

MOUNTAIN ADAPTATION OUTLOOK SERIES

Outlook on climate change adaptation in the Tropical Andes mountains





Summits of the Iliniza volcano, Ecuador

Foreword

Mountain ecosystems enrich the lives of over half of the world's population as a source of water, energy, agriculture and other essential goods and services. Unfortunately, while the impact of climate change is accentuated at high altitude, such regions are often on the edge of decision-making, partly due to their isolation, inaccessibility and relative poverty.

That is why the United Nations Environment Programme and GRID-Arendal have partnered on a series of outlook reports about the need for urgent action to protect mountain ecosystems and to mitigate human risk from extreme events. Covering the Western Balkans, Southern Caucasus, Central Asia, (Tropical) Andes and Eastern Africa, the reports assess the effectiveness of existing adaptation policy measures and the extent to which they apply to mountain landscapes, going on to identify critical gaps that must be addressed to meet current and future risks from climate change.

The result of a broad assessment process involving national governments and regional and international experts, the reports offer concrete recommendations for adaptation. This includes sharing regional good practices with the potential for wider replication to improve cost efficiency and adaptation capacity.

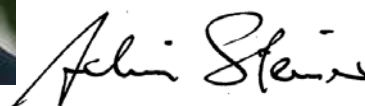
While each of the regions is covered in a dedicated report, they all face similar issues. On one hand, rising temperatures and changing precipitation patterns affect a range of mountain ecosystems, including forests, grasslands and lakes. On the other, drivers such as pollution from mining and unsustainable agriculture erode their ability to cope with these changes. The combined impact is increasing vulnerability among the local and downstream populations who depend on mountain ecosystems – especially when they are isolated from markets, services and decision-making institutions.

By the end of this century, the coldest years in the Tropical Andes Mountains will be warmer than the warmest years to which humans and other species have adapted so far. A vast variety of ecosystems are found in these mountains, including the Amazon basin, snow-capped peaks and more arid areas like the Atacama Desert, the world's driest. These support the lives of tens of millions of people, so cooperation and information sharing among Andean countries are crucial for the health of these ecosystems, which is why assistance from the respective governments has been much appreciated in creating this report.

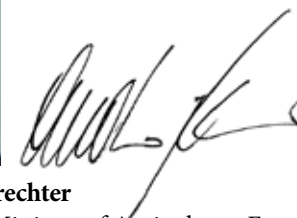
We hope that this report will serve as a practical companion for local, regional and national policy makers seeking to protect fragile mountain ecosystems and the people who depend on them.



Achim Steiner
UNEP Executive Director and Under-Secretary-General of the United Nations

A handwritten signature in black ink, appearing to read 'Achim Steiner'.

H.E. Andrä Rupprechter
Austrian Federal Minister of Agriculture, Forestry, Environment and Water Management

A handwritten signature in black ink, appearing to read 'Andrä Rupprechter'.

Executive summary

The Tropical Andes are the home to many diverse communities, from remote farming villages to large urban centres and capitals, such as Merida, Bogotá, Quito, Cusco and La Paz. In total, about 60 million people live between 1,000 to 4,500 meters. The climate in the region is tropical, with low seasonal variation in temperatures. However, there is strong seasonality of precipitation, in particular in the Peruvian Andes. In Colombia and Venezuela, the Andes are generally more humid, while the Altiplano and the Bolivian Andes are drier.

The Tropical Andes will experience some of the most drastic climate changes in South America. By the end of this century, the coldest years in the Tropical Andes mountains will be warmer than the warmest years to which humans and other species have adapted so far. Different climate models all indicate warming everywhere, but there is much more uncertainty when it comes to projections of precipitation and seasonality. However, the general trend across the region is that precipitation will increase in the already wet northwest and decrease

in the drier Altiplano area and northeast. The rainy season in the Altiplano area is also becoming more concentrated, and the dry season longer.

The Tropical Andes are among the world's biodiversity hotspots most vulnerable to climate change. These mountains contain a wide spectrum of microclimates, harbouring a unique diversity of ecosystems. Glaciers, high mountain grasslands, mountain forests, rivers, lakes and wetlands provide essential services for society. Therefore, damage from climate change on these ecosystems can consequently harm society. To adapt successfully to climate change, mountain ecosystem services and mountain communities must be recognized and protected.

