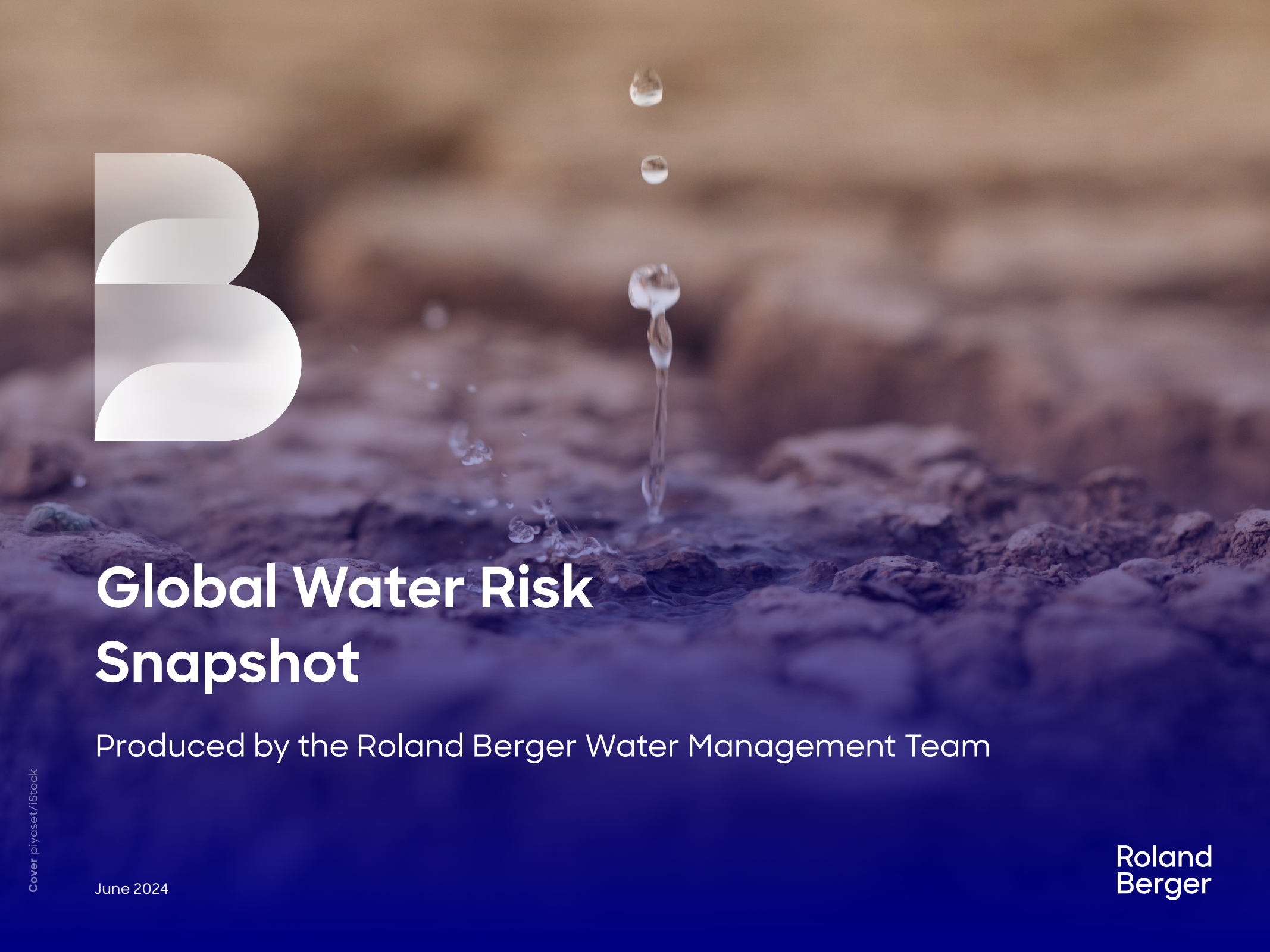


Global Water Risk Snapshot

Produced by the Roland Berger Water Management Team

June 2024

Roland Berger

Cover piyaset/iStock

Management Summary

The Earth's water cycle is a delicate balance that ensures water is distributed across various ecosystems. But overconsumption, pollution, and climate change are disrupting that balance - increasing water-related risks around the world. Water risk typically occurs when the demand for water exceeds supply, when poor water quality restricts its use, or during extreme weather events. It can take many forms but typically manifests as the depletion of water sources, flooding damage, or the degradation of water resources or aquatic environments.

Water risk can have a direct impact on communities, such as when cities face 'Day Zero' scenarios in which water supplies come close to depletion. But water is also a strategic business risk. Water is essential across many industries, from agriculture to data centers, serving as a direct and indirect input that ensures business productivity. Shortages or declines in water quality have significant economic consequences, while floods destroy billions worth of assets each year. Companies operating in water-scarce regions face rising costs and decreased competitiveness.

A global issue felt at a local level

Water risk is a global issue, but it manifests in hyper-localized ways. Understanding specific risks requires deep analysis – down to the water basin level. The Global Water Risk Snapshot is designed to call broader attention to the increasing threat of water-related risks around the world. It provides a high-level indication of how water risks impact different parts of the world today – and where they could intensify in the future. There are many factors to consider when assessing water risk, from physical risks, such as water scarcity, risks that are impacted by regulatory initiatives and reputational risks influenced by public awareness and conflict. The Global Water Risk Snapshot focuses primarily on physical risks in 10 different countries, providing additional context around local regulatory or reputational factors, as relevant.

Addressing water-related risk requires sustainable management practices, technological innovations, and collaborative efforts to ensure the equitable and efficient use of the planet's most vital resource. Roland Berger is working closely with businesses, utilities, and government organizations to develop comprehensive water strategies to increase water resilience and help make a meaningful contribution to global water security.

Understanding key water risk factors

Physical water risks assess natural & human-induced conditions in river basins, the status of water ecosystems, and suitability for specific uses

Understood as the most tangible form of water risk, physical water risk factors primarily include water scarcity, increased flooding, and/or reduced water quality.

For the purposes of this overview, our team utilized publicly available data from multiple sources including the WWF Water Risk Filter, World Resources Institute Aqueduct Floods, and local assessments.

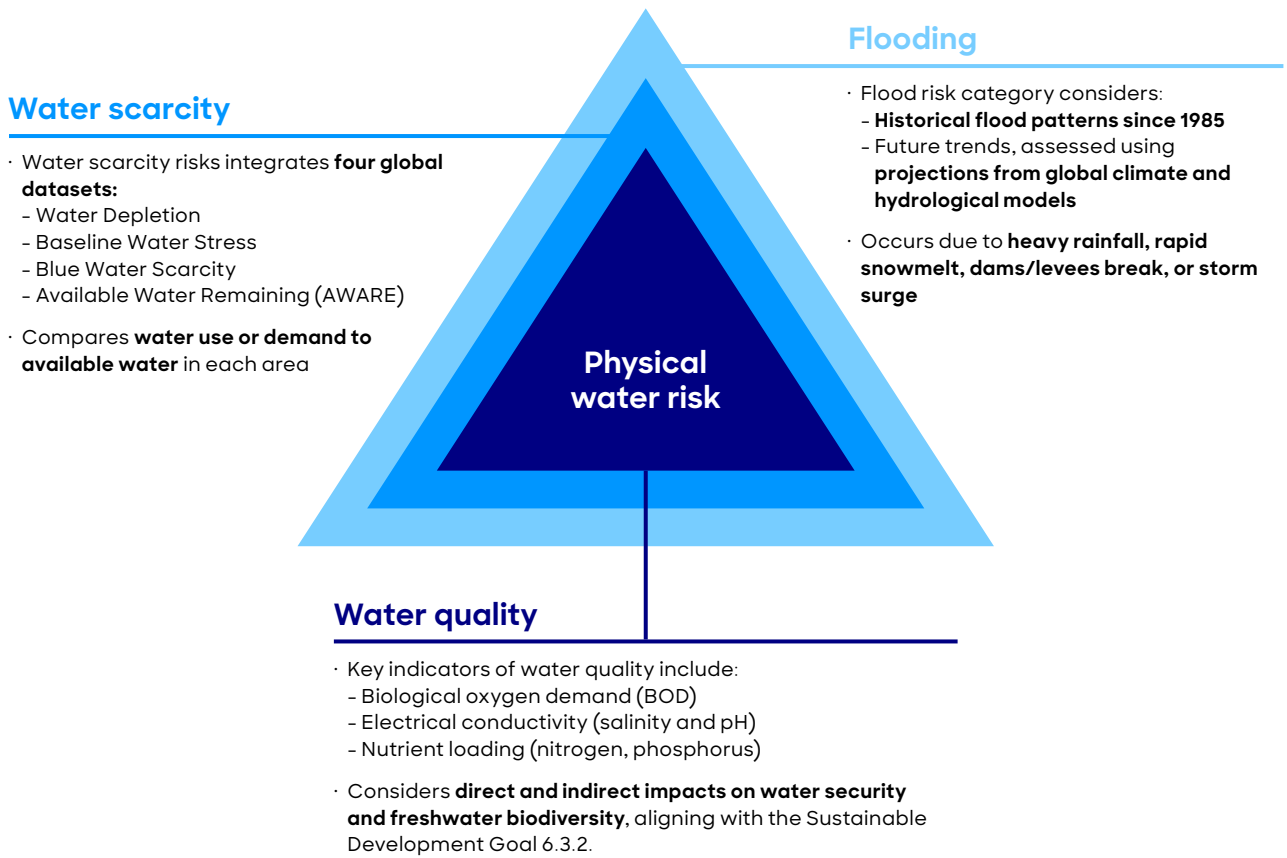
To assess water scarcity, the WWF Water Risk Filter compares water demand against water availability and considers how human activity could worsen the impact of natural factors, such as aridity and drought.

Aqueduct's flooding data considers historical flooding patterns tracked since 1985, with projections from global climate and hydrological models.

The WWF's water quality assessments concentrate on parameters that directly and indirectly impact water security and freshwater biodiversity, aligning with the UN Sustainable Development Goal (SDG) 6.3.2, including biological oxygen demand (BOD), electrical conductivity (salinity and pH), and nutrient loading (nitrogen, phosphorus).

While in-depth analysis is required to develop a full picture of physical water risks, this data can help illustrate regions in which more drastic action may be required to improve water resilience.

Physical risks include the threat of water scarcity, flooding and reduced water quality



Source: WWF Water Risk Filter, World Resources Institute Aqueduct Floods

Snapshot of global water risk

Water scarcity impacts every continent but is most directly felt in regions with arid climates

Looking specifically at water scarcity risks from a global perspective, the regions most impacted include the Middle East, North Africa, Sub-Saharan Africa, Central Asia, and parts of South Asia. However, high-risk levels are experienced in every major region of the world. The Middle East and North Africa region faces severe water scarcity due to its arid climate, limited freshwater resources, and high population growth. Countries such as Saudi Arabia, United Arab Emirates and Egypt rely heavily on desalination plants and underground water sources to meet their water demands. Central Asia, including countries such as Uzbekistan, Turkmenistan, and Kazakhstan, faces water scarcity due to the arid climate, overuse of water resources for agriculture, and inefficient irrigation practices. A notable consequence of scarcity is the shrinking of the Aral Sea. In South Asia, countries such as India and Pakistan also face water scarcity. due to a combination of factors, including population growth, inadequate infrastructure, and inefficient water management. The Indus River, a vital water source for both countries, is under stress due to overuse and climate change. Addressing water scarcity in these regions and on a global scale requires sustainable water management practices, investment in infrastructure, and international cooperation.

Physical risks: A global look at water scarcity risks

Figure 1: **Global water scarcity risk - 2020**

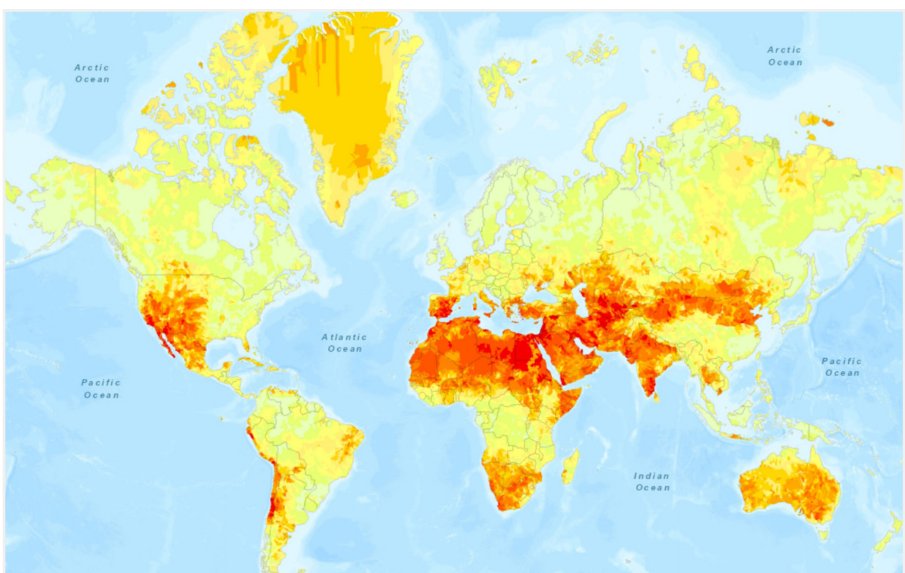
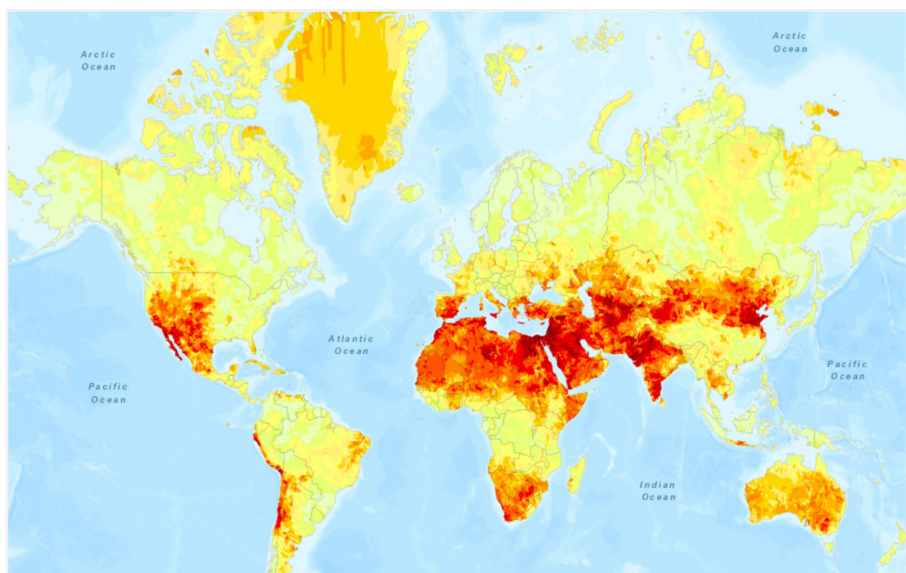
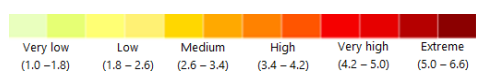


