The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels

Article

Accepted Version

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The 2022 Report of The *Lancet* Countdown on Health and Climate Change: compounding health crises

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Total word count: 14217

List of Abbreviations

A&RCC – Adaptation & Resilience to Climate Change
AC – Air Conditioning
CO_2 – Carbon Dioxide
CO_2e – Carbon Dioxide Equivalent
COP – Conference of the Parties
D&A – Detection and Attribution
EE MRIO – Environmentally-Extended Multi-Region Input-Output
EJ – Exajoule
EM-DAT – Emergency Events Database
ERA – European Research Area
ETS – Emissions Trading System
EU – European Union
EU28 – 28 European Union Member States
FAO – Food and Agriculture Organization of the United Nations
GBD – Global Burden of Disease
GDP – Gross Domestic Product
GHG – Greenhouse Gas
GNI – Gross National Income
$GtCO_2$ – Gigatons of Carbon Dioxide
GW – Gigawatt
GWP – Gross World Product
HIC – High Income Countries
IEA – International Energy Agency
IHR – International Health Regulations
IPC – Infection Prevention and Control
IPCC - Intergovernmental Panel on Climate Change
IRENA - International Renewable Energy Agency
LMICs – Low- and Middle-Income Countries
LPG – Liquefied Petroleum Gas
Mt – Metric Megaton
$MtCO_2e$ – Metric Megatons of Carbon Dioxide Equivalent
MODIS – Moderate Resolution Imaging Spectroradiometer
NAP – National Adaptation Plan
NASA – National Aeronautics and Space Administration
NDCs - Nationally Determined Contributions
NHS – National Health Service
NO_x – Nitrogen Oxide
NDVI – Normalised Difference Vegetation Index
OECD – Organization for Economic Cooperation and Development
$PM_{2.5}$ – Fine Particulate Matter

PV – Photovoltaic
SDG – Sustainable Development Goal
SDU – Sustainable Development Unit
SSS – Sea Surface Salinity
SST – Sea Surface Temperature
tCO_2 – Tons of Carbon Dioxide
tCO2/TJ – Total Carbon Dioxide per Terajoule
TJ – Terajoule
TPES – Total Primary Energy Supply
TWh – Terawatt Hours
UN – United Nations
UNFCCC – United Nations Framework Convention on Climate Change
UNGA – United Nations General Assembly
UNGD – United Nations General Debate
US$ – 2021 United States Dollars (unless clarified in the text)
WHO – World Health Organization
WMO – World Meteorological Organization

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Executive Summary

Compounding Health Crises in a Heating World

Publication of the 2022 report of the Lancet Countdown lands in a world confronting profound and concurrent systemic shocks. Countries and health systems continue to grapple with the health, social and economic devastation of the COVID-19 pandemic, while Russia's war on Ukraine and a persistent fossil fuel overdependence has plunged the world into a global energy and cost of living crisis. As these crises unfold, climate change rises unabated. Its worsening impacts are increasingly opening fissures in the foundations of human health and wellbeing, exacerbating the vulnerability of the world's populations.

In 2021-2022, as the COVID-19 pandemic continued to overwhelm health systems around the world, extreme weather events caused devastation across every continent and added extra pressure to health services, with the influence of climate change on many of them increasingly understood and quantified through detection and attribution studies. Floods in Australia, Brazil, China, Western Europe, Malaysia, South Africa, and South Sudan caused hundreds of deaths, displaced hundreds of thousands of people, and caused billions of dollars in economic losses. Wildfires ravaged Canada, the United States, Greece, Algeria, Italy, Spain, and Turkey; and record temperatures were recorded in many countries, including Australia, Canada, India, Italy, Oman, Turkey, Pakistan, and the United Kingdom.

Exposed to rapidly rising temperatures, vulnerable populations faced 3.7 billion more heatwave days in 2021 than annually in 1986-2005 (indicator 1.1.2), while heat-related deaths increased by some 68% between 2000-2004 and 2017-2021 (indicator 1.1.5) – a death toll that was significantly amplified by the confluence of the COVID-19 pandemic.

Simultaneously, the changing climate is affecting the spread of infectious diseases, putting populations at increased risk of emerging diseases and co-epidemics. Coastal waters are becoming increasingly suitable for the transmission of *Vibrio* pathogens; the number of months suitable for malaria transmission rose by 31.3% and 13.8% in the highland areas of the Americas and Africa, respectively, from 1951–1960 to 2012–2021; and the likelihood of dengue transmission rose by 12% in this same period (indicator 1.3.1). Indeed, the coexistence of dengue outbreaks with the COVID-19 pandemic led to aggravated pressure to health systems, misdiagnosis, and difficulties in management of both diseases in many regions of South America, Asia and Africa.

The impacts of climate change also translate to economic losses, increasing pressure on families and economies already facing the synergistic challenges of the COVID-19 pandemic and of the international energy and cost of living crises, and further undermining the socioeconomic determinants that good health depends on. Heat exposure led to 470 billion potential labour hours lost globally in 2021 (indicator 1.1.4), with income losses equivalent to 0.72% of the global economic output, and rising to 5.6% of the gross domestic product in low Human Development Index (HDI) countries, where workers are most vulnerable to financial shocks (indicator 4.1.3). In addition, extreme weather events caused damage worth US$253 billion in 2021, particularly overburdening people in low HDI countries where essentially none of the losses were insured (indicator 4.1.1).

Climate change is also affecting every pillar of food security, compounding the impacts of other coexisting crises. Rising temperatures threaten crop yields directly, with the growth seasons of maize 9 days shorter, and that of winter and spring 6 days shorter, in 2020 as compared to 1981-2010 (indicator 1.4). These effects add onto the rising impact of extreme weather on crops and supply chains, socioeconomic pressures, and the heightened risk of infectious diseases, to undermine food availability, access, stability, and utilisation. Indeed, new analysis suggests that extreme heat was associated with 98 million more people reporting moderate to severe food insecurity in 103 countries in 2020, than annually in 1981-2010 (indicator 1.4). These impacts exacerbate the fragility of global food systems, acting in synergy with other concurrent crisis to reverse progress towards hunger eradication. Indeed, after remaining stable since 2015, 150 million more people were affected by hunger since the outbreak of the COVID-19 pandemic and the associated economic impacts, while Russia's invasion of Ukraine and the energy crisis has affected international agricultural production and supply chains, increased the cost of living, and could lead to 13 million more people facing undernutrition in 2022 alone.

A Debilitated First Line of Defence

With the compounding health risks of climate change on the rise, world populations increasingly turn to health systems as their first line of defence. But precisely when they are most needed, the world finds global health systems grappling with the effects of the COVID-19 pandemic and supply chain disruptions, and extreme weather events increasingly affect fail health system infrastructure.

Strengthening health system resilience is therefore critical to prevent a rapidly increasing loss of lives and suffering in a changing climate. However, only 48 out of 95 countries reported having assessed their climate change adaptation needs (indicator 2.1.1) and, even with COVID-19 experience, only 63% of countries reported high to very high implementation status for health emergency management in 2021 (indicator 2.2.4).

The lack of proactive adaptation is exposed in the response to extreme heat. Despite the local cooling and overall health benefits of urban greenspaces, only 27% of global urban centres were at least moderately green in 2021 (indicator 2.2.3), while the fraction of households with air conditioning increased by 66% from 2000 to 2020 – a maladaptive response that deepens the energy crisis and further increases urban heat, air pollution, and greenhouse gas emissions.

As converging crises further threaten the world's life-supporting systems, rapid, decisive, and coherent intersectoral action is primordial to protect human health.

Health at the Mercy of Fossil Fuel Ambitions

2022 marks the 30th anniversary of the signing of the UN Framework Convention on Climate Change, in which countries agreed to prevent dangerous anthropogenic climate change, and its deleterious effects on human health and welfare. However, little meaningful action has since followed. The carbon intensity of the global energy system has decreased by less than 1% since the UNFCCC was established, and global electricity generation is still dominated by fossil fuels, with renewable energy contributing to only 8.2% (indicator 3.1). Meanwhile, the total energy demand has risen by 59%, pushing energy-related emissions to a historical high in 2021. Current policies put the world on track to a catastrophic 2.7°C by the end of the century, and even under the commitments countries set in their recently-updated Nationally Determined Contributions (NDCs), global emissions could be 17.5% above 1990 levels by 2030 – far from the 43% decrease from current levels required to meet Paris Agreement goals and keep temperatures within the limits of adaptation.

The current fossil fuel dependence is not only undermining global health through increased climate change impacts, but also affected human health and wellbeing directly, by subjecting households to volatile fossil fuel markets, frail supply chains, and geopolitical conflicts. As a result, millions lack access to the energy needed to keep their homes at healthy temperatures, preserve food and medication, and achieve the 7th sustainable development goal (SDG7). With governments not providing sufficient support, access to clean energies has been particularly slow in low HDI countries, and only 1.4% of their electricity came from modern renewables (mostly wind and solar power) in 2020 (indicator 3.1). Around 60% of healthcare facilities in low and middle-income countries still lack access to the reliable electricity needed to provide basic care. Meanwhile, biomass accounts for as much as 31% of the energy consumed in the domestic sector globally, mostly from traditional sources – a proportion that rises to 96% in low HDI countries (indicator 3.2). The associated burden of disease is substantial, with the air in people's homes exceeding the World Health Organization's guidelines for safe concentrations of small particulate air pollution ($PM_{2.5}$) in 2020, by a staggering 30-fold on average in in 62 countries assessed (indicator 3.2). After six years of improvement, the number of people without access to electricity increased in 2020 as a result of the socioeconomic pressures of the COVID-19 pandemic. The current energy and cost of living crisis now threatens to further reverse progress towards affordable, reliable, sustainable and modern energy, further undermining the socioeconomic determinants of health.

In parallel, at a time when fossil fuel burning threatens global health and overburdens health systems, and high energy prices deepen the cost of living crisis, oil and gas companies have registered record profits, hampering efforts to shift to cleaner energies. Indeed, the current production strategies of 15 of the world's largest oil and gas companies would generate emissions that would exceed, by 37% in 2030 and 103% in 2040, their share of emissions consistent with 1.5°C of global heating (indicator 4.2.6), continuing to undermine efforts to protect the health of the world's population from climate change, and overburdening health systems. Meanwhile, governments continue to favour fossil fuel production and consumption in detriment of global health: 69 of 86 countries reviewed had net-negative carbon prices (i.e. provided a net subsidy to fossil fuels), for a net total of US$400 billion in 2019 alone , allocating amounts often comparable or even exceeding their total health budgets (indicator 4.2.4). Simultaneously, wealthier countries failed to mobilise the considerably lower sum of US$100 billion annually by 2020 which was committed at the 2009 Copenhagen Accord to support climate action in "developing countries", and climate efforts are being undercut by a profound lack of funding (indicator 2.1.1), exposing the low prioritisation of a healthy, low-carbon future in the global political agenda. Now, the impacts of climate change on global economies, together with the recession triggered by COVID-19 and worsened by geopolitical instability, may paradoxically further reduce the willingness of countries to allocate the funds needed to enable a just climate transition.

A Health-centred Response for a Thriving Future

The world is yet again at a pivotal moment. However, with countries facing concurrent crises, the implementation of long-term emissions-reduction policies risks been deflected or defeated by challenges wrongly perceived as more immediate. Addressing each of the concurrent crises in isolation risks alleviating one, while worsening another. For example, the response to COVID-19 has so far failed to deliver the green recovery the health community proposed, and is aggravating climate change-related health risks: less than one third of US$3.11 trillion allocated to COVID-19 economic recovery is likely to reduce greenhouse gas emissions or air pollution, with the net effect likely to increase emissions. Further, the COVID-19 pandemic affected climate action at the city level, and 30% of 798 cities reported that it COVID-19 reduced financing available for climate action (indicator 2.1.3).

Now, as countries search for alternatives to Russian fossil fuels, many continue to favour fossil fuel burning with some even turning back to coal, and shifts in global energy supplies threaten to increase fossil fuel production. Even if implemented as a temporary transition, these fossil fuel-centred response could reverse progress on air quality improvement, push the world irreversibly off-track from meeting the commitments laid out in the Paris Agreement, and lock in a future of accelerated climate change, threatening human survival.

On the contrary, a health-centred response to the current crises would still provide the opportunity to deliver a low-carbon, resilient, healthy future, where world populations can not only survive, but also thrive. Such response will see countries promptly shifting away from fossil fuels, reducing their dependence on frail international fossil fuel markets, and accelerating a just transition to clean energy sources. Such response will reduce the likelihood of the most catastrophic climate change impacts, while improving energy security, delivering a path for economic recovery, and offering immediate health benefits. Improvements in air quality will help prevent the 1.2 million deaths resulting from exposure to fossil fuel-derived ambient $PM_{2.5}$ in 2020 alone (indicator 3.3), and a health-centred energy transition will enhance low-carbon travel and increase urban green spaces, promoting physical activity, and improving physical and mental health. Turning to the food sector, an accelerated transition to balanced and more plant-based diets will not only help reduce the 55% of agricultural sector emissions coming from red meat and milk production (indicator 3.5.1), but also prevent up to 11.5 million diet-related deaths annually (indicator 3.5.2), and substantially reduce the risk of zoonotic diseases. These health-focused shifts will reduce the burden of communicable and non-communicable diseases, in turn reducing the strain on overwhelmed healthcare providers. Importantly, accelerating climate change adaptation will deliver more robust health systems, minimizing the negative impacts of future infectious disease outbreaks and geopolitical conflicts, and restoring the first line of defence of global populations.

Glimmers of Hope

Despite decades of insufficient action, emerging, albeit few, signs of change provide some glimmers of hope that a health-centred response might be starting to emerge. Individual engagement with the health dimensions of climate change, essential to drive and enable an accelerated response, continues to increase (indicator 5.2), and coverage of health and climate change in the media reached a new record high in 2021, with a 4.7% increase from 2020 (indicator 5.1). This increased engagement is also reflected by country leaders, with a record 60% of countries drawing the attention to between climate change and health in the 2021 UN General Debate, and with 86% of national updated or new NDCs making references to health (indicator

5.4). At the city level, local authorities are progressively identifying risks of climate change on the health of their populations (indicator 2.1.3), a first step to delivering a tailored response that strengthens local health systems. The health sector itself, while still responsible for 5.2% of all global emissions (indicator 3.6), has shown impressive climate leadership, and 60 countries had committed to transitioning to climate-resilient and/or low- or net zero-carbon health systems as part of the COP26 Health Programme at the time of writing.

Signs of change are also emerging in the energy sector. While total clean energy generation remains grossly insufficient, it reached record high levels in 2020 (indicator 3.1). Zero-carbon sources accounted for 80% of investment in electricity generation in 2021 (indicator 4.2.1), and renewable energies have reached cost parity with fossil fuel energies. Now, as some of the highest-emitting countries attempt to cut their dependence on oil and gas in response to the war in Ukraine and soaring energy prices, many are focusing on increasing renewable energy generation, raising hopes for a health-centred response . However, increased awareness and commitments must be urgently translated into action for hope to turn into reality.

A Call to Action

After 30 years of UNFCCC negotiations, Lancet Countdown indicators show that countries and companies continue to make choices that increasingly threaten the health and survival of people alive today. As countries strive to recover from the coexisting crises the evidence is unequivocal: an immediate, aligned and health-centred response is essential to secure a liveable future, and today presents a new opportunity to deliver a healthier world, in which present and future generations can not only survive, but also thrive.

Introduction

Due to human activity, average global temperatures are 1.1°C above the pre-industrial average, and the past seven years were the warmest on record.[1] Climate change is increasing the frequency and intensity of many extreme events, resulting in severe damage to the natural and social systems on which health depends. These changes are also shifting the geographic range of climate-sensitive infectious diseases, affecting food and water security, worsening air quality, and damaging socioeconomic systems. While the world grappled with the ongoing COVID-19 pandemic, 2021 and 2022 was marked by weather events of unprecedented intensity: record temperatures of nearly 50°C in British Columbia claimed 570 lives,[2] floods in Australia, Canada, China, Malaysia South Sudan and Western Europe led to hundreds of deaths hundreds of thousands of people displaced from their homes, and billions of dollars in losses,[3,4] and wildfires caused devastation in the US, Greece, Algeria, and Turkey. And yet, energy-related greenhouse gas (GHG) emissions rebounded to a historical record in 2021,[5] and atmospheric CO_2 reached its highest concentration in over 2 million years.[6]

Current policies put the world on track to 2.4–3.5°C of heating above pre-industrial times by 2100, and there is a 48% chance the 1.5°C threshold enshrined in the Paris Agreement will be exceeded within 5 years.[7-9] COVID-19 recovery efforts have thus far failed to deliver the transformation the health community and others called for,[10] and ongoing geopolitical conflicts put the 1.5°C threshold further out of reach. The findings in this report, summarised in Panel 1, underscore the urgency of delivering climate action, and can inform an aligned response to compounding crises, to protect the health of present and future generations.

Panel 1: Key findings of the 2022 report of the Lancet Countdown

1. Climate change is undermining every dimension of global health tracked, increasing the fragility of the global systems that health depends on, increasing the vulnerability of population health and functioning of healthcare facilities, and compounding the impacts of coexisting global crises.

2. Climate change is increasingly undermining global food security, exacerbating the effects of the COVID-19, geopolitical, energy and cost of living crises. New analysis shows that extreme heat due to climate change accounted for an estimated 98 million more people reporting moderate to severe food insecurity in 103 countries in 2020, than the 1981-2010 average (indicator 1.4).

3. Global health systems have been drastically weakened by the effects of the COVID-19 pandemic. For example, 30% of 798 cities reported that COVID-19 reduced financing available for climate change and 42% reported no change; only 22% reported an increase in financing (indicator 2.1.3).

