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Policy Brief

Challenges in Sustainable Water Supply in the Tropical Andes due to Climate Change

Sierra Nevada del Cocuy, Boyacá, Colombia wPetruss CC BY-SA 3.0

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ACCIÓN

Photo credit: M. Vuille (UAlbany/ACCION)

Glaciers in the Andes have important economic, environmental, social, cultural and spiritual meaning for local Andean populations.

The objective of this policy brief is to synthesize the current scientific information regarding climate change, glacier retreat and their impacts on water resource availability in the Tropical Andes. It summarizes the discussions and outcomes from a series of meetings that were held on this topic between 2012 and 2014 in Santiago, Chile; Lima, Peru and Quito, Ecuador.

These meetings brought together scientists, educators, water managers, policy -and decision-makers and were jointly organized and sponsored by UNESCO International Hydrological Programme (IHP), the Government of Flanders, Belgium and the Andean Climate Change Interamerican Observatory Network (ACCION).The Project contributed to the Andean Glaciers project (2012-2016) funded by Flanders Trust Fund for Science.

Note from the coordinators:

This Policy Brief is a contribution to Phase VIII (2014-2021) of the IHP "Water security: responses to local, regional and global challenges". It aims to transform scientific information and experience into action by answering local and regional needs for tools to improve adaptation to global changes and build capacity to address and meet today's global water challenges.

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Glaciers in the Andes provide vital services for human well-being

The importance of glaciers for life and livelihood

- Glaciers provide an important **freshwater source for local populations** in many parts of the Andes. Glacial melt water is used by Andean populations in **agriculture** to irrigate fields, to supply towns and municipalities with **drinking water** and **water for sanitation**. This environmental service is especially relevant during the dry season, when other water sources are not available. Its importance varies from region to region and depends on the presence of other water regulators such as reservoirs or wetlands, the length of the dry season and the water demand (population growth). In the Cordillera Blanca, Peru, for example, studies show that water availability may decrease up to 30% in some catchments, should glaciers completely melt. In general the relevance of glacial melt water is largest close to the glacier and decreases with increasing distance from the glaciated watershed.

- Glacier melt water is crucial to maintain **ecosystem health** downstream, affecting everything from **fish population** in rivers to wildlife inhabiting **wetlands** ('bofedales') or the **pastures** local herders rely on for grazing their Alpaca and Lama herds.

- Melt water released from glaciers is also used to sustain important **economic activities**, such as **hydropower production** or the **mining industry**, which forms an important economic sector in many Andean countries.

- Glaciers in the Andes serve as **early warning signs** that the Andean environment is undergoing rapid change. The visible changes seen in many parts of the Andes provide unique illustrations to educate the public about the impacts of climate change.

- Glaciers in the Andes have an economic value by attracting visitors from around the world who enjoy the glaciated landscape for a variety of **tourism activities** such as, hiking, backpacking and mountaineering. In the case of the Chacaltaya glacier, in Bolivia, the complete disappearance of a glacier led to the closure of the world's highest ski resort.

Further impacts of glacier melt

- Glacier melt contributes to global sea-level rise affecting coastal areas and low-lying island nations

- Glacier melt contributes to **slope instability** and increases the potential for **natural hazards** such as slope failures and mud slides. The retreat of glaciers in many areas has led to the **formation of lakes**, which are often dammed by unconsolidated glacial deposits. These lakes can be a hazard to populations downstream as earthquakes or rocks and avalanches falling into the lake can lead to rapid **glacial lake outburst floods** and **mudslides** downstream.

Photo credit: M. Vuille (UAlbany/ACCION)

Glacial melt water provides a habitat for wildlife and pastures for grazing used by Andean herders and their Lama and Alpaca.

Glaciers in the Andes are threatened by climate change

Glaciers along the entire tropical Andes are in a state of retreat. The rate of retreat is accelerating. Many smaller and lower-elevation glaciers have already disappeared and many more will likely disappear over the coming decades. The current retreat is unprecedented since at least the mid-17th century.