Figure 2: **Global water scarcity risk - 2050**



Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)



Snapshot of global water risk

Heavy rainfall, geographical features, inadequate infrastructure, and population density can intensify flooding impacts

Riverine and coastal flooding and flash floods pose threats to both urban and rural areas around the world. However, some of the regions most impacted by flood risks include Southeast Asia, South Asia, Central America, parts of Africa. Southeast Asia, particularly countries such as Indonesia, Vietnam, and Thailand, faces high vulnerability to flooding due to factors such as monsoon rains, low-lying topography, and densely populated river deltas. In South Asia, countries such as India, Nepal, Bangladesh and Pakistan also experience frequent flooding due to heavy monsoon rains, as well as inadequate drainage systems, and deforestation. Overflows of major rivers such as the Ganges and Brahmaputra can result in devastating floods, affecting millions of people and causing significant damage to infrastructure and agriculture. Central America is prone to flood risks due to its geographical location and exposure to tropical storms and hurricanes. Countries such as Honduras, Nicaragua, and Guatemala face the dual threat of heavy rainfall and storm surges, leading to flash floods and mudslides that can cause extensive damage to communities and infrastructure. Parts of Africa, including countries such as Nigeria, Sudan, and Mozambique, are also impacted by flooding risks. Factors such as irregular rainfall patterns, poor infrastructure, and inadequate urban planning contribute to the vulnerability of these regions.

Physical risks: A global look at flood risks

Figure 1: **Global flood risk - 2020**

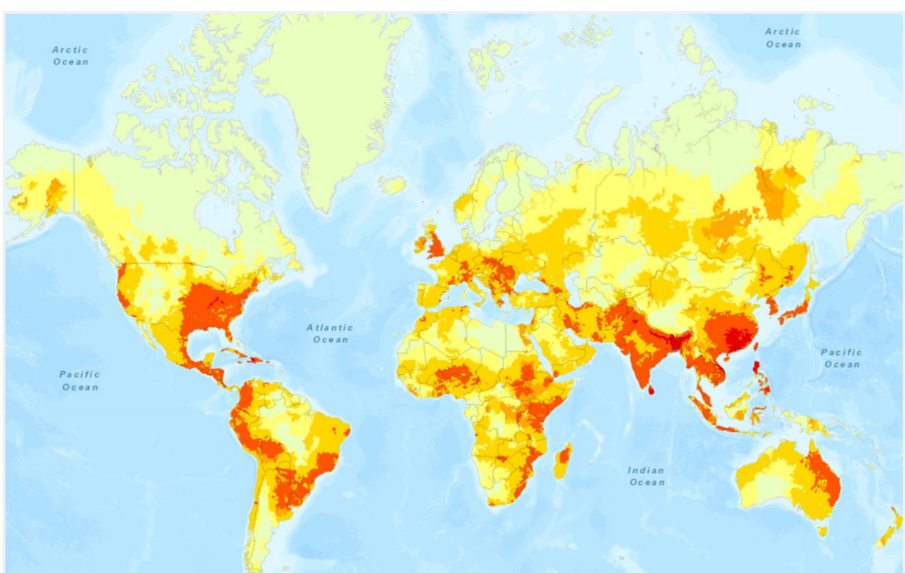
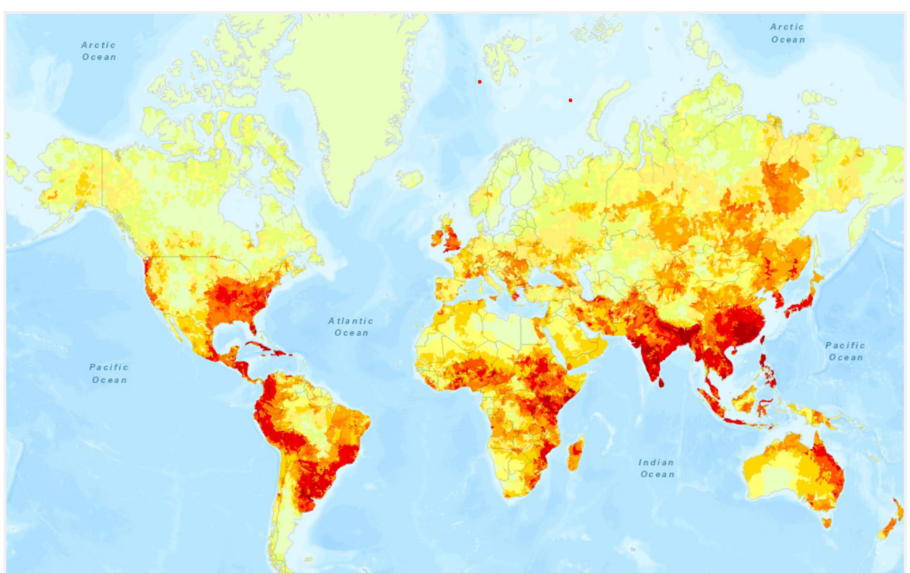
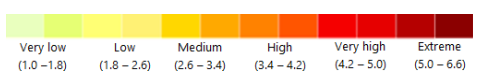


Figure 2: **Global flood risk - 2050**



Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, AAFC, NRCan, Hirabayashi et al. (2013)



Snapshot of global water risk

Several factors are contributing to the degradation in the quality of freshwater resources around the world

Worldwide, we see several factors contributing to declining water quality. Agricultural runoff, particularly in areas with heavy fertilizer use, rapid urban development, and . industrial activities all contribute to chemical and nutrient loading and increased biological oxygen demand (BOD) levels, leading to harmful algal blooms, oxygen depletion, and degradation of aquatic ecosystems. Water quality risks are found around the world, including in regions that are not as impacted by other physical risks factors, such as scarcity or flooding, as well as in regions with robust water legislation or relatively modern water infrastructure. For instance, the European Environment Agency reports that 60% of Europe's rivers, lakes and other surface water bodies are not in good condition.[1] In the developing world, untreated sewage or inadequate wastewater treatment systems also contribute to the contamination of rivers and groundwater sources and can lead to waterborne diseases and environmental degradation.

Physical risks: A global look at water quality risks

Figure 1: **Global water quality risk - 2020**

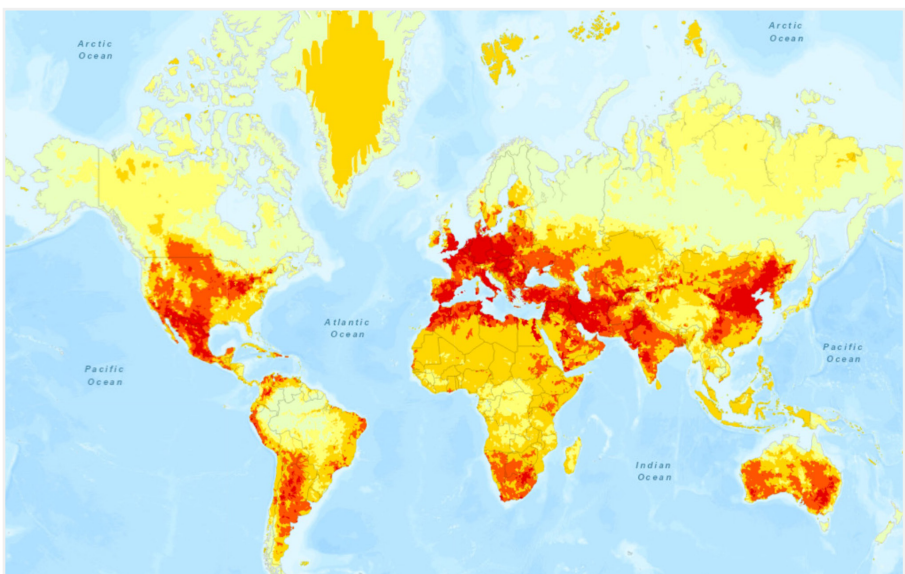
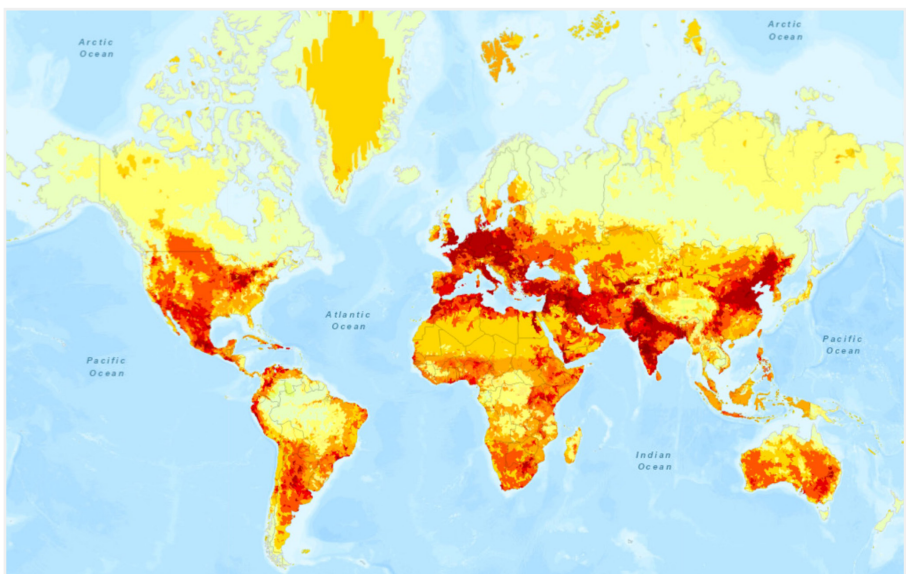
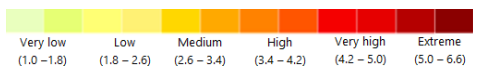


Figure 2: **Global water quality risk - 2050**



1 European Environment Agency, Ecological status of surface waters in Europe, 2021

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)



Country insights - USA

Water scarcity is likely to worsen and expand into regions experiencing significant population growth and increased industrial and agricultural activity

Water scarcity risk analysis

Southern California and arid parts of the Southwest US are currently facing significant water scarcity issues due to rising temperatures, prolonged droughts, and population growth. (Figure 1). Looking ahead to 2050, water scarcity is expected to worsen in already impacted areas while also expanding deeper into central and southern regions, including parts of Colorado, Nebraska, and Texas (Figure 2). Large cities in the South and Southwest are some of the country's fastest growing areas. States such as Arizona, New Mexico, and Texas are also home to major manufacturing plants for the likes of Lucid Motors, Intel, and Tesla, while California, Nebraska, and Texas are among the biggest centers of agricultural production. Water use for agriculture and manufacturing coupled with growing cities may further strain water resources and could potentially exacerbate the vulnerability of these areas to water risk over time. Several recent measures have been implemented nationwide to reduce water-related risks. The Bipartisan Infrastructure Law allocates funds for infrastructure updates and risk mitigation activities in 17 western states impacted by declining water levels in the Colorado River.

