

Climate Change Overview: Impacts, Mitigation, and Adaptation in Iraq

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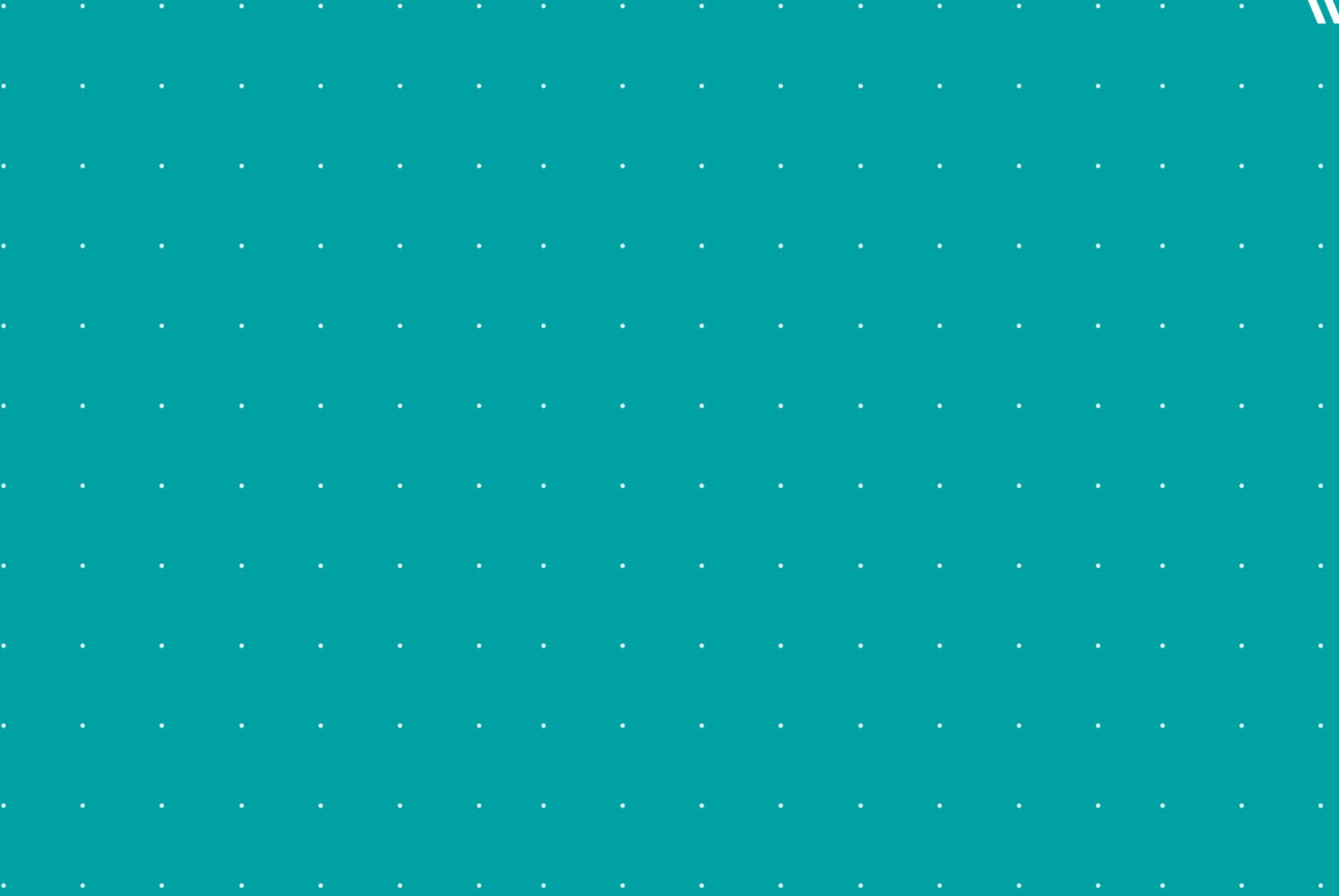
KAPITA's Research team deeply thanks and appreciates GIZ for being an outstanding enabler for us.

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Table of Contents

| | |
|---|----|
| Attribution | 2 |
| Executive Summary | 6 |
| Introduction | 8 |
| A Brief History of Iraq | 10 |
| Geography and Climate | 12 |
| Climate Change: Now and the Future | 14 |
| Major Climate Change Issues in Iraq | 16 |
| Desertification | 18 |
| Water Scarcity and Drought | 21 |
| Declining Precipitation | 26 |
| Extremely High Temperatures | 29 |
| Dust and Sand Storms | 32 |
| Soil Erosion and Salinization | 36 |
| Increased Energy Consumption | 38 |
| Nationally Determined Contributions of Iraq (NDC) | 42 |
| Energy Sector | 45 |
| Industrial Sector | 46 |
| Agricultural Sector | 47 |
| Waste Sector | 48 |
| Housing Sector | 48 |
| Green and Cleantech Startups | 50 |
| Conclusions | 53 |
| Recommendations | 54 |
| References | 55 |
| KAPITA Business Hub | 58 |
| Our Services | 59 |



Executive Summary

As global warming becomes more evident, Iraq is on the front row of the climate change show. Kapita's research team conducted a thorough analysis of Iraq's present climate scene, the major issues caused by and exacerbating the calamity, and the Iraqi government's efforts in the global battle against climate change.

The following is a summary of key findings from this report:

Introduction

- The Underlying Driver of Change.

Long periods of dry weather frequently induced migrations that brought about the evolution of the first human civilizations and provoked the collapse of others throughout Iraq's history.

- Scorching Summers.

Lasting from April to October, Iraq's summers are characterized by extremely high temperatures, which can reach up to 51 Celsius degrees, as well as low humidity and a lack of precipitation.

- Squeezed Population.

Due to the country's harsh climate, its 42 million inhabitants are concentrated in limited regions that provide them with food, water, and economic necessities.

- Grim Future.

According to several sources, Iraq will face a multitude of catastrophic climate anomalies by 2050. These include a 2 Celsius degree increase in mean annual temperature, a 9% decline in mean annual average rainfall, and a 22% decrease in runoff, threatening life as we know it in the country.

Major Climate Change Issues in Iraq

- Growing Desertification.

40 percent of Iraq's land is desert, this number will continue to grow with an annual loss of 100 square kilometers of arable land to desertification.

- Struggling Agriculture.

As cultivated land continues to dwindle and farmers abandon their properties, the country faces a decline in agriculture that falls well short of meeting public demand.

- Shrinking Waters.

Water resources continue to decline in levels as water insecurity threatens 7 million of the Iraqi population, with over 20,000 people displaced due to drought and drastic climate consequences.

- Rainfall Levels Below Average.

With precipitation falling 40% below normal levels in some regions of the country, the winter of 2020/2021 recorded the second lowest rainfall in four decades.

- Record-Breaking Rising Heat.

Temperature is soaring high to new extremities as degrees above 50°C are becoming more common with the country being reported to warm at least 2 times faster than the global average.

- Prevailing Dust and Sand Storms.

2022 saw some of the country's worst dust and sand storms in recent history, with dozens of people hospitalized and airports shut down.

Over the last two decades, the number of dusty days each year has increased from 243 to 272, and is expected to reach 300 by the year 2050.

- Expanding Salty Wastelands.

Spread of salinization in the central and southern regions is growing and contributing to a yearly 5% loss of used farmlands with an estimated damage of US\$ 300 million annually.

- More Energy Consumed, More Carbon Released.

The peak demand for electricity has recorded an increase of about 46% in recent years as the country tries to cope with the prolonged, extremely hot summers and is projected to further expand. The energy reliance on fossil fuels and the fall of hydro power generation intensified CO2 emissions by 194% between the last two decades.

Nationally Determined Contributions of Iraq (NDC)

- Joining the Paris Agreement.

Iraq ratified the Paris Agreement in October 2021 with the submission of its first NDC, laying the foundations for the country's efforts to mitigate climate change.

- A Green Revolution.

Iraq's government is committed to reforming numerous sectors (industrial, agricultural, etc.) in order to meet its goal of a 1-2% decrease in total greenhouse gas emissions by the year 2030.

- Top Contributor of GHG.

The energy sector is the primary source of greenhouse gas emissions in Iraq, accounting for 75% of total emissions. As a result, the Iraqi government has prioritized this sector in order to address the issue and develop more environmentally friendly energy sources.



yaz00ne alani
Iraqi photographer

Introduction



NASA

<https://unsplash.com/photos/whDrFMucHkc>

A Brief History of Iraq

Throughout time, the land of Mesopotamia was known for having a predominantly hot climate. Taking a look into the components of the Lower Mesopotamian environment, consisting of deserts, foothills, steppes, and marshes, they all share a common aspect: a lack of precipitation in the summer. The weather, in general, was characterized by hot, dry summers and mild, dry winters in deserts and steppe areas, while foothills had mild winters and dry, warm summers (S. Iqbal, 2017).

In Northern Mesopotamia and for the past 1000 years, communities have exploited the arable land for agriculture, benefiting from the natural rainfall. However, dating back to 6400 B.C., climate change played a key role in the cradle of civilization as a mass migration is seen to have taken place from the more moderate northern area to the arid southern region of ancient Mesopotamia.

This could be attributed to severe climate effects where drought and immense cooling urged people to move towards warmth in the south.

The yearly flood cycle of the Tigris and Euphrates rivers in the spring fertilized land with mineral-rich silt that was a key factor for

flourishing agriculture. The Mesopotamians controlled the floods by establishing irrigation canals, drainage ditches, and water reservoirs. This yielded double the production of rain-fed agriculture, which brought about the first class-based society and the first cities (Geotimes, 2004).

Climate has been creating a notable influence on the development and collapse of human civilizations.

Researchers have recorded dust activity between 5,200 and 3,700 years ago and identified a 300 year long major drought around 2200 B.C. that have greatly influenced the collapse of Akkadia, the world's first empire established in Mesopotamia (S. A. Carolin et al., 2018).

Similarly, the Neo-Assyrian empire might have seen a mega drought that deteriorated agriculture and economy, producing conflicts that led to the fall of Nineveh in 612 B.C. while the complete collapse took place by the end of the seventh century. The data suggests a strong relation between decreased rainfall-increased dust, deteriorated rain-fed agriculture, and population abandonment, possibly resulting in migration to new areas (A. Sinha et al., 2019).

As time progressed to more recent periods, researchers were able to construct climate history in a far more detailed approach. Keeping in mind the re-occurrence of drought in this hot nature, it was shocking to find evidence of extreme cold climate in Iraq during the Islamic Golden Age between 816-1009 AD, including snowfalls and hailstorms.

Remarkably, chilling weather periods were identified as: five in winter, two in spring, one in summer in addition to two cold periods that remained for a year. Rare conditions of snow falls in 908 and 944 were reported (F. Domínguez-Castro et al., 2012).

Furthermore, the same study reported that in December 926, the canals of river Tigris in Baghdad were frozen with severely low temperatures while the whole river turned to ice at Mosul to an extent that inhabitants could sit and cross over it.

Another remarkable incident of thick snowfall occurred in November 1007, covering Baghdad for a week. The snow was also reported in Tikrit, Wasit, Kufa, and Basrah.

Fast forward to the modern period in Iraq and since 1950 (Ministry of Foreign Affairs of the Netherlands, 2018):

- A rise of approximately 0.7°C per century was recorded in annual mean temperature.
- The demolition of palm trees during the Iraq-Iran war in the 1980s and destruction of the marshlands in early 1990 led to disappearance of about 90% of the marshes by 2001, 58% were revived by 2006, while 50% of the palms have been lost since 1980, all of which promoted the declining of biodiversity (International Committee of the Red Cross [ICRC], 2021, KAPITA, 2020).
- An overall drop in precipitation rates (ranging from 1.3 to 6.2 mm/year) has influenced the reduction in levels of main water resources such as rivers and groundwaters, especially in desert areas, in addition to springs and aquifers. Consequently, two severe periods of 1998-1999 and 2007-2008 were recorded which covered around 87% and 82% of the country, respectively (M. Hameed et al., 2018). The rainfall drop has also affected the annual rate of dust storms that has rigorously increased from having a maximum of 24 days/year for the period 1951-1990 to having around 300 dust activities in 2013. This increase in dustiness is related to other environmental factors as well: drying of the marshes, land degradation, and desertification. The advancements and conflicts that Iraq has gone through have not only touched the population's lives but the climate they live in as well, where pollution and impact can be vividly seen accumulating over the years.



Geography and Climate

Located in southwest Asia, the Republic of Iraq is bounded on the north by Turkey; on the east by Iran; on the west by Jordan and Syria; and on the south by Saudi Arabia and Kuwait.

Topographically, the country is divided into four geographical regions: mountains to the north and northeast (1); a northern upland region between the Tigris and Euphrates rivers (2); central and southeastern Iraq's Tigris-Euphrates alluvial lowlands (3); and the desert to the west and south (4).

