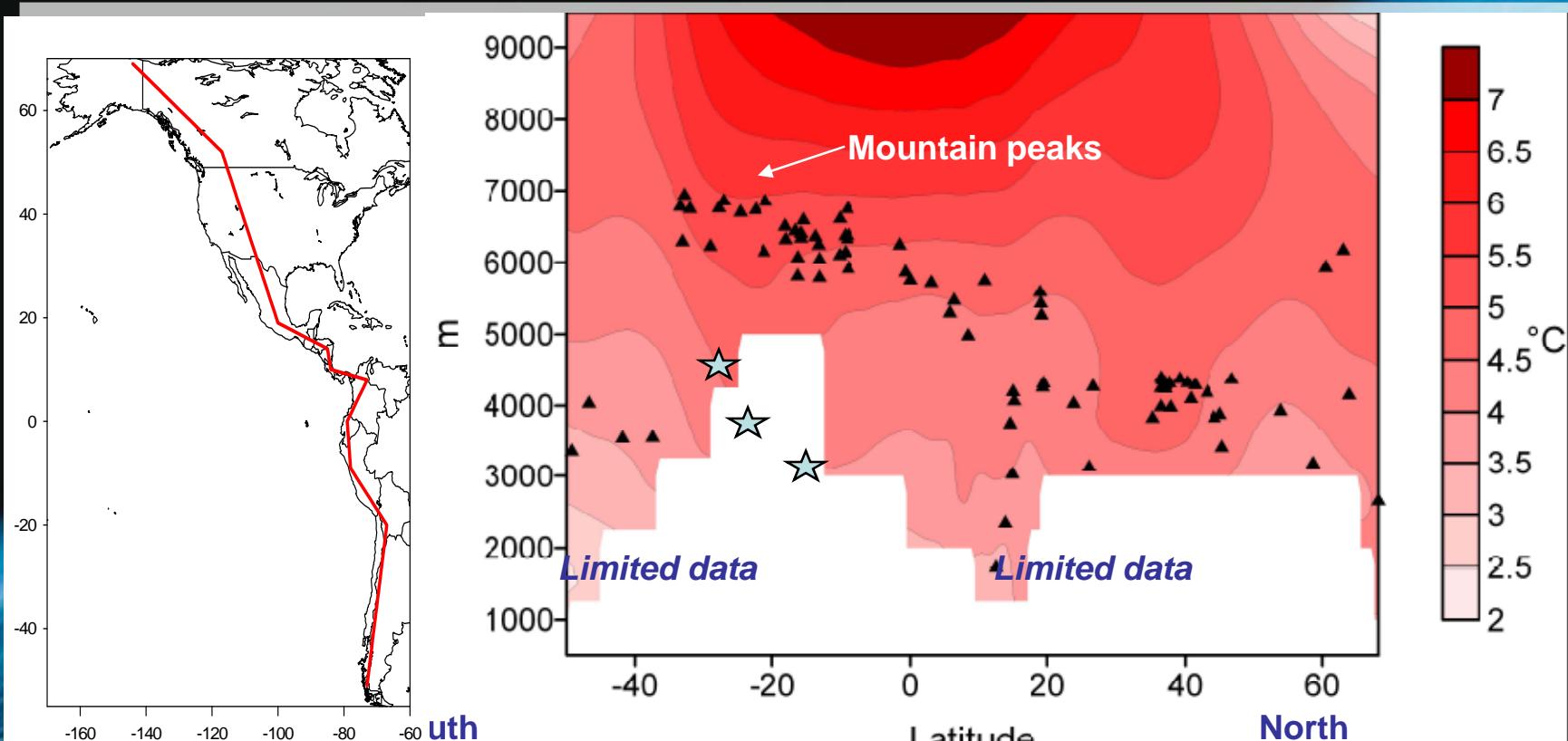


Figure 4. Monthly maximum temperatures gathered at Las Brisas met station over the period 1981-2003 along with the annual total number of fire events registered in the Los Nevados Natural Park over the period 1994-2007. MTmax, ATmax and mTmax represent, respectively, the maximum temperatures observed on the warmest days, the maximum temperatures observed under “average” conditions; and the maximum temperatures on the coldest days.