USA: Water scarcity risk (Current & Predicted)

Figure 1: **Water scarcity risk - 2020**

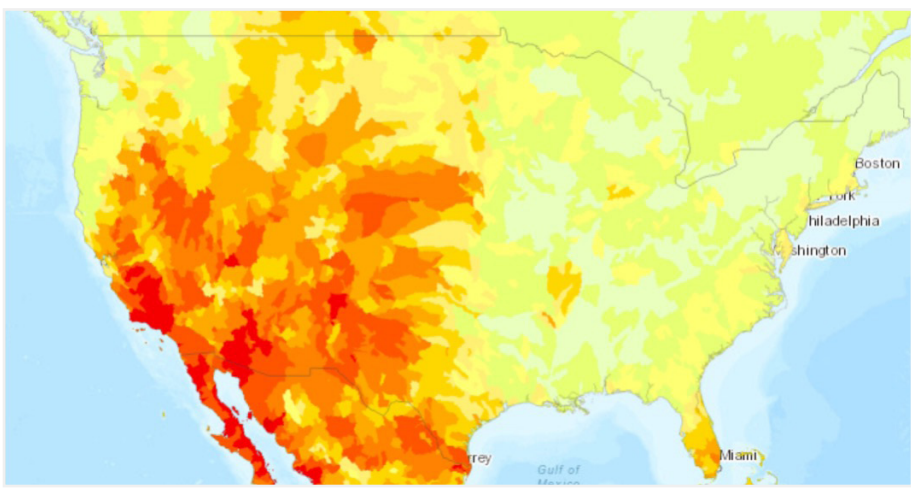
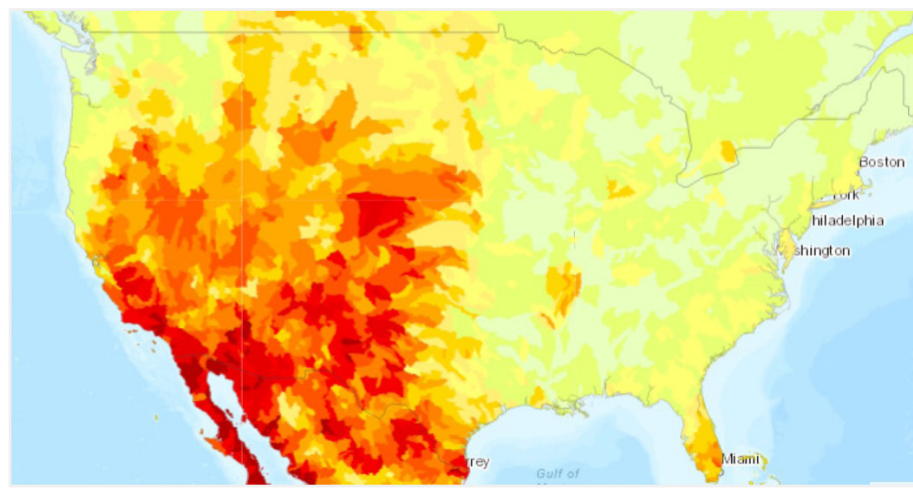
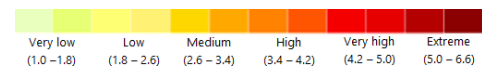


Figure 2: **Water scarcity risk - Predicted 2050**



Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)



Country insights - USA

The eastern US experiences frequent coastal and urban flooding and river overflows, driving the need for investment in flood protection infrastructure

Flood risk analysis

Flooding is a costly disaster in the United States, with more than USD 31 billion in structural damage to commercial buildings and homes alone each year[1]. Coastal areas are susceptible to storm surge flooding from hurricanes and tropical storms, while inland regions can experience riverine flooding caused by heavy rainfall or snowmelt. The US experienced four major flood events in 2023: one in California, two events in the Northeast, and one in Florida but overall, the Mississippi River and its tributaries are prone to flooding due to their extensive drainage basins (Figure 1). Projections for 2050 show flood risk intensifying, particularly around the Missouri and Mississippi Rivers (Figure 2). Aqueduct Floods estimates annual urban damages from flooding (damage to residential, commercial, and industrial buildings) will cost the nation USD 94 billion alone by 2050. About 60 % of the damages by 2050 will be caused by coastal flooding. Typically, cities have utilized 'gray' infrastructure such as levees, dikes, flood walls, dams, reservoirs, and sea walls to mitigate flooding risks. Increasingly, however, cities are also adopting 'green' infrastructure measures, also known as nature-based solutions, such as wetlands, seagrass beds, oyster reefs, riparian buffers, mangroves, and living shorelines to help manage water flows. In April, the US government announced funding of up to USD 295 million for flood resilience projects in 16 states as part of the Bipartisan Infrastructure Law.

USA: Flood risk (Current & Predicted)

Figure 1: **Flood risk - 2020**

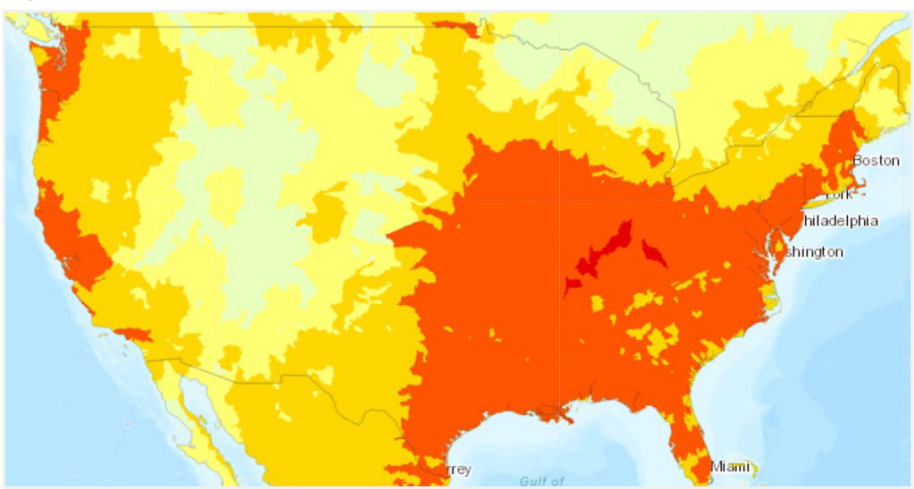
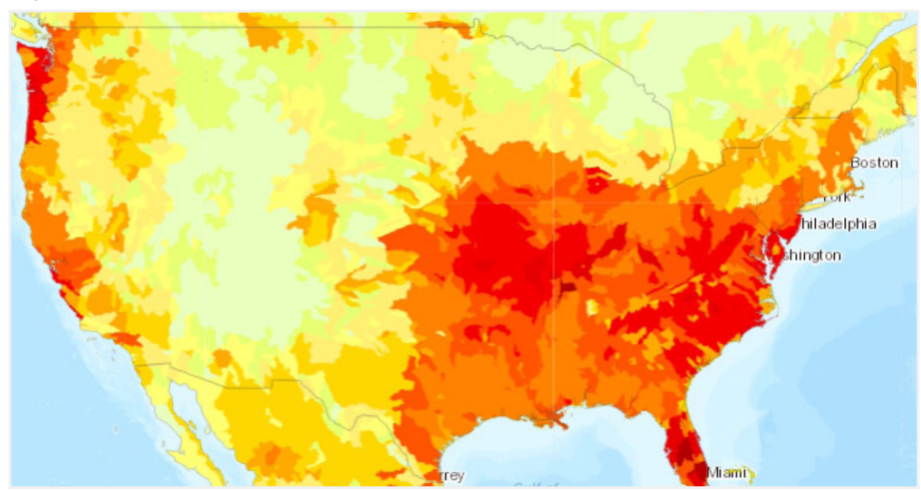
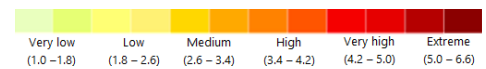


Figure 2: **Flood risk - Predicted 2050**



1 Source: Joint Economic Committee Report on Economic Cost of Flooding, June 2024
https://www.jec.senate.gov/public/_cache/files/bc171a7e-2829-462d-8193-7b7c4d59a6e3/jec-report-on-economic-cost-of-flooding.pdf

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, AAFC, NRCan, Hirabayashi et al. (2013)



Country insights - Mexico

Northern and central parts of Mexico feel the brunt of the country's water scarcity woes

Water scarcity risk analysis

Mexico's water scarcity woes are primarily caused by a combination of drought and groundwater over-abstraction. More than 100 municipalities are already deemed highly vulnerable to drought and the country has faced several severe and prolonged drought, up to 90% of its territory.[1] Groundwater depletion is driven by the agricultural sector, which is expected to account for over 75% of annual withdrawals by 2050.[2] Around 115 of Mexico's 650+ aquifers are deemed overexploited, and 17 face saline intrusion.[3] Poor access to water resources is further exacerbated by a growing population, high water leakage rates, reduced rainfall and dams becoming inoperable due to low water levels or damage. Water scarcity is set to intensify, impacting several major economic hubs, including areas around Mexico City, Monterrey, Ciudad Juarez, Tijuana, Queretaro, and San Luis Potosi (Figure 2). These hubs are home to industry parks serving a variety of sectors including automotive, trade and transportation, food and beverage, and manufacturing companies. Mexico City, a population of over 22 million people, is threatened to reach "day zero" conditions, wherein water systems fall to such low levels they cannot support community water needs, by 2028. The Mexican government is addressing its water crisis by investing approximately USD 5.4 billion in 15 priority water projects. This involves large-scale construction of dams, aqueducts, and irrigation districts.

Mexico: Water scarcity risk (Current & Predicted)

Figure 1: **Water scarcity risk - 2020**

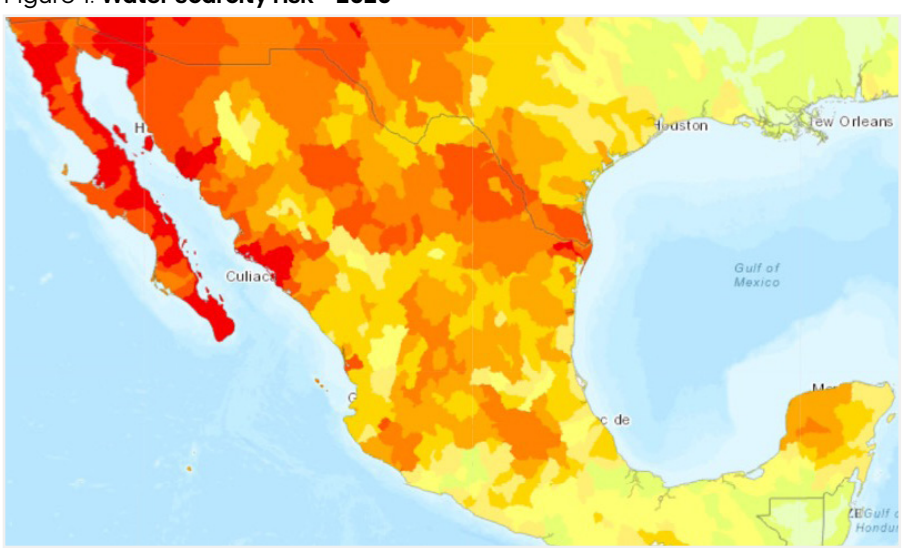
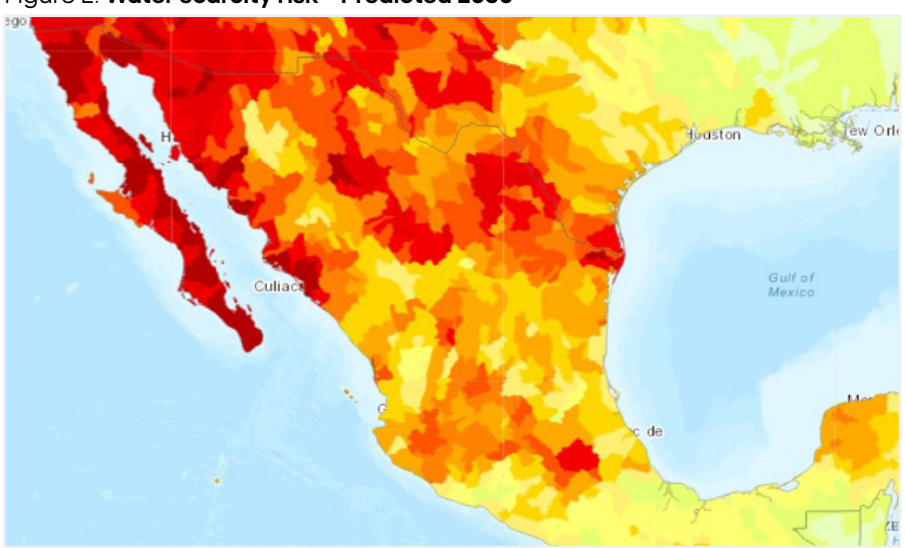
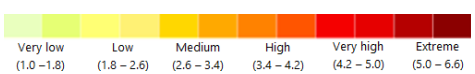


Figure 2: **Water scarcity risk - Predicted 2050**



1, 2, 3 Source: Mexico Government PNH 2020-2024

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)



Country insights - Mexico

Poor water quality plagues Mexico nationwide from untreated municipal and industrial wastewater discharge

Water quality analysis

Water pollution, primarily resulting from untreated municipal wastewater, industrial discharges, and agrochemicals impacts much of Mexico's surface waters (Figure 1). Wastewater treatment remains inefficient - approximately 30% of collected municipal wastewater is left untreated annually. Nearly 25% of Mexico's wastewater treatment plants (819 total) were abandoned or non-operating as of 2018.[1] Moreover, wastewater collection systems are deteriorated and leaky, contributing to groundwater pollution. Industrial wastewater discharge is another concern, contributing up to 340% more pollution than that generated by municipalities.[2] Agricultural runoff contains nitrogen and phosphorus while mining and steel industries contribute to the release of toxic heavy metals. With water quality risks predicted to worsen, the country has a challenging road ahead. The Mexican government operates over 1,700 monitoring sites to track surface water quality nationwide. In 2022, nearly 30% of the sites were rated water quality non-compliant.

