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Scorching Records: The Hottest May in History and Its Impact on Our Planet, Breaking Records and Intensifying the Climate Crisis

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ABSTRACT

May 2024 has been recorded as the hottest May in history, with global temperatures averaging 1.18 degrees Celsius above the 20th-century norm, marking the twelfth consecutive month of unprecedented heat. This review aims to present a comprehensive analysis of the data pertaining to this record-breaking month. According to the National Oceanic and Atmospheric Administration (NOAA), May 2024 was the warmest May in their 175-year global record. Most of the world's land masses experienced above-average temperatures, with notable exceptions in eastern Antarctica, western Russia, southern South America, Greenland, and western North America. The persistence of elevated temperatures highlights the ongoing impacts of climate change, necessitating urgent action to mitigate its effects on ecosystems and human health. In Africa, May 2024 was recorded as the warmest month ever. The exceptionally high ocean temperatures that began in April 2023 persisted for a record 14 months, concluding in May 2024. While sea surface temperatures were below average in certain areas of the Southern and Southeast Pacific, as well as the Southern Indian Ocean basins, most other regions experienced above-average temperatures, particularly in the tropical Atlantic Ocean. Following Africa, Europe recorded the third warmest May, with North America in fifth place, South America in eleventh, Asia in ninth, and Oceania in sixth. According to the latest climate bulletin from the Copernicus Climate Change Service (C3S), the global average temperature for May 2024 was 1.52°C higher than the pre-industrial average for 1850-1900. This marked the average global temperature was 1.63°C higher than the pre-industrial average and 0.75°C higher than the average from 1991–2020, solidifying this period as the warmest on record. The review provides a comprehensive account of the record-breaking temperatures observed in May 2024, examining their extensive impacts on climate, ecosystems, and economies. It also highlights the critical consequences of rising global temperatures and outlines global initiatives aimed at addressing the climate crisis.

Keywords: Climate change; Climate impacts; Copernicus Climate Change Service; Global warming; May 2024; Record temperatures.

INTRODUCTION

Society has often been surprised by the magnitude by which recent climate extremes exceeded previous observed records. As extreme weather events intensify and become more frequent, communities around the world are grappling with unprecedented challenges, from record-breaking heatwaves and wildfires to intense hurricanes and floods (Heinrich *et al.,* 2024). The unpredictability and severity of these events serve as stark reminders of the escalating impacts of climate change on our environment, economies, and daily lives. Addressing these challenges requires concerted global efforts to mitigate greenhouse gas emissions and build resilience in vulnerable communities (Dar *et al.,* 2024).

Climate change is one of the complex environmental problems with significant impacts on ecosystems, biodiversity, and human societies (Bader and El-Shazly 2024). Climate change occurs as a result of the interaction and combination of various factors and can result in serious environmental, economic, and social impacts (Karayol and Akyol, 2024). The excessive release of greenhouse gases into the atmosphere is trapping heat, causing the planet's temperature to rise at an alarming rate. This warming has far-reaching consequences, including more frequent and intense extreme weather events, rising sea levels, melting glaciers, and disruptions of ecosystems. Addressing climate change requires urgent global cooperation to reduce emissions, transition to clean energy sources, and build resilient communities (Shah *et al.,* 2024).

Significant global changes have emerged over the past 65 years, such as observed and projected climatic shifts in the twenty-first century and global warming. Climate change (CC) presents a complex intergovernmental challenge with far-reaching impacts on worldwide ecological, environmental, socio-political, and socio-economic aspects (Abbass *et al.,* 2022). In recent years, mounting evidence underscores the escalating impacts of climate change and the increasing costs associated with adaptation. These impacts disproportionately burden populations in the Global South, reflecting historical inequalities in emission generation (Tol, 2024).

Although international climate action mostly focuses on measuring global climate change through average temperature increases, the effects of climate change are predominantly observed at a local level through

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extreme regional climate and weather events (Padalino *et al.,* 2024). Heatwaves, also known as extreme heat events, are a recurring cause of mortality due to weather. They have been proven to decrease labor productivity and have a significant influence on crucial ecosystems worldwide. Various studies indicate that as global temperatures increase, we should expect a greater occurrence of heat-waves and unprecedented heat events (Fischer *et al.,* 2021).

In a climate that is gradually warming over the span of a century, it might be unexpected for previous temperature records to be surpassed by significant margins. As the average global temperature increases steadily, large-scale deviations from past records were recorded (Perkins *et al.,* 2012). However, recent trends have shown that extreme weather events and temperature anomalies are occurring more frequently and with greater intensity than historical norms, challenging this expectation. This underscores the complex dynamics of climate change and the importance of monitoring and understanding its evolving impacts on our planet (Wang *et al.,* 2024).

In May 2024, global temperatures reached unprecedented levels, surpassing all previous records for that month in the ERA5 reanalysis dataset, which spans back to 1940. This milestone marked the twelfth consecutive month in which each month set a new record for warmth according to the ERA5 records for their respective times of the year. This pattern of successive record-breaking months bears striking resemblance to a similar streak observed during the years 2015 and 2016, underscoring the intensifying trend of global warming (Copernicus, 2024a and b).

The significance of these temperature records extends beyond mere statistical anomalies. In May 2024 global temperatures increased approximately 1.52°C above the estimated average for the pre-industrial period from 1850 to 1900. This reference period is crucial as it serves as a baseline for understanding how human activities, particularly industrialization and the burning of fossil fuels, have altered Earth's climate system (Copernicus, 2024).The ERA5 reanalysis dataset, compiled by the European Centre for Medium-Range Weather Forecasts (ECMWF), integrates vast amounts of observational data from satellites, weather stations, and other sources. It provides a comprehensive view of global climate variables, including temperature, humidity, wind patterns, and more, allowing scientists to analyze long-term climate trends and variations (Hersbach *et al.,* 2020).