4. Insufficient climate change adaptation efforts mean health systems they remain vulnerable and ill-prepared to cope with the increasing climate change-related health hazards. Only 48 out of 95 countries have assessed their climate change adaptation needs (indicator 2.1.1) and in 2021 only 63% of countries reported high to very high implementation status for health emergency management (indicator 2.2.4). Increasing adaptation for health is essential to prevent the worst health impacts from climate change, and will additionally increase resilience of health systems to better manage future infectious disease outbreaks and other health emergencies (indicator 2.3.1).

5. As the single biggest source of greenhouse gas emissions, mitigation of the energy sector must accelerate to keep global temperatures within the 1.5°C target set in the Paris Agreement, and prevent the most dangerous levels of global heating. However, the energy sector is still heavily reliant on fossil fuels, its carbon intensity decreased by less than 1% since the year the UNFCCC was signed, and a simultaneous increase in energy demand of 59% has pushed total energy sector emissions to record high levels in 2021 (indicator 3.1). Now, even this limited progress is at risk of being reversed: as countries search for alternatives to Russian fossil fuels, many are turning back to coal, and shifts in global energy supplies risk a net increase in fossil fuel production, further increasing emissions from the energy sector.

6. The slow adoption of renewable energies, which contribute to only 2.2% of total global energy supply (indicator 3.1), means households remain vulnerable to highly volatile international fossil fuel markets, and millions lack access to reliable, clean sources of fuel. Traditional biomass still

accounts for 31% of the energy consumed in the domestic sector globally, and for 96% of that in low HDI countries (indicator 3.2). New analysis shows that the air in people's homes in the 62 countries analysed exceeded the World Health Organization's guidelines for safe concentrations of small particulate air pollution ($PM_{2.5}$) in 2020, by 30-fold on average (indicator 3.2). The current energy and cost-of-living crises, together with the limited access to clean energies, now threatens to make matters worse.

7. A new indicator this year tracks the current production strategies of 15 of the largest oil and gas companies (both publicly-listed international companies (IOCs), and state-owned national companies (NOCs)) and reveals that, on the basis of their current strategies and market shares, they will exceed their share of greenhouse gas emissions compatible with the 1.5°C climate target by an average of 87% (for IOCs) and 111% (for NOCs) in 2040. the realisation of these strategies would make meeting the goals of the Paris Agreement virtually unattainable (indicator 4.2.6).

8. In 2019, 69 countries out of 86 reviewed (80%) had net-negative carbon prices (i.e. provided a net subsidy to fossil fuels), for a net total of US$400 billion. These subsidies exceeded 10% of national health spending in 31 countries, and exceeded 100% in 5 countries (indicator 4.2.4). At the same time, climate efforts are being undercut by a profound lack of funding (indicator 2.1.1), and fossil fuel companies register record profits as a result of the high energy prices.

9. Despite the critically insufficient progress to date, a health-centred response to the coexisting crises still offers an opportunity to deliver a healthy, low-carbon future. Accelerating the transition to clean energy and improved energy efficiency can avoid the most catastrophic climate change impacts, as well as improve energy security, support economic recovery, prevent the 1.2 million annual deaths resulting from exposure to fossil fuel-derived ambient $PM_{2.5}$ (indicator 3.3), improve health outcomes by promoting active forms of travel, and deliver greener, healthier, and more livable cities. The associated reduction in the burden of communicable and non-communicable diseases, will in turn also reduce the strain on overwhelmed healthcare providers.

10. The media, the scientific community, corporations and country leaders are increasingly engaging in health and climate change (indicators 5.1-5.5), and new analysis shows that 86% of updated or new Nationally Determined Contributions now reference health (indicator 5.4).

11. As countries attempt to cut their dependence on international oil and gas supplies in response to the war in Ukraine and energy crisis, some are focusing efforts on increasing renewable energy generation, raising hopes that a health-centred response could be emerging. However, the increased engagement and commitments must be urgently translated into action for hope to turn into reality and secure a world in which populations can not only survive, but also thrive.

Taking stock of progress on health and climate change

The *Lancet* Countdown: Tracking Progress on Health and Climate Change is an international, transdisciplinary collaboration of 51 academic institutions and UN agencies, monitoring the changing health profile of climate change.[11]

Its 43 indicators (Table 1) are the result of seven years of refinement, and reflect the consensus of 99 multidisciplinary researchers, the guidance of the *Lancet* Countdown's Scientific Advisory Group and High-Level Advisory Board, and the continuous support of *The Lancet* and the Wellcome Trust. Most indicators have been improved this year to better monitor links between climate change and health. New and re-introduced metrics monitor the impact of extreme temperature on food insecurity; exposure to wildfire smoke; household air pollution; the alignment of fossil fuel industry with a healthy future; and health considerations in countries' Nationally Determined Contributions (NDCs). All new or substantially modified indicators were assessed by an independent expert panel, to ensure their appropriateness and robustness,[12,13] and some existing indicators were also independently assessed, to ensure their continued relevance and rigour.

This report, more concise than previous iterations, is complemented by an online data visualisation platform, where indicators can be explored in greater detail and geographical resolution. Reports from the *Lancet* Countdown regional centres in Asia (Tsinghua University, China), Europe (Barcelona Supercomputing Center, Spain), South America (Universidad Peruana Cayetano Heredia, Peru), and Australia (Macquarie University and The University of Sydney) offer more detailed regional assessments. Meanwhile, newly established centres are working to explore in further depth the links between health and climate change in Small Island Developing States (SIDS) (University of the West Indies, Jamaica) and Africa (Medical Research Council Unit, The Gambia). Through these expanding local networks, the *Lancet* Countdown now brings together over 250 researchers from almost 100 institutions around the globe.

As the world strives to meet Paris Agreement commitments, *Lancet* Countdown indicators are contributing to national and international climate and health monitoring systems, and they have been incorporated into the European Climate and Health Observatory and into the climate and health assessment of the Italian National Institute of Health (Istituto Superiore di Sanità).[14] In 2023 the UNFCCC will run the first Global Stocktake (GST), an assessment of collective progress towards meeting Paris Agreement goals, designed to help countries adjust efforts to meet climate targets. Taking stock of the health impacts of climate action, this report can help countries realise the ambition of making the Paris Agreement the "most important public health agreement of the century".[15]

Table 1: The indicators of the 2022 report of The Lancet Countdown

Working Group	Indicator	
Health Hazards, Exposures, and Impacts	1.1: Health and Heat	1.1.1: Exposure to Warming
		1.1.2: Exposure of Vulnerable Populations to Heatwaves
		1.1.3: Heat and Physical Activity
		1.1.4: Change in Labour Capacity
		1.1.5: Heat-Related Mortality
	1.2: Health and Extreme Weather Events	1.2.1: Wildfires
		1.2.2: Drought
		1.2.3: Extreme Weather and Sentiment
	1.3: Climate Suitability for Infectious Disease Transmission	
	1.4: Food Security and Undernutrition	
Adaptation, Planning, and Resilience for Health	2.1: Assessment and Planning of Health Adaptation	2.1.1: National Assessments of Climate Change Impacts, Vulnerability and Adaptation for Health
		2.1.2: National Adaptation Plans for Health
		2.1.3: City-Level Climate Change Risk Assessments
	2.2: Enabling conditions, Adaptation Delivery, and Implementation	2.2.1: Climate Information for Health
		2.2.2: Air Conditioning: Benefits and Harms
		2.2.3: Urban Green Space
		2.2.4: Health Adaptation-Related Funding
		2.2.5: Detection, Preparedness and Response to Health Emergencies
	2.3: Vulnerabilities, Health Risk, and Resilience to Climate Change	2.3.1: Vulnerability to Mosquito-Borne Disease
		2.3.2: Lethality of Extreme Weather Events
		2.3.3: Migration, Displacement and Rising Sea Levels
Mitigation Actions and Health Co-Benefits	3.1: Energy System and Health	
	3.2: Clean Household Energy	
	3.3: Premature Mortality from Ambient Air Pollution by Sector	
	3.4: Sustainable and Healthy Transport	
	3.5: Food, Agriculture, and Health	3.5.1: Emissions from Agricultural Production and Consumption
		3.5.2: Diet and Health Co-Benefits
	3.6: Healthcare Sector Emissions	
Economics and Finance	4.1: The Economic Impact of Climate Change and its Mitigation	4.1.1: Economic Losses due to Climate-Related Extreme Events
		4.1.2: Costs of Heat-Related Mortality
		4.1.3: Loss of Earnings from Heat-Related Labour Capacity Loss
		4.1.4: Costs of the Health Impacts of Air Pollution
	4.2: The Economics of the Transition to Zero-Carbon Economies	4.2.1: Clean Energy Investment
		4.2.2: Employment in Low-Carbon and High-Carbon Industries
		4.2.3: Funds Divested from Fossil Fuels
		4.2.4: Net Value of Fossil Fuel Subsidies and Carbon Prices
		4.2.5: Production- and Consumption-based Attribution of CO_2 and $PM_{2.5}$ Emissions
		4.2.6: Compatibility of Fossil Fuel Company Strategies With the Paris Agreement
Public and Political Engagement	5.1: Media Coverage of Health and Climate Change	
	5.2: Individual Engagement in Health and Climate Change	
	5.3: Scientific Engagement in Health and Climate Change	
	5.4: Government Engagement in Health and Climate Change	
	5.5: Corporate Sector Engagement in Health and Climate Change	

Section 1: Health Hazards, Exposures, and Impacts

Climate change is already affecting the health of people across the globe. Detrimental impacts occur directly through increased exposure to extreme weather, and indirectly through cascading impacts on the physical, natural, and social systems on which health depends. Additionally, climatic changes are amplifying the existing threats to food and water security, built infrastructure, essential services, and livelihoods.

Section 1 tracks the health hazards, exposures, and impacts of climate change, with indicators that monitor vulnerabilities now explored within Section 2. Indicators have been improved and expanded to provide a more comprehensive picture of the health impacts of climate change,[13] and help disentangle the effects of climatic and demographic changes on health-related outcomes. Three new sub-indicators track the influence of wildfires on exposure to $PM_{2.5}$ air pollution (indicator 1.2.1), the links between both heat and extreme precipitation and online sentiment expressions (indicator 1.2.3), and the increasing impact of extreme heat on global food security (indicator 1.4.1).

1.1 Health and Heat

Climate change is leading to an increase in average global temperatures and in the frequency, intensity, and duration of heatwaves.[16] Exposure to extreme heat is associated with exacerbation of underlying cardiovascular and respiratory disease, acute kidney injury and heat stroke,[17] adverse pregnancy outcomes,[18,19] worsened sleep patterns,[20] impacts on mental health, and increases in non-accidental and injury-related deaths.[21] It also affects health indirectly by limiting people's capacity to work and exercise.[22-26] The elderly, pregnant women and newborns, the socially deprived, and those working outdoors are particularly at risk.[27,28]

Indicator 1.1.1: Exposure to Warming

Headline finding: From 2000 to 2021, populations were exposed to an average increase in summer temperature two times higher than the global mean.

Inhabited land areas experience faster warming than oceans. By overlapping gridded temperature and population data, this indicator shows that the temperatures humans were exposed to during summer seasons in 2021 were 0.6°C higher than the 1986–2005 average, representing twice the global mean temperature increase over the same period (0.3°C).

Indicator 1.1.2: Exposure of Vulnerable Populations to Heatwaves

Headline finding: Children under 1 year old experienced 600 million more person-days of heatwaves, and adults over 65 years 3.1 billion more person-days, in 2012–2021, compared to 1986–2005.

Between 2021 and 2022, the world saw record temperatures in Oman, the Middle East,[29] Australia,[30] numerous Mediterranean countries, and Canada.[31] This indicator overlays daily temperature and demographic data to track the exposure of vulnerable age-groups to heatwaves (defined as a period of 2 or more days where both the minimum and maximum temperatures are above the 95th percentile of 1986–2005, as defined previously).[32,33] Over 2012–2021, children younger than 1 year experienced 600 million more person-days of heatwaves (4.4 more days per child) annually relative to the 1986–2005 average, while adults older than 65 years experienced 3.1 billion more days (3.2 more days per person) (Figure 1). In 2021, people over 65 in Canada experienced a record of 47 million more person-days of heatwaves (2.4 million in children under 1 year) than annually in 1986–2005, mainly due to an unprecedented heatwave which was over 150 times more likely to occur due to climate change (Panel 2).

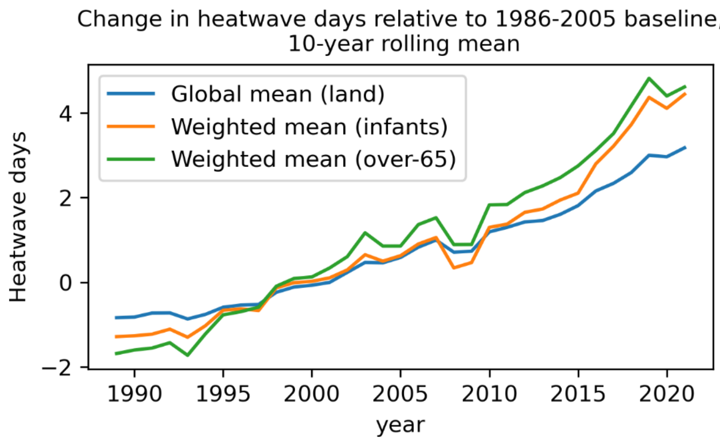

Figure 1: Comparison of change in heatwave days relative to 1986–2005 baseline (10-year rolling mean) between global mean for land, mean weighted by infant population, and mean weighted by over-65 population.

Indicator 1.1.3: Heat and Physical Activity

Headline finding: Over the last 10 years, people experienced on average an extra 281 hours annually during which the high heat posed at least a moderate heat stress risk during light outdoor physical activity, compared to 1991-2000.

Regular physical activity contributes to a healthy body weight, improves physical and mental health,[34-36] and helps prevent many non-communicable diseases.[37] However, hot weather reduces the likelihood of engaging in exercise, and increase heat illness risk when it is undertaken.[22-24] This indicator has been improved to track the daily hours during which physical activity would entail heat stress risk.[38] Compared to a 1991-2000 baseline average, the number of annual hours of moderate-risk and high-risk of heat stress during light outdoor physical activity increased globally in 2012-2021 by an average of 281 (33% increase) and 238 (42%) hours per person, respectively. The greatest rise occurred in medium HDI countries, with a 310 (20%) and 296 (26%) increase in the number of moderate-risk and high-risk hours per person annually, respectively.

Indicator 1.1.4: Change in Labour Capacity

Headline finding: In 2021, heat exposure led to the loss of 470 billion potential labour hours, a 37% increase from 1990–1999. 87% of the losses in low HDI countries occurred in the agricultural sector.

Heat exposure affects labour productivity and puts the health of exposed workers at risk.[39] The resulting labour loss undermines livelihoods and the socioeconomic determinants of health.[40] This indicator monitors the potential work hours lost as a result of heat exposure and, in an improvement from previous years' reports, of solar radiation, by associating wet bulb globe temperature with the typical metabolic rate of workers in specific economic sectors. Since 1999, the potential hours lost increased by 5.6 billion hours per year (Figure 2). In 2021, 470 billion hours were lost – a rise of 37% from the annual average in 1990–1999, and an average of 139 hours lost per person. Two thirds of all labour hours lost globally in 2021 occurred in the agricultural sector. This proportion was highest in low HDI countries, at 87%

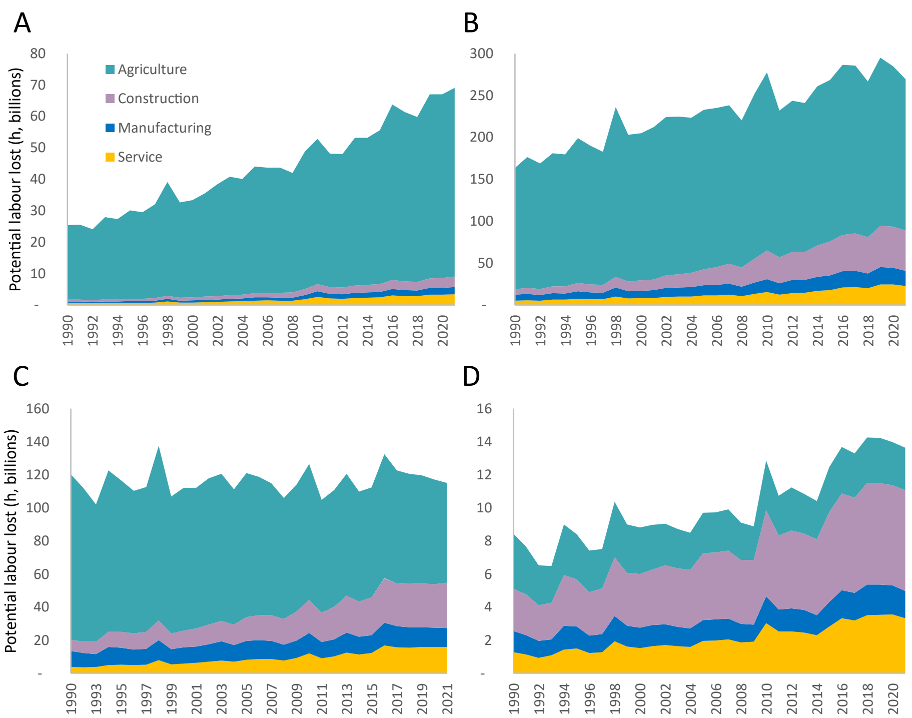

Figure 2: Potential labour lost due to heat-related factors in each sector, assuming all work is undertaken in the sun. Low HDI (A), medium HDI (B), high HDI (C), and very high HDI (D) groups (2019 HDI country group). HDI=human development index.

Indicator 1.1.5: Heat-Related Mortality

Headline finding: Heat-related mortality for people over 65 increased by approximately 68% between 2000-2004 and 2017-2021.

