OCCUPATIONAL AND ENVIRONMENTAL HEALTH PROBLEMS RELATED TO CLIMATE CHANGE IN EGYPT (REVIEW ARTICLE)

BY

El-Sherif GH

Department of Occupational and Environmental Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt

Corresponding Author: *El-Sherif GH.* ***E-mail:*** *ghadaelsherief@kasralainy.edu.eg*

DOI: *10.21608/ejom.2025.371549.1366*

Submit date: *2025-04-1* ***Revise date:*** *2025-04-17* ***Accept date:*** *2025-04-18*

Abstract

Climate change refers to noticeable, long-term shifts in the Earth's climate, caused by both natural factors and human activities. The general climate of Egypt is dry, hot, and deserted. Temperatures in Egypt have increased and stronger warming was observed over the past 30 years. Climate change has caused unusual environmental conditions like rising sea levels, stronger tropical storms, floods, heat waves, wildfires, droughts, coral reef bleaching, and even extreme winter storms. Climate change affects workers' health through exposure to excessive heat, ultraviolet radiation, contact with pathogens, air pollution and extreme weather. Egypt will probably get hotter and drier, and precipitation is likely to decrease. The Nile Delta is highly vulnerable to sea level rise. Additionally, elevated levels of air and water pollution in Egypt significantly contribute to premature mortality and increased morbidity rates. Workers, who work in high temperatures and under direct sunlight, lacking protective occupational safety standards, are exposed to heat stress and heat-related diseases. Livestock and crops are expected to experience increased heat stress under rising temperatures, leading to declines in crop yields as well as reduced milk and meat production, thereby compromising key food sources. Furthermore, global warming is projected to alter the distribution and seasonality of vector-borne diseases by enabling vectors to persist in regions and during periods that are currently unsuitable due to low temperatures. Effective climate governance is built upon the dual strategies of mitigation, aimed at reducing greenhouse gas emissions, and adaptation, which focuses on adjusting systems to minimize the impacts of climate change. The electricity generated from renewable sources is predicted to significantly decrease emissions. Adaptation strategies include protection of coastal line from sea level rise and finding solutions for water scarcity and food security issues.

Key Words: Climate change, Excessive heat, Sea level rise, Tropical storms, Climate governance.

Introduction

Climate change refers to long-term, quantifiable alterations in the climate system, driven by natural processes or anthropogenic activities that modify the atmospheric composition. (Salonen and Reiser, 2023).

The effects of climate change on health can be either direct (e.g., exposure to extreme temperatures, drought or floods) or indirect (e.g., changes in infectious disease epidemiology, vector ecology or changes in the availability and/or quality of food, water and air). In the Middle East region, including Egypt, heightened vulnerability to climate change is likely associated with rapid population growth and urbanization, demographic shifts such as an aging population, ongoing political and military conflicts, large-scale population displacement, and limited economic capacity (Al-Delaimy et al., 2020).

Climate profile of Egypt

The average annual temperature for Egypt is 22.5°C, ranging between 30°C in July and 13°C in January. The average annual precipitation is 33.3 mm, with the highest precipitation levels during December to February, and very low precipitation levels during the rest of the year (World Bank CCKP, 2020) (Figure 1).

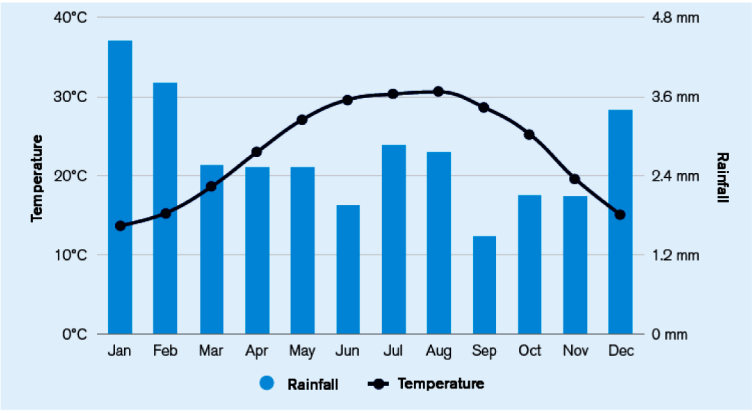

Figure (1): Average Monthly Temperature and Precipitation of Egypt for 1991–2019 ***(World Bank CCKP, 2020)***

Environmental Impacts of Climate Change

1. Warmer Ocean Water:

Rising Sea Level and Tropical Storms:

As global warming continues, the surface temperature of oceans will continue to increase leading to melting of the ice and rising of the sea level. The estimated 100-year extreme sea-level event will become more frequent by 2100, making the tropical regions at higher risk, because the tropical storms will probably increase in frequency and intensity (Tebaldi et al., 2021).