Mexico: Water quality risk (Current & Predicted)

Figure 1: **Water quality risk - 2020**

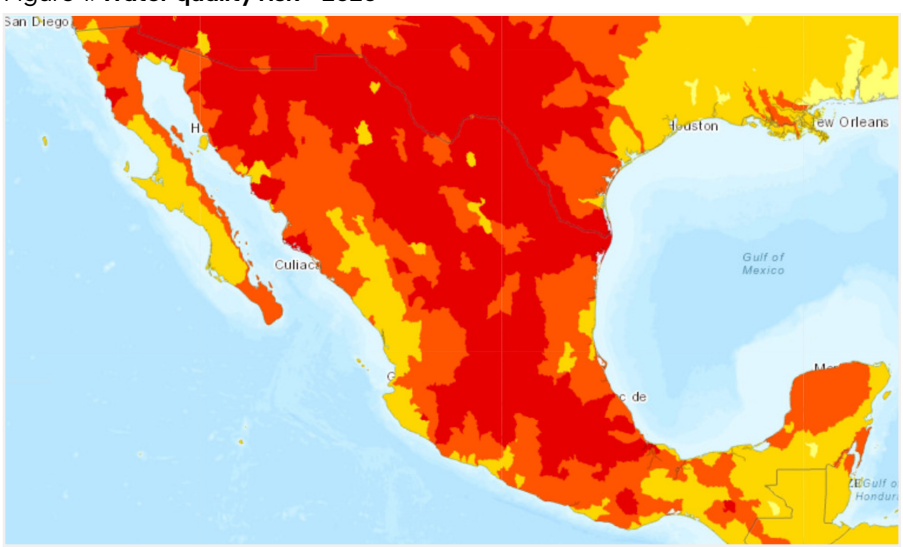
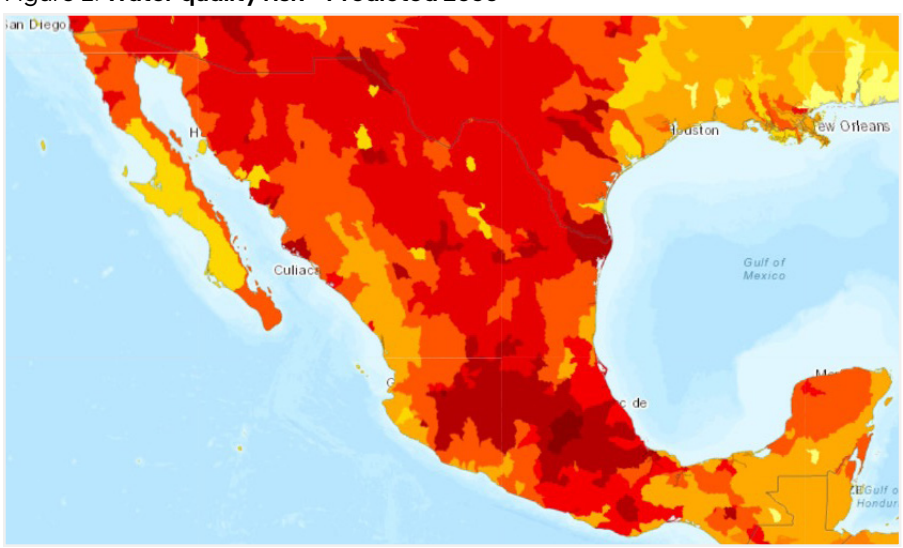
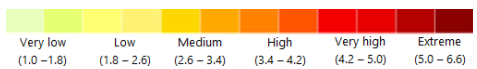


Figure 2: **Water quality risk - Predicted 2050**



1, 2 Source: Mexico Government PNH 2020-2024

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)



Country insights - UK

Flood risk is already high across much of the UK and conditions could worsen over the coming decades

Flood risk analysis

Floods resulting from record-breaking rainfall in the winter of 2023 and Storm Henk in January 2024 were severe, particularly across the English Midlands. Further, between October 2022 and March 2024, England had its wettest 18 months since Met Office records began in 1836.[1] Most of England is exposed to medium-to-high flood risk, and all of Wales is medium-high risk (Figure 1).

By 2050, coastal and riverine flooding is expected to worsen, with Aqueduct Floods estimating costs in annual urban damages will be USD 6.2 billion. Coastal flooding is the dominant type of flood risk faced by the UK, and will cause 90 % of the damage costs in 2050. The highest-risk flood areas will be surrounding London, Southwest England (e.g., Cornwall), South Wales, and the eastern coast of Northern Ireland.

There are several clusters of industrial and manufacturing plants based in the highest flood risk regions: including Southeast England (London), the Midlands and Northern England (Manchester, Sheffield, Leeds) and South Wales (Cardiff). These industrial clusters are mostly retail and manufacturing sectors, with floods potentially threatening operations.

Recent measures to address flood risk include updates to the UK's Flood and Water Management Act 2010. These aim to improve control over flooding and wastewater discharges, primarily through Implementing improved stormwater management infrastructure.

UK: Flood risk (Current & Predicted)

Figure 1: **Flood risk - 2020**

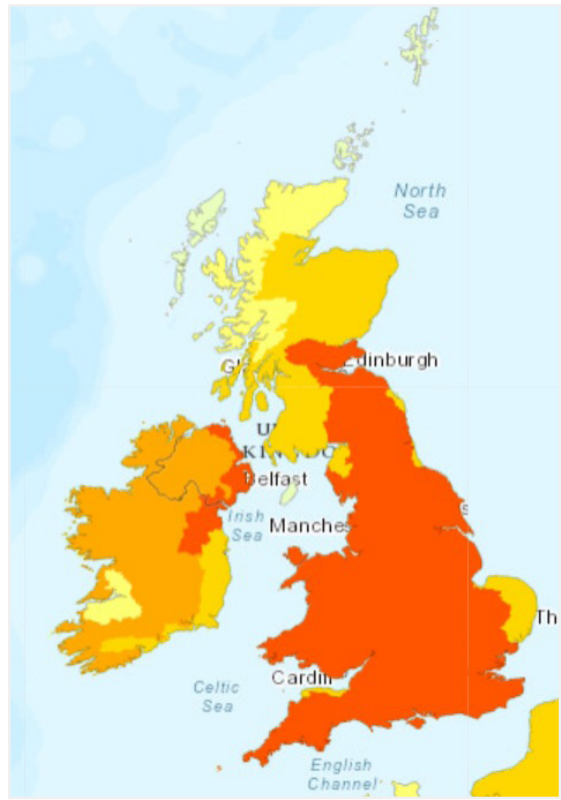
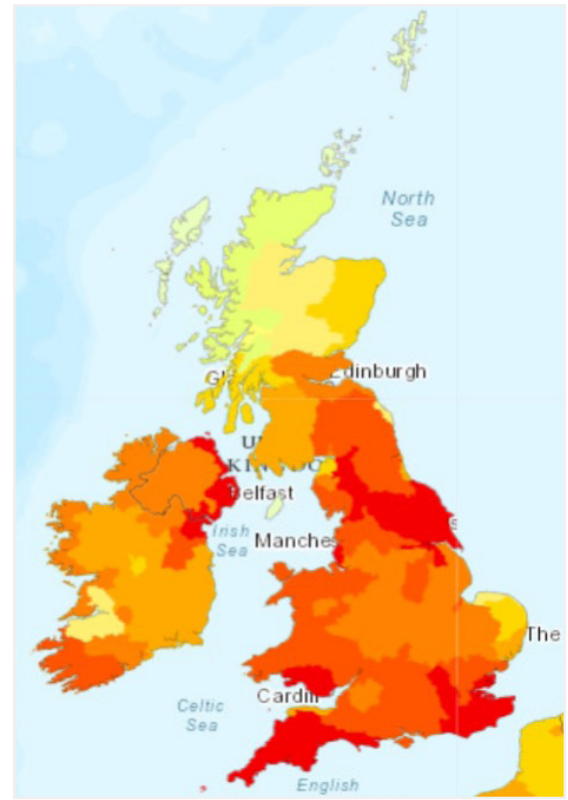
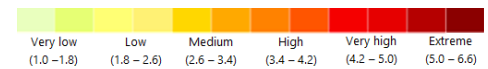


Figure 2: **Flood risk - Predicted 2050**





1 Source: UK Environment Agency, "National Drought Group meets after record wet October to March"

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, AAFC, NRCan, Hirabayashi et al. (2013)

Country insights - UK

England and eastern Ireland are afflicted by poor water quality, largely due to agricultural runoff and combined sewer overflows

Water quality risk analysis

Water quality is very poor, particularly in the Southeast. In 2020, the country ranked last on The European Environment Agency bathing water quality assessment, which tests for microbial contamination as well as cyanobacteria (algae bloom).

Most of the UK's water quality problems stem from three primary pollution sources; fertilizers and pesticides from agriculture (~40%), untreated sewage released by water companies (~35%), and run-off from roads and towns (~18%).[1]

The problem of untreated sewage leakage is a direct consequence of the UK's ageing wastewater network, with some pipes dating back more than 150 years. Antiquated infrastructure, coupled with the prevalence of combined sewer systems, leads to sewage overflows during periods of heavy rain and contaminates waterways.

By 2050, water quality is expected to worsen. The Environment Act 2021, which requires wastewater companies and utilities to continuously monitor water quality in rivers upstream and downstream of storm overflows, has been amended, allowing companies to delay improving spillage from 2035 to 2050.

Additionally, the UK chose to opt out of European Environment Agency (EEA) membership post-Brexit, limiting oversight by the rest of Europe and potentially reducing the incentive for action.

UK: Water quality risk (Current & Predicted)

Figure 1: **Water quality risk - 2020**

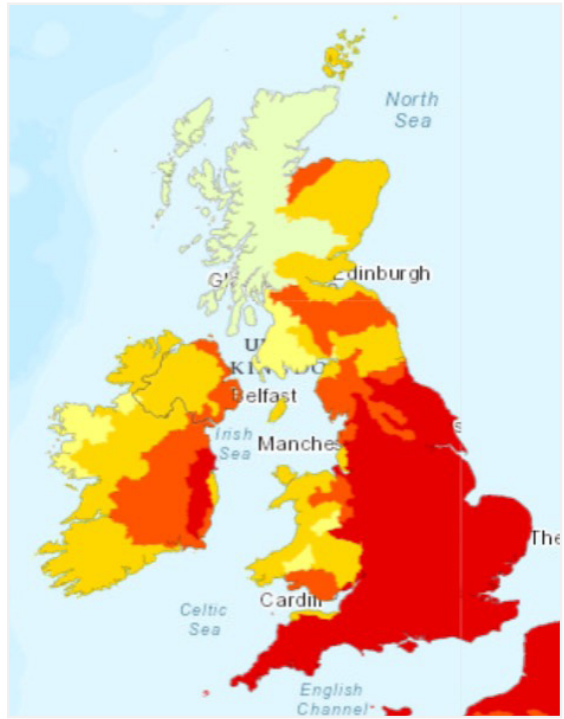
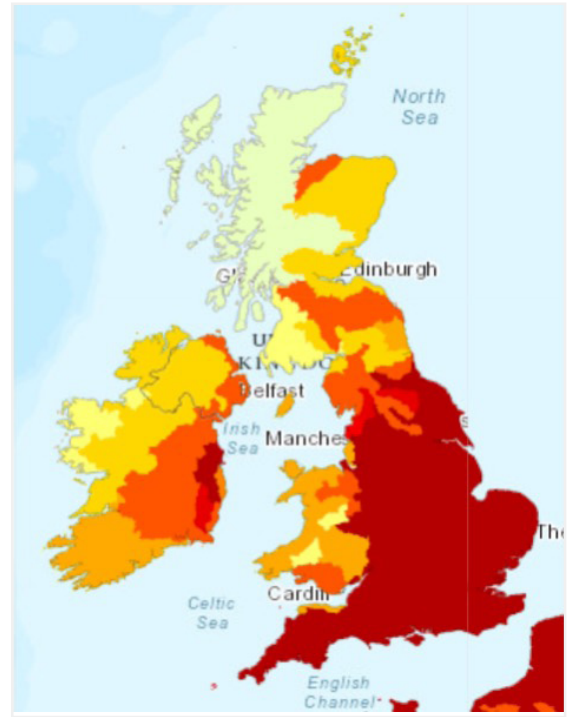
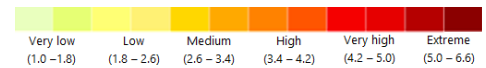


Figure 2: **Water quality risk - Predicted 2050**





1 Source: UK Environment Agency, Water and sewerage companies in England: environmental performance report for 2020, BBC

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)

Country insights - France

Worsening drought and rising temperatures impact France, with water supply expected to drop 10% by 2050

Water scarcity analysis

France experiences medium water scarcity, primarly in the central, west coast, and southwestern regions (Figure 1).

Groundwater levels are declining, with reserves during the summer of 2023 an estimated 60% lower than the previous year. Droughts and high temperatures are expected to become more frequent and more severe such as during the 2022 drought, which was the driest summer in 500 years.[1]

The 2022 drought impacted over 2,000 municipalities' water supplies, of which 340 villages needed to truck in water. The drought also impacted energy production with the supplier EDF reducing output at nuclear plants in some regions as river temperatures where too high to support its cooling systems.[2]

By 2050, water scarcity risk is expected to worsen in the same regions, with water inavilability threatened to increase from 30% to 40%. Like in recent droughts, French municipalities may have to restrict household water usage and conserve water for irrigation.

In March 2023, French President Emmanuel Macron launched a national Water Plan with 53 measures, including targets for water reuse and leakage reduction.

France: Water scarcity risk (Current & Predicted)

Figure 1: **Water scarcity risk - 2020**

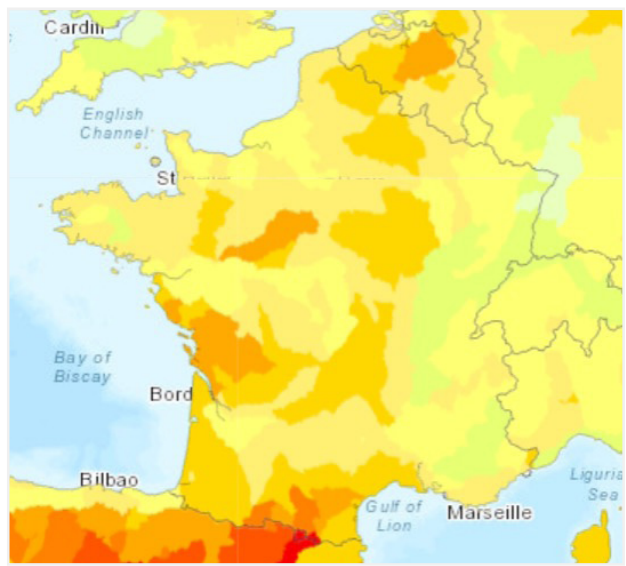
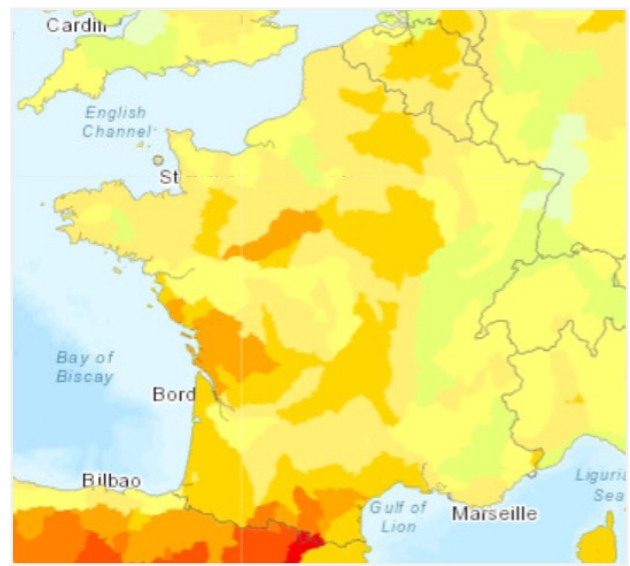
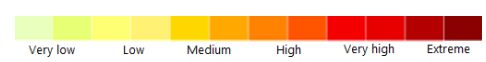


Figure 2: **Water scarcity risk - Predicted 2050**





1 Source: European Drought Observatory, Reuters
2 Source: The Guardian

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)

Country insights - France

North and Northwest France face intensifying water quality risk, resulting from industrial activity, agricultural runoff, and combined sewer overflows

Water quality analysis

Water quality risk is highest in Northern, Eastern and Northwestern France, as well as the areas surrounding major cities such as Paris, Lyon and Marseille (Figure 1).

