YEMEN Climate Fact Sheet

Yemen Climate Fact Sheet

I- GENERAL CLIMATE OVERVIEW

Yemen is a largely arid sub-tropical country where temperature depends primarily on elevation, and, in the coastal areas, is determined by distance from the sea. Mean temperatures in the highlands range from below 15°C in winter to 25°C in summer, and in the coastal lowlands from 22.5°C in winter to up to 35°C in summer (WB CCKP, 2021).

Rainfall regimes differ in the highlands and in coastal areas, with relatively little rainfall received in the centre of the country. The annual frequency of rain days increases with elevation, with the mean number of wet days showing a strong decline from west to east. Coastal areas receive 80% of the annual rainfall during the winter months, while rainfall in the highlands follows two distinct rainy seasons: the saif (April-May) and the kharif (July-September). The saif rains are governed by the north-west trade winds (entering the Red Sea Convergence Zone), while kharif rainfall is governed by mechanisms of the Inter-Tropical Convergence Zone. Kharif rains typically fall in short events (WB CCKP, 2021).

II- CLIMATE CHANGE TRENDS

The ND-GAIN Country Index summarizes a country's vulnerability(1) to climate change and other global challenges in combination with its readiness(2) to improve resilience. Yemen's ND-GAIN Index rank is 171. It is the 22nd most vulnerable country and the 180th most ready country. The high vulnerability score and low readiness score of Yemen places it in the upper-left quadrant of the ND-GAIN Matrix, which means it has both a great need for investment and innovations to improve readiness and a great urgency for action (University of Notre Dame, 2023).

From Past to Present:

The average annual mean temperature in Yemen for the year 1901 was 25.12 °C. This number increased to reach 25.62 °C in 2021 (+ 0.50 °C) (figure 1).

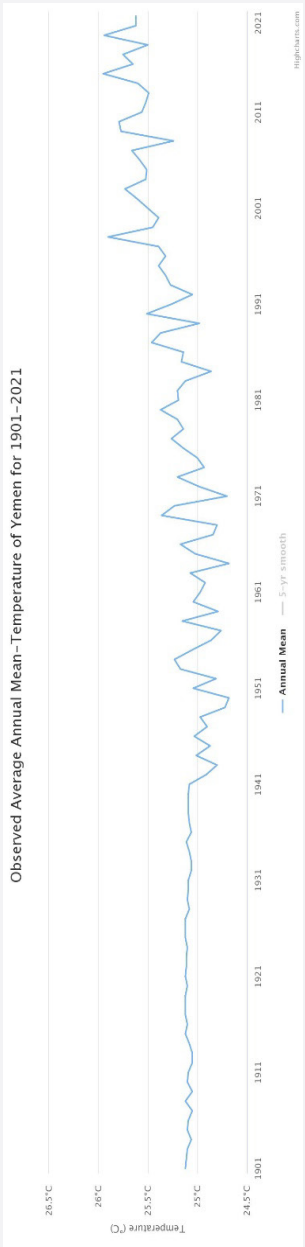


Figure-1: Observed Average Annual Mean Temperature (1901-2021) (WB CCKP, 2021)

1 Vulnerability measures a country's exposure, sensitivity, and ability to adapt to the negative impact of climate change. ND-GAIN measures the overall vulnerability by considering vulnerability in six life-supporting sectors – food, water, health, ecosystem service, human habitat, and infrastructure.

2 Readiness measures a country's ability to leverage investments and convert them to adaptation actions. ND-GAIN measures overall readiness by considering three components – economic readiness, governance readiness and social readiness.`

On the other hand, an increase of 29% in total annual precipitation over the last 30 years was observed. However, a decrease in the average rainfall at a rate of 12 mm per month per decade, generally affecting the drier season, with noted declines in the Highlands has also been suggested (Ministry of Foreign Affairs of the Netherlands, 2018).

Projected:

- **Temperature:** While mean temperature for the reference period 1995-2014 was between 23.31 and 24.07 ºC, it is expected to increase and reach 25.70 ºC by mid-century under a high-emission scenario(3), and 29.01 ºC by the end of the century under a high-emission scenario (figure 2, Top). In addition, the number of hot days where the maximum temperature (Tmax) is greater than 35 ºC is expected to rise from 68.29 days (2014 reference) to reach 98.00 days by mid-century and 157.93 days by end of century under a high-emission scenario (figure 2, Bottom).

