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Climate Health Emergency

Understanding the health impacts of the climate crisis

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ABSTRACT

The climate crisis is the greatest threat to global health. Anthropogenic greenhouse gas emissions have increased the temperature of the Earth by over 1.5 °C and caused sea levels to rise by over 24 cm since the beginning of the 20th century. 2024 was the warmest year on record and the last 10 hottest years have all occurred in the last 10 years. Climate models suggest that global surface temperature could rise between 1.5 °C and 5.5 °C compared with the pre-industrial period by 2100, and sea-level rise could be between 0.5 m and 1.3 m. Climate change is already causing significant shifts in weather patterns and an increase in extreme weather events around the world, including droughts, heatwaves, wildfires, storms and floods. These are having an impact on the spread of infectious diseases and the severity of non-infectious diseases. Climate change is already causing food and water insecurity, increasing levels of malnourishment and the burden of disease. The unpredictable impacts of climate change and the perceived inaction from local, national and international leaders, is creating anxiety that is contributing to deteriorating mental health, particularly in young people. The health impacts of climate change will increase in the future if nothing is done to curb greenhouse gas emission. We need action to deal with the climate crisis while improving the health, security and income of the very poorest people in our global society. We must plan for a net zero world that provides healthy, safe and low environmental impact lives for 10 billion people by 2050.

Anthropogenic climate change

Human activities have increased levels of the greenhouse gases (GHG) carbon dioxide by 50% and methane by over 150% in our atmosphere since the beginning of the Industrial Revolution.[1] Carbon dioxide levels in the atmosphere are now higher than anytime in the last 3 million years.[2] In 2024 we emitted the most greenhouse gases of any year recorded.[3]

Anthropogenic GHG emissions have increased the temperature of the Earth by over 1.5 °C and caused sea levels to rise by >25 cm since the beginning of the 20th century. Since 1880, the 10 warmest years on record have all occurred in the past 10 years.[4] 2024 was the warmest year ever recorded: global temperatures crossed the 1.5 °C threshold, set by global leaders in Paris in 2015, for the first time.[5]

Significant resulting changes in the Earth's climate system have been observed:[2] warming of the land and oceans and sea levels rising all over the world, melting of permafrost, earlier occurrence of plant growth in spring, shifts in geographic ranges of some plants, animals and insects. Extreme weather events have increased globally,[2] including superstorms, mega-floods, severe droughts, unprecedented heatwaves and uncontrollable wildfires.

Over 35 global climate models have been run for different future scenarios, ranging from no climate action to maximum efforts to keep temperature rises below 1.5 °C.[6] These models suggest that, by the end of the century, global temperatures could rise between 1.5 °C-5.5 °C compared with the pre-industrial period (Fig. 1). In all predictions, average land and ocean precipitation increase.

Extreme heat, drought, and wildfires

As temperatures increase, heatwaves increase. As precipitation becomes more variable and concentrated into more intense rainfall events, so dry periods extend, and droughts increase (Fig. 2). The combination of extreme heat and drought causes more wildfires.[2]

Heatwaves are often referred to as the 'silent killer'. As discussed by Maslin,[7] they disproportionately affect older people. Sustained night-time temperatures are the main cause of death because while sleeping, older people are unable to consciously regulate their body temperature. *The Lancet* Countdown 2024 report tracked the global heat-related mortality for people over 65 years of age for the last 45 years. It shows a dramatic increase heat exposure of older people since 2010, due to increasing heatwave occurrences and ageing populations.

Heatwaves and droughts, however, are relative terms, as it depends where they occur and whether a region already has adaptations in place. The 2003 European heatwave killed about 70,000 people. Hardest hit was France, with 14,800 deaths in the first 3 weeks of August: deaths in Paris increased by 140%. Authorities realised that many of these deaths were due to the very weak public health response, resulting in many countries in sweeping policy changes, including better heatwave prediction and preparations, improved building design, air conditioning

This article reflects the opinions of the author(s) and should not be taken to represent the policy of the Royal College of Physicians unless specifically stated.