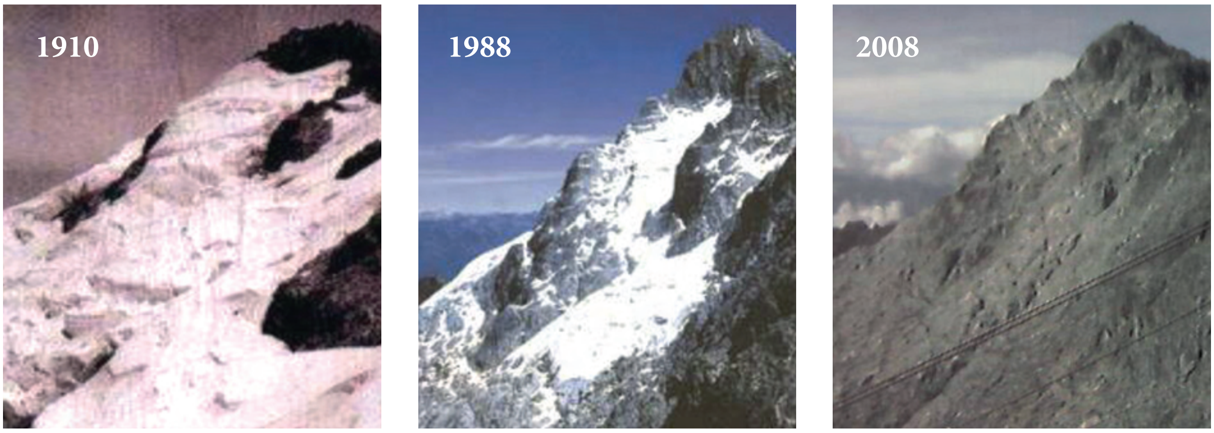


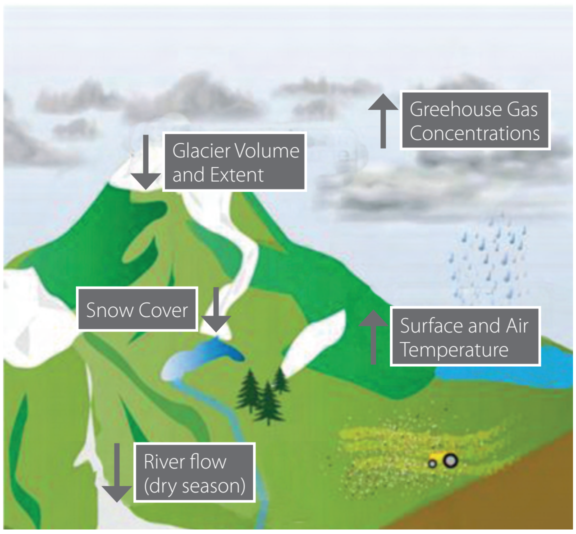
Photo credit: Eduardo Carillo

Glacier Espejo Pico Bolivar (5002 m), Venezuela

The increase in temperature, due to our increasing global greenhouse gas emissions, is viewed as the main cause of Andean glacier retreat. Temperature has increased steadily over the 20th and early 21st century, with a warming of approximately 0.1°C per decade. As a result of the warming, the freezing line (line separating snowfall from rain) has steadily risen, increasingly exposing lower elevations of glaciers to rain as opposed to snow. In the Cordillera Blanca, Peru and the Cordillera Real, Bolivia, for example, the freezing line has risen by more than 150 m since 1960.

In **Venezuela** glaciers have almost completely disappeared. Only one glacier was left in 2011 with an area of less than 0.1 km^2. It will likely most disappear within a decade. In **Colombia** glaciers lost roughly half of their surface area during the second half of the 20th century. In **Ecuador** glaciers are located almost exclusively on isolated volcanoes and their extent decreased by 30-40% over the past 3-4 decades. In **Peru** glaciers in the Cordillera Blanca and Cordillera Vilcanota have decreased in size by 20-30% over the past 3-4 decades. In the Cordillera Real, **Bolivia**, glaciers have similarly lost roughly 1% of their surface area per year since the mid 20th century. In summary, in-situ, aerial and satellite-based monitoring documents that glaciers in the tropical Andes have lost substantial parts of their surface area, especially at lower elevations. The rate of retreat is now several times faster than it was 50 years ago.

A decrease in snowfall may have played a role in glacier retreat at some locations, but it cannot explain the coherent retreat seen from Venezuela to Bolivia. Natural factors, such as the sun, volcanoes or the El Niño - Southern Oscillation (ENSO) also cannot explain the observed retreat, even though ENSO can influence glacier melt and snow accumulation from one year to the next.



Source: modified from IPCC, AR5, WGI

The Andean environment is changing due to increasing greenhouse gas concentrations and resulting higher temperatures. Arrows indicate whether components are increasing (upward arrow) or decreasing (downward arrow).

The current rapid retreat leads to a temporary water surplus in many rivers. This raises sustainability concerns, as populations downstream adapting to increased quantities of water will be faced with shortfalls once glaciers disappear or become too small in size to maintain this environmental service at the current level.