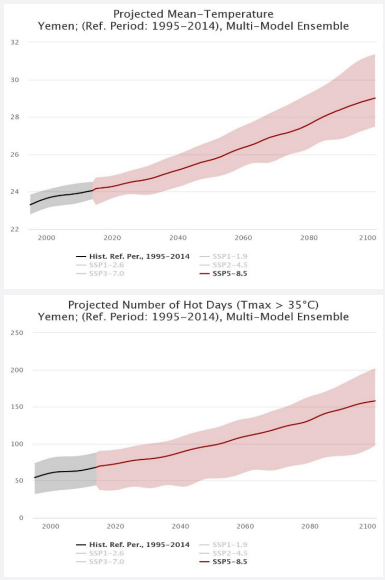


Figure-2: Projected Mean Temperature (Top) and Projected Number of Hot Days [Tmax greater than 35 ºC] (Bottom) (WB CCKP, 2021)

- **Precipitation:** While the average precipitation for the reference period 2014 was 101.51 mm, it is projected to increase by mid-century under a high-emissions scenario to reach 143.62 mm and by end of century under a high-emissions scenario to reach 199.32 mm (figure 3).

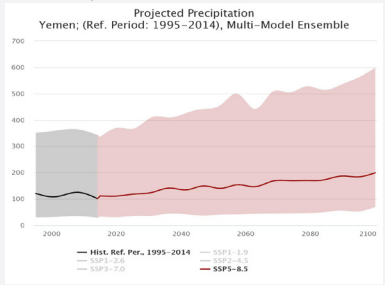


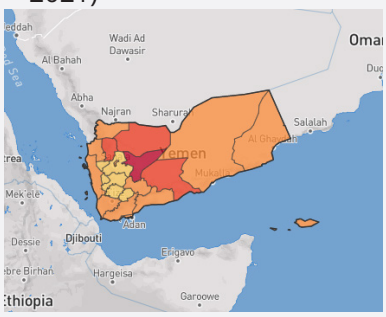
Figure 3: Projected Precipitation (WB CCKP, 2021)

III- CLIMATE CHANGE IMPACTS

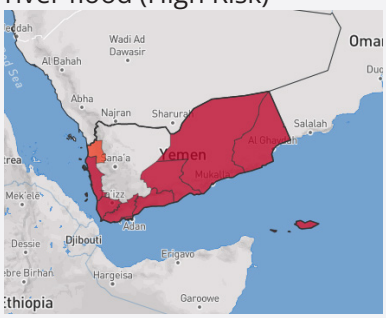
a- Natural Hazards

One of the main impacts of the change in temperature and rainfall patterns is the occurrence of natural hazards. Figure 4 summarizes the risk level of natural hazards in Yemen. It shows that the country has a high risk of river, urban, and coastal floods as well as landslides, extreme heat, water scarcity, and wildfire.

The main climate-related natural hazards that have occurred from 1900 till 2023 in Yemen are seen in table 1:



river flood (High Risk)



coastal flood (High Risk)

3 SSP5\RCP8.5-The highest baseline emissions scenario in which emissions continue to rise throughout the twenty-first century, depicting a world of rapid and unconstrained growth in economic output and energy use.

Table 1: Climate-related Natural Hazards (from 1900 till 2023) (EM-DAT, 2023)

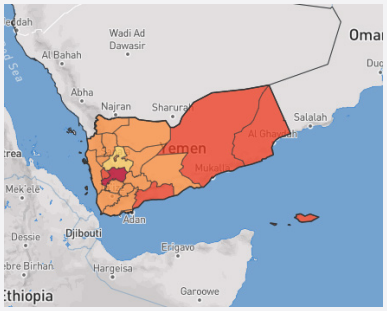
Disaster Type	Occurrence (1900-2023)
Flood	47 (of which 17 recorded riverine floods, 14 recorded flash floods)
Storm	6 (of which 4 recorded tropical cyclones)
Drought	4
Landslide	3
	Total deaths: 1 999 **Total damages ('000 US$): 6 361 223**

Figure 5 shows that under a high-emissions scenario, sea level rise is projected to increase and reach 0.24 m by mid-century and 0.72 m by the end of the century.

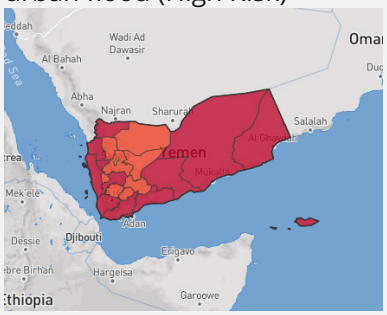
Yemen is prone to coastal damage caused by increased storm surges and sea level rise. Projected storm surge intensification has the potential to affect more than 50% of the country's coastal land area, coastal population, and coastal GDP. It may also increase juvenile mortality in commercially valuable fish species which can reduce the fisheries sector (which contributes 2.4% of GDP) and increase the vulnerability of up to 80,000 fishermen who depend on this sector for work. In addition, rising sea levels may cause accelerated coastal erosion, saltwater intrusion, increased frequency of floods, damage to ecosystems, and mass displacement and economic turmoil in coastal communities (USAID, 2017).