The contamination of French water bodies by pesticide residues and other chemical contaminants is a concern. According to the French Agency for Food, Environmental and Occupational Health and Safety (ANSES), an estimated one-third of the population received tap water that failed to meet quality standards in 2023.

By 2050, water quality is expected to worsen – even reaching 'extreme' risk levels around Paris, likely due to pollution resulting from manufacturing and refining processes, as well as combined sewer overflows, and runoff from agricultural activity (Figure 2).

The most impacted regions include major agricultural areas across Normandy, Hauts-de-France and parts of Brittany as well as major industrial areas in central France. In Brittany, the excessive use of fertilizers and the improper management of manure may lead to high levels of nitrates and pesticides in water bodies. In Northern and Eastern regions, there is a high concentration of industrial activities, which can result in discharge that contributes to water pollution in rivers. Regions with extensive vineyards, such as Bordeaux and Burgundy, face water quality issues due to the use of pesticides and fertilizers in grape cultivation.Although the Water Plan aims to preserve water quality and restore the water cycle, measures announced to date may not be sufficient in ensuring high water quality nationwide.

France: Water quality risk (Current & Predicted)

Figure 1: **Water quality risk – 2020**

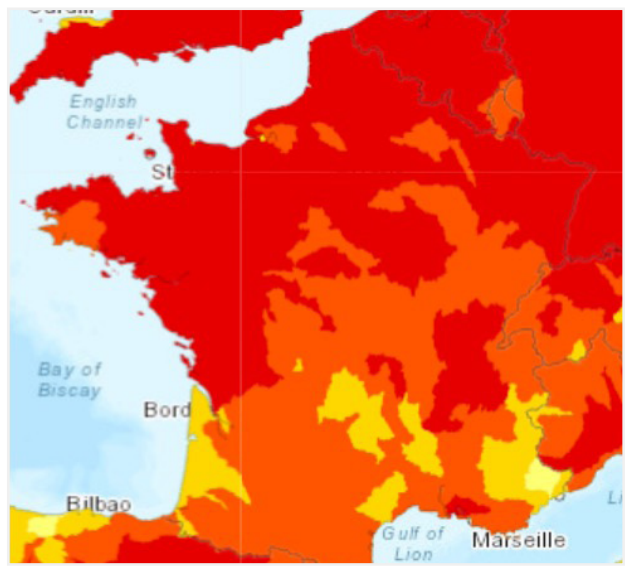
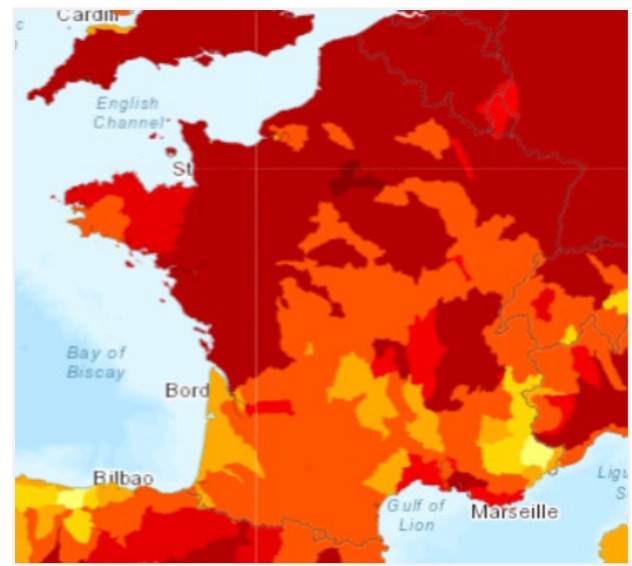
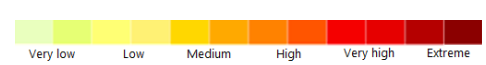


Figure 2: **Water quality risk – Predicted 2050**





Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)

Country insights - Spain

Southern Spain faces severe water scarcity due to prolonged droughts and the depletion of its reservoirs

Water scarcity analysis

Spain has experienced high water scarcity in the Southeastern region over the past years due to a long-running drought caused by record-high temperatures and a string of heat waves (Figure 1).

In February, reservoirs were running dry, with capacities in the most impacted regions dropping to less than 20%. This led to a state of emergency being declared in Catalonia, with water allowances limited to 200 liters per person. In some towns, water was brought in via truck, a stark reminder of the severity of the situation. Restrictions were eased slightly in May.[1]

By 2050, the risk of water scarcity in the South is projected to increase significantly, due to rising temperatures, more frequent heatwaves, and reduced rainfall (Figure 2). It is estimated that the available water could decrease by an additional 40%.

Drought could threaten the livelihoods of thousands of farmers in the South. The area is a significant agricultural region, accounting for 70-80% of water use.

Recent measures being taken to address water scarcity risk include a EUR 2.2 billion investment package to tackle drought, of which EUR 1.4 billion focuses on supporting affected irrigators and increasing water supply with new infrastructure, such as desalination plants and a water transfer for Doñana National Park.

Spain: Water scarcity risk (Current & Predicted)

Figure 1: **Water scarcity risk - 2020**

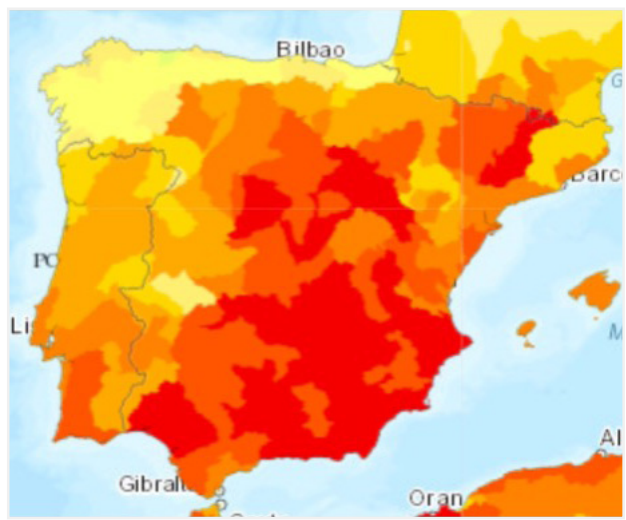
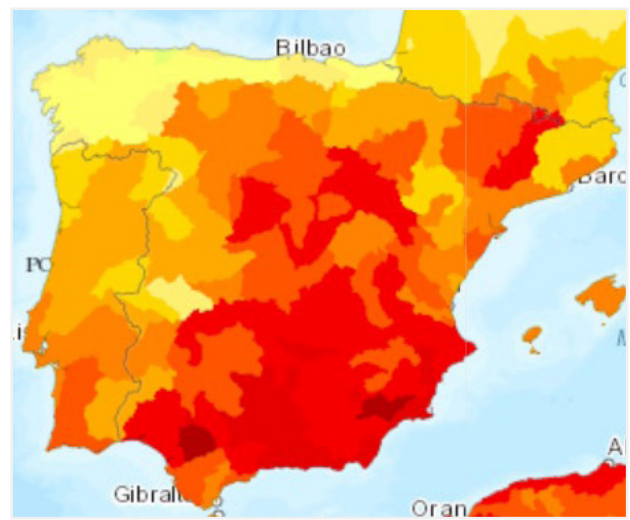
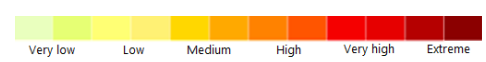


Figure 2: **Water scarcity risk - Predicted 2050**





1 Source: Generalitat de Catalunya

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)

Country insights - Spain

Severe water quality issues and arid conditions contribute to significant water stress in Spain

Water quality analysis

Spain has experienced very high-water quality risk over the past few years due to the growing trend of intensive agriculture.

As the third-largest EU member in agricultural land use, Spain is often referred to as the 'Garden of Europe'. However, this reputation comes at a cost; heavy water consumption and excessive fertilizer use.

The primary culprit behind water contamination is the use of these fertilizers, rich in nitrates. These nitrates trigger the growth of algae, which depletes the water's oxygen levels, leading to mass fish deaths, as witnessed in Mar Menor, a once-thriving tourist spot and marine life sanctuary.[1]

The adverse effects of agricultural overuse are exacerbated by drought. The remaining water reserves are often contaminated with silt and cyanobacteria, rendering them unsafe for human consumption.

Conditions are not expected to improve by 2050. Water quality risk is expected to worsen in the Northwestern and Eastern regions; the area's most sensitive to algae blooms. These regions are home to the country's two largest cities, Madrid and Barcelona, where urban wastewater discharge can also significantly impact water quality. This is expected to worsen as these major cities draw high tourism activity.

Spain drafted the 'Spain 2050' report to promote sustainable agriculture and improve water quality and quantity sources. Part of this plan includes using nature-based solutions for restoration and recovery, increased monitoring, and reclaimed reuse.

Spain: Water quality risk (Current & Predicted)

Figure 1: **Water quality risk - 2020**

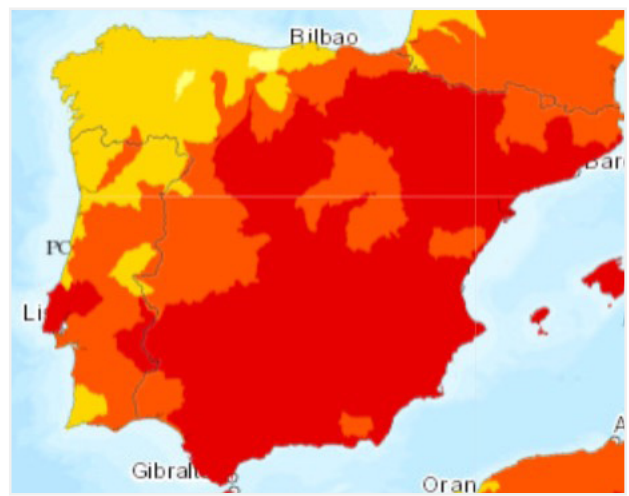
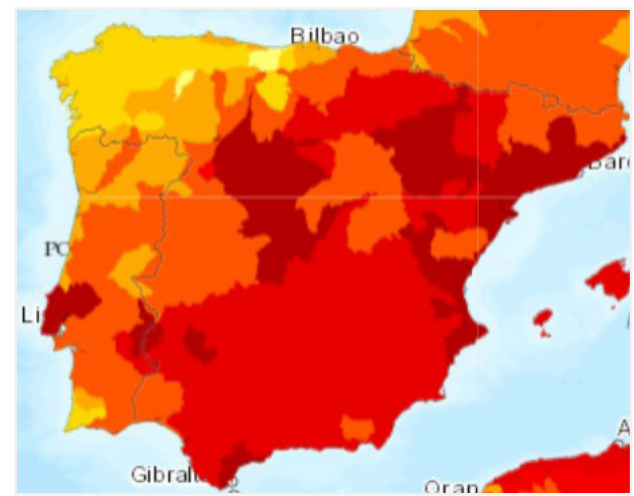
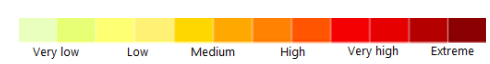


Figure 2: **Water quality risk - Predicted 2050**





1 Source: Wise Freshwater, European Environment Agency

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)

Country insights - Lebanon

Poor water management and economic turmoil make Lebanon one of the world's most water-stressed countries

Water scarcity analysis

Multiple issues are exacerbating the strain on Lebanon's water resources, including water mismanagement, population growth, urbanization, climate change, and an economic crisis (Figure 1). By 2050, almost the entire country land area is forecasted to face extreme water scarcity (Figure 2).

The Lebanese population has historically faced water supply shortages. The most recent major event was in 2021 when water supply was on the verge of collapse. UNICEF warned over 70% of the population faced critical water shortages due to political and economic turmoil.

Additionally, groundwater resources are overexploited, with the World Bank estimating there are around 60,000 unlicensed, illegal wells across the country. Coastal aquifers also face saltwater intrusion, further threatening supplies. Surface water storage capacity is low, at only about 6%, against the regional average of 85% (MENA).[1] In areas with water distribution systems, there is a 40% water loss as a result of leakages and illegal water connections.[2]

International organizations are heavily involved to try to alleviate water scarcity in the country. In 2017, the World Bank initiated the Lebanon Water Supply Augmentation Project to construct the Bisri Dam for over 1.6 million people in the Beirut area. However, the project was cancelled in 2020 after the Lebanese government's failed to complete required actions to keep the project running.