Storm Surges and Coastal Floods:

Storm surges are caused by the prevailing atmospheric pressure and wind conditions that can either elevate and drive the water towards the coast leading to a positive surge, or depress and draw the water away from the coast leading to a negative surge (Xuan et al., 2021).

Accelerated Coral Reef Bleach:

Normally, some microscopic algae, called zooxanthellae, live within the tissues of the coral animal and provide it with up to 90% of its energy requirements. The increased water temperature leads to the release of free oxygen radicals by the algae during the processing of incoming light to produce energy. The oxygen free radicals can cause degeneration or release of the zooxanthellae from the tissue, leading to the appearance of the bright white coral skeleton, which is called bleaching of the coral reef (Marshall and Schuttenburg, 2006).

2. Extreme Terrestrial Weather Patterns:

Extreme Heat Waves:

A period of consecutive days during which the prevailing temperatures exceed their normality is the general heat wave (HW) definition (Alghamdi and Harrington Jr, 2018).

The effects of heat waves on human include low outdoor labor productivity and social stability, or infrastructure failures due to higher electricity demands and lower power production (Auffhammer et al., 2017).

Persistent Drought:

In 2022, Europe experienced a severe summer drought, resulting in substantial socioeconomic impacts. Approximately 14–41% of the 2022 drought event has been attributed to soil drying induced by prior warming, occurring before the onset of the 2022 hydrological year. This highlights the importance of accounting for lagged

effects of climate change to avoid underestimating associated risks (Bevacqua et al., 2024).

Wildfires:

A wildfire needs three essential conditions to start: fuel, oxygen, and an ignition source. Climate change can provide each of these conditions. Enhanced evaporation of soil moisture during dry periods creates combustible vegetation, which serves as fuel for wildfires. Additionally, strong winds supply increased oxygen to the fires, promoting their expansion and intensification . More extreme and frequent heat waves provide ignition sources for wildfires (Sun et al., 2019).

The major air pollutants during wildfires, which are most important to public health, are carbon monoxide, ozone, and particulate matter (Rongbin et al., 2020).

Inland Floods:

The globe is getting warmer, and warm air can carry more water; thus, it can increase the intensity of rainfall with the risk of flooding. Floods can cause serious effects when people, property, infrastructure or vulnerable ecosystems are in the way of the flood water, or when the rate of precipitation is greater than the capacity of the sewage system (Speight and Krupska, 2021).

Landslides and Mudflows

A landslide is the movement of a mass of rock, debris, or earth down a natural or an artificial slope, under the influence of gravity (Comegna et al., 2013).

Rapid mass movement (with velocity within 1–25 /s) of saturated soil or sediment under the action of gravity is called “debris flow”. A ‘mudflow’ occurs when sediment is predominantly composed of fine clay particles and lacks significant coarse materials, resulting in a viscous, fluid-like consistency. This phenomenon is typically triggered by prolonged or intense rainfall on mountainous slopes or by the rapid movement of a landsliding mass. Mudflows represent a significant hazard in mountainous and volcanic regions, posing risks to human life and causing substantial economic losses through property damage each year (Ancey, 2013).

Effects of Climate Change on Occupational and Environmental Health

Excessive Heat

Key health conditions associated

with heat exposure include heat stress, heat stroke, acute and chronic renal injury, and myocardial infarction in adults. In children, heat exposure can lead to electrolyte imbalances, fever, respiratory disorders, and renal complications (Watts et al., 2019).

Exposure to high temperatures and elevated humidity levels in the workplace can result in detrimental health effects, particularly for workers in agriculture, construction, transportation, retail, brick manufacturing, and other manual labor sectors. (Pathak, 2023). Workplaces characterized by elevated indoor temperatures include ferrous and non-ferrous foundries, brick kilns, ceramic factories, glass manufacturing facilities, rubber plants, electrical industries, bakeries, commercial kitchens, laundries, chemical processing plants, mining operations, smelting facilities, and steam tunnels. Office workers may also face heat-related health risks in environments that are insufficiently equipped to manage high temperature conditions (ILO, 2024).