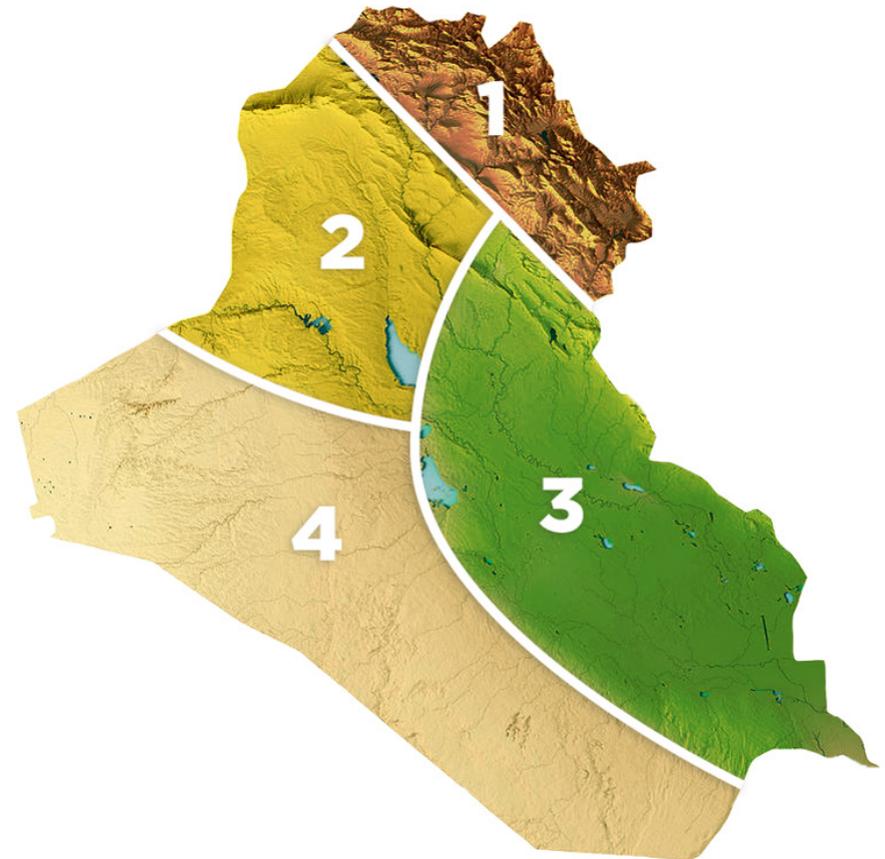
Iraq has a predominantly continental and subtropical semi-arid climate, with the exception of the northern and northeastern mountainous regions, which have a Mediterranean climate.

Summer and winter, with brief transitional times in between, are the two major seasons in the country with noteworthy weather conditions. Summer, which lasts from late April to October, is defined by clear skies, exceptionally high temperatures, low relative humidity, and no precipitation.

During the season, temperatures range between 35 and 51 degrees Celsius throughout the country. Winters, on the other hand, are mild to cold. They last from November to March and can be anywhere between 2 and 15 degrees Celsius.

Rainfall in Iraq is seasonal, falling largely between December and February for the bulk of the country, except for the north and northeast regions, where the rainy season lasts from November to early April (Climate Change Knowledge Portal, 2022).

Geographical Regions





Climate Change: Now and the Future

In recent years, global climate change has become an established truth that cannot be argued against any longer. Iraq, in particular, is experiencing the full spectrum of climate change's effects, all the more so given the country's fragile state and dilapidated infrastructure.

What was formerly regarded as the Middle East's breadbasket and part of the Fertile Crescent. Iraq has long since departed from that standard. Across the nation, climate change is increasing temperatures, decreasing rainfall, accelerating desertification, causing intense sand storms, depleting water resources, weakening agriculture, and wreaking havoc on the economy.

Iraq's 42 million people are concentrated in a few locations within the country due to the harsh climate. These conditions have led to a direct impact on the lives of the people and their economic, water, and food security.

According to the Climate Change Knowledge Portal and USAID, the following are the climate change projections for Iraq if no immediate measures to mitigate the crisis are taken:

- By 2050, the mean annual temperature will have risen by 2°C.
- By 2050, mean annual average rainfall is expected to decrease by 9%, with the greatest decrease of 17% expected in December, January, and February.
- Increased frequency of heat waves and decreased number of frost days.
- A decrease in the maximum amount of rain that may fall in any 5-day period, but an overall increase in rainfall intensity.
- An average 22% decrease in runoff across the nation.





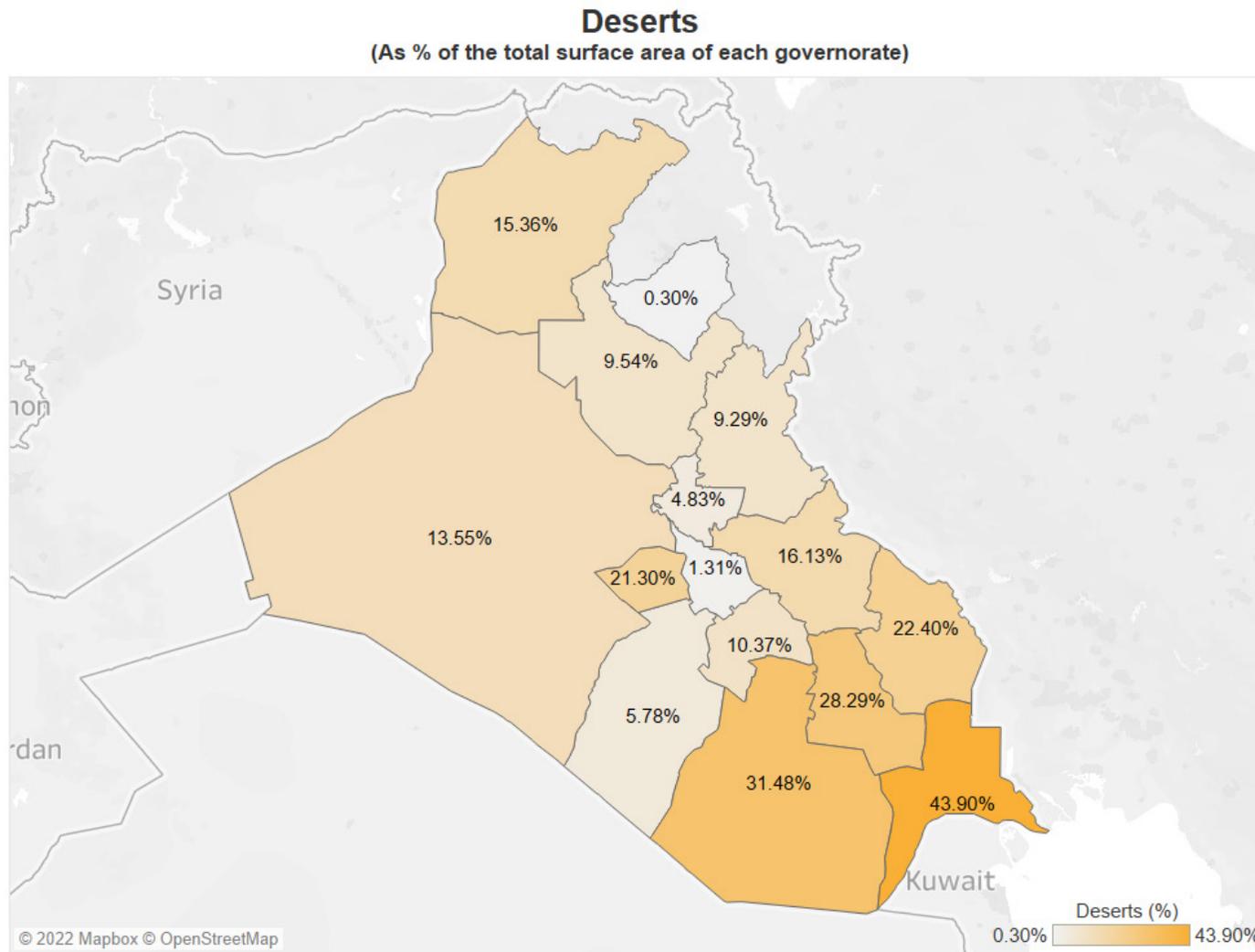
Major Climate Change Issues in Iraq



Photo by ASAAD NIAZI/AFP via Getty Images

Desertification

The United Nations Convention to Combat Desertification, held in 1994, defines desertification as “land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities.”



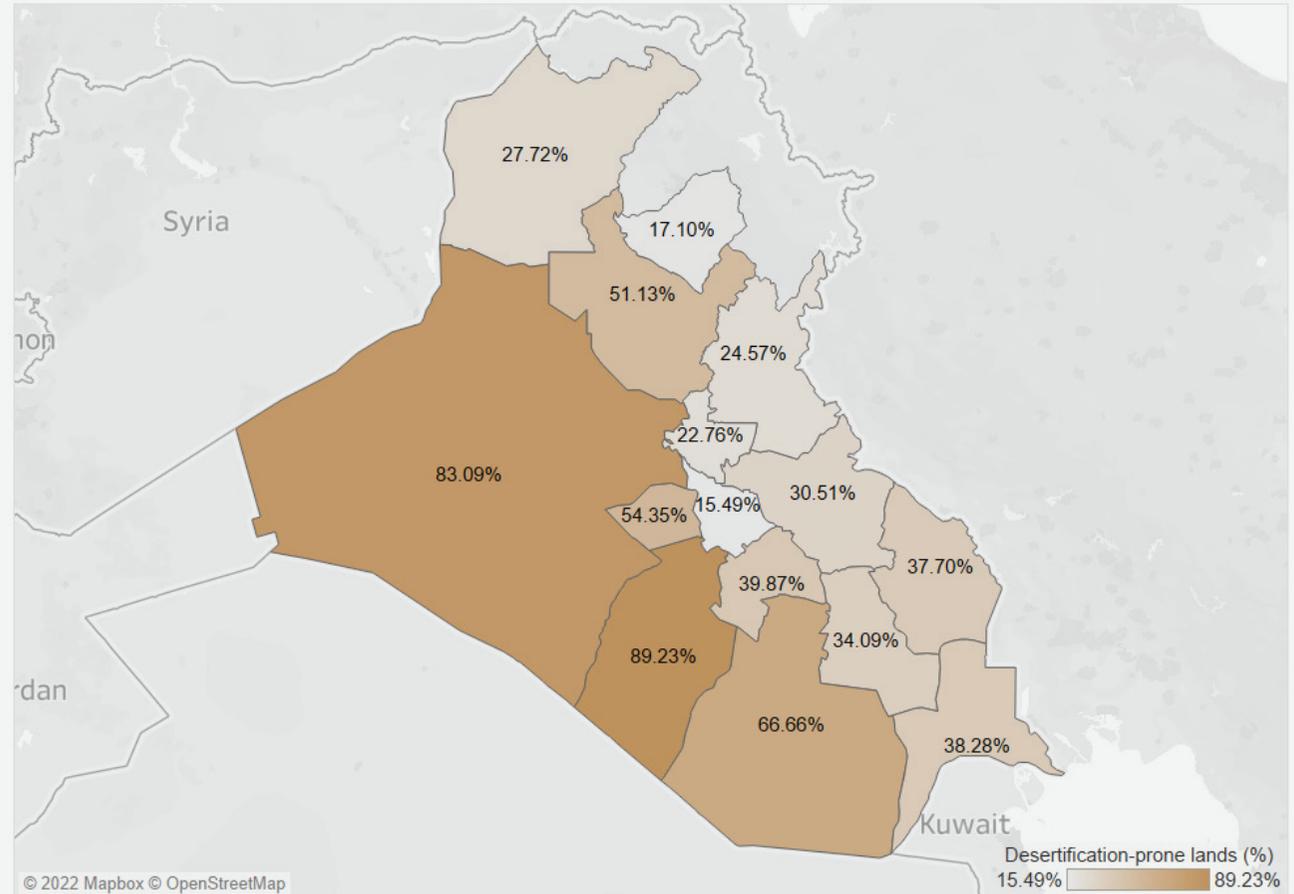
Source: COSIT, 2021. Copyrights: KAPITA Business Hub, 2022

The desertification of Iraq is caused by a range of factors. Climate elements contributing to the problem include, but are not limited to, high temperatures, water scarcity, and erosion of soil.

The issue is further exacerbated by human-induced factors such as population growth, which increases the depletion of natural resources; unregulated tree felling playing a major role in deforestation, poor water management, and inefficient farming practices.

The sum of these variables has brought the country to the brink of agricultural collapse. With an annual loss of 100 square kilometers of arable land due to desertification and more than 40% of the country already a desert, the agricultural sector is clearly declining and continues to do so (Ministry of Agriculture, 2017). Between 1970 and 2010, estimated cultivated lands decreased from 12.2% to 8.3% of the country's total area (Al-Saidi et al., 2021).

Desertification-prone Lands
(As % of the total surface area of each governorate)



Source: COSIT, 2021. Copyrights: KAPITA Business Hub, 2022

Furthermore, the growing population and subsequent urban expansion have had their toll on agricultural lands. According to the World Bank Group (2022), the Iraqi population skyrocketed from 7 million in 1960 to 40 million in 2020.

This massive increase in population is accompanied by an increase in demand for crops and foods, which the agricultural sector is struggling to meet. The economic difficulties associated with the desertification phenomenon manifest themselves in a variety of ways. First and foremost, a decrease in the output of agricultural produce, which will result in the migration of small-scale farmers from their dried-up farms to urban centers.

As a result, the local population would be forced to compete for limited resources and employment opportunities. Additionally, desertification has a negative impact on irrigation and poses a threat to biodiversity, natural ecosystems, and livestock populations. To illustrate the gravity of the situation, between 1990 and 2010, an estimated 6,000 plant species were wiped out due to desertification (Al-Saidi et al., 2021). Finally, the cost of repairing these deteriorated lands can place a significant financial strain on the government.

Depending on the extent of the damage, slightly deteriorated river-irrigated lands can be recovered for anywhere between US\$100-300 per hectare. Lands that have been severely damaged, however, can cost up to US\$ 5,000 per hectare to correct (Planetary Security Initiative, 2021).



Water Scarcity and Drought

A shortage in water supply and water security in general is an imminent problem that is facing the entire human population worldwide. Iraq, in specific, is no stranger to the re-occurrence of drought periods throughout its history.

However, as depicted earlier, increased changes in the climate in terms of rising heat and significantly reduced rainfall are likely to result in a more frequent trend of those extreme events.

Furthermore, the poor management of water resources, reduced volumes of water flowing into the Tigris and Euphrates rivers from origin countries, increased population demand, inefficient water consumption in the oil and agriculture sectors, and conflicts, all contribute to the water insecurity which threatens at least 7 million of the total Iraqi population.