Lebanon: Water scarcity risk (Current & Predicted)

Figure 1: **Water scarcity risk - 2020**

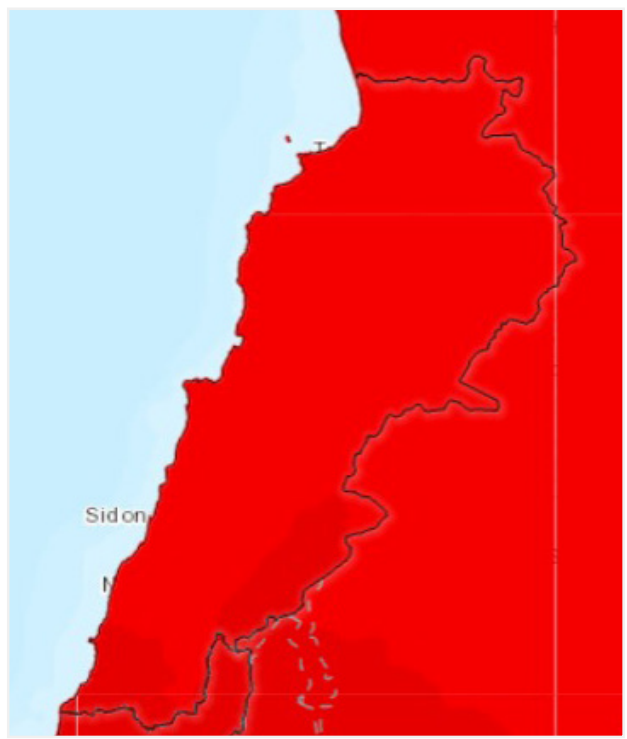
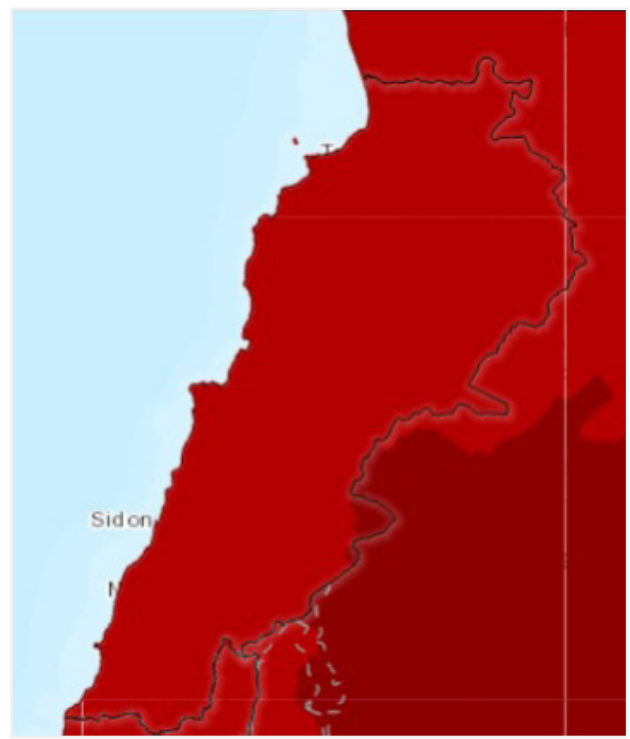
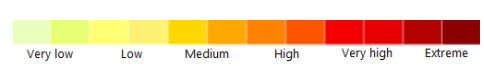


Figure 2: **Water scarcity risk - Predicted 2050**





1 Source: World Bank, Lebanon Water Supply Augmentation Project (Bisri Dam)
2 Source: UNICEF

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)

Country insights - Lebanon

Lebanon faces significant water quality challenges with conditions set to worsen in the coming decades

Water quality analysis

Lebanon experiences 'very high' water risk across a significant portion of its territory, with much of its water infrastructure being either neglected or damaged. A combination of factors, including urbanization, a lack of proper waste management systems and dumping of pollution into water bodies has caused water quality to deteriorate over time (Figure 1).

Around 90% of wastewater collected in Lebanon is discharged directly into rivers without treatment, suggesting that surface water in the country likely contains a range of microbial pathogens, such as bacteria, viruses, and parasites.[1]

USAID estimates that nearly one in three Lebanese buys alternative sources of drinking water, usually from mobile water trucks or in bottles.

By 2050, water quality risk is expected to worsen, likely driven by surface water contamination and nitrate pollution (Figure 2).

Recent measures being taken in country to address water quality risk include Lebanon Water Project (LWP), which is funded by USAID to improve access to safe drinking water, wastewater management, and promote efficient irrigation in partnership with Lebanon's five public water utilities.

Lebanon: Water quality risk (Current & Predicted)

Figure 1: **Water quality risk - 2020**

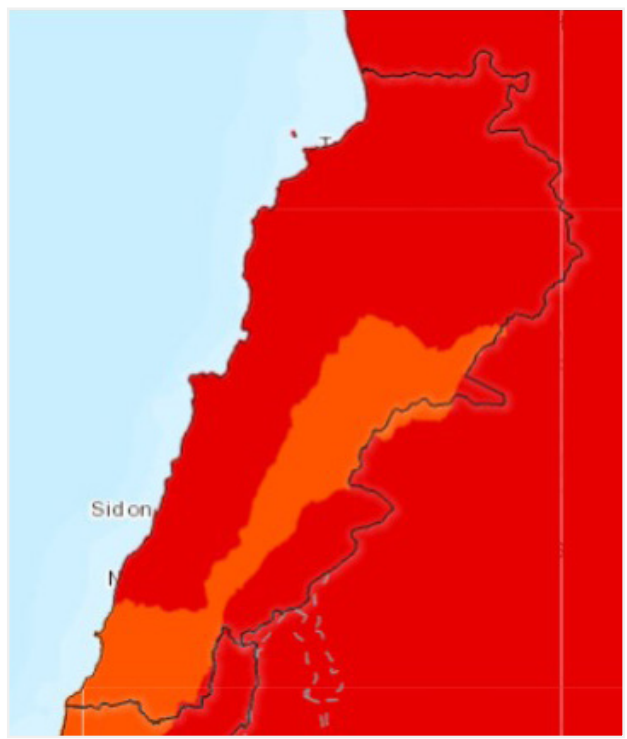
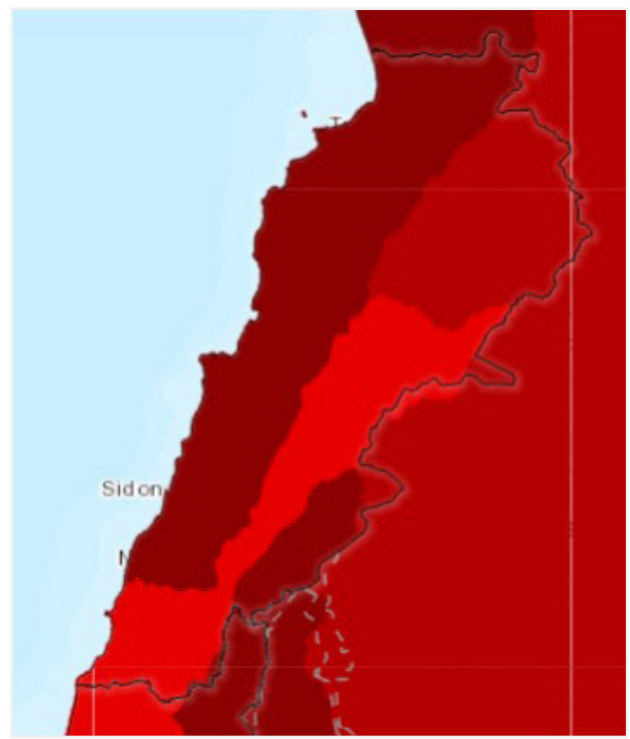
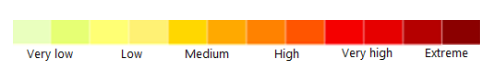


Figure 2: **Water quality risk - Predicted 2050**





1 Source: World Health Organization, "River water pollution in Lebanon: the country's most underestimated public health challenge"

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)

Country insights - Saudi Arabia

Saudi Arabia ranks among the world's 10 most water-stressed countries, with arid conditions and high water consumption for agricultural use

Water scarcity analysis

Saudi Arabia (KSA) is an arid country with scarce freshwater resources. To support its municipal needs, the country relies on a combination of seawater desalination (60%) and groundwater (40%). For agricultural purposes, it relies primarily on groundwater. (Figure 1).

Through 2050, water scarcity will intensify throughout the country. Several areas are forecasted to face 'extreme' risk levels, driven by climate change and growing demand (Figure 2). Annual rainfall totals have been decreasing and the population is expected to reach more than 48 million by 2050.

Up to 80% of water demand is driven by the agricultural sector,[1] which presents opportunities to optimize usage, such as drip irrigation techniques. Most water withdrawals are from deep groundwater aquifers, which tend to be nonrenewable. To diversify water resources, Saudi Arabia's desalination plants produce around 20% of total desalinated water globally.[2]

The country is addressing scarcity by increasing wastewater reuse for irrigation, expanding desalination capacity, and rehabilitating land to protect water sources from drought and desertification.

New construction projects, including desalination plants, are part of this strategy, such as the Shuaibah 3 and Jubail 3B plants. Large nature-based solution projects are also included such as at Thadiq National Park, north of the country's capital, Riyadh. The project involves afforestation and constructing dams for rainwater collection to minimize evaporation.

Saudi Arabia: Water scarcity risk (Current & Predicted)

Figure 1: **Water scarcity risk - 2020**

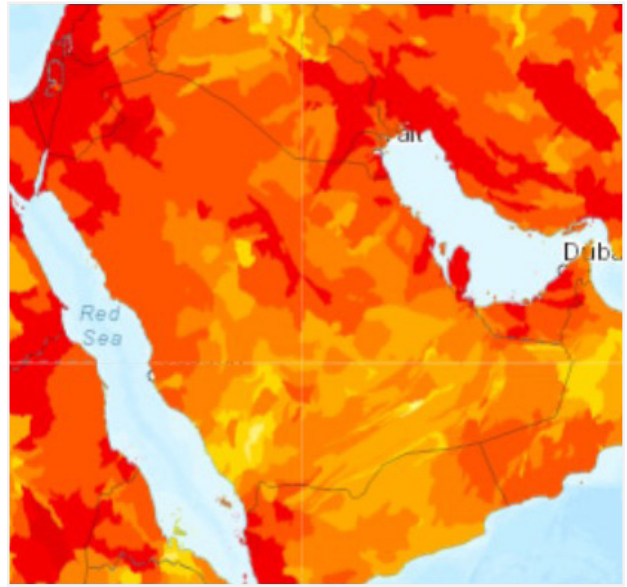
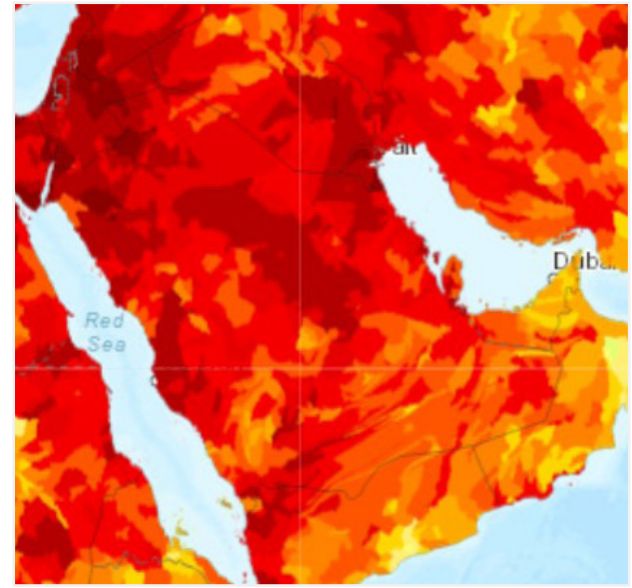
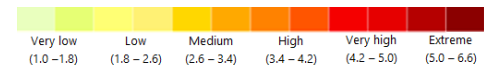


Figure 2: **Water scarcity risk - Predicted 2050**



1 Source: Suhail, M.; Faraj, T.K.; Ahmad, W.; Ravshanov, A.X.; Khan, M.N. Issues of Water Resources in Saudi Arabia: Past, Present, and Future. Sustainability 2024, 16, 4189. https://doi.org/10.3390/su16104189

2 Source: U.S. Saudi Business Council



Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)

Country insights - Saudi Arabia

Saudi Arabia water quality will worsen in developed areas likely caused by urban runoff and wastewater pollution

Water quality analysis

Like other countries in the arid Middle East region, Saudi Arabia's (KSA) water quality issues primarily stem from anthropogenic pressures. As of 2020, only 65% of the country had wastewater coverage, with untreated wastewater posing risks to ecosystems and human health.[1] Other factors contributing to declining water quality include include stormwater runoff, especially in urban areas, and agricultural fertilizer runoff (Figure 1).

Human activity will likely drive worsening water quality through 2050, especially impacting the central areas and population centers like Riyadh (Figure 2).

In line with its national Vision 2030 strategy and National Water Strategy, Saudi Arabia aims to achieve at least 95% wastewater service coverage within the next few years. Several large-scale and more small-scale plants (less than 25,000 cubic meters per day treatment capacity) are required to meet the treatment needs and safeguard the environment. The water strategy relies heavily on private investment to realize wastewater treatment projects.

Other projects in line with the Vision 2030 strategy include constructing green public spaces, such as Green Riyadh, that act as natural buffers to combat some water pollutants.