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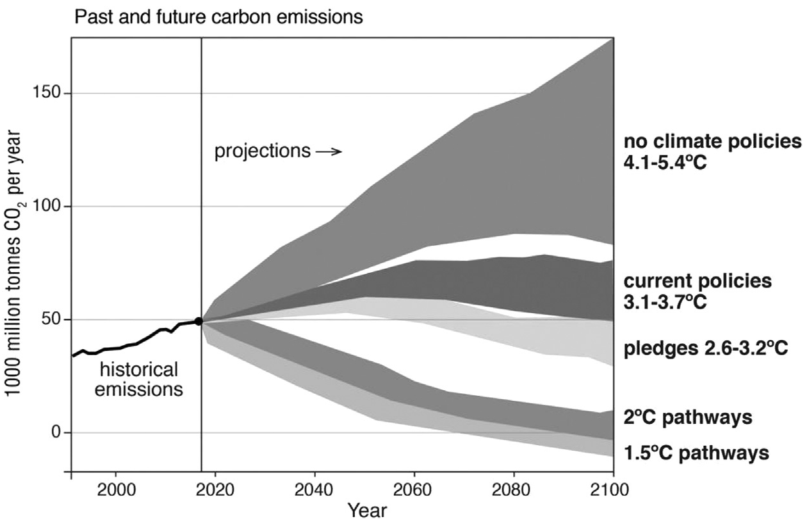

Fig. 1. Future carbon emission scenarios and potential global warming by 2100. Note pledges refers to the NDCs submitted at COP26 in Glasgow.[7]

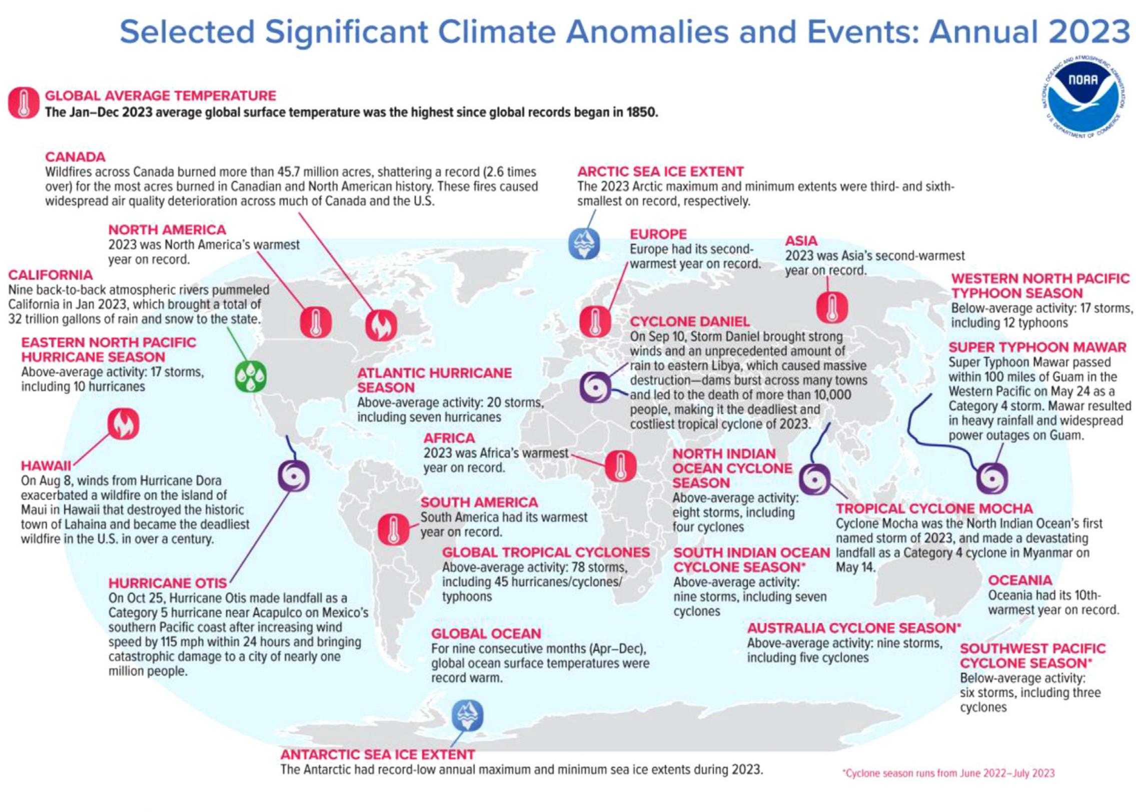

Fig. 2. Extreme weather events in 2023 complied by the National Oceanic and Atmospheric Administration.