Key risks from climate change

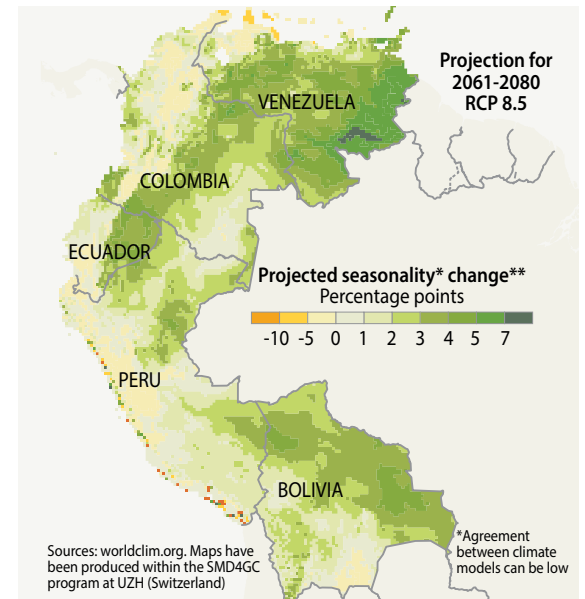
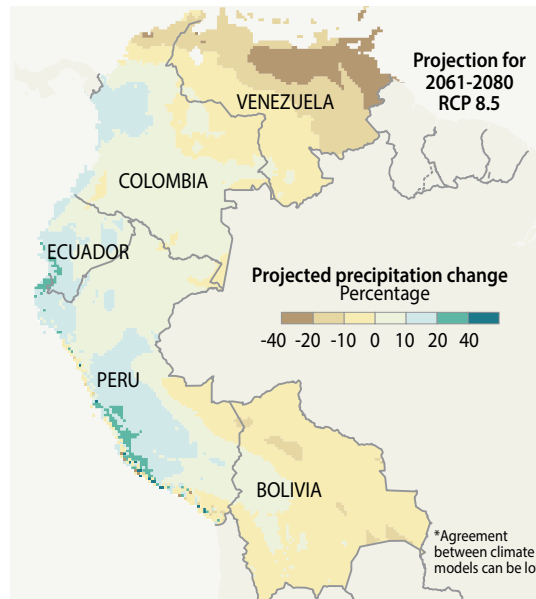
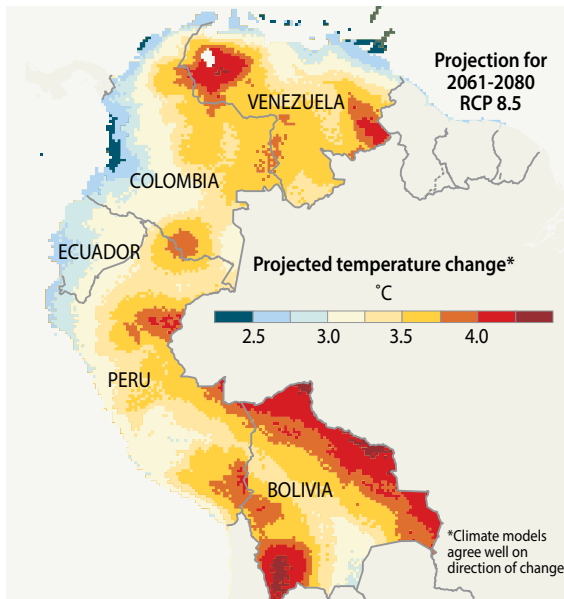
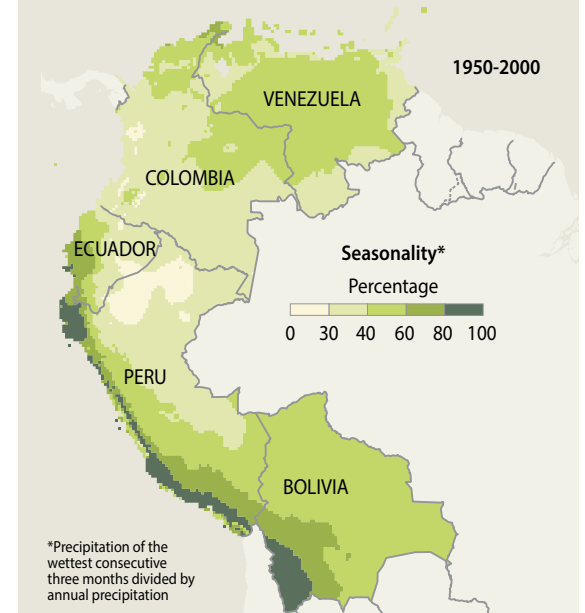
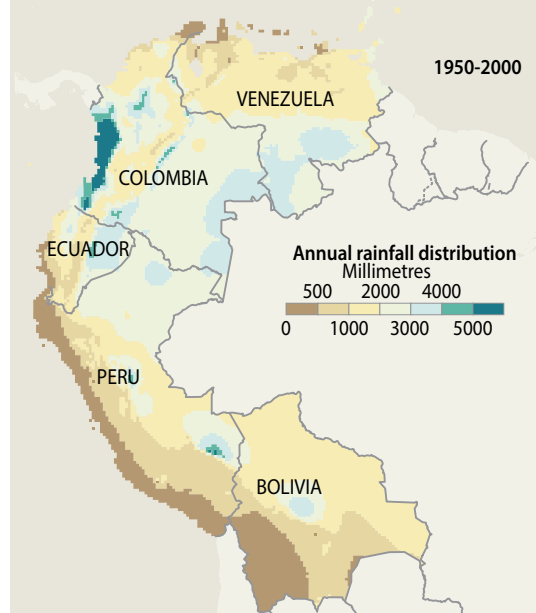
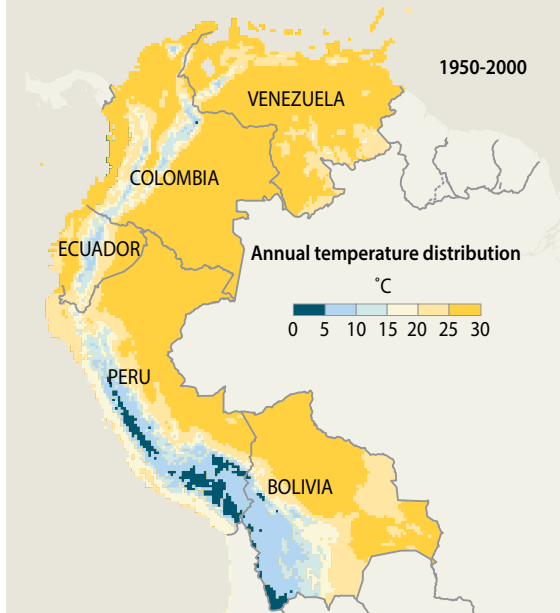
Change in precipitation regime will have serious implications for the provision of water for drinking, sanitation, agriculture, energy and industries. Temperature increase in turn will alternate the biochemical composition of soil and vegetation; hereby changing its capacity to regulate water flows. Extreme events, albeit not only caused by climate change, will further reduce the capacity of the soil and vegetation to prevent landslides. Glacier melt releases heavy metals into water flows which can pose health risks for those using the water. The increase and concentration of the demand for water and other resources will be amplified by population growth and urbanization.

