

**ASISTENCIA A LOS PAÍSES ANDINOS EN LA REDUCCIÓN DE RIESGOS Y DESASTRES  
EN EL SECTOR AGROPECUARIO**

**POLICY BRIEF 1. HYDROLOGICAL DYNAMICS OF SOUTH AMERICA**

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### POLICY BRIEF 1. HYDROLOGICAL DYNAMICS OF SOUTH AMERICA

## How can institutional arrangements reflect the hydrological dynamics that articulate South America as a territorial unit?

South America is a territorial unit geographically articulated around trans-national watersheds. The nature of the geographical link is determined by the law of gravity from the higher Andean ecosystems above 4000 masl in the birth of rivers that make up the various river basins of South America from both, the Atlantic side (for example, the Amazon and Plata) as well as the Pacific watershed (for example, the Rimac). It is necessary to build a multi-disciplinary institutionality that reflects that cross-border dynamics from remote rural communities located in the upper bounds of the Andes and that articulates from there to the top, via the municipal structure up to national governments and agencies, as well as supra-national institutions such as CAN, MERCOSUR and the recently established UNASUR.

### Hydrological dynamics: the role of the Andes

The tropical Andes mountain range spans from northern Colombia to southern Peru, and is of strategic importance for the environmental stability of the South American continent. **Water is the linking thread which connects the tropical Andes to most watersheds in South America**, not only those flowing west to the Pacific Ocean, providing water for cities such as Lima, Quito and La Paz, but also east to the Atlantic Ocean, by way of the Amazon river basin and the La Plata river basin.

As such, **the hydrological stability of most of the continent depends on services provided by micro-ecosystems found around and above 4 000 masl (páramos, wetlands and glaciers).**

Significant threats already abound e.g. droughts, floods, growing pressures to water quality, continuing loss of wetlands, and the impact of these losses on the natural functions of floodplains and estuaries.

Within this context, the delicate stability of the region is being seriously threatened by climate change. According to the IPCC (2007):

“By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forests by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation (WGII 13.4, SPM) (...) Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. (Although), in temperate zones, soybean yields are projected to increase. Overall, the number of people at risk of hunger is projected to increase (*medium confidence*). (WGII 13.4. Box TS.6). Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation (WG II 13.4, SPM).

Climate change is, thus, underlining the effects of this interconnectedness within the region, as water can no longer be taken for granted. Melting glaciers are perhaps the best example. Yet, the potential impacts of climate change, adding to the intensity and frequency of these processes, claim for an increasingly integrated, transboundary management approach for the whole area. Although some initial progress has been made in this regard - as will be analysed below - further progress has been constrained by a poor understanding of the vigorous physical, economic, and sociopolitical links between these geopolitical spaces.



## The Tropical Andes and the Amazon and Río de la Plata Basins

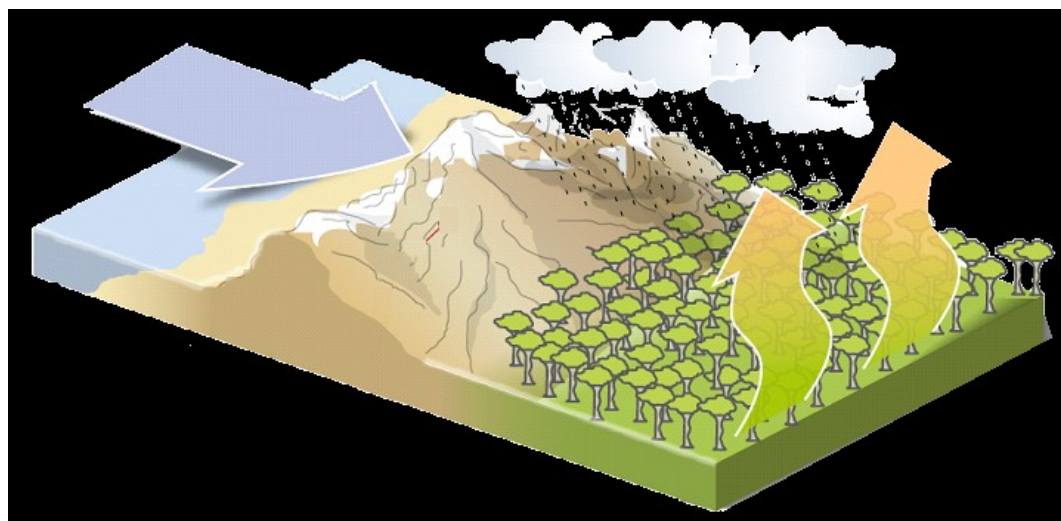
The Andean range constitutes a natural wall that stops clouds from pursuing their west-bound journey further. The clouds then either precipitate on the Andes, feeding the water recharging zones located more than 4 000 masl, or deviate them back to the west, where they eventually precipitate on the Amazon basin. These clouds are formed with humidity captured from the Atlantic Ocean by the trade winds (*vientos alisios*) which blow from east to west.