To assess the impact of extreme temperatures or heatwaves on human health, the combined effects of relative humidity and temperature are often quantified through the heat index (HI), which reflects an individual's perception of comfort or discomfort under prevailing environmental conditions (Morsy and El-Afandi, 2021) (Table 1).

Classification	HI (°C)	Effect on the body
Caution	26–32	Fatigue possible with prolonged exposure and/or physical activity
Extreme caution	32–41	Heatstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	41–54	Heat cramps or heat exhaustion likely and heat stroke possible with prolonged exposure and/or physical activity
Extreme danger	> 54	Heatstroke highly likely

Table (1): Heat Index Severity Categories and Its Effect on the Human Body ***(Morsy and El-Afandi, 2021)***

Ultraviolet (UV) Radiation

Construction and agriculture workers are at particularly higher risk (ILO, 2024). Acute injuries resulting from ultraviolet (UV) exposure, such as sunburn, skin blistering, and ocular damage, are typically transient. However, prolonged exposure can lead to severe long-term effects, including cataracts, macular degeneration, pterygium, compromised immune function, and skin cancers such as melanoma, basal cell carcinoma (BCC), and squamous cell carcinoma (SCC) (Wright and Norval 2021).

Extreme Weather and Climate Events

Climate change increases the frequency, intensity, and duration of some weather and climate events, e.g., heat waves, heavy rainfall, and droughts in some regions. Several injuries, illnesses, and deaths may occur during and after extreme weather and climate events. Chronic medical and mental health problems can also be affected by extreme events and their consequences. Moreover, as noticed after hurricanes, these events can critically disturb public health care services, water sanitation, and food supply systems long afterward (Ebi et al., 2018).

Workers at elevated risk include healthcare professionals, firefighters, emergency responders, construction workers, cleanup personnel, agricultural workers, and fishermen (ILO, 2024).

Infectious and Vector-borne Diseases (VBDs)

According to ILO estimates, over 15,170 workers die annually due to occupational exposure to parasitic and VBDs, such as malaria, trypanosomiasis, chagas disease, schistosomiasis, leishmaniasis, lymphatic filariasis, onchocerciasis, cysticercosis, echinococcosis, dengue, trachoma, yellow fever, and rabies. This accounts for about 7.6% of all deaths due to parasitic and VBDs (ILO, 2024).

Temperature fluctuations resulting from climate change can create conducive environments for the proliferation of certain organisms in food and water sources, as well as reduce the incubation periods of some pathogens, thereby facilitating the spread of vectors and diseases (Lee et al., 2017).

Water Safety and Food Security

Alterations in precipitation patterns and the melting of snow and ice are disrupting hydrological systems,

impacting both water quantity and quality (Ebi and Hess, 2020).

Climate change can threaten food security by its effects on agriculture, biodiversity loss, depletion of fisheries, soil degradation, and freshwater scarcity (IPCC, 2019).

Workplace and Ambient Air pollution

The increased levels of air pollutants can affect outdoor workers by increased exposure to PM2.5, ozone and allergens (Schulte et al. 2023).

Climate change can influence indoor air quality by elevating outdoor air pollutants, such as ozone and particulate matter, which may result in higher indoor concentrations. Additionally, shifts in precipitation patterns and the occurrence of storms can lead to an increase in indoor pollutants like mold, dust mites, and bacteria. For instance, flooding can create a humid indoor environment, promoting the growth of mold (US EPA, 2024[a]).

Agrochemicals

Climate change can reduce the efficacy of pesticides by accelerating volatilization and degradation processes, which are significantly influenced by high moisture levels, elevated temperatures, and direct sunlight exposure. Additionally, climate change facilitates the proliferation and alters the distribution of pests by modifying temperature and precipitation patterns, as well as affecting the availability and spatial distribution of host plants for pests (Delcour et al., 2015).

Workers in agriculture, forestry, chemical industries, pesticide sales, green space, e.g. parks, and vector control may face hazardous exposures. Many pesticides have been classified by the International Agency for Research on Cancer (IARC) as carcinogenic to humans (Group 1) and probably carcinogenic to humans (Group 2A). Other health effects include neurotoxic effects, e.g., Parkinson's disease and Alzheimer's disease, reproductive disorders, cardiovascular disease, COPD, endocrine disruption and immune suppression (ILO, 2024).

