

# Yemen

## 1. Country overview

Yemen is a country located in the Arabian Peninsula and occupies an area of 527,970 square kilometres (km<sup>2</sup>). The capital city is Sana'a. The population of Yemen – as of July 2020 – was 29.8 million (Central Intelligence Agency (CIA) 2020). Nearly half of Yemen's population is under 18 years of age and three-quarters of the population lives in rural areas (CIA 2020).

“On-going conflict, a lack of adequate natural resources management, weak governance as well as other factors seriously hinder Yemen's ability to address the current and future impact of climate change” (Ministry of Foreign Affairs (MFA) 2018). Yemen's humanitarian conditions have continued to decline rapidly in the last decade, with a large portion of the population in need of aid.

Yemen has been facing food insecurity and water scarcity, gender inequality and slow economic growth. These challenges are intensified by climate change. Yemen ranks 168th out of 181 countries in the Notre Dame Global Adaptation Initiative (ND-GAIN) index (ND-GAIN n.d.). The ND-GAIN index summarizes a country's vulnerability to climate change and other global challenges in combination with its readiness to improve resilience. This ranking indicates that Yemen has high vulnerability levels, and low levels of readiness to adapt to climate change (ND-GAIN n.d.).

### 1.1 Climate

Yemen has a semi-arid to arid-tropical climate with significant variability geographically. There are five main ecological zones: coastal plain, temperate highlands, high plateaus, desert interior, and the islands archipelago (United States Agency for International Development (USAID) 2016).



Figure 1: Map of Yemen.

Source: [Encyclopædia Britannica](https://www.britannica.com/place/Yemen)

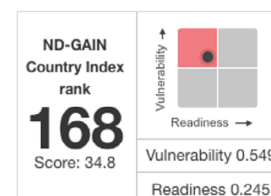


Figure 2: Yemen's ND-GAIN Ranking (ND-GAIN 2021).

Annual average temperature in Yemen is 23.4°C (World Bank n.d.). The coastal plain usually remains dry and hot and receives less than 50 millimetres (mm) of rainfall annually. In some places, the annual rainfall has been decreasing in recent decades, generally affecting the hot, dry summer months of June–September (USAID 2016). The majority of Yemen’s northeastern plain is a desert.

The high plateaus, however, receive between 100–600mm of rainfall annually (USAID 2016). In general, winters in the high plateaus can be cold (below 0°C) and summers are temperate and dry. “Monsoon climate patterns dictate the seasons, with winter (December–March) and summer (June–September) corresponding to different monsoon seasons. Spring (April–May) and fall/autumn (October–November) are transition periods that separate the seasons” (United Nations Framework Convention on Climate Change (UNFCCC) 2013).

In 2015, an unusually strong cyclone resulted in major flooding and damage to the coastal areas of Yemen (Prevention Web 2015). The year 2020 has also seen several major flooding events (Relief Web 2020).

## 1.2 Climate change

### Historical Climate

### Projected climate

#### Temperature

In general, Yemen’s temperatures have been rising steadily for the last three decades; rising at a rate faster than the global average. In many places in Yemen, temperatures are 2°C higher than they were before climate change (USAID 2016).

Research shows that temperatures will likely rise further; with estimates of 1.2–3.3°C by 2060, depending on the rate of climate change (UNFCCC 2013).

Temperature extremes will also continue to rise. By the end of this century, the hottest day of the year is projected to be 3–7°C hotter than it is today. Using a heat index, scientists estimate that there are about 14 extremely uncomfortable days per year at present, and there could be over 100 such days by the end of the century (World Bank 2014).

#### Precipitation and water

Trends in precipitation are more difficult to identify for the entire country. There are studies showing a reduction of rainfall in the high plateau (USAID 2016), while others show an increase in some areas (Climate Service Center Germany (GERICS) 2015).

The country will likely face more extreme weather, with stronger and more intense flooding and droughts. The frequency of storms is expected to increase as well (USAID 2016).

There is a wide range of potential projections for whether rainfall will increase or decrease overall, with models showing different results. Very heavy precipitation events will likely increase in the late summer and autumn seasons in September–November (MFA 2018).