Comprising 98% of Iraq's water supply, the Euphrates and Tigris rivers have lost 30% of their flow in reference to the 1980s and it

is further projected to decline to 50% by 2030 (T. von Lossow, 2018).

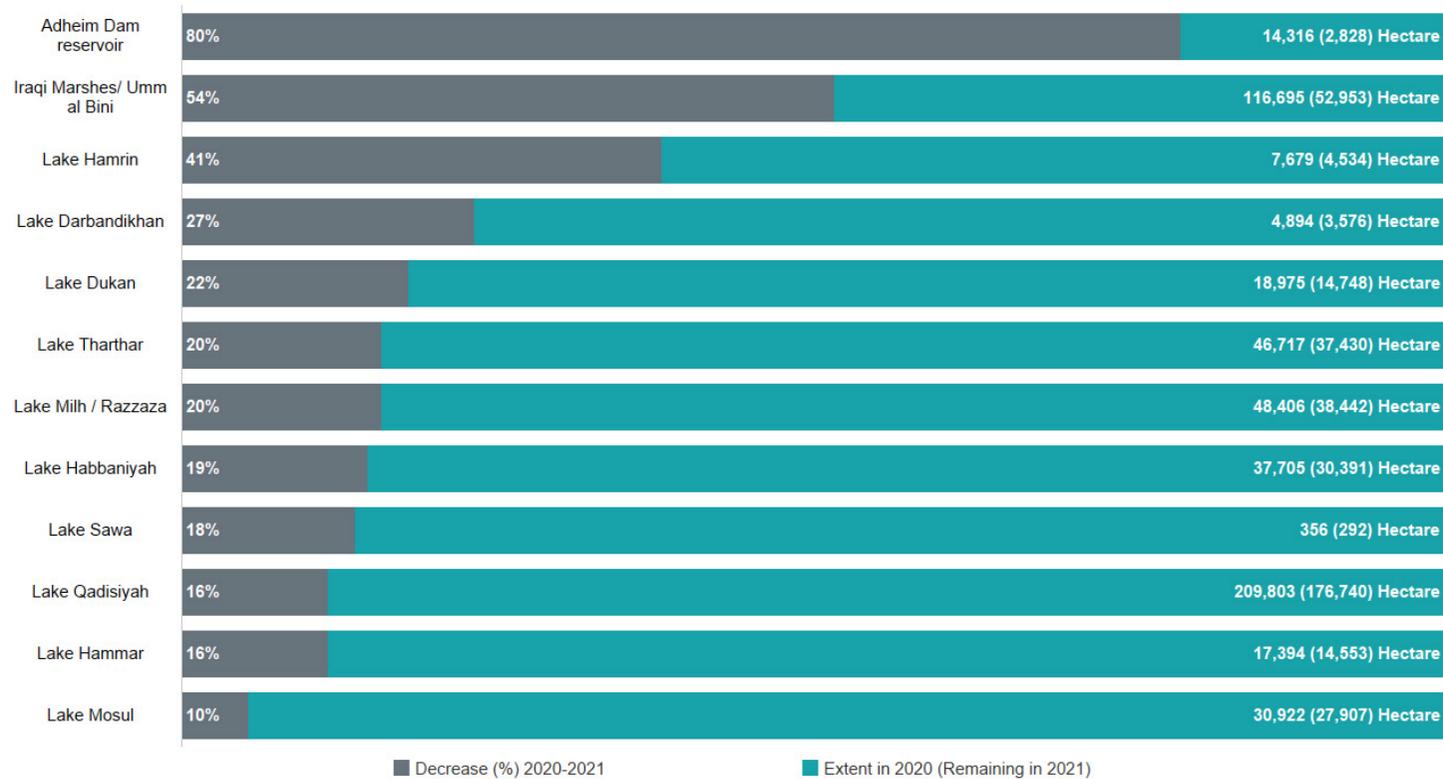
The 2020-2021 rainfall season was the second driest in the last 40 years, causing a reduction in water flow in Tigris and Euphrates by 29% and 73%, respectively (UNICEF, 2021).

A new analysis of water levels in 12 major lakes and water reservoirs for a one-year time span (September 2020-2021) has shown a notable decrease within just one year. A striking reduction in water surface area of 80% took place in the Adheim Dam, being left with 2,828 hectares by the end of September 2021.

Other significant decreases are the Hamrin Lake, Iraqi Marshes, Lake Dukan, and Lake Darbandikhan (PAX, 2021). Bearing in mind that Iraq operates hydro power plants on its dams, the influence of this decline could be significant to the power generation used to support electricity needs (P. Pilesjo & S. S. Al-Juboori, 2016).



Surface Water Loss 2020-2021



Source: PAX, 2021. Copyrights: KAPITA Business Hub, 2022

Moreover, this water reduction is increasingly damaging agriculture and its farmers, especially since around 75% of the population in agricultural areas work in crop production, mainly wheat and barley (Kapita, 2020). In Nineveh, it is expected that production of wheat will decrease by 70%, and by 50% in the Kurdistan Region of Iraq. A recent assessment addressing the impact of drought on crop production for the season 2020–2021 has identified a 37% wheat crop failure and a 30% failure for barley production. Furthermore, about 37% of farmers reported livestock losses attributed to lack of water, food, or diseases. Consequently, monthly income fell below acceptable rates in six governorates, with one in five families suffering from food insufficiency (The Norwegian Refugee Council [NRC], 2021a, 2021b).

This life hardship imposed by drought, which has caused farmers to lose work, has consequently promoted displacement. In March, the International Organization for Migration (IOM, 2022) reported an update that 3,358 families (20,148 individuals) are displaced because of water scarcity and other climate effects in southern and central provinces with 64% of displacements (2,152 families) being intra-district.

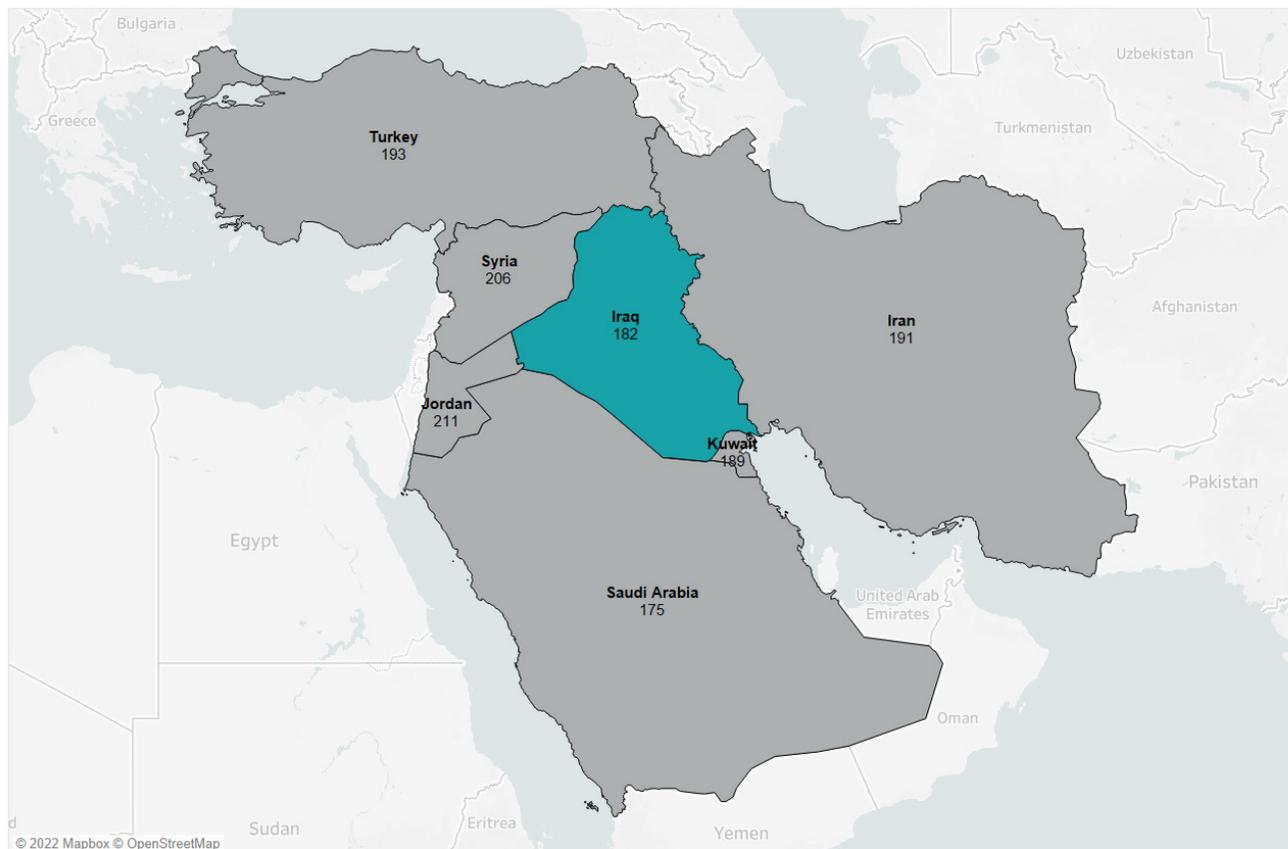
The families relocated to 128 sites, of which 74% are urban. Notably, Diyala Province recorded drought-induced displacement for the first time with 115 families. 25 families in Wasit had to relocate because of a tribal dispute over water access.

This is another aspect of the drought issue which displays its extent as an igniting cause for many societal conflicts, possibly armed and fatal, in the south (Planetary Security Initiative, 2020). The fall in precipitation rates and the resulting drought have also impacted the returnees in Ninawa province, mainly in southern rural areas with 303 families (1,818 individuals) being displaced (IOM, 2021).

The effect of climate change felt by neighboring countries, left its impact on Iraq as well. According to Water Risk Filter (WWF, 2021), Iraq has a relatively high risk of water scarcity as it ranks 182 out of 251 countries world-wide. Not very far away are Iran and Turkey, ranking 191 and 193 respectively.

Country Risk Profile Water Scarcity

* Higher ranks indicate higher risk



Source: World Risk Filter, 2021. Copyrights: KAPITA Business Hub, 2022

Therefore, this risk is likely to increase in Iraq as both countries are trying to combat the scarcity effect by managing the flow of the Euphrates and Tigris rivers.

Turkey is conserving water in its dams and recently completed the greatly threatening Ilisu dam, the largest hydropower project in the country. Similarly, Iran's dams on the Tigris upstream have also reduced water levels in its Iraqi tributaries, subjecting the flow to cutoffs at the Diyala river and reductions at the Lower Zaab river by 70% (The National, 2021).

The government has not yet found solid solutions to this problem, as well as to the broader issue of water resources mismanagement combined with drought.

To stress the catastrophic impact of climate change, it is important to note that Lake Sawa, also known as the Pearl of the South and situated in the city of Samawa in Iraq, has completely dried up in recent days.

The geological and environmental significance of Lake Sawa in Iraq's natural landscape made it a popular tourist attraction for decades. However, the once-mesmerizing lake, thousands of years old, is now nothing more than a wasteland (The New Arab, 2022).



Deserted hotels that once served tourists of Lake Sawa. April 26, 2022. Asaad Niazi, AFP.



Lake Sawa. April 24, 2022. European Union, Copernicus.

Declining Precipitation

Rain is a critical component of the climate that influences the Earth's biosphere. Therefore, fluctuations in the amount of precipitation can have drastic effects on the ecosystem and numerous aspects of life. Iraq, one of the world's most climate-vulnerable countries, is on the verge of a full-fledged calamity. The decrease in precipitation and the resulting harm to the ecosystem contributed considerably to Iraq's realization of this conclusion.

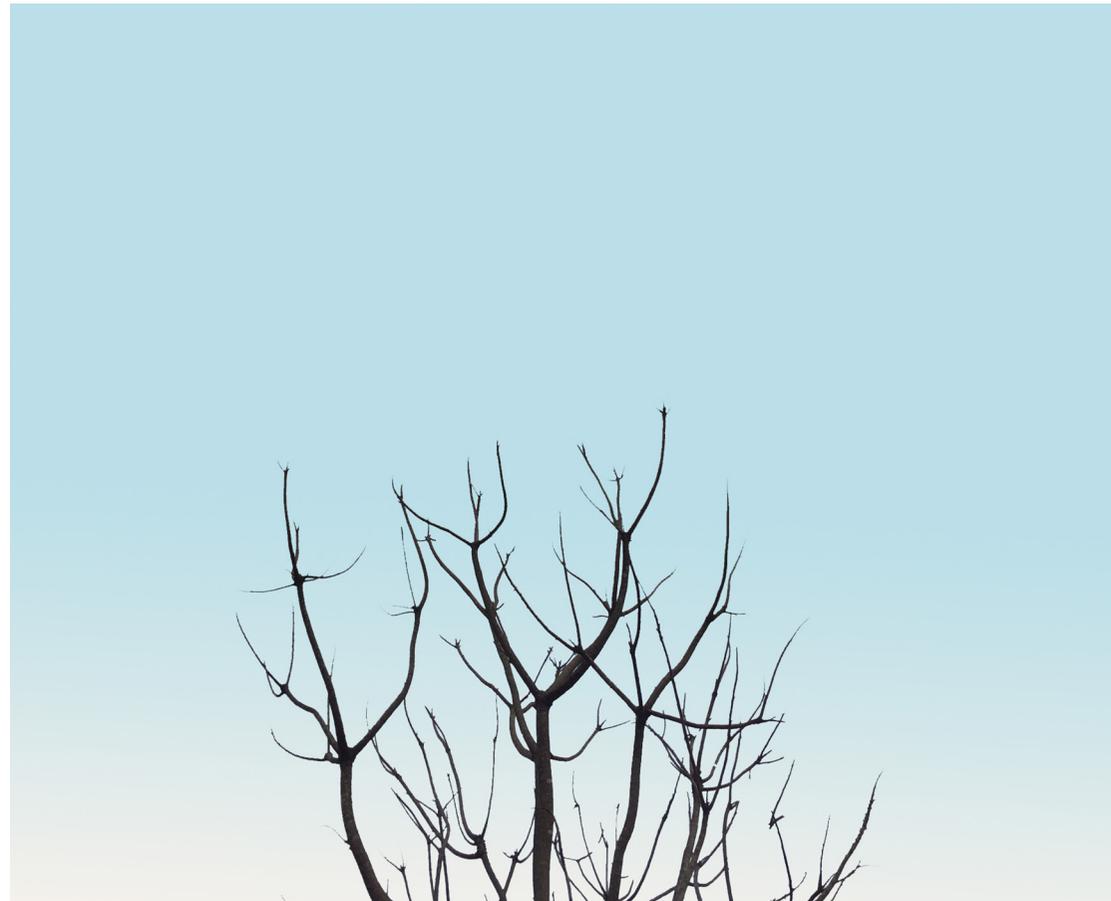
Iraq's precipitation is highly variable seasonally and regionally. The north and north-east receive the greatest rainfall, with between 400 and 1,000 millimeters per year, mainly starting in November and ending in March, while the steppe receives an annual average of 200 to 400 millimeters. The south of the country receives only between 40 and 60 millimeters of precipitation, primarily from October to December (NUPI, 2022).