Water availability is essential to all key economic activities in the Tropical Andes, especially for



Peru

Climate change in the Tropical Andes



Tens of millions of people rely on water and other services flowing down the Tropical Andes Mountains. Sustainable mountain development should be a priority, given the multitude of ecosystem goods and services the Andes provide, not only to those living in the high sierra, but also to the millions living downstream.

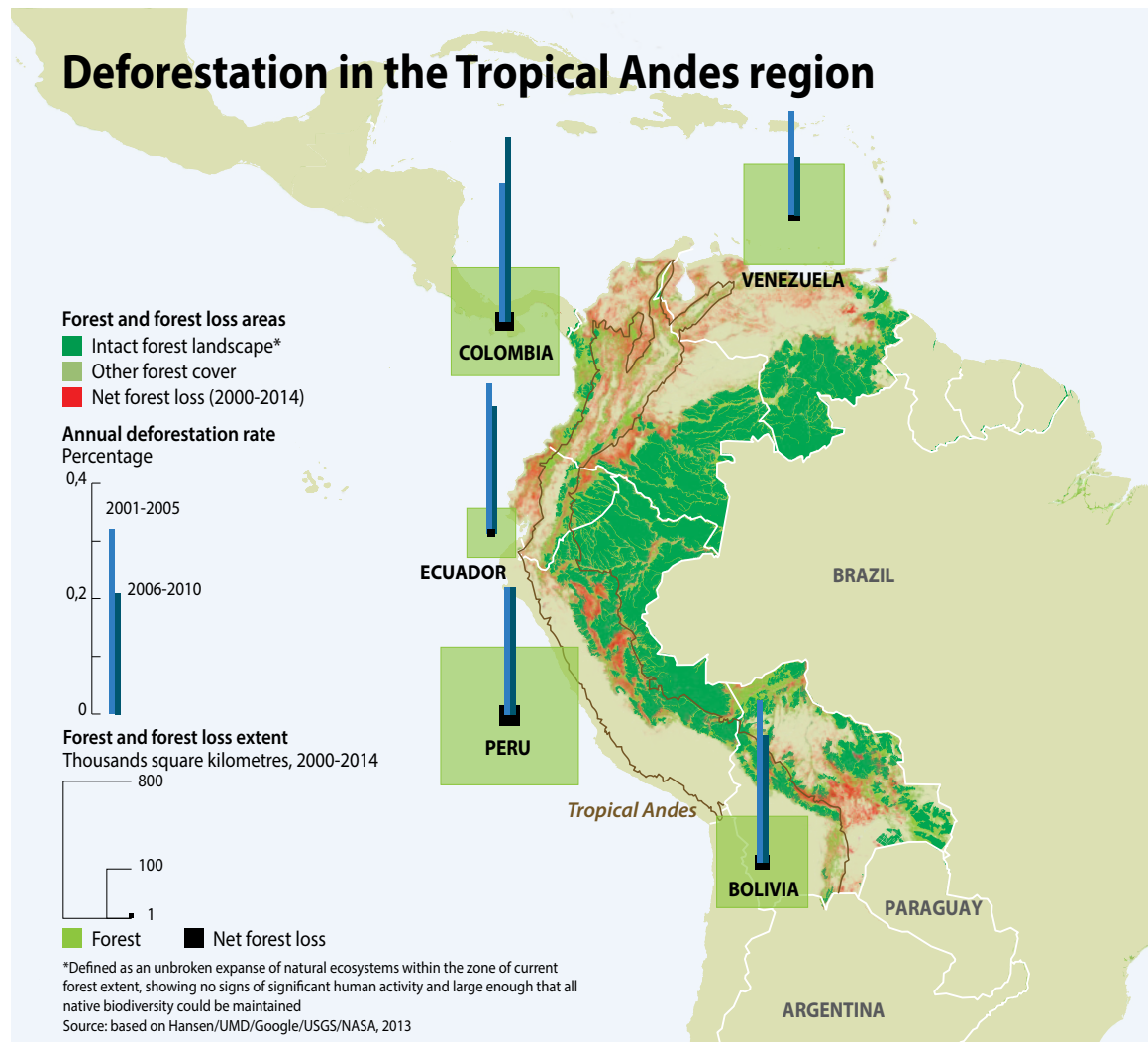
hydropower, which generates the majority of the electricity in the region. Mining is another key economic activity in the Tropical Andes, which relies heavily on water resources. In areas where water is becoming scarce, inclusive management systems are necessary to prevent conflict between stakeholders.

Agriculture is among the most important subsistent and economic activities in the Tropical Andes, and one of the sectors that is most affected by climate change. Tubers, such as potatoes and oca, are particularly vulnerable to warming. As the mountains become warmer, crops need to be moved to higher elevations. Warming is also threatening high mountain grasslands, which are particularly important for pastoral communities and water regulation.

Agricultural problems affect some of the poorest and most vulnerable to food-insecurity, with substantial negative effects on human health. Furthermore, insects and vector borne diseases have moved upwards in elevation as the climate has warmed. Malaria, dengue fever and other diseases will therefore become more prominent in the mountains.

Extreme climatic events are predicted to increase in strength and can in turn cause floods, droughts and





industries and increases the costs of hazardous events and adaptation policies. Furthermore, remote mountain areas are often under-prioritized by central governments. Adaptation, targeting mountain specific environments, is currently underdeveloped but is necessary to avoid the above risks.

Because of the complex topography in mountainous regions, available climate models are often too coarse to provide precise and less ambiguous projections at the local level. This adds uncertainty to the development of adaptation policies, which are crucial to face climate hazards both in the mountains and in the lowlands. There is also a lack of mountain-specific data, and knowledge on how climate change affects social and biological systems, which both are crucial to develop and implement effective adaptation strategies. Furthermore, insufficient technical capacity on mountains and adaptation is another barrier to successful policy development and implementation, especially at the sub-national government levels.

landslides. These events have the potential to cause enormous harm to humans, infrastructure and the environment. Socio-economic indicators determine to a significant degree the outcome of such extreme events for different social groups. For example, poor people living in slums in the steep hillsides of Andean cities are more vulnerable to landslides.

