



CLIMATE CHANGE RISK PROFILE

Yemen

COUNTRY OVERVIEW

Yemen is the poorest and most water-insecure country in the Middle East and North African region. The country faces very serious risks from climate change that threaten the fragile state of the country. More than half of Yemen's 27 million people live below the poverty line, and the Yemeni population's growth rate is among the highest in the world (2.5 percent as of 2015). The capital, Sana'a, is the most water-stressed city in the world, and it relies on the water from the world's most water-stressed aquifer. Long politically fractured, it has been embroiled in a civil war since 2015. The civil war has compounded Yemen's longstanding challenges of endemic poverty, severe food insecurity, and extreme water scarcity. (14)



CLIMATE PROJECTIONS



Increase in temperatures of 1.2 to 3.3°C by 2060



More extreme weather, with intense precipitation, floods and droughts



Rising sea level

KEY CLIMATE IMPACTS

Agriculture

Reduced agricultural productivity
Degradation of arable land and desertification



Water Resources

Increased water scarcity
Reduced water quality



Human Health

Increased food insecurity
Increased transmission of climate-sensitive diseases



Coastal Zones

Increased coastal erosion
Displacement of coastal communities
Destruction of coastal ecosystems and low-lying wetlands
Intensification of storm surges



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This document was prepared under the Global Environmental Management Support Project (GEMS) 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 or the United States government.

Yemen has a semi-arid to arid tropical climate with three distinct ecological zones (see map) that are governed primarily by topography. These are the coastal plain, the western Sarawat mountains, and the eastern highlands. The overwhelming majority of the Yemeni population lives on the western and southwestern face of the coastal plain, from the Saudi Arabian border to Aden, and in the Sarawat mountains. The east of the country is very sparsely settled away from the coast, and is primarily inhospitable scrubland (the Hadhramaut) and desert (the Empty Quarter).

Yemen's challenges of economic under-development, food insecurity, extreme water stress, and political factionalization intersect with and stand to be intensified by climate change impacts. Frequent droughts in recent decades have contributed to food shortages. In 2015, the unusually strong Cyclone Chapala, resulting in part from high, record-breaking sea surface temperatures, made landfall in Yemen, causing widespread flooding. Increased temperatures, extreme weather events, and sea level rise are likely to worsen food security and water scarcity and adversely affect coastal zones. Ongoing conflict, ineffective governance, and a lack of adequate environmental management policies (among other factors) position Yemen at a great disadvantage as it faces the impacts of climate change. (1, 4, 5, 6, 12, 14, 16, 17)

CLIMATE SUMMARY

Monsoon climate patterns dictate Yemen's seasons, with winter monsoons occurring from December to March and summer monsoons from June to September. Spring (April-May) and fall (October-November) are transition periods that separate the seasons. The coastal plain is arid, with a warm winter and hot, humid summer. Rainfall on the coast is very low, ranging from 10 to 100 mm per year. The average diurnal temperature in Aden ranges from 16°C to 27°C in the winter, with a diurnal humidity range of 38 to 58 percent. In the summer temperatures increase, rising from 27°C to 38°C daily, though temperatures in excess of 50°C are not uncommon. These summer temperatures are accompanied by high humidity levels between 76 and 82 percent. The elevation of the western Sarawat mountains provides a more hospitable climate. In Sana'a the diurnal winter temperature ranges from 8°C to 17°C, while the summer range is from 22°C to 28°C. Humidity is lower in the mountains than on the coast, with winter and summer ranges extending from 12 to 23 percent and 45 to 75 percent, respectively. Rainfall on the western side of Sarawat far exceeds that of the coast, averaging 100 to 600 mm/year—though some areas average up to 1,000 mm. The eastern highlands are climatically similar to the coast, with very low rainfall (50 to 100 mm/year), warm, dry winters (11°C to 26°C and 9 to 25 percent humidity), and hot, humid summers (29°C to 41°C), with temperatures in excess of 50°C not uncommon, and 52 to 77 percent humidity). (7)

HISTORICAL CLIMATE

Key climate changes since the 1960s include:

- Increase in temperature at a rate of approximately 0.39°C per decade, with most rapid rate of increase occurring during the summer months (June–August).
- Decrease in average rainfall at a rate of 1.2 mm per month (-9 percent) per decade, generally affecting the drier seasons, with declines particularly noted in the western mountains.
- Insufficient data to determine trends in frequency of hot/cold days and nights or trends in heavy rainfall events. (11)

FUTURE CLIMATE

Projected changes include:

- Mean annual temperature increasing by 1.2°C to 3.3°C by 2060, with warming occurring more rapidly in the country's interior than in the coastal areas.
- Substantial increase in frequency of hot days and nights (exceeding temperature of current hottest 10 percent of historical days/nights); decrease in frequency of cold days and nights.
- Wide range of projections (increases and decreases) for rainfall, with probable increases in September to November rainfall.
- Proportion of total rain falling in heavy events occurring from September to November is expected to increase.
- Amounts of rain in maximum 1- and 5-day events occurring September to November are expected to increase.
- Sea level rise of 0.30 m to 0.54 m by 2100. (7, 11, 15)

