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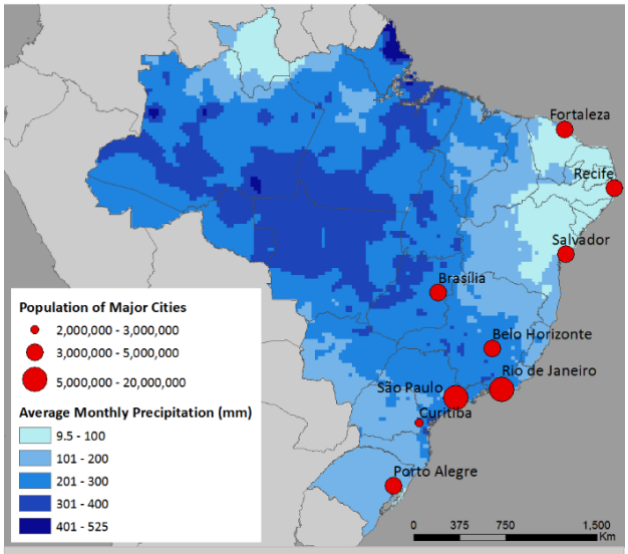
FACT SHEET

CLIMATE RISK PROFILE
BRAZIL

COUNTRY OVERVIEW

Brazil harbors nearly 60% of the Amazon, the greatest area of continuous tropical rainforest in the world and home to 20% of the world's freshwater. The productive, biodiverse ecosystems found in the Amazon Basin provide essential services for the nearly 30 million people, including 350 indigenous communities, living there, as well as vital ecosystems services regionally and globally. However, the impacts of climate change in the Basin vary significantly and are vast; higher temperatures may change the range and distribution of temperature sensitive species, increased severity of drought can greatly affect the Amazon's freshwater ecosystems and the people that rely on them, change in rainfall and temperature could impact the spread of disease, and sea level rise and storm surge will have substantial impacts on lowland areas of the Amazon delta. Coupled with deforestation and environmental degradation, these impacts greatly threaten both the Amazon's natural resources as well as tourism to the region. Climate variability and change also threaten agriculture in Brazil. Recent economic growth in Brazil has been driven in part by agricultural policies promoting intensification as well as social policies, such as *Bolsa Família*, designed to support poor families through a federal assistance program of cash transfers. Despite these interventions, nearly a third of the country's 203 million people remain food-insecure. Should climate impacts decrease agricultural production, Brazil's food insecurity could increase, as could pressure from farmers on the Amazon's land and resources. Threats to Brazil's agricultural sector also contribute to urban migration, which can exacerbate other climate-related risks; for example, increases in temperature and urban flooding can lead to greater prevalence of infectious and vector-borne diseases, as with the 2015-2016 Zika outbreak. (6,12,20,25,34,38)



MONTHLY PRECIPITATION IN BRAZIL

CLIMATE PROJECTIONS

1.7°C – 5.3°C increase in temperatures by 2085 over much of the Amazon region

Increased length of dry period and increased drought in the Amazon

0.2- to 2-meter rise in sea levels by 2100

KEY CLIMATE IMPACTS

Ecosystems
Changes to coastal and riparian water flow
Shifts in ecosystem structure and composition
Increased risks of fire and invasive species

Tourism
Reduced ecotourism resulting from ecosystem impacts
Damaged coastal infrastructure

Agriculture
Increased food insecurity
Reduced crop yields
Less productive freshwater fisheries