for hospitals and retirement homes, increased training for health professionals, an emphasis on responsible media coverage with health recommendations, and planned regular visits to the most vulnerable. These new policies throughout Europe have prevented a significant number of deaths during subsequent heatwaves. Climate models suggest that the temperature of the 2003 heatwave could be the average summer temperature in Europe by 2050 and heatwaves above this new baseline may still occur: the unprecedented 40 °C heatwave in south-east England in July 2022 was 16 °C above the average peak temperature in July for the previous decade. Adaptation to heatwaves, however, takes planning, resources and money: it has been possible in much of Europe, but such preparation is absent in many parts of the world due to poverty and poor governance.

Droughts are also a major killer. Lasting months to years, droughts are usually caused when an area receives consistently below average rainfall. Droughts reduce crop production and kill livestock. Even a short, intense drought can cause significant damage and harm. Prolonged drought has caused famine, mass migrations and humanitarian crises.[8] From a disease perspective, droughts are much worse than floods because of a lack of fresh drinking water and stagnant pools of water that can bring disease. In 2019, almost three times the global land surface area was affected by excess drought compared with 1986–2005. Climate

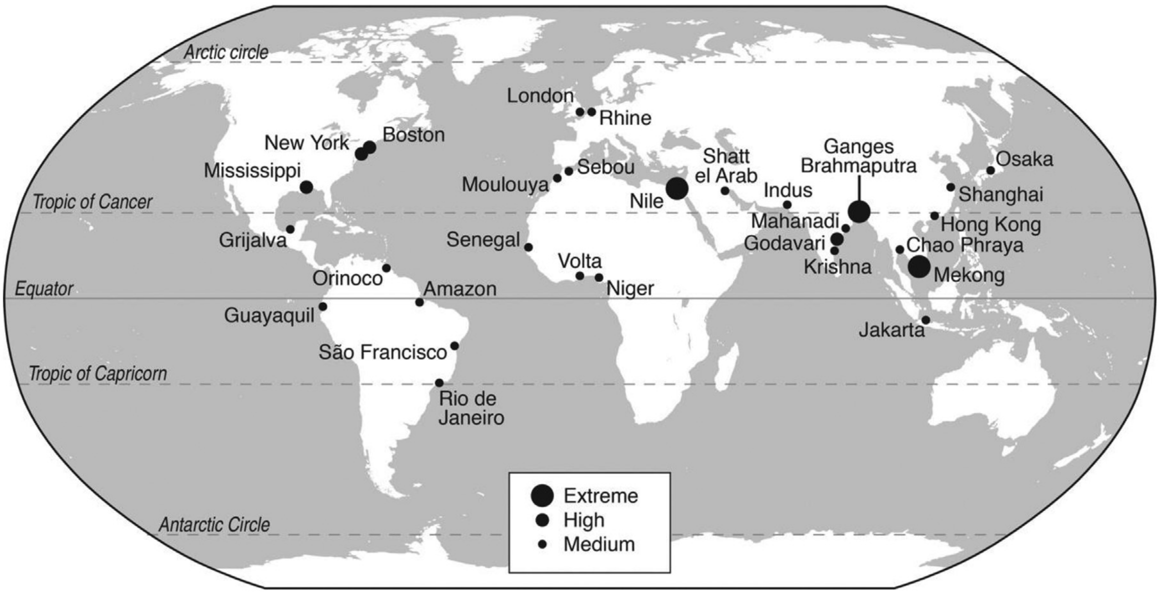

Fig. 3. Areas most vulnerable to climate change driven sea level rise.[7]

change will increase drought frequency in areas vulnerable to drought and cause them in areas that have never had them (Fig. 3).