The winter season of 2020–2021 has been marked as the second-lowest record in four decades by below-average rainfall, notably in Iraq's northern governorates (WFP, 2021). Such weather prevailed throughout the country from November 2020 to January 2021. Between February and April 2021, precipitation was above-average levels in the country's central regions, particularly the Diyala and Wasit governorates.

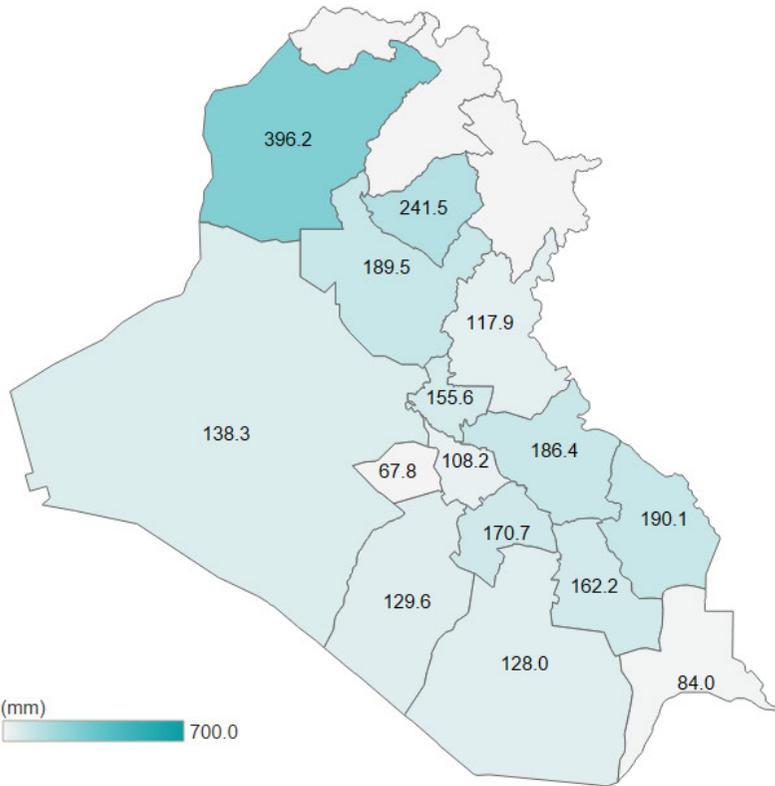
The northern regions of the country, on the other hand, experienced below-normal precipitation, especially in the governorates of Nineveh, Duhok, and Erbil. This was detrimental to their communities since they rely significantly on rainwater to cultivate agriculture (FAO et al., 2021).

Reflecting these tendencies, the seasonal overview from November 2020 to April 2021 shows rainfall below normal in the country's northern regions; Nineveh, Duhok, western Erbil, western Kirkuk, and northern Salah al-Din. Precipitation was up to 40% below average.

This has almost certainly resulted in decreased planted area, crop failures, and a damaging effect on the production of wheat and barley, the two major rainfed winter crops. Estimates show a decline of 70% in the production of wheat, while barley cultivation is almost completely diminished in Nineveh (FAO et al., 2021).



Total Rainfall by Governorate
Year:2020



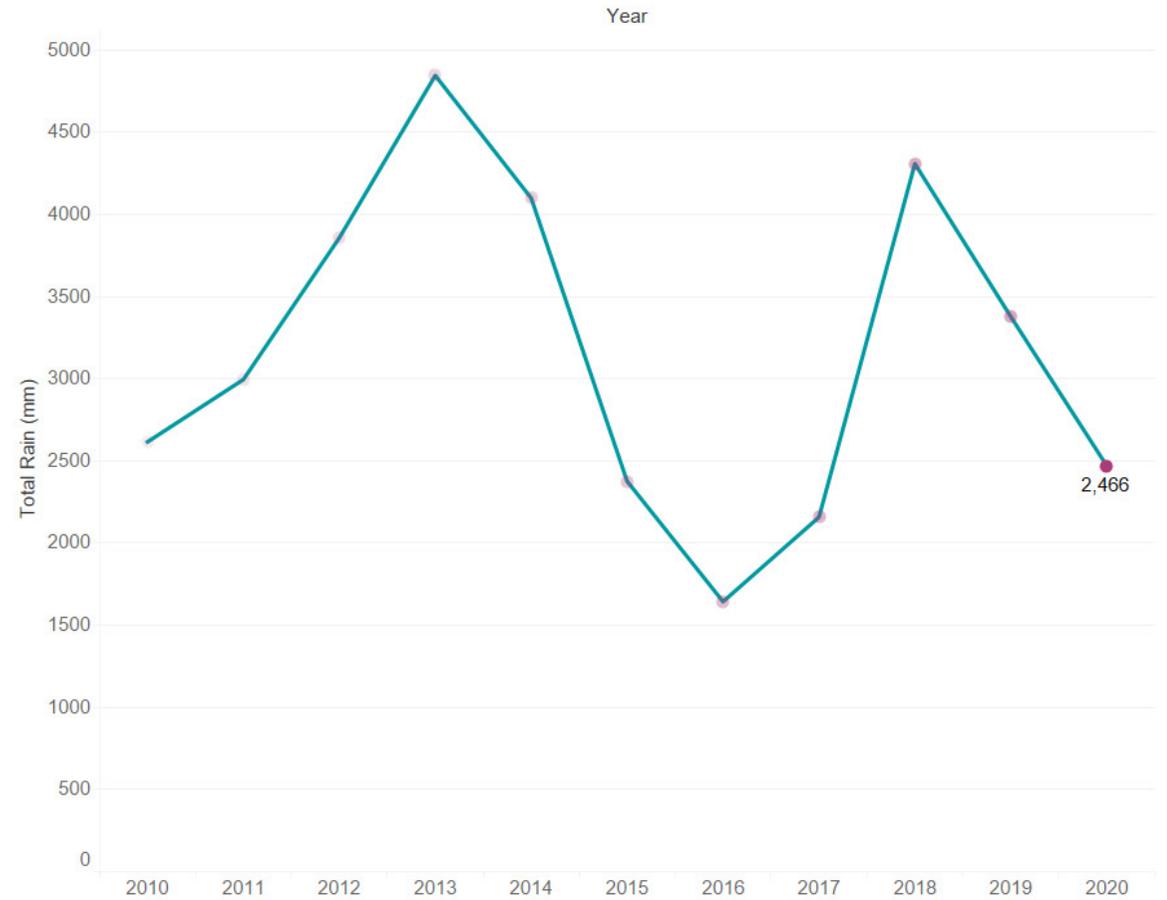
Rain (mm)
80.0 700.0

© 2022 Mapbox © OpenStreetMap

Source: COSIT, 2021. Copyrights: KAPITA Business Hub, 2022

Year of Y..2020

Total Rainfall in Iraq



Show history

This data is reinforced by the conclusions of several analytical studies, which indicate that the Kurdistan Region and northern cities exhibited a higher precipitation deficit than the center and southern regions of Iraq.

The severe precipitation shortfall in these areas, along with rising temperatures and a scarcity of water from neighboring countries, will naturally have a negative effect on surface water levels. This is predicted to restrict people's access to water, forcing them to increasingly rely on groundwater, particularly during seasons with lower average precipitation, such as summer and autumn. Increased groundwater consumption may exacerbate a water problem, especially if groundwater reservoirs are not refilled.

This trajectory can have destructive effects on agriculture, limiting access to livelihoods, and increasing

food poverty (Reach Initiative, 2021).

In regards to future precipitation projections in Iraq, multiple simulation models predict that if no measures to address this issue are taken, annual rainfall levels in various locations of Iraq may diminish. By 2050, mean annual rainfall is anticipated to decline by 9%, as is the number of rainy days (NUPI, 2022).

This would exacerbate ongoing climatic issues such as sandstorms, water scarcity, and soil erosion. These obstacles are expected to have a significant effect on the health of the Iraqi people as well as the agricultural and industrial sectors, which account for a sizable portion of the country's GDP (UNEP, 2020).

Extremely High Temperatures

Global Warming is an outcome resulting from accumulation of carbon dioxide and other air pollutants, known as “greenhouse gases”, in the atmosphere for years or centuries where they absorb solar light and radiation that have reflected off earth.

As they trap heat from dissipating into space, the planet’s temperature gets hotter (The Natural Resources Defense Council [NRDC],

2021). During the last century in Iraq, the advancements in consumption of fossil fuels have further triggered this phenomenon. From the first glance at the figure, a gradual shift is predominantly marked in the monthly temperatures from reduced cooling to increased heating, especially in the past three decades (World Bank Group, 2022).

Mean Change in Monthly Temperature



Change in: -2.00 2.00

Source: World Bank, 2022. Copyrights: KAPITA Business Hub, 2022

A long-term warmth tendency has unveiled an increase in minimum temperature (0.48–1.17 °C/decade) larger than that of maximum temperature (0.25–1.01 °C/decade) with the temperature rise being (2–7) times faster than that increasing globally.

Accordingly, the number of warm nights is growing at a rate of 2.92–10.69 days/decade, accompanied by a decreasing pattern of (2.65 to – 8.40 days/decade) on cold days at some stations (S. A. Salman, 2017). This supports the climate data analysis which has shown that the country's temperature has increased by 2.3°C since the close of the 19th century (1880–1899), double the globe's heat change for the same time span (The Washington Post, 2020).

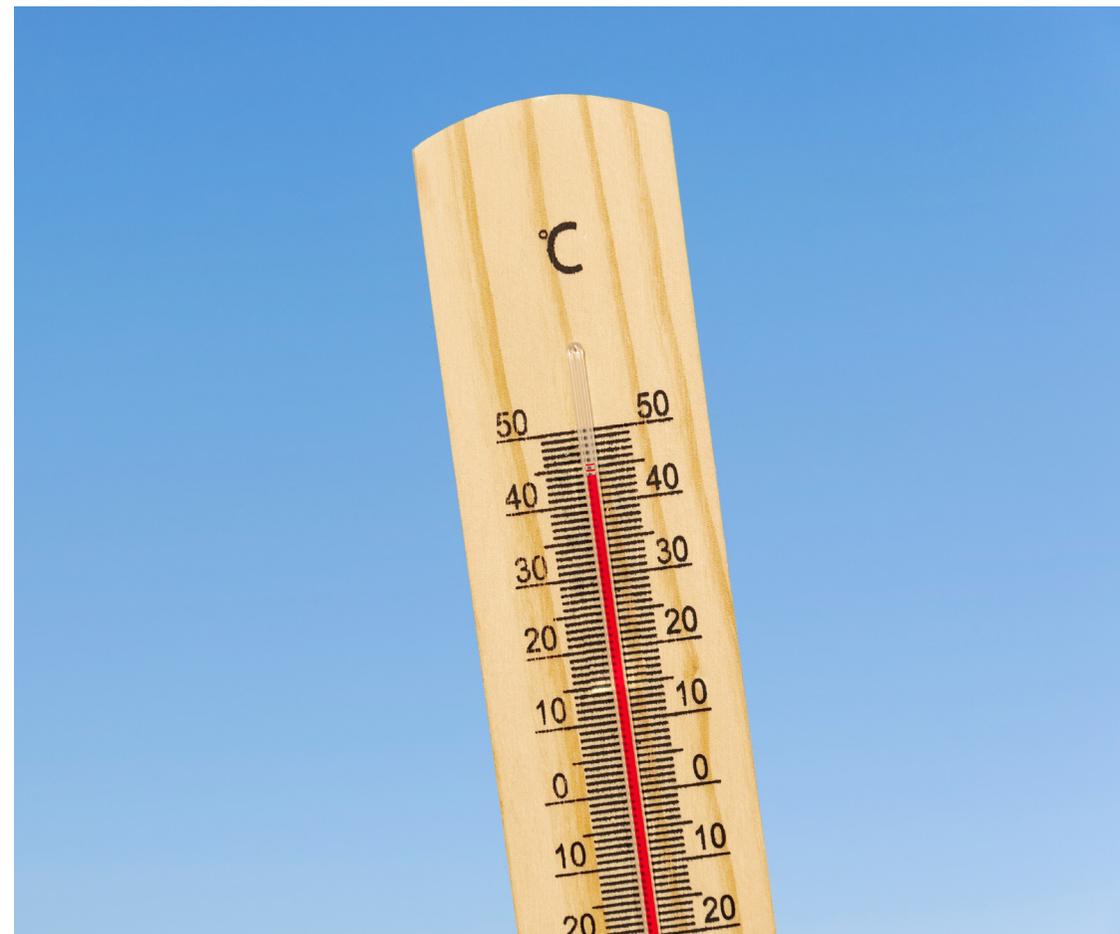
Consequently and in recent years, the temperature is either breaking records or coming very close to it, as the temperature soars above 50°C. Basra province, in 2016, broke the record for the hottest temperature in Iraq with 53.8°C. In 2020, Baghdad experienced a 51.8°C breaking its former highest temperature record of 51°C set in 2015 (The Weather Network, 2020).