The implications of record-breaking temperatures extend beyond meteorological curiosity. They highlight the urgent need for concerted global action to mitigate climate change and its impacts. Rising temperatures can lead to a host of consequences, including more intense heat-waves, altered precipitation patterns, sea-level rise, and disruptions to ecosystems and human societies (Tao *et al.,* 2024). Efforts to address climate change involve reducing greenhouse gas emissions through policy measures, technological innovation, and international cooperation (Moustafa and Ghowail, 2022). The Paris Agreement, adopted in 2015 by nearly every country in the world, aims to limit global warming to well below 2°C above pre-industrial levels, with efforts to limit it to 1.5°C Achieving these targets requires transformative changes across energy, transportation, agriculture, and other sectors to transition towards a low-carbon economy (Warren *et al.,*2024). The record-breaking temperatures observed in May 2024 underscore the urgency of addressing climate change on a global scale. As temperatures continue to rise and extreme weather events become more frequent, the imperative for ambitious climate action grows stronger. The ERA5 dataset provides valuable insights into these trends, informing policies and decisions aimed at safeguarding the planet for future generations. Understanding and responding to the challenges posed by climate change requires a collective effort from governments, businesses, communities, and individuals worldwide. This review provides a comprehensive overview of what occurred in May 2024 regarding record-breaking temperatures and discusses their wide-ranging effects on climate, ecosystems and economies, as well as the critical impact of increasing global temperatures and the global efforts towards climate action.

Climate change: Extreme May 2024

In May 2024, the global climate continued to present alarming trends, with the past twelve months setting unprecedented records, largely attributed to escalating greenhouse gas emissions compounded by the influence of an El Niño event in the tropical Pacific. Samantha Burgess, Deputy Director of the Copernicus Climate Change Service (C3S), emphasized that without achieving net-zero global emissions, temperatures will continue to rise, record-breaking occurrences will persist, and extreme weather events will become more frequent, specifically, in Europe, May 2024 recorded an average temperature 0.88°C above the 1991-2020 average, ranking it as the third warmest May on record for the continent. The temperature anomalies were most pronounced across northern regions, contrasting with below-average temperatures observed over Russia and parts of southwestern and southeastern Europe (Copernicus, 2024a and b).

Beyond temperatures, precipitation patterns in May 2024 varied significantly across Europe. Northern regions, including Iceland, the UK, Ireland, and central and southeastern Europe, experienced above-average rainfall, as indicated by anomalies in precipitation, soil moisture, and relative humidity (Van Daalen *et al.,* 2024). Conversely, dry conditions prevailed over large swathes of the Iberian Peninsula, where Mediterranean areas are enduring prolonged drought. Similarly, northeastern Germany extending across Eastern Europe to the Caspian Sea, including southern Fennoscandia and the Baltic countries, also faced drier-than-average conditions. Particularly notable was the persistent low-pressure system over central Europe, which triggered intense storm-like rainfall, leading to river overflow, widespread flooding, and extensive damage across the

region (Lavers *et al.*, 2024).

These contrasting climate impacts highlight the complexity and regional variability of climate change effects within Europe. The stark disparities between wetter and drier conditions underscore the challenges faced by different regions in managing water resources, mitigating flood risks, and adapting to changing climatic conditions. As global temperatures continue to rise, the urgency for coordinated international efforts to reduce greenhouse gas emissions and enhance resilience against extreme weather events becomes increasingly critical for safeguarding communities and ecosystems across Europe and beyond (Weyland *et al.*, 2024).

The global mean near surface temperature change is the primary measure utilized to monitor the Earth's increasing climate temperature. Policy makers utilize it to establish global objectives for mitigating human-caused greenhouse gas emissions, with the aim of stabilizing worldwide temperatures and preventing perilous levels of climate change. The Paris Agreement, established by the United Nations Framework Convention on Climate Change in 2015, seeks to restrict the increase in global temperatures to a level significantly below 2°C over the levels recorded before the industrial period. Additionally, it strives to make efforts to limit the temperature rise to 1.5°C above pre-industrial levels.

Before 2023, the hottest year ever recorded, as determined by the average of the six main global temperature datasets used by the World Meteorological Organization (WMO), was 2016. The temperature anomaly above pre-industrial levels (considered to be 1850-1900) was $+1.29 \pm 0.12$°C, according to the WMO in 2024. Nevertheless, the previous record was surpassed in 2023 by a significant anomaly of +1.45 ± 0.12°C (WMO, 2024). Taking this into consideration, there was a significant curiosity on whether 2024 will be much hotter and if it will be the first year to surpass a +1.5°C increase in the WMO average temperature (Dunstone *et al.*, 2024).

The remarks from Carlo Buontempo, Director of the Copernicus Climate Change Service (C3S), and the subsequent statement by UN Secretary-General António Guterres underscore the gravity of the climate situation in May 2024 and its broader implications. Carlo Buontempo, C3S Director, comments: “It is shocking but not surprising that we have reached this 12-month streak. While this sequence of record-breaking months will eventually be interrupted, the overall signature of climate change remains and there is no sign in sight of a change in such a trend”. He also adds: “We are living in unprecedented times, but we also have unprecedented skill in monitoring the climate and this can help inform our actions. This series of hottest months may ultimately be viewed as relatively cool. However, if we can stabilize greenhouse gas (GHG) concentrations in the atmosphere in the near future, we could potentially revert to these "cooler" temperatures by the end of the century.” Carlo Buontempo acknowledges the unprecedented nature of the twelve-month streak of record-breaking global temperatures. He notes that while this sequence of extreme heat will eventually be interrupted, the underlying trend of climate change remains robust and shows no signs of abating. Buontempo emphasizes the critical role of advanced climate monitoring capabilities in informing effective climate action. He suggests that stabilizing greenhouse gas concentrations promptly could potentially revert future temperatures to what is now considered "comparatively cold" by the end of the century. United Nations Secretary-General, António Guterres, states: For the past year, every turn of the calendar has turned up the heat.

