POLICY BRIEF

United Nations Educational, Scientific and Cultural Organization

International Hydrological Programme

Flanders State of the Art

CLIMATE CHANGE IMPACTS ON WATER RESOURCES IN THE TROPICAL ANDES:

Prioritizing scientific research for developing adaptation policies

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EXECUTIF SUMMARY

STATE OF CURRENT KNOWLEDGE AND GAPS

» Water supply

Water availability in the Andes is driven by spatiotemporal patterns in precipitation, and to a lesser extent in evapotranspiration, as well as the water storage and attenuation capacity of local and regional hydrological processes. First order impacts of climate change relate to alterations of precipitation and evapotranspiration, which govern surface water fluxes and availability. On a regional scale, an increase of precipitation over the inner tropics (southern Colombia, Ecuador, northern Peru) is expected, while Global Circulation Models tend to show a decreasing precipitation trend in the outer tropics (northern Colombia, Venezuela, southern Peru, Bolivia, and northern Chile). However, these regional trends mask strong local patters, often driven by topography. The interaction of synoptic climate processes and topography is not well resolved in the GCMs, such that impacts of climate change on local climates is extremely uncertain. The impact on evapotranspiration is more certain, because of the direct relation between temperature and available energy for evaporation. A temperature increase therefore will increase evapotranspiration, except in those regions were water availability is limited (e.g., the Pacific slopes of the Peruvian and Chilean Andes), or where a decreasing precipitation trend counteracts the increase in available energy.

On a longer time frame, climate change also affects the hydrological behaviour of river basins in the Andes. The melting of glaciers is a clear example, but changes in vegetation, wetland extent, and soils may also affect the water storage and regulation capacity. The consequences of these changes are very diverse and often only poorly understood and extremely difficult to predict, but there is a tendency towards decreasing water storage and regulation, and therefore an acceleration of the hydrological response. This will decrease water availability during dry periods and increase it during wet periods (potentially increasing water-related risk such as floods).

Climate change should be seen in a wider context of hydrological change. Land-use change and ecosystem degradation in the Andes are widespread, and may often overshadow the impact of climate change. This is especially the case for water quality. Both diffuse and point sources of contamination are increasing at a dramatic rate, and pose severe risks to water resources. Intensification of agriculture, urbanisation and increasing urbanization are identified as major drivers for the deterioration of water quality.

›› Water demand

The Andes experience a fast increase of water demand, underpinned by rapid economic and demographic growth rates. Additionally, nearly all major cities in and around the Andes are consistently growing faster than the national average, thus putting disproportionate pressure on often underdeveloped water capture and distribution systems. This can lead to both water shortages and water quality degradation because of the use of suboptimal water sources and contamination in the distribution system. In addition to demographic growth, South American economic growth has focused strongly on industries that are at the same time highly water intensive and polluting, in particular agriculture and mining.

CURRENT ADAPTATION STRATEGIES AND BOTTLENECKS (REGIONAL, NATIONAL, LOCAL)

TABLE 1: Summary of the major bottlenecks to climate change adaptation identified from interviews with policy actors in Peru, discussion of their causes, and potential recommendations.

BOTTLENECK	CAUSES	RECOMMENDATIONS
Lack of consensus on terminology and framework for "vulnerability" and "adaptive capacity"	• One size fits all" labels, lack of understanding of idiosyncrasies of local issues; • So-called "wicked problems" with no straightforward solutions • Anxiety and sense of threat can lead to apathy and indecision	• Better identification of drivers of vulnerability at a local level; • Improved definition and use of measures of vulnerability • Application of "clumsy solutions" in policy making • Better define and create safe spaces for supportive communication in policy
Difficulties to identify collaborators and adaptation projects	Lack of transparency and global communication	Better and more transparent platforms (e.g., online) for adaptation projects, networking and associations
Failure of adaptation strategies	• Risk perception at local level is shaped by multiple interconnected factors (e.g., economic security, political power, cultural beliefs) which were not considered together; • Inadequate or lack of evaluation strategies;	• Emphasis on stakeholder engagement and participation. Local risk perceptions are crucial to project success • Development of tailored evaluation of adaptation strategies
Adaptation uncertainties	Adaptation is unexplored territory and there are no existing, proven strategies	Identification of opportunities for cost-benefit analysis to select "win - win" or "no – regret" projects
Inconsistent and limited approach to water resources management in a climate change context	• Privatization of water services favour national elite and demands of globalized markets • No cross-sector water sue quantified and mapped	• Water tax introduction • Development of clear water rights • Use water footprinting as a tool

TABLE 2: SWOT (Strengths, Weaknesses, Opportunities, and threats) analysis of climate change adaptation in Peru, as an example country for the Andes.