Sea levels are projected to continue rising, with estimates of 0.30–0.54 metres (m) by 2100 (UNFCCC 2013).

## 2. Humanitarian sectors and climate change

### 2.1 Water and habitat

#### Water

For decades now, Yemen has been suffering from water stress – both extremes of floods and droughts across the country. About 6 per cent of Yemen’s rainfall runs off as surface water into stream beds. It experiences extreme water scarcity due to overexploitation of groundwater that leads to saltwater intrusion in coastal areas. “Agriculture is estimated to use 93 per cent of available surface- and groundwater. However, rapid increases in water abstraction and use have affected the water balance. The rate of groundwater overdraft is currently twice the recharge rate, and is increasing, bringing depletion of water reserves, inequity, and shortages, with negative socioeconomic consequences. Reforms to tackle water problems have been underway for a decade, but no headway has been made in reining in the rate of overdraft” (World Bank 2010). Most of Yemen is desert already and desertification as well as evapotranspiration have further exacerbated this. Currently, Yemen’s water table is depleting at a staggering 2–7m annually due to the exploitation of groundwater. (Republic of Yemen 2015).

Yemen will likely face more intense water scarcity along with a decrease in water quality. Increased temperatures mean that there is more evaporation of water, so surface water sources and reservoirs are likely to dry up more quickly in the future. (MFA 2018)

Research by the World Bank (2010) indicates that Yemen’s “groundwater reserves are likely to be mostly depleted irrespective of climate change, reducing agricultural output by up to 40 per cent” (World Bank 2010). Significant variations in rainfall distribution will lead to more droughts or more floods based on the magnitude, duration and frequency of rainfall in the area.

Climate change adaptation investments include efficient irrigation systems and training on harvesting techniques as well as cropping patterns. Integrated management of water resources at all levels is imperative if Yemen is to slow down its current water crisis. An increase in sea levels could lead to the deterioration of Yemeni wetlands, coastal mangrove migration, land erosion, infrastructure damage, and seawater intrusion (UNFCCC 2015).

#### Energy and Infrastructure

Flood events have had major impacts on infrastructure in Yemen, and the risk of heavy rainfall events and flooding is expected to increase with climate change. In 1993–2008, researchers found 19 flood or flash flood events recorded in the country. Irrigation facilities and rural roads were heavily affected by flood events in 2008, which caused high surges in the valleys (Wiebelt *et al.* 2011). Earlier this year, flash flood events caused impacts in several places across the country, and this has affected infrastructure that delivers power and water to the population (IFRC 2020). Roads are very susceptible to flood events, and climate change adaptation

strategies include techniques for siting roads to address flood risk; building them with attention to permeability and drainage (Willway *et al.* 2008). In rapidly urbanizing areas, the design of adequate drainage systems is critical for adapting to the increased risk of flood events or more erratic rainfall with climate change.

Increased temperature extremes, especially for extended periods, can result in increased morbidity and mortality. This necessitates the promotion of passive (and sometimes active) cooling strategies in building design and construction. Increased temperatures affect the durability of construction materials; for example, the asphalt used for roads can buckle during a heatwave if not designed with rising temperatures in mind (Willway *et al.* 2008). Increased temperatures cause an increase in water evaporation, which can have implications for the availability of surface water and the operation of hydropower facilities.

Additionally, concerns are being raised about the significant risk to Yemeni infrastructure posed by sea level rise and extreme weather events (such as tropical cyclones) on the coasts. Indeed, Yemen has been listed as one of the five most vulnerable low-income countries to these phenomena – more than 50 per cent of its coasts are considered at risk of sea level rise, and 50 per cent of its coastal urban areas are exposed to potential impacts (Al Safaani *et al.* 2015)

## 2.2 Economic security

Around 11.4 per cent of Yemen’s gross domestic product (GDP) can be attributed to its agriculture sector, with a majority of the workforce employed across it. A large per cent of the population is food insecure; the Famine Early Warning Systems Network (FEWS NET) estimates that, for 2020, 17–19 million people are in need of humanitarian assistance (FEWS NET 2020a). The biggest hindrance to agriculture in Yemen is water scarcity. Yemen’s main crops include cereals, fodder, fruit, vegetables and legumes. The main cash crops are qat and coffee (MFA 2018). Qat is a very water-intensive crop, without nutritional value, therefore creating additional tensions. “Exacerbating the problem, these fields that used to consist primarily of grape vines, are now rapidly being replaced by farmlands filled with a thirsty crop called qat. Qat, a mild narcotic plant, is chewed daily in almost every part of the country and is an integral part of the culture” (Jamjoon 2010).