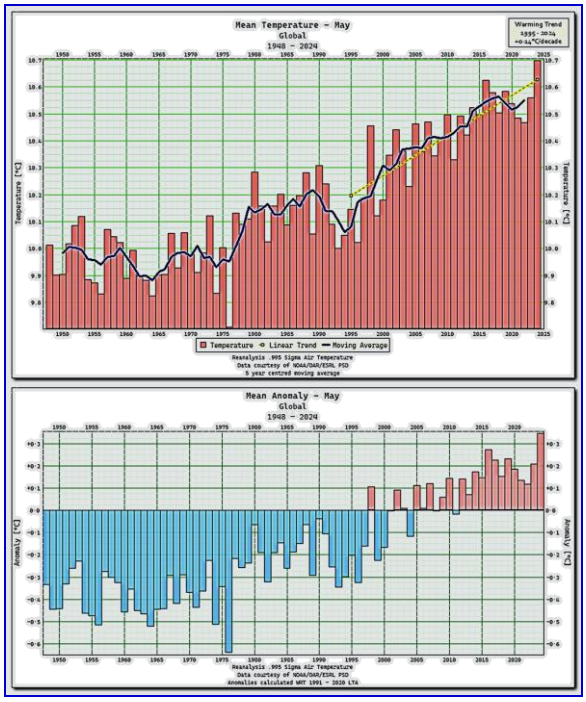

Figure (1): May 2024 has set a new record as one of the hottest months globally from 1948 to 2024, according to sources from Weather Diary (2024).

Our planet is trying to tell us something, but we do not seem to be listening. We are shattering global temperature records and facing the consequences. It is climate crunch time. Now is the moment to mobilize, act, and deliver. UN Secretary-General António Guterres echoes these concerns, highlighting the urgency of the climate crisis. He emphasizes that each passing month sets new temperature records, sending a clear message from our planet. Guterres stresses the need for immediate mobilization, action, and tangible results in addressing climate change, asserting that it is indeed "climate crunch time”.

The global average temperature was 1.52°C above the pre-industrial average from 1850 to 1900. This marks the 11th consecutive month since July 2023 in which temperatures have been at or above 1.5°C above pre-industrial levels. Over the last 12 months (June 2023 - May 2024), the global average temperature has been the highest on record, surpassing the 1991-2020 average by 0.75°C and exceeding the 1850-1900 pre-industrial average by 1.63°C, as shown in Figure (2).

Rising temperatures and ecosystem collapse

Climate change profoundly impacts global ecosystems, disrupting natural processes and threatening biodiversity (Darwish, 2024). Rising temperatures exacerbate habitat loss and fragmentation, forcing many species to migrate to more suitable climates. However, such migrations often result in isolated populations, reducing their capacity to adapt and survive (Van Daele, 2024). Additionally, altered precipitation patterns driven by climate change lead to more frequent and severe droughts and floods. These extremes disrupt ecosystems by affecting plant growth, water availability, and soil stability, thereby accelerating soil erosion (Rupngam and Messiga, 2024).

The ongoing rise in global temperatures not only endangers individual species but also destabilizes entire ecosystems. Increased temperatures drive shifts in species distributions, with some unable to migrate quickly enough to escape the heat. This can alter predator-prey dynamics, potentially causing the collapse of food webs. The loss of biodiversity further weakens ecosystem resilience, making it more difficult for ecosystems to recover from disturbances such as wildfires and extreme weather events.

Coral reefs are particularly vulnerable to these changes. Rising sea temperatures lead to coral bleaching, a phenomenon where corals expel their symbiotic algae, resulting in the loss of color and vitality. This bleaching can decimate marine biodiversity, as coral reefs provide critical habitats for a wide range of marine species. Terrestrial ecosystems face similar threats; increasing droughts and floods can degrade soil composition and fertility, significantly affecting plant and animal life.

Ocean acidification is another critical consequence of climate change, resulting from the absorption of excess carbon dioxide by the oceans. This process lowers pH levels, posing a significant threat to marine life. Coral reefs and shellfish, which rely on calcium carbonate to construct their shells and skeletons, are particularly at risk. Acidic waters hinder this process, compromising the structural integrity of these organisms (Jiang *et al.*, 2024). Rising ocean tempera-tures further exacerbate coral bleaching, with cascading effects on marine ecosystems (Klein *et al*., 2024).

