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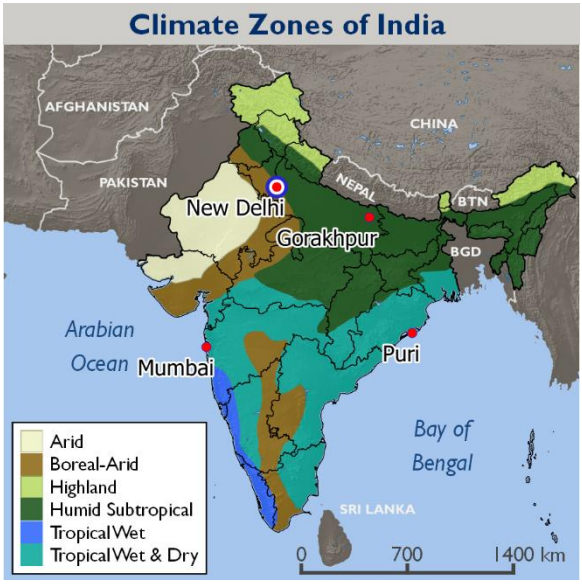
FACT SHEET

CLIMATE RISK PROFILE
INDIA

COUNTRY OVERVIEW



India's rapid economic growth over the last two decades led to substantial gains in life expectancy, agricultural production and literacy. However, this growth was accompanied by persistently high poverty rates (25 percent in rural areas and 14 percent in urban), unsustainable dependence on agriculture for rural livelihoods and increasing urbanization rates (2.4 percent annually), especially in vulnerable coastal areas. India's diverse climate zones, ecosystems and topography translate to unevenly distributed climate risks across the country. In the agriculturally important regions of central Maharashtra, the Indo-Gangetic plains and southern coastal zones, rising temperatures and increased extent and incidence of droughts have caused declines in rice and wheat yields; projections suggest this could lead to a 1.8 percent loss of GDP by mid-century. India's most important river systems (Indus, Ganges and Brahmaputra) are fed by Himalayan glaciers, which are under threat from increased temperatures, severely impacting water availability for agricultural, domestic and industrial use. Drought has negatively impacted energy production as coal-fired power plants have shut down when there is insufficient water for cooling and hydropower production has been reduced. An estimated 12.6 million people live directly on land that is at risk from sea level rise and nearly 171 million people depend on coastal ecosystems vulnerable to sea level rise, cyclones and storm surges. (2, 8, 13, 14, 20, 24, 27, 30)

CLIMATE PROJECTIONS

- 1.2–2.5°C increase in temperatures by 2050
- Increased flooding from sea level rise and extreme precipitation events
- Increased severity of drought and heat waves

KEY CLIMATE IMPACTS

Agriculture
Degradation of agricultural lands
Reduced grain yields and milk production
Saltwater inundation and intrusion

Water
Reduced water quality
Increased water stress
Increased flood risk

Ecosystems
Loss of biodiversity
Increased coastal and forest degradation

Human Health
Increased heat wave- and heat stress-related mortality and morbidity
Diminished food security

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This document was prepared under the Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) Task Order No. AID-OAA-I-14-00013 and is meant to provide a brief overview of climate risk issues. The key resources at the end of the document provide more in-depth country and sectoral analysis. The contents of this report do not necessarily reflect the views of USAID.

CLIMATE SUMMARY

India's wide-ranging climate zones include the cold glaciated Himalaya; the humid subtropical north, center and east; the tropical south and southwest, and the arid and semi-arid west and southern center. The summer monsoon (June–September) is a prominent climate feature across the country; it accounts for about 80 percent of annual precipitation, which varies significantly from the Thar Desert (northwest), which receives less than 130 mm, to the northeast, parts of which receive over 11,000 mm. The Himalaya provide a warming effect as they protect the country from cold northern air. Annual average temperatures range from 2.4°C in parts of Jammu and Kashmir to 28.8°C in parts of the south. Temperature extremes range from -45°C in Dras, Jammu and Kashmir to 51°C in Phalodi, Rajasthan. (5, 7, 9, 14, 15, 16, 28)