A recent study covering 43 countries estimated that 37% of heat-related deaths are attributable to human-induced climate change.[41] However, limited data sharing and reporting restricts the capacity to produce accurate estimates globally, to assess adaptation measures, and to identify vulnerable populations.[11,13] Using a generalised exposure-response function to provide an estimate of heat-related deaths globally, this indicator finds that annual heat-related mortality of people over 65 increased by an estimated 68% between 2000-2004 and 2017-2021.

1.2 Health and Extreme Weather Events

Detection and attribution studies unequivocally demonstrate the increasing influence of anthropogenic climate change on weather extremes (Panel 2).[42] Resulting direct injuries and death are often compounded with impacts on sanitation and service provision, forced displacement, loss of assets and infrastructure, economic losses, and adverse mental health outcomes, with oftentimes cascading, long-lasting effects.[43-46] This suite of indicators, complemented by indicators 2.3.2 and 4.1.1, explores the links between climate change, extreme weather events, and health.

Panel 2: Detection and attribution studies: Ascertaining the influence of climate change in health-harming extreme events

Detection and attribution (D&A) studies are increasingly exposing the influence of climate change on weather-related morbidity and mortality, and being applied in public health to inform decision making.[47] However, only a small proportion of all extreme events that occur are being assessed, and seldom those affecting the highly vulnerable low or middle HDI countries. Expanding the coverage and funding available for D&A studies, and strengthening their health assessment, can help better elucidate the health costs of climate change and provide compelling evidence to support climate action.[48,49]

D&A studies were published for 31 discrete weather-related events occurring between 2019 and 2021. All except two of the analysed events occurred in high or very high HDI countries. The events for which D&A studies were published included extreme heat, heavy precipitation and floods, wildfires, storms, tornadoes, cyclones, or drought events. Climate change was shown to have increased the likelihood or severity of 84% of these events (24 studies), in which over 113,300 deaths were registered. All but one of the nine extreme heat events studied, which caused 13,480 deaths, were found to have been made more likely or intense due to climate change. Climate change decreased the likelihood or severity of just three events, all of which related to extreme rainfall, reflecting the climate-induced alteration of hydrological cycles. Most of the events studied had cascading effects on health systems, and most were compounded by concurrent crises. A full list of the events assessed is presented in the appendix (pp 24), while some key examples are explored in further detail below.

Australia's 'black summer'

Australia's 2019–2020 'black summer' fires were unprecedented in scale, intensity, and extent of damage. Anthropogenic climate change increased their probability by more than 30%,[50] both directly and through compounding mechanisms.[51] The fires directly caused some 450 deaths, 1300 emergency asthma presentations, and 1120 cardiovascular and 2030 respiratory admissions,[52] in addition to worsening mental health outcomes and displacing of 47 000 people.[53-55] In addition, these events contributed to 715 Mt of CO_2 emissions, equivalent to some 0.2% of global greenhouse gas emissions that year.[56]

South African drought

Between 2015–2019, South Africa's Western Cape record drought was two to nine times more likely due to climate change. [57,58] In a neighbouring rural region, the drought limited provision of, and access to, HIV care, thereby contributing to treatment failure.[59] Although health data were limited, it is likely that vulnerable populations were disproportionately exposed to the drought, resulting in adverse health,[60] including mental health,[61] outcomes.

Floods in Western Europe

In July 2021 north-western Europe was exposed to devastating floods, primarily driven by heavy rainfall that was 1.2 to 9 times more likely due to climate change.[62] The floods directly killed over 200 people across Europe.[63,64] Health was also impacted as a result of damage to pharmacies, hospitals and clinics; scarce potable water; destruction of sewerage infrastructure; and disruption of healthcare services, including the administration of COVID-19 vaccines.[63,65]

North American heat dome

In June-July 2021, Northwest North America experienced a 6-day heat wave that was at least 150 times more likely to occur due to climate change, and “virtually impossible” without it,[66] directly causing at least 569 excess deaths in British Columbia, and over 100 in Washington state.[67,68] Material deprivation and reduced access to urban green spaces were found to have increased mortality risk.[69,70] Alaska, Idaho, Oregon, and Washington registered over 1,000 heat-related emergency service presentations, a 69-fold increase over the same period the year prior.[71]

South Asian heat wave

During March-April 2022, India and Pakistan experienced a prolonged heat wave that was 30 times more likely due to climate change[2]. Despite widespread underreporting, 90 deaths were attributed[3], alongside reduced wheat yields which have further compounded global shortages caused by the war in Ukraine· The full health impacts of lost income, increased hospitalisations, and food and energy insecurity, in addition to a glacial lake outburst flood and forest fires, are not yet quantified[2].

Indicator 1.2.1: Wildfires

Headline finding: Human exposure to days of very-high or extremely-high fire danger increased in 61% of countries from 2001–2004 to 2018–2021.

Wildfires affect health through thermal injuries, exposure to wildfire smoke, loss of physical infrastructure, and impacts on mental health and wellbeing.[72-74] Drier and hotter conditions increasingly favour their occurrence, intensity, and spread, and undermine control efforts.[75] This indicator uses remote sensing to track exposure to days of high meteorological wildfire danger and wildfire exposure, this year better accounting for cloud cover in the detection of wildfire spots. New to this report, the indicator incorporates atmospheric modelling (IS4FIRES-SILAM model) to track exposure to wildfire smoke ($PM_{2.5}$).[76,77]

Globally, people each experienced an average of nine extra days of very- or extremely-high meteorological wildfire danger in 2018–2021 compared to 2001–2004, with 61% (110/181) of countries seeing an increase (Figure 3) – a trend driven by climate variation rather than demographic shifts. The yearly average wildfire exposure increased by 9.17 million person-days between 2003–2006 and 2018–2021. Increases were observed in 64% (21 of 33) of low HDI, compared to 42% (27 of 65) of very high HDI countries, which could reflect differences in wildfire prevention and management.

Population exposure to wildfire-derived $PM_{2.5}$ was modelled using the SILAM chemistry transport model.[78] Data shows a statistically significant increase in 16.5% of the global land surface from 2003 to 2021, and a statistically significant decrease in 8.8% of the surface land area.

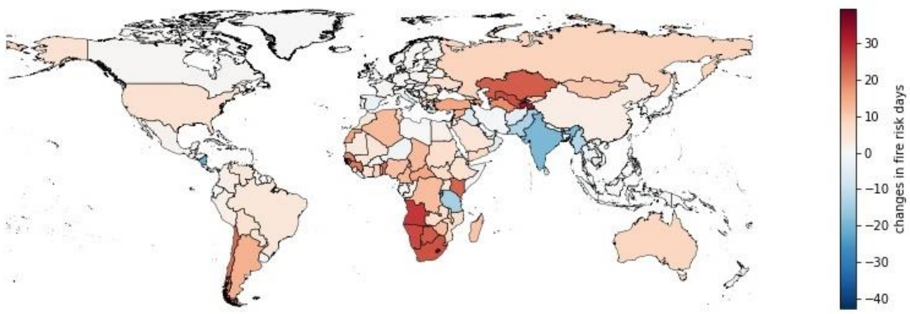

Figure 3: Population-weighted mean changes in extremely high and very high fire danger days in 2018-2021 compared with 2001-2004. Large urban areas with population density ≥ 400 persons/km² are excluded.

Indicator 1.2.2: Drought

Headline finding: On average, 29% more of the global land area was affected by extreme drought annually in 2012–21, than in 1951–1960.

Droughts undermine food and water security, threaten sanitation, affect livelihoods, and increase the risk of wildfires and infectious disease transmission.[42,79] This indicator uses the 6-monthly Standard Precipitation and Evapotranspiration Index (SPEI6) to capture changes in extreme drought (SPEI ≤ -1.6) due to precipitation and temperature-driven evapotranspiration.[80] On average in 2012–21, almost 47% of the global land area was affected by at least 1 month of extreme drought each year, up by 29% from 1951–60. The Middle East and Northern Africa, where 41 million people lack access to safe water and 66 million lack basic sanitation,[81] were particularly affected, with some areas experiencing over 10 extra months of extreme drought.

Indicator 1.2.3: Extreme Weather and Sentiment

Headline finding: Heatwaves during 2021 were associated with a statistically significant decrease of 0.20 percentage points in the number of tweets expressing positive sentiment, while extreme precipitation days were associated with a statistically significant decrease of 0.26 percentage points.

Heatwaves and extreme weather increase the risk of mental health disorders (Panel 3).[21,82,83] This indicator uses a multivariate ordinary least squares fixed effects model to monitor the influence of heatwaves and, new to this year's report, extreme precipitation, on online sentiment expression.[84] It analyses 7.7 billion tweets from 190 countries and adjusts by month, calendar date, and location. Days of extreme precipitation during 2021 reduced the percentage of tweets that had positive expression by a statistically significant 0.26 percentage points, a record reduction in positive expression during extreme precipitation days since 2015. Since 2015 heatwave days and days of extreme precipitation have consistently worsened sentiment expression. In 2021, heatwave days increased the proportion of tweets that expressed negative sentiment by a statistically significant 0.20 percentage points, producing the largest effect in the historical series. The 2021 Pacific Northwest heatwave increased negative sentiment 9.8 times and decreased positive sentiment 3.7 times the 2015–2020 average effects of heatwaves on sentiment. Further, the 2021 Western European extreme rainfall events increased negative sentiment 4.9 times, and decreased positive sentiment 6.6 times the 2015–2020 average effects of extreme precipitation on sentiment.

Panel 3: Mental health and climate change

Climate change is affecting mental health, psychological wellbeing and their social and environmental determinants.[82,83,85-87] Acute temperature increase, heatwaves, and humidity have been associated with worse mental health outcomes and increased suicidality.[88,89] Through more indirect pathways, hazards like droughts can disrupt agricultural production, affect livelihoods, and cause food and water scarcity and other hardships that affect family relationships, increase stress, and negatively impact mental health - with differences between genders.[90-92] Climate change may also exacerbate conflict and violence (including gender-based violence),[93-95] and can influence people's decision to migrate, which can in turn affect mental health and well-being.[96] Additionally, climate change may impact the mental health of populations who either choose to stay or are unable to migrate, with studies showing that mental health can be compromised by the feeling of being trapped.[97-99]

Marginalised and vulnerable populations are often disproportionately affected by climate-change related mental health impacts – which can compound pre-existing mental health inequalities, especially where health systems are inadequate. Indigenous peoples may be more strongly affected by climate change-induced ecological breakdown.[100,101] The elderly, women and religious or ethnic minorities are particularly at risk of adverse mental health outcomes, and youth have been shown to be more prone to anxiety, phobias, depression, stress-related conditions, substance abuse and sleep disorders, as well as reduced capacity to regulate emotions, and increased cognitive deficits.[102] The increasingly visible effects of the climate crisis have given rise to emerging concepts such as climate change anxiety, solastalgia, eco-anxiety and ecological grief.

Integrating mental health considerations within adaptation, mitigation and disaster risk reduction (DRR) efforts, could both reduce climate change-related mental health risks, and deliver mental health co-benefits. Actions to reduce heat and ambient air pollution through urban redesign - such as improved shade and green space, walkable neighbourhoods, and improved active and public transport infrastructure - may deliver mental health co-benefits through increased physical activity, improved sleep quality, social connectivity, cooling spaces and exposure to greenness.[103,104] Furthermore, climate activism may be associated with increased mental wellbeing,[105] although it might increase distress for others.[106] This emphasises the importance of including mental health considerations when designing climate policies. Yet, despite multidimensional connections between climate change and mental health, few National Adaptation Plans (7/18 documents assessed by the WHO) and Nationally Determined Contributions (10/197 documents representing 9/197 parties assessed by Climate Watch) consider mental health and psychosocial implications.[107,108] Additionally, only 28% of countries report having a functional programme that integrates mental health and psychosocial support within preparedness and DRR, including for climate-related hazards.[109]

The persistent lack of standardised definitions, stigmatisation and lack of recognition of mental health in many places, together with lack of available data, undermines the capacity to identify populations at risk, to develop targeted resilience strategies, to monitor and assess the mental health implications of climate change and climate action - and ultimately to develop mental health indicators.[110-113]

Nonetheless, the world has sufficient experience and evidence to guide immediate action. Dramatically accelerating efforts to address the impacts of climate change on mental health and psychosocial well-being is essential to protect all dimensions of human health.[111]

Indicator 1.3 Climate Suitability for Infectious Disease Transmission

Headline finding: The climatic suitability for the transmission of dengue increased by 11.5% for A. aegypti *and 12.0% for* A. albopictus *from 1951–1960 to 2012–2021; the length of the transmission season for malaria increased by 31.3% and 13.8% in the highlands of the Americas and Africa, respectively, from 1951–1960 to 2012–2021.*

Climate change is affecting the distribution and transmission of many infectious diseases, including vector-, food-, and water-borne diseases.[114-116] This indicator monitors the influence of the changing climate on the potential for transmission for key infectious diseases that are a public health concern.

With the increased movement of people and goods, urbanisation, and climate change, *Aedes*-transmitted arboviruses spread rapidly over the last two decades, and half the world population now lives in countries where dengue is present.[117-119] Combining data on temperature, rainfall, and population, this indicator tracks the basic reproduction number (R0) for dengue, Zika and chikungunya as a proxy for their transmissibility and, new to this report, the number of months suitable for their transmission. On average, during 2012–2021, the R0 was 11.5% higher for the transmission of dengue by *A. aegypti*, 12.0% by *A. albopictus*, 12.0% for Chikungunya, and 12.4% for Zika, with respect to 1951–1960, globally (Figure 4). During this same period, the length of the transmission season increased for all arboviruses by approximately 6%.

The number of months suitable for the transmission of *Plasmodium falciparum* by *Anopheles* mosquitoes was computed using temperature, precipitation and humidity thresholds and, new to this year, land classes suitable for the vector. The number of suitable months in highlands (≥ 1500m above sea level), increased by 31.3% in the WHO region of the Americas , and 13.8% in Africa between 1951–1960 and 2012–2021.

Non-cholera *Vibrio* bacteria survive in brackish waters, and can cause gastroenteritis if ingested in contaminated food, and potentially lethal wound infections through direct contact with contaminated water.[120] Between 2014–2021 and 1982–1989, due to changes in sea salt concentrations and temperature, the area of coastline suitable for *Vibrio* pathogens increased from 47.5% to 86.3% in the Baltic, 30.0% to 57.1% in the US Northeast and from 1.2% to 5.7% in the Pacific Northwest, three regions where *Vibriosis* is regularly reported. An extra 4.3% of the coastal waters in Northern latitudes (40–70° N) had temperatures suitable for *Vibrio* in 2014–

2021 compared to 1982–1989, with 2021 the second most suitable year on record (11.3% of the coastal area suitable) – making brackish waters in these latitudes increasingly suitable for *Vibrio* transmission.

The ongoing 7th cholera pandemic, which started in the 1960s, is responsible for over 2.8 million cases and 95,000 deaths annually.[121,122] While inadequate sanitation is the main enabler, climate conditions are increasingly favouring the survival of *Vibrio cholerae* in natural waters, keeping an environmental reservoir and favouring its spread.[116] Using an ecological niche model, this indicator estimates that since 2003–2005 alone, an extra 3.5% of the global coastal waters have become suitable for its transmission.

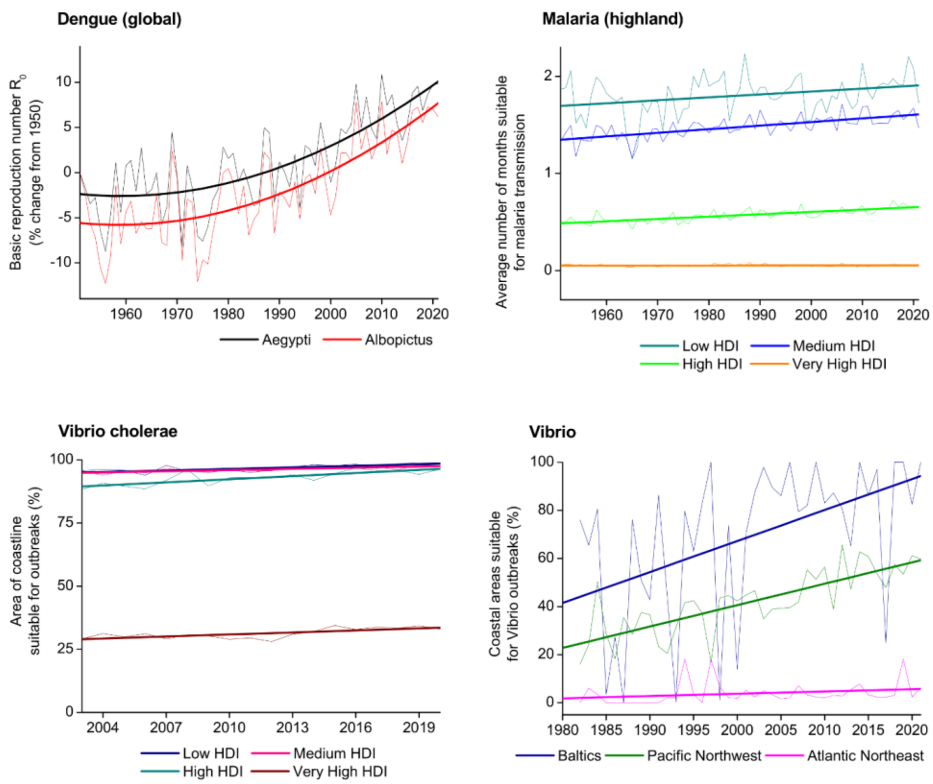

Figure 4: Change in climate suitability for infectious diseases. Thin lines represent the annual change. Thick lines represent the trend since 1951 (for malaria), 1951 (for dengue), 1982 (for Vibrio bacteria), and 2003 (for Vibrio cholerae). HDI=human development index.