Shifts in growing seasons are also becoming increasingly evident, as plants and animals adjust their life cycles in response to rising temperatures. These changes disrupt ecological relationships and create additional challenges for the survival of many species. As climate change accelerates, the implications for ecosystems are severe and far-reaching

Global temperature and economic growth

Climate change is fundamentally driven by the increase in average global temperatures, which intensely affects the Earth's climate system. Rising temperatures disrupt weather patterns, alter ocean currents, and modify atmospheric conditions, leading to significant changes in the frequency, greatness, and distribution of extreme weather events worldwide. Understanding the economic implications of climate change required exa-

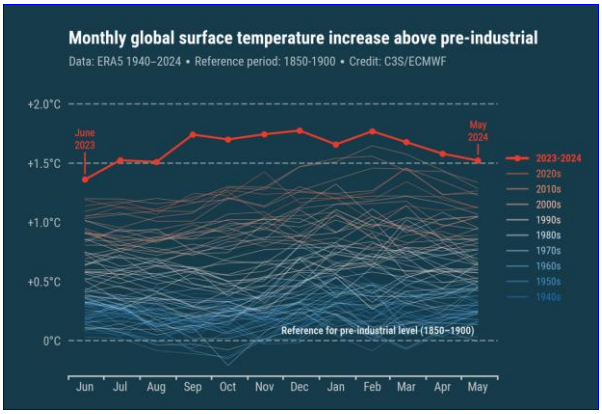

Figure (2): The image graph illustrates global temperature trends: A visual analysis of record-breaking May 2024 heat surpassing pre-industrial levels. The image showed mmonthly records temperatures (°C) compared to the average from 1850–1900; covering the period from January 1940 to May 2024. The most recent period (June 2023 – May 2024) is highlighted by a thick red line, while other years are represented by thin lines color-coded by decade, ranging from blue (1940s) to brick red (2020s). The data is derived from the ERA5 dataset. Source: Copernicus Climate Change Service (2024).

amining fluctuations in global temperature (Bilal and Känzig, 2024). As anthropogenic green-house gas emissions continue to drive temperature increases, the associated risks to global economies become more pronounced. These impacts include reduced agricultural productivity, increased disaster recovery costs, shifts in labor productivity, and sensitive pressures on infrastructure. Moreover, the cascading effects on trade, public health, and societal resilience emphasize the critical need for climate adaptation and mitigation measures to safe-guard long-term economic stability.

Agriculture and food security

Agriculture, a cornerstone of many economies, is particularly vulnerable to temperature changes. Rising temperatures can lead to reduced crop yields, changes in growing seasons, and increased pressure on water resources. Extreme weather events, such as droughts and floods, further exacerbate these challenges, threatening food security and livelihoods. In regions heavily reliant on agriculture, such as parts of Africa, South Asia, and Latin America, these impacts can be especially severe, affecting economic stability and development (Lou *et al.*, 2024).

Labor productivity and health

Temperature extremes affect labor productivity, particularly in sectors like construction, manufacturing, and agriculture, where outdoor work is common. Heat stress can reduce worker efficiency and increase health risks, leading to lost workdays and higher healthcare costs. As temperatures continue to rise, industries and governments must invest in measures to protect workers and maintain productivity, which can strain economic resources (Caruso *et al.*, 2024).

Energy demand and infrastructure

Warmer temperatures significantly influence energy demand patterns. The increased use of air conditioning and cooling systems during heat waves leads to higher electricity consumption, which affects both household budgets and industrial operations. Additionally, rising

temperatures place stress on infrastructure, including transportation networks and buildings, necessitating costly upgrades to enhance resilience against climate impacts (Yuan *et al*., 2024). These changes in energy demand and infrastructure requirements highlight the need for strategic planning and investment in sustainable energy solutions to mitigate the effects of climate change. This revision improves clarity, coherence, and flow while maintaining the scientific integrity of the content. The added concluding sentence emphasizes the broader implications of the discussed issues.

Severe consequences of climate change on a global scale

Severe consequences of climate change are manifesting on a global scale. The distribution of climate change risk and susceptibility is uneven, as is the ability to adapt to its negative impacts, which include health consequences, economic implications, and forced relocation (Parsons *et al*., 2024).

In Haiti, Brazil and USA

On May 20, 2024, Haiti's Civil Protection issued a flood alert for four departments due to intense rainfall affecting the country (Figure 3). Reports indicate that 50 individuals sustained injuries and 200 residences were impacted. In the Bassing-Blue village, located in the Nord-Ouest department, over 300 families have been forced to evacuate their homes. Astonishing for the effect of climate change, is the occurrence of severe flooding which has already occurred in Haiti from November 30 to December 4, where multiple houses and streets in various regions, particularly in the North, North-west, and Grande-Anse departments, were flooded following days of heavy rainfall. Preliminary reports indicate multiple losses and significant property damage, especially in the Grande-Anse Department, where approximately 80% of specific cities (Jérémie and Dame-Marie) were flooded. This flooding event exemplifies the severe impacts of climate change, leading to widespread devastation and disruptions (Octave and Joseph, 2024).

Similarly, on May 23, 2024, the Government of Rio Grande do Sul in Brazil released new data regarding severe rainfall affecting 468 municipalities in the state (Figure 4). This represents an increase of one city compared to the report from May 22 (PAHO, 2024). On the same day, the United States Federal Emergency Management Agency (FEMA) reported intense weather conditions impacting parts of the Central Plains and Midwest (Figure 5). The report indicated five fatalities (an increase of one since May 22) and noted that one shelter was established to accommodate three individuals. Additionally, a total of 35 individuals in Iowa were reported injured (PAHO, 2024).

In addition, the recent heat wave in the United States has had significant and varied impacts across different regions, influenced by factors such as geography, urbanization, and socio-economic conditions. For example, Death Valley recorded an alarming 129°F (53.9°C) on July 77. This extreme weather not only led to health emergencies but also contributed to wildfires in California as dry conditions prevailed (Barlow and Basara, 2024).

Figure (3): Photograph of urban flooding, Haiti, 2024 , after extreme weather event: Challenges and impacts. Source: The Haitian time (2024).

Figure (4): Photograph of the 2024 Rio Grande do Sul floods. Source: France 24. (2024).