HISTORICAL CLIMATE

Historic climate trends include:

- Increased average annual temperatures by 0.06–0.08°C per decade (1901–2013), with substantially stronger warming of 0.14–0.25°C per decade over the last 30 years.
- Increased frequency and intensity of heavy precipitation events.
- Lack of agreement on overall precipitation trends – global data show no change from 1901–2013 and national data show reduced precipitation in areas of central India.
- Overall losses in glacial cover estimated at 2.7 percent per decade since 1978.
- Rise in sea levels over the last 50 years, ranging from 0.8–1.3 mm per year (west coast) to 5.2 mm per year (Bay of Bengal).

FUTURE CLIMATE

Projections for mid-century indicate:

- Increased average annual temperature of 1.5–2.5°C (subtropical) and 1.2–2.2°C (tropical).
- Increased average annual precipitation by 2–17 percent; a tendency for increased precipitation during the wet season and decreased precipitation during the dry season.
- Reduced precipitation in some regions; increased dry spells in the east.
- Increased frequency and intensity of heavy precipitation events.
- Increased duration of heat waves and number of days and nights considered 'hot' (temperatures exceed current climate by 10 percent).
- Diminished glacial extent; variable by region.
- Sea level rise of 100–400 mm.

SECTOR IMPACTS AND VULNERABILITIES

HUMAN HEALTH

In recent years India experienced various extreme weather events that directly or indirectly impacted health. A heat wave during the 2016 drought left much of northern India above 40°C for weeks, increasing the risk of heat-related issues such as stroke, exhaustion and even death. A 2015 heat wave claimed 2,300 lives. Flood risk is increasing in the country's interior, including in the capital Delhi, and along both coasts due to the combination of increasing heavy rainfall events, sea level rise and poorly managed urban development. In July 2013, a heavy rainfall event in Uttarakhand led to flooding that affected 4,200 villages and left more than 5,500 dead. Diarrheal disease is expected to increase by 21 percent in northern India due to warming trends (favoring pathogen growth), increased rainfall and extreme precipitation (straining sanitation systems and distributing pathogens), and drought (causing people to resort to low-quality water sources). India already has high rates of child mortality due to diarrheal disease (about 300,000 deaths per year). Temperature and precipitation trends are projected to expand the transmission window of malaria and dengue by 2–3 months (mainly in the north) and the geographic coverage into new areas of Himachal Pradesh and the northeastern states. (3, 4, 10, 12, 15, 19, 21, 22, 26)

Climate Stressors and Climate Risks HUMAN HEALTH

Stressors	Risks
Increased temperatures and heat waves	Increased heat stress-related mortality and morbidity, particularly in urban areas and among agricultural workers
Increased drought and frequency of extreme precipitation	Expanded transmission windows for malaria and dengue
	Increased flood-related mortality and morbidity including an increase in gastrointestinal disease from degraded water quality

AGRICULTURE

Half of the population and most of the country's poor depend directly or indirectly on agricultural production. Principal food crops are rice, wheat, millet and legumes. Climate-sensitive rainfed agriculture accounts for 60 percent of cultivated area and 40 percent of national production. Increasing temperatures and more severe dry seasons are likely to exacerbate drought impacts, and by 2030, India's agriculture sector is expected to suffer more than $7 billion of annual losses due to drought alone. Studies indicate that a temperature increase beyond 1°C during the cropping cycle will diminish yields and quality (protein and micro-nutrient content) in rice, potato, mung bean and soybeans. In the fertile Indo-Gangetic Plains, an area that produces 14–15 percent of the global wheat yield, a 50 percent reduction in wheat yield due to heat stress is projected in the most productive areas by 2050.