Wildfire risk has increased in 114 out of 196 countries between 2016–2019 compared to the baseline period 2001–2004;[1] most significantly in the Southern Hemisphere. Over this period, there was a global increase of nearly 72,000 daily population exposures to wildfire per year. The USA's record-breaking 2017 and 2018 fires resulted in one of the largest increases globally, repeated in 2024 and 2025 with massive fires in California. With increasing extreme heat and droughts, wildfire risk will continue to grow across the world. Smoke from wildfires aggravates respiratory disease more than that from other sources.[9]

Storms and floods

Storms and floods are major natural hazards. Over the past two decades, they have been responsible for over half the fatalities and economic losses from natural catastrophes.[10] Evidence complied by the Intergovernmental Panel on Climate Change (IPCC) (2021) shows that temperate regions, particularly in the Northern Hemisphere, have become stormier over the past 50 years. Since 2005 there has been an increase in the number and severity of flood events, with three times the global land area flooded in 2019 compared with 1986–2005.[1] Climate models suggest the proportion of rainfall occurring as heavy rainfall has and will continue to increase, as will year-to-year variability, increasing the frequency and magnitude of floods.

Climate models indicate an increase in the strength of summer monsoons due to global warming over the next 100 years. For example, for the Asian summer monsoon the rainfall will increase by 10–20%, with an inter-annual variability of 25–100% and a dramatic increase in the number of days with heavy rain.[1] It is this increase in precipitation variability between years that makes planning very difficult for governments, local authorities and farmers.

When it comes to the predictions of future tropical cyclones (typhoons or hurricanes), the multiple complex interacting factors make the modelling more uncertain. The IPCC (2021) suggests the number of tropical cyclones may not increase, but the proportion reaching category four and five may increase by 10% when global temperatures hit 1.5 °C above pre-industrial times, increasing to 13% at 2 °C and 20% at 4 °C. However, when hurricanes hit developed countries, the major effect is usually economic loss, while in developing countries it is loss of life. For example, Hurricane Katrina, which hit New Orleans in 2005, caused >1,800 deaths and >$150 billion in damage. In contrast Typhoon Haiyan, in 2013, which was the most powerful tropical cyclone ever recorded, devastated large portions of South-East Asia, particularly the Philippines, affecting 11 million people, causing over 6,300 deaths, but resulted in a reported $2.2 billion in damages.

Coasts

Sea level could rise by 50–130 cm by 2100 compared with pre-industrial times.[11] Many major cities around the world are vulnerable to flooding. *The Lancet* Countdown 2024 report estimates that, without intervention, 145–565 million people could be affected and displaced,[12] with major health consequences.

Flooding and extreme weather events are not only physical threats but also have significant mental health consequences. Psychological impacts like stress and anxiety are often more prevalent than physical injuries among those affected, and can persist long after the event, with many experiencing ongoing anxiety triggered by rain.[13] A concerning rise in suicide and suicidal thoughts occurs in the aftermath of such disasters, with elevated risks continuing for up to 18 months. These findings underline the far-reaching and enduring toll that flooding imposes, not only on physical infrastructure but also on the mental wellbeing of affected populations. Floods can disrupt supply chains and travel, particularly important for those going to hospitals for time-dependent healthcare interventions and those whose health is critically dependent on medications.