- **Natural Hazards and Displacements:**

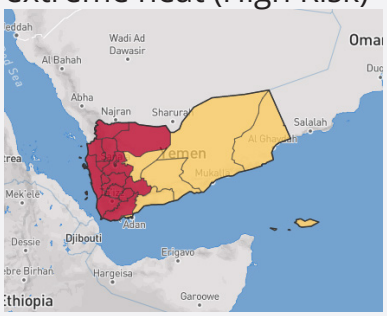
Yemen is already facing a dire humanitarian situation due to the armed conflict. This situation worsened in 2020 due to extreme flooding events which devastated communities and fuelled the spread of diseases like cholera, dengue, malaria, and diphtheria. More than 300,000 people were affected, most of them IDPs who had fled conflict areas who now lost their shelters, incomes, and any form of livelihoods. New displacements in 2020 due to disasters exceeded that caused by the intensifying conflict. In mid-July 2021, storms and heavy rains caused devastating flooding in many parts of Yemen causing fatalities, destroying homes, and damaging farms and roads. By early August 2021, over 174,000 people were affected across the country, with at least 30 deaths. More than 5,400 houses had been destroyed, and another 5,100 damaged. Conflict-displaced persons living in IDP camps were hit particularly hard, with most shelters in IDP camps either partially damaged or destroyed, particularly in Al Bayda governorate, Dhamar governorate, Al-Jawf governorate, as well as Amran governorate. In Sana'a, 12,999 people in 10 IDP hosting sites were affected by floods (IFRC, 2021).



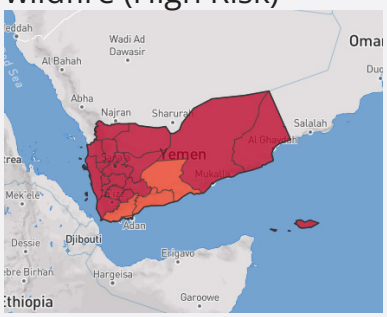
urban flood (High Risk)



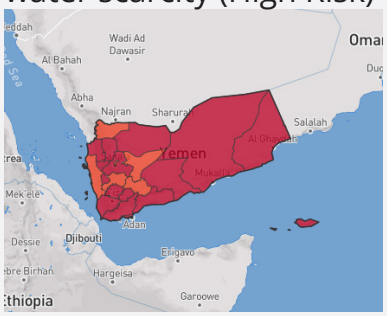
extreme heat (High Risk)



wildfire (High Risk)



water scarcity (High Risk)



landslide (High Risk)

b- Water

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 (USAID, 2017). Per capita water availability has dropped from 196 m^3 per year in 1990 to only 87 m3 per year in 2010, positioning Yemen as having one of the lowest rates of per capita water availability in the world, roughly 2 % of the world average (Yemen's Third National Communication, 2018).

c- Agriculture and Fisheries

- The agriculture sector contributes to 11.4% of the GDP and employs most 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 somewhat declined. Rainfall from July to August can be intense, leading to flooding that causes soil erosion and loss of agricultural land, with coastal plains and deserts being the most vulnerable. During other months, dry periods and droughts lead to desertification accounting for 3 to 5% annual loss in arable land. Both floods and drought have contributed to diminishing crop yields. On the other hand, water scarcity is the largest interference to agricultural productivity in Yemen, and further depletion of water resources is expected to reduce agricultural productivity by up to 40%. However, it is essential to mention that future climate change impacts on agriculture will vary among the diverse regions in Yemen. For instance, higher temperatures may increase crop yields in the highlands, whereas significant decreases in crop yields are expected in the south (USAID, 2017). On the other hand, Yemen is already undergoing a food security crisis caused by the long-term conflict in the country. This situation was further exacerbated by the Russia-Ukraine conflict, as Yemen imports 40% of its wheat from Ukraine and Russia (ReliefWeb, 2022).
- According to Yemen's Ministry of Fish Wealth statistics for 2012, fishing is the main occupation of about 83,157 active artisanal fishermen directly supporting about 475,000 members of their families, with fish processing plants spread along the Yemen Red Sea and Gulf of Aden coastal zones employing many people, including women, in canning and other activities (Yemen's Third National Communication, 2018). Climate change will increase

cyclone (Low Risk)