Indicator 1.4 Food Security and Undernutrition

Headline finding: Relative to 1981–2010, higher temperatures in 2021 shortened crop growth seasons globally by 9.3 days for maize, 1.7 days for rice and 6 days for winter and spring wheat, and heatwave days in 2020 were associated with 98 million more people reporting moderate to severe food insecurity.

Food insecurity is increasing globally, with 720-811 million people hungry in 2020. Climate change is exacerbating risks of malnutrition through multiple, interconnected pathways (Panel 4). Less-educated and lower-income households have a higher chance of being food insecure,[123]and due to social roles and reduced land ownership, women, and the households they lead, may be more prone to malnutrition.[124-126]

Higher temperatures during growing seasons lead to faster crop maturation, which reduces the maximum potential yield that could be achieved with no limitations of water or nutrients. Combining temperature and crop growth data, the first part of this indicator shows that, relative to the 1981–2010 average, crop growth seasons in 2021 continue to shorten globally for all staple crops tracked: by 9.3 days for maize, 1.7 days for rice, and more than six days for winter and spring wheat.

The increasing atmospheric CO_2 concentrations are also increasing sea surface temperature, temperatures of inland water bodies, acidifying oceans and reducing their oxygenation, which exacerbate coral reef bleaching and undermine marine and inland fishery productivity.[127-131] Together with a shift to farm-based fish products of lower nutritional quality, climate change is thus putting marine food security at risk. [132-134] The average sea surface temperature in coastal waters of 142 countries increased globally by nearly 0.7ºC in 2019–2021 compared with 1980–1982.

New to this year, the third part of this indicator examines the impact of heatwave days during crop growth season of maize, rice, sorghum, and wheat, on self-reported experience of food insecurity. It combines data from the FAO Food Insecurity Experience Scale from 103 countries with temperature, using a time-varying regression.[135,136] Compared to 1981–2010, increases in the number of heatwave days resulted in an increase of 3.7 percentage-points in self-reported moderate to severe food insecurity in 2020, approximately equivalent to an additional 98 million people reporting moderate or severe food insecurity.

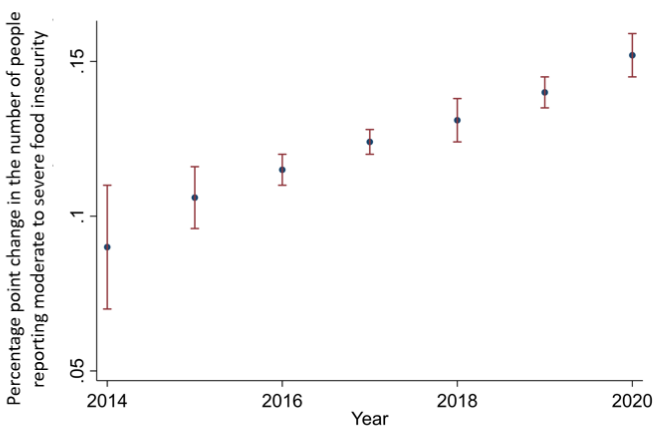

Figure 5: Change in the percentage of people reporting moderate to severe food insecurity due to heatwave days (percentage point change) occurring during four major crop (maize, rice, sorghum, and wheat) growing seasons.

Panel 4: Climate Change and Food Insecurity

Food security requires all people, at all times, to have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.[137 138]

In 2015, the world committed to ending malnutrition and achieving global food security by 2030 (SDG2).[139] However, the prevalence of undernourishment has increased since 2017.[140] Government-imposed restrictions during the COVID-19 pandemic, worsened this situation[141], and the number of undernourished people increased by 161 million to 720-811 million between 2019 and 2020.[140] Russia's war on Ukraine is further exacerbating food insecurity: Russia and Ukraine typically supply around 30% of global wheat exports, and 20% of maize, and the expected shortfall in supply, coupled with the energy crisis, is likely to drive further increases in food prices. This could result in an additional 7.6 to 13.1 million people undernourished globally in 2022. Meanwhile, conflict in places like Afghanistan, Burkina Faso, Chad, Democratic Republic of Congo, Ethiopia, Nigeria, Mozambique, Myanmar, Syria, Mali, Niger, and South Sudan, further worsens the food crises in those regions.[142]

This panel explores how climate change undermines each dimension of global food security and nutrition, and highlights priorities for climate action, providing a cross-cutting assessment of the evidence presented in this report.

Food availability, access, and stability

Climate change is putting food production, supply chains and access at risk. Rising temperatures are reducing crop growth duration (indicator 1.4) in many countries, posing a threat to crop yields. The increasing intensity and frequency of extreme weather events, including heatwaves (indicator 1.1.2), droughts (indicator 1.2.2), and wildfires (indicator 1.2.1), can damage crops and agricultural lands, affect livestock, disrupt supply chains, and affect food availability and stability of supplies.[143,144] Changing environmental conditions affect the spread of crop and livestock pests and diseases, driving production losses.[145,146] Increasing water temperatures and ocean acidification threaten fish stocks thereby undermining marine food supplies (indicator 1.4), while rising sea levels and sea water intrusion can lead to soil salinisation and crop loses.[147-150] Exposure to high temperatures and extreme weather events reduces labour capacity, and 65% of all potential hours of labour lost globally occurred in the agricultural sector, with agricultural workers, in low and medium HDI countries disproportionately affected. (indicator 1.1.4).

More broadly, reduced labour capacity can result in lower incomes (indicator 4.1.3), while extreme events can lead to direct economic damages, particularly in LMICs where most losses are not insured (indicator 4.1.1). The resulting economic loses can contribute to reduced purchasing power, undermining food access.

Food utilisation and malnutrition

Diarrhoeal diseases are the leading cause of malnutrition in children under 5,[151] while other infections can severely affect nutrient absorption and utilisation.[152-154] Climate change therefore increases the risk of malnutrition, by increasing the transmission risk of many infectious diseases, such as malaria, dengue and vibriosis (indicator 1.3), while the increasing incidence of floods, droughts, and other extreme events affect sanitation and disease outbreaks (indicator 1.1.2). Further, although increasing atmospheric CO_2 concentration may increase crop yields through the fertilisation effect, it may also reduce the nutritional quality of some grains,[155] and rising sea levels can increase the salinity of the soils and water supplies (indicator 2.3.3), leading to unhealthy levels of sodium in diets.[156]

Mitigation, adaptation planning, and resilience for health

Addressing threats to food insecurity requires coordinated and robust action across multiple sectors of governments and societies. There are some signs of progress in this respect: while 10% of the first NDCs made reference to this issue, the proportion increased to 17% in the second NDCs, updated from January 2020 onward (indicator 5.4). Further, 49% of cities identified climate-related risks to food and agriculture assets and services in 2020 (indicator 2.1.2).

Shifting to low-carbon, plant-forward diets would have the multiple benefits of reducing agricultural GHG emissions (indicator 3.5.1), improving health outcomes (indicator 3.5.2), reducing the diversion of grains to livestock and the demand of land for crop production, water demand, and the risk of agriculture-related zoonotic disease outbreaks.[157] [158] Nonetheless, the possibility of increased exposure to agricultural chemicals in plant-based foods needs to be addressed and minimized through sustainable agricultural practices to avoid related health harms in this transition.[159] Interventions to increase the resilience of food systems, and improve sanitation and healthcare can minimise climate-related nutritional risks. These include proactive safety nets, nudge programmes that encourage savings, and mother and child feeding programmes.[160] Investment in sustainable irrigation methods,[161-163] drought-resistant crops,[164] financial support for smallholder agriculture,[165,166] regional crop storage[167], insurance/reinsurance, and early warning systems for extreme weather events that might damage crops, or increase infectious disease transmission., are each likely important in specific contexts.

Conclusion

With 1.1ºC of global average surface heating, climate change is increasingly affecting the pillars of mental and physical health. Changing climatic conditions are increasing the risk of heat-related illness (indicators 1.1.1–1.1.5), changing the pattern of infectious disease transmission (indicator 1.3), increasing health risks from extreme events (indicators 1.2.1–1.2.3), undermining sanitation, and having multidimensional impacts on food and water security (indicator 1.3 and panel 4). Importantly, these impacts often occur simultaneously, exacerbating the pressure on health and health-supporting systems, and potentially triggering cascading impacts on the social and natural systems that good health depends upon.

With the world on track to 2.4–3.5°C of heating by 2100, this section exposes the urgency of accelerating mitigation and adaptation to prevent the most devastating health outcomes of a heating world.

Section 2: Adaptation, Planning, and Resilience for Health

With rapidly increasing climate change-related health hazards, transformative, proactive, and effective adaptation measures are immediately required to manage the health threats of unavoidable global heating, reducing exposure and vulnerabilities, and increasing resilience.[42] Given the interconnected and multifactorial nature of health determinants and climate impacts, adaptation must be integrated across sectors, and into policies and programs in health systems, governments, and private corporations.[42]

Three clusters of indicators are presented here. Adaptation plans and risk and vulnerability assessments—key first steps in health adaptation—are covered in indicators 2.1.1–2.1.2. The implementation of health adaptation measures and their financing are presented in indicators 2.2.1–2.2.5. The final set of indicators, presented within Section 1 in previous *Lancet* Countdown reports, have been refined and better explored to assess population vulnerabilities, resilience and adaptation interventions, and the risks associated with changing climate hazards (indicators 2.3.1–2.3.3).

2.1: Assessment and Planning of Health Adaptation

Evidence-based policy making requires comprehensive evaluation of the health threats of climate change. Climate change and health risk, vulnerability and adaptation assessments identify vulnerable populations, assess the influence of existing policies, programmes and health system capacities in building resilience, and determine future adaptation needs. The following indicators monitor the extent to which such assessments are being undertaken, and their contribution to shaping adaptation plans that can protect populations from climate-related health impacts.

Indicator 2.1.1: National Assessments of Climate Change Impacts, Vulnerability and Adaptation for Health

Headline finding: In 2021, 48 out of 95 *countries reported having completed a climate change and health vulnerability and adaptation assessment, but these only strongly influenced resource allocation in nine countries.*

Using data from the 2021 WHO Health and Climate Change Global Survey,[168] this indicator monitors whether countries have completed a health vulnerability and adaptation assessment. Although 48 out of 95 countries reported completing such assessment, only nine reported that its findings 'strongly' influenced the allocation of human and financial resources to address health risks of climate change, and just 18 reported that assessments 'strongly' informed the development of health policies and programmes.

Indicator 2.1.2: National Adaptation Plans for Health

Headline finding: Approximately half of countries (49 out of 95) reported having a national health and climate change plan in place in 2021.

This indicator monitors whether countries have a national health and climate change plan in place, drawing on data from the 2021 WHO Health and Climate Change Global Survey.[168] Only about half of countries (49/95) reported having a national health and climate change plan in place. 65% of these countries indicated a 'moderate' or lower level of implementation, with 70% of countries citing insufficient finance as a main barrier. As part of the new COP26 Health Programme Initiative on Climate Resilient Health Systems,[169] 59 countries committed to conducting a vulnerability and adaptation assessment, and using the findings to inform the development of a Health National Adaptation Plan, which contributes to the UNFCCC's National

Adaptation Plan process. Implementing commitments to the COP26 Health Programme will strengthen access to climate finance, inform national roadmaps for investments in climate resilient and sustainable health systems, and support the implementation of critical health adaptation interventions.

Indicator 2.1.3: City-level Climate Change Risk Assessments

Headline finding: 78% of cities reporting to the CDP's global survey had completed or were in the process of conducting city-level climate change risk assessments.

Cities are home to over half of the world's population[170] and, through local interventions, are critical to delivering adaptation to climate change. Using data reported to the CDP,[171] this indicator reveals that, over the past 5 years, the number of cities that declared having conducted climate assessments grew from 205 of 449 respondents (2016) to 725 out of 930 (2021), reflecting an increased recognition of the city-level impacts of climate change. While 91% (849 of 930) of responding cities belonged to very high or high HDI countries, responding cities from low and medium HDI countries increased by 70%, from 24 out of 471 in 2020, to 41 out of 522 in 2021. 64% (530 of 822) of cities reported that climate change threatened public health and/or health services. In a shift from last year's reporting, infectious diseases were identified as the most prominent climate-related health hazard (identified by 382 cities), followed by heatwaves and poor air quality (339 and 267 cities, respectively). The COVID-19 pandemic affected climate action at the city level, with 39% of cities (310 of 805) reporting it increased emphasis on climate action, and only 14% (116 of 805) reporting it decreased this emphasis. However, 30% of (242 of 798) cities reported that COVID-19 reduced financing available for climate change while only 22% (178 of 798) reported an increase in financing.

2.2: Enabling Conditions, Adaptation Delivery and Implementation

Interventions in health-related sectors can reduce climate-related exposure, vulnerability and hazards, minimising risks to health and well-being.[42] Interventions must be integrated across sectors, and include health system strengthening, capacity building, behaviour change, early warning systems, physical infrastructure, and climate-smart agriculture, with adequate financing essential to their implementation. Indicators in this section track progress on delivering such interventions.

Indicator 2.2.1: Climate Information for Health

Headline finding: In 2021, less than 40% of countries had climate-informed health surveillance systems in place for vector-borne, waterborne and/or airborne diseases.

Delivering a robust preparedness and response to climate hazards requires that health system have access to, and utilise, climate information. This indicator uses data from the 2021 WHO Health and Climate Change Global Survey, to monitor the use of climate information for health surveillance and early warning systems.[168]

In 2021, 39% of countries (30 out of 78) reported having climate-informed health surveillance systems for vector-borne diseases, 32% (25 out of 78) for waterborne diseases, 35% (23 out of 65) for airborne diseases, and 21% (14 out of 66) for zoonoses. However, only 13% (6 out of 47) had such surveillance for mental health risks and 11% (8 out of 70) for foodborne diseases.

As extreme weather intensifies, climate-informed health early warning systems (HEWS) can help limit and respond to its health impacts. About one third of countries reported having climate-informed HEWS in place for heat-related events (28 of 84) and other extreme weather events (26 of 86). Half of the very high HDI countries (13 of 26) had HEWS for extreme weather events compared to only 19% (6 out of 31) of low or medium HDI countries. While 64% (16 of 25) of the very high HDI countries had climate-informed HEWS for heat-related events this dropped to just 13% of low or medium HDI countries (4 of 30).

Indicator 2.2.2: Air Conditioning: Benefits and Harms

Headline finding: While helping prevent heat-related illness, AC in 2020 was also responsible for 0.9 gigaton of CO_2 emissions and 24,000 deaths attributable to $PM_{2.5}$ exposure.

While air conditioning (AC) is effective at protecting against heat-related illness,[172] 1.8–4.1 billion people in LMICs exposed to heat stress lack indoor cooling, and AC is often unaffordable in these countries.[173,174] Where used, it also contributes to greenhouse gas emissions, air pollution, urban heat island effects, power outages, and energy poverty.[175-179] Using data from the International Energy Agency,[180] this indicator reports that about one-third of households globally had AC in 2020, up by 66% from 2000. AC use in 2020 was responsible for 0.9 gigaton of CO_2 emissions and for 24,000 deaths from $PM_{2.5}$ exposure. Sustainable cooling alternatives need to be rolled out rapidly to avoid the worst health impacts from rising temperatures (panel 5).

Indicator 2.2.3: Urban Green Space

Headline finding: In 2021, just 27% of urban centres were classified as moderately-green or above.

Nature-based solutions can contribute to climate change adaptation and have ecosystem benefits.[42] Green spaces reduce urban heat islands, positively affect physical and mental health, and provide adaptation to extreme heat.[181-183] This indicator reports population-weighted Normalized Difference Vegetation Index (NDVI) as a proxy for green space exposure in 1038 urban centres. Despite increasingly extreme heat, average global exposure to urban greenspace remained consistently low since 2015 (mean NDVI 0.34), and just 27% of urban centres were moderately-green or above in 2021 (Figure 6). Only 33% of cities in very high HDI countries, and 39% of those in medium HDI countries, had at least moderate levels of greenness; a proportion that is even lower in high and low HDI countries (16% for both).

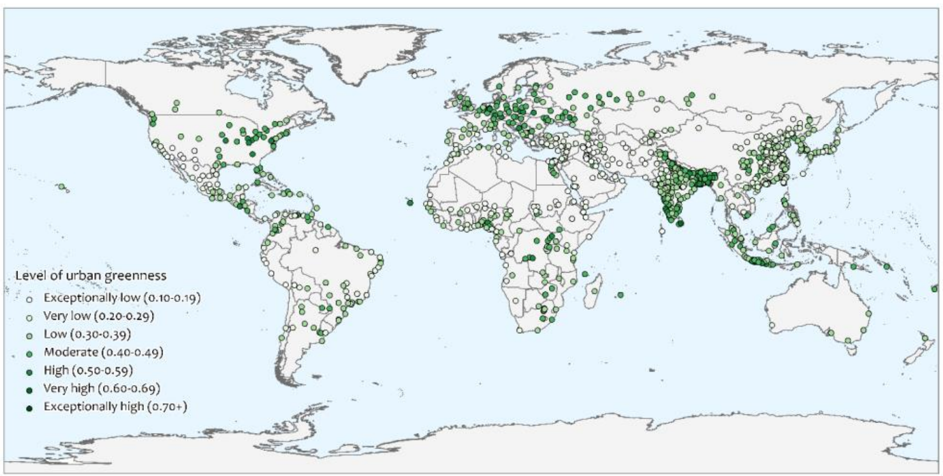

Figure 6: Level of urban greenness in urban centres with more than 500,000 inhabitants in 2021. The numbers in brackets represent the population-weighted NDVI level.