Mental Health

Suicidal thoughts, depression, anxiety, impaired brain function, psychological discomfort, and increased violation were all reported among employees exposed to extremely hot temperatures (Kjellstrom et al., 2017). Mental health problems, especially post-traumatic stress disorder (PTSD),

are more common after natural disasters and extreme weather events (Walinski et al., 2023).

Effects of Climate Change in Egypt

Climate Change in Egypt

Climate projections indicate that Egypt's mean annual temperature could increase by approximately 2.1°C by 2050 and potentially by 4.4°C by 2100, assuming unabated greenhouse gas emissions. This anticipated trajectory toward increased frequency of extreme heat events and a decline in cold weather occurrences poses serious implications for public health, agricultural productivity, and the intensification of water scarcity in the region (Al-Mailam et al., 2023).

The Nile Delta is subsiding due to sea level rise and by the effect of dams along the Nile, which limit natural sediment flow to the Nile Delta. The rate of subsidence is reported as 0.4 mm/year in Alexandria but appears to be as much as 4.1 mm/yr in Port Said (UNDP, 2018) (Table 2).

Region	Alexandria	Al-Burullus	Port Said
Subsidence (mm/yr)	0.4	1.1	4.10
SLR (mm/yr)	1.2	1.2	1.2
Tidal trend (mm/yr; 1 + 2)	1.6	2.3	5.3

Table (2): Observed SLR and Subsidence Rates in Selected Nile Delta Locations *(UNDP, 2018)*

Annual PM2.5 in Greater Cairo from 1999 to 2016 is presented in figure (2). Average concentration over the 18-year period was 84 μg/m^3 with the lowest concentration of 66 μg/m^3 in 2016 (World Bank, 2019).

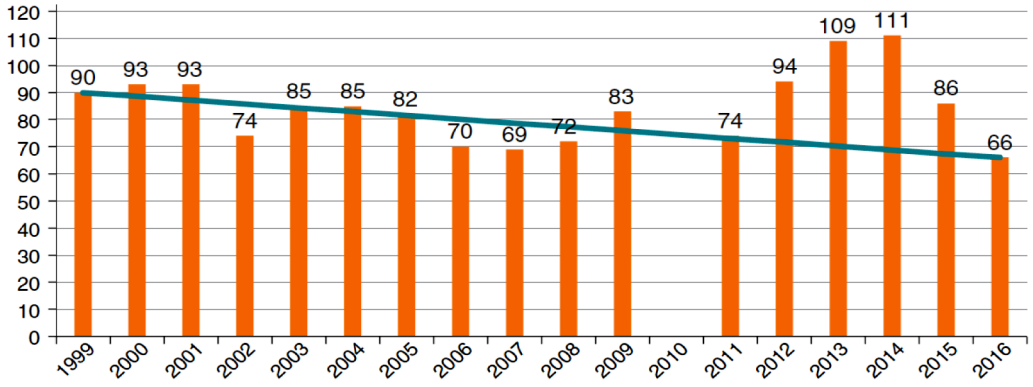

Figure (2): Annual Average PM2.5 in Greater Cairo 1999–2016 ***(World Bank, 2019)***

Health Effects of Climate Change in Egypt

Air and water Pollution

Annual premature deaths from ambient PM2.5 exposure in Greater Cairo are estimated at about 12,100 to 13,000 in 2017 (Table 3) (World Bank, 2019).

	Low	Central	High
IHD	7,176	7,437	7,666
Stroke	1,545	1,601	1,651
COPD	875	912	945
Lung cancer	244	262	278
ALRI	1,608	1,701	1,781
Diabetes Type II	654	655	655
Total	**12,103**	**12,569**	**12,976**

Table (3): Estimated Annual Deaths from Ambient PM2.5 Air Pollution in Greater Cairo, 2017 ***(World Bank, 2019)***

Heat Stress

The issue of heat stresses from working in high temperatures and/or under direct sunlight is raised with each heat wave. Several workers around the country of Egypt lack occupational safety standards to protect them from this danger, such as agriculture, fishing, mining, quarrying, manufacturing, electricity and gas supplies, water supply, sewage networks, waste treatment, construction, vehicle repair, transport and storage, food and accommodation services, ovens, and delivery. Their number totals 21,798,800 workers according to the latest official statistics (ECESR, 2024).