Key findings

Mountain communities in the Tropical Andes are particularly vulnerable and exposed to climate hazards, partly due to their disproportionate poverty and specific features of mountain environments. For example, geographic inaccessibility affects all

Adaptation policies must be based on long-term observations and projections as the impact of climate change occurs over decades and centuries. However, current institutional designs favour actions with short-term gain. Too often stakeholders are forced





Peru

to implement reactive policies instead of more cost-effective preventative action. A long-term perspective in adaptation also involves the development of indicators to measure success and failure to allow for improvement of the policies and strategies.

The lack of technical knowledge and capacity on climate change issues, which is prevalent amongst local stakeholders, hinders their ability to adapt to changes. This could partly explain the lack of implementation of existing adaptation policies in mountain communities. Furthermore, effective adaptation calls for the coordination of climate change adaptation across policy sectors and places, but weak institutions currently hinder this. There are however some existing policy frameworks (e.g. for Risk Management) that, even though they were not created under the climate change label, could easily be used for adaptation purposes and have a complete set of policy instruments.

Problems caused by climate change in the mountains are often transboundary due to their importance for hydrology, the location of basins and the continuation of social and biological systems. International



Wax palms in Cocora valley, Colombia

cooperation and coordination on mountain policy could increase adaptive capacity. The Tropical Andean countries share many challenges and opportunities, which creates potential for mutual cooperation and benefit. The lack of sharing of information between countries in the region hinders effective development and implementation of adaptation policies.

Another barrier is the lack of participation of women and indigenous people from mountain communities and the inclusion of traditional knowledge in the

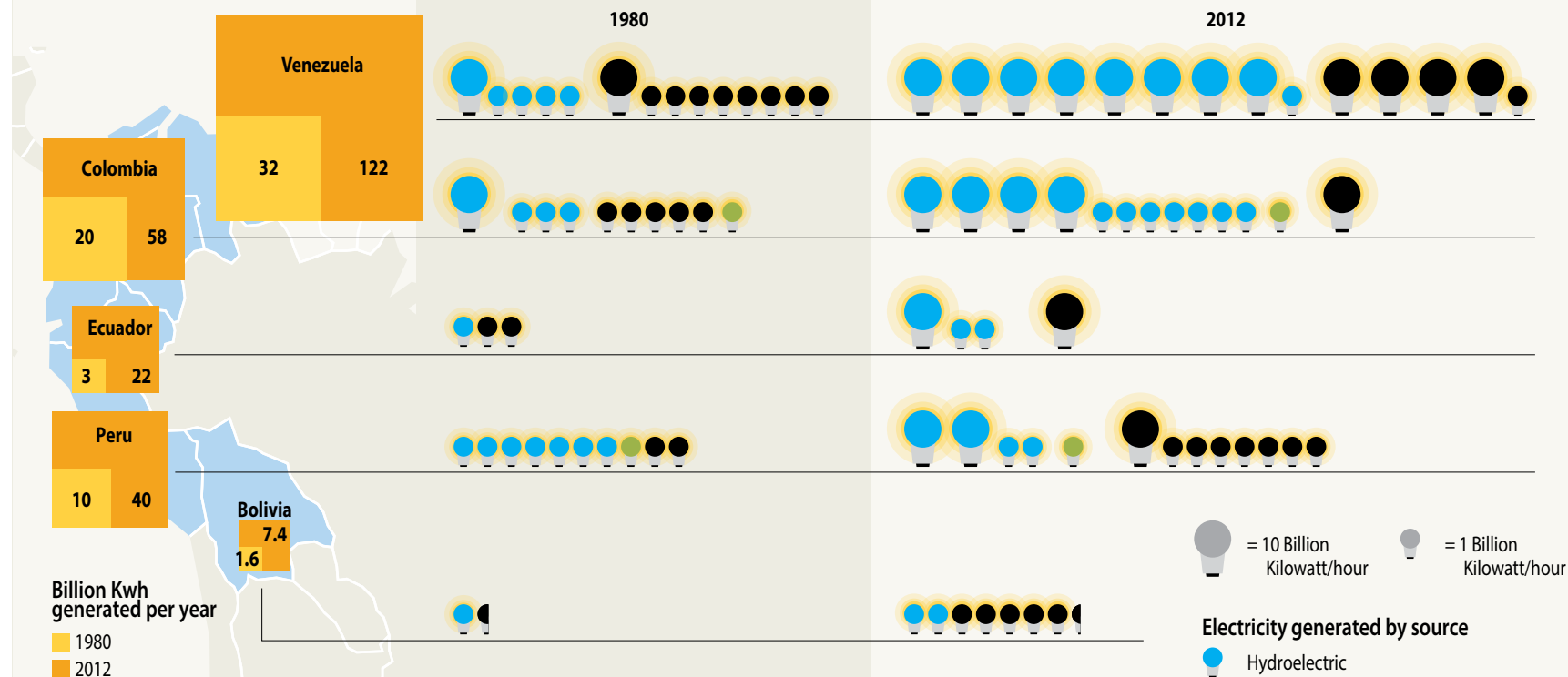
design and implementation of mountain adaptation policies. The highest numbers of indigenous people in the countries live in the high sierra in central Peru and in the Altiplano. Thriving in some of the world's most difficult environments demonstrates ingenuity and adaptability, but these capacities are currently underutilized by society due to poverty, sexism and ethnic discrimination. Adaptation measures should build on traditional knowledge and include women, indigenous people and vulnerable groups in the planning and implementation of adaptation measures.