# GCMs project continuing and very fast warming of mountain ranges



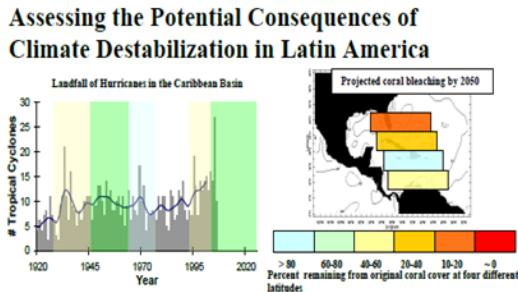
8 member ensemble under A2 scenario

Source: Bradley et al 2006

# Economic consequences from climate impacts in Latin America



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The World Bank  
Latin America and the Caribbean Region  
Sustainable Development Department (LCSSD)

- Examples: 11% of Caricom GDP could be lost by 2050;
- Collapse of coral biome would represent direct economic losses of about US\$9 billion;
- Additional cost to compensate for climate-induced water regulation losses for Quito are estimated at US\$100 for 2018;
- Additional generation costs of up to US\$1. 5 billion if water regulation is lost in the Peruvian Andes;
- Additional costs from extreme weather events may cost US\$100 billion by 2050 in the Caribbean

# Climate strategy in Latin America

- Adaptation is priority one, given the large and irreversible impacts of climate change in the region;
- Support low carbon development maintaining and or reducing carbon footprint from key economic sectors
- Facilitate linkage between knowledge and policy making

# Adaptation portfolio in LAC

- First project was approved in 1998
- Ten projects, about US\$200 M
- Eco-system based approach
- Focus on trends rather than variability
- Adjust economic activities to anticipated level of ecosystem services

# Link knowledge and decision-making.

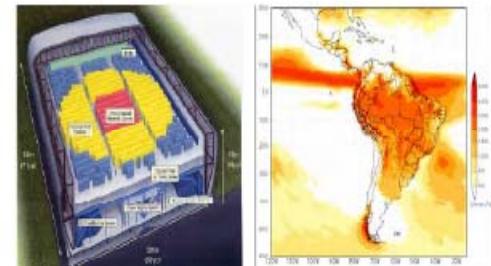
MOUs and cooperation agreements  
for operational support with:

- Meteorological Research Institute (Japan)
- National Center for Atmospheric Research (USA)
- Pool of glaciology institutes (Innsbruck, IRD, UMASS)
- Japanese Space Agency (Japan)
- Institute pour le Recherche du Developpement (France)
- Georgia Tech University (USA)
- NOAA (USA)
- Stockholm Environmental Institute (SEI)



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**Visualizing Future Climate in  
Latin America:  
Results from the application of the  
Earth Simulator**



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# Monitoring climate

WB Support to climate observation systems:

- Network of stations in glaciarized basins of immediate economic relevance
- Remote sensing of six basins in the Andes (Bolivia, Colombia, Ecuador, Peru)
- Paramo observation system (Colombia)
- Reconstruction of proxy and meteorological records