Yemen’s agricultural practices are unique in the sense that it is mostly dominated by small-scale farmers and uses a terrace system of irrigation (Republic of Yemen 2012). Since precipitation events can be intense in the summer months of July and August, Yemen usually experiences soil erosion and flooding at this time (MFA 2018). Adaptation to prepare for such extreme precipitation events in the future will be critical.

Livestock has been affected by the erratic water balance as well. Rising temperatures affect many of the critical factors for livestock production. Water availability as well as animal production, reproduction and health are all affected, as are forage and water quantity and quality. One adaptation to centralize livestock feed storage is to grow and maintain a fodder bank for community use. Other climate change adaptation supports have included high quality farming supply and seeds, as well as training to expand farmer skill sets.

Climate change is expected to increase temperatures, variability of rainfall and heavy precipitation events. The increase in heavy rains in combination with rising temperatures,

especially in the north, could lead to shortened growing seasons. Shorter growing seasons pose another threat to food security (MFA 2018).

In addition, Yemen's economy is dominated by the oil sector, which accounts for almost 30 per cent of GDP, 50 per cent of the national budget revenue, and 70 per cent of all exports (UNFCCC 2015). Since Yemen's economy is dependent on oil, the risk of stranded assets is significant<sup>1</sup>.

Prior to the 2011 crisis, the agricultural sector accounted for about a third of the labour force and contributed 11 per cent to the overall GDP (World Bank 2012). With Yemen's labour force dependent on agriculture and water resources, food insecurity and water scarcity could intensify in the coming years.

Together, Yemen is highly vulnerable to food insecurity exacerbated by climate change and "faces decreasing financial and economic resilience as oil revenues dwindle, putting pressure on the exchange rate and on the treasury. As water resources shrink, food imports will rise and become costlier with increasing global prices" (World Bank 2010).

The country is a net importer of food, and changes in global food prices due to climate change and climate impacts in other countries will have impacts on the purchasing power of Yemenis, especially non-farm rural households. These households are also affected by the lack of agricultural labour opportunities during droughts. To support these households in an era of climate change, researchers recommend investments in rural non-farm employment, such as construction and food processing, while also encouraging opportunities in urban areas (Wiebelt *et al.* 2013).

Climate change adaptation efforts can include diversification of livelihoods, renewable energy projects, enforcement of laws and regulations on the use of natural resources, as well as providing technical solutions to develop and disseminate technology to the rural poor.

## 2.3 Health

Yemen is considered one of the poorest countries in the region. Its health sector is very fragile. Declining water resources, food insecurity and the ongoing conflict all affect Yemenis. The country reports high numbers of serious illnesses related to vector-borne diseases, especially malaria. As the global climate shifts, Yemen has seen an increase in cholera as a result of depleting safe drinking water sources. The ongoing conflict has exacerbated these issues, leaving nearly 2 million people, half of whom are children, malnourished (USAID 2016).

Many of the endemic and epidemic diseases in Yemen are affected by climate events. The spread of cholera, for example, is affected by heavy rain and drought events, and there have been efforts to use satellite-observed rainfall in combination with disease monitoring to predict

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<sup>1</sup> Stranded assets are defined as resources or infrastructure that once were valuable but are no longer, often due to external factors such as changes in technology, habits, acceptability etc. These assets are understood to be at the end of their economic life, no longer valuable enough to meet the owner's rate of return. Currently, the term is often used to refer to fossil fuel assets that have not yet been extracted and have lost their investment value notably due to the energy transition.

locations of upcoming cholera outbreaks in the country (Met Office 2018). Short-term weather forecasts and weather observations have been used around the world to anticipate outbreaks of vector-borne and waterborne diseases, such as dengue fever and cholera.