Panel 5: Heat adaptation strategies through sustainable low-energy cooling

Of all natural disasters, heatwaves cause the most deaths,[184] with older adults and those with cardiovascular disease, living with poverty and isolated in low-cost housing, most at risk.[185] Air-conditioning (AC) can offer effective protection,[172] but is expensive and thus inaccessible to many.[186] Peak energy demands from widespread AC use can overwhelm energy systems and result in electricity blackouts and brownouts, particularly in places where energy infrastructure is frail or sources are restricted, worsening health impacts.[187] As more people adopt AC worldwide, the soaring electricity demand also hinders low-energy transition, and contributes to increased GHG emissions (indicator 3.1).[188] Through waste heat generation, AC use also intensifies urban heat, and contributes to increased exposure to air pollution (indicator 2.2.2). Sustainable and affordable cooling alternatives are therefore urgently needed.

Modifications in the landscape and built environment can provide local cooling benefits. Water bodies act as heat sinks, and vegetation provides shading and cooling by evapo-transpiration.[189] Reflective roofs and better building insulation can attenuate heat transfer to the individual.[186] However, such interventions can require long-term changes to urban or regional infrastructure. Alternatively, heat resilience in the immediate-term can be built through low-resource and sustainable cooling behaviours at the personal scale. The use of window blinds can help reduce indoor temperatures by blocking solar radiation. Where AC is available, moving indoor air with fans elevates the upper temperature of warm discomfort by 3-4˚C, allowing for AC to be set at a higher temperature,[190] reducing AC-energy demand.[191] Electric fans provide effective cooling up to at least 40˚C for resting and active young adults,[192,193] and to around 38˚C for resting older adults, while using 30-times less energy than AC.[194] However, in very hot-dry conditions (>45˚C with <15% relative humidity (RH)), fans must be used with extreme caution because they can worsen physiological heat strain and dehydration;[193] an effect likely aggravated in older adults. Evaporative coolers, depending on their size, use 2 to 5-times less energy than AC, and can reduce indoor temperatures by 5-10˚C in dry weather (<20-30% RH). However, they are inefficient cooling devices in high humidity (>50-60% RH) unless used with a dehumidifier[195] and are dependent on reliable water supply. In cases where electricity is unavailable, including during power blackouts, studies suggest that cooling could be achieved by frequently wetting large skin areas, which may reduce physiological heat strain and improve thermal comfort up to at least

47˚C.[196] Donning lightweight water-soaked clothing, provides similar benefits up to at least ~43˚C.[197] Immersing both feet in cool water (<20˚C) for 10 minutes every 20 minutes might reduce dehydration and improve thermal comfort up to at least 47˚C.[196] Immersing both hands/arms to the elbow in 10˚C water can blunt core temperature rises at air temperatures up to 40˚C.[198]

Public health campaigns promoting these evidence-based sustainable cooling strategies in advance of, and during, bouts of extreme heat will not only help reduce energy demand and energy poverty, but also reduce the risk of heat-related morbidity and mortality, and help build resilience in the face of rising global temperatures.

Indicator 2.2.4: Health Adaptation-Related Funding

Headline finding: In 2021, only 15% of US$1.14 billion under the Green Climate Fund went towards adaptation activities with health benefits.

Financial resources are essential to implementation health adaptation interventions.[42] This indicator uses transactional data from kMatrix's Adaptation and Resilience to Climate Change dataset, to monitor global spending with the potential to support adaptation in healthcare sectors, and in sectors of health relevance (e.g. agriculture, water and built environment). In the fiscal year 2020/21, US$21.78 billion was spent in transactions that could support health and healthcare adaptation (5.6% of total adaptation-related spending), and US$111.2 billion (28·5%) was spent in transactions with the potential to deliver adaptation in health-relevant sectors. In a reversal of previous years' trend, the share of spending in these two sectors with respect to total adaptation-related spending fell slightly (by less than 0.1%).

The second part of this indicator monitors global multilateral funding for health-related adaptation projects by the Green Climate Fund (GCF). In 2021, the GCF approved US$726 million for 15 adaptation projects and US$414 million for eight 'cross-cutting' mitigation and adaptation projects. Of this, only 15% (US$166 million) went to projects whose benefits included 'increased resilience of health and wellbeing'. Furthermore, of the 54 concept notes submitted for adaptation and cross-cutting projects (US$1.6 billion), only four focused on health systems (US$218 million), none of which were approved. These findings highlight a deficit in the prioritisation of health within adaptation funding.

Indicator 2.2.5: Detection, Preparedness and Response to Health Emergencies

Headline finding: 63% of 177 countries reported high to very high implementation status for health emergency management in 2021.

This indicator monitors implementation of core capacity 7 (C7), health emergency management, of the International Health Regulations (IHR). With slight changes from previous years, emergency management under core capacity 7 is now comprised of three capacity requirements: planning for health emergencies, management of health emergency response, and emergency logistic and supply chain management. In 2021, 63% of countries (112 out of 177) reported high to very high implementation (capacity score of 61-100) of health emergency management. Considering HDI, large disparities existed, with only 35% of low or medium HDI countries reporting high to very high implementation status of health emergency management compared to 88% of very high HDI countries.

The COVID-19 pandemic triggered a review of the IHR by the World Health Assembly in 2020.[199,200] Proposed reforms include regular country reviews and monitoring mechanisms, increased support for their implementation, and better information sharing, all of which can help strengthen health systems from climate change- related health hazards. Climate change emergency preparedness and response requires a multisectoral approach with strengthened leadership and coordination of international financial and health institutions, and increased ability to address public health misinformation. Such measures would deliver cascading benefits through the whole health system.[199,201]

2.3: Vulnerabilities, Health Risk and Resilience to Climate Change

Climate change adaptation aims to reduce human exposure and vulnerability to climate hazards; minimising health risks, and ultimately minimising climate change-related health impacts. The following indicators provide a glance at the effectiveness of adaptation and health system strengthening in modifying climate-related health risks.

Indicator 2.3.1: Vulnerability to Mosquito-Borne Diseases

Headline finding: Improvements in healthcare contributed to a 43% decrease in vulnerability to severe dengue outcomes in low HDI countries from 1990 to 2019, while urbanisation drove a 5% increase in very high HDI countries.

Dengue incidence increased eightfold in the past two decades, driven by population movement, international trade, urbanisation, and increasing climatic suitability (indicator 1.3).[117-119,202,203] While controlling its spread is challenging,[204] timely and adequate treatment is essential to prevent severe health outcomes.[42,205,206] This indicator tracks the relative vulnerability to severe adverse dengue outcomes in countries where the climatic conditions are suitable for dengue outbreaks (R0>1, as per indicator 1.3), combining two main determinants of dengue vulnerability: healthcare access and quality (using mortality from key preventable diseases as a proxy), and the proportion of population in urban environments.[202,207] Between 1990 and 2019, improvements in healthcare contributed to a ~~45~~43% reduction in vulnerability to severe dengue outcomes in low HDI countries, and a ~~28~~23% reduction in medium HDI countries. However, urbanisation drove an increase of ~~17~~5% in vulnerability to dengue in very high HDI countries.

Indicator 2.3.2: Lethality of Extreme Weather Events

Headline finding: The average lethality per climate-related disaster has decreased from 837 deaths in 1980–1989 to 46 in 2012–2021, and is negatively associated with healthcare spending.

The number of reported climate and weather-related disasters increased five-fold over the last 50 years.[208] Using data from the Centre for Research on the Epidemiology of Disasters,[209] data in this indicator shows that the proportion of all climate-related events that were deadly has increased steadily since at least 1980. However their lethality decreased globally from an average of 837 deaths per event in 1980–1989 to 46 in 2012–2021 ($P<0.031$). The average number of people affected per disaster is negatively correlated with GDP, HDI, and the percentage of GDP spent on healthcare, with the latter showing the strongest correlation. With many extreme events becoming increasingly frequent and severe, these results underscore the importance of health system strengthening, including through the implementation of the priorities outlined in the Sendai Framework for Disaster Risk Reduction.[210] Given the socially-defined gender differences in the impacts and response of extreme events, a gender-sensitive approach is particularly needed.[211]

Indicator 2.3.3: Migration, Displacement, and Rising Sea Levels

Headline finding: In 2020, 149.6 million people were settled less than 1 metre above current sea level, in regions increasingly at risk from the hazards of the rising seas.

Global mean sea level (GMSL) has risen by 3.7mm per year between 2006 and 2018, and will reach 0.28–1.01 m or more by 2100, depending on climate change mitigation efforts, ice sheet collapse, and local factors.[74,212-215] Using land elevation and population data, this indicator reports that there were 149.6 million people living less than 1m above sea level in 2020, a slight increase from the 145.2 million people settled there in 2010. These populations face risks from flooding, coastal and riverbank erosion, severe storms, soil and water salinisation, spread of infectious diseases, and permanent inundation.[215-217] With insufficient in situ adaptation, human relocation (forced, or as a proactive adaptation measure) could be a response, and its health impacts will largely depend on the support given to migrant populations.[42] The development of policies to protect the health of migrant and immobile populations is critical. As of December 2021, 45 policies connecting climate change and migration were identified in 37 countries.

Conclusion

The indicators in this section expose how, while national and city-level assessment of the climate-related health risks is gradually increasing and health system strengthening might have reduced the impact of extreme events, the pace and scale of climate change adaptation, planning, and resilience is far from what is necessary to reduce the health impacts of climate change. Despite rising heat, only 27% of urban centres have at least a moderate level of greenness, and just 28 of 84 countries report having heat-related early warning systems for health. Funding to support health adaptation remains grossly insufficient, and is seldom influenced by vulnerability and adaptation assessments. The past year saw global health, economic, and conflict shocks that lacerated public health, with climate change playing a role in exacerbating many of them. Without global coordination, transparency, and cooperation between governments, communities, civil society, businesses, and public health leaders, the world will remain vulnerable to international emergencies. The gap between the health impacts of climate change, and adaptation investment and implementation continues to increase, to the detriment of all.

Section 3: Mitigation Actions and Health Co-Benefits

Due to COVID-19-related responses, anthropogenic CO_2 emissions fell by 5.4% on 2020 - the largest drop over the past 25 years.[218] However, with little structural change to limit fossil fuels use, emissions rebounded by 6% in 2021, reaching an all-time high.[219] The current 1.1°C of warming proved to be already dangerous to health (Section 1). To limit temperature rise to 1.5°C above pre-industrial levels, emissions should decrease 45% from 2010 levels by 2030. However, even if commitments in countries' NDCs were enacted, emissions in 2030 would be 13.7% above 2010 levels.[220] The grossly insufficient decarbonisation, compounded by geopolitical conflict, has made it vastly more challenging to limit temperature rise to 1.5°C, and the window of opportunity to achieve this is rapidly closing.[8]

Accelerated decarbonisation would not only prevent the most catastrophic health impacts of accelerated heating but, if designed to maximise health benefits, could also save millions of lives through healthier diets, more active lifestyles, and improved air quality.[221] Indicators in this section monitor the world's efforts to reduce GHG emissions across energy (indicators 3.1 and 3.2), transport (indicator 3.4), food and agriculture (indicator 3.5) and healthcare (indicator 3.6), and monitor the health benefits that could arise from prioritising health in mitigation policies.

Indicator 3.1: Energy System and Health

Headline finding: CO_2 emissions from fossil fuel combustion alone rebounded in 2021 by 4.8% after a 5.8% drop in 2020 due to COVID-19-related impacts.

Energy systems are the largest single source of greenhouse gas emissions and are major contributors to air pollution. Global energy system transition to renewables is not only critical for climate change mitigation,[8] but could also contribute towards universal, affordable, and clean energy;[222] reduce air pollution; and decrease dependence on international markets and foreign policies. Using data from the IEA, this indicator shows that the carbon intensity of the global energy system continued to fall in 2019 for the seventh consecutive year, to 55.4 tCO_2/TJ. However, this is still far from the requirements of keeping global warming at 1.5°C, with a reduction of less than 1% from 1992 levels, the year the UNFCCC was adopted. At the pace recorded from 2014, fully decarbonising the energy system would take 150 years. In addition, the increasing demand for energy means fossil fuel use is still rising, and fossil fuel-derived CO_2 emissions rebounded in 2021 by 4.8%, after a 5.8% drop in 2020 during the COVID-19 pandemic (Figure 7), driving CO_2 emissions to a record high.[219]

Phasing-out coal is particularly urgent, given its high GHG and air pollution intensity. However, coal still provides 26.7% of global energy supply, 2.8 percentage points more than in 1992. Responsible for 54% of global coal energy use in 2019, China's coal expansion was a major contributor to the rise in global GHG emissions since the early 2000s, with its per capita emissions at 7tCO_2/person in 2019 now equivalent to the OECD average.[223]

Growth in renewable electricity reached record levels in 2020, with the installation of 139 GW of solar PV and 93 GW of wind power. This corresponded to 90% of new electricity installation in 2020,[224] and to renewables providing 8.2% of global electricity, twice 2013 levels. However, big differences exist between countries globally, and only 1.4% of the electricity of low HDI countries is produced from modern renewables (mostly solar, wind and geothermal), against 9.5% in very high HDI countries. Concerningly, 60% of healthcare facilities in low and middle-income countries still lack access to the reliable electricity needed to provide basic care,[225] only 2.2% of total world energy comes from renewable sources, and fossil fuel use, in absolute terms, has grown faster. A low-carbon transition can help countries increase local energy production, gain independence from volatile fossil fuel markets, and reduce energy poverty.

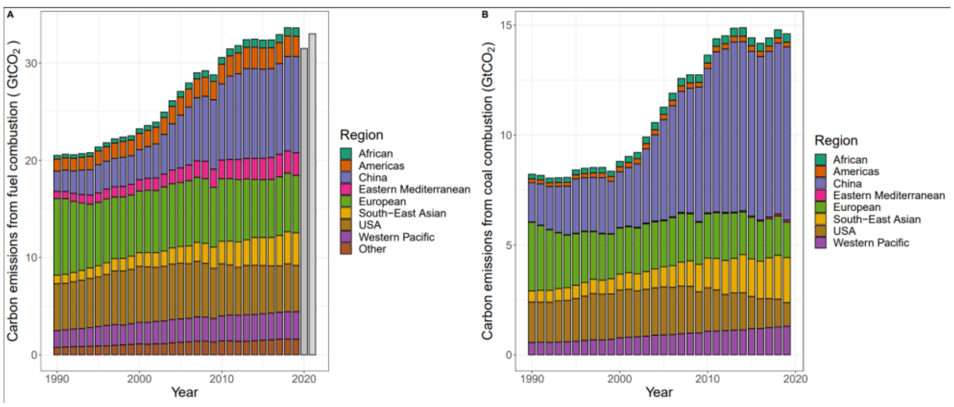

Figure 7: Greenhouse gas emissions from the global energy system. Panel A: Global CO_2 emissions from fossil fuel usage. Preliminary and modelled values shown for years 2020 and 2021 respectively. Panel B: Global CO_2 emissions from the use of coal

Indicator 3.2: Clean Household Energy

Headline finding: Despite improved access to clean fuels, biomass and fossil fuels accounted for 31% and 26% of global household energy, respectively, in 2020.

Around 770 million people lack access to electricity in their homes,[226] and their use of dirty fuels is leading to high exposure to air pollution.[227] In parallel, with residential energy contributing to 17% of global GHG emissions, transitioning to clean fuels in the domestic sector is essential to meet mitigation goals.[228] Drawing on IEA data, this indicator reveals that biomass still represented the largest source of residential energy in 2020 (31%), while electricity contributed to 25%, and fossil fuels to 26%. Africa and Southeast Asia improved access to clean energy from 13% and 19% respectively in 2000, to 20% and 64% in 2020. However, they remain heavily reliant on solid biofuels. Data from the WHO indicates that globally, while 86% of the urban population had access to clean fuels and technologies for cooking in 2020, only 48% of rural populations did. Inequities were also marked between countries, with 98% of the population in very high HDI countries having access to clean fuels and technologies for cooking, against just 13% in low HDI countries (Figure 8).

The WHO estimates that the use of solid fuels for cooking resulted in 3.8 million deaths attributable to household air pollution (HAP) in 2016.[229] Providing the capacity to monitor changes in HAP exposure year on year, this new indicator builds on a previously published model,[230] to estimate HAP using a Bayesian hierarchical model that accounts for fuel usage, stove types, socioeconomic variables, and ambient air pollution in 62 countries. It estimates the use of solid fuels for cooking and heating resulted in a global average $PM_{2.5}$ concentration in people's homes of 150 μg/m^3 in 2020 (168 μg/m^3 in rural households and 91 μg/m^3 in urban dwellings). With values broadly exceeding the 5 μg/m^3 threshold recommended by the WHO,[231] the delayed transition to clean household energies is profoundly affecting people's health.

Economic hardship during the COVID-19 pandemic has deepened energy insecurity in households in countries of all HDI levels. The number of people without access to electricity increased in 2020 for the first time in six years,[232] with shifts and dirty fuels, and increasing exposure to household air pollution.[233,234] Indeed, the share of the population without access to electricity in Sub-Saharan Africa increased by three percentage points, to 77% in 2020.[226] Russia's invasion of Ukraine threatens to exacerbate this situation, through rising energy prices and supply chain disruption.[235,236]

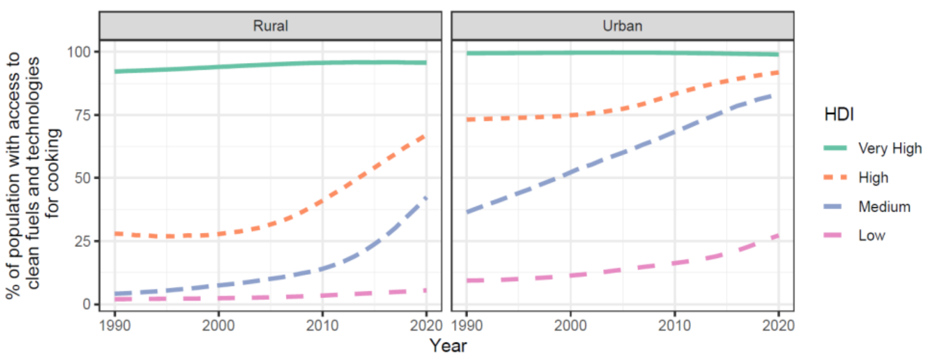

Figure 8: Percentage of the rural and urban population with primary reliance on clean fuels for cooking, by HDI country group.