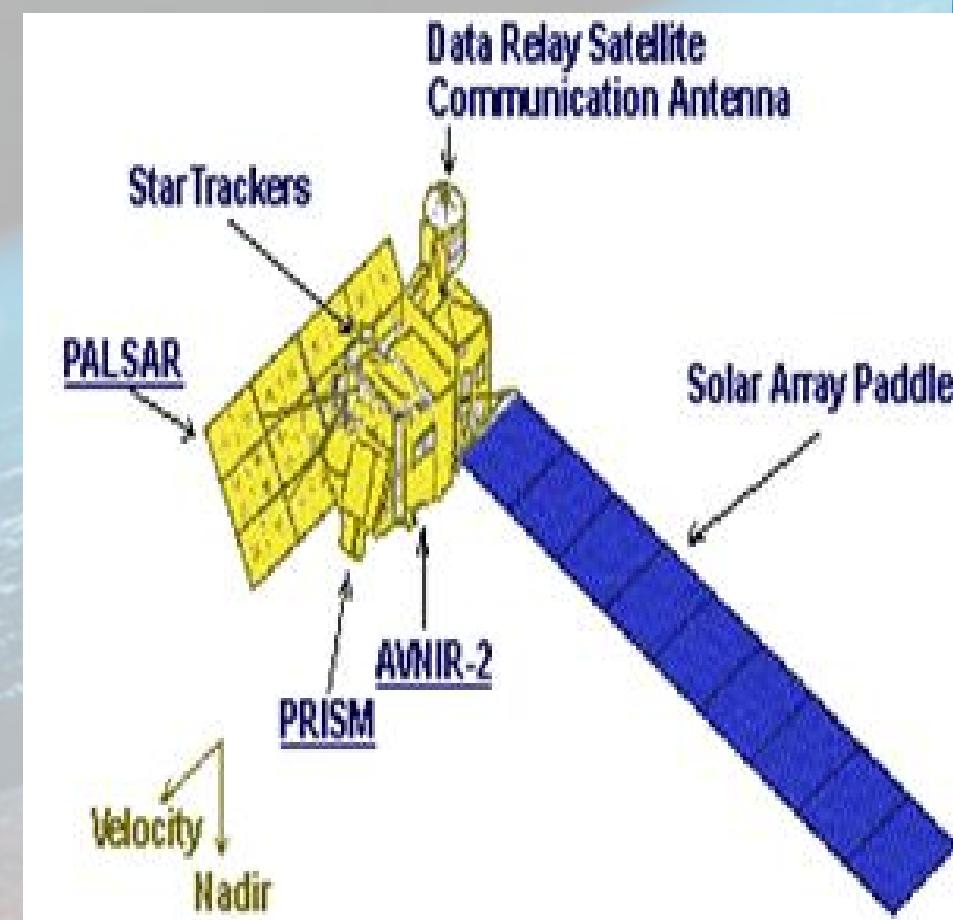


# Monitoring climate

- Remote sensing of:
  - Glaciares
  - Arrecifes coralinos
  - Humedales costeros
  - Paramos
  - Amazonas

Bolivia, Colombia, Ecuador,  
Perú, México, Caribbean

- Training in interpretation and data management
- Exchange of data and publication



# Modeling climate

- Earth Simulator Runs
- Ensemble runs using Oak Ridge Computer Model
- Regional modeling of hydrology response to climate in basins with glaciers and paramo
- Application of sub grid hydrology down-scaling techniques
- Probability Density Functions from GCMs



The Earth Simulator Center

# Colombia: Integrated National Adaptation Program (in operation since July 2006)



- Promote adaptation measures to climate impacts in
  - Paramo Ecosystem
  - Insular Areas
  - Health System

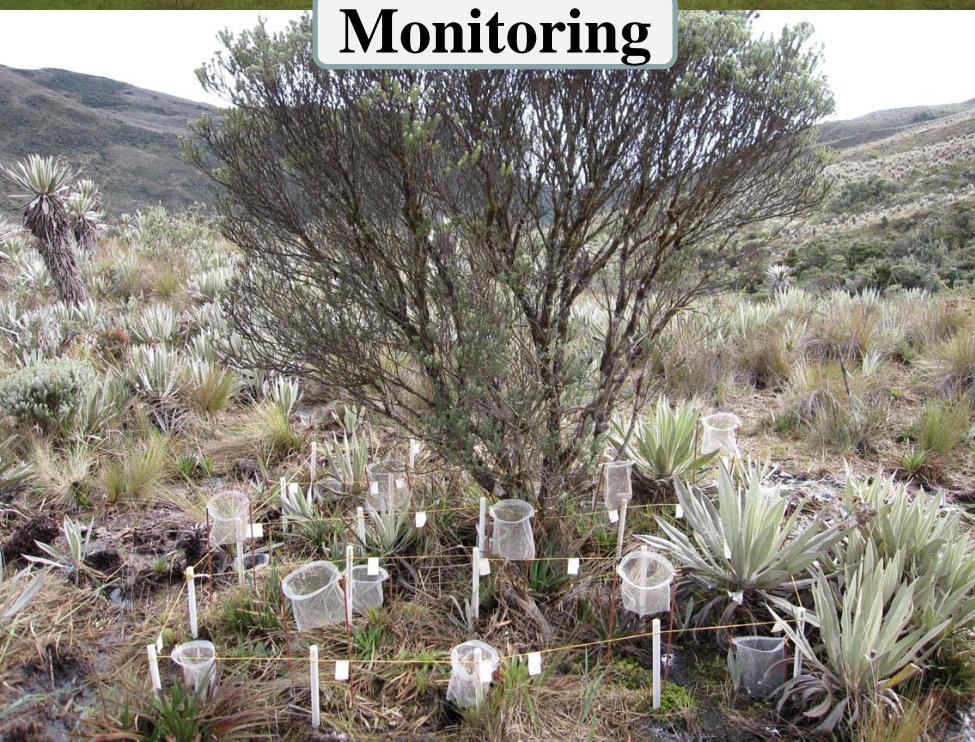
# Adaptation to Climate Impacts in Paramo Ecosystems in Colombia (as part of INAP project)