Saudi Arabia: Water quality risk (Current & Predicted)

Figure 1: **Water quality risk - 2020**

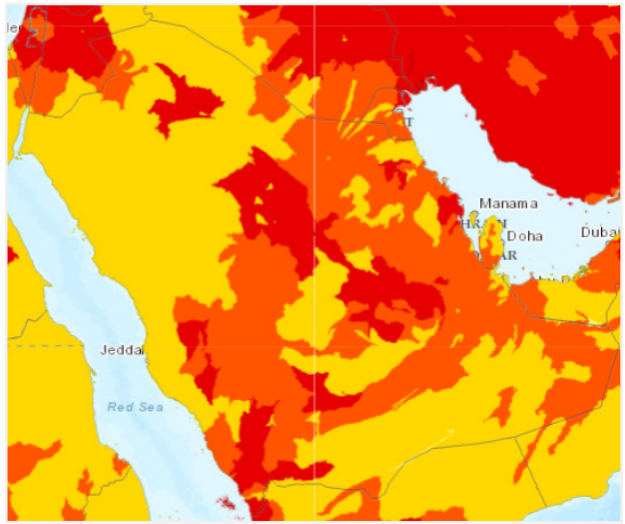
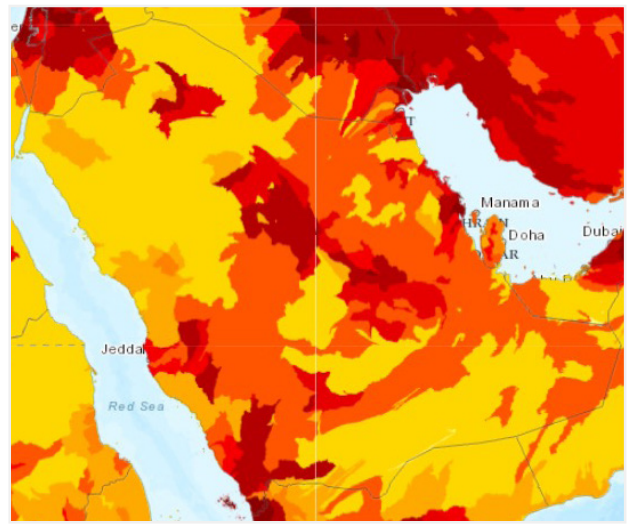
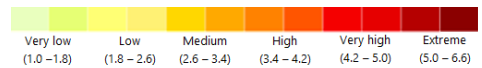


Figure 2: **Water quality risk - Predicted 2050**





1 Source: U.S. Saudi Business Council

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)

Country insights - United Arab Emirates

UAE is one of a few countries where data show water scarcity risks could decrease over time, potentially due to changing weather patterns

Water scarcity analysis

Desert accounts for around 80% of the United Arab Emirates' territory. Desertification, drought and rising surface temperatures are top threats to the country's water availability, with most regions currently facing 'high' or 'very high' scarcity risks (Figure 1).

However, new data suggests that climate change could result in increased rainfall in this area. While increased precipitation may help renew stressed groundwater resources, it can also result in localized flooding, as witnessed in April when the country received record rainfall that flooded highways and trapped people in their homes. In January, a report suggested that the annual precipitation is expected to increase over most of the UAE by up to 30% by the end of this century.[1] Changes could also result, however, in precipitation extremes, including prolonged drought.

The government has enacted national strategies to address water risk, including the National Strategy to Combat Desertification 2030. Under this strategy, the government plans to reduce water consumption, improve efficiency and increase the use of recycled water by 60%. It also set an ambition to restore at least 80 % of degraded land to fight desertification.

Authorities also launched the Water Security Strategy 2036 to promote sustainable water management. Some of the objectives include reducing water demand by 21%, lowering water scarcity index by three degrees, and increasing water storage capacity to two days for emergency conditions. As noted in Figure 2, while some regions still face 'high' risks, many of the most at risk areas could see significant improvements by 2050.

United Arab Emirates: Water scarcity risk (Current & Predicted)

Figure 1: **Water scarcity risk - 2020**

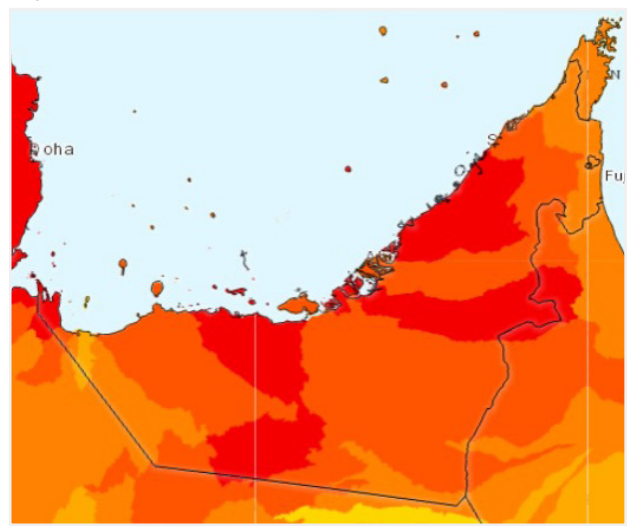
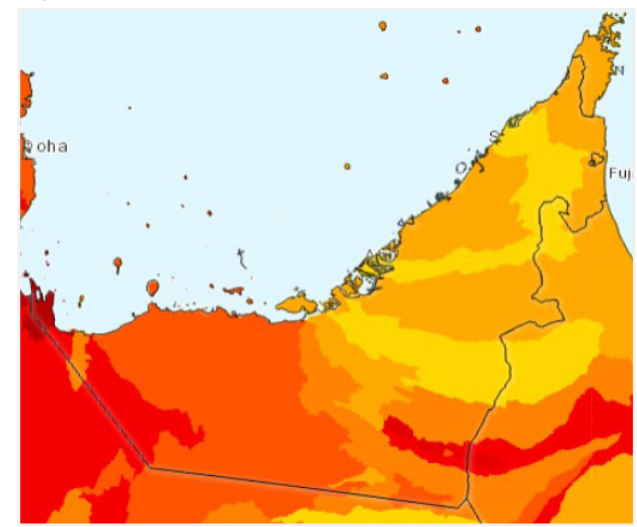
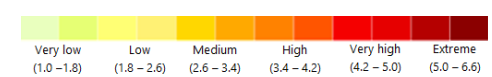


Figure 2: **Water scarcity risk - Predicted 2050**



1 Rao, K.K., Al Mandous, A., Al Ebri, M. et al. Future changes in the precipitation regime over the Arabian Peninsula with special emphasis on UAE: insights from NEX-GDDP CMIP6 model simulations. Sci Rep 14, 151 (2024).



Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)

Country insights - United Arab Emirates

UAE faces worsening water quality from urbanization and pollution

Water quality analysis

The United Arab Emirates (UAE) has experienced very high risk of water quality issues in the Northeastern parts of the country (Figure 1). This impacts a highly urbanized area, including Dubai, with surface water experiencing high loading of salt, nitrogen, phosphorus, and biochemical oxygen demand (BOD). Much of this loading is a consequence of urban wastewater discharge, including desalination, leaching of fertilizer, and stormwater runoff.

By 2050, water quality risk is expected to worsen and expand further west, likely driven by over-extraction of the country's groundwater and discharge from desalination plants resulting in higher water salinity.

The agricultural sector consumes nearly two-thirds of the nation's water. Water resources for the country's Northeast could also be threatened by changing weather patterns and a growing population over the next 20 to 30 years.

Recent measures being taken in UAE to address water quality risk include implementing the Water Security Strategy 2036. The strategy aims to ensure sustainability and continuous access to water during normal and emergency conditions. A top objective of the strategy is to improve water quality by minimizing pollution and the release of hazardous chemicals, and to increase recycling and safe reuse of treated wastewater to 95%[1].

United Arab Emirates: Water quality risk (Current & Predicted)

Figure 1: **Water quality risk - 2020**

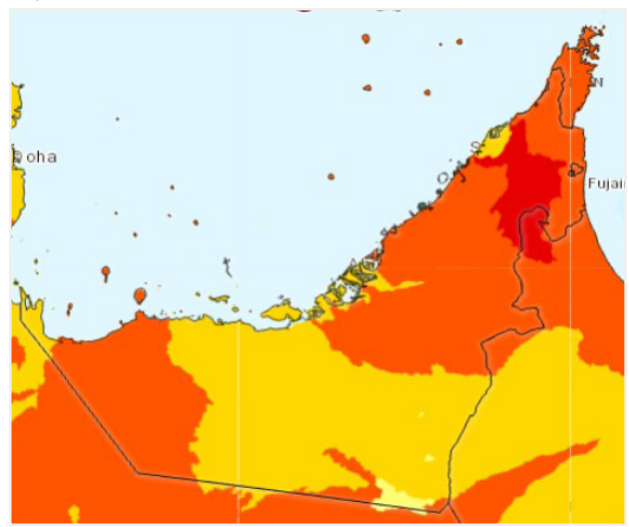
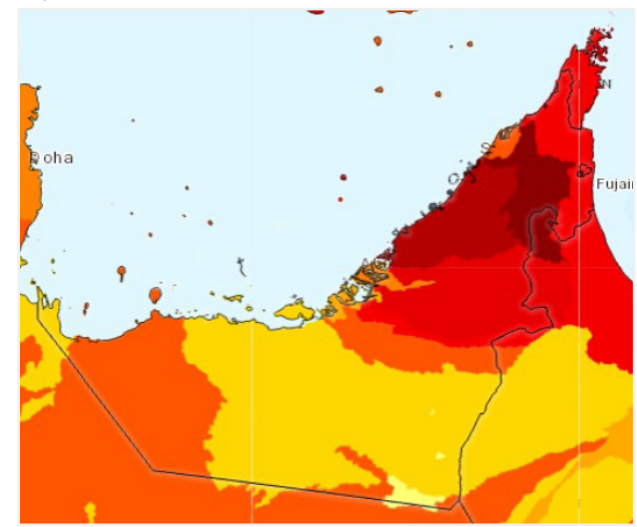
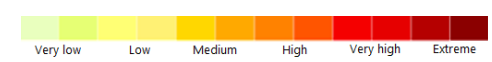


Figure 2: **Water quality risk - Predicted 2050**





1 Source: The UAE Water Security Strategy 2036

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)

Country insights - India

India faces worsening water quality from urbanization and pollution

Water scarcity analysis

More than 330 million people (22 % of the population) are currently impacted by water scarcity in India, the world's most populated country (Figure 1).[1]

Groundwater mismanagement and low rainfall totals has led to the rapid depletion of groundwater levels. Moreover, groundwater is effectively free for farmers leading to aggressive pumping for irrigation. Rainfall recharges about 70 cubic miles of groundwater per year but withdrawals exceed more than 200 cubic miles per year. When wells dry up, families migrate to cities, increasing water stress in urban areas as well.

Historically, India has relied on monsoons to bring 80 % of the country's annual rainfall, but climate patterns are becoming more erratic. As a result, India's drought-prone area has increased 57 % since 1997.[2]

Scarcity affects large manufacturing hubs including Delhi, Chennai and Hyderabad, with the potential to disrupt manufacturing operations, including in the pharmaceuticals, chemicals, and textiles sectors and in the construction industry.

By 2050, high to extreme water scarcity will affect over 50 % of India's territory and more than double the population impacted (Figure 2).

In 2021, India's Ministry of Housing and Urban Affairs announced a program to improve water infrastructure in more than 4,300 towns, including targets that 20 % of domestic water needs and 40 % of industrial water needs should be met by reused water. The state of Gujarat has set an even more ambition plan to reuse 70 % of treated wastewater by 2025 and 100 % by 2030.

India: Water scarcity risk (Current & Predicted)

Figure 1: **Water scarcity risk - 2020**

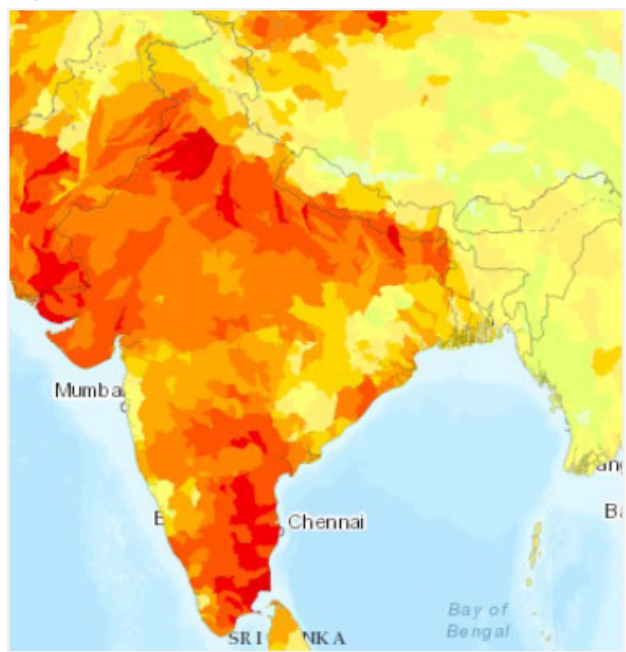
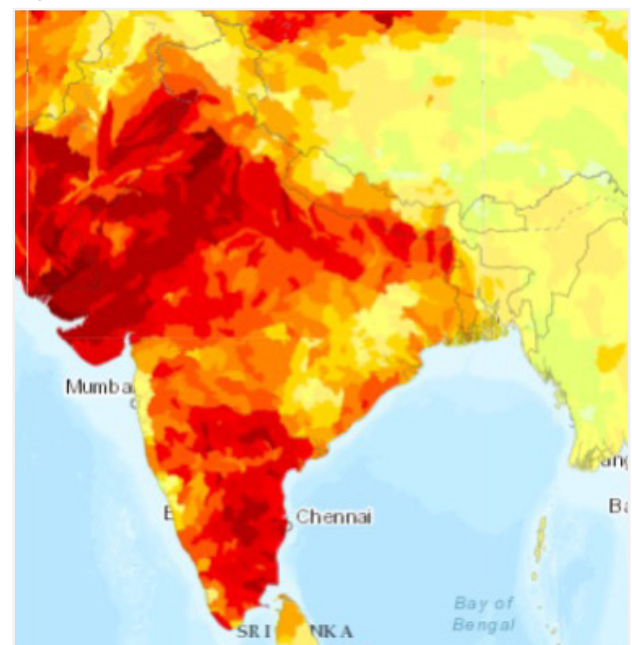
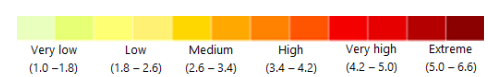


Figure 2: **Water scarcity risk - Predicted 2050**





1 Source: Circle of Blue
2 Source: World Bank, "India: Managing the Complex Problem of Floods and Droughts"

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Greve et al (2018) Kummu et al (2017)

Country insights - India

The Northeast, South Central, and the West Coast of India are most vulnerable to flood risk through 2050

Flooding risk analysis

India relies on the monsoon to account for around 80% of its rainfall.[1] However, rainfall is becoming more erratic to predict and severe weather increasingly common. Intense rainfall events cause flash floods and destruction to the most at-risk areas.