Figure (5): FEMA expands disaster aid for extreme weather events, citing climate change. Source: DeLuca (2024).

These events highlight the urgent need for comprehensive climate adaptation strategies to mitigate the adverse effects of climate change on vulnerable populations. As global temperatures rise, the frequency and intensity of extreme weather events are expected to increase, straining communities and infrastructure worldwide.

The increase in global temperatures directly impacts the Earth's water cycle. Higher temperatures lead to increased evaporation rates (Kuang *et al*., 2024), enhancing the atmosphere's capacity to retain moisture. This results in greater precipitation and runoff in some areas while exacerbating drought conditions in others (Moustafa *et al.*, 2023). Consequently, already wet regions experience increased moisture, while dry areas suffer from reduced availability. Intensified drought conditions can lead to forest die-off, increasing susceptibility to wildfires. Additionally, decreased humidity levels heighten fire hazards in regions with abundant debris, which scientists refer to as biomass/fuel availability (Kreider *et al*., 2024). These alterations in the water cycle highlight the elaborate relationships between increasing temperatures and ecosystem health, further demon-strating the serious consequences of climate change on ecosystems worldwide.

In May 2024, rising temperatures are likely to intensify wildfire activity across various regions (Figure 6). The increased heat and prolonged dry conditions create an ideal environment for wildfires to ignite and spread rapidly, posing significant risks to both ecosystems and communities. Preparation and proactive measures will be crucial in mitigating the impact of these fires.

Pakistan's 2024 Climate Catastrophe

In 2024, Pakistan experienced a series of devastating natural disasters that underscored the escalating impacts of climate change. Intense heatwaves, widespread flooding (Figure 7A-B), glacial lake outburst floods, and landslides resulted in significant loss of life, extensive infra-structure damage, and substantial economic disruption (Adnan *et al*., 2024).

Extreme Heat and Water Scarcity

The country endured severe heat waves during May 2024, with temperatures soaring above 45°C (113°F) in many regions (Ahmad, 2024). This extreme heat led to a public health crisis, characterized by heatstroke and dehydration. The situation was exacerbated by water shortages, as increased demand for cooling and irrigation strained water resources (Kenny *et al.*, 2024). Devastating Floods Pakistan was subsequently battered by unprecedented monsoon rains, resulting in widespread flooding across the country (Bazai *et al.*, 2024). The early onset and intensity of the rains overwhelmed drainage systems, leading to both riverine and flash floods, the flooding caused massive destruction of homes, infrastructure, and agricultural land (Amengual et al., 2024). Entire communities were displaced, and the loss of life was significant (Figure 8). The Indus River basin and its tributaries bore the brunt of the flooding, with floodplains inundated and water levels reaching alarming heights (Ghanbari *et al.*, 2024).

Glacial Peril

The northern regions of Pakistan, particularly Gilgit-Baltisan, faced the added threat of glacial lake outburst floods (GLOFs) (Wells *et al.*, 2023). Rapid glacial melt caused by rising temperatures led to the formation of unstable glacial lakes, when these lakes burst, they unleashed torrents of water and debris, destroying property and endangering lives (Hill, 2024). The valleys of

Figure (6): Photograph of Alberta wildfire. source: https://www.alberta.ca/alberta-wildfire.

Figure (7): Photograph of the impact of torrential rains in Pakistan (2024): widespread flooding (A) and Community displacement (B). Source: Farida time (2024).

Hunza and Shigar were particularly vulnerable to these catastrophic events (Hussain and Khan 2024).

Landslide Threat

To compound the crisis, heavy rains triggered landslides in hilly and mountainous areas across the country. These landslides blocked roads, damaged property, and claimed lives. They also exacerbated the impact of flooding by obstructing river channels and increasing the risk of further inundation (Sana *et al*., 2024).

From crisis to action: Advancing climate adaptation in Pakistan

The disasters that struck Pakistan in 2024 serve as a stark reminder of the urgent need for effective climate adaptation measures. Investing in early warning systems, strengthening flood defenses, systems, strengthening flood defenses, and developing resilient infrastructure are crucial steps to mitigate the impacts

of climate change (Malik *et al*., 2024). Additionally, raising public awareness about climate risks and disaster preparedness is essential for enhancing community resilience; the long-term implications of these events extend far beyond immediate relief and recovery efforts (Morganstein, 2024).

To safeguard its population and economy from future climate-induced catastrophes, Pakistan must prioritize sustainable development and implement climate-resilient practices (Hassan *et al*., 2024). The National Climate Change Policy (NCCP) emphasizes the importance of adaptation strategies across various sectors, including water management, agriculture, and urban planning. By fostering collaboration among government agencies, local communities, and international partners, Pakistan can effectively enhance its capacity to respond to the challenges posed by climate change.

In India

In May 2024, India experienced an unprecedented heatwaves that gripped large parts of the country, marking one of the most severe heat events in recent history (Khaiwal *et al*., 2024). Temperatures soared to record-breaking levels, significantly surpassing the seasonal averages and illustrating the intensifying impacts of climate change (Oliveira *et al*., 2024). This extreme heat-wave served as a stark manifestation of the broader climate challenges facing the nation (Ravindra *et al*., 2024).

The effects of the heatwave were widespread and severe. Agricultural productivity took a major hit as crops withered under the relentless sun, leading to reduced yields and heightened food insecurity (de Bont *et al.,* 2024). The intense heat also exacerbated water scarcity, putting additional strain on already limited resources and complicating efforts to meet the needs of both urban and rural populations. Furthermore, the surge in power demand as people sought relief through air conditioning put immense pressure on the electricity grid, resulting in frequent outages and added strain on energy infrastructure (Feng *et al*., 2024). From health view, heat-related illnesses, such as heatstroke and dehydration, led to a tragic loss of life. Meanwhile, the extreme temperatures disrupted daily life, affecting transportation, education, and outdoor activities, and forcing many to adapt to a new and challenging environment. This extreme heat event highlighted India's growing vulnerability to the impacts of climate change.