Risks for India's plantations vary by region and species. Coconut palm, a tree that benefits from increased CO_2 concentrations, for example, is expected to experience increased productivity in cooler regions where increasing temperatures will not exceed the tree's threshold, but decreased productivity in warmer regions where climate change will push temperatures over the threshold. Warming trends will increase heat stress on dairy animals (mainly water buffaloes and cows), leading to a decrease in milk production of up to 15 million tons annually by 2050. Along the coasts, sea level rise poses an additional threat to agriculture, particularly rice and aquaculture, through inundation and saline intrusion. (2, 14, 15, 17, 28)

Climate Stressors and Climate Risks AGRICULTURE

Stressors	Risks
Increased temperatures	Reduced grain yields and quality due to heat stress; reduced plantation productivity where temperature thresholds are exceeded
Increased drought ***(in the northwest)***	Diminished milk production due to heat stress
More extreme rainfall events and severe dry seasons	Reduced yields due to drought and water stress, particularly for rainfed agriculture
Sea level rise	Degraded crop and pasture land from flooding, erosion and drying
	Saltwater inundation and intrusion and storm surges, impacting coastal aquaculture and agricultural land productivity

ECOSYSTEMS

India is home to parts of three global biodiversity hotspots – Himalaya, Indo-Burma, and Western Ghats – that are rich in endemic flora and fauna, including the Indian rhinoceros and the endangered Indian elephant and Bengal tiger. Warming is projected to lead to shifts in species distribution and reduce the range of endemic plant species by 41 percent by 2080. Projections show that more than 2,000 plant species and up to 214 vertebrate species in the Indo-Burma hotspot could be lost under a scenario in which atmospheric CO_2 concentrations are doubled. In west and central regions, forest cover is expected to shift to drier forest types as the drying effect of increased evaporation outpaces increases in precipitation. Forest fires, which already account for the loss of an average of 1 million hectares each year, may increase with warmer temperatures. Any change in forest cover would impact the 275 million people, including many indigenous communities, who are directly dependent on forests for their livelihoods.

Climate Stressors and Climate Risks ECOSYSTEMS

Stressors	Risks
Increased temperatures	Reduced and shifted ranges for species, leading to biodiversity loss
Increased drought (regionally)	Shifts in forest cover (decrease in central and western regions)
More severe dry seasons	Increased forest degradation from wildfires, impacting biodiversity and livelihoods dependent on forests
Sea level rise	Degradation/loss of coastal wetland habitats and mangroves

Sea level rise, increased salinity and heat stress are expected to diminish mangrove forests (i.e., Sundarbans, Pichavaram, and Bhitarkanika) that provide habitat for wildlife, wood for fuel and housing, and storm surge protection.
(1, 6, 14, 18, 23, 29)

WATER RESOURCES

India's water resources, once considered abundant, are now under considerable stress due to population growth, increased production of water-intensive crops, pollution and lack of government planning. This reduction in quantity and quality of water supplies is likely to be exacerbated by increased temperatures and rainfall variability. Himalayan glaciers feed some of India's most important river systems – the Indus, Ganges, and Brahmaputra – which support 660 million people and feed canal systems and groundwater aquifers across the country. The glaciers help to moderate river flows in a country where 50 percent of precipitation falls in just 15 days and over 90 percent of river flows occur in just four months. Increased temperatures have led to a net loss in Himalayan glacial cover in recent decades, exposing communities that depend on glacial water to shortages during the dry season and flooding during the wet season. In the long term, loss of glaciers will reduce available water for agriculture (currently accounting for 90 percent of withdrawals), drinking and hydropower production.

Increased evaporation and decreased precipitation in some regions are expected to increase the risk of drought. Particularly at risk are areas of the southern peninsula (Krishna basin), northeast (Brahmaputra basin), and north central region (Narmada basin). Drought is already an issue in India; in early 2016, after two years of below average rainfall, India's 91 reservoirs were at just 17 percent of capacity, leaving 300 million people with water shortages.