Figure-4: Climate-Related Natural Hazards Risk Level (ThinkHazard, 2020)

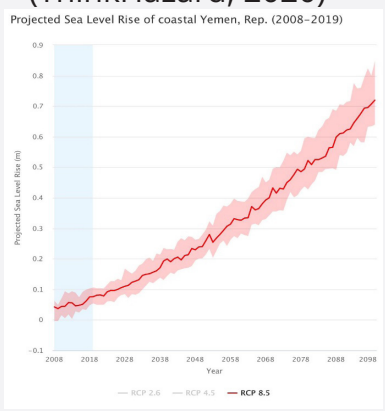


Figure-5: Projected Sea Level Rise of Coastal Yemen (WB CCKP, 2021)

juvenile mortality in commercially valuable fish species which will certainly increase the vulnerability of workers in this sector (USAID, 2017).

d- Energy

Yemen is highly reliant on petroleum products such as diesel and gasoline. In fact, in 2012, diesel and gasoline consumption totalled 215,125 TJ, or about 74% of total energy consumption. The transport sector is the largest consumer of petroleum products (28%), followed by households (26%), electricity (20%), industry (14%), and agriculture and commercial with 6% each. The consumption of petroleum products has significantly increased since 1995. Specifically, total fuel consumption increased from 139,344 TJ in 1995 to 289,784 in 2012, an average annual growth rate of 4.4% per year. Despite a rapid increase in total electricity consumption over the past decade, per capita electricity consumption is still quite low - 191 kWh/capita/year in 2012 compared with the world average of about 2,800 kWh/capita/year. Yemenis have the lowest access to electricity in the MENA region (48.4%, compared to a regional average of 90%). Rural dwellers form over 70% of the population, however, only about 33.5% have access to electricity compared with about 78.9% of the urban population. It is worth noting that only about half of the population that has access to electricity are connected to the electric grid, with the other half having private access through diesel generators that typically operate only a few hours per day (Yemen's Third National Communication, 2018).

Renewable Energy: The annual average solar insolation in Yemen ranges between 5.2–6.8 kWh/m2/day with the governorates of Al Beida and Dhamar in the central-western region accounting for the highest annual average radiation levels. Renewables benefited from the energy crisis in Yemen: after the public grid was unable to provide reliable electricity, the Yemeni population started using diesel generators, however due to fuel shortages, this option became less attractive which increased the use of solar energy especially from 2015. It is worth noting that the boom was mainly for small-scale systems, with 85% of the households in mountainous areas around Sana'a owning solar panels. In addition, Yemen has high wind energy potential estimated to be around 34 GW. Specifically, the coasts of the Red Sea and the south-west coastal area of Yemen have high wind potentials. The north-west area of Mokha is one of the most suitable zones for wind power installation. However, despite the wind energy potential being among the best worldwide, there are currently no wind farms operating in the country. Projects that have been developed before the conflict such as the Al Mokha at the Red Sea with a capacity of 60 MW have been suspended (Ersoy et al., 2022).

e- Health

Climate change is expected to intensify natural hazards that threaten public health. Exposure to these climate-related hazards will severely aggravate health problems and may lead to vector borne and waterborne diseases which may extend their range into areas that are presently unaffected. Moreover, chronic diseases such as cardiac, respiratory, and renal diseases may be aggravated by atmospheric conditions that exceed historical variability. The largest risks to public health will occur mainly in areas and communities where conditions of food insecurity and poverty prevail. The elderly, poor, and internally displaced are among the most vulnerable in the country (Yemen's Third National Communication, 2018). Water scarcity and inadequate waste management and sanitation facilities have led to some of the worst cholera outbreaks (ReliefWeb, 2021). Yemen was hit by the worst cholera outbreak in the world starting in 2016 (Al-Mekhlafi, 2018). Over 2.1 million out of the estimated 28.6 million people in Yemen have been infected with cholera, and more than 3000 people reportedly died because of this disease in June 2020 (Ng et al., 2020). In addition, ongoing conflict in the country has exacerbated water scarcity and food insecurity issues, leaving 2 million people (including 1.3 million children) malnourished, with projected losses in agricultural productivity due to impacts of climate change expected to intensify Yemen's severe food insecurity (USAID, 2017).