Indicator 3.3: Mortality from Ambient Air Pollution by Sector

Headline finding: In 2020, exposure to ambient anthropogenic $PM_{2.5}$ contributed to 3.3 million deaths. Of these, 1.2 million were directly related to fossil fuel combustion.

Exposure to air pollution increases the risk of respiratory and cardiovascular disease, lung cancer, diabetes, neurological disorders, and adverse pregnancy outcomes.[237] This indicator estimates the mortality attributable to ambient $PM_{2.5}$, combining atmospheric modelling with information of activity in emitting sectors. This year, baseline mortality data was updated, and attributable deaths from type 2 diabetes also included.[238] In 2020, exposure to ambient $PM_{2.5}$ contributed to 4.2 million deaths, unchanged from 2015, while mortality per 100,000 decreased by 5% (Figure 9). Of these, 80% (3.3 million) were attributable to anthropogenic emissions; of which 1.2 million (35%) were directly related to fossil fuel combustion. Deaths due to coal combustion have decreased by 18% from 687,000 in 2015 to 561,000 in 2020, largely due to strict air pollution control measures in China and coal phase down in Europe.

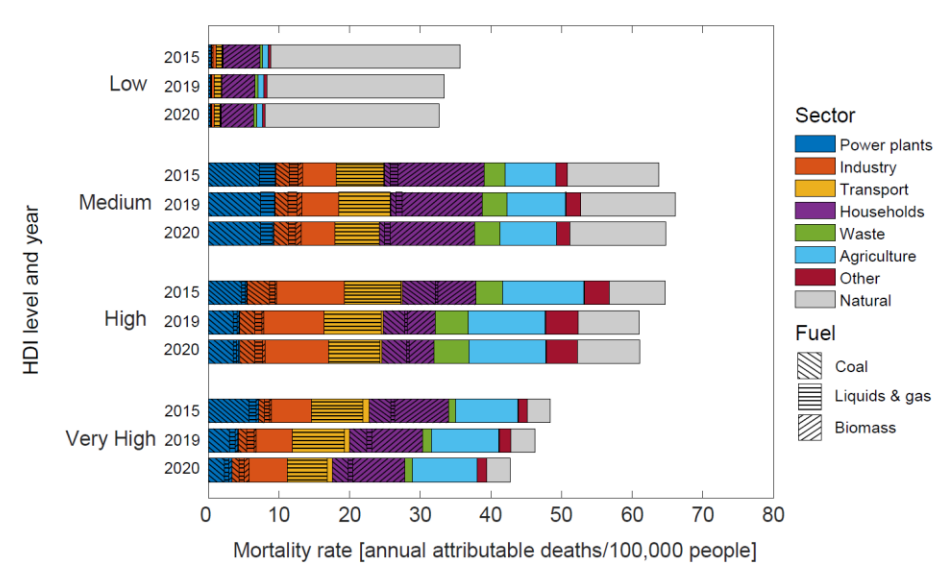

Figure 9: Mortality attributable to ambient $PM_{2.5}$ exposure by region, sector, and source fuel.

Indicator 3.4: Sustainable and Healthy Road Transport

Headline finding: Fossil fuel use in road transport fell by 0.8% in 2019, while electricity use grew by 15.7%.

The transport sector contributed to 25% of global CO_2 emissions in 2019.[5,219,239] If combined with energy grid decarbonisation, electric vehicles can be an important mitigation tool. The use of electricity for road transport grew by 237% in the last decade, but still represents just 0.3% of total fuel use for road travel. Sales of electric vehicles more than doubled in 2021,[240] a growth led by China, with nearly 3.4 million sales (12% of the total). However, only 1% of the global car stock is electric.[241]

Road transport decarbonisation through modal shift to active travel can deliver health benefits from reduced air pollution, which accounted for 497,000 deaths in 2020 (indicator 3.3), and increased physical activity.[242,243] Smartphone data suggests that public transit use has returned to pre-pandemic levels in 85% of countries for which data are available,[244] and highlights the need to deliver robust policies that encourage shifts towards active travel and public transit modes.

3.5: Food, Agriculture, and Health

The global food system contributes one third of all GHG emissions.[245] Emissions from the agricultural sector are dominated by ruminant rearing, mostly mediated by methane emissions and land use change.[246,247] Shifting to low-carbon plant-forward diets can not only help mitigate agricultural-sector emissions, but also have important health co-benefits from improvements in dietary risk factors and mortality from non-communicable diseases.[238,248,249] The following two indicators track agricultural emissions (indicator 3.5.1) and the health impacts of carbon-intensive diets (indicator 3.5.2), identifying the potential health opportunity of agricultural decarbonisation.

Indicator 3.5.1: Emissions From Agricultural Production and Consumption

Headline finding: Red meat and milk contribute to 55% of global agriculture emissions.

This indicator, improved from previous reports to include data on 140 food types, estimates that emissions from agricultural product consumption have remained stable at around 0.9tCO_2e/capita, while total emissions have increased 31% since 2000 (Figure 10). In 2019, 55% of global agricultural emissions came from red meat and dairy products. Per capita emissions from red meat and dairy consumption in very high HDI countries were twice those in the rest of the world (0.8 tCO_2e/capita vs 0.4tCO_2e/capita). Increases in palm oil production account for some of the greatest changes since 2000, for which emissions in South-East Asia (mainly Indonesia) increased over 600%.

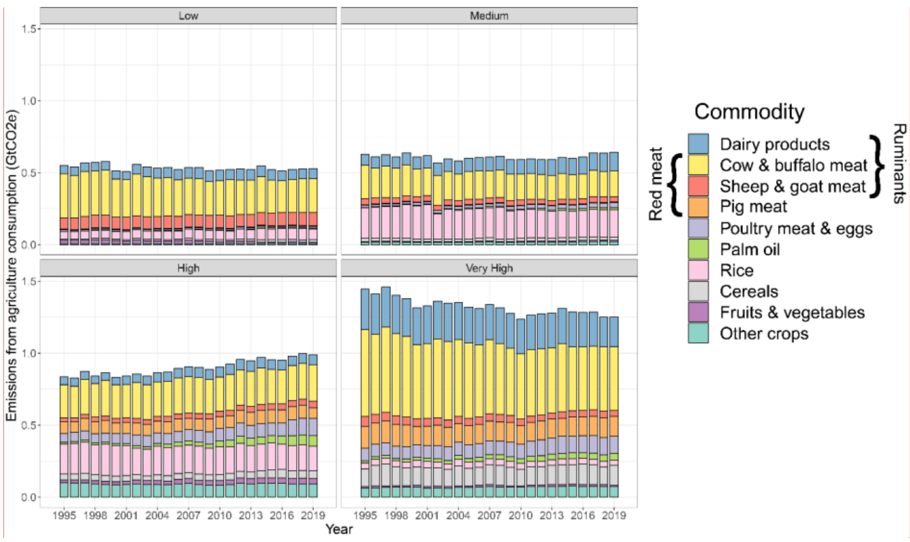

Figure 10: Emissions of greenhouse gases on farms associated with food consumption (production and net imports) per person by HDI level.

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Indicator 3.5.2: Diet and Health Co-Benefits

Headline finding: In 2019, 11.5 million deaths were attributable to imbalanced diets, 17% related to high intake of red and processed meat and dairy products.

This indicator tracks the health burden from unhealthy diets and, new to this year, of imbalanced energy intake.

In 2019, 11.5 million deaths were attributable to imbalanced diets. 17% (2 million) of them were related to red and processed meat and dairy consumption, of which 93% occurred in high and very high HDI countries. In low and medium HDI countries, the low consumption of fresh fruit and vegetables was the major contributor to diet-related mortality; at 44% of all diet-related deaths in low HDI countries, and 37% in medium HDI countries.

Indicator 3.6: Healthcare Sector Emissions

Headline finding: From 2018 to 2019, emissions from the healthcare sector grew more than 5%, reaching 5.2% of global GHG emissions.

Given the health impacts of climate change, health systems must be at the forefront of decarbonisation to fulfil their mandate of doing no harm. This indicator monitors healthcare sector emissions combining healthcare expenditure data with a global environmentally-extended multi-region input-output model. It estimates that in 2019, the healthcare sector contributed approximately 5.2% (2.7 Gt CO_2e) of global GHG emissions, a rise of over 5% from the previous year. Of the 37 health systems analysed individually, the USA's had the most per-capita emissions, 50 times those of India's (Figure 11). Despite this, the USA has the 6^{th}-lowest healthy life expectancy at birth (66.2 years). Per capita emissions in the 10 countries with the highest life expectancy ranged from 1065 kgCO_2e/person in the Republic of Korea, to 321 kgCO_2e/person in France, highlighting that high quality healthcare can be achieved with lower emissions. Recent decarbonisation commitments from over 50 national health services provide hope for emerging progress (Panel 6).[250]

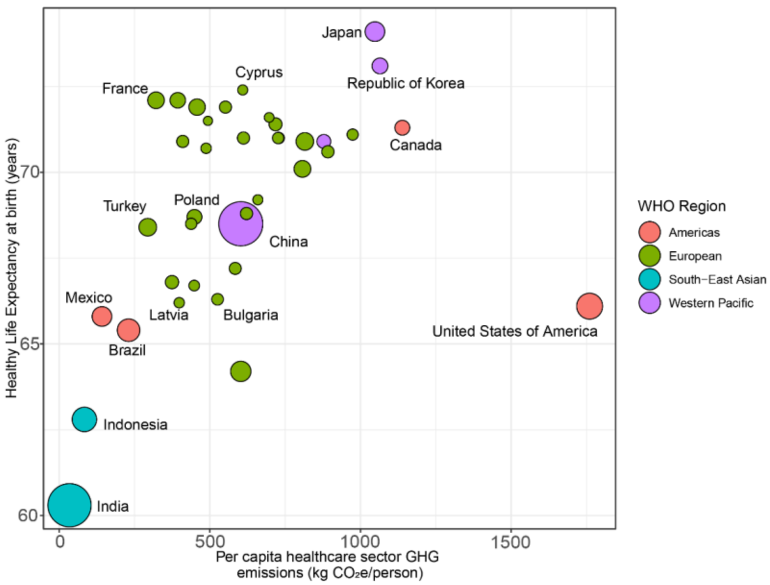

Figure 11: National per-capita greenhouse gas emissions from the healthcare sector against the healthy life expectancy at birth in 2019, by WHO region. The point circle size is proportional to country population $kgCO_2e$=kilograms of carbon dioxide equivalent.

Panel 6: Healthcare, COVID and Climate Change

The COVID-19 pandemic has greatly altered patterns of healthcare usage in countries around the world, and in turn, their healthcare-associated emissions. Many health systems experienced massive increases in expenditures on personal protective equipment (PPE), diagnostic testing, and provision of critical care, but also saw decreases in non-COVID-19 essential and elective care. As a result, healthcare GHG emissions are expected to have shifted substantially in 2020–2021, perhaps even decreasing in some countries. But while reducing usage and associated emissions is a goal of healthcare climate change mitigation efforts, this must not come at the expense of deferring or avoiding necessary care. Measures of progress toward decarbonising the health sector need to be simultaneously oriented toward achieving both optimal health and reduced GHG emissions.

The pandemic has highlighted risks associated with healthcare's sprawling supply chains, including widespread shortages of basic medicines, equipment, and PPE, among others. Leading health systems must simultaneously focus on reducing these supply chain risks and mitigating GHG emissions. COP26 resulted in historic commitments by 60 countries thus far, to develop climate-resilient and/or low- or net zero-carbon health systems,[250] and many are beginning to implement and share best practices that both improve resilience and reduce life cycle GHG emissions[251].

Conclusion

Following the easing of COVID-19 pandemic lockdowns, CO_2 emissions rebounded to record levels in 2021. With each year that global GHG emissions fail to fall, reaching net-zero by 2050 becomes more challenging, putting lives at increased risk from climate change.

Whilst impacts of COVID-19 on the indicators in this section are still emerging, many of the challenges to delivering mitigation and health co-benefits have been entrenched since the start of the pandemic, including the domestic overreliance on biomass, record levels of coal extraction in China, and rebounding emissions from road transport. The ongoing energy crisis, deepened by Russia's war on Ukraine, threatens to worsen this situation, further undermining progress and exacerbating energy poverty. Increasing energy efficiency, conservation, and adoption of renewables, on the other hand, could deliver healthier, more resilient, and self-sufficient energy systems. Millions of lives could be saved each year through an accelerated transition to cleaner fuels, healthier diets, and active modes of travel.

Section 4: Economics and Finance

Limiting global temperature rise to 1.5°C requires rapid decarbonisation in all economic sectors. While the up-front investment required to deliver a low-carbon transformation is substantial, this would deliver immediate economic benefits and health co-benefits, in addition to avoiding long-term climate change impacts.[252,253] With the right incentives, and market and governance conditions, the necessary private sector investment is available. Separately, it is disappointing that parties to the UNFCCC have so far failed to deliver on the goal of mobilising the much smaller sum of US$100 billion annually to support climate action in "developing" countries to which they committed 13 years ago; a commitment essential not only to deliver global climate goals, but also to ensure a just transition.[8] In addition, the ongoing energy crisis, stimulated by the COVID-19 pandemic and exacerbated by the war in Ukraine, is deepening energy poverty, and exposing further dimensions of the human costs of a fossil fuel-dependent global energy system. Indicators in this section explore the economic costs of climate change, and monitor the transition to a low-carbon, healthy, and just global economy.

4.1 The Economic Impact of Climate Change and its Mitigation

Climate change is causing additional healthcare costs and loss of labour productivity. This, in turn, affects household incomes and national economies, and the damage caused by climate-related extreme events results in further economic losses. Indicators in this section track the economic costs associated with the health impacts of climate change, revealing the potential benefits from accelerated climate action.

Indicator 4.1.1: Economic Losses due to Climate-Related Extreme Events

Headline finding: Very high HDI countries suffered around half the global economic losses due to climate-related extreme events in 2021, and double the rate of the global average as proportion of GDP. While around half of their losses were insured, the vast majority of the losses in other countries were uninsured.

The loss of infrastructure and resulting economic losses due to extreme events can exacerbate the health impacts through disruption of essential services and impacts on the social determinants of health. This indicator tracks the economic losses from climate-related extreme events, using data provided by Swiss Re.[254]

In 2021, climate-related extreme events induced measurable economic losses of US$ 253 billion, with 84% of these losses in very high HDI countries. As a proportion of GDP, losses in the very high HDI group are double the global average. However, nearly half of these losses were insured, while insured losses represented only 8% and 5% of all losses in high and medium HDI countries and were effectively zero in the low HDI country group. These high levels of uninsured losses exacerbate the economic burden of climate change in lower HDI countries, with losses going either unreplaced, or the cost of replacement falling directly on individuals and institutions.

Indicator 4.1.2: Costs of Heat-Related Mortality

Headline finding: The monetised value of global heat-related mortality was estimated to be US$144 billion in 2021, equivalent to the average income of 12.4 million people.

This indicator combines estimates of years of life lost (YLL) data from indicator 1.1.6 with value of statistical life-year (VSLY), to estimate the monetised loss caused by heat-related mortality. The valuation of life across varying HDI levels presents a methodological and ethical challenge, which this indicator addresses by presenting the cost of deaths attributable to heat as the proportion of GDP and the equivalent annual average income. From 2000 to 2021, monetised losses increased at an average rate of US$4.9 billion each year, equivalent to 0.16% of gross world product (GWP) in 2021 (Figure 12). The last six years register the highest losses, at an average equivalent to the income of 12.4 million people, 73% higher than in 2000–2005. In 2021, very high HDI countries incurred the highest losses, equivalent to 5.3 million of their residents' average income, with losses equivalent to 4.7 million, 1.48 million and 0.51 million average incomes in high, medium and low HDI countries, respectively.

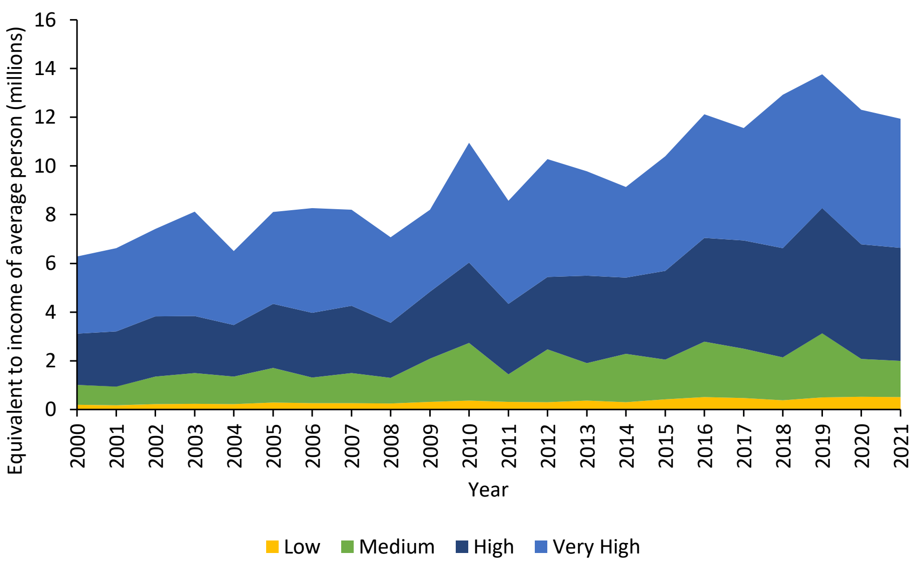

Figure 12: Monetized value of heat-related mortality (in terms of equivalence to the average income) by HDI country groups from 2000 to 2021

Indicator 4.1.3: Loss of Earnings from Heat-Related Labour Capacity Reduction

Headline finding: The global potential income loss from labour capacity reduction due to extreme heat was US$669 billion in 2021. The agricultural sector was the most severely affected, incurring 82% and 71% of the average losses in low and medium HDI countries, respectively.