Climate Stressors and Climate Risks WATER RESOURCES

Stressors	Risks
Increased temperatures	Increased glacial melt in the short term, leading to flooding and waterlogging
Increased drought (regionally)	Reduced contribution of glacial melt to Himalayan rivers in the long term, reducing water available for irrigation and hydropower
More severe dry seasons	Increased flooding and saline intrusion, threatening water quality, agricultural land and infrastructure
Increased monsoon precipitation	Drought-induced water stress for domestic, agricultural and hydropower use
Sea level rise	

In urban areas, projected increased flooding due to heavy rainfall is expected to stress sewerage and drainage infrastructure, increasing the risk of water contamination. Depleted groundwater supply around many cities has led to increased reliance on surface water supplies that are highly seasonal and susceptible to contamination by flooding and depletion by drought.

In coastal aquifers, reduced fresh water flows during drought may increase the risk of saline intrusion, which will be further exacerbated by sea level rise. Increasing groundwater extraction for agriculture and development in coastal areas has already caused saline intrusion issues in areas of Kerala and Goa. (2, 5, 11, 12, 13, 14, 19, 25)

POLICY CONTEXT

INSTITUTIONAL FRAMEWORK

With high levels of climate risk, India has shown commitment to international processes and domestic policies that address climate change through adaptation. India's Ministry of Environment, Forests and Climate Change leads government initiatives on climate change. An Advisory Council on Climate Change chaired by the Prime Minister with broad stakeholder representation guides national climate change strategy. The National Action Plan on Climate Change works through designated national missions to address climate change adaptation and mitigation. In 2014, the government established a National Adaptation Fund. India has direct access to the global Adaptation Fund through the accredited National Bank for Agriculture and Rural Development.

NATIONAL STRATEGIES AND PLANS

India's priority sectors for adaptation initiatives are agriculture, water, health, urban areas, coastal regions, disaster risk management, biodiversity and rural livelihoods. India is developing its Third National Communication with support from the Global Environment Facility (GEF).

- Initial National Communication (2004), Second National Communication (2012), and First Biennial Update Report (2015)
- India Intended Nationally Determined Contribution to UNFCCC (2015)
- National Action Plan on Climate Change (2008) and State Action Plans
- National Disaster Management Plan (2016)

KEY RESOURCES

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Map modified from Senapati et al. 2013. Impact of Climate Change on Indian Agriculture & Its Mitigating Priorities.

SELECTED ONGOING EXPERIENCES

As the world's fourth largest emitter of greenhouse gas emissions, much of India's climate change-related work is focused on mitigation but the focus on adaptation is growing, as highlighted below.

Selected Program	Amount	Donor	Year	Implementer
Preparation of Third National Communication to UNFCCC	$35 million	GEF, UNDP	2013–2018	Ministry of Environment, Forests and Climate Change; UNDP
Sustainable Livelihoods and Adaptation to Climate Change	$8 million	GEF Special Climate Change Fund	2014–2018	World Bank, Ministry of Rural Development
Climate Resilient Coastal Protection and Management	$54 million	GEF Special Climate Change Fund	2014–	Asia Development Bank, Ministry of Water Resources, Environment and Forests
National Cyclone Risk Mitigation Project II	$387 million	World Bank	2015–2021	National Disaster Management Authority
Climate change adaptation in industrial areas	Not listed	GIZ	2014–2018	Governments of Andhra Pradesh and Telangana
Climate Change Adaptation in Rural Areas of India	Not listed	GIZ	2009–2014	Ministry of Environment, Forests and Climate Change
Climate Change Adaptation – North Eastern Region of India	Not listed	GIZ	2011–2015	Ministry of Development of North Eastern Region
Strengthening Climate Change Resilience in Urban India	$8.75 million	ADB	2016–2018	Ministry of Finance, Ministry of Urban Development
Climate Adaptation in Vennar Subbasin in Cauvery Delta Project	$100 million	ADB	2016–2021	Government of Tamil Nadu
Cereal Systems Initiative for South Asia (CSISA) Phase II	$33.6 million	Gates Foundation, USAID	2012–2015	CGIAR members