Egypt's densely populated cities suffer from the heat-island effect. Urban populations tend to use air conditioning to survive the summer heat, however, the increased energy consumption for cooling will backfire, expelling hot air to make cities like Cairo even warmer (Al-Mailam et al., 2023).

Food Security

Rising temperatures are projected to elevate evapotranspiration rates, thereby increasing the water requirements of major crops such as wheat, maize, rice, tomatoes, and sugarcane. Consequently, this may lead to a decline in crop yields. Additionally, elevated thermal stress and potential nutritional deficits are expected to adversely affect livestock and poultry, resulting in reduced growth rates and diminished milk production (UNDP, 2018).

Water Scarcity

Given that the Nile River lies approximately one meter above sea level, a projected sea-level rise of 0.5 to 1 meter could result in a reduction of the river's flow by an estimated 19% to 32%, potentially compromising up to one-third of its freshwater availability by 2100. Notably, the Nile is already experiencing a gradual recession, with its extent diminishing at a rate of approximately 3 to 5 millimeters per year (Sefelnasr A and Sherif M, 2014).

Water collection procedures increase the possibility of exposure to water contaminated with viruses, bacteria or certain parasites, like Schistosoma, which can enter the body through the skin (Elmorshedy et al., 2020).

Infections and Vector-Borne Diseases (VBDs)

The ecological and socio-economic

factors found in the East Mediterranean and Middle East (EMME) region, including Egypt, provide suitable conditions for the spread of several VBDs, including malaria, dengue, leishmaniasis and West Nile fever (Waha et al., 2017).

Mitigation and Adaptation Responses

Climate governance is fundamentally structured around two core pillars: mitigation and adaptation. Mitigation involves efforts to limit or eliminate greenhouse gas emissions, either by reducing their release or enhancing their removal from the atmosphere. In the case of Egypt, mitigation strategies may include transitioning from fossil fuel-based energy systems to renewable energy sources, improving energy efficiency, and enacting regulatory or policy measures aimed at curbing emissions (Al-Mailam et al., 2023).

The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as the process of adjusting to actual or anticipated climate change and its impacts, with the aim of minimizing adverse consequences or leveraging potential benefits. Adaptation strategies can be either anticipatory—implemented in advance of climate impacts—or reactive—undertaken in response to observed changes (IPCC, 2022).

Mitigation and Emissions Reduction

Since 1990, Egypt's emissions have been decreased by 42% and the carbon intensity of its economy has decreased by almost 25% between 2005 and 2019, indicating a trend toward less intensive energy consumption (Al-Mailam et al., 2023).

The most important renewable energy achievements in the power generation sector were the launch of Benban Solar Park in Aswan (total of 1,465 MW), Assuit hydropower plant (32 MW), Kom Ombo Solar Power Plant (26 MW), and Gabal El-Zeit Wind Power Plant (580 MW) (Egypt's 2nd updated NDC, 2023).

Egypt's Green Hydrogen Strategy was announced during COP27, which was developed in collaboration with the European Bank for Reconstruction and Development (EBRD) and the Arab Union for Sustainable Development and Environment (AUSDE). Green Hydrogen is obtained by the electrolysis of water; thus, water is the raw material.

Also, the process is entirely powered by clean energy. It also generates no polluting emissions into the atmosphere (Bakr, 2023).

The challenge of greenhouse gas (GHG) emissions from the public transportation sector is being addressed through the implementation of the Bus Rapid Transit (BRT) system, which aims to replace diesel-powered buses with electric alternatives (Al-Mailam et al., 2023).

The expansion in the Greater Cairo underground metro network included the operation of stage 4 of 11.5 km in length of the third Cairo metro line as a step towards the modal shift to low carbon mass transit (Egypt's 2nd updated NDC, 2023).

Climate Adaptation Actions

Excessive heat

Some countries' legislation sets a range of acceptable temperatures for certain workplace environments. In Bahrain, workers are not allowed to work outdoors between 12 p.m. and 4 p.m. from July 1st to August 31st each year. Similar laws are found in Qatar, Kuwait, Oman, Saudi Arabia and the United Arab Emirates (UAE). In other countries, like Egypt, Senegal, Indonesia, Japan, Korea, Switzerland, Denmark, Italy and India, specific maximum temperatures are not determined. Occupational safety and health (OSH) legislation in these countries focuses on acclimatization programs, ventilation, rest breaks in the shade or air conditioning, training, and the supply of personal protective equipment (PPE) (ILO, 2024).