SECTORS IMPACTS AND VULNERABILITIES

AGRICULTURE

The agriculture sector contributes 11.4 percent of gross domestic product (GDP) and employs the majority of Yemen’s work force. Cultivated food crops include cereals, fodder, fruits, vegetables, and legumes. Cash crops include qat and coffee, although coffee production has declined somewhat. Yemen’s agricultural sector is dominated by small, subsistence farms and derives from a terrace system with one planting season from July to August. Rainfall during these months can be intense, leading to flooding that causes soil erosion and loss of agricultural land. Agricultural activities in the coastal plains and deserts are most vulnerable to floods. During other months, dry periods and drought lead to desertification, accounting for 3-5 percent annual loss in arable land.

Both floods and drought have contributed to diminishing crop yields. Water scarcity continues to be the largest hindrance to agricultural productivity in Yemen, and further depletion of water resources is expected to reduce agricultural productivity by up to 40 percent. In addition, the production of qat, the leaves of which have a mild narcotic effect, consumes almost 40 percent of available water resources and uses 38 percent of Yemen’s irrigated land, contributing further to a decline in land available for food cultivation. Overall, climate change impacts on Yemeni agriculture are expected to worsen, especially with more intense rainfall and prolonged droughts. However, future climate change impacts on agriculture will vary among regions given Yemen’s regional climate variability. For example, higher temperatures may actually increase crop yields in the highlands, whereas significant decreases in crop yields are expected in the south. (4, 5, 7, 8, 13, 15)

Climate Stressors and Climate Risks AGRICULTURE	
Stressors	Risks
Increased temperatures	Overall decreased agricultural productivity (although changes in crop yields vary among regions)
Drought	Loss of arable land due to desertification
Floods	Increased soil erosion
Increased rainfall variability	Migration from rural to urban areas due to crop failures and loss of livelihoods

WATER RESOURCES

Sana’a is the world’s most water-stressed city and draws water from the world’s most water-stressed aquifer, the Arabian Aquifer System. The rate of groundwater extraction currently exceeds a sustainable rate at which water can be replenished, depleting groundwater sources at a rate of 1 to 7 meters per year. At this rate, Yemen’s groundwater reserves will likely be depleted within 20 to 30 years regardless of climate change, and Sana’a could be without water by 2017. Greater rainfall variability in the future could increase drought occurrence, diminishing water supplies more rapidly. Similarly, increased temperatures could lead to higher evapotranspiration rates, further slowing the replenishment of water sources. Extreme water shortages can lead to mass displacement, loss of economic viability, and conflict. Furthermore, overexploitation of groundwater resources and rising sea levels due to climate change increase the likelihood of saltwater intrusion. This causes the groundwater to become brackish and unsuitable for human consumption unless treated. (1, 5, 6, 7, 13, 15)

Climate Stressors and Climate Risks WATER RESOURCES	
Stressors	Risks
Increased temperatures	Reduced recharge rates and increased rate of depletion
	Reduced access to safe drinking water
Drought	Increased conflict over water
Sea level rise	Saltwater intrusion into groundwater sources

COASTAL ZONES

Yemen is particularly susceptible to coastal damage due to increased storm surges and sea level rise. Projected storm surge intensification for Yemen has the potential to affect more than 50 percent of the country’s coastal land area, coastal population, and coastal GDP. Rising sea levels may cause accelerated coastal erosion, saltwater intrusion, increased frequency of floods, damage to ecosystems, and mass displacement and economic upheaval in coastal communities. Intensifying storm surges may increase juvenile mortality in commercially valuable fish species, thereby diminishing the fisheries sector (which contributes 2.4 percent of GDP) and increasing the vulnerability of up to 80,000 fishermen who depend on this sector for work. (3, 5, 7)

HUMAN HEALTH

Declining agricultural productivity, water scarcity, and ongoing conflict contribute to the fragile state of Yemen’s health sector. Yemenis suffer from serious vector-borne diseases, including malaria. Climate change may affect the prevalence and morbidity and mortality rates of such diseases. Recent outbreaks of cholera in Yemen have resulted from declining availability of safe drinking water sources. Ongoing conflict in Yemen has exacerbated water scarcity and food insecurity issues, leaving 2 million people (including 1.3 million children) malnourished. Projected losses in agricultural productivity due to impacts of climate change could intensify Yemen’s severe food insecurity. Furthermore, increased storm surges and floods could lead to displacement, injuries, and loss of life. Floods resulting from a tropical storm in 2008 killed 180 and displaced 20,000 people, causing losses and damages amounting to US\$1.6 billion. Extreme weather events also affect water and road infrastructure and agriculture, contributing to food and water issues, as well as limiting access to healthcare. Women and children, two already disadvantaged demographics, are particularly vulnerable to the potential adverse impacts on public health brought about by climate change. (2, 14, 17)