Health
Shifting risk of infectious diseases
Increased heat stress

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CLIMATE SUMMARY

Brazil's climate varies from equatorial in the north to temperate in the south. Nearly 59% of the Amazon, the largest humid equatorial rainforest and river basin in the world, is in Brazil, contributing to the country's rich biodiversity, various climates, and extraordinary wealth of ecosystems. The Amazon is so vast that it is responsible for generating as much as 50% of its own rainfall, and covers nearly half of Brazil, which is nearly the size of Australia. Within the Amazon Basin, the average temperature is 27.9˚C during the dry season and 25.8˚C during the rainy season. The Amazon region surrounding the mouth of the Amazon River in the state of Pará experiences an excess of 3,000 millimeters (mm) of rainfall annually, whereas the northwestern region of the Brazilian Amazon, in the state of Roraima, is drier, with annual rainfall between 1,500 and 1,700 mm. Outside of the Amazon, the northeast region of Brazil (Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia) is semi-arid with average temperatures of 23˚C to 28˚. This region can get much hotter during the dry season, has a short, erratic rainy season from March to May, and annual rainfall averages of 500 to 1,300 mm. The central-western region (Goiás, Mato Grosso, and Mato Grosso do Sul) has little rainfall during the dry season, with most of the average annual rainfall of 1,300 to 1,500 mm occurring in the rainy season, and an average temperature of 26˚C. The southeast (Espírito Santo, Minas Gerais, Rio de Janeiro and São Paulo) is mostly humid and subtropical but the coastal regions experience a mix of tropical savannah and oceanic climates. The mean summer temperatures range from 22˚C to 28˚C and the mean winter temperatures range from 15˚C to 23˚C. Southern Brazil (Paraná, Santa Catarina and Rio Grande do Sul) is characterized as a subtropical climate. Annual temperatures range from 14˚C to 22˚C. (6,7,26,40)

HISTORICAL CLIMATE

- Temperature in the Amazon Basin has warmed 0.5˚C since 1980, with greater warming in the dry season.
- The tropical wet region, covering most of the Amazon, has experienced a 5% increase in rainfall over the last 30 years.
- The Amazon has seen 3 significant droughts in the last 20 years (2005, 2010, 2015/16), often associated with the El Niño-Southern Oscillation (ENSO).
- The number of cold nights has increased overall for the country, but decreased in the states of Santa Catarina and Paraná.
- The number of warm days[1] during the dry season has increased moderately, but there has been a significant increase in the number of warm days in the winter.
- Although uncertainty exists as to how much sea level rise has occurred in Brazil due to lack of data, it is likely consistent with global averages of 190 mm between 1900 and 2010. (2,7,10,13,14,34)

FUTURE CLIMATE

- The annual mean temperature is projected to increase in much of the Amazon by 1.7˚C to 5.3˚C by 2085.
- The duration of heat waves in much of the Amazon is projected to increase by 18 to 214 days by 2085.
- The dry season in the Amazon will likely get longer and there will likely be decreased precipitation, especially during the dry season.
- Droughts in the Amazon will increase as ENSO events become stronger and more frequent in the future.
- The tropical wet region is projected to have a significant increase in dry spells, from a decrease of 5 dry days to an increase of 19 days, depending on the model.
- The Amazon river delta is in an area with higher then global average sea level rise, between 0.2 and 2 meters by 2100, likely leading to more severe impacts. (3,7,10,13,16,19,30,34,36)

[1] A warm day is defined as a day that has a higher maximum temperature than 90 percent of all days of the 1971 to 2000 period

SECTOR IMPACTS AND VULNERABILITIES

ECOSYSTEMS

Climate Stressors and Climate Risks ECOSYSTEMS	
Stressors	Risks
Increased temperatures	Decreased tree cover, and reduced availability of natural resources for livelihood generation
Decreased rainfall	Increased desertification and forest fires
Increased drought	Decrease in biodiversity
Sea level rise	Reduced availability of freshwater, increased flooding and coastal erosion
More frequent extreme weather	Increased risk of invasive species establishment