Some of the most destructive weather-related events are summarized in table 2:

Table 2: The Most Destructive Weather-Related Events in Yemen and Their Impacts (Yemen's Third National Communication, 2018)

Date	Weather-Related Events	Impacts
June 1996	Flash floods in the governorates of Shabwa, Mareb, and Hadramout	drowning fatalities and 338 238,210 people suffering from hypothermia, diarrheal disease, and waterborne/ vector-borne disease
October 2008	Heavy rains associated with tropical storm brought 90 mm of rainfall over the course of 30 hours, leading to severe flooding in Hadramout and Al Mahara governorates	Over 70 deaths, and the displacement of 25,000 people
November 2015	Cyclone Chapala was the first known hurricane-strength storm to make landfall in Yemen since modern records began in 1940s. Hadramout, Al-Mahara, Shabwa governorates and Socotra Island were hardest hit	The displacement of over 36,000 people and a subsequent outbreak of dengue fever that left 7 people dead

IV- CLIMATE CHANGE RESPONSE: NATIONAL AND INTERATIONAL

➔ National laws and policies include:

- **Law No. 26 of 1995 on the environment protection:** This Law is composed of 5 Sections divided into 95 articles. Section I deals with terms and definitions and defines objectives of this Law which are: protection of environment; pollution control; protection, preservation and development of natural resources; protection of the society, public health, and all being livings from all dangerous and hazardous activities; protection of the national environment from external hazards activities; accomplishment of all international obligations relating to the environment protection and pollution control; and the contribution in the protection of ozone layer and climate. Section II provides for the following matters: water and soil protection; creation of protected areas; use, circulation, trade, registration, control, inspection of pesticides; and the issuance of licence for pesticides. Section III refers to the dangerous and hazardous activities to environment especially control of activities that are dangerous and hazardous to the environment; laying down standards, criterion, and technical requirements for the activities; issuance of licences for and EIA for projects; trade and circulation of

hazardous waste disposal; environment protection and economic development; and environment monitoring. Section IV pertains to marine pollution. Offences, penalties, and compensations for environmental damages are given in Section V (ILO, 2014).

- **National Adaptation Programme of Action (2009)** (Ministry of Foreign Affairs of the Netherlands, 2018).

➔ The different international documents submitted as part of the UNFCCC are seen in table 3:

Table 3: Timeline of UNFCCC Document Submission (ClimateWatch, 2022)

Date	Document Submitted
2001	First National Communication
2013	Second National Communication
2015	INDC
2018	Third National Communication

V- REFERENCES

Al-Mekhlafi, H. M. (2018). Yemen in a Time of Cholera: Current Situation and Challenges. The American Journal of Tropical Medicine and Hygiene, 98(6), 1558–1562. https://doi.org/10.4269/ajtmh.17-0811

ClimateWatch. (2022). Retrieved from https://www.climatewatchdata.org/countries/YEM

EM-DAT. (2023). Retrieved from https://public.emdat.be/

Ersoy et al. (2022). Sustainable Transformation of Yemen's Energy System. Retrieved from https://library.fes.de/pdf-files/bueros/jemen/19245.pdf

IFRC. (2021). Displacement in a Changing Climate. Retrieved from https://www.ifrc.org/sites/default/files/2021-10/IFRC-Displacement-Climate-Report-2021_1.pdf

ILO. (2014). Retrieved from https://www.ilo.org/dyn/natlex/natlex4.detail?p_lang=en&p_isn=83565&p_country=YEM&p_count=97

Ministry of Foreign Affairs of the Netherlands. (2018). Retrieved from https://www.government.nl/documents/publications/2019/02/05/climate-change-profiles

Ng, Q. X., de Deyn, M. L. Z. Q., Loke, W., & Yeo, W. S. (2020). Yemen's Cholera Epidemic Is a One Health Issue. Journal of Preventive Medicine and Public Health, 53(4), 289–292. https://doi.org/10.3961/jpmph.20.154

ReliefWeb. (2021). Yemen: Clean water and safe sanitation for displaced people in the world's largest crisis. Retrieved from https://reliefweb.int/report/yemen/yemen-clean-water-and-safe-sanitation-displaced-people-world-s-largest-crisis

ReliefWeb. (2022). Retrieved from https://reliefweb.int/report/yemen/impact-russian-ukrainian-war-yemen

ThinkHazard. (2020). Retrieved from https://www.thinkhazard.org/en/report/269-republic-of-yemen

University of Notre Dame. (2023). Retrieved from https://gain.nd.edu/our-work/country-index/rankings/

USAID. (2017). Retrieved from https://pdf.usaid.gov/pdf_docs/PA00MX8Q.pdf

World Bank Climate Change Knowledge Portal (WB CCKP). (2021). Retrieved from https://climateknowledgeportal.worldbank.org/country/yemen-rep

Yemen's Third National Communication. (2018). Retrieved from https://unfccc.int/sites/default/files/resource/Yemen_TNC_%202018.pdf