The highest ridges of the Andes are the continental divide from which water flows west to the Pacific and east to the Atlantic oceans. The rivers flowing westward carry a relatively limited amount of water, both because they are short and because the western slopes where the watersheds are located are particularly dry due to the fact that most of the winds come from the east, and therefore lose most of their water on the eastern side. By contrast, to the east, two main river basins dominate the landscape: the Amazon and the Río de la Plata river basins.

The Amazon river basin occupies the entire central and eastern area of South America, lying to the east of the Andes mountain range and extending from the Guyana Plateau in the north to the Brazilian Plateau in the south. The Basin covers more than 6 100 000 km<sup>2</sup>, or 44 percent of the land area of the continent. The Amazon river, which runs for approximately 7 100 km from its sources in Peru, Ecuador, Colombia and Bolivia to the Atlantic coast of Brazil, is the world's longest and deepest river. It is the second widest following the Río de la Plata. This basin covers more than 6 100 000 km<sup>2</sup>, or 44 percent of the land area of the South American continent.

**Preserving the hydrological cycle in the Amazon Basin is of utmost importance for the biodiversity of the area, the local climate, and the continuing use of its water resources.**

The Andean slopes are subject to severe erosion, with more than 1 000 tons/km<sup>2</sup>/year of sediment flowing towards the Atlantic Ocean. This process, together with changes in the hydrologic cycle associated with changes in global climate and exacerbated by the alteration of the Amazonian forests due to fires and droughts, pose serious environmental threats of a transboundary nature to the whole Amazonian basin. Sedimentation also causes:



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- the elevation of river bottoms, thus being a key source for increasingly frequent floods in the region. This elevation of river beds may also be concealing a gradual drying-up of the volume of water contained in watersheds as rivers do not show the real extent to which they dry out. On the other hand;
- sedimentation affects biodiversity which is probably one of the causes for the disappearance of algae species in watersheds;
- it heavily deteriorates the quality of water, thus increasing the cost for its treatment to make it drinkable for human consumer in urban and rural settings;
- last but not least, sedimentation clogs irrigation and industrial paraphernalia, as well as the tubes for provision of human consumption, causing damages that may cost a fortune to repair.

The Río de la Plata basin also arises on the eastern slopes of the Andes, at altitudes above 4 000 masl. It extends over some 3.1 million km<sup>2</sup> and comprises the Paraguay River sub-basin, which includes the diverse Chaco ecosystem, and the Pantanal wetlands. This basin extends almost all the southern part of Brazil, the south-eastern part of Bolivia, western Uruguay on its border with Argentina, the whole of Paraguay, and an extensive part of northern Argentina. In total, it accounts for 17 percent of the surface area of the South American continent. It should be noted here that Uruguay is the only South American country that is only marginally fed by watersheds of Andean origin, as the Río de la Plata acts more as a water versant for Uruguay. In fact, the two rivers that feed that country are the Río Uruguay and the Río Grande, which are both born in the Cuchillas range that cuts across Brazil from east to west. However, this only refers to water above soil surface.

In addition, water that infiltrates into the groundwater system from within the Basin provides recharge for the Guarani Aquifer, which extends 1.2 million km<sup>2</sup>, below Argentina, Brazil, Paraguay and Uruguay. Thirty-one large dams and 57 large cities, each with populations in excess of 100 000 persons and including the capital cities of Argentina, Brazil, Paraguay, and Uruguay are to be found within this basin (OAS 2005; World Bank 2002).



## Building institutional arrangement around the hydrological dynamics strengthening the South American integration process

Institutions are defined, following the neo-institutional economics framework, as the rules of the game that is, the humanly devised constraints (rules, laws, self-imposed codes of conduct) that shape human relationships, and patterns the mechanisms people use to control their use of the environment. According to Folke *et al.*:

“They link society to nature, and have the potential to coordinate the human and natural systems in a complementary way for both ecological and human long-term objectives” (Folke *et al.* 2007:30).



### Institutional Arrangements around the Management of Natural Resources

Natural resources management is related to crucial sustainability issues. All natural-resource based productive activities can generate both positive and negative impacts on local communities and their biophysical environments, particularly raising the issue of inequitable distribution of costs and benefits across stakeholders.