Ecosystems and ecosystem services are essential for Brazil, though under serious threat from climate variability and change. Temperatures are projected to increase by 1˚C to 2.2˚C across the country by 2060, and some models predict an increase of as much as 2˚C to 3˚C by 2050 in the Amazon. Prolonged drought and flooding in regions of the Amazon, combined with other drivers such as deforestation, will alter existing ecosystems. More than 30 million people, including indigenous groups, live in the Amazon basin and rely on its natural resources for livelihood generation. Freshwater, traditional medicines, essential oils, fish, açaí berries, and Brazil nuts are all sourced from this biodiverse region, which also contains both flooded (várzea) and non-flooded forests (terre firme). Marine fisheries support local communities by providing income and nourishment. Mangrove forests, which serve as breeding grounds for marine species and act as natural barriers that prevent flooding and erosion, are found in about 90% of the country's coastline. The southeastern Amazon faces the greatest risk of climate-related changes, with rainfall projected to decrease by nearly 20% and temperatures expected to increase the most in this area; the states of Pará, Mato Grosso, and Rondônia also expect to be greatly impacted. Drier conditions from prolonged drought, combined with increased evapotranspiration due to increased temperatures, will likely impact the 20% of the global freshwater contained in the Amazon. Decreased rainfall also threatens forest resources while excessive heat and dryness have increased tree mortality along forest edges, contributing to both more invasive species and a rise in forest fires. In the Pantanal region, on the border of Bolivia and Paraguay, recent increases in inter-annual variability of floods and droughts threaten the local species adapted to seasonal flooding, the broader ecosystem, and the humans that rely upon these natural resources. In addition, sea level rise threatens Brazil's vast mangrove forests and is increasingly impacting coastal communities, infrastructure, and ecosystems. (1,8,12,22,28,40,41)

TOURISM

Climate Stressors and Climate Risks TOURISM	
Stressors	Risks
Higher temperatures	Prolonged droughts impacting ecotourism
	Decreased biodiversity
Changes in rainfall	Forest fires decreasing natural attractions [and affecting health]
More frequent extreme weather events	Shifting prevalence of disease
	Damage to infrastructure
Sea level rise and coastal flooding	Lack of access to coastal resources

Tourism in Brazil accounted for 8.5% of the country's gross domestic product (GDP) in 2016, although largely outside the Amazon Basin. For example, in the state of Amazonas, tourism only accounts for 1% of GDP. However, Brazil's tourism sector is heavily dependent on the country's abundant natural resources and coastline and could be impacted by increased temperatures and rainfall. Already, increased temperatures, coupled with changes in rainfall patterns, have contributed to prolonged droughts. In 2005 and 2010, for example, the southeastern Amazon experienced severe droughts, a significant deterrent to eco-tourism contingent on unique species such as the arapaima fish and natural resources like the popular açaí berry. The droughts also significantly impacted river transportation, with navigation suspended along sections of the Madeira and upper and central Amazon Rivers during both events; this was likely also an impact of the 2015 and 2016 drought caused by El Niño. In addition to droughts, forest fires, land clearing by fire for agriculture, and extreme weather events all pose an increasing threat to the tourism industry, as does a rise in severe flooding in the last decade. In 2012, Brazil experienced the worst flood on record, and much of the Brazilian

Amazon was in a state of emergency. Highways flooded, roads and bridges sustained significant damage, and the rising waters affected local small businesses and tourism attractions. In the future, the combination of higher temperatures, changing rainfall patterns, and more frequent and intense extreme weather events, could also impact tourism by potentially increasing vector and waterborne disease outbreaks country-wide. For example, Zika was introduced to Brazil in 2013, and the 2015 and 2016 outbreak in the Americas likely resulted from favorable climate conditions partially caused by El Niño. Overall, Zika contributed to an estimated $6.5–$9 billion direct loss to Brazil's tourism sector between 2015 and 2017. Additional threats to tourism include sea level rise and coastal floods, which threaten important coastal natural resources, built infrastructure, and coastal populations. Between 2070 and 2100, 618,000 people per year are projected to be impacted by flooding due to sea level rise in Brazil. (9,12,18,39)