Agriculture

One of the major worries concerning climate change is the effect it will have on agriculture.[14] The main question is whether the world can feed itself with an extra two billion people on the planet by 2050 and a rapidly changing climate. Fig. 4 shows the drop in cereal grain yields that have already occurred due to climate change. Modelling suggests that, in higher latitudes, agricultural productivity may increase due to the longer growing season, carbon dioxide fertilisation and reduced frost damage – but this will be offset by more frequent crop damage due to extreme weather events. Production will fall significantly in the tropics and subtropics, due to much hotter temperatures and more variable rainfall. Compounding these challenges is the declining nutritional quality of staple crops. Rising temperatures and prolonged droughts are

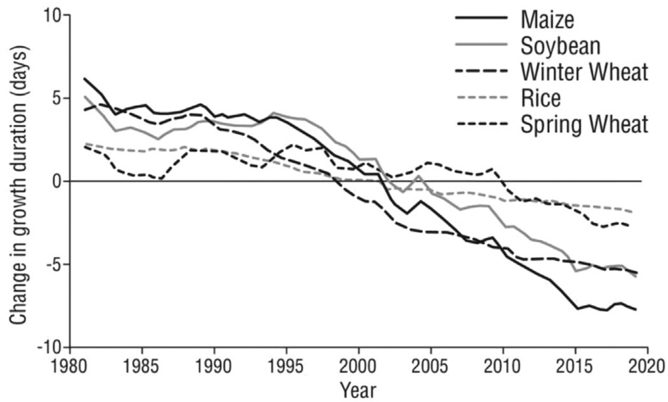

Fig. 4. Changes in cereal grain yields between 1980 and 2020.[7]

diminishing protein content and essential micronutrients in key crops such as wheat, maize, millet and sorghum. Regions dependent on rainfed agriculture, particularly in sub-Saharan Africa, are disproportionately affected.[15] This dual threat further exacerbates the vulnerability of populations already grappling with food insecurity, intensifying the global challenge of malnutrition and hunger. Higher temperatures and humidity will also be a challenge for many societies that rely heavily on subsistence agriculture, as higher air temperatures and humidity make working outside more difficult and increase the likelihood of hyperthermia and heat-related illnesses.

Human health

The potential health consequences of climate change are immense: managing those impacts presents an enormous challenge. Not only are there direct impacts as outlined above on the healthy, but those with existing health conditions will typically be in the vanguard of the vulnerable, as many chronic health conditions reduce resilience to changes and challenges. Not only may the prevalence of conditions increase, but the individual and societal burden of existing health conditions may worsen.

Climate change impacts on basic human needs will drive many of the health consequences. There are two major areas that could affect the health of billions of people: water and food.[16] The most important threat is lack of access to fresh drinking water. There are still one billion people without regular access to safe drinking water, causing health problems ranging from dehydration to worsening chronic kidney diseases. Without climate change mitigation, up to 50% of the world population could live in countries experiencing water stress by 2050, 80% living in developing countries. Food security rests on three main pillars: production and availability; access and affordability; supply stability. According to the UN World Food Programme, we currently produce enough food for everyone alive today and enough to cover the predicted increase in population this century. But there are >730 million people on the brink of starvation today, a significant increase in the last 5 years, because they cannot buy enough food, for complex reasons related both to climate change (including the devastating effects of ocean acidification)[17] exacerbated by global demand, internal and regional conflict and speculation on global markets. In 2008–9 there was a 60% rise in food prices, and in 2011–12 a 40% jump, both linked to food speculation. Malnutrition causes its own health conditions and reduces resilience to super-added challenges posed by climate change impacts, such as floods and droughts. The global health burdens of such interacting factors will be enormous. Low- and middle-income countries are particularly vulnerable, as limited healthcare systems and resources make adaptation harder.