Water Scarcity and Food Security

Egypt is pursuing a bilateral partnership with the Republic of Congo aimed at enhancing food security while preserving its limited domestic water resources. As part of this initiative, Egypt is investing in the cultivation of 20,000 hectares of arable land in the water-rich region of Mossendjo, with an agreement to receive 60% of the resulting wheat and rice production (Al-Mailam et al., 2023).

The COP27 Sharm el-Sheikh Implementation Plan welcomed the foundation of the four-year Sharm el-Sheikh joint work on implementation of climate action on agriculture and food security (COP27, 2022).

Coastal Adaptation Strategies Against Rising Sea Levels

The Egyptian national strategy

for coastal adaptation chiefly adopted the protection approach, such as seawalls, revetments, sand dunes and nourishment. Moreover, there are different actions such as constructing modern fish farming and regular dredging for coastal lakes and lagoons. These hopeful adaptation actions may show beneficial responses to SLR hazards (Sharaan et al., 2022).

Conclusion

Climate change is a global phenomenon, which has considerable effects on the environment and human health. Egypt is considered highly susceptible to climate change due to its primary dependence on the Nile River for providing the national needs for water. Egypt's agriculture sector is susceptible to higher temperatures, endangering food security of the country. The Nile Delta is most at risk to sea level rise due to its relatively low elevation compared to the land around it. Air and water pollution levels in Egypt are high and contribute to many premature deaths and morbidity. Egypt's mitigation efforts encompass increased investment in renewable energy sources and a strategic reduction in reliance on fossil fuels. In terms of coastal adaptation, the national strategy has adopted a protection-oriented approach, employing measures such as seawalls, revetments, artificial sand dunes, and beach nourishment to safeguard vulnerable coastal zones.

Recommendations

Saving energy together with using renewable energy sources to generate electricity rather than fossil fuels are important ways of adapting to climate change. Shifting to mass electrical transportation, and electric cars is a huge step in reducing emissions caused by traffic. Egyptian government and employers need to pay more attention to occupational exposure to excessive heat during summer months. Egyptian legislations need to set maximum temperatures above which the work must stop. Recycling wastewater is a very promising way to adapt for water scarcity. Recycling agricultural wastes e.g. rice hay instead of burning them can help reduce air pollution and carbon emissions. National regulations and codes need to be developed to organize the processes of production, storage, transport and use of green hydrogen.

References

1. Al-Delaimy W, Ramanathan V and Sánchez Sorondo M (2020): Health of people, health of planet and our responsibility: Climate change,