Flooding already impacts areas with densely populated cities including Mumbai, Bangalore, Hyderabad and Ahmedabad. Assam (northeast of Bangladesh) and the riverine area along the Brahmaputra are the most at risk flood areas today (Figure 1).

Flooding is expected to become more widespread over the next few decades (Figure 2), with Aqueduct Floods estimating it will cost the nation USD 845 billion in annual urban damages. Riverine flooding is the main flood type affecting India, expected to cause more than 90% of the damage costs in 2050.

Major infrastructure projects involving the World Bank and Indian government are coming to fruition. The Major Irrigation and Flood Management Project in West Bengal is providing better protection against flooding for 2.7 million farmers.

India: Flooding risk (Current & Predicted)

Figure 1: **Flooding risk - 2020**

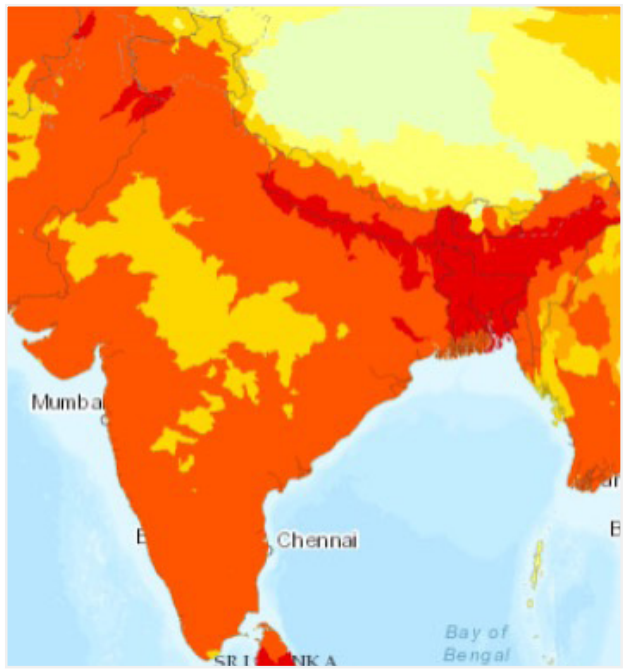
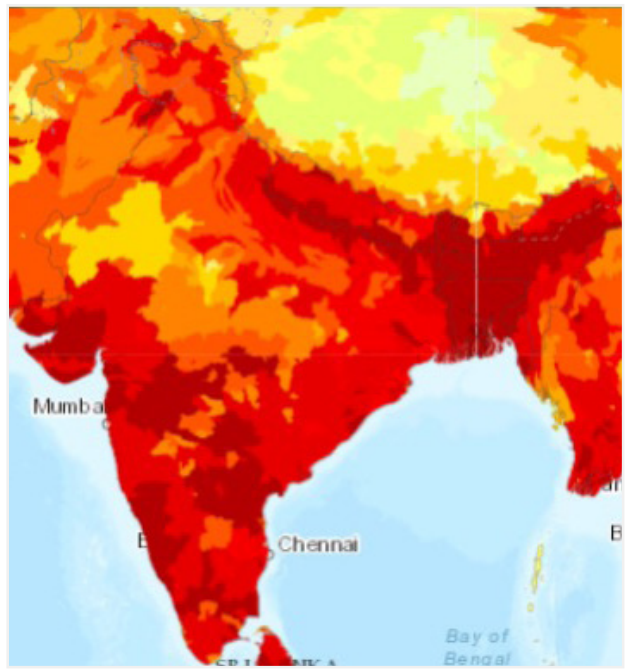
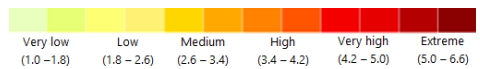


Figure 2: **Flooding risk - Predicted 2050**





1 Source: NASA

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, AAFC, NRCan, Hirabayashi et al. (2013)

Country insights - China

China's Southern provinces experience the highest flood risk, with conditions likely to worsen by 2050

Flood risk analysis

Typhoons and storm surge cause flood risks, particularly in Southern China. Rapid urbanization has contributed to worsening conditions as it corresponds with an increase in impervious surfaces (such as concrete) on land that would otherwise absorb water. Between 2008 and 2021, China's urbanization rate increased by nearly 15%.[1]

Areas with very high flood risks include several major urban areas such as Hong Kong, Shenzhen, and Guangzhou (Figure 1).

Shenzhen, Guangzhou, Dongguan are also home to large industrial parks that host tenants from high-tech IT, green petrochemicals, textiles, light industry, and home appliances.

By 2050, coastal and riverine flooding is expected to worsen especially in southern areas (Figure 2). Aqueduct Floods estimates annual urban damages from flooding will cost the nation more than USD 272 billion in 2050.

Nearly 70% of the damage costs are expected to be caused by riverine flooding (such as in the Pearl River basin in Guangdong province). To improve flood management, China is implementing 'sponge city' concepts to expand green infrastructure that mimic natural water storage in urban settings.

China: Flood risk (Current & Predicted)

Figure 1: **Flood risk - 2020**

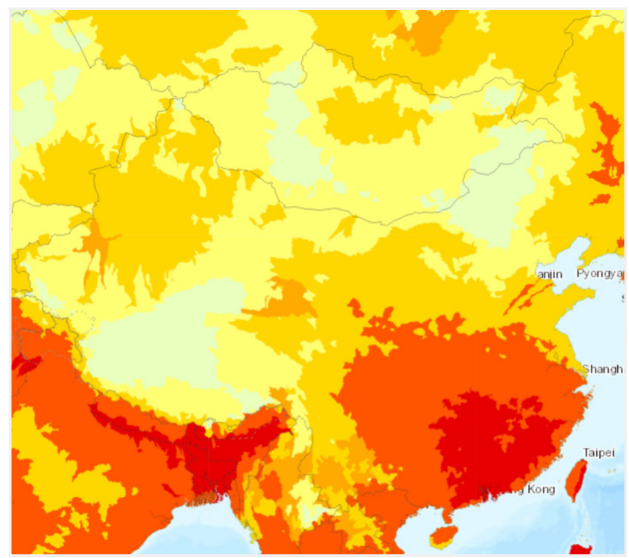
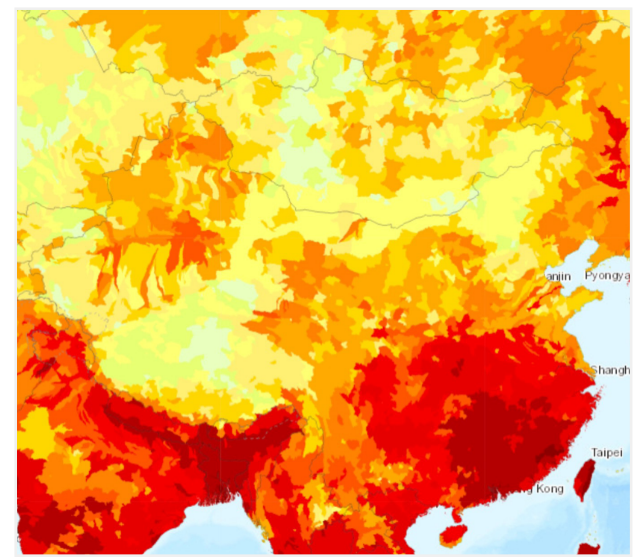
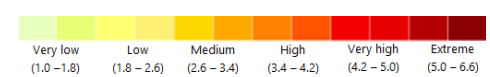


Figure 2: **Flood risk - Predicted 2050**





1 Source: Statista, "China: Urbanization from 2012 to 2022"

Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, AAFC, NRCan, Hirabayashi et al. (2013)

Country insights - China

Historical water quality issues persist in China and will be further exacerbated in 2050

Water quality analysis

Historically, China has experienced poor water quality due largely to exponential economic growth, limited regulations, and unchecked industrial discharge. In 2007, the OECD estimated that hundreds of millions of people drank contaminated water with arsenic, fluorine, chemicals, and landfill waste.[1]

In response, the Chinese government initiated a series of measures, including new water quality regulations, discharge limits, and the establishment of wastewater treatment plants. Between 2017 and 2024, the share of surface waters that are suitable for domestic use (or better) increased from 70% to 89.9%. Pollution, primarily nitrogen and phosphorus from both human activities and agriculture, remains a challenge.

Looking ahead to 2050, the areas with the highest population density, which also experience the most intense agricultural impact, are projected to see a near doubling of nitrogen from human activity and food production. Moreover, the Northeast is anticipated to face increased industrialization, which could exacerbate conditions.

Despite these challenges, China continues to take steps to improve the quality. In 2022, the standards for drinking water quality were revised to become more stringent on hygiene standards for water supply and inspection methods.[2] In 2024, new regulations on water conservation were implemented with quotas for crops, water-intensive technologies, industrial products, and services.

China: Water quality risk (Current & Predicted)

Figure 1: **Water quality risk - 2020**

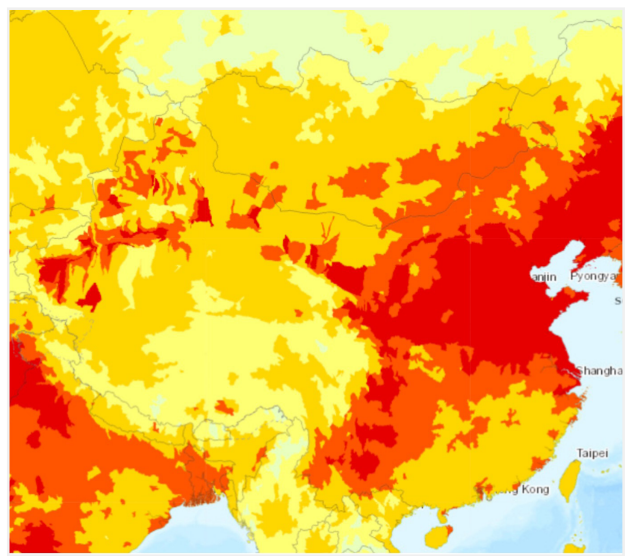
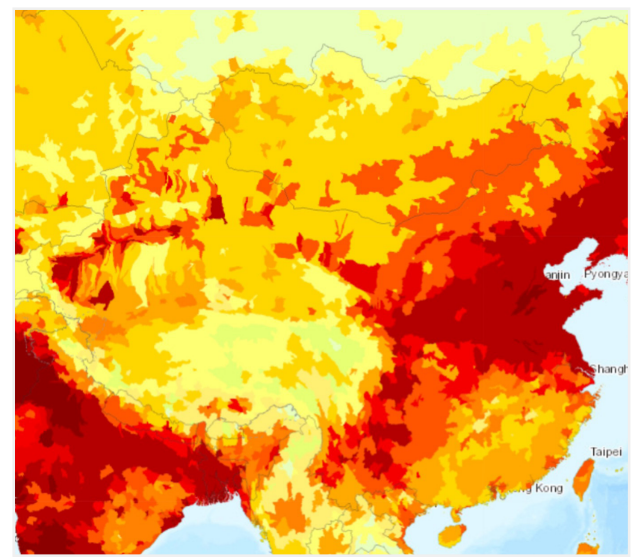
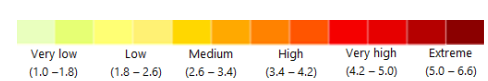


Figure 2: **Water quality risk - Predicted 2050**



1 Source: The World's Water, Vol. 7

2 Source: The Standards for Drinking Water Quality of China (2022 Edition) Will Take Effect[J]. China CDC Weekly, 2023, 5(13): 297-300. doi: 10.46234/ccdcw2023.054



Source: WWF Water Risk Filter, Leaflet | Powered by Esri | RJGC, Esri, HERE, Garmin, FAO, NOAA, EPA, AAFC, NRCan, Xie & Ringler (2017)

Notes

Risk visualization maps are sourced from the WWF Risk Filter Suite, as of May 2024.

*All visualizations of 2050 risk predictions (water scarcity risk, flooding risk and water quality risk) are indicative of conditions in a world similar to current socio-economic development trends and intermediate GHG emission levels, a pathway which will lead to an increase of global mean surface temperature of approximately 2°C by the end of the 21st century.

The visualizations of water scarcity in 2050 are derived from the Water Risk Filter water scarcity risk in the year 2020 (baseline), added with projected changes from the International Institute for Applied Systems Analysis (IIASA) Water program, and from the Water Scarcity Atlas' futures tool.

The visualizations of flooding risk in 2050 are derived from the Water Risk Filter flooding risk in the year 2020 (baseline), added with projected changes from the University of Tokyo.

The visualizations of water quality risk in 2050 are derived from the Water Risk Filter water quality risk in the year 2020 (baseline), added with projected changes from the International Food Policy Research Institute (IFPRI), covering nitrogen, phosphorus, and BOD loading.

Estimates by Aqueduct assumes 'business as usual' economic development and rising carbon emissions.

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