Moreover, there is likely to an increase in health burdens, in particular cardiovascular, respiratory and renal conditions.[12,18–20] For many conditions, the impacts have been little studied. For example, climate change is linked to a rising burden and/or prevalence of noncommunicable neurological diseases, including stroke, multiple sclerosis and Alzheimer's disease.[21] Key drivers include higher global temperatures, increased air pollution, and greater exposure to environmental toxins like pesticides and heavy metals. These factors interfere with essential brain functions, such as protein folding and cellular repair, while also triggering oxidative stress and inflammation. Industrial expansion and agricultural practices, intensified by climate change, have worsened human exposure to these toxins. Pollution exposure, both acute and chronic, is an acknowledged risk to human health. The major cause of pollution is the burning of fossil fuels, further motivating action on reducing GHG; adverse weather events, such as heatwaves, can acutely amplify pollution impacts. Furthermore, global warming due to climate change results in higher temperatures and continuous heat stress, resulting in increased core temperatures, dehydration and blood hyperosmolality leading to kidney disease.[22,23] A systematic review and meta-analysis demonstrated that a 1 °C rise in temperature resulted in 1% increase in kidney-related morbidity and a 3% increase in kidney-related mortality.[24] Extreme heat exposure is also associated with a higher risk of emergency department visits related to kidney disease.[25] This risk of increased kidney disease due to rising temperatures is especially relevant for those working outside, where heat stress has been shown to double the risk for developing acute kidney injury and chronic kidney disease.[26] Indeed, epidemics of chronic kidney disease linked to heat stress are being seen across the world and it has been suggested that nephropathy linked to heat stress may represent one of the first epidemics due to global warming.[26] In low- and middle-income countries, especially in rural communities, this projected rise in kidney disease will have significant societal and economic costs and result in significantly increased demands and associated costs for health services in these countries.

Another threat to human health is the transmission of infectious diseases, which is directly affected by climatic factors. Climate change will particularly influence vector-borne diseases, that is, diseases that are carried by another organism; an example is malaria, which is carried and transmitted by mosquitoes. Infective agents and their vector organisms are sensitive to factors such as temperature, surface-water temperature, humidity, wind, soil moisture, and changes in forest distribution.[12] It is, therefore, projected that climate change and altered weather patterns would affect the range (both altitude and latitude), intensity and seasonality of many vector-borne and other infectious diseases. For example, there is a strong correlation between increased sea-surface temperature and sea level, and the severity of the cholera epidemics in Bangladesh. With predicted future climate change and consequent rise in Bangladesh's relative sea level, cholera epidemics could become more common.

In general, then, increased warmth and moisture caused by climate change will enhance transmission of diseases.[12] But while the potential transmission of many of these diseases increases in response to climate change, we should remember that our capacity to control the diseases will also change. New or improved vaccination can be expected; some vector species can be constrained by use of pesticides. Nevertheless, there are uncertainties and risks here, too: for example, long-term pesticide use encourages the breeding of resistant strains, while killing many natural predators of pests.

The most important vector-borne disease is malaria, with currently 500 million infected people worldwide. *Plasmodium vivax*, which is carried by the *Anopheles* mosquito, is the organism that causes malaria. The main climate factors that have a bearing on the malarial transmission potential of the mosquito population are temperature and precipitation. Assessments of the potential impact of global climate change on the incidence of malaria suggest a widespread increase of risk because of the expansion of the areas suitable for malaria transmission. Already in the past 5 years, the area suitable for malaria transmission in highland areas was 39% higher in Africa and 150% higher in East Asia compared to the

1950s. Mathematical models mapping out the temperature zones suitable for mosquitoes suggest that, by the 2080s, the potential exposure of people could increase by 2–4% (260–320 million people). The predicted increase is most pronounced at the borders of endemic malarial areas and at higher altitudes within malarial areas. The changes in malaria risk must be interpreted on the basis of local environmental conditions, the effects of socioeconomic development, and malaria control programmes or capabilities. Climate change will also provide excellent conditions for *Anopheles* mosquitoes to breed in southern England, continental Europe and northern USA.

Imagining a positive future

If we do everything in our power to contain climate change now, we could limit the global temperature rise to 1.5 °C in the 2030s and for the remainder of the century. Because we have completely replaced fossil fuels with renewable energy. Over a trillion trees have been planted, sucking carbon dioxide from the atmosphere. The air is cleaner than it has been since before the industrial revolution.

Cities have been restructured to provide all-electric public transport and vibrant 'health' green spaces. Many new buildings have a photoelectric skin which generates solar energy and green roofs which cool the cities, making them a more pleasant place to live. High-speed electric trains reaching 300 mph link many of the world's major cities. Intercontinental flights still run, using large and efficient planes running on synthetic kerosene that is made by combining water and carbon dioxide sucked directly from the atmosphere.