air pollution and health, p. 419. Springer Nature.
2. Alghamdi AS and Harrington J Jr (2018): Time-sensitive analysis of a warming climate on heat waves in Saudi Arabia: temporal patterns and trends. Int J Climatol 38:3123–39. https://doi.org/10.1002/joc.5489
3. Al-Mailam M, Arkeh J and Hamzawy A (2023): Climate Change in Egypt: Opportunities and Obstacles. Work paper. Published by Carnegie Endowment for International Peace Publications Department. 1779 Massachusetts Avenue NW. Washington, DC 20036. CarnegieEndowment.org. Available at:https://carnegieendowment.org/research/2023/10/climate-change-in-egypt-opportunities-and-obstacles?lang=en
4. Ancey C (2013): Mudflow. In: Bobrowsky, P.T. (eds) Encyclopedia of Natural Hazards. Encyclopedia of Earth Sciences Series. Springer, Dordrecht. https://doi.org/10.1007/978-1-4020-4399-4_246
5. Auffhammer M, Baylis P and Hausman CH (2017): Climate change is projected to have severe impacts on the frequency and intensity of peak electricity demand across the United States. Proceedings of the National Academy of Sciences of the United States of America; 114(8): 1886–91. https://doi.org/10.1073/pnas.1613193114
6. Bakr (2023): Egyptian Path of Investments in Green Hydrogen. The Egyptian Cabinet, Information and Decision Support Center (IDSC). Policy Perspective. Available at: https://idsc.gov.eg/upload/DocumentLibraryIssues/AttachmentE/8444/Egyptian%20Path%20of%20Investments%20in%20Green%20Hydrogen.pdf
7. Bevacqua E, Rakovec O, Schumacher DL, Kumar R, Thober S, et al. (2024): Direct and lagged climate change effects intensified the 2022 European drought. Nat Geosci; 17: 1100–7. https://doi.org/10.1038/s41561-024-01559-2
8. Comegna L, Picarelli L, Bucchignani E and Mercogliano P (2013): Potential effects of incoming climate changes on the behaviour of slow active landslides in clay. Landslides; 10(4): 373–91. http://dx.doi.org/10.1007/s10346-012-0339-3
9. COP27 Sharm el-Sheikh Implementation Plan (2022): Egypt. Available at: https://unfccc.int/documents/624444
10. Delcour I, Spanoghe P and Uyttendaele M (2015): Literature Review: Impact of Climate Change on Pesticide Use. Food Research International, Impacts of climate change on food safety; 68 (February): 7–15. https://doi.org/10.1016/j.foodres.2014.09.030
11. Ebi KL, Balbus JM, Luber G, Bole A, Crimmins A, et al. (2018): Human health. In: US Global Change Research Program. Fourth National Climate Assessment. Vol. 2. Washington (DC): US Global Change Research Program. p.572–603. Available at: https://nca2018.globalchange.gov/chapter/14/
12. Ebi KL and Hess JJ (2020): Health Risks Due to Climate Change: Inequity in Causes and Consequences. Environmental Health; 39:12. https://doi.org/10.1377/hlthaff.2020.01125
13. Egypt's Second Updated Nationally Determined Contributions (NDC) (2023): United Nations Nationally Determined Contributions Registry. Available at: https://unfccc.int/NDCREG?field_party_region_target_id=All&field_document
14. Egyptian Center for Economic and Social Rights (ECESR) (2024): Before the Disaster: Urgent Measures Needed to Protect Workers from Heat Stress Risks. Available at: https://ecesr.org/en/before-the-disaster-urgent-measures-needed-to-protect-workers-from-heat-stress-risks-2/. Last updated on Thursday, 13 June, 2024.
15. Elmorshedy H, Bergquist R, Fayed A, Guirguis W, Abdel-Gawwad E, et al. (2020): Elimination of schistosomiasis requires multifactorial diagnostics: evidence from high- and low-prevalence areas in the Nile Delta, Egypt. Infect Dis Poverty ;9:31.https://doi.org/10.1186/s40249-020-00648-9
16. International Labour Organization (ILO) (2024): Ensuring safety and health at work

in a changing climate (Global report). ISBN 9789220405079 (web PDF), 9789220405062 (print). Available at: www.ilo.org/publns