In Saudi Arabia

In May 2024, Saudi Arabia experienced extreme weather conditions that were attributed to the effects of climate change, the country saw unprecedented heat waves, with temperatures soaring to record highs (Syed *et al.,* 2024). This severe heat was part of a larger pattern of unusual weather phenomena affecting the region, including prolonged droughts and intense sandstorms, these extreme conditions had significant impacts on various aspects of life in Saudi Arabia (Almulhim *et al.,* 2024). Agriculture and water resources were particularly affected, as the country already faces challenges related to water scarcity and arid conditions. The heat waves exacerbated these issues, leading to concerns about food security and increased pressure on water management systems (Almadini, 2024). In May 2024, the Saudi Ministry of Foreign Affairs reported that the extreme heat-waves had resulted in a significant number of deaths. According to their announcement, there were approximately 2,300 fatalities attributed to the unusually high temperatures. This number underscored the severe impact of the heat-waves on public health and the urgent need for effective climate adaptation and emergency response strategies as in (CLIMA, 2024).

In Sudan

In May 2024, Sudan faced a complex crisis characterized by widespread conflict, but a particularly devastating climate-related disaster emerged amid the turmoil. Widespread fires ravaged numerous regions, resulting in extensive community displacement and significant property damage. Between April 29 and May 7, 2024, fires displaced an estimated 1,900 individuals (approximately 380 households) and partially or completely damaged over 355 houses (Monshipouri and Mohajer 2024). These fires were attributed to increased temperatures and drier conditions, exacerbating the already dire humanitarian situation in the country (Figure 7).

Rising temperatures and increasingly arid weather, often linked to climate change, exacerbated the intensity and spread of the fires (Johnston *et al.,* 2024). The impact was severe thousands of people were displaced, seeking refuge in overcrowded camps, and the destruction of homes and farms left communities struggling to rebuild (Youvan , 2024). Areas such as Darfur and Kordofan were particularly hardhit. This confluence of conflict and climate-induced disasters created an unprecedented crisis for the Sudanese people (Atassi *et al.,* 2024). Although the fires and resulting displacement are well-documented, other climate-related issues like heat waves and drought may have also been occurring, but their effects are less reported due to the overarching crisis (John, 2024).

Figure (8): Photograph of the heat crisis in Sudan, which faces a severe crisis in 2024: A disaster unfolds with widespread impact and humanitarian consequences. Source: Kirui (2024).

In Canada

Canada has witnessed an increase in extreme weather events, yet identifying specific climate-related disasters for May 2024 remains challenging due to data limitations (Donatti et al., 2024). The complex nature of these events, which often involve precursors and consequences that extend beyond a single month, complicates accurate data collection and analysis (Vogel *et al*., 2024). Furthermore, the evolving climate land-scape, characterized by rising temperatures and shifting precipitation patterns, intensifies the unpredictability of such disasters. As a result, researchers face significant difficulties in forecasting and responding to these climate impacts effectively. Enhanced monitoring and data-sharing initiatives are crucial to improving our understanding of these phenomena and developing robust strategies for mitigation and adaptation. May in Canada typically represents a transitional period between spring and summer, characterized by potential weather-related challenges, including flooding. During this time, the combination of snowmelt and rainfall can cause rapid increases in river levels, leading to inundation in low-lying areas (Lindenschmidt *et a*l., 2024). Although wildfires are more prevalent during the summer months, they remain a potential risk in drier regions, even during late spring. Severe storms, including thunderstorms, tornadoes, and hail, also pose a threat during this period (Wang et al., 2024).

Wildfires in Canada: A Growing Concern

As May announcers the beginning of the wildfire season in many regions of Canada, it is increasingly evident that the intensity and frequency of these fires were accelerating as documented in figure (9A-B). This surge can be largely attributed to climate change, which has brought about rising temperatures and altered precipitation patterns. These changes have created conditions that are more conducive to the outbreak and spread of wildfires (MacCarthy *et al.,* 2024).

Several factors contribute to the heightened risk of wildfires. Drought is a significant factor, as extended periods of dryness decrease soil moisture and turn forests into highly flammable environments (Jain *et al.*, 2024). Heat-waves further exacerbate this problem by increasing temperatures, which accelerates the drying process and makes vegetation even more susceptible to ignition. Additionally, insect infestations, such as those caused by the pine beetle, have become more prevalent in warmer conditions. These pests weaken trees, reducing their resilience to fire and contributing to the spread of wildfires (Graus *et al.,* 2024).

The impact of wildfires is profound and multi-faceted. On an ecological level, wildfires can lead to the loss of critical habitat for wildlife, disrupt ecosystems, and contribute to soil erosion in Figure (9) (Tedim *et al.,* 2021). The destruction of vegetation also poses significant air quality issues, as smoke and particulate matter from fires can degrade air quality and pose health risks to humans (Marcos *et al.,* 2023). Furthermore, wildfires can cause substantial property damage and put human lives at risk, particularly in communities situated near forested areas (Villaverde *et al.,* 2024). The disruption of daily life due to evacuation from fire zones may leave individuals without access to emergency provisions and shelter.

