

**Climate change and resource abundance:**

## **Do we need to worry about water in the Amazon?**

*Major droughts and floods have struck the Amazon region in the past decade, and climate research suggests increasing incidence of extreme events in the decades to come. What are the potential implications of climate change for the water balance of the world's largest tropical rainforest? What action is needed?*

Only the polar ice caps hold more freshwater than the Amazon. The 2<sup>nd</sup> largest river on Earth is about 6,500 kilometres long and has more than 7,000 affluents, with 17 of them larger than the Rhine River. The region holds close to 15 percent of the world's freshwater resources – more than those of the United States, Canada and the European Union together.

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### *The Amazon – a “water-based” economy*

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*Amazônia*, as the Brazilians call the region, depends on its rivers. Most areas of the vast rainforest are only accessible by boat. The waterways allow forest dwellers to have access to markets and public services, like education and health in the region's few urban

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centres. Apart from that, the river is the local population's bath tub, washing machine and, often, the only source of drinking water. Its fish are a major protein provider and critical for survival in the seasonally flooded *várzeas* – plains and riverbanks that hold some of Latin America's most fertile soils for agricultural uses during the dry season.

In *Amazônia*, water is everywhere. An estimated 60 percent of the abundant rainfalls are constantly being recycled back into the atmosphere in the form of water vapor. The whole ecosystem works as a gigantic sponge. Scientists are only now beginning to understand the role that this green sponge plays in the distribution of water to other Latin American regions. Recent research indicates that a lot of rain that falls in the more temperate regions of Southern Brazil, Paraguay and Northern Argentina actually comes from the Amazon “sponge” – important information for decision-makers in Brasília, Asunción and Buenos Aires, because the heartbeat of the three national economies is determined by this rain: the generation of electricity through hydropower. The *Itaipú* dam, one of the world's biggest hydroelectric dams, right on the border between the three countries is one of few facilities in the region. In 2008, *Itaipú* alone produced 19 percent of all electricity consumed

in Brazil and 90 percent consumed in Paraguay. This is also important information for the rest of the world, for not only does the region power Brazil and Paraguay, it is also a global breadbasket: 40 percent of the world's soybeans alone – a prime source of vegetal protein – are cultivated there. Again, some of the rain on which these beans grow comes down south from the Amazon.

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### *Climate models struggling with the lack of data*

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How will global climate change affect the Amazon and its water balance? The fact is that we know stunningly little about that. Predicting future climate in the Amazon is a challenge not only due to the complexity of interactions between rainforest vegetation and the atmosphere. Few historical climate records exist, on the basis of which climate models could be validated. Thus, the 2007 report of the *Intergovernmental Panel on Climate Change* (IPCC) states that climate models generally fail to consistently predict changes in average annual rainfall over the Amazon.

Nevertheless, most climate models predict increasing annual mean temperatures and intensity of dry and rainy seasons, with significant implications for the water balance in the Amazon basin (*ESPA-AA 2008*): a warmer Amazon with an even drier dry season and an even wetter rainy season. This could mean the repetition of the 2005 drought or this year's flood even more frequently in the future. The long-term ecological consequences might turn out to be even more dramatic. The impacts of climate change could detonate the Amazon “sponge”, with unknown consequences for the ecological services it generates. The phenomenon is known as the “Amazon Dieback” – the conversion of large tracks of forest into less densely forested savanna landscapes.

According to a related hypothesis, an “ecological tipping point” could be reached through the combined impacts

of climate and land use change. Every year, a forest area about the size of Belgium goes up in flames. Farmers in the Amazon use fire to clear lands from standing forest and to prepare the soil for agriculture and pasture. Especially in dry years, fires frequently get out of control at the forest edges and, what is not intended, destroy large tracks of forest. Apart from their threat to humans and biodiversity, such accidental fires are known to blow millions of tons of carbon, currently stored in the forest's biomass, into the atmosphere as CO<sub>2</sub> emissions. The "tipping point" theory suggests that the Amazon could enter into a gigantic ecological feedback loop, similar to the Siberian Permafrost soils, thus contributing to its own dieback through ever increasing greenhouse gas emissions.

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### *Vulnerability despite resource abundance*

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For many good reasons, drought ridden, extremely poor, and highly populated tropical regions in Africa and South Asia lie at the centre of the world's efforts to prepare for the impacts of climate change. Yet, as the emerging evidence from the Amazon indicates, natural resource abundance does not necessarily render ecosystems and the population less vulnerable to impacts of climate change. The Amazon Initiative Consortium – an alliance of research institutes in the region – has recently launched research projects at three Amazon sites in Brazil, Ecuador, and Peru in order to assess the vulnerability of local economies and production systems to

climate risk. Many rural economies in the Amazon are built around three major pillars: forest use, agriculture and fisheries. Depending on resource access, rural dwellers may engage in more than one or even all of these economic activities. Prolonged and more intense dry seasons, as predicted by some climate models, will further reduce the set of available diversification options for smallholders, such as valuable (but water intensive) perennial cash crops in the eastern Amazon. Even the robust, and therefore most popular, Amazonian staple crop, cassava, fails when the rainy season arrives later than expected or whenever excess rain causes its roots to rot before reaching maturity. The vulnerabilities of fisheries and the increased risks of devastating fires, described above, add to this gloomy picture.