This is in line with the fact that 2016 and 2020 are the warmest years recorded globally (NASA, 2021). What is more important than records is the prevalent long-term warming trend with an increasing frequency of extreme temperatures that is becoming a routine. Unless global emissions are reduced, the Middle East, including Iraq, is set to experience 121 days per year of extreme heat by the end of the century, making certain areas in Iraq uninhabitable, which reveals the great threat heat is imposing to existence within the country (Foreign Policy, 2021).

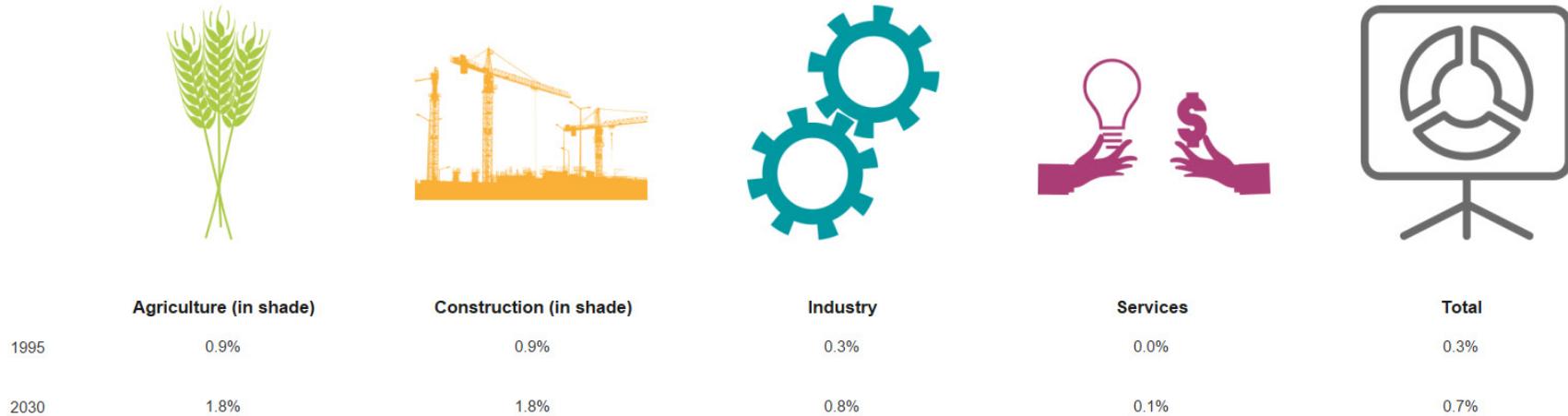
Relatively, the government declared its first ever heat holiday back in 2011 and advised citizens to stay at home, a matter that has become more frequent throughout the last decade, displaying the extent of this extreme heat in shutting down the entire public sector (The Washington Post, 2011; NPR, 2022).

On the other hand, workers in the private sector with outdoor jobs as in agriculture, construction, Industry, services, transport, and tourism are at higher risk of health issues and lower productivity which negatively affects their daily or monthly income.

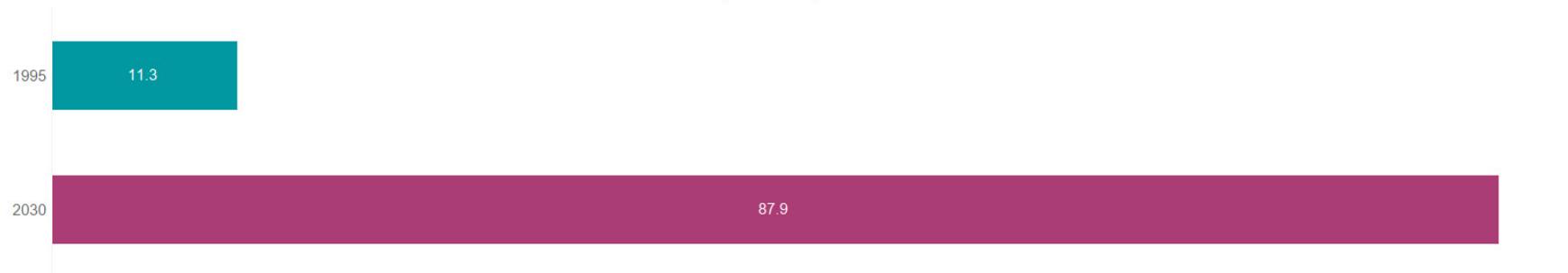
This specific effect on certain sectors is portrayed in the figure with a comparison in the working hours lost due to heat stress for the year 1995 and the projected loss for 2030. It also shows the lost hours percentage for the economy as a whole and the equivalent loss in terms of full-time jobs. The main affected workers are expected to be in the agriculture and construction sectors where the percentage of hours lost has doubled to 1.8% (International Labor Organization [ILO], 2019).



Working Hours Lost to Heat Stress



Equivalent Loss in Terms of Full-time Jobs (Thousands)



Source: ILO Estimates, 2019. Copyrights: KAPITA Business Hub, 2022

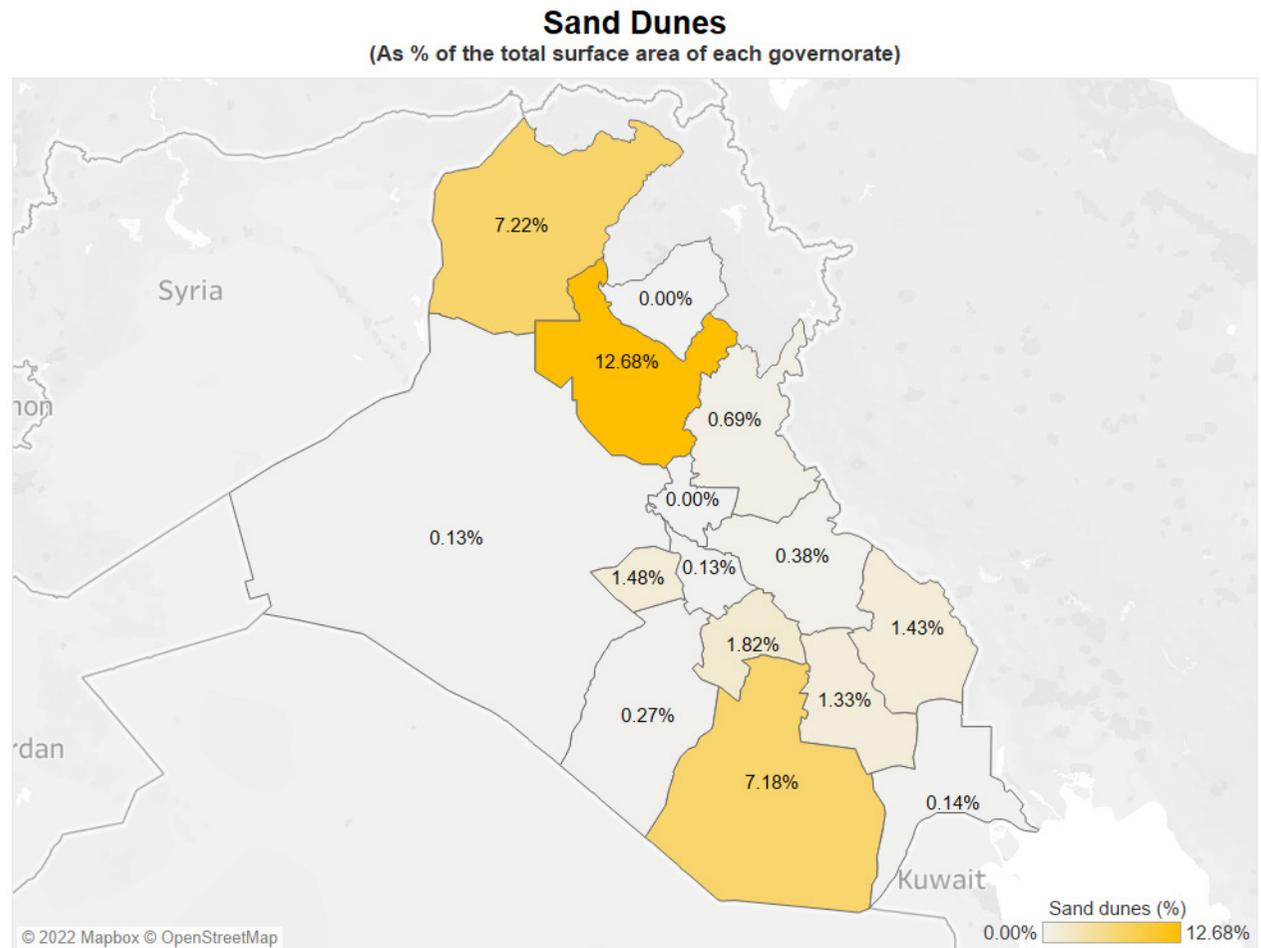
Aside from labor, the rising heat accompanied with low precipitation accounts for the reservoirs' water evaporation that decreases the country's water supply by more than 10% yearly. It is also considered as the main driver to many climatic and environmental problems that are expected to have a greater impact in the future as temperatures escalate to higher extremities (Save the Tigris, 2021).

Dust and Sand Storms

The formation of dust storms occurs when strong winds blow over soils that are loose and bare, lifting massive quantities of sand and dust into the atmosphere (WMO, 2022).

For the Iraqi people, sandstorms are nothing out of the ordinary. Due to the country's desert environment, it frequently encounters sandstorms, particularly during the summer and spring seasons.

These storms are whipped up by a northwest wind known as the "Shimali," which can blast through the country's sand dunes at any given time. Shimali winds can persist for several days in succession, intensifying during the day and waning at night, resulting in disastrous dust storms (Sissakian et al., 2013).



Source: COSIT, 2021. Copyrights: KAPITA Business Hub, 2022

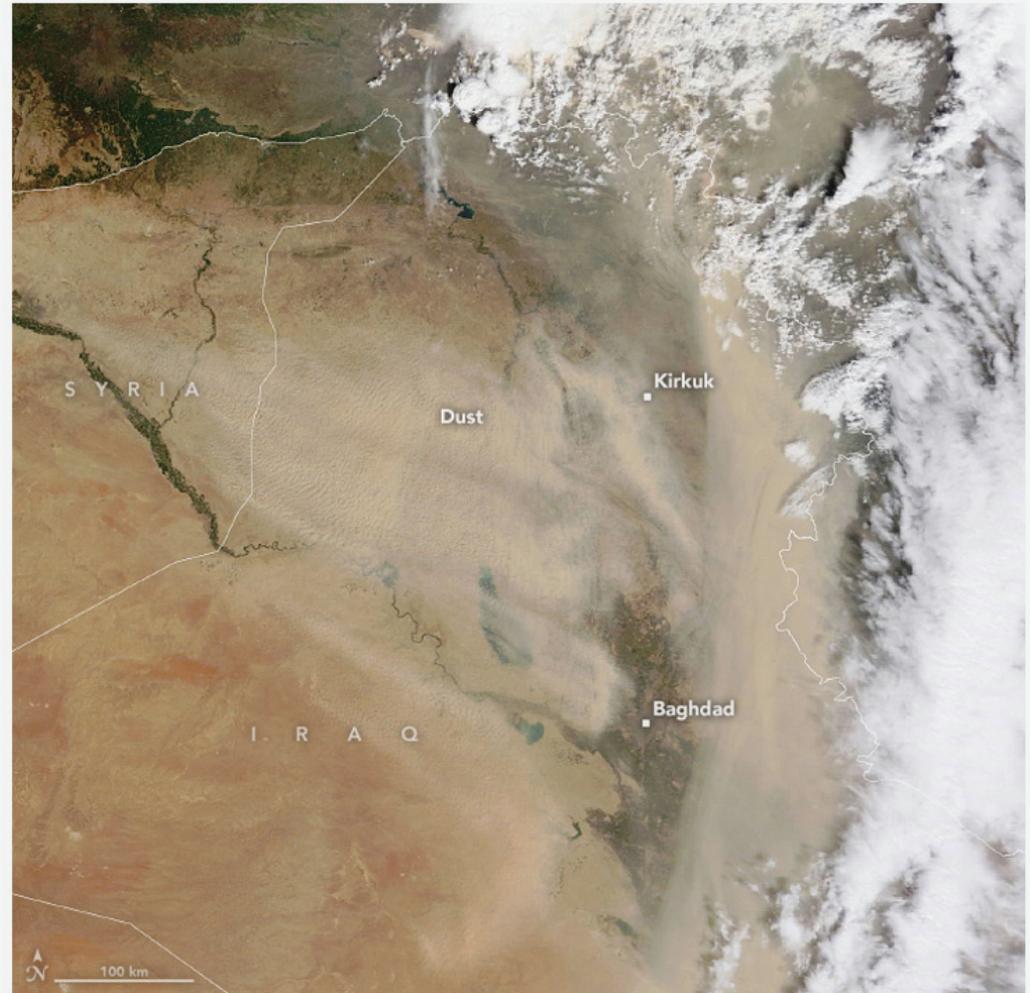


In recent years, however, Iraq has seen an alarming increase in the number of sandstorms. This is attributable to dramatic swings in annual rainfall, increasing temperatures, poor water management, and the abandonment of agricultural fields. These dust storms can pose all sorts of threats to human health, transportation, and agriculture, as well as the country's economy.