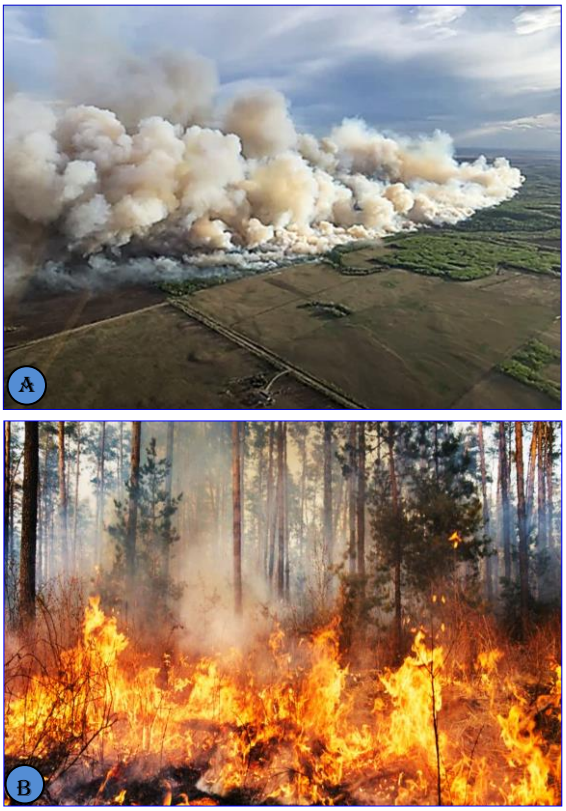

Figure (9): Photograph of wildfire in Canada. A, A wildfire in Grande Prairie County, located east of Teepee Creek, Alberta, Canada. Source: Kennedy (2024). B, A wildfire in a forested area of Canada, May 16th, 2024. Source: Forest Fire News (2024).

It is important to recognize that the wildfire situation in Canada varies widely across the country. Certain regions are more prone to wildfires due to factors such as topography, vegetation type, and human activities. For instance, areas with dense forests and dry conditions are at a higher risk, while urban areas may face different challenges. Understanding these regional differences is crucial for effective wildfire management and mitigation strategies (Dastour *et al.,* 2024).

In Egypt

The Egyptian climate has always been characterized by hot summers, with temperatures often exceeding 40 ^{o}C. However, in recent years, the effects of climate change have intensified these extreme weather events including the May-July 2024 heatwave, which was particularly severe**,** with temperatures raised to over 50 ^{o}C in the most parts of the country. This record-breaking heatwave had a devastating impact on agriculture, with crops wilting and livestock suffering from heat stress. The increased demand for electricity to power air conditioning units also placed a strain on the country's energy infrastructure.

Another influential individual during this period was Minister of Agriculture, efforts to support farmers and protect agricultural livelihoods in the face of the heatwave were carried out including implemented emergency measures to provide farmers with access to water and livestock feed, as well as subsidies to help

offset the losses acquired during the heatwave to minimize the impact of the extreme weather on Egypt's food production and agricultural sector. However, the agricultural system faced significant challenges due to the high evaporation rates from water resources, particularly from the Nile River. This situation intensified water scarcity for irrigation, further straining agricultural practices. The combination of extreme temperatures and reduced water availability highlights the urgent need for effective strategies to sustain resilience within Egypt's agricultural sector.

For health sector, a public health perspective, posed significant challenges, with a surge in heat-related illnesses and hospitalizations reported across the country, particularly for elder people and children. A crucial role in raising awareness about the dangers of extreme heat and providing guidance on how to stay safe during the heatwave was announced all over Egyptian regions. An advocacy for increased access to cooling centers and public health interventions helped to reduce the number of heat-related fatalities during this period.

In conclusion, the July 2024 heatwave in Egypt highlighted the urgent need for proactive measures to address the challenges of climate change and awareness that should be taken. The efforts implemented during this period enabled the country to navigate the effects of the heatwave and enhance its resilience to future climate-related events.

Global efforts towards climate action

Since the hottest month in 2024, global efforts towards climate action have intensified significantly, particularly following the commitments made at COP 28 in Dubai. Countries around the world promised to phase out fossil fuels from their energy systems and set ambitious targets to triple renewable energy capacity and double energy efficiency by 2030. The UN's Climate Promise 2025 initiative aims to help countries align their Nationally Determined Contributions (NDCs) with the 1.5°C goal, emphasizing the importance of integrating climate strategies with national development priorities. At the COP29 conference held in November 2024, nearly 200 countries agreed to triple climate finance for developing nations, raising the target from USD 100 billion to USD 300 billion annually by 2035. This landmark agreement underscores the necessity of financial support for mitigation and adaptation efforts, especially as countries prepare to submit new climate action plans by early 2025. Additionally, significant advancements were made in carbon market frameworks and adaptation strategies, highlighting a collective commitment to addressing the climate crisis through enhanced cooperation and ambitious action.

Climate action is now a central focus of international cooperation, encompassing a range of strategies and initiatives aimed at reducing greenhouse gas emissions, enhancing resilience, and promoting sustainability. However, action for climate change was started since 2015 with Paris Agreement, adopted in 2015. This landmark accord, negotiated under the United Nations Framework Convention on Climate Change (UNFCCC), aims to limit global warming to well below 2°C above pre-industrial levels, with an aspiration to limit it to 1.5°C (Naser and Pearce, 2022).

One of the most significant milestones in global climate action is the Paris Agreement, adopted in 2015. This landmark accord, negotiated under the United Nations Framework Convention on Climate Change (UNFCCC), aims to limit global warming to well below 2°C above pre-industrial levels, with an aspiration to limit it to 1.5°C (Naser and Pearce, 2022). The agreement sets out nationally determined contributions (NDCs) that require countries to outline and commit to their own climate action plans. Countries are expected to regularly update and enhance these commitments to reflect their highest level of ambition (Pauw and Klein 2021).