This indicator quantifies the loss of earnings that could result from heat-related labour capacity loss, combining data from indicator 1.1.4 with hourly wage data from the International Labour Organization (ILO).

The global potential loss of earnings was US$669 billion in 2021, equivalent to for 0.72% of GWP in 2021. In 2021, low and medium HDI countries experienced the highest average relative income losses, equivalent to 5.6% and 3.9% of their GDP respectively (Figure 13). Of all global losses, 40% occurred in the agricultural sector. Agricultural labourers of low and medium HDI countries, often amongst the world's poorest,[255-257] endured on average 82% and 71% of the losses in those countries, respectively. Affecting individual finances, these losses impact on people's wellbeing, food security, and the social determinants of health,[2] and cascade through the economies of the nations they live in.

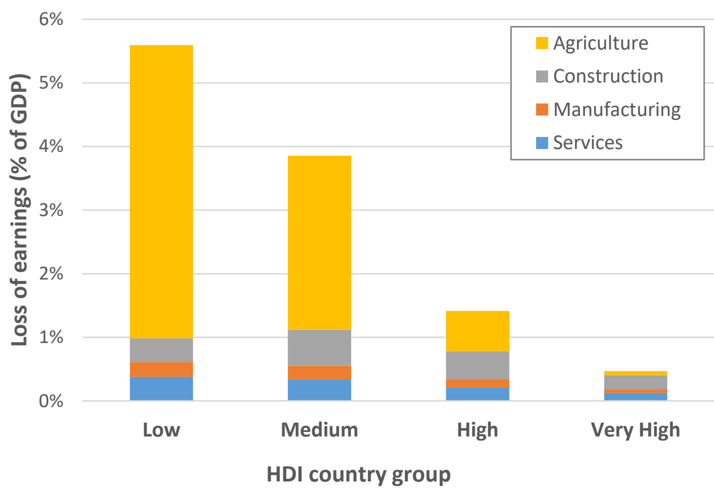

Figure 13: Average potential loss of earnings per Human Development Index country group as a result of potential labour loss due to heat exposure. Losses are presented as share of GDP and sector of employment.

Indicator 4.1.4: Costs of the Health Impacts of Air Pollution

Headline finding: In 2020, the monetised costs of premature mortality due to air pollution amounted to US$2.3 trillion, the equivalent of 2.7% of gross world product.

This indicator places an economic value on the YLLs from exposure to anthropogenic ambient $PM_{2.5}$ as per indicator 3.3. While costs relative to average income and GDP decreased between 2019 and 2020 in all HDI groups, in 2020 the total cost amounted to US$2.3 trillion, or the equivalent of 2.7% of GWP. The high HDI country group has the greatest costs relative to per capita income, equivalent to the annual average income of 92.3 million of its people. The medium

HDI group has the greatest costs relative to the size of their collective economies, equivalent to nearly 4% of GDP.

4.2 The Economics of the Transition to Net Zero-Carbon Economies

Meeting the Paris Agreement goals requires a low-carbon transition of the whole economy. Indicators in this section monitor jobs and investment in low-carbon energy, net carbon pricing, and the effect of global trade on emissions. A new indicator quantifies the extent to which the activities of oil and gas firms are in line with the pathways needed to achieve 1.5°C of heating.

Indicator 4.2.1: Clean Energy Investment

Headline finding: Between 2020 and 2021, investment in global energy supply investment increased by 14%; zero-carbon sources accounted for 80% of investment in electricity generation in 2021.

As described in the previous section, phasing out fossil fuels , and particularly coal, and investing in low-carbon energy supply is essential for both mitigating climate change and for reducing premature mortality due to air pollution. Taking data from the IEA, this indicator monitors trends in global investment in energy supply and energy efficiency.

Between 2020 and 2021 total investment increased by 14%, with investment increasing in all forms of energy supply and end-use efficiency except coal for electricity generation. In 2021, electricity generation accounted for 28% of investment. Of this, 80% was invested in zero-carbon sources. However, fossil fuels continue to account for more than 90% of non-electricity sector investment. Energy efficiency accounted for 15% of all investment – an increase from 13% in

2020. To be on track for net-zero global emissions by 2050, investment in low-carbon energy, efficiency and electricity networks must nearly quadruple by 2030, and account for at least 90% of all energy investment.[258]

Indicator 4.2.2: Employment in Low-Carbon and High-Carbon Industries

Headline finding: With over 12 million employees, direct and indirect employment in renewable energy exceeded direct employment in fossil fuel extraction for the first time in 2020.

Employees in fossil fuel extraction industries, particularly coal mining, can have a greater incidence of non-communicable disease than the general population.[259] Increasing employment in the renewable industry could improve health and livelihoods. It could also deliver improvements in gender balance, with a greater proportion of women employed in the renewable sector than in the fossil fuel industry.[260]

This indicator shows that over 12 million people were employed directly or indirectly by the renewable energy industry in 2020, up by 5% from 2019. For the first time, direct and indirect employment in renewables exceeded direct employment in fossil fuel extraction industry, which recorded 10.5 million employees (down by 10% from 2019), reaffirming that renewable energy could support job security, now and in the future.

Indicator 4.2.3: Funds Divested from Fossil Fuels

Headline finding: The global value of funds committing to fossil fuel divestment between 2008 and 2021 was US$40.23 trillion, with health institutions accounting for US$54 billion.

By divesting holdings in fossil fuel companies, organisations can both reduce the social licence of fossil fuel companies to operate, and hedge against risk of losses due to so-called stranded assets in an increasingly decarbonised world.[261,262] This indicator tracks the value of funds divested from fossil fuels using data provided by stand.earth and 350.org.[263]

From 2008 until the end of 2021, 1,506 organisations, with assets worth at least US$40.23 trillion, have committed to divestment. Of these organisations, only 27 are health institutions, with assets totalling US$54 billion. The value of new funds committed to divesting in 2021 was US$9.42 trillion, with no new health institutions divesting.

Indicator 4.2.4: Net Value of Fossil Fuel Subsidies and Carbon Prices

Headline finding: 80% of the 86 countries reviewed had a net-negative carbon price in 2019, hindering the transition away from fossil fuels. The resulting net loss of government revenue was in many cases equivalent to large proportions of the national health budget.

Carbon prices help economies transition from high-carbon fuels, but many governments subsidise fossil fuels, encouraging health-harming emissions and slowing the low-carbon transition. This indicator compares carbon prices and monetary fossil fuel subsidies to calculate net economy-wide average carbon prices and revenues, covering 86 countries responsible for 92% of global CO_2 emissions.

In 2019, 42 countries had a carbon pricing mechanism in place, but only 17 produced a net-positive carbon price – all of which were very high HDI countries (Figure 14). 69 countries out of 86 reviewed (80%) had net-negative carbon prices (i.e., provided a net subsidy to fossil fuels), for a net total of US$400 billion that year alone. The median subsidy value in these countries was US$1.6 billion, with ten countries each exceeding US$10 billion of net subsidies. In 31 countries, net subsidies exceeded 10% of national health spending, and exceeded 100% in 5 countries.

Redirecting government support from subsidising fossil fuels to low-carbon power generation, health protection, public health promotion and healthcare is likely to deliver net benefits to health and wellbeing.[264,265] International financing mechanisms are needed to support low-income countries vulnerable to energy costs in their transition to sustainable energy sources, particularly in the light of the ongoing energy crisis, and to safeguard all dimensions of human health.[265]

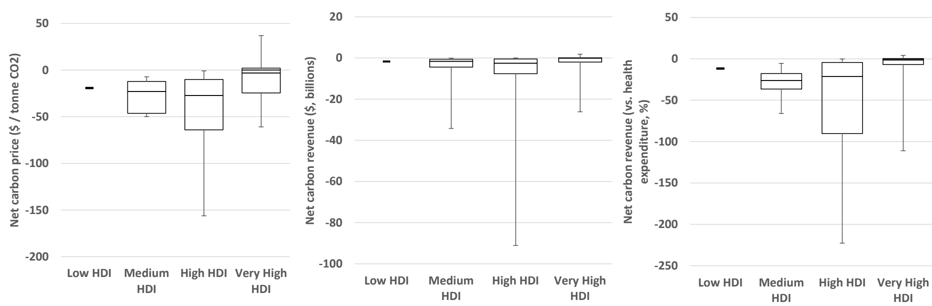

Figure 14: Net carbon prices (left), net carbon revenues (centre), and net carbon revenue as a share of current national health expenditure (right), across 86 countries in 2019, arranged by Human Development Index country group: low (n=1), medium (n=7), high (n=24) and very high (n=54). Boxes show the interquartile range (IQR), horizontal lines inside the boxes show the medians, and the brackets represent the full range from minimum to maximum.

Indicator 4.2.5: Production- and Consumption-Based of CO_2 and $PM_{2.5}$ Emissions

Headline finding: In 2020, 18% of CO_2 and 17% of $PM_{2.5}$ global emissions were emitted in the production of goods and services traded between countries of different HDI levels. The very high HDI country group remained as the only group with net outsourcing of both CO_2 and $PM_{2.5}$ emissions from its consumption.

The production of goods and services result in local greenhouse gas and $PM_{2.5}$ emissions, which can be monitored through production-based emission accounting. However, these goods and services are often consumed in different locations. Consumption-based emission accounting allocates emissions to countries according to their consumption of goods and services. This indicator uses an environmentally-extended multi-region input-output (EE-MRIO) model and the same air pollution modelling described in indicator 3.3,[266-268] to assess countries' consumption- and production-based contribution to CO_2 and $PM_{2.5}$ emissions.

In 2020, 18% of CO_2 and 17% of $PM_{2.5}$ global emissions were emitted in the production of goods and services traded between countries of different HDI levels. Emissions were 3% and 7% lower, respectively, than the year before—likely as a result of restrictions during the COVID-19 pandemic. In 2020, the very high HDI country group contributed the most consumption-based (47%) CO_2 emissions, whereas the high HDI country group contributed the most production-based (46%) CO_2 emissions. However, on a per-capita basis, consumption-based emissions were highest in very high HDI countries, 1.3 times higher than the global average, and 26.3 times higher than per-capita emissions in low-HDI countries

Meanwhile, high HDI countries were the biggest contributors to both production-based (39%) and consumption-based (36%) $PM_{2.5}$ emissions, even if their contribution share fell from 2019 (Figure 15). Per-capita $PM_{2.5}$ emissions were largest in low HDI countries, a reflection of poorer air quality control measures and the use of dirtier fuels. The very high HDI country group remained the only group with higher consumption-based than production-based emissions of both CO_2 and $PM_{2.5}$ emissions.

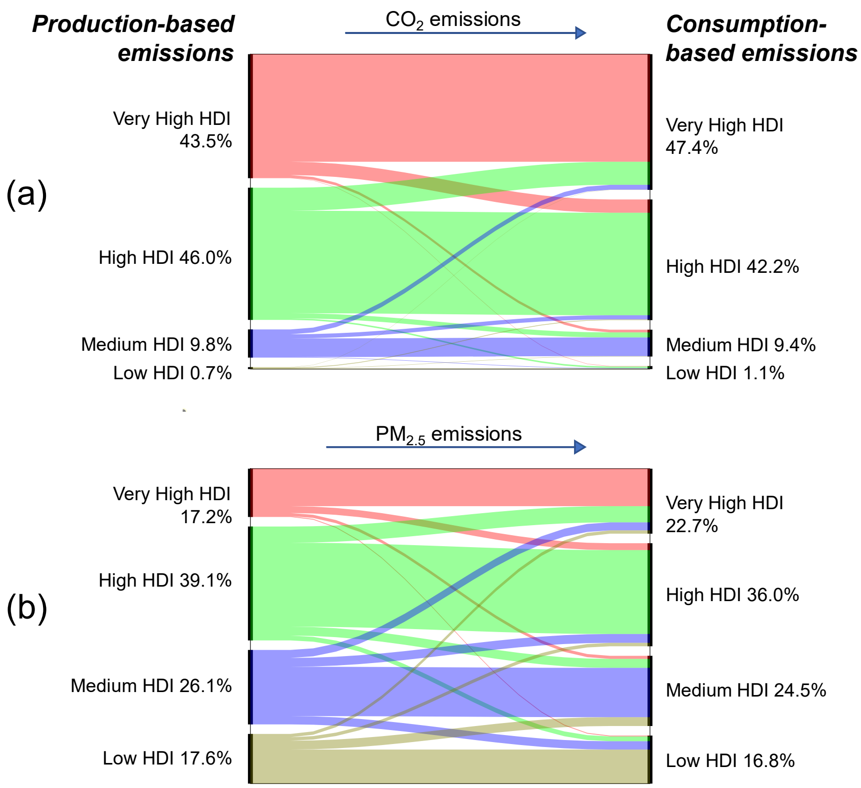

Figure 15: CO_2 and $PM_{2.5}$ emissions emitted in the production of goods and services traded among countries in 2020, grouped by Human Development Index

Indicator 4.2.6: Compatibility of Fossil Fuel Company Strategies with the Paris Agreement

Headline finding: The current strategies of 15 of the largest oil and gas companies would lead to production exceeding their share of levels consistent with limiting global average surface temperature rise to 1.5°C by 37% in 2030, and 103% in 2040.

Emissions from oil and gas need to be reduced dramatically to enable a healthy future.[8,269] This indicator assesses the extent to which current oil and gas company production strategies are compatible with Paris Agreement goals, regardless of their claims and commitments. It uses data from the Rystad Energy database on commercial activities for the eight largest publicly-listed international oil and gas companies (IOCs) by production volume, and the seven largest state-owned national oil and gas companies (NOCs). These IOCs and NOCs accounted for 14% and 28% of total global production, respectively, in 2021 (42% overall). Projected emissions under current strategies are compared to a pathway compliant with 1.5°C, assuming constant market shares at the 2015-2019 average.

Data in this indicator suggests that the current production strategies of these companies would generate greenhouse gas emissions that exceed their share compatible with 1.5°C by an average of 39% for these IOCs, and 37% for the NOCs, in 2030. These excess emissions would rise to 87% and 111%, respectively, in 2040 (Figure 16). Cumulative production from 2020 to 2040 is projected to exceed their share of the 1.5°C benchmark by 36% for IOCs and 38% for NOCs.

According to these results, the activities of some of the largest oil and gas companies are far from compliant with the goals of the Paris Agreement. Strong government action and pressure from civil society could be essential to bring about such compliance, through a far faster transition from fossil fuels to low-carbon energy sources.

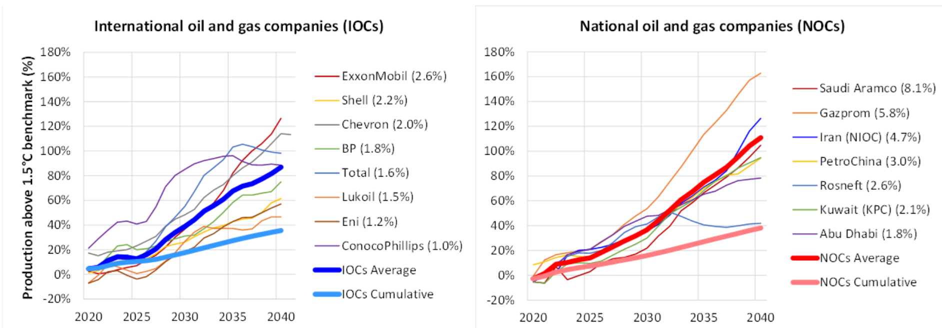

Figure 16: Compatibility of large oil and gas company production strategies with Paris 1.5°C climate target. Percentages in brackets in the legend represent the average 2015-19 global market share for each company.

Panel 7: Financing the response to compounding crises

The economic benefits of keeping temperatures below 1.5ºC of heating and minimising climate change impacts through accelerated adaptation, are expected to outweigh the costs of climate action.[8] While delivering the needed transition to net-zero emissions will require substantial capital investment,[252] the money is available. However, it is concentrated in relatively few economies that bear much of the historic responsibility for human-caused climate change, have only moderate direct and immediate geographic vulnerability to climate change, and can most afford to decarbonise and adapt.[270] Conversely, the lower-income countries that have contributed the least to cumulative CO_2 emissions generally are more vulnerable, and have more limited resources to decarbonise and protect populations from climate hazards, and to recover from climate impacts. In acknowledgement of this, in the 2009 Copenhagen Accord "developed countries commit[ted] to a goal of mobilizing jointly US$100 billion dollars a year by 2020 to address the needs of developing countries".[271] To date, only US$79 billion has been committed[252], two-thirds of this being in the form of loans, with most of the remainder evenly split between public grants and private finance.[252] At COP26, it was acknowledged that the US$100 billion target would not be met until 2023,[272] a delay that not only jeopardises mitigation goals, but also leaves poorer countries more vulnerable to exacerbated climate change-related loss and damage. The economic impacts of COVID-19 and of geopolitical conflicts threaten to further put this target out of reach

This is in stark contrast with countries' response to the COVID-19 pandemic, in which over US$15 trillion for 'rescue' spending by governments were announced globally during 2020 and 2021, with a further US$3.11 trillion pledged for 'recovery' spending (concentrated heavily in OECD countries, plus China). Although US$92 billon were pledged to improve future pandemic preparedness, and could therefore increase the capacity to manage future climate health hazards,[273] the net effect of recovery spending is likely to worsen climate change-related health outcomes: less than US$1 trillion was allocated to purposes that are likely to reduce GHG emissions or air pollution, and the net effect of recovery spending is likely to result in increased emissions through direct or indirect investment in carbon-intensive activities.[273]

The COVID-19 response demonstrated the extent to which decision-makers in developed economies are willing and able to rapidly raise and allocate vast sums of public money to tackle what they perceive as a clear and present danger to the health of their population and economy. Under this light, the paucity of international climate finance reveals a concerning finding: despite the extensive evidence on the unprecedented short- and long-term dangers of climate change, and the cost effectiveness of climate action, climate change is not yet viewed as a crisis by those decision makers who may most effectively address it. The capacity to mobilise the necessary resources is however clear. With the window of opportunity for keeping temperatures below 1.5°C rapidly closing, averting the catastrophic health impacts of climate change depends now on political will.