In 2022, the surge of prolonged dust storms in Iraq led to a variety of complications. Numerous hospitalization cases were recorded throughout the country as a result of dust-induced respiratory illnesses (The Guardian, 2022).

The airports of Baghdad, Erbil, Sulaimani, and Najaf temporarily halted all flights during April due to poor visibility, which poses a danger when aircrafts land and take off (Rudaw, 2022).

Dust Storm



Source: NASA Earth Observatory Images, April 9, 2022.

The Director-General of the Iraqi Ministry of Health and Environment states that the number of dusty days each year has climbed from 243 to 272 over the last two decades and is predicted to reach 300 by the year 2050. Additionally, he elaborates that the primary reasons for the delay in implementing the green belts around cities to protect against these storms are a lack of financial resources as well as a lack of water resources to provide for these vast areas due to the country's water scarcity over the last decade (INA, 2022).

This issue is further exacerbated by man-made factors such as the indiscriminate use of groundwater and the paucity of water in the Tigris and Euphrates rivers due to the construction of dams by Iran and Turkey.

This contravention of international agreements has led the Iraqi Ministry of Agriculture to announce a 50% reduction in its agricultural plan for the current year and the abandonment of agriculture by displaced farmers, leaving behind barren plains prone to harsh winds and storms (Rawbet Center, 2022).



Soil Erosion and Salinization

Several drawbacks contribute to land degradation in Iraq, where increased soil salinity is considered one of the most threatening issues that lead to land degradation and soil erosion.

In the past decades, the problem has increased significantly, raising concerns for the already suffering agriculture scene and it is expected to further grow in the future. As explained earlier, the growing impact of climate change accompanied with inefficient agriculture and water practices, reduced precipitation, high evaporation rate, drought, and desertification, have all deteriorated the quality and quantity of natural plant cover, soil quality and related crops production (Ministry of Agriculture, 2017).

As shown in the following map, the saline content increases within the irrigated areas downstream through central and southern provinces. That is where the salinization process exerts itself as one of the major concerns drastically hampering crop production and farming development. The inefficient use of the already diminishing irrigation water and the conflict-damaged irrigation and drainage infrastructure have advanced growing groundwater tables and have led to “soil salinity-induced land degradation” (Qureshi et al., 2013).

Affected Soil by Salinity



2

Source: Food and Agriculture Organization of the UN, 2022. Copyrights: KAPITA Business Hub, 2022

Salinization has affected the productivity of 70% of the total irrigated area of Iraq, with up to 30% of it turned into wastelands. Severe salinity (>16 dS/m) is dispersed in 4% of the irrigation-fed regions, 50% moderate salt content (>4 dS/m) and 20% slightly saline (>2 dS/m) (S. A. Qureshi & A. A. Al-Falahi, 2015).

Salinity affects the Tigris and Euphrates rivers as they flow downstream in Iraq, where the saline levels of entering waters have been reported to be stable since the 1980s (ICARDA, 2013). The rivers' water that is used in irrigation takes in large salt content, which mainly results from irrigation drainage and salted groundwater.

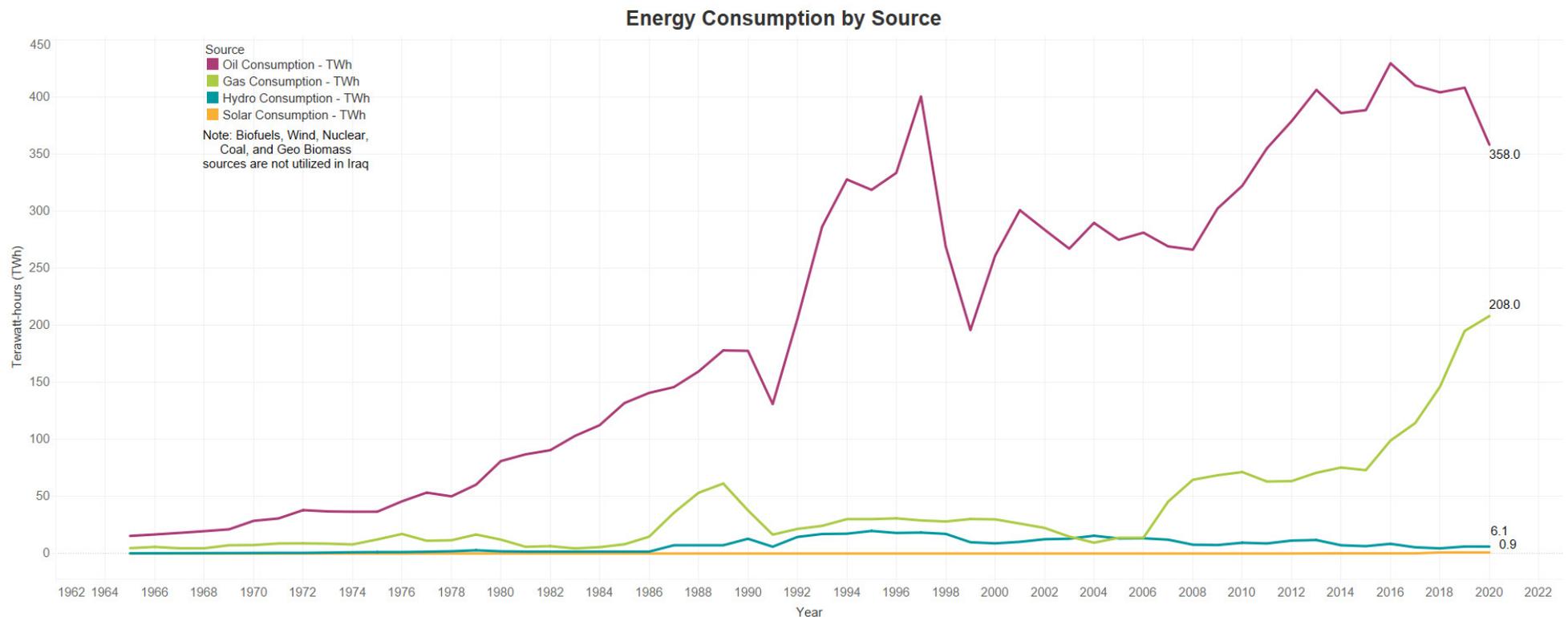
During the last two decades, soil degradation and salinization have been causing substantial damage to agriculture. Reportedly, 5% of used areas are lost annually to salinization and water logging. Of the 3.5 million hectares of irrigation-fed land, about 1.5 million hectares are in the range of permissible salt content, whereas high saline has stopped 0.5 million hectares from being utilized by farmers. This impact of salinization is currently causing a US\$ 300 million loss each year. The production drop has been reported to be from 40% to 60% due to salinity. Hence, a reduction in salt content could double cultivated land in irrigation projects' areas which is reported to be only 30%, possibly increasing crop yield by US\$ 3.2 billion per year (WFP, 2018).



Increased Energy Consumption

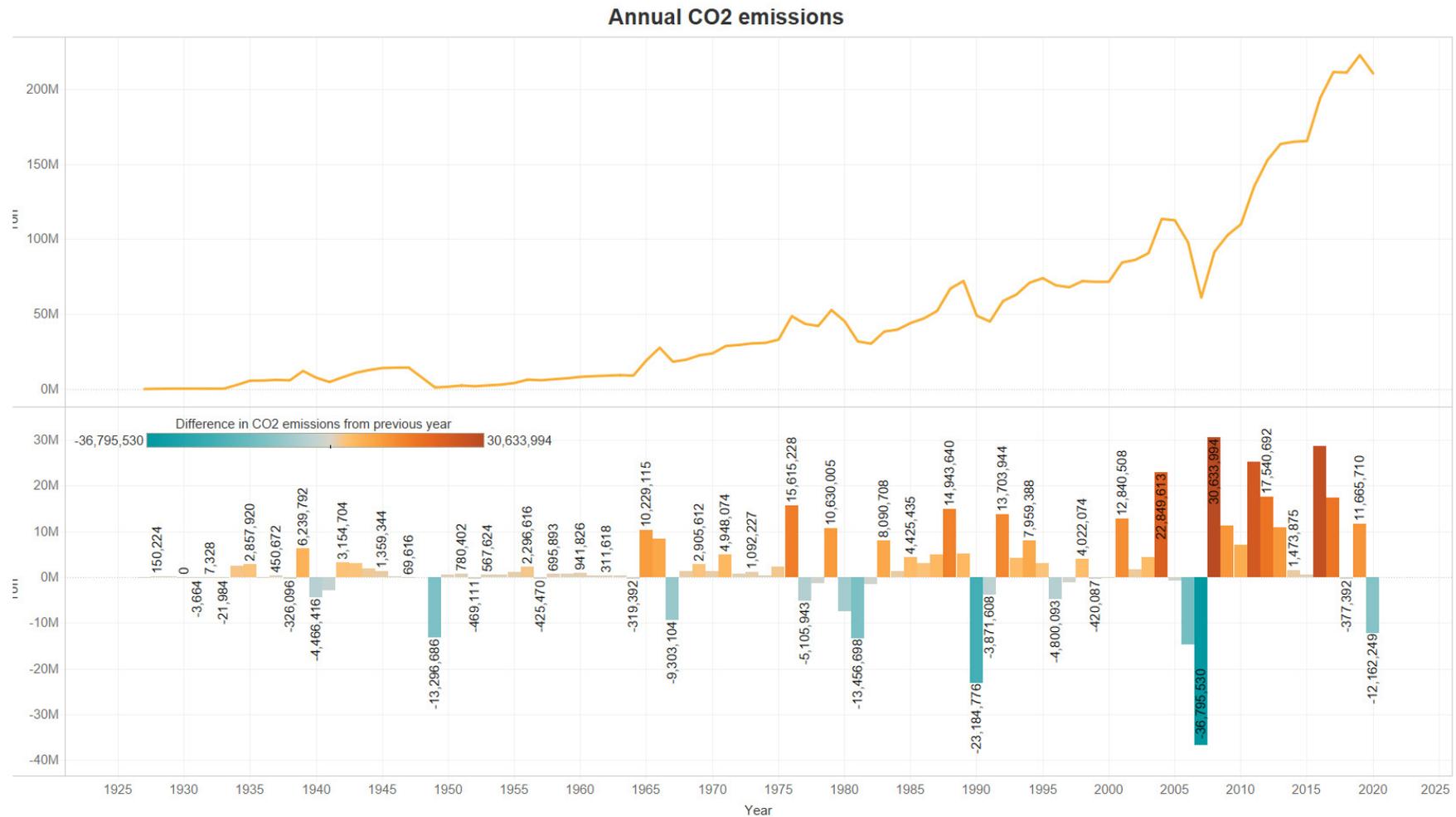
Energy is one of the sectors that is both affecting and is affected by climate change. The amount of energy consumed yearly has escalated from only 20 Trillion Watt hours (TWh) in 1965 to 610 TWh in 2019, which decreased a bit in 2020 to 573 TWh (British Petroleum [BP], 2021).

This increase is mainly due to the country's expansion, but climate impacts also play a vital role in this change. From the figure below, fossil fuels are the main source of energy, constituting about 99% of the energy consumed. Those fuels are also the main contributors to greenhouse gas (GHG) emissions.



Source: BP, Statistical Review of World Energy, 2021. Copyrights: KAPITA Business Hub, 2022

When taking only the last two decades (2000–2020), the annual emitted CO2 (the main constituent gas of GHG) increased by 194% from 71.72 million tons to 210.83 million tons, contributing to 0.61% of the global CO2 emissions which are the primary cause of global warming (Global Carbon Project, 2021). Inversely, the share of primary energy from low carbon sources, mainly hydropower, has gradually diminished to its lowest percentile in recent years, contributing to only around 1% of total energy use and 2% of electricity as compared to the 1990s, when low carbon sources had the greatest representation comprising 27% of electricity supply in 1995 particularly (Our World in Data, 2022). As explained earlier, the low rates of rainfall and reduced water share from upstream countries have had their impact on hampering the generation of hydropower.