Drought is associated with increased risk of malnutrition, vector-borne diseases and waterborne diseases. With an expected increase in the variability of rainfall in the future, this is a key risk. Investments in ensuring that the population has access to water and sanitation as well as healthcare services can help reduce these impacts. Researchers also recommend disease surveillance systems to combat outbreaks in Yemen in an era of climate change (Bellizzi and Lane (in review)).

Increased storm surges and floods have led to displacement, injuries and loss of life. In 2008, a major storm took the lives of 180 people and displaced an additional 20,000 people. The losses and damages amounted to 1.6 billion US dollars (USAID 2016). This year, 2020, has seen major impacts from several flood events, from a storm and flash flooding in March (United Nations Office for the Coordination of Humanitarian Affairs (OCHA) to floods in August (Al Jazeera 2020).

Extreme heat can increase morbidity and mortality of the most vulnerable such as older people, especially those above 65 years of age; people with pre-existing health conditions, such as heart disease, respiratory illness and diabetes; young children; and people who are homeless or have inadequate housing, such as those living in camp settings (Singh *et al.* 2019).

As climate change exacerbates the ongoing food and water insecurity, Yemenis are at high risk of needing medical assistance. The incidence of heat-related illnesses is likely to rise along with the frequency of waterborne diseases. Vulnerable populations, such as children, are at a higher risk of the adverse impacts of climate change on health. Extreme weather events will likely continue to displace many people and damage public infrastructure, healthcare facilities and agriculture.

## 2.4 Protection

There are 3,625,000 internally displaced persons (IDPs) in Yemen and about 250,000 refugees (United Nations High Commissioner for Refugees (UNHCR) n.d.). People who are displaced, including IDPs and refugees, are often particularly vulnerable to climate extremes. This includes flood events that can quickly destroy the limited infrastructure in camps, as well as heatwaves that leave people with few options for cooling and shelter. [Recent floods in 2020](#), for example, destroyed tents and assets in camps for displaced people in Yemen. Floods in 2013 affected more than [8,000 people in Yemeni IDP camps](#) (The New Humanitarian 2013) and destroyed local infrastructure including latrines, schools and a clinic. These camps are not always designed with flood risk in mind and might not consider the impacts of climate change.

People in detention frequently have heightened vulnerability to natural disasters due to: spatial marginalization resulting from prison locations on hazard-prone land and/or isolation from emergency evacuation services; limited to no connections to social networks, which are crucial aspects to hazard resilience; and political marginalization, including lack of policies and services to prevent disaster impacts on imprisoned populations (Gaillard and Navizet 2012). These vulnerabilities, coupled with more frequent and intense disasters due to climate change, may leave prison populations in especially precarious positions to hazards such as extreme heat and flooding.

## 2.5 Policy

Yemen signed the Paris Agreement in 2016, though it has not ratified the agreement to date. In 2015 Yemen submitted its Nationally Determined Contribution (NDC) to the UNFCCC. This document outlines the country's climate change mitigation and adaptation commitments.

National adaptation priorities outlined in this communication are:

1. promotion and scale-up of rainwater harvesting to reduce climate induced water shortage
2. promotion of agriculture drought management as well as sustainable crop and livestock management
3. plan and implement proper land resources management programs
4. livelihood approaches for integrating natural resources management and preservation of sensitive ecosystems
5. disaster risk management including flood and drought management
6. capacity building for integrated coastal zones and marine resources management
7. capacity building and awareness raising
8. institutional capacity for building resilience to climate change including planning, programing, monitoring and resources mobilization" (Republic of Yemen 2015).

The NDC also emphasizes the importance of implementing these priorities under the guidance of key national policies and frameworks, namely: "the National Water Sector Strategy and Investment Plan, the National Agriculture Sector Strategy and the National Biodiversity Strategy and Action Plan, among others" (Republic of Yemen 2015). Finally, this section of the NDC also commits Yemen to further detailing priorities in a National Adaptation Plan. Globally, countries are now in the process of compiling their next NDC submission to the UNFCCC ahead of the UN Climate Change Conference COP26, which will take place in the UK in late 2021.

Yemen ranks 130th out of 188 countries in per capita greenhouse gas emissions and contributes only 0.8 per cent of global emissions (MFA 2018). However, Yemen's NDC commits to a 14 per cent emissions reduction, against business as usual scenarios, by the year 2030 (Republic of Yemen 2015).