Conclusion

Indicators in this section expose some of the extensive costs attached to the health impacts of climate change. Through economic impacts, climate change is undermining livelihoods, and the socioeconomic conditions on which good physical and mental health depend. Substantial and sustained investment in the low-carbon transition is essential to limit these impacts and deliver a healthy future. Both governments and the private sector have crucial roles to play in making this happen. Indicators show that investments and employment continue to slowly transition from fossil fuels to clean energy, along with divestments from fossil fuel assets. However, the pace must be accelerated to prevent devastating economic and health impacts of climate change. And still, governments continue to incentivise a carbon-intensive and health-harming economy by subsidising fossil fuels; to a level of value often equivalent to substantial proportions of national health budgets. Meanwhile, oil and gas companies are on track towards exceeding their share of maximum emissions compatible with 1.5°C of heating by over 100% in 2040, and need to be subjected to greater regulations and scrutiny to align their activities with agreed climate targets. Governments around the world are in a unique position to accelerate the transition and must set policy, and where possible directly invest, as we emerge from the depths of the pandemic to a world of economic and geopolitical uncertainty.

Section 5: Public and Political Engagement

The integration of health and climate policies is essential to delivering a rapid climate transition that protects human health,[274,275] particularly in countries and communities that have contributed least to rising global temperatures, and are yet the most affected by them.[276-279] Public and political engagement with the health dimensions of climate change is essential to deliver equity-focused climate policies at speed and scale, and to bridge implementation gaps.[280,281]

This section focuses on key domains of public and political engagement in health and climate change: engagement by the mainstream media (indicator 5.1), individuals (indicator 5.2), the scientific community (indicator 5.3), governments (indicator 5.4) and the corporate sector (indicator 5.5). Where appropriate, analyses begin in 2007, the year before the UN World Health Assembly made a multilateral commitment to protect people's health from climate change.[282] Wherever appropriate, the analysis includes engagement with climate change adaptation and pandemic preparedness, to capture engagement with key dimensions of a coordinated response to climate change and the COVID-19 pandemic. For all indicators, detailed methodological description and further analysis are presented in the appendix.

Indicator 5.1 Media Engagement in Health and Climate Change

Headline finding: Coverage of health and climate change reached a record of 14 474 articles in 2021; however, this coverage only constitutes a small proportion of climate change coverage.

Newspapers, in their print and online versions, are a widely-used source of public information that influence public perceptions of climate change,[283,284] governments,[285] and the social media agenda.[286] This indicator covers newspapers across 37 countries, including China's *People's Daily*, based on keyword searches (in English, German, Portuguese, Spanish and Chinese) of relevant newspaper databases.

In 2021, global coverage of both climate change, and health and climate change, reached a new record high, with 14 474 articles that year, 4.7% more than in 2020 (Figure 17). In China's People's Daily, climate change coverage also reached its highest recorded level. Coverage of health and climate change remained limited, with only 1% of People's Daily articles relating to both issues; none of these articles related to pandemic preparedness and only one to adaptation.

In English language newspapers (n=51) across 24 countries, 20% of articles referring to both health and climate change also referred to adaptation and 48% to the pandemic. Very few (5%) referred to health, climate change, adaptation, and the pandemic.

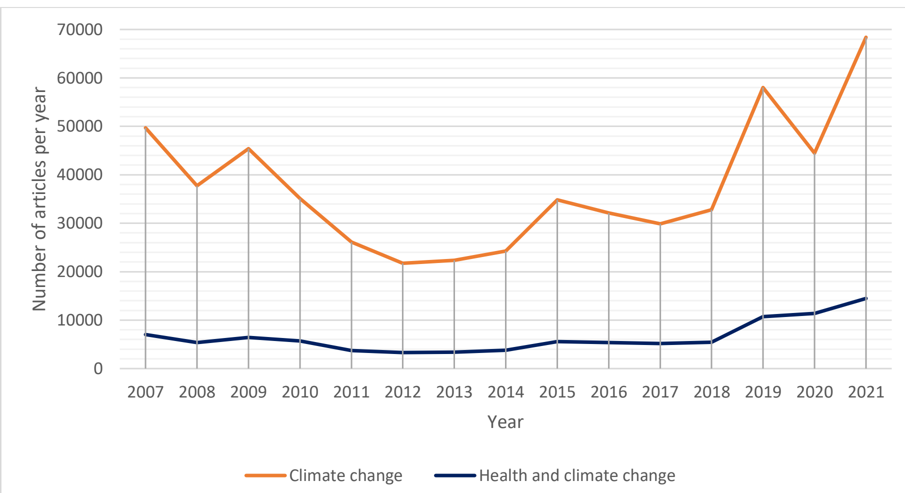

Figure 17: Newspaper coverage of health and climate change in 36 countries, 2007-2021

Indicator 5.2 Individual Engagement in Health and Climate Change

Headline finding: Individual engagement in health and climate change increased by 19% between 2020 and 2021 - but health and climate change are seldom topics that people engaged with at the same time.

The indicator is based on global usage of the online encyclopaedia Wikipedia, an information source with increasing coverage and comprehensiveness and wide public reach,[287-292] that amplifies the diffusion of science.[293,294]

The indicator tracks people's movements between articles on health and on climate change ("clickstream statistics"), based on the English Wikipedia, the most popular language edition in multiple countries worldwide.[295,296]

Users click between articles on health or on climate change, with these domains heavily co-visited internally. There are fewer connections between domains: health and climate change are seldom topics that people engage with at the same time. Of all clickviews leading to a climate change-related article, 0.3% came from a health-related article; of clickviews leading to a health-related article, 0.02% came from a climate change-related article. These movements increased by 19% from 2020 to 2021, reversing the decline between 2019 and 2020. The COVID-19 pandemic continued to be a catalyst with, for example, COP26 triggering a higher engagement on health and climate change, mainly driven by interest in the pandemic situation in its host country.

Indicator 5.3: Scientific Engagement in Health and Climate Change

Headline finding: The number of scientific papers investigating health and climate change increased by 22% from 2020 to 2021.

Scientific engagement is tracked in peer-reviewed journals, the primary source of scientific evidence for the media and governments.[292,297] The indicator employs an enhanced methodology in this year's report, using supervised machine learning and associated methods (topic modelling and geoparsing) to map scientific articles on health and climate change over time,[298] and extends the time period to 1985–2021.

In 2021, over 3,200 articles engaged with health and climate change, an increase of 22% compared to 2020 (Figure 18). However, this represents a very small proportion of scientific articles on climate change and on climate impacts.[299] The majority of health and -climate change articles were located in, and led by, authors in the WHO regions of Western Pacific and the Americas. While research on the health implications of climate change continues to dominate (86% of articles), climate solutions (mitigation and adaptation) are being given increasing attention. 20% of health and climate change articles engaged with pandemic preparedness.

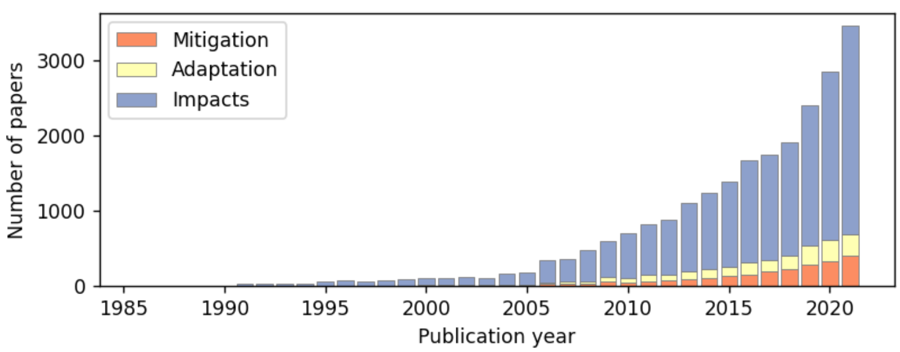

Figure 18: Number of scientific papers on health and climate change, with focus (impacts, mitigation, adaptation) indicated, 1985-2021

Indicator 5.4: Government Engagement in Health and Climate Change

Headline finding: The proportion of countries referring to the health-climate change nexus increased in both the 2021 UN General Assembly (to 60%) and in updated NDC submissions (to 86%).

Government engagement, essential for climate action,[300] is tracked by two indicators: statements made by national leaders at UN General Debate (UNGD) at the UN General Assembly, the policy-making body of the UN,[301] and NDCs, the major policy instrument to protect health from "dangerous anthropogenic interference with the climate system".[302,303] Analysis is based, respectively, on the UNGD text corpus,[304] and on content analysis of the first and the updated NDCs accessed from the UNFCCC interim registry. [305-308]

In 2021, the proportion of countries referring to the health-climate change nexus at the UNGD increased to 60%, its highest recorded level, up from 47% in 2020 (Figure 19). As in 2020, the COVID-19 pandemic drove this engagement. As St Lucia's UNGD address noted, "The COVID-19 pandemic and the climate change challenge…provide us with a harsh and timely reminder that human health and planetary health are linked."[309]

Countries with low HDI, particularly Small Independent Developing States (SIDS), continue to lead engagement: 76% of SIDS discussed the health-climate change nexus in the 2021 UN General Debate. However, growing engagement with health and climate change is evident across all countries, including those with high and very high HDI.

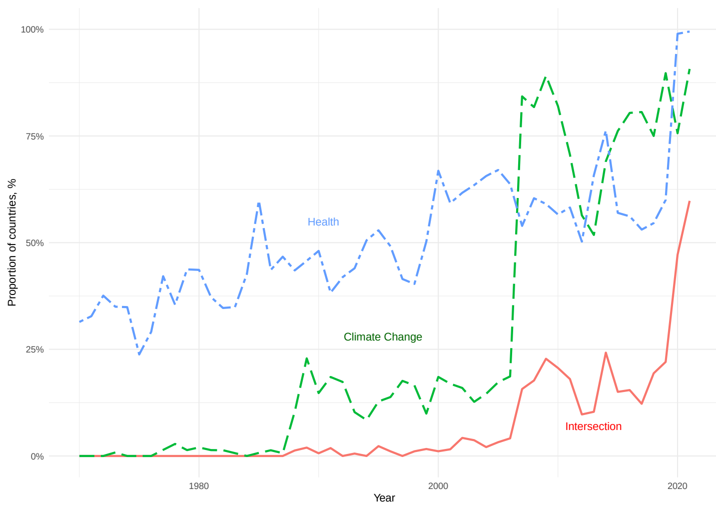

Figure 19: Proportion of countries referring to health, climate change and the intersection between the two in UN General Debates, 1970-2021.

Greater engagement with health is also evident in updated or new NDCs submitted by 126 UN member states (including the one representing 27 EU nations). Of these, 86% refer to health, an increase from 82% in the first NDCs. The increase is greatest for member states in the high HDI category, where all now refer to health, followed by the very high HDI group (where 71% made references in the updated NDCs, up from 65% in the first round). The proportions have slightly declined for the medium (87% to 86%) and low (94% to 86%) HDI groups. Most health references relate to adaptation needs or efforts (83% of the NDCs mentioning health, compared to 87% in the first round); 40% also relate to mitigation (up from 18%).

References to the health sector also increased, from 74% in the first round to 81% in the second round. Healthcare infrastructure was a particular focus: up from 39% to 73%. For example, Albania's second NDC[310] outlines how "health facilities could be damaged by climate-related changes, such as SLR [sea level rise], heavy rains or extreme temperatures".

Indicator 5.5: Corporate Sector Engagement in Health and Climate change

Headline finding: Engagement in health and climate change increased in 2021 to its highest level among companies in the UN Global Compact, with 38% of corporations referring to the health-climate change nexus.

The indicator tracks engagement in health and climate change in the annual Communication of Progress (COP) among companies signed up to the UN Global Compact,[311] the world's largest corporate sustainability framework operating across 165 countries without restriction by sector or company size.[312,313] In an improvement from previous iterations in which only English-language COPs were analysed, COPs in all languages are now included.

Engagement in health and climate change reached its highest level in 2021, with 38% of corporations referring to the health-climate change nexus in their COP report. However, as in previous years, there was much greater corporate engagement in climate change (87%) and health (72%) as separate issues. Engagement in the health-climate change nexus was greatest in companies based in the Western Pacific (53% COPs) and South-East Asia (43%) regions.

Conclusion

Engagement in health and climate change reached its highest recorded level in 2021, with climate change solutions becoming an increasing focus of health-climate change engagement (for example in scientific research and the enhanced NDCs). As in previous years, government engagement is led by countries most vulnerable to a climate crisis not of their making.[274,314,315]

As in 2020, the COVID-19 pandemic continues to be a major driver of health-climate change engagement. In the media, a large proportion of English-language newspapers engaging with health and climate change referred to the pandemic. The pandemic also triggered engagement by individuals and by government leaders in health and climate change. This raises the question of whether greater engagement is contingent on the pandemic context.

While health-climate change engagement increased in 2021, there is greater engagement with health and climate change as separate issues, a pattern evident for individual Wikipedia users, government leaders at the UNGD and companies in the UNGC. Similarly, media and scientific engagement in climate change continues to outstrip engagement in health and climate change. Despite mounting evidence of the health toll of climate change, health and climate change have yet to be securely linked in the public, political and corporate domains that hold the key to climate action.

Conclusion: The 2022 Report of the *Lancet* Countdown

In its seventh iteration, the 2022 report of the *Lancet* Countdown paints the direst picture yet. At 1.1°C of heating,[74] climate change is increasingly undermining every pillar of good health, and compounding the health impacts of the ongoing COVID-19 pandemic and geopolitical conflicts.

The health harms from extreme heat exposure are rising, affecting mental health, undermining the capacity to work and exercise, and resulting in annual heat-related deaths in people over 65 increasing by 68% from 2000-2004 to 2017-2021 (indicators 1.1.1-1.1.5). Increasingly extreme weather is affecting physical and mental health directly and indirectly, with economic losses particularly overburdening low HDI countries, where they are mostly uninsured (indicators 1.2.1–1.2.3 and 4.1.1). The changing climate is exacerbating the risk of infectious disease outbreaks (indicator 1.3), and threatening global food security (Panel 4), with heatwave days associated with 98 million more food insecure people in 2020 than in 1981–2010 (indicator 1.4).

These health impacts add further pressure on overwhelmed health systems (panel 6). With a further 0.4°C temperature rise probably unavoidable, accelerated adaptation is more urgent than ever. Yet, national and city authorities are not acting fast enough, while adaptation funding remains grossly insufficient (indicators 2.1.1, 2.1.2 and 2.2.4). The increased use of air conditioning and scant adoption of nature-based solutions (indicators 2.2.2-2.2.3) reflect a drift towards unplanned, maladaptive responses. Concerningly, and at least partly fuelled by wealthier countries' failure to meet climate finance goals (panel 7), the adaptation response often lags behind in low HDI countries, exacerbating their vulnerability to a climate crisis largely not of their making.

Despite these profound health impacts, mitigation efforts remain inadequate to avert catastrophic temperature rise.[8] CO_2 emissions from fuel combustion grew 4.8% in 2021 (indicator 3.1), while agricultural GHG emissions have increased by 31% since 2000 (indicator 3.5.1). The inaction came with major health costs: fossil fuels contributed to 1.3 million deaths from ambient $PM_{2.5}$ exposure in 2020; the overdependence on solid fuels, deepened by the energy crisis, exacerbated exposure to indoor air pollution (indicators 3.3 and 3.2);[233,234,316] and consumption of carbon-intensive meat and dairy resulted in 2 million deaths in 2019 alone. Meanwhile, governments keep providing billions of dollars annually for fossil fuel subsidies (indicator 4.2.4).

However, some indicators provide a sliver of hope. Governmental engagement with health and climate change reached record levels in 2021, and the updated NDCs reflect increased awareness of the need to protect health from climate change hazards (indicator 5.4). Renewable electricity generation and electric vehicle use reached record growth, and investments and employment in the clean energy industry are slowly increasing (indicators 3.1, 3.4, 4.2.1 and 4.2.2). If sustained, these shifts could deliver energy security, better jobs, cleaner air, and a path for a green COVID-19 recovery. Meanwhile, the health sector is increasingly preparing to face climate hazards (indicator 2.2.1), 60 countries committed to developing climate-resilient and/or low- or net zero-carbon health systems during COP26.[250] Importantly, an expanding number of countries are starting to develop their own observatories, to monitor and identify progress on health and climate change. However, this could come too little too late.

With countries facing multiple crises simultaneously, their policies on COVID-19 recovery and energy sovereignty will have profound, and potentially irreversible consequences for health and climate change. However, accelerated climate action would deliver cascading benefits, with more resilient health, food, and energy systems, and improved security and diplomatic autonomy, minimising the health impact of health shocks. With the world in turmoil, putting human health at the centre of an aligned response to these concurrent crises could represent the last hope of securing a healthier, safer future for all.

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