Mérida city, Venezuela

Hydroelectric power lights up the Tropical Andes

Electricity production trends and sources



Source: U.S. Energy Information Administration, accessed November 2015

Recommendations

Monitoring and research

1. Increase the amount of meteorological measurement stations and maintain existing stations to sustain long-term observations and accurate local projections in mountain areas. Efforts to maintain and expand on the existing meteorological measurement infrastructure would reduce costs of adaptation policies by allowing targeted and efficient measures to be implemented. More funding should be awarded to initiatives such as the Initiative on Hydrological Monitoring of Andean Ecosystems (iMHEA), which currently has more than 20 monitoring sites to respond to specific hydrological concerns of the communities and local authorities.

2. To fund and promote more research on mountain specific impacts of climate change on social and biological systems is necessary for more efficient adaptation action. Particular attention should go to the locally specific challenges between the different settings. National data should be disaggregated geographically, to allow researchers to understand the different adaptation needs in different parts of countries. Enhance the monitoring of mountain specific biodiversity such as through the Global Observation Research Initiative in Alpine Environments (GLORIA-Andes) adapted for the Andes and the Andean Forest Monitoring Network.

Key risk sectors

3. Address key risks threatening water resources, land resources, loss of biodiversity and ecosystems, food security and health. Mountain communities are particularly vulnerable and exposed to climate hazards. Policies addressing food and water availability in these communities are important to prevent poverty and associated ills. Water resources provided by mountains are also crucial to the vast majority of the population living downstream. There is no one-fits-all adaptation strategy possible for the entire Tropical Andes and so there is a need for both mountain specific adaptation measures relevant at the local level and specific adaptation plans for each different setting/case.

4. Implement Ecosystem based Adaptation (EbA) measures. Mountain ecosystems are not only threatened by climate change but also other stressors including pollution and land-use changes. To successfully combine economic growth with preservation of the ecosystems in vulnerable mountain communities, it is important to strengthen and properly manage ecosystems, and sustainably increase the benefits gained by society. EbA encompasses a range of low-cost options that promote the sustainable use of natural resources whilst planning for and adapting to changing climate conditions. EbA can benefit mountain communities as well as communities in downstream areas.

5. Expand measures to prevent and manage extreme events driven by climate change. The design of tools, mechanisms and technologies to address climate driven events (such as floods or wildfires) must be forward-looking and preventive in nature to increase the resilience of people, ecosystems and infrastructure. The development of early-warning systems would be very beneficial to reduce casualties, especially in the case of flooding. In some cases it would be beneficial to use the policy instruments of other frameworks (e.g. those of Risk Management) for climate change adaptation purposes.

Governance

6. Move from reactive to preventive action.

A long-term approach focused on prevention is needed to adapt to climate change. Many effects to which society must adapt occur in time perspectives of decades and centuries. Efficient adaptation must acknowledge where long-term preventive measures are preferable to short-term reactive measures and efforts must be made to ensure continuity both in policy as well as policy implementing institutions.