Projections of future climate change in the Andes suggest an additional warming in the order of 3 – 5 degrees °C by the end of the 21st century, with strongest warming at the highest elevations where glaciers are located. As a result, many smaller lower lying glaciers are likely to disappear over the coming decades, with those located below 5400 m being the most vulnerable. Larger glaciers will continue to retreat and cover a much smaller area with a reduced ability to provide freshwater for multiple uses during the dry season.

Opportunities for adaptation exist – A call to action

Anticipating and adapting to changes in glacier streamflow and water availability well in advance is the key to avoid the worst outcomes. The main focus of any adaptation strategy must be to reduce the vulnerability and increase the resilience of the affected population. Such strategies can be applied in different sectors to strengthen actors involved in climate change adaptation. A few best practices and suggestions for early adaptation are listed below:

- The institutional standing of authorities involved in glacier research needs to be strengthened and **capacity building** in the region needs to be enhanced. Similarly existing **research networks** need to be supported to allow for synergistic activities and interdisciplinary research. **International cooperation** needs to be aligned with the national and regional needs.

- Funding for **long-term climate and glacier monitoring** needs to be made available to document the changing glacial environments. Currently the lack of (and access to) data is an impediment for research, modeling and adequate management of water resources. The differences in design, quality and efficiency between monitoring networks are equally a challenge.

Photo credit: M. Vuille (UAlbany/ACCION)

Long –term monitoring of climate change and glacier recession are fundamentally important.

- The large uncertainties in future projections of regional climate change and glacier retreat stemming from inadequate model resolution, model dependency and scenario uncertainty provide a formidable challenge. When communicating uncertainties to decision-makers, the pursuit of **no-regret strategies** in light of uncertainties should be encouraged and **co-benefits of adaptation** strategies should be emphasized.

- Water **conservation measures**, new irrigation methods and sanitation projects that help reduce water use should be encouraged where possible. Technical solutions such as building small reservoirs, construction of water treatment plants, tapping into new groundwater resources or installing private water storage systems may be able to **alleviate water stress** in some locations. Negative impacts of such constructions (loss of land, water loss due to evaporation, the potential for displacement of local populations) need to be minimized at all cost.

- Scientific results need to be accessible and translated into a language that is understandable by planners, water managers, policy makers and the affected local population alike. This can be achieved, for example, through better visualization and is fundamentally important to improve communication among these groups. Establishing effective mechanisms of communication and

Photo credit: Jorge Luis Ceballos

Campanillas Glacier, Sierra Nevada de El Cocuy, Colombia.

Photo credit: ANA, Peru

Visualization of scientific data and access of the public to such information is vitally important.

creation of platforms of exchange will not only strengthen the communication between the scientific community and policy makers, but also increase the awareness and the acceptance of adaptation projects by the local population.

➤ Adaptation projects often fail to acknowledge existing **local adaptation strategies** and ignore traditional local knowledge. Adequate participation of the most vulnerable groups, the rural indigenous communities, would strengthen **citizen involvement** and led to higher acceptance of adaptation projects. A meaningful participation of local affected populations in watershed governance would also help avoid conflicts and water competition among economic sectors.

Glossary of terms

Adaptation. Initiatives and actions that help reduce the vulnerability of natural and human systems against actual or expected impacts from climate change. Adaptation can be anticipatory (before impacts are being felt) or reactive (in hindsight, once impacts are apparent).

El Niño - Southern Oscillation (ENSO). Initially used to describe the occurrence of unusually warm-water off the coast of Ecuador and Peru, refers to a basin-wide warming of the tropical Pacific. This event is associated with a seesaw in surface air pressure, called the Southern Oscillation. This coupled atmosphere-ocean phenomenon, leads to significant disruptions in climate along the tropical Andes and the west coast of South America.

Glacier. A mass of land ice, which flows downhill under gravity. A glacier is maintained by accumulation of snow at high altitudes, balanced by melting at lower altitudes.

Greenhouse gas emissions. Are gases in our atmosphere that absorb and emit thermal infrared radiation, causing the greenhouse effect. While these gases occur naturally in our atmosphere, the burning of fossil fuels has lead to a rapid increase of their concentration in our atmosphere causing our planet to warm. The main emitted greenhouse gases are carbon dioxide, methane and nitrous oxide.

Freezing line. The altitude at which the temperature is at 0°C (the freezing point of water) and hence roughly the altitude where snow turns to rain.

Glacial deposits. Sand, gravel and rocks deposited by a glacier or its melt water.

Glacial lake outburst floods. Flooding that occurs when a dam containing a glacier lake fails and the lake is rapidly discharged.