In 2003, an Environmental Protection Agency was opened in Yemen to establish, implement and manage environmental policies and strategies. To date, the agency has successfully coordinated environmental actions nationally and internationally. An Inter-Ministerial Committee for Climate Change was established in Yemen in 2009. The main mission of this organization is to help bolster national coordination and leadership on climate change issues (UNFCCC 2013).

# References

- Al Jazeera. *At least 172 killed in Yemen flash floods this month*, 2020. <https://www.aljazeera.com/news/2020/08/12/at-least-172-killed-in-yemen-flash-floods-this-month/>
- Al Saafari, M.A., Nagi, H.M., Alhababy, A. and Abubakr, M.M. 'Impact of sea level rise and climate change on the coastal zone of Aden Governorate, Republic of Yemen' in *Faculty of Science Bulletin, Sana'a University*, Vol. 27, pp. 15–32, 2015. [https://www.researchgate.net/publication/308920314\\_IMPACT\\_OF\\_SEA\\_LEVEL\\_RISE\\_AND\\_CLIMATE\\_CHANGE\\_ON\\_THE\\_COASTAL\\_ZONE\\_OF\\_ADEN\\_GOVERNORATE\\_REPUBLIC\\_OF\\_YEMEN](https://www.researchgate.net/publication/308920314_IMPACT_OF_SEA_LEVEL_RISE_AND_CLIMATE_CHANGE_ON_THE_COASTAL_ZONE_OF_ADEN_GOVERNORATE_REPUBLIC_OF_YEMEN)
- Bellizzi, S. and Lane, C. *Health consequences of drought in the WHO eastern Mediterranean region: Hotspot areas and needed actions* (in review).
- Central Intelligence Agency (CIA), *World Factbook. Middle East: Yemen*, 2020. <https://www.cia.gov/library/publications/the-world-factbook/geos/ym.html>
- Climate Service Center Germany (GERICS). *Climate-fact-sheet: Yemen*, 2015. [https://www.climate-service-center.de/products\\_and\\_publications/fact\\_sheets/climate\\_fact\\_sheets/index.php/en](https://www.climate-service-center.de/products_and_publications/fact_sheets/climate_fact_sheets/index.php/en)
- CNN. Jamjoun, M. and Somra, G. 'Qat crops threaten to drain Yemen dry' in *Environment*, 13 December 2010. <https://edition.cnn.com/2010/WORLD/meast/12/02/yemen.water.crisis/index.html>
- Famine Early Warning Systems Network (FEWS NET). *Conflict and currency shortages remain of high concern for acute food insecurity in Yemen*, 2020a. <https://fews.net/east-africa/yemen>
- FEWS NET. *Deteriorating macroeconomic conditions expected to drive further food price increases – Yemen*, 2020b. <https://fews.net/east-africa/yemen>
- Gaillard, J.C and Navizet, F. 'Prisons, prisoners and disaster' in *International Journal of Disaster Risk Reduction*, Vol. 1(1), 33–43, 2012. <https://doi.org/10.1016/j.ijdr.2012.05.001>
- International Food Policy Research Institute (IFPRI), Wiebelt, M., Breisinger, C., Ecker, O., Al-Riffai, P., Robertson, R. and Thiele, R. *Climate change and floods in Yemen: Impacts on food security and options for adaptation. IFPRI Discussion Paper 01139*, 2011. [https://www.researchgate.net/publication/241758644\\_Climate\\_Change\\_and\\_Floods\\_in\\_Yemen\\_Impacts\\_on\\_Food\\_Security\\_and\\_Options\\_for\\_Adaptation](https://www.researchgate.net/publication/241758644_Climate_Change_and_Floods_in_Yemen_Impacts_on_Food_Security_and_Options_for_Adaptation)
- Notre Dame Global Adaptation Initiative (ND-GAIN). *ND-GAIN country index*, n.d. <https://gain.nd.edu/our-work/country-index/>
- International Federation of Red Cross and Red Crescent Societies (IFRC). *Emergency Plan of Action – Yemen: floods*, 2020. <https://reliefweb.int/sites/reliefweb.int/files/resources/MDRYE009.pdf>
- Met Office. 'World first as UK aid brings together experts to predict where cholera will strike next' in *News*, 28 August 2018. <https://www.metoffice.gov.uk/about-us/press-office/news/corporate/2018/yemen-2018>
- Ministry of Foreign Affairs (MFA). *Climate change profile: Yemen*, 2018. <https://www.mofa-ye.org/Pages/en/>
- The New Humanitarian, *Yemen flash floods damage IDP camps*, 2013. <https://www.thenewhumanitarian.org/fr/node/253853>
- Prevention Web. *Cyclone Chapala disaster risk reduction situation report*, 2015. [https://www.preventionweb.net/files/46530\\_pwsitrep20154cyclonechapala.pdf](https://www.preventionweb.net/files/46530_pwsitrep20154cyclonechapala.pdf)
- Red Cross Red Crescent Climate Centre, Singh, R., Arrighi, J., Jjemba, E., Strachan, K., Spires, M. and Kadihasanoglu, A. *Heatwave Guide for Cities*, 2019. <https://www.climatecentre.org/downloads/files/IFRCGeneva/RCCC%20Heatwave%20Guide%202019%20A4%20RR%20ONLINE%20copy.pdf>
- Republic of Yemen, *National Agriculture Sector Strategy*, 2012 [https://extranet.who.int/nutrition/gina/sites/default/filesstore/YEM%202012%20NationalAgricultureStrategy\\_2012-2016.pdf](https://extranet.who.int/nutrition/gina/sites/default/filesstore/YEM%202012%20NationalAgricultureStrategy_2012-2016.pdf)
- United Nations Framework Convention on Climate Change (UNFCCC), *Republic of Yemen. Intended Nationally Determined Contribution (INDC) under the UNFCCC*, 2015. <https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Yemen/1/Yemen%20INDC%2021%20Nov.%202015.pdf>