7. Promote Result Based Management:

Complementary policy instruments are required to allow policies to be implemented. Adaptation policies should be designed with built-in indicators and mechanisms to measure degrees of success and failure of what is being implemented. Policy monitoring and evaluation is especially important in remote areas and in areas where there is little prior experience. Monitoring the degree of implementation, as well as how well policies perform in terms of reaching their goals, is central to a long-term approach to adaptation action.

8. Enhancing technical capacity on climate change adaptation.

Climate change affects all aspects of society and government. To reach the goals of climate change adaptation, it is therefore important that decision makers and implementers on all levels are educated about climate science and adaptation policy. This could be advanced by including information about climate change adaptation in the training of local governments, especially within mountain areas. Awareness raising is generally valuable to ensure that local people, private companies and governments work towards shared goals in climate change adaptation.

Regional cooperation

9. Create an Andean data-sharing platform for adaptation.

The tropical Andean countries share many challenges and opportunities in the mountains due to climate change, which creates the potential for mutual benefit. Both natural and social scientific research and measurements, as well as lessons learned from implemented adaptation policies, should be shared to reduce costs and improve all countries' adaptive capacity. Facilitating interdisciplinary discussions among experts on mountains and climate change could be an important part of the knowledge sharing process.

10. Improve the coordination among Andean countries on sustainable development in the mountains.

International cooperation and coordination on mountain policy would be of mutual benefit to all Andean countries in order to strengthen their adaptive capacity and jointly take advantage of opportunities. The many shared goals also means that coordination can, for example, avoid the unnecessary duplication of research, policy efforts and other measures. The benefits of an Andean data-sharing platform can be further enhanced by regional coordination on the establishment and standardization of indicators and monitoring systems. Regional coordination can also ensure demand driven research and monitoring. Mutual commitments in the region on adaptation policies, including joint objectives and programmatic priorities, could also facilitate a long-term approach.



Mountain EbA Programme, Peru



Potatoes



Ecuadorian-Peruvian-traditional-fabrics



Peru



Notes

1. Cuesta, F., 2012. Panorama andino de cambio climático: Vulnerabilidad y adaptación en los Andes Tropicales [WWW Document]. Portal CONDESAN. <http://www.condesan.org/portal/publicaciones/panorama-andino-de-cambio-climatico-vulnerabilidad-y-adaptacion-en-los-andes-tropicales> (accessed 8.11.15).
2. Magrin, G.O., J.A. Marengo, J.-P. Boulanger, M.S. Buckeridge, E. Castellanos, G. Poveda, F.R. Scarano, and S. Vicuña, 2014: Central and South America. In: *Climate Change 2014. Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L.White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1499-1566
3. Malcolm, J.R., Liu, C., Neilson, R.P., Hansen, L., Hannah, L., 2006. Global Warming and Extinctions of Endemic Species from Biodiversity Hotspots. *Conserv. Biol.* 20, 538–548.
4. López-i-Gelats, F., Paco, J.L.C., Huayra, R.H., Robles, O.D.S., Peña, E.C.Q., Filella, J.B., 2015. Adaptation Strategies of Andean Pastoralist Households to Both Climate and Non-Climate Changes. *Hum. Ecol.* 1–16.
5. Siraj, A.S., Santos-Vega, M., Bouma, M.J., Yadeta, D., Ruiz Carrascal, D., Pascual, M., 2014. Altitudinal changes in malaria incidence in highlands of Ethiopia and Colombia. *Science* 343, 1154–1158.

Photo credits

- 1 iStock/Devasahayam Chandra Dhas
- 2 iStock/robas
- 4 Musuq Briceño
- 7 Musuq Briceño
- 8 Tine Rossing
- 9 Carlos Díaz Huertas
- 9 iStock/javarman3
- 10 iStock/robas
- 14 Carlos Díaz Huertas
- 14 iStock/MarkSkalny
- 14 iStock/zanskar
- 14-15 Musuq Briceño
- 16 iStock/filrom

Front cover photo: Southern Bogota, Colombia

Back cover photo: Salar de Uyuni salt flat, Potosí, Bolivia

Cartography by Riccardo Pravettoni/Cartografare il Presente



CONDESAN

Consortio para el Desarrollo Sostenible
de la Ecorregión Andina



A Centre Collaborating with UNEP

www.unep.org

United Nations Environment Programme

P.O. Box 30552 - 00100 Nairobi, Kenya

Tel.: +254 20 762 1234

Fax: +254 20 762 3927

e-mail: unepub@unep.org

www.unep.org