AGRICULTURE

Central to Brazil's economy, total agricultural output has more than doubled since the early 1990s, with the sector accounting for 5.5% of GDP in 2016 and employing approximately 18 million people, or 15% of the formally employed population in 2017. While the rise in agricultural productivity is heavily driven by technological advancements, increasing temperatures, changes in the amount and distribution of rainfall, and increased droughts pose significant risk to the sector. Such climate risks threaten land availability and contribute to agricultural intensification, further driving deforestation and leading to soil erosion and deterioration. Some of the most important crops include soybeans, maize, wheat, cotton, coffee, oranges, and sugarcane. Preliminary assessments indicate that soybean and cotton crops will be moderately impacted by climatic changes, but maize and wheat yields will decline significantly. Of the 5 million farms in Brazil, 85% of them are small family farms, which are more vulnerable to climate shocks and changes, affecting livelihoods. The Brazilian livestock industry is also at risk due to increased drought and temperature, particularly the beef sector, which accounts for 14% of the world's beef output. Although Brazil's food production is robust enough to meet both domestic and export demands, nearly a third of the country is food-insecure, highlighting challenges with inequality in Brazil that are likely to be exacerbated by climate change. For example, if climate change leads to decreased agricultural production, as projected, food insecurity will likely increase, and some projections indicate Brazil could lose up to 11 million hectares of agricultural land by 2030 as a result of cumulative climate change impacts. Brazil's robust fishing industry is likewise at risk from increased ocean temperatures and potentially changing currents. For example, in the Northern Brazil Shelf, which hosts a $700 million fishing industry that is already threatened by overfishing, rising ocean temperatures could decrease maximum fish catch potential by 16% to 50%. (11,20,24,25,30,33,34)

Climate Stressors and Climate Risks AGRICULTURE

Stressors	Risks
Increased temperatures	Dry conditions decreasing crop yield and livestock production
Decreased rainfall	Decreased available arable land, driving continued deforestation
Increased flooding	Erosion and depletion of nutrient rich soil
Increased drought	Damaged agricultural land and infrastructure
	Less productive freshwater and marine fisheries

HEALTH

Brazil has a high incidence of climate-sensitive diseases. Higher temperatures generally create more favorable conditions for vector-borne and other infectious diseases. Likewise, increased flooding is often associated with increased prevalence of waterborne diseases, such as cholera. Within Brazil, both coastal areas and riparian communities in the Amazon River basin are thus particularly at risk because of increased flooding from sea level rise and

Climate Stressors and Climate Risks HEALTH

Stressors	Risks
Increased temperatures	Favorable conditions for infectious diseases
	Higher prevalence of heat-related medical conditions
Increased flooding and drought events	Decreased food and water security
	Coastal and inland flooding leading to increased water-borne disease
Sea level rise	Lack of access to health care due to flood and drought affecting waterway transport.

a rise in extreme weather events leading to more inland flooding. Malaria is currently present in the Amazon, northern, and central-west regions of Brazil, with less than 150,000 cases reported in 2014. However, by 2070, 126 to 168 million people in Brazil are projected to be at increased risk due to the climate change causing malaria to spread to denser population areas further south of the Amazon. The prevalence of other vector-borne diseases is also likely to change in response to increased temperature, as exemplified by the Zika outbreak in 2015 and 2016. Zika was likely introduced to Brazil in 2013 and spread throughout the Americas partially due to favorable climate conditions caused by El Niño. Higher temperatures are expected to increase heat-related medical conditions and are shown to target the elderly, children, and the chronically ill. Projected decreases in agricultural productivity are also a concern for human health because they may result in decreased nutrition and higher rates of malnutrition. Overall water quality is expected to decrease due to flooding, agricultural runoff, and contaminants associated with mining. Additionally, extreme flooding events are likely to increase occurrence of waterborne diseases. Potentially exacerbating these risks, access to health care may also be limited due to both flooding and drought exacerbated by climate change, which could make important waterways used for transportation in the Amazon impassable. (5,32,36)