- UNFCCC, Republic of Yemen. *Second National Communication under the United Nations Framework Convention on Climate Change*, 2013. <https://unfccc.int/resource/docs/natc/yemnc2.pdf>
- United Nations High Commissioner for Refugees (UNHCR). *Global focus, UNHCR operations worldwide: Yemen*, n.d." <https://reporting.unhcr.org/node/2647>
- United Nations Office for the Coordination of Humanitarian Affairs (OCHA). *Yemen: floods – Mar 2020*, 2020. <https://reliefweb.int/disaster/ff-2020-000123-yem>
- United States Agency for International Development (USAID). *Climate risk profile: Yemen*, 2016. <https://www.climatelinks.org/resources/climate-change-risk-profile-yemen>
- Wiebelt, M., Breisinger, C., Ecker, O., Al-Riffai, P., Robertson, R. and Thiele, R. 'Compounding food and income insecurity in Yemen: Challenges from climate change' in *Food Policy*, Vol. 43, pp. 77–89, 2013. <https://doi.org/10.1016/j.foodpol.2013.08.009>
- Willway, T., Baldachin, L., Reeves, S. and Harding, M. *The effects of climate change on highway pavements and how to minimise them: Technical report*, 2008. <https://www.thenbs.com/PublicationIndex/documents/details?DocId=287230>
- World Bank. *Joint Social and Economic Assessment for the Republic of Yemen*, 2012. <https://reliefweb.int/sites/reliefweb.int/files/resources/Joint%20Social%20and%20Economic%20Assessment%20for%20the%20Republic%20of%20Yemen.pdf>
- World Bank. *Future impact of climate change visible now in Yemen*, 2014. <https://www.worldbank.org/en/news/feature/2014/11/24/future-impact-of-climate-change-visible-now-in-yemen>
- World Bank. *Yemen: Assessing the impacts of climate change and variability on the water and agricultural sectors and the policy implications*, 2010. <http://documents1.worldbank.org/curated/en/979121468153566240/pdf/541960ESW0Gray1OFFICIAL0USE0ONLY191.pdf>
- World Bank, Climate change knowledge portal. *Country: Yemen*, n.d. <https://climateknowledgeportal.worldbank.org/country/yemen/climate-data-historical>