Global diets have shifted away from meat. Farming efficiency has greatly improved during the transition from industrial-scale meat production to plant-based sustenance, creating more land to rewild and reforest. Urban farms and vertical farms have developed to ensure that high nutritious plant-based crops are available in towns and cities. Wealth generation and greater global equity means the majority of people have secure access to food, clean safe water, shelter, electricity and healthcare.

The idea of 'half of the Earth' is being implemented, allowing the protection and restoration of the natural biosphere and its ecological services. Elsewhere, fusion energy is finally set to work at scale providing unlimited clean energy for the second half of the 21st century. But this future depends on what decisions are made today.

Conclusions

Climate change is the greatest threat to human health now.[16] The impacts of climate change will increase significantly as the temperature of the planet rises. Climate change threatens global biodiversity and the wellbeing of billions of people (See Table 1). But we have all the solutions to deal with climate change, both by ensuring that the world reduces emissions quickly, getting to net zero by 2050, and by adapting and protecting the most vulnerable populations in our society. Progress can be made through investments in public health systems, improved ac-

Table 1
Potential impacts of future climate change adapted from Maslin.[7]

POTENTIAL IMPACTS OF CLIMATE CHANGE

°C above pre-industrial levels	
1.5°C	• Major effects on warm water coral reef ecosystem. • Significant impacts on vulnerable ecosystems and species (polar regions, wetlands, and cloud forests). • Increase in coastal and river flooding. • Increase in extreme weather events. • Increase in the spread of tropical infectious disease. • Increase in heat-related morbidity and mortality.
2°- 3°C	• The Maldives, the Marshall Islands, Tuvalu, and many other small island nations have been abandoned. • Major loss of warm water coral reef ecosystem. • Major changes in the Arctic regions with a substantial loss of Arctic sea-ice. • Major increase in extreme weather events and the spread of infectious disease. • Major increase in heat related morbidity and mortality, especially in the low latitudes. • Significant impacts on vulnerable ecosystems (polar regions, wetlands, cloud forests, and mangroves). • Significant increase in coastal and river flooding around the world. • Significant impacts on low latitude fisheries. • Decrease in crop yields and productivity especially in the tropics and sub-tropical regions.
3°-4°C	• Major impacts on all ecosystems including significant increase in species extinctions. • Loss of all warm water and many coldwater coral reef ecosystems. • Arctic completely free of sea ice in summer, Arctic temperature increase by 8°C. • Majority of mountain glaciers have disappeared, including all ice on Kilimanjaro (Tanzania). • Major increase in extreme weather events and spread of infectious disease. • Major decreases in agricultural and fishery production and available water resources. • Food and water security become major political and humanitarian issues. • Environmental forced mass migration increases. • Ocean and terrestrial carbon sinks reduce accelerating climate change.
4°- 5°C	• Catastrophic loss of ecosystems and species all around the world. • Melting of Western Antarctic/Greenland ice sheets accelerate, causes significant global sea level rises. • Fifth of world population affected by flooding and major coastal cities are abandoned. • Environmental forced mass migration accelerates and there is an increase in conflicts over resources. • In many countries summer temperatures persistently stay above 40°C. • Heat waves with temperatures as high as 50°C have become common. • Over 3.5 billion people are now water stressed. • Wildfires have created major air pollution events and human health crises. • Global food production plummets, leading to widespread malnutrition and starvation.
5°- >6°C	• **Do not go there.**

cess to care, and tighter regulation of environmental pollutants, but most importantly in tackling climate change itself. We have already started the transition; the question is how quickly we can achieve sufficient reductions in atmospheric GHG and how many people will be adversely affected due to the delay in transitioning. Individual clinicians can make a difference, not least in starting the conversation with patients and providing advice.[27]

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CRediT authorship contribution statement

Mark Maslin: Writing – review & editing, Writing – original draft, Conceptualization. **Raina D. Ramnath:** Writing – review & editing. **Gavin I. Welsh:** Writing – review & editing, Writing – original draft. **Sanjay M. Sisodiya:** Writing – review & editing, Writing – original draft.

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