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### *How to adapt to the unknown?*

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"In the long history of mankind, those who learned to collaborate and improvise most effectively have prevailed." The phrase is attributed to Charles Darwin, the founder of modern evolution theory, and it is probably relevant to all efforts to adapt to the largely uncertain consequences of climate change. Lessons learnt from the *Pilot Program for the Conservation of the Tropical Rainforests of Brazil* (PP-G7),

supported by GTZ in the Brazilian Amazon over the last decade, highlight the capacity of collective action as crucial to facing vulnerability at local level (Szlafsztain 2009). In an economy where human well-being depends on access to common pool resources (such as water, fish and forests), where property rights are weak and law enforcement is low, capacity for collective action allows for alternative ways of coping with scarcity and conflict. Through PP-G7 support, several dozens of community-based fishery agreements have been established in regions where demographic pressures threatened to deplete the fish stocks. These pressures could be exacerbated by climate change in the future.

Another source of adaptive capacity may be traditional knowledge and collective memory (Brondizio/Moran 2008). Other than Amazonian traditional and indigenous populations, immigrated farmers from diverse cultural backgrounds appear to be less well prepared to learn from past climate extremes and adjust production systems accordingly. On the other hand, climate change might bring about alterations so fundamental that traditional knowledge alone will not be sufficient to respond to the new challenges. Hence, in the long run, it might be the traditional and indigenous populations whose livelihood

*In Amazonia water is everywhere. The waterways give access to public services like schools, health-centres and markets.*

Photo: Iuri Fernandes





Photo: Iuri Fernandes

*The Amazon region is a global carbon and biodiversity pool and home to a large rural population. The region is highly vulnerable to climate damage.*

strategies are adapted to historically reliable seasonal climate variability that are particularly vulnerable to the extremes of climate change.

## *Strategies and policies for adaptation*

As elsewhere, water policies in the Amazon countries are primarily concerned with managing water quality and access. With climate risks affecting multiple sectors of the economy in fundamentally distinct ways, water policy can only be one element in a multi-sector policy approach to adaptation. So far, governmental climate-related policies all over the world have focused on mitigation of climate change. The Brazilian National Climate Change Plan, presented at the XIV Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC)

in Poznań/Poland in December 2008, equally emphasises the dimension of emission reductions. The Plan, nevertheless, recognises the imminent need to generate adaptive capacity based on new Research & Development and calls for the scientific community to focus on the identification of vulnerabilities as well as forecast networks and systems. Indeed, any strategy to successfully adapt to climate related risk hinges on knowledge about the likelihood of adverse events and potentially related vulnerabilities of social and economic systems. Research has therefore gained considerable stake as a potential catalyst in the development of adaptation strategies.

Against this backdrop, the slowly moving, yet steady, attempt to base multiple-sector policies in the Amazon on the outcome of an official regional Ecological Economic Zoning appears as a step into the right direc-

tion. If carefully drafted, the Zoning approach could contribute to avoiding the placement of human settlements in flood-prone areas or in critical forest segments where degradation and conversion to agriculture increases fire susceptibility during dry seasons. It could also help in identifying potential bottlenecks in the fluvial transport network and in reducing the impact of new hydroelectric power plants.

Nonetheless, vulnerability to climate change remains a major development challenge both in terms of the Amazon's role as a global carbon and biodiversity pool and with regard to its rural population that largely depends on natural resources as an income source and safety net. Harnessing *Amazônia's* potential for global climate change mitigation should thus go hand in hand with well-planned efforts to reduce the vulnerability of both people and ecosystems to an increasingly uncertain climate.

*References are available upon request from the authors.*

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## **Zusammenfassung**

Die Wirtschaft der Amazonasregion ist in hohem Maße vom Wasser abhängig – als Verkehrsmittel und als Lebensgrundlage für die Menschen. Die Ökosysteme des Amazonas, die auch über den regionalen Wasseraustausch entscheiden, sind jedoch durch den Klimawandel bedroht, auch wenn über die Wahrscheinlichkeit negativer Einflüsse und damit verbundener möglicher Auswirkungen bisher nur wenig bekannt ist. Forschung und der Aufbau von Kapazitäten für gemeinsame

Maßnahmen sind daher Voraussetzungen für die Anpassung an den Klimawandel. Seit 2008 gibt es hierfür auf nationaler Ebene strategische Ansätze. Die Region beginnt gerade erst, sich auf die künftige Entwicklung vorzubereiten.

## **Resumen**

La economía de la región amazónica depende en gran medida del agua para el transporte y los medios de vida. Otro factor importante para el ciclo hidrológico regional reside en que los ecosiste-

mas amazónicos se hallan amenazados por el cambio climático, si bien se sabe muy poco sobre la probabilidad de eventos adversos y las vulnerabilidades potencialmente vinculadas con éstos. Por lo tanto, la investigación y el desarrollo de capacidades para la acción colectiva constituyen las piedras angulares para la adaptación al cambio climático. Desde 2008 han surgido enfoques de políticas estratégicas. La región recién ha comenzado a prepararse para hacer frente al futuro.