**Water frequently functions as the link between the climate system and human society.** Climate physically expresses itself through meteorological phenomena, mainly precipitations, such as rain, hail, snow, as well as temperature conditions. The former phenomena are of a physical nature which directly impact on the landscape. They draw their trail upon the territory as the artist draws his figures on the canvas. The latter are of a thermic nature and are responsible for the transformation of precipitations which are in essence constituted by water into its liquid and solid forms. It is the combination between the tectonic history of the earth and climatic conditions that has shaped current landscapes. Humans, ever since their appearance as a species over the past few millennia, have been attempting to determine the combination between climatic and tectonic phenomena to their advantage. It is the extent to, and the way how, humans gather into institutional structures that will ensure an impact on the landscape.

The watershed approach adopted in this paper encompasses not only its biophysical components, but its associated productive structures, social systems, and cultural components. Human societies are, thus, considered here as an integral part of the watershed.

Although natural resources management is not only related to water resources and services, in South America in particular, **water is the linking thread which connects the Andes to both the watersheds draining towards the Pacific and the Atlantic.** This is why strategies related to climate change adaptation must increasingly focus on water resources management.

Watershed management institutions, in particular, refer to the administrative rules that are in place to regulate and manage water resources and the provision of water services.

**Local institutional arrangements, at the watershed level, play a vital role in strengthening the capacity of local populations to climate change adaptation.** Throughout history, how to manage climatic variability has been a constant concern for local populations. If, as a result of climate change, this variability is enhanced, however, quantifiable risks and non-quantifiable uncertainties have to be included in the local strategies for natural resources management.

### Transversal Institutional Arrangements for the Management of Natural Resources, agricultural production and food security

Watersheds constitute a special case of multiple use common pool resources. Throughout rural Latin America, and particularly in the tropical Andes and its related continental watersheds, agriculture and livestock production are the main livelihood strategies of most rural populations.

**Agricultural and livestock production have a huge impact on the hydrological regime and quality of water downstream,** the importance of which varies of course with the size of the watershed, climate, soil characteristics, topography, geology, etc.

As mentioned above, the IPCC predicts that climate change will particularly affect tropical and subtropical agriculture through increased temperatures, changes in rainfall patterns, and increased frequency and intensity of extreme events. Thus, it is important to analyse both the vulnerability and resilience of food systems with respect to climate change at both the local Andean watersheds, and their more encompassing South American transnational watershed levels.

## The watershed approach and the sustainable management of natural resources

Water is a prime natural resource and a basic human need. It has to be treated as an essential environmental asset for sustaining all life forms.

The current administration of water resources is fragmented and dispersed, revealing a weak institutional framework. National integrated approaches to water management are needed. First, there is a notorious absence of national policies for water resources. The national state roles are usually fragmented and devoid of any basin perspective.

**There is thus a need for national governing entities aimed at the formulation of laws and their implementation.** Complex issues of equity and social justice in regard to water distribution are required to be addressed. Economic growth and expansion of economic activities inevitably lead to increasing demands for water for diverse purposes: domestic, industrial, agricultural, hydro-power, navigation, recreation, etc. The demand for water in both rural areas and cities is increasing. As a result, water, which is already a scarce resource, will become even scarcer in future. This underscores the need for the utmost efficiency in water utilization and a public awareness of the importance of its conservation.

This is true at both the local watershed level and at more encompassing basins. The objective of the watershed approach adopted in this paper is to create awareness of these interconnectedness, and particularly to create a strategic awareness of the hydrological dynamics linking the tropical Andean region to both the Amazon and Río de la Plata basins. In the South American continent, common supranational approaches and guidelines are necessary. Planning, development and management of water resources need to be governed by both a local and a continental perspective.

### The local watershed approach to agricultural production & food security

Agricultural production and food security depend on a variety of factors. On the supply side, they depend on environmental constraints such as soil erosion, aquifer depletion, melting of the mountain glaciers that feed major rivers and irrigation systems. Some engendered by direct anthropic interventions, and others on biophysical processes. On the demand side, the food equation also depends on population growth and consumption changes.

In particular, environmental constraints related to climate change, such as rising temperatures that reduce crop yields, and melting of the mountain glaciers that feed major rivers and irrigation systems threatens today food security.