STRENGTHS		Establish a functioning insurance market		**OPPORTUNITIES**
		Develop clear water markets	User water footprinting as a tool	Establish more bridging organisations and intermediaries to facilitate horizontal and vertical communication
	Pluridisciplinary cooperation and facilitating both horizontal and vertical communication	Water tax introduction	Development of on- and offline platforms for communication of adaptation projects and associations	Opportunities for cost-benefit analysis to select "win – win" or "no regret" projects
	Rapid set-up and investment in the development of a national and regional adaptation strategies in comparison with other countries – builds needed foundations for urgent actions	Use proper uncertainty quantification as an opportunity to identify research priorities and no-regret approaches	Clumsy solutions	Create safe spaces for supportive communication in policy
"One size fits all" approaches and labels	"Wicked" problems with no obvious solutions	Difficulties to identify collaborators and adaptation projects	Failure of some adaptation strategies	Privatization of water services favoured national elite and globalised markets demands – sector partiality
Inconsistent and limited approaches to water resources management in climate change context	Risk perception at local level shaped by multiple interconnected factors (e.g., economic security, political power, cultural beliefs) which are not considered together	No cross-sector water use quantified and mapped	Lack of stakeholder engagement and participation – local risk perceptions are crucial to project success	Anxiety and sense of threat induce apathy, indecision, and inaction
Lack of transparency and global communication	Lack of consensus on terminology and framework for "vulnerability" and "adaptive capacity"	Careful and appropriate use of term "vulnerability"	Lack of criteria and guidelines on definition and quantification of vulnerability	
Unclear horizontal (cross ministry) bridges for action	No existing proven strategies for adaptation			
WEAKNESSES				**THREATS**

SCIENTIFIC RESEARCH PRIORITIES FOR DEVELOPING ADAPTATION POLICIES

A gap-analysis to identify the policy relevant issues that are not currently included or not given priority, resulted in the following priorities for scientific research for developing adaptation policies at the national and regional levels:

- Considering the importance of a data-based approach to adaptation, **data collection** is of primordial importance and should be given unconditional priority. Current deficiencies in monitoring networks are seen as a principal bottleneck to advance adaptation-relevant science. The design of monitoring networks requires further integration of efforts from governmental institutions, universities and NGOs. This would not only optimise resource allocation, but also allows better tuning of monitoring requirements between different actors. Data collection and processing should pursue improved compatibility, comparability and exchange of information at national and regional level. Data collection should be tailored better for decision-making, which has implications for the design of monitoring networks.

- **Understanding the processes driving changes in the water cycle**. Arguably the largest change in water availability is due to changes in water demand, due to population growth, urbanization, industrial growth, and expansion and industrialisation of agriculture. Scientific literature is extremely scarce for the Andes.

- **Regionalisation and interpolation of process understanding**. The density and state of knowledge of hydrological processes and water resources management in the Andes is extremely variable, with clear “hotspots” of scientific activity. This process tends to be self-reinforcing, as scientific activity tends to attract further research, either because of practical considerations (investments in instrumentation and facilities) or to build upon the existing body of research.

- Tools and methods to facilitate **modelling, simulation and scenario analysis for adaptation planning** remains a bottleneck. The large majority of environmental models has been developed for different environments, processes, and data availability. This leads to suboptimal predictive capacity, and large uncertainties. Even though uncertainty analysis has become standard practice in many branches of environmental prediction, the use of uncertainty analysis in policy-oriented scenario analysis is still in very early stages. Specific targets of scientific research include (1) evaluation of models (at the level of region or country), ensemble modelling, model intercomparison, and communication of model assumptions and their relation to scientific evidence.

- **Improved tailoring of environmental models to decision-making.** Participants at the Quito workshop perceived a discrepancy between the level of complexity of models, and the level of complexity of decision-making. Complex solutions should be provided for complex problems, and easy solutions to easy problems.

- **Visualisation and communication of scientific results**, especially computer simulations. New technologies of web-services, mobile communication and cloud computing are driving the development of a new era of infographics, which have the potential to reduce the gap between the scientific discipline of environmental model development and the policy application of model simulations. Especially in regions of high uncertainties, this can help avoiding high and unrealistic expectations regarding scientific knowledge and environmental models, as well as that they are seen as clear-cut cases for particular policies.

- Lastly, **robust decision making and the pursuit of no-regret strategies** has been explored as a potential strategy to deal with the large uncertainties related to predicting the impact of climate change on water resources. The exploration and application of these concepts in the tropical Andes is still very much in its infancy.

FOR MORE INFORMATION

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