The lake itself is formed by glacier melt water, located either at the front of a glacier or on the glacier itself. Such events can be triggered by dam erosion, earthquakes, avalanches or rock falls into the lake or other events that lead to dam failure.

Mudslides. A rapid flow of sand, clay, gravel and rocks that becomes fluid due to mixing with large amounts of water.

No-regret strategies. A policy or strategy that would generate net social and economic benefits regardless of whether or not the climate is changing.

Projections of Climate Change. A potential future evolution of the climate system in response to assumed changes in greenhouse gas emissions usually simulated with the aid of climate models.

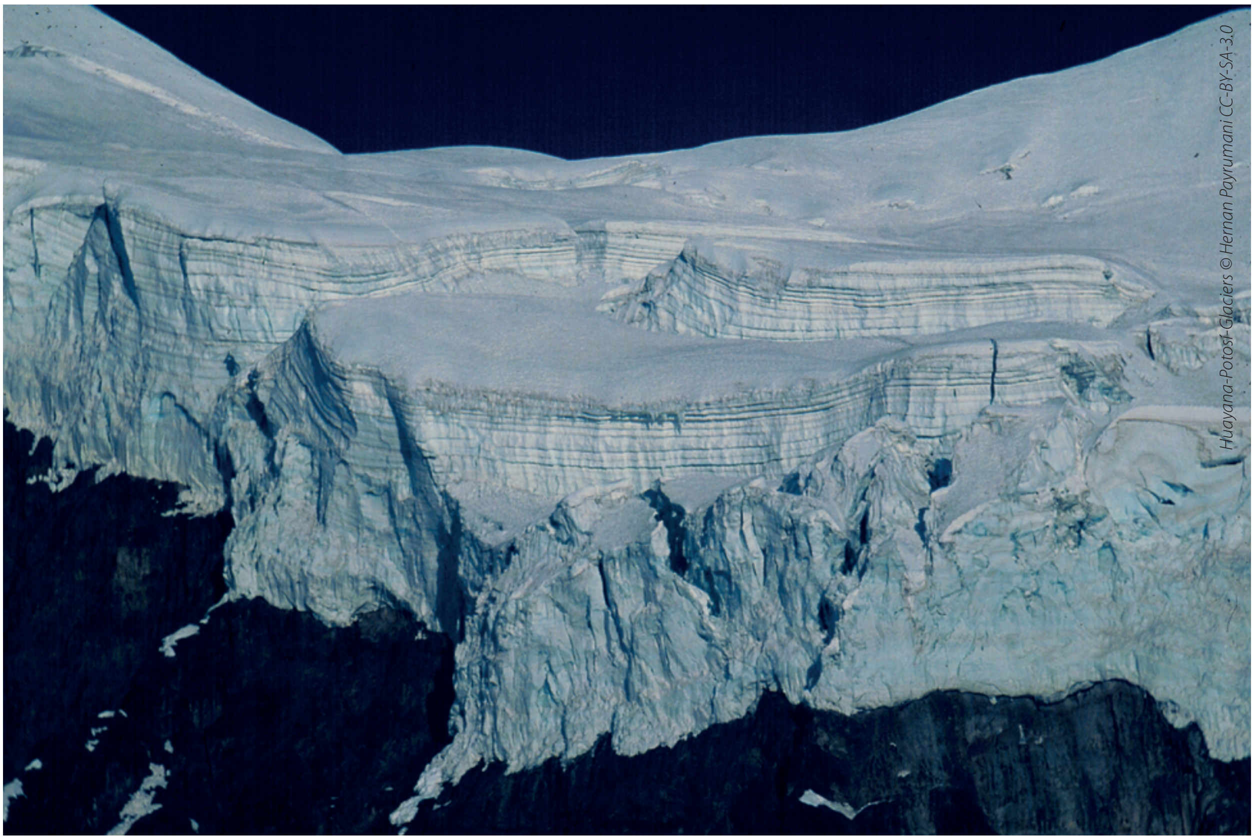
Resilience. The ability of a social or ecological system, to absorb disturbances and to adapt to stress and change.

Sea level rise. Sea level rise occurs as the total mass of water in the ocean increases due to melting of snow and ice. Sea level also rises as a result of the warming ocean as the total water volume expands.

Vulnerability to climate change. Is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate variation (Füssel and Klein, 2006)[1].

Watershed governance. The process of embedding water in all levels of decision-making and action in a watershed. This can be achieved through improved collaboration between citizens and decision-makers at the watershed scale.

Water stress. The extent to which a region's development is limited by the available freshwater supply relative to its water demand.



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