The challenges created by the **threats to food security engendered by climate change require both the active involvement of local populations in policy design, implementation, monitoring and evaluation; as well as national and supranational policies and institutions to address the common problems engendered by the hydrological dynamics linking the whole continent.**





## Institutions for the integration of South America

### Supranational entities institutionalising this approach throughout

The two main international organizations which promote the economic integration of the South America continent are the Andean Community and MERCOSUR. The Andean Community of Nations, or CAN, established in 1969, is a subregional organization which currently includes Bolivia, Colombia, Ecuador, and Peru. MERCOSUR, the Southern Common market, established in 1986, is also a subregional agreement of integration, which includes Argentina, Brazil, Paraguay, and Uruguay as full member countries, and Bolivia, Chile and Peru as associated members. The Andean Development Corporation (CAF), created in 1970, is a multilateral financial institution, which has become the main source of multilateral financing for the Andean countries and Latin America's principal source of finance for infrastructure and integration. Its shareholders are Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Jamaica, Mexico, Panama, Paraguay, Peru, Dominican Republic, Trinidad and Tobago, Uruguay, Venezuela and Spain.



### External funds

GEF, the Global Environmental Fund, is currently involved in the implementation and/or preparation of several International Waters Projects in Latin America, Europe, Africa, South East Asia, and the Middle East. The Guarani Aquifer System project which was recently implemented by GEF, with World Bank funds, provides valuable lessons which could served for future trans-boundary agreements between MERCOSUR and the Andean Community.

### The challenges ahead

Creating the legal and normative frameworks by national governments, and channeling resources recognizing the environmental services' provision of upstream dwellers to downstream inhabitants is one of the biggest challenges ahead.

A good example, however, of the inter-national management of transboundary watersheds is provided by Perú and Bolivia's joint management of the Titicaca Lake and its related watersheds.

### The trans-boundary nature of ecosystem services

Despite its large surface water reserves, the drinking water supply in MERCOSUR's most heavily populated regions is increasingly groundwater.

Demands for groundwater are increasing, due to both demographic growth and economic expansion, and as a consequence of the pollution of surface water sources. The country members of MERCOSUR have long-standing experience in collaborating on transboundary water issues, most notably with regard to the Plata river basin, which has had a general treaty and an Intergovernmental Committee since the 1960s. In addition, bilateral projects and specific treaties exist with respect to other water systems, such as the Uruguay River (between Uruguay and Argentina), and the Paraná River (between Brazil and Paraguay).





### The joint management by Perú and Bolivia of the Titicaca Lake System

The Titicaca Lake System, situated at an altitude of 4300 masl, in the highest plateau of the Andes, straddles the border of Bolivia and Peru and comprises a network of four distinct watersheds, which have the characteristic of a closed and integrated system. The surface of Lake Titicaca, in particular, is evenly distributed between Bolivia and Peru, countries that exercise an “exclusive and indivisible joint ownership” over its waters. In fact, the joint ownership model not only applies to the Titicaca Lake waters but to the complete basin, as a way of ensuring an integrated management of the system.

In 1995, a Bi-national Master Plan for the Control and Prevention of Floods, and the Use of Resources of the system was approved and a year later a Bi-national Autonomous Authority (TLBAA), an entity of public international law, was installed. One of the most successful aspects of the TLBAA has been its very smooth operation. The process of creating this entity went through four stages:

- conducting an evaluation of resources;
- designing a legal framework;
- building a management model;
- implementing the management strategy.

These stages represent a model which could be replicated elsewhere in the process of managing other trans-boundary water resources.



### Conclusions

- Policies and **institutional reforms are thus needed to ensure these local, national, and even supra-national hydrological dynamics are thoroughly managed**, ensuring water is put to best use by establishing regulatory institutional reforms. An impending challenge asking for the establishment a truly South American pluri-national agency, with clear roles and responsibilities in relation to the sustainable water management of the region's watersheds.
- **A strategy for climate change adaptation/ disaster risk management / natural resource management, in the case of South America must be addressed with a regional approach that goes beyond national borders to become a strategy for the management of natural resources in the sub-continent of South America as a territorial unit.** This territorial unity of the region is determined by the hydrological dynamics which, according to the law of gravity, has its origin in micro-ecosystems located above 4000masl, to its mouth in the Pacific and Atlantic oceans.
- There are advantages in the governance of this continental dynamic by supranational institutions, such as the CAN (logo), the MERCOSUR (logo) and / or newly established UNASUR.
- Feedback from these supranational bodies must start from the communities in the higher elevations of the Andes, which act as true guardians of the water recharge areas that feed the watersheds that flow through the sub-continent.



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#### Photos and images:

**Page 2:** CAN, 2008. “El Cambio Climático no tiene Fronteras”

**Page 3:** UCER, FAO Bolivia

**Page 4:** CAN, 2009. “Atlas de los Andes del Norte y Centro

**Page 5:** NASA, 2007. Earthobservatory.” Source of the Amazon river”

**Page 6:** Gonzalo Pajares