Climate Stressors and Climate Risks COASTAL ZONES	
Stressors	Risks
Sea level rise	Deterioration of coastal ecosystems and low-lying wetlands
Floods	Accelerated coastal erosion
Increased storm surges	Displacement of coastal communities
	Diminished fisheries and associated livelihoods
	Saltwater intrusion into groundwater sources

Climate Stressors and Climate Risks HUMAN HEALTH	
Stressors	Risks
Increased temperatures	Reduced quality and quantity of safe drinking water, leading to increased risk of waterborne illnesses (e.g., cholera)
Increased rainfall variability	Spread and growth of vector-borne diseases (e.g., malaria)
Drought	Heightened food insecurity leading to increased and severe malnutrition (particularly in children)
Floods	Displacement, injuries, and death from floods and storms
Increased storm surges	Deterioration of vital infrastructure (e.g., water, roads) and reduced access to healthcare

POLICY CONTEXT

INSTITUTIONAL FRAMEWORK

In 2003, the Environment Protection Authority (EPA) was launched in Yemen to establish, implement, oversee, and enforce environmental policies and strategies. This also includes coordinating national, regional, and international action on environmental protection in Yemen. Yemen ratified the UN Framework Convention on Climate Change in 1996 and the Kyoto Protocol in 2008 as a Non-Annex I country, and the EPA serves as a focal point for their implementation. In 2009, Yemen established the Inter-Ministerial Committee for Climate Change to bolster national coordination and climate change leadership. (7, 10)

NATIONAL STRATEGIES AND PLANS

- [Initial National Communication](#) (2001) and [Second National Communication](#) (2013)
- [National Adaptation Programme of Action](#) (2009)
- [National Action Plan to Combat Desertification](#) (2000)
- Other related sectoral policies include: the [National Agriculture Sector Strategy 2012-2016](#), the [National Strategy for Environmental Sustainability](#), and the [National Biodiversity Strategy and Action Plan](#).

KEY RESOURCES

1. Al Harazi, F. (World Bank). 2014. [Future Impact of Climate Change Visible Now in Yemen](#).
2. Al-Jazeera. 2016. [UNICEF: Cholera Outbreak Hits War-Torn Yemen](#).
3. Dasgupta, S., et al. 2009. [Climate Change and the Future Impacts of Storm-Surge Disasters in Developing Countries](#).
4. Food and Agriculture Organization. 2012. [FAO Country Programming Framework \(CPF\) for the Republic of Yemen](#).
5. Netherlands Commission for Environmental Assessment: Dutch Sustainability Unit. 2015. [Climate Change Profile: Yemen](#).
6. Purvis, K. 2016. [Where Are the World's Most Water-Stressed Cities?](#)
7. Republic of Yemen. 2013. [Second National Communication under the UNFCCC](#).
8. Republic of Yemen. 2015. [Intended Nationally Determined Contribution \(INDC\) under the UNFCCC](#).
9. Republic of Yemen Environment Protection Authority. 2009. [Yemen National Adaptation Programme of Action \(NAPA\)](#).
10. United Nations Development Programme. 2012. [Synthesis Paper: Governance of Climate Change in Yemen](#).
11. United National Development Programme. 2012. [Yemen: Climate Change Country Profile](#).
12. Worland, J. 2015. [Why Yemen Was Hit by a Rare Tropical Cyclone](#).
13. World Bank. 2010. [Yemen – Assessing the Impacts of Climate Change and Variability on the Water and Agricultural Sectors and the Policy Implications](#).
14. World Bank. 2016. [Yemen Overview](#).
15. World Bank. n.d. [Climate Change Knowledge Portal: Yemen](#).
16. World Bank. n.d. [Yemen](#).
17. World Bank Group. 2014. [Turn Down the Heat: Confronting the New Climate Normal](#).

SELECTED ONGOING EXPERIENCES

Selected Program	Amount	Donor	Year	Implementer
Climate Information System and Pilot Program for Climate Resilience Program Coordination	\$19 million	Climate Investment Funds/World Bank	2013-2019	EPA, Republic of Yemen
Adaptation to Climate Change through Integrated Water Harvesting Technologies in Yemen	\$4.9 million	Least Developed Country Fund (LDCF)	2013-2015	Ministry of Water and Environment, Republic of Yemen; UNDP
Integrated Coastal Zone Management in Yemen	\$5.02 million	Least Developed Country Fund (LDCF)	2010-2016	Ministry of Fish Wealth EPA, Ministry of Water and Environment, Republic of Yemen
Rural Growth Programme	\$10 million	Adaptation for Smallholder Agriculture Programme (ASAP)	2013-2020	Republic of Yemen
Rural Adaptation in Yemen	\$10 million	Least Developed Country Fund (LDCF)	2013-unknown	International Fund for Agricultural Development (IFAD)
Yemen: Preparation of Scaling Renewable Energy Program Investment Plan	\$0.3 million	World Bank	Ongoing	Ministry of Energy and Electricity, Republic of Yemen