Medida de adaptación	Actividades
	(i) Restore and conserve natural ground cover in upper watersheds in Paramo ecosystems (Chingaza Paramo).
	(ii) Strengthen land management and enforcement plans to reduce anthropogenic impacts that may increase fragility to climate impacts. Involve local community in management and conservation activities.
	(iii) Strengthen capacity to prevent and respond to mountain fires. (iv) Eliminate mining activities.

# Colombia: Integrated National Adaptation Project



**Monitoring**

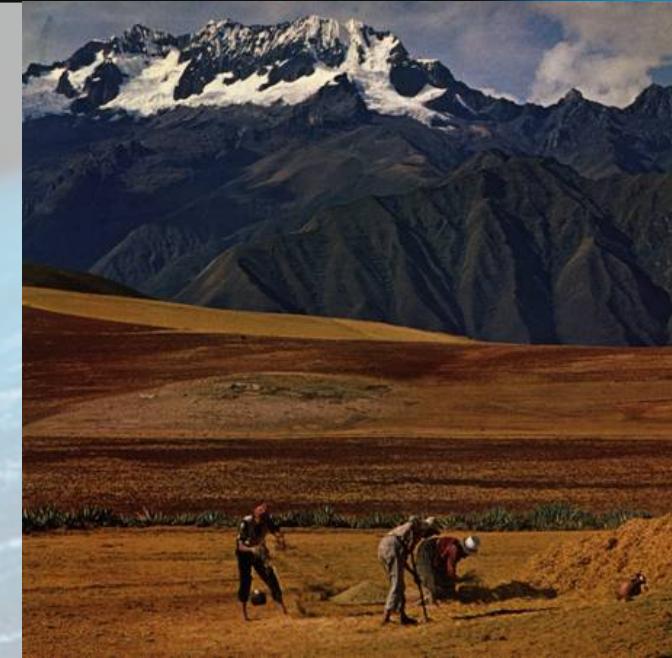


**On-the-ground  
interventions**



# Adaptation to climate impacts in Glaciarized basins (Bolivia, Ecuador Peru)- SCCF, \$32 million

- Water supply
  - Reservoir in Tuni (Bolivia) to compensate loss of water regulation
  - Alternative catchments to serve Quito water supply need
- Agriculture
  - Adaptation of agricultural activities to reduced runoffs during dry periods
- Disaster prevention
  - Protection of vulnerable areas to extreme flows
- Approved Aug 2008



# Glacier Lake Outburst Flow (GLOF) in Peru

- In Shullcas and Santa Teresa basins, to address GLOFs:
  - Disaster management and prevention
  - Early warning system
  - River defenses

# Pilot: Global laboratory for adaptation to glacier retreat in the Tuni-Condoriri basin in Bolivia

- Objective: Address the consequences of glacier retreat in water supply for the region encompassing La Paz and El Alto, through the development, construction and operation of a High Altitude Reservoir and the instrumentation, monitoring and modeling of the basin and operation of the reservoir for global information purposes.
- Storage capacity: 2 million cubic meters
- Construction schedule: One year
- Estimated cost: US\$ 7 million.
- Adoption of water management model including glacier and mountain wetland module to project future hydrology condition

# Adaptation to the Impacts of Rapid Glacier Retreat in the Tropical Andes



**Reforestation of  
selected  
microcatchments**

**Adaptation of  
infrastructure to  
future needs**



# Conclusions

- Glacier and paramo ecosystems will change over time as a result of climate change
- Services from these ecosystems will be severely affected
- Urgent adaptation actions are required that ameliorate the net impacts on environmental and economic services.