17. Intergovernmental Panel on Climate Change (IPCC) (2019): Climate change and land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems: summary for policymakers. Geneva. Available at: https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/
18. Intergovernmental Panel on Climate Change (IPCC) (2022): Summary for Policymakers. In: Climate Change: Impacts, Adaptation and Vulnerability. Cambridge, UK: Cambridge University Press: 3–33. https://doi.org/10.1017/9781009325844.001.
19. Kjellstrom T, Lemke B and Otto M (2017): Climate conditions, workplace heat and occupational health in South-East Asia in the context of climate change. WHO South-East Asia J Public Health; 6(2):15–21. DOI: 10.4103/2224-3151.213786.
20. Lee HF, Fei J, Chan CY, Pei Q, Jia X and Yue RP (2017): Climate change and epidemics in Chinese history: A multi-scalar analysis. Soc Sci Med; 174:53–63.
21. Marshall PA and Schuttenburg HZ (2006): A Reef Manager's Guide to Coral Bleaching. Published by: Great Barrier Reef Marine Park Authority, Townsville, Australia. Page 7.
22. Morsy M and El Afandi G (2021): Decadal changes of heat wave aspects and heat index over Egypt. Theoretical and Applied Climatology, 146: 71–90.https://doi.org/10.1007/s00704-021-03721-x
23. Pathak H (2023): Impact, adaptation, and mitigation of climate change in Indian agriculture. Environ Monit Assess; 195(1): 52. DOI: 10.1007/s10661-022-10537-3.
24. Rongbin Xu, Pei Yu, MichaelJA, Fay HJ, Jonathan MS, et al. (2020): Wildfires, Global Climate Change, and Human Health. N Engl J Med; 383(22): 2173-81. DOI: 10.1056/NEJMsr2028985.
25. Salonen AO and Reiser D (2023): Climate Change. In: Encyclopedia of Sustainable Management. Springer. Idowu SO, Schmidpeter R, Capaldi N, Zu L, Del Baldo M and Abreu R (eds), Cham. pp 565–69. https://doi.org/10.1007/978-3-031-25984-5_75
26. Schulte PA, Jacklitsch BL, Bhattacharya A, Chun H, Edwards N, Elliott KC, et al. (2023): Updated Assessment of Occupational Safety and Health Hazards of Climate Change. J Occup Environ Hyg: 20(5–6): 183–206.
27. Sefelnasr A and Sherif M (2014): Impacts of Seawater Rise on Seawater Intrusion in the Nile Delta Aquifer, Egypt. Groundwater; 52(2): 264-76. https://doi.org/10.1111/gwat.12058
28. Sharaan M, Iskandar M and Udo K (2022): Coastal adaptation to Sea Level Rise: An overview of Egypt's efforts. Ocean and Coastal Management; March 218: 106024. https://doi.org/10.1016/j.ocecoaman.2021.106024Get rights and content
29. Sun Q, Miao C, Hanel M, Borthwick AGL, et al. (2019): Global heat stress on health, wildfires, and agricultural crops under different levels of climate warming. Environ Int; 128: 125-36. https://doi.org/10.1016/j.envint.2019.04.025
30. Speight L and Krupska K (2021). Understanding the impact of climate change on inland flood risk in the UK. Weather; 76 (10): 330-1. ISSN 1477-8696. https://doi.org/10.1002/wea.4079
31. Tebaldi C, Ranasinghe R, Vousdoukas M, Rasmussen DJ, Vega-Westhoff B, et al. (2021): Extreme sea levels at different global warming levels. Nat Clim Chang; 11: 746–51.
32. United Nations Development Program (UNDP) (2018): National Adaptation Plans in Focus: Lessons from Egypt. Available at: https://www.adaptation-undp.org/sites/default/files/resources/naps_in_focus_lessons_from_egypt.pdf.
33. United States Environmental Protection Agency

(EPA) (2024)a: Climate Change Impacts on Air Quality. Available at:https://www.epa.gov/climateimpacts/climate-change-impacts-air-quality#7foot.Last updated on September 23rd, 2024.

34. Waha K, Krummenauer L, Adams S, Aich V, Baarsch F et al. (2017): Climate change impacts in the Middle East and Northern Africa (MENA) region and their implications for vulnerable population groups. Re Environ Change; 17(6):1623–38. DOI: 10.1007/s10113-017-1144-2.
35. Walinski A, Sander J, Gerlinger G, Clemens V, Meyer-Lindenberg A et al. (2023): The Effects of Climate Change on Mental Health. Dtsch Arztebl Int. Feb 24; 120(8):117-24. DOI: 10.3238/arztebl.m2022.0403. PMID: 36647584; PMCID: PMC10154789.
36. Watts N, Amann M, Arnell N, Ayeb-Karlsson S, Belesova K, et al. (2019): The 2019 report of the Lancet Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. Lancet; 394(10211): 1836–78. DOI: 10.1016/S0140-6736(19)32596-6.
37. World Bank (2019): Arab Republic of Egypt Cost Assessment of Environmental Degradation. Air and Water Pollution. World Bank, Washington, DC. Available at:https://documents1.worldbank.org/curated/ar/619601570048073811/pdf/Egypt-Cost-of-Environmental-Degradation-Air-and-Water-Pollution.pdf
38. World Bank (2020): Climate Change Knowledge Portal (CCKP) Egypt. URL:https://climateknowledgeportal.worldbank.org/country/egypt.
39. Wright CY and Norval M (2021): Health Risks Associated With Excessive Exposure to Solar Ultraviolet Radiation Among Outdoor Workers in South Africa: An Overview. Frontiers in Public Health 9 (April): 678680. https://doi.org/10.3389/fpubh.2021.678680
40. Xuan J, Ding R and Zhou F (2021): Storm surge risk under various strengths and translation speeds of landfalling tropical cyclones. Environ Res Lett; 16(12): 124055. DOI 10.1088/1748-9326/ac3b78.https://doi.org/10.5194/nhess-24-2559-2024