source: Global Carbon Project, 2022. Copyrights: KAPITA Business Hub, 2022

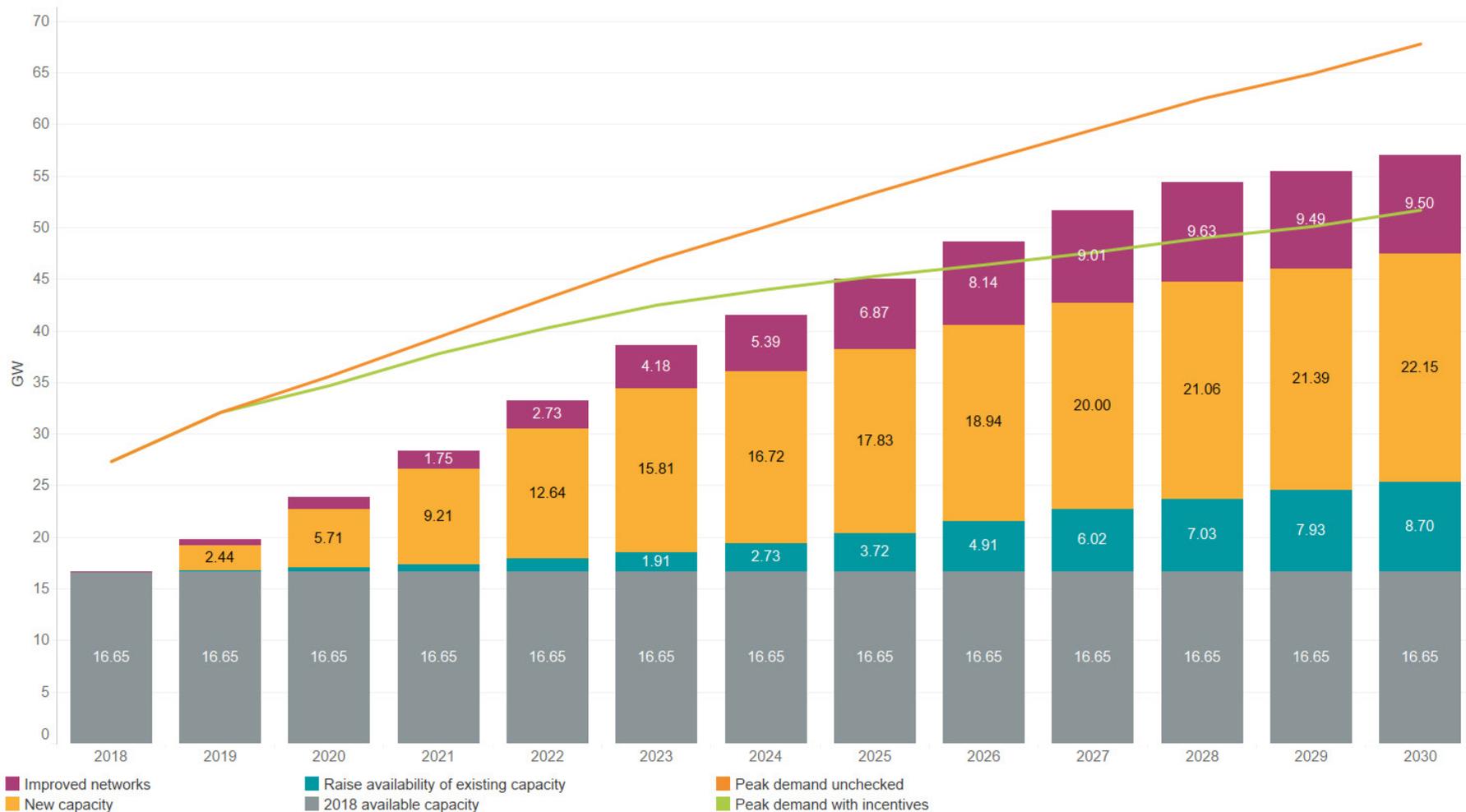
Nevertheless, the energy consumption figure shows the emergence of a new energy source, that is solar power. Even though its percentage is negligible, representing 0.16% in 2020, the 700% growth from just 0.02% in 2013 sets the hopes for a greater expansion in the future, as the adoption of this low carbon energy would help in alleviating climate change and make the best benefit of the long-term scorching heat that is even set to go warmer. This warmth, felt largely in recent years, has had its impact on electricity use. Just between 2014 and 2018, the peak demand increased by 46% to 27.3 GW and even though the power supply increased during the same period to 16.4 GW, this 33.3% increase was not sufficient to meet with the growing demand that is already projected to grow further as the heat is soaring up to record breaking temperatures (International Energy Agency [IEA], 2019).

The gap between supply and demand, and the common power cuts in peak summer months, which show the inefficiency in transmission and distribution, have given rise to small-scale power generators known as neighborhood generators. The need in heated summers for those privately owned generators costs Iraqis about 60-120 USD/kWh. In just 2018, the total charge was a rigorous US\$ 4 billion, the same as the allocation for the Ministry of Electricity in the government budget (R. Mills and M. Salman, 2020).

Realizing the expected growth in demand in line with the drastic changes in the country's heated climate, IEA (2019) projected that, with certain actions to be taken, Iraq can reach a balance by 2030 with capacity exceeding peak demands, having a grid network supplying most customers 24 hours a day.

Those measures may include: encouraging serviced population to avoid non-essential use during the most heated peak hours so as to serve a greater number of households; improving distribution networks, cutting down losses which are as high as 40 TWh at least by half; increasing available capacity by adding more small and large mobile generators to quickly support peak power shortages; introducing new capacities; placing more interest in utilizing captured gas for efficient power generation and increasing the share of renewable energy.

Electricity Supply and Demand, 2018-2030



Source: IEA, Iraq's electricity supply and demand, 2018-2030, IEA, Paris <https://www.iea.org/data-and-statistics/charts/iraqs-electricity-supply-and-demand-2018-2030>.



**Nationally
Determined
Contributions
of Iraq (NDC)**



Climate Planet 05.-17.11.2017
#Uniting4Climate

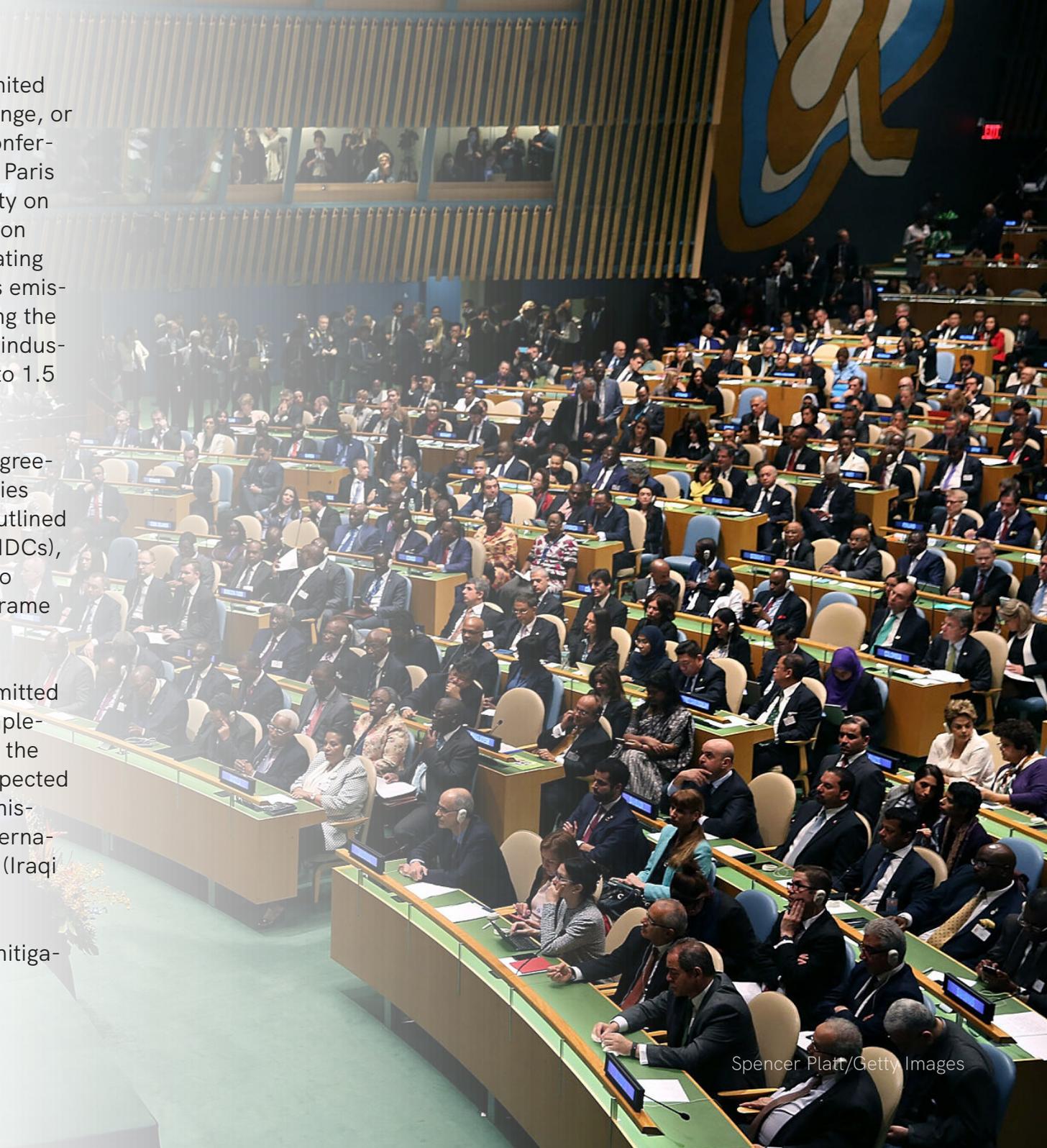


Between November and December 2015, the United Nations Framework Convention on Climate Change, or UNFCCC for short, convened its twenty-first Conference of Parties (COP21) in the city of Paris. The Paris Agreement is a legally binding international treaty on climate change that was adopted and agreed upon by 196 countries at COP21. It commits participating countries to pursue reduction of greenhouse gas emissions as soon as possible with the goal of keeping the global average temperature increase above pre-industrial levels below 2 degrees Celsius, preferably to 1.5 degrees Celsius (IEA, 2022).

Put into force on November 4, 2016, the Paris Agreement is structured on a five-year cycle of countries taking progressively ambitious climate action, outlined in their “nationally determined contributions” (NDCs), which detail their objectives and commitments to mitigate climate change for the post-2020 timeframe (UNFCCC, 2022).

Ratifying the Paris Agreement in 2021, Iraq submitted its first NDC in October, in which it aspires to implement its nationally determined contributions for the period from 2021 to 2030 with the goal of an expected reduction of 1–2% of its total greenhouse gas emissions by national effort, and up to 15% when international financial and technical support is granted (Iraqi NDC, 2021).

According to Iraq’s NDC, the following are the mitigation strategies the government is committed to:



Energy Sector

Iraq intends to reduce its emissions through this crucial sector, given that security and peace are ensured on the one hand, and developed nations fulfill their promises in terms of financing, transferring environmentally friendly technologies, and capacity building on the other. As this sector generates the largest rate of greenhouse gas emissions, accounting for 75% of Iraq's total emissions, the government is dedicated to the following measures to accomplish its goals:

- Reduce gas flaring and reinvest the proceeds in oil and natural gas extraction processes.
- Invest in and develop petroleum industries to reduce resource depletion and methane emissions.
- Conduct periodic inspections of oil and gas plants for methane gas leaks.
- Utilize combined cycles to boost electrical energy generation.
- Replace liquid fuel with gaseous fuel in electric power plants, in addition to improving the quality of the fuel used to reduce carbon emissions.
- Utilize hydroelectric power.
- Implement carbon capture, utilization and storage technologies (CCUS) to reduce carbon emissions and enhance industrial processes.
- Adopt renewable energy technologies, particularly solar energy.
- Invest in innovative and sustainable public transportation, such as the construction of the monorail project.
- Gradual transition to hybrid and eco-friendly automobiles.
- Utilize fuel-efficient engines and advanced operating systems in aircrafts.
- Examine and update current laws and determine the necessity of enacting new ones relating to trade and industrial investment legislation, as well as customs tariffs.
- Wind energy production in potential locations, particularly in the Kurdistan region.
- Support the participation of the private sector in developing the public transport system.

Industrial Sector

The Ministry of Industry and Mineral Resources aims at reforming this sector, which is one of the most significant contributors to greenhouse gas emissions, through the following range of legislative and administrative proceedings:

- Develop and rehabilitate industrial processes in current projects through the introduction of low-carbon technologies, such as those used to manufacture cement, bricks, fertilizers, and petrochemicals.
- Commence recycling projects, including the recycling of heat and gasses released by industrial furnaces, as well as plastics and rubber materials.
- Support the private industrial sector, including small and medium-sized enterprises, in the field of emissions reduction to develop environmentally friendly industrial technologies.



Agricultural Sector

Agriculture is a significant economic sector in the country and is a major source of greenhouse gas emissions. This is because most of Iraq's crops are grains such as wheat, barley, rice, and corn, in addition to horticultural crops and palm trees. Thus, the critical measures in this sector's management can be described as follows to ensure a real reduction in emissions:

- Control the cultivation of crops that generate large quantities of methane, such as rice, while also limiting their water consumption. Additionally, battling soil erosion and restoring degraded lands are within the sector's plan.
- Utilize renewable energy technologies such as solar and wind energy to power irrigation pumps.
- Combat natural forest fires and repair burned and degraded fields through integrated management. Moreover, create a system for protecting and maintaining natural and man-made forests, expand their areas, and establish green belts to mitigate CO2 emissions.
- Increase environmental awareness of climate-smart agriculture, improve nitrogen fertilizer application techniques to reduce N2O emissions, and promote no-tillage farming to reduce emissions from agricultural machinery use, as has been effectively implemented in the Kurdistan Region.
- Reduce enteric fermentation emissions by selecting and refining adequate feeds for livestock.



Waste Sector

Iraq intends to localize green investment in waste management on a broad scale in order to diversify its economic sources via the following approaches:

- Adopt a solid waste management law that promotes waste recycling, waste conversion to energy, and the elimination of garbage burning.
- Employ plasma technology to generate electricity from waste.
- Implement an integrated waste management system.
- Invest in landfill methane in the production of electricity.
- Implement tire recycling initiatives.

Housing Sector

Through the housing sector, Iraq seeks to implement the concepts of rationalizing electrical energy use and transitioning to low-emission paths, based on the localization of principles that promote the use of renewable energy nationwide. The following are the proposed strategies:

- Utilize energy-saving lighting technology.
- Issue green building codes and modern technologies for thermal insulation, lighting, and sustainable cities.
- Implement effective design of buildings to maximize the use of lights and solar energy.
- Utilize photovoltaic technologies to power buildings, small towns, and cities.
- Establish an integrated design strategy that incorporates the use of smart-meter technologies within buildings.
- Apply current construction technologies such as glassfibre-reinforced concrete and insulating concrete forms to minimize the use of steel and cement in construction.