POLICY CONTEXT

In recent years, the Government of Brazil has implemented numerous policies to decrease deforestation rates, which dropped to one-sixth of 2004 levels by 2014. All the same, the Amazon remains under threat of deforestation, with the deforestation rate spiking by 29 percent in 2016 from the previous year, likely a result of more lenient law enforcement allowing for increased logging, reform of the forest code, and speculation on land. In 2008, Brazil adopted the National Climate Change Plan, which seeks to address (1) greenhouse gas emissions reduction, (2) vulnerability, impact, and adaptation, (3) research and development, and (4) enhancement of skills and dissemination of information. The National Climate Change Policy, which was approved in 2009, offers a legal framework to actualize the goals expressed in the National Climate Change Plan. The legal framework dictates principles, guidelines, and instruments for attaining national targets regardless of the evolution of global climate agreements. In 2016, Brazil prepared its Third National Communication to the U.N Framework Convention on Climate Change, noting the significant strides the country has made and reaffirming active participation in and support of the Convention. In addition, the Climate Fund Program was created as an instrument of the National Climate Change Policy to guarantee funds to support projects intended to mitigate climate change. (4,16)

INSTITUTIONAL FRAMEWORK

The Ministry of Environment (MMA, Portuguese acronym) was established in 1985 and is responsible for developing policies and strategies for mitigation of greenhouse gases and for adaptation to climate change effects. Meanwhile, the Brazilian Institute of Environment and Renewable Resources (IBAMA, Portuguese acronym) serves as the enforcement agency for MMA. Also housed in the MMA is the Chico Mendes National Institute for Biodiversity Conservation (ICMBio, Portuguese acronym), which is responsible for managing federally protected areas and regularly conducts environmental assessments. Another key arm of the government is the Brazilian Institute for Agricultural Research (EMBRAPA, Portuguese acronym) which was established by the Ministry of Agriculture, Livestock, and Food Supply (MDA, Portuguese acronym) to promote cutting edge agricultural research and sustainable development in rural areas. The Brazilian National Institute for Space Research (INPE) provides real time data that has helped slow deforestation (17,31).

NATIONAL STRATEGIES AND PLANS

- National Plan on Climate Change (2008)
- National Adaptation Plan to Climate Change (2016)
- Third National Communication to the UNFCCC (2016)

KEY RESOURCES

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Map resource. Precipitation data is from the Global Precipitation Climatology Center (GPCC); Cities data are from the Natural Earth Populated Places dataset

SELECTED ONGOING EXPERIENCES

Below are selected projects focused on climate change adaptation, or some aspect of it, in Brazil.

Selected Program	Amount	Donor	Year	Implementer
Partnership to Conserve Amazon Biodiversity	$50 million	USAID	2014–2019	Government of Brazil, Ministry of Environment
Amazon Sustainable Landscapes Project	$60 million	GEF Trust Fund	2017-N/A	Government of Brazil, Ministry of Environment
Brazil: Recovery and protection of climate and biodiversity services in the Paraiba do Sul basin of the Atlantic Forest of Brazil	$3 million	GEF Trust Fund	2012-present	Government of Brazil, Ministry of Science, Technology and Innovation
Paraiba Sustainable Rural Development	$80 million	International Bank for Reconstruction and Development	2017-2023	State of Paraiba, Secretariat of State for Family Agriculture and Semiarid Development
Taking Deforestation Out of the Soy Supply Chain	$6.6 million	GEF Trust Fund	2015-2017	UNDP, Conservation International, WWF, IFC
Sustainable, Accessible and Innovative Use of Biodiversity Resources and Associated Traditional Knowledge in Promising Phytotherapic Value Chains in Brazil	$5.7 million	GEF Trust Fund	2016-2017	Government of Brazil, Ministry of Environment
Development of systems to prevent forest fires and monitor vegetation cover in the Brazilian Cerrado	$9.5 million	Strategic Climate Fund Grant	2016-2020	Research and Development Foundation