In addition to international agreements, numerous countries and regions have established their own climate policies and strategies. For instance, the European Union has emerged as a leader in climate action, setting ambitious targets for reducing carbon emissions, increasing renewable energy use, and promoting energy efficiency through its European Green Deal. Similarly, China has committed to reaching peak carbon emissions before 2030 and achieving carbon neutrality by 2060, marking a significant step from the world’s largest emitter of greenhouse gases (Siddi, 2020). Subnational efforts are also crucial in the fight against climate change. Cities, states, and provinces around the world are implementing innovative solutions tailored to their specific contexts. For example, cities like Copenhagen and San Francisco are investing in green infrastructure, expanding public transportation, and supporting renewable energy projects. These local initiatives not only contribute to overall emission reductions but also showcase practical approaches to addressing climate change (Mello and TerMinassian, 2023).

In conclusion, global efforts to mitigate and adapt to climate change are inherently complex, requiring the engagement of diverse stakeholders, including governments, industries, scientific communities, and civil society. Despite progress made in addressing climate challenges following the record-breaking temperatures in 2024, much work remains to be done to meet global climate goals. A comprehensive and sustainned approach, integrating innovative technologies, policy frameworks, and community-level action, is critical to effectively reduce greenhouse gas emissions, enhance resilience to climate impacts, and promote sustainable development. Through continued collaboration across sectors and regions, there is optimism that a more sustainable, equitable, and climate-resilient future can be achieved.

CONCLUSION

In conclusion, May 2024 stands as a pivotal moment in the ongoing narrative of climate change, marked by unprecedented record-breaking temperatures. This review has highlighted the extensive impact of these temperature anomalies on climate systems, ecosystems,

and economies. The far-reaching consequences underscore the urgent need for robust and coordinated global climate action. As temperatures continue to rise, it is crucial for nations, communities, and individuals to strengthen their efforts in mitigating climate change and adapting to its effects. The challenges ahead are significant, but they also present an opportunity for transformative change towards a more resilient and sustainable future.

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أرقام قياسية حارقة: أكثر شهور مايو حرارة في التاريخ وتأثيرها على كوكبنا، تحطيم الأرقام القياسية وتفاقم أزمة المناخ

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الملخـــص العـربـي

يهدف هذا المقال إلى توثيق جميع البيانات التي تم رصدها على مستوى العالم بشأن أكثر شهور حرارة في عام 2024. فقد كان شهر مايو للعام 2024، هو الأكثر حرارة في معظم دول العالم، وفقًا لسجلات الإدارة الوطنية للمحيطات والغلاف الجوي الأمريكية (NOAA) التي تمتد على مدار 175 عامًا. حيث بلغ متوسط درجات الحرارة العالمية في هذا الشهر 1.18 درجة مئوية فوق المعدل، وهو أعلى من متوسط درجة الحرارة البالغ 14.8 درجة مئوية الذي سُجّل في القرن العشرين. يعتبر شهر مايو 2024 هو الشهر الثاني عشر على التوالي الذي شهد درجات حرارة قياسية على مستوى الكوكب، باستثناء بعض المناطق في شرق أنتاركتيكا، وغرب روسيا، وجنوب أمريكا الجنوبية، وغرينلاند، وغرب أمريكا الشمالية. كما سجلت معظم كتل اليابسة في العالم درجات حرارة أعلى من المتوسط. وفي قارة إفريقيا، استمرت درجات حرارة المحيطات في تسجيل مستويات مرتفعة منذ أبريل 2023، وهو ما امتد لفترة قياسية بلغت 14 شهرًا، واستمر حتى مايو 2024، وفي بعض المناطق استمر حتى نهاية يوليو من نفس العام. على مستوى المحيطات، كانت درجات حرارة سطح البحر أقل من المتوسط في بعض أجزاء حوض المحيط الهادئ الجنوبي، وجنوب شرق المحيط الهادئ، وحوض المحيط الهندي الجنوبي. ولكنها كانت أعلى من المتوسط في معظم المواقع الأخرى، مع تسجيل درجات حرارة قياسية في المحيط الأطلسي الاستوائي. وفقًا لما ورد في نشرة المناخ التي أصدرتها خدمة كوبرنيكوس لتغير المناخ(C3S) ، سجل شهر مايو 2024 درجة حرارة عالمية تزيد بمقدار 1.52 درجة مئوية عن المتوسط قبل الثورة الصناعية (1850-1900)، مما جعله الشهر الحادي عشر على التوالي (منذ يوليو 2023) الذي كانت فيه درجات الحرارة عند أو أعلى من 1.5 درجة مئوية. كما كانت الأشهر الاثني عشر الماضية (من يونيو 2023 إلى مايو 2024) هي الأكثر حرارة على الإطلاق، حيث بلغ متوسط درجة الحرارة العالمية 1.63 درجة مئوية فوق المعدل قبل الصناعة، وأعلى بـ 0.75 درجة مئوية من متوسط الفترة بين 1991 و2020. يستعرض هذا المقال بشكل مفصل درجات الحرارة القياسية التي تم رصدها في مايو 2024، مع التركيز على تأثيراتها الواسعة على المناخ والأنظمة البيئية والاقتصادات. كما يناقش المقال العواقب الحرجة التي قد تنتج عن ارتفاع درجات الحرارة على المستوى العالمي، بالإضافة إلى المبادرات العالمية التي تهدف إلى معالجة أزمة تغير المناخ.