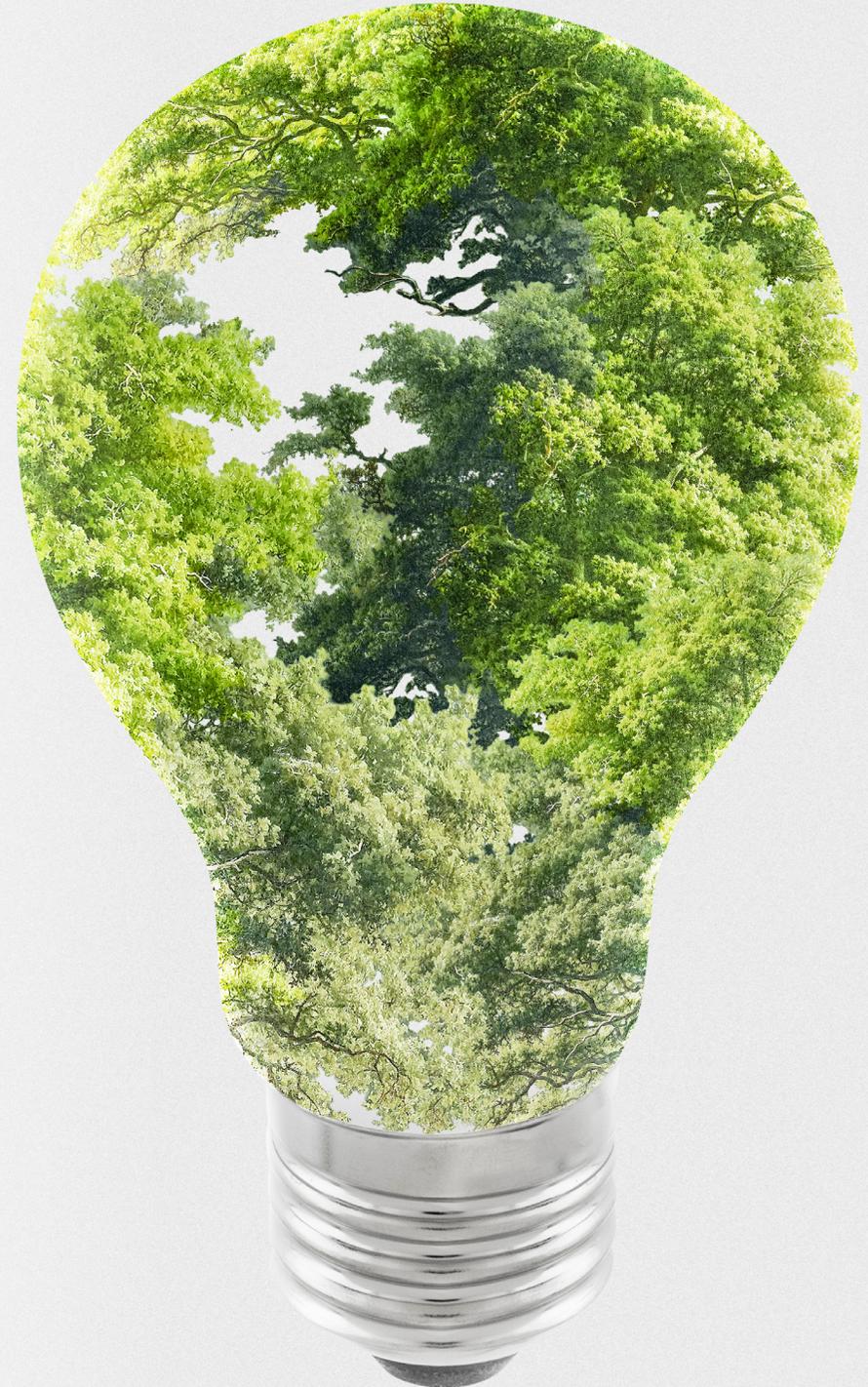
Haidar Mohammed Ali/AFP via Getty Images

Green and Cleantech Startups

Climate change has gained traction in Iraq's public and private sectors in recent years. The dire need to discover green solutions to existing problems in the country's infrastructure has led the community on a quest for fresh, unprecedented ideas to combat climate change.

With the vision of tackling environmental pollution, the Iraqi startup ecosystem is blooming with ground-breaking applications to reduce greenhouse gas emissions, promote sustainability, and raise public awareness of climate change.

Among those startups worth mentioning are the following:





Tanweer Energy Solutions

Founded in 2019, Tanweer Energy Solutions is a company that provides energy-efficient electrical grids, smart building utilities, solar panels, and UPS backup systems for commercial and industrial projects. Additionally, the company offers PPAs (Power Purchase Agreements). This entails no upfront fees for the solar plant acquired by the clients, but paying monthly payments for the next 10-15 years, based on consumption. Tanweer installed backup solar systems at KAPITA's headquarters, resulting in a CO2 reduction of 1.7 tons over the course of 11 months.



Ecopotamia

Ecopotamia is an online store founded to provide the community with eco-friendly, sustainable, plastic-free products. With products such as bamboo toothbrushes and reusable cotton face masks, Ecopotamia aims at combating climate change by reducing daily waste and encouraging mindful consumption.



Eco Life

Aiming towards a zero-waste environment, Eco Life was founded in 2019. The startup store provides plastic alternative products to promote sustainability and climate change awareness. Additionally, Eco Life utilizes Iraqi resources to encourage locally manufactured products, such as their signature drinking straws made of cane harvested from Diyala marshlands.



Green Shaov

Green Shaov provides agricultural development services by applying artificial intelligence principles to enhance productivity and variety of crops. Services include consultation by agricultural engineers, smart management of green houses, soil moisture control through smart irrigation systems that promote efficient water use, soil quality and adaptation management through technology-based soil meters, in addition to other services.



Green Gold

Green Gold is a youth initiative that attempts to reduce organic waste through recycling and conversion into organic fertilizers of superior quality and competitive pricing. The startup is credited with being the first project to produce seed pods in an endeavor to increase public awareness of agriculture's importance, foster green areas, and guide the community toward environmentally beneficial approaches that minimize pollution.



Mosul Solar

Mosul Solar was inspired in 2020 by the prolonged power cuts of up to 22 hours a day in Mosul. To help mitigate the electricity problem with a cheaper, more reliable, and environmentally clean power source, the business provides and installs solar cells for all kinds of residential and commercial units.



KESK

Established in 2018, KESK is the first initiative to embrace the notion of green design and construction in Iraq. With the aim of raising awareness on climate change issues, KESK was established to alleviate Iraq's energy crisis by providing a variety of green solutions such as solar power technologies, energy efficiency analysis, and sustainable construction consultancy services.



Ecomena

Ecomena focuses on tackling environmental pollution through waste management. Aiming to reduce waste, the startup recycles plastic into eco-friendly, durable plastic materials that have residential, commercial, and structural applications.

Conclusions

Climate change is drastically advancing with Iraq being one of the fastest warming areas on the planet. The country is facing an ascending pattern of temperature rise that is continuing to break historical records and cause increasing energy consumption to meet cooling needs, accompanied by a descending rate of rainfall to one of its lowest seasons in 40 years.

The harsh climate is influencing the loss of water abundance, which has deteriorated the clean energy generation of hydropower to its lowest levels at the present time, with a representation of 1% of electricity supply. The agricultural sector is directly impacted and is incurring great losses due to the blazing dry weather accompanied by water scarcity. Climate change is diminishing vegetation cover, causing land degradation, a consequent increase in dust storms and desertification that is costing Iraq a loss of 100 Km² annually to deserts, in addition to halting use of large cultivable areas due to the spread of salinity.

Based on the current situation, CO₂ emissions are likely to increase and cause greater warmth. Heat waves and extreme temperatures are likely to become more common, harming population health and eventually making certain regions uninhabitable.

The flow of the Tigris and Euphrates is projected to further decline, especially with a reduced share from upstream countries. Consequently, the already worsening climate change features such as water scarcity, land degradation, and dustiness are expected to deepen and create greater hardships and issues that affect the country and its vital sectors (agriculture, industry, and energy).



Recommendations

A series of actions needs to be taken into consideration so as to help mitigate the growing effects of climate change, those are outlined as follows:

- Desertification prevention and reversal require significant policy initiatives and managerial strategies from the government.
- Foster a climate-conscious culture among the public in order to promote eco-friendly behaviors such as mindful water consumption, recycling, less reliance on plastic products, and reduced littering.
- Maintain vegetative covers and hasten the implementation of greenbelt projects to prevent further soil erosion and degradation.
- Assist farmers in desertification-prone areas by providing them with the necessary supplies they require to avoid rural migration.
- Push negotiations with Turkey and Iran, the riparian countries on the Tigris and Euphrates rivers as well as their tributaries, to acknowledge Iraq's

rights to its shared waters and to enhance regional cooperation in pursuit of water and climate security.

- Establish oasis in deserts and arid areas with the goal of mitigating the effects of climate change on biodiversity.
- Build wastewater treatment systems in villages and rural communities to provide irrigation-quality water, as well as mobile organic waste treatment plants to generate biogas and organic fertilizer on-site.





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KAPITA Business Hub

KAPITA is a private sector development company that aims to empower small and medium-sized enterprises (SMEs) through investment, research, incubation/acceleration, and market development programs.





Our Services

- Acceleration and Incubation Programs

We partner with global organizations to provide acceleration and incubation programs

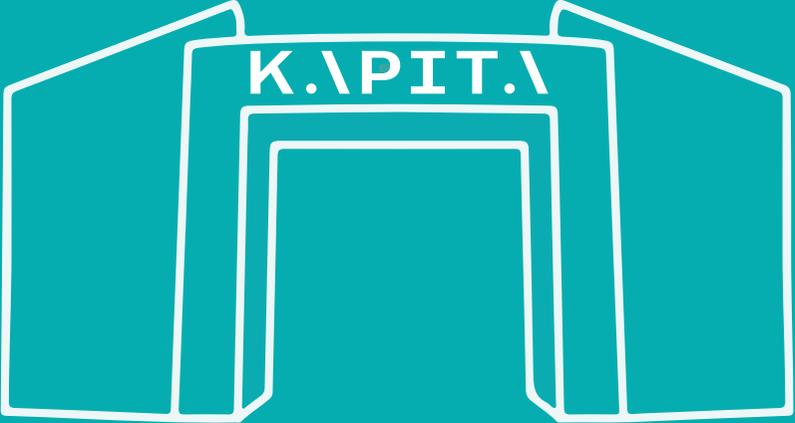
- Investment and fundraising

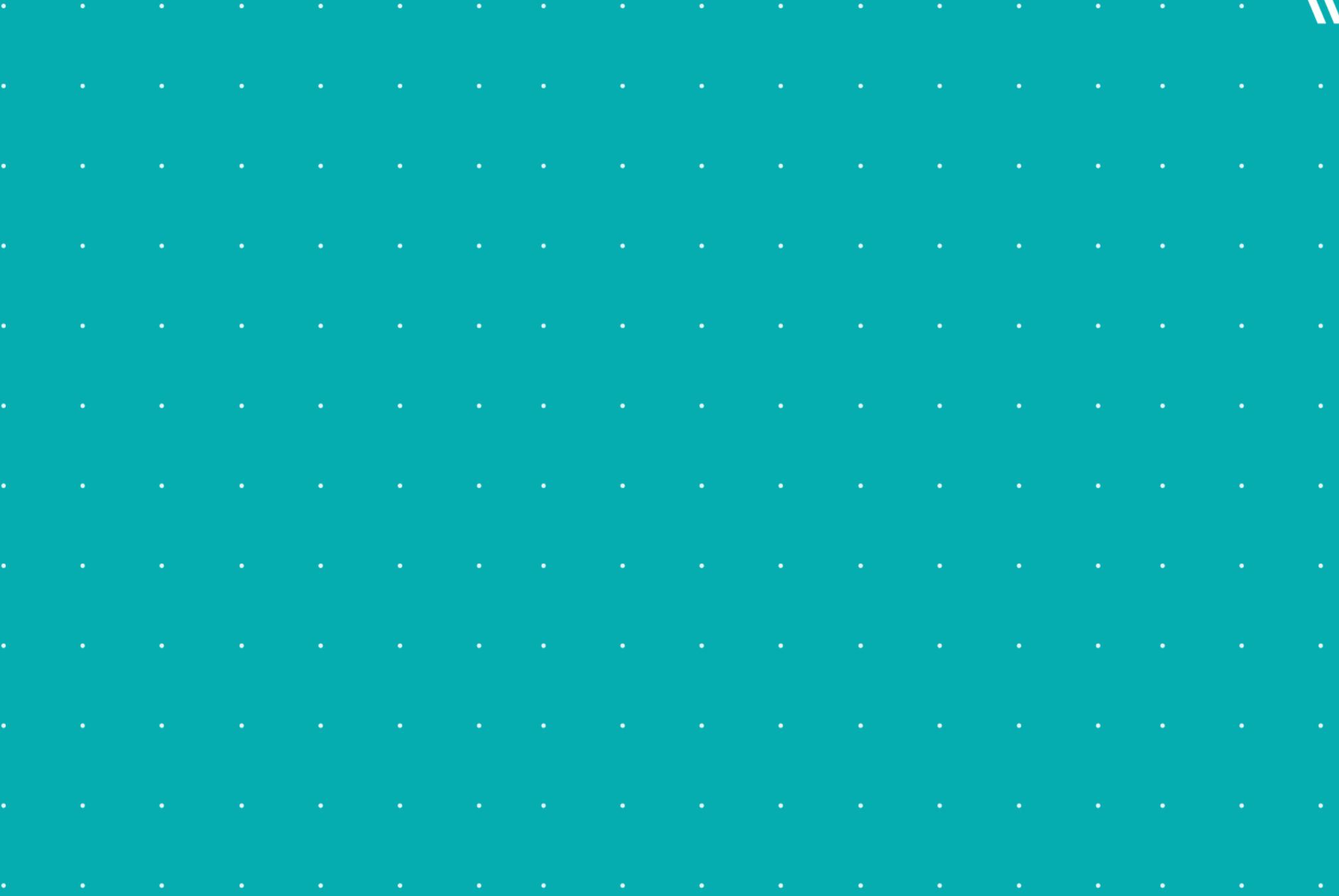
We sit at the heart of entrepreneurship ecosystem in Iraq and is actively looking to facilities investments.

- Research and professional services

We have strong market insights into The Iraqi market and work to transform Iraqi private sector to a data-driven one









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Κ.ΑΡΙΤ.Α