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The 2021 Report of The *Lancet* Countdown on Health and Climate Change

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[Insert institutional logos for inside cover]

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[**Word Count**: 17,822]

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List of Abbreviations

A&RCC – Adaptation & Resilience to Climate Change
CDP – Carbon Disclosure Project
CFU – Climate Funds Update
CO_2 – Carbon Dioxide
CO_2e – Carbon Dioxide Equivalent
COP – Conference of the Parties
ECMWF – European Centre for Medium-Range Weather Forecasts
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
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
HDI – Human Development Index
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
MRIO – Multi-Region Input-Output
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
SIDS – Small Island Developing States
SSS – Sea Surface Salinity
SST – Sea Surface Temperature
tCO_2 – Tons of Carbon Dioxide
tCO_2/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
VC – Vectorial Capacity
WHO – World Health Organization
WMO – World Meteorological Organization

The 2020 Report of the Lancet Countdown on Health and Climate Change

Executive Summary

The Lancet Countdown: Tracking Progress on Health and Climate Change is an international collaboration which independently monitors the health consequences of a changing climate. Publishing updated, new and improved indicators each year, it represents the consensus of leading researchers from 38 academic institutions and UN agencies. The 44 indicators of the 2021 report of the Lancet Countdown expose an unabated rise in the health impacts of climate change, and the current health consequences of the delayed and uneven response of countries around the world – providing a clear imperative for accelerated action that puts the health of people and planet first.

This year's report coincides with the 26th UN Framework Convention on Climate Change Conference of the Parties (COP26), a moment when countries are facing pressure to realise the ambition of the Paris Agreement to keep global average temperature rise to 1.5 °C, and mobilise the finance required for all countries to deliver an effective climate response. These negotiations unfold in the context of the COVID-19 pandemic – a global health crisis which has claimed millions of lives, affected livelihoods and communities around the globe and exposed deep fissures and inequities in the world's capacity to cope with, and respond to, health emergencies. Yet, in its response to both crises, the world is faced with an unprecedented opportunity to ensure a healthy future for all.

Deepening inequities in a warming world

Record temperatures in 2020 resulted in a new high of 3.1 billion more days of heatwave exposure among people over 65 and 626 million more exposures affecting children under 1 year old, as compared to a 1986-2005 baseline (indicator 1.1.2). Looking to 2021, people in these age groups, along with those facing social disadvantages, were the most affected by the record-breaking temperatures of over 40°C that affected the Pacific northwest areas of the USA and Canada in June 2021 – an event that would have been virtually impossible without human-caused climate change. Although the tally will not be known for several months, hundreds of people prematurely died from the heat. Furthermore, populations in countries with low and medium levels of UN-defined Human Development Index (HDI) have experienced the biggest increase in heat vulnerability over the past 30 years, with risks to their health further exacerbated by the lower availability of cooling mechanisms and urban green space in these countries (indicators 1.1.1, 2.3.2 and 2.3.3).

Agricultural workers in countries with low and medium HDI were among the worst affected by exposure to extreme temperatures, bearing almost half the 295 billion potential work hours lost due to heat in 2020 (indicator 1.1.4). These lost work hours could have devastating economic consequences to these already vulnerable workers – data in this year's report shows that potential earnings lost were equivalent to 4-8% of national GDP in the low HDI country group (indicator 4.1.3).

Through these impacts and alongside rising average temperatures and altered rainfall patterns, climate change is beginning to reverse years of progress in tackling the food and water insecurity that still affects the most underserved populations around the world, undermining a cornerstone of good health. In any given month in 2020, up to 19% of the global land surface was affected by extreme drought, a value that had not exceeded 13% from 1950 to 1999 (indicator 1.2.2). In parallel, warmer temperatures are affecting the yield potential of the world's major staple crops: a 6.0% reduction for maize; 3.0% for winter wheat; 5.4% for soybean; and 1.8% for rice in 2020, relative to 1981-2010 (indicator 1.4.1); exposes the rising risk of food insecurity in a warming world.

Adding to these health hazards, the changing environmental conditions are also increasing the suitability for the transmission of many water-, air-, food-, and vector-borne pathogens. Although socioeconomic development, public health interventions, and advances in medicine have reduced the global burden of infectious disease transmission, climate change threatens to undermine eradication efforts.

The number of months with environmentally suitable conditions for the transmission of malaria (*Plasmodium falciparum*) rose by 39% from 1950-1959 to 2010-2019 in densely populated highland areas in the low HDI country group – threatening highly disadvantaged populations, previously comparably safe from this disease due to their geographical location (indicator 1.3.1). The epidemic potential for dengue, Zika and chikungunya, which currently affect primarily populations in Central and South America, the Caribbean, Africa and south Asia, increased globally by 13% for the transmission by *A. aegypti* and 7% higher for *A. albopictus* from the 1950s, with the biggest relative increase was seen in countries with very high HDI (indicator 1.3.1). However, it is people in the low HDI country group who are confronted with the highest vulnerability to these arboviruses (indicator 1.3.2).

Similar findings are observed in the environmental suitability for *Vibrio cholerae*, a pathogen estimated to cause almost 100,000 deaths annually, particularly among populations with poor access to safe water and sanitation. Between 2003 and 2019, the coastal areas suitable for *Vibrio cholerae* transmission increased significantly across all HDI country groups – but, with 98% of their coastline suitable to the transmission of *Vibrio cholerae* in 2020, it is people in the low HDI country group that face the highest environmental suitability for this disease (indicator 1.3.1).

The concurrent and interconnecting risks posed by extreme weather events, infectious disease transmission, and food, water and financial insecurity are overburdening the most vulnerable. Through multiple simultaneous and interacting health risks, climate change is threatening to reverse years of progress in public health and sustainable development.

Even with overwhelming evidence on the health impacts of climate change, countries are not delivering an adaptation response proportionate to rising risks their populations face. In 2020, 63% of all countries were yet to achieve a high level of implementation of national health emergency frameworks, leaving them unprepared to respond to pandemics and climate-related health emergencies (indicator 2.3.1). Importantly, only 55% of low HDI countries had reported at least medium-level of implementation of these frameworks, compared with 89% of very high HDI countries. In addition, only 37 of 70 countries reported having a national adaptation plan for health, with insufficient human and financial resources identified as the key barrier for their implementation (indicator 2.1.1). With a world facing unavoidable temperature rise, even under the most ambitious climate change mitigation, accelerated adaptation is essential to reduce vulnerabilities and protect the health of people around the world.

An inequitable response fails everyone

Six months into 2021, the world had failed to deliver global equitable access to the COVID-19 vaccine: more than 75% of all vaccine doses had been given to people in just 10 countries. Data in this report exposes similar inequities in the global climate change mitigation response.

To meet the Paris Agreement goals and prevent catastrophic levels of warming, global greenhouse gas emissions must halve within a decade. However, at the current pace, it would take over 150 years for the energy system to fully decarbonise (indicator 3.1), and the unequal response between countries is resulting in an uneven realisation of the health co-benefits of a low-carbon transition.

Partly responsible for the slow decarbonisation rate is the use of public funds to subsidise fossil fuels. Out of 84 countries reviewed, 65 were still providing an overall subsidy to fossil fuels in 2018, using funds in many cases equivalent to substantial proportions of the national health budget, and which could otherwise be redirected to deliver net benefits to health and wellbeing. Further, all the 19 countries whose carbon pricing policies did outweigh the effect of any fossil fuels subsidies came from the very high HDI group (indicator 4.2.4).

While countries in the very high HDI group have collectively made the greatest progress in energy system decarbonisation, they are still the main contributors to CO_2 emissions through their local production, accounting for 45% of the global total (indicator 4.2.5). Meanwhile, with a slower pace of decarbonisation and poorer air quality regulations, the medium and high HDI country groups produce the most $PM_{2.5}$ emissions and have the highest rates of air pollution-related mortality – about 50% higher than the total mortality in the very high HDI group (indicator 3.3). Turning to the low HDI country group, with comparatively lower levels of industrial activity, its local production contributes to only 0.7% of global CO_2 emissions, and it has the lowest mortality rate from ambient air pollution. However, with only 12% of its inhabitants relying on clean fuels and technologies for cooking, the health of these populations is still at risk from dangerously high concentrations of household air pollution (indicator 3.2). Importantly, even within the most affluent countries, people in the most deprived areas overwhelmingly bear the health burden from exposure to air pollution. These findings expose the health costs of the delayed and unequal mitigation response, and underscore the millions of lives to be saved annually through a low-carbon transition that prioritises the health of all populations.

However, the world is not on track to realising these health gains: current global decarbonisation commitments would lead to 2.7-3.1°C of warming by the end of the century, and present direction of post-COVID-19 spending is threatening to make this situation worse, with just 18% of all funds committed for recovery by the end of 2020 expected to reduce greenhouse gas emissions. Indeed, the economic recovery from the pandemic is already predicted to lead to an unprecedented 5% increase in GHG emissions in 2021, which will bring global anthropogenic emissions back to their peak levels.

In addition, the current economic recession is threatening to further undermine the target of mobilising US$100 billion per year from 2020 onwards to promote low-carbon shifts and adaptation responses in the most underserved countries - even while this quantity is now dwarfed by the trillions allocated to COVID-19 recovery. The high levels of borrowing that lower income countries had to resort to during the pandemic could further erase their ability to deliver a green recovery, and maximise the health gains to their population of a low-carbon transition.

An unprecedented opportunity to ensure a healthy future for all

The overshoot in emissions resulting from a carbon-intensive COVID-19 recovery would irreversibly push the world off track meeting climate commitments and the Sustainable Development Goals – and lock in humanity to an increasingly extreme and unpredictable environment. Data in this report expose the health impact and health inequities of the current 1.2°C world and confirms that, on the current trajectory, climate change will become the defining narrative of human health.

However, by directing the trillions of dollars that will be committed to COVID-19 recovery towards the WHO's prescriptions for a healthy, green recovery, the world could meet the Paris Agreement goals, protect the natural systems that support wellbeing, and minimise inequities through reduced health impacts and maximised co-benefits of a universal low-carbon transition. Promoting equitable climate change mitigation and universal access to clean energies could save millions of lives annually from reduced exposure to air pollution, healthier diets, and more active lifestyles, and contribute to reducing health inequities globally. This pivotal moment of economic stimulus represents a historical opportunity to securing the health of present and future generations.

There is a glimpse of this story unfolding through several promising trends in this year's data: electricity generation from renewable wind and solar energy has increased by an annual average of 17% between 2013-2018 (indicator 3.1); investment in new coal capacity decreased by 10% in 2020 (indicator 4.2.1); and the global number of electric vehicles reached 7.2 million in 2019 (indicator 3.4). Additionally, the global pandemic has driven increased engagement in health and climate change across multiple domains in society, with 91 heads of state making the connection in the 2020 UN General Debate, and newly widespread engagement among very high HDI countries (indicator 5.4). Whether COVID-19 recovery supports, or reverses these trends, is yet to be seen.

Neither SARS-CoV-2 nor climate change respect national borders. Without widespread, accessible vaccination across all countries and societies, the virus and its new variants will continue to put the health of everyone at risk. Likewise, tackling climate change requires all countries to deliver an urgent and coordinated response, with COVID-19 recovery funds allocated to support and ensure a just transition to a low carbon future and climate change adaptation in all corners of the world. Leaders of the world have an unprecedented opportunity to deliver a future of improved health, reduced inequity, and economic and environmental sustainability. However, this will only be possible if the world acts together to ensure no one is left behind.

Introduction

The COVID-19 pandemic has changed societies in ways previously unimaginable, with deepening and widespread concerns about global health security, inequities, and anthropogenic influences on the environment. As of the 11th of May 2021, the pandemic had resulted in almost 191 million cases and 4.1 million deaths,[1,2] and its multidimensional impacts on health and wellbeing, together with its disruption to work, social, and leisure activities, still continue. The overwhelming healthcare demand caused 94 of 105 countries examined to experience disruptions to the delivery of essential health services, further undermining health and wellbeing.[3] Adding to this, COVID-19 led to a worldwide economic recession, an estimated 90 million people were pushed below the extreme poverty threshold in 2020,[4,5] and pandemic-induced borrowing by the World Trade Organization's 'developing' countries amounted to US$130 billion by July that year.[6]

But while the world's attention has been diverted towards the ongoing acute health crisis, the health effects of human-induced climate change continue to increase. Climate change contributed to the unusually high temperatures seen during 2020 in the United Kingdom and Siberia, to the record-breaking well-over 40°C heatwave that affected populations across the Pacific northwest areas of the USA and Canada in June 2021 and caused over 1000 deaths, with that number expected to increase, to an accelerated glacier retreat that is putting the city of Huaraz (Peru) under imminent flooding risk, and to Australia's devastating 2019/2020 bushfire season.[7-11] Over a six month period in 2020, 84 disasters from floods, droughts, and storms affected 51.6 million people in countries already struggling with COVID-19,[12] with the escalating impacts threatening their ability to respond to health emergencies. Meanwhile, climate impacts may undermine the capacity of countries to repay their debts, further hindering their progress towards the Sustainable Development Goals (SDGs).[13,14] As with COVID-19, the health impacts of climate change are inequitable, with disproportionate effects on the most vulnerable in every society, including the poor, members of minority groups, women, children, older adults, people with chronic diseases and disabilities, and outdoor workers.[15] Such interrelationships between climate change and COVID-19 provide ongoing evidence of the interconnectedness of the world, and of the health consequences of inequities. The 2021 report of the *Lancet* Countdown depicts the synergies and interactions between these two crises.

The world is now 1.2°C warmer than in the pre-industrial period, the past seven years rank as the hottest seven on record, and 2020 tied with 2016 as the hottest yet.[16-18] Atmospheric CO_2 concentrations have reached a concerning milestone – now 50% higher than in the pre-industrial era.[19] Changes such as reduced soil moisture could limit the Earth's carbon reuptake, resulting in further CO_2 in the atmosphere.[20] Furthermore, some climate tipping points are close to or may have surpassed critical thresholds and could interact to further destabilise the Earth's climate system.[21,22] While the dramatic reductions in transport and industrial manufacturing during the pandemic resulted in energy-related emissions for 2020 falling by 5.8%, the largest annual percentage decline since World War II, this was short-lived and emissions have risen in 2021.[23-25] Without an adequate response, the health effects of climate change will worsen throughout the coming decades.

The world now turns with hope to the 2021 UN Framework Convention on Climate Change (UNFCCC) conference in Glasgow (COP26), originally scheduled for 2020. Over the past year, the world has seen more ambitious climate targets from governments and businesses, and 73% of global emissions are now covered by net zero emissions targets announced by May 2021. Nevertheless, these announcements are non-binding, and even with their full implementation the world would be on track to ~2.4°C (1.9-3.0°C) of warming by 2100.[26]

These climate announcements are being made against the backdrop of huge investments in economic recovery from COVID-19. Depending on their consistency with climate targets, these investments could take the world in one of two directions – either driving it towards the goals of the Paris Agreement, or locking it into increased emissions and climate change that will damage the health of current and future generations. As humanity faces a critical turning point, the indicators in this report provide the health evidence to inform a global response to the impacts of climate change, and identify the considerable health, environmental and economic benefits that would result if a 'green recovery' from COVID-19 was prioritised.

Five years of tracking progress on health and climate change

The *Lancet* Countdown is an independent, international, and multidisciplinary collaboration that monitors the health impacts of climate change, and progress – or lack thereof – in the world's response. It draws on the expertise of climate scientists, economists, energy and transport experts, social and political scientists, public health experts and health professionals among others, spanning 38 academic and UN institutions. Together, they report on 44 indicators, organised within five domains: climate change impacts, exposures, and vulnerabilities; adaptation, planning, and resilience for health; mitigation actions and health co-benefits; economics and finance; and public and political engagement. The 2021 report of the *Lancet* Countdown is its sixth annual report, building on nine years of collaborative work.

The *Lancet* Countdown's indicator domains were selected through an open, global consultation process that identified scientifically documented links between health and climate change, with indicators developed according to well-established methods, and to the availability of reliable and regularly updated data with adequate geographical and temporal scales.[27] Each year, the indicators have been improved upon through an open, iterative and adaptive approach, and new indicators have been introduced to provide an increasingly complete picture of the health dimensions of climate change. For the two most recent reports, prior to the formal peer review, all new indicators underwent an independent assessment process led by world experts in their respective domains, adding rigour and transparency to the collaboration's research. Existing indicators are undergoing a similar, independent quality improvement process, aimed at ensuring they continue to use the best available data and methods.

Three new important indicators are added to the 2021 report: the first incorporates considerations of mental wellbeing by tracking the effect of heat on expressed online sentiment; the second captures the influence of heat on safe physical activity; and the third tracks consumption-based greenhouse gas and $PM_{2.5}$ emissions. Most of the pre-existing indicators underwent major improvements, with strengthened methods, datasets and metrics, and expanded geographical and temporal coverage. All indicators, including their methods, data sources, caveats, and plans for future improvements, are described in detail in the appendix – an essential manual for this report. The final indicators for the 2021 report are listed in panel 1.

Each indicator, wherever possible and appropriate, is disaggregated into very high, high, medium, and low Human Development Index (HDI) country groups, as defined by the United Nations Development Programme (UNDP), in the latest year for which data are available (2019).[28] This composite index captures three key dimensions: a long and healthy life (with life expectancy as a proxy), education (captured by the mean of years of schooling for adults), and standard of living (measured by per capita gross national income).[28] In line with the priorities of *The Lancet*'s Diversity Board, gender disparities are also considered wherever relevant. However, a stark lack of gender-disaggregated data, means that few indicators are able to capture these differences quantitatively, and often do so using sex disaggregation as a proxy for gender (see panel 2).

The COVID-19 pandemic will alter the trends of many of the indicators reported – some of which can be identified in this report, and others which will become apparent in the coming years. COVID-19 has also altered population demographics and mortality rates, as well as the structure and size of the labour force. These changes are not reflected in the current indicators, presenting methodological challenges in the assessment of the health impacts of climate change. How this impacts the methods and assumptions of the *Lancet* Countdown's indicators will become clearer in future reports, as more data become available.

The global reach of the *Lancet* Countdown is expanding. Two regional offices – in South America (based at Universidad Peruana Cayetano Heredia, Lima, Peru) and in Asia (based at Tsinghua University, Beijing, China) – were established in 2020. These regional collaborators contributed indicators to the global 2021 report and are working on nationally- and regionally-relevant health and climate change research, accompanied by local communications and policy engagement. A third regional office, based at the University of the West Indies, was established in September 2021, aiming to build on the network and evidence base of health and climate change in Small Island Developing States (SIDS). The *Lancet* Countdown is also working in collaboration with the European Environment Agency, incorporating policy-relevant data from its indicators into the European Climate and Health observatory.

National and regional reports were published for Australia (in partnership with the *Medical Journal of Australia*), China, and SIDS.[29-31] For the third year now, the data underpinning each of the *Lancet* Countdown's indicators have been shared through an online data visualisation platform, where they can be explored at finer spatial and temporal scales.

The work of this collaboration is driven by the ongoing support from *The Lancet* and the Wellcome Trust, the *Lancet* Countdown's scientific advisory group and higher-level advisory board, and, importantly, the *Lancet* Countdown's authors and collaborators. The collaboration welcomes further offers of support from new experts and new institutions, willing to build on this analysis, as the *Lancet* Countdown monitors the world's response to the health effects of climate change across this decade.

Working Group	Indicator	
Climate Change Impacts, Exposure, and Vulnerability	1.1: Health and Heat	1.1.1: Vulnerability to Extremes of Heat
		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 and Sentiment
		1.1.6: Heat-Related Mortality
	1.2: Health and Extreme Weather Events	1.2.1: Wildfires
		1.2.2: Drought
		1.2.3: Lethality of Extreme Weather Events
	1.3: Climate-Sensitive Infectious Diseases	1.3.1: Climate Suitability for Infectious Disease Transmission
		1.3.2: Vulnerability to Mosquito-Borne Diseases
	1.4: Food Security and Undernutrition	1.4.1: Terrestrial Food Security and Undernutrition
		1.4.2: Marine Food Security and Undernutrition
	1.5: Migration, Displacement and Rising Sea Levels	
Adaptation, Planning, and Resilience for Health	2.1: Adaptation Planning and Assessment	2.1.1: National Adaptation Plans for Health
		2.1.2: National Assessments of Climate Change Impacts, Vulnerability, and Adaptation for Health
		2.1.3: City-Level Climate Change Risk Assessments
	2.2: Climate Information Services for Health	
	2.3: Adaptation Delivery and Implementation	2.3.1: Detection, Preparedness and Response to Health Emergencies
		2.3.2: Air Conditioning: Benefits and Harms
		2.3.3: Urban Green Space
	2.4: Health Adaptation-Related Global Funding and Financial Transactions	
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: Mitigation in the Healthcare Sector	
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 Reduction
		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: Coal and 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
Public and Political Engagement	5.1: Media Coverage of Health and Climate Change	
	5.2: Individual Engagement in Health and Climate Change	
	5.3: Coverage of Health and Climate Change in Scientific Journals	
	5.4: Government Engagement in Health and Climate Change	
	5.5: Corporate Sector Engagement in Health and Climate Change	

Panel 1. The Indicators of the 2021 report of the Lancet Countdown

Section 1: Climate Change Impacts, Exposures, and Vulnerability

Climate change threatens human health and wellbeing through impacts on weather, ecosystems and human systems – increasing exposure to extreme events, changing the environmental suitability for infectious disease transmission, altering population movements, and undermining people's livelihoods and mental health.[32-36] The resulting strains on health and social systems are felt disproportionately by the most disadvantaged in society, with climate change amplifying inequities.[32,33]

Section 1 of the 2021 report monitors the health impacts of climate change, with indicators tracking climate hazards, human exposure and vulnerabilities, and the resulting health outcomes. The first group of indicators addresses the direct implications of rising temperatures for health, exploring changes in the exposure and vulnerabilities of world populations to extreme heat, as well as its impacts on health and wellbeing (indicators 1.1.1–1.1.6, see panel 1). Each of these indicators takes gridded heat data as a starting point, and overlays them with relevant exposure and vulnerability data to reflect health outcomes. Two new indicators are introduced: one examines how heat is reducing the possibility to undertake outdoor exercise safely (indicator 1.1.3); the other approaches the challenge of assessing the influence of extreme heat on sentiment, using Twitter data to capture people's online expressions (indicator 1.1.5).[37]

The second group of indicators in this section sheds light on climate-sensitive extreme events, tracking exposure to wildfire and wildfire risk (indicator 1.2.1), the incidence of droughts (indicator 1.2.2), and the lethality of extreme weather events (indicator 1.2.3). Capturing the influence of environmental changes on ecological niches for human pathogens, the section also models the changing suitability for the transmission of climate-sensitive infectious diseases, expanding the analysis from previous years to capture three new diseases of global public health relevance (Zika, chikungunya and *Vibrio cholerae*), and improving models to reflect the reproduction number for arbovirus transmission. With health outcomes of vector-borne disease transmission strongly influenced by socioeconomic factors and healthcare access, indicator 1.3.2 incorporates considerations of implemented adaptation measures to capture the changing vulnerability to arboviruses. This is followed by indicators of environmental pressure on terrestrial and marine food productivity, this year extending the analysis to assess the association between heat stress and severe food insecurity (indicators 1.4.1 and 1.4.2). The final indicator in this section focuses on exposure to sea level rise and its implications for human mobility (indicator 1.5).

1.1 Health and Heat

Indicator 1.1.1: Vulnerability to the Extremes of Heat

Headline finding: although vulnerability to heat in the low and medium Human Development Index country groups remains 27-38% lower than that of the very high Human Development Index group, it is increasing rapidly and is today 19% and 20% higher than in 1990, respectively

Exposure to extreme heat poses an acute health hazard, with individuals over 65 years of age,[38-40] urban populations,[39,40] and those with underlying health conditions[38,39] particularly at risk. Heat disproportionately affects the marginalised or under-resourced that have limited access to cooling mechanisms and healthcare, amplifying health and social inequities.[41-44]

This indicator tracks vulnerability to extreme heat, through an index that combines the proportion of the population older than 65 years, the prevalence of relevant chronic diseases (respiratory disease, cardiovascular disease, and diabetes) in that group, and the proportion of the total population living in urban areas.

With aging populations, high prevalence of chronic diseases, and increasing urbanisation, the very high HDI countries exhibited the highest vulnerability to extremes of heat. Vulnerability is rising across all HDI groups, with countries of low and medium HDI experiencing the highest increases from 1990 levels (19% and 20%, respectively). The heat indicators that follow each present worsening trends, highlighting a great need to identify populations that are vulnerable to the health impacts of heat, at the national and at the local level. Further work will be done to capture other heat vulnerabilities within this indicator.

Indicator 1.1.2: Exposure of Vulnerable Populations to Heatwaves

Headline finding: in 2020, compared with the 1986-2005 baseline, children under 1 and adults over 65 were affected by 626 million and 3.1 billion more days of heatwave exposure, respectively

Young children and older persons are especially susceptible to the health risks of high temperatures and heatwaves.[45] This indicator reports the total number of days adults aged over 65 years and (for the first time) children from birth to 1 year, were exposed to life-threatening heatwave events. In an improvement from previous years, the definition of a heatwave now aligns with the World Meteorological Organization (WMO) and other scientific literature.[46-48] Additional details are given in the appendix (pp 5-7).

Results show a steady increase in the person-days of exposure for adults over 65 years, with the last 10 years seeing an annual average of 2.9 billion additional events and 3.1 billion more person-days of exposure (or an average of 4.1 days per person >65 years) in 2020, with respect to the 1986-2005 baseline (Figure 1). For children under 1 year, there were an estimated 626 million additional person-days of exposure (4.6 days per person <1 year) affecting this vulnerable group in 2020, compared with baseline years.

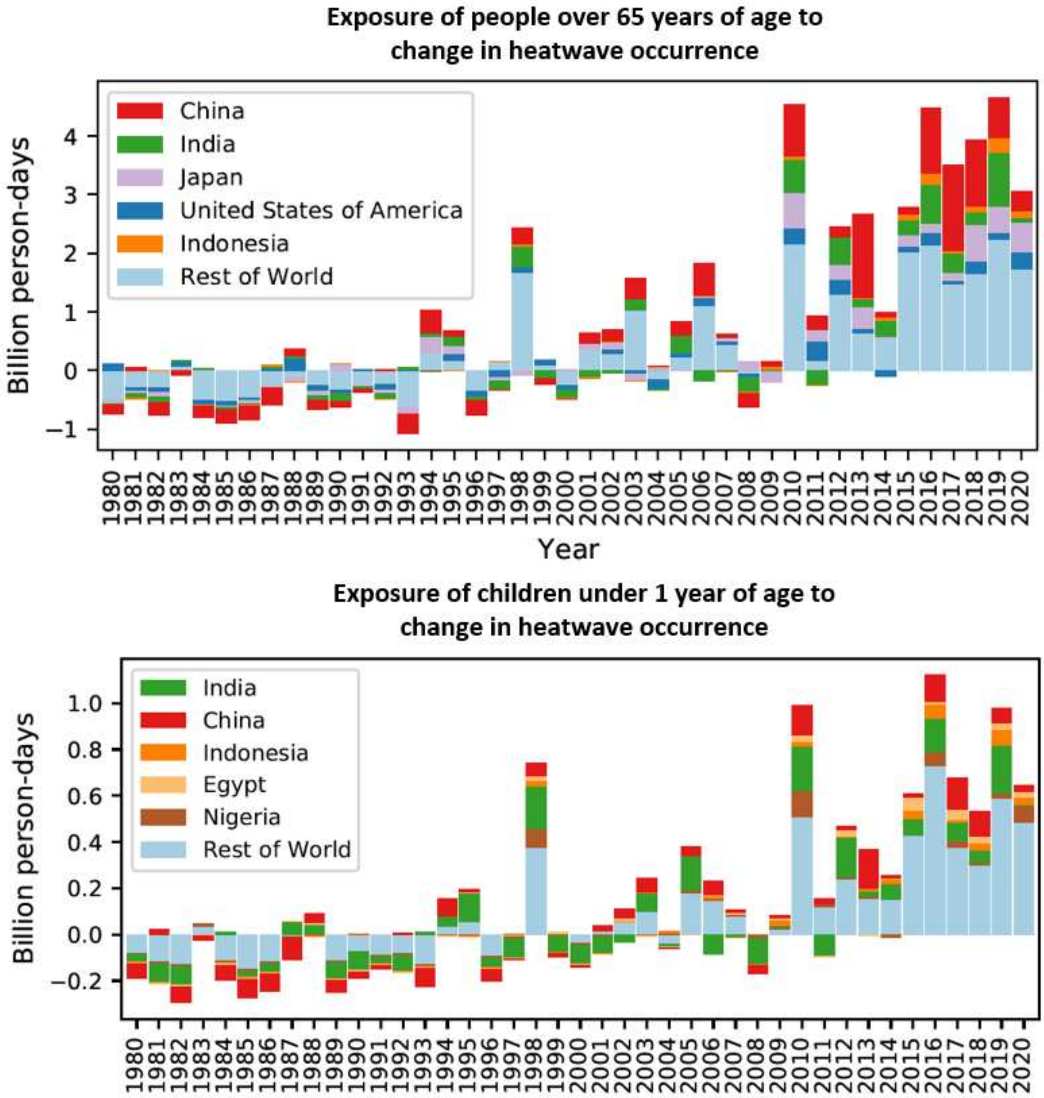


Figure 1. Change in person-days of heatwave exposure relative to the 1986-2005 baseline. A) in the population aged over 65 years; B) in the population aged under 1 year of age. In each case, the countries with the highest exposure averages over the past 5 years are highlighted.

Indicator 1.1.3: Heat and Physical Activity

Headline finding: the last four decades saw an increase in the number of daily hours in which temperatures were too high for safe outdoor exercise, with people in the medium Human Development Index country group experiencing an average loss of 4.4 hours of safe exercise per day in 2020

Physical exercise provides mental health benefits, and reduces the risk of cardiovascular disease, diabetes, cancer, cognitive decline and all-cause mortality.[49-53] However, high temperatures can reduce the frequency and duration of physical activity, and the desire to engage in exercise,[54-56] and even low levels of physical activity can pose a risk to health under high temperatures.[57] This indicator estimates the hours of physical activity potentially lost per person due to ambient temperature, humidity, and radiant heat, by tracking the number of hours per day during which the wet bulb globe temperature (WBGT) exceeds 28°C, a threshold above which national sports medicine authorities of the USA, Australia and Japan recommend outdoor physical activities to be conducted with discretion.[58,59]

Due to rising temperatures, the loss in the number of hours available for safe physical activity per day increased in all four country HDI groups (Figure 2). The greatest rate occurred the medium HDI country group, with an average increase from 3.5 hours per person per day in 1980 to 4.4 hours per person per day in 2020.

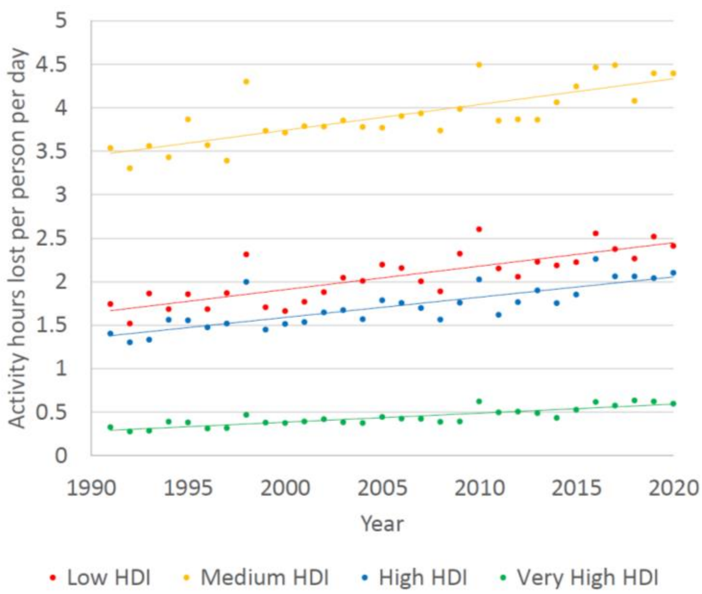


Figure 2. Average potential activity hours lost per person per day by 2019 Human Development Index country group, 1980-2020.

Indicator 1.1.4: Change in Labour Capacity

Headline finding: in 2020 the world lost 295 billion potential work hours due to extreme heat exposure, with 79% of all losses in countries of low Human Development Index level occurring in the agricultural sector

As well as through its direct impacts on health, high temperatures can also affect people's ability to work.[60] This indicator estimates the potential work hours lost as a result of heat exposure, by linking WBGT with the power (metabolic rate) typically expended by a worker within the construction, manufacturing, agriculture, and all other sectors.

In a rising trend, 295 billion potential work hours were lost across the globe in 2020 due to heat exposure – equivalent to 88 work hours per employed person. The three most populous countries with medium HDI levels, Pakistan, Bangladesh, and India experienced the greatest losses (2.5-3 times the world average, equivalent to 216-261 hours lost per employed person in 2020). In contrast, the three most populous countries with very high HDI levels (the USA, Japan, and Russia) accounted for the smallest numbers of labour hours lost. With lockdowns around the world, COVID-19 led to the loss of millions of hours of effective labour, particularly within service, construction, and manufacturing sectors.[61] The changes in labour structure induced by COVID-19 are not currently accounted for by this indicator.

Almost half of the total potential work hours lost globally occurred in the agricultural sector of low and medium HDI countries. Occupational heat exposure disproportionately affects labourers in the agricultural sector of low HDI countries, with 79% (25.8 out of 32.6 billion hours) of these countries' losses occurring in this sector, compared with only 12% (1.1 out of 9.3 billion hours) in very high HDI countries. The impacts could therefore extend to food production. While heat affects labour capacity across all genders, differences in occupation may drive gender disparity. Men make up 80% of the total employment in the construction sector, and indigenous women and women in rural areas, who are highly dependent on local natural resources for their livelihood would be particularly affected by the impacts of climate change on labour capacity.[62-64]

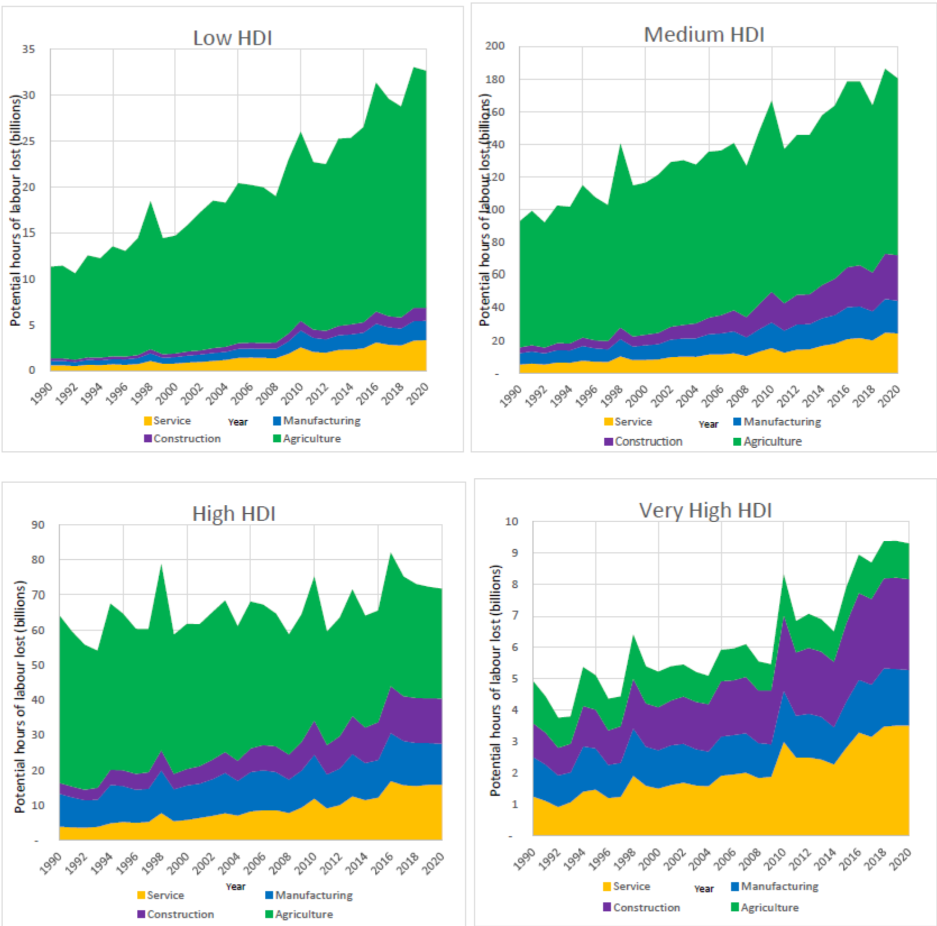


Figure 3. Heat-related potential hours of labour lost by sector and 2019 country Human Development Index group, 1990-2000

Indicator 1.1.5: Heat and Sentiment

Headline finding: Exposure to heatwave events significantly worsens expressed sentiment, with a 155% increase in negative expressions during heatwaves in 2020 relative to the 2015-2019 average

Climate change-related increases in heat extremes pose diverse risks to mental health globally, ranging from altered affective states to elevated mental health-related hospitalisations and suicidality.[34-36,65-68] However, because the definition, acknowledgement, stigmatisation, and treatment of mental health varies across different regions and cultures,[37] capturing the mental health impacts of climate change still remains a challenge that the Lancet Countdown will work to address in upcoming years.

This indicator, new to the 2021 report, tracks the effect of heatwaves on the sentiment of expressions from Twitter users around the world, using previously published methods for estimating climate impacts.[69-71] Briefly, this indicator classifies the sentiment expressed in over six billion geolocated tweets collected between 2015 and 2020, using the Linguistic Inquiry Word Count (LIWC) sentiment classification tool.[72] It then deploys a multivariate ordinary least squares fixed effects model to estimate the annual effect of heatwaves on expressed sentiment. In this way, it compares sentiment expression during as-good-as-random heatwave days (as defined in indicator 1.1.2) with non-heatwave days in 40,000 unique localities for nearly one million individuals per day. Potential temporal and geographical confounders were are adjusted for by taking into account the month, calendar date, and location of each tweet in the analysis. Further detail is provided in the appendix (pp 15-18). This indicator offers a glimpse into the influence of extremes of heat on sentiment of people around the world. However, since Twitter access and social media use are not evenly distributed, higher income countries are disproportionately represented.

Local heatwave exposure was found to significantly reduce positive expressions and increase negative expressions (Figure 4). In 2020, the percentage point increase in negative sentiment during a heatwave day rose to 0.20 (95% CI: 0.31-0.08), 155% higher than the 2015-2019 average effect. Compared to the recent 2015-2019 baseline, the magnitude of this additional increase was substantive, equivalent to three quarters of the total rise in negative sentiment observed during a benchmark flooding event (see appendix, p 18). In parallel the reduction in positive sentiment observed during 2020 was 11.9% smaller than that observed during 2015-2019.

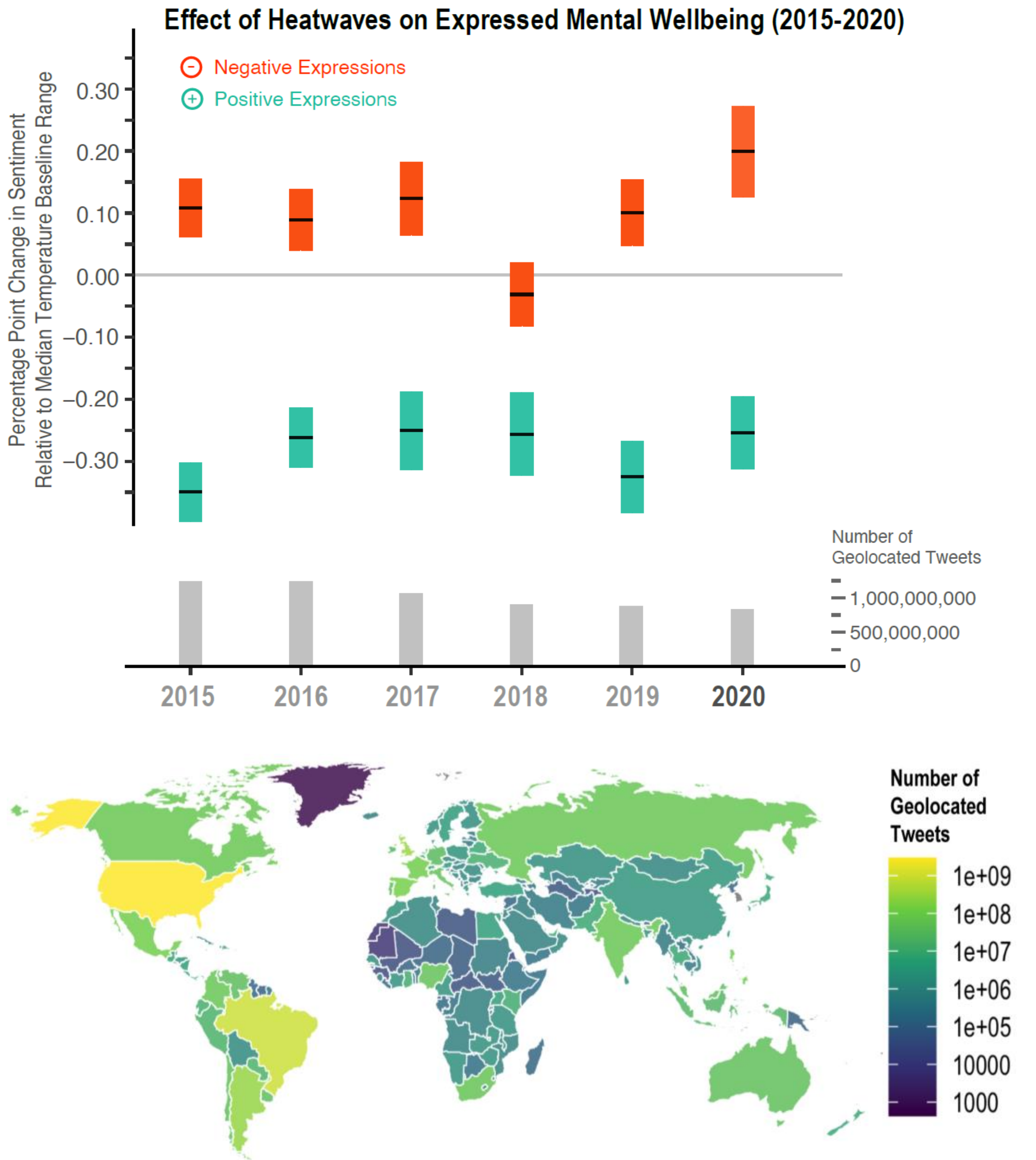


Figure 4. Heatwaves and sentiment. Top: Annual effect of heatwave exposure on the sentiment of online expressions from 2015-2020. Coloured intervals depict 95% CIs of the estimated average change in positive (green) and negative (orange) sentiment expressions during days with heatwaves, relative to the median daily maximum temperature baseline range for each location and year. Sentiment was extracted from Twitter posts using a dictionary-based approach across multiple languages. Grey bars depict the geolocated Tweet count by year of observation. Bottom: Country-level count of geolocated tweets for 2015-2020.

Indicator 1.1.6: Heat-Related Mortality

Headline finding: heat-related mortality in the ≥65 population reached a record high of an estimated 345,000 deaths in 2019. Between 2018 and 2019, all WHO regions except for Europe saw an increase in heat-related deaths in this vulnerable age group

Exposure to extreme heat increases risk of cardiovascular, cerebrovascular and respiratory mortality, as well as all-cause mortality.[73] As in the 2020 report, this indicator uses the exposure-response function and minimum mortality temperature defined by Honda and collaborators[74] to estimate deaths attributable to extremes of heat, with work ongoing to increase the accuracy of local estimates.[74,75] Using life expectancy data from the Global Burden of Disease 2019 Study,[76] years of life lost (YLL) were also calculated to better reflect health burdens.

Heat-related mortality for the 65-and-older population increased throughout the period of study, reaching a record high of almost 345,000 deaths in 2019 (Figure 5) - 80.6% higher than in the 2000-2005 average. Between 2018 and 2019, India and Brazil experienced the biggest absolute increase in heat-related mortality. Although heat related mortality fell from 2018 to 2019 in the WHO European region (due to fewer attributable deaths in countries such as Germany, Russia, and the UK), this region still remains the most affected, with almost 108,000 deaths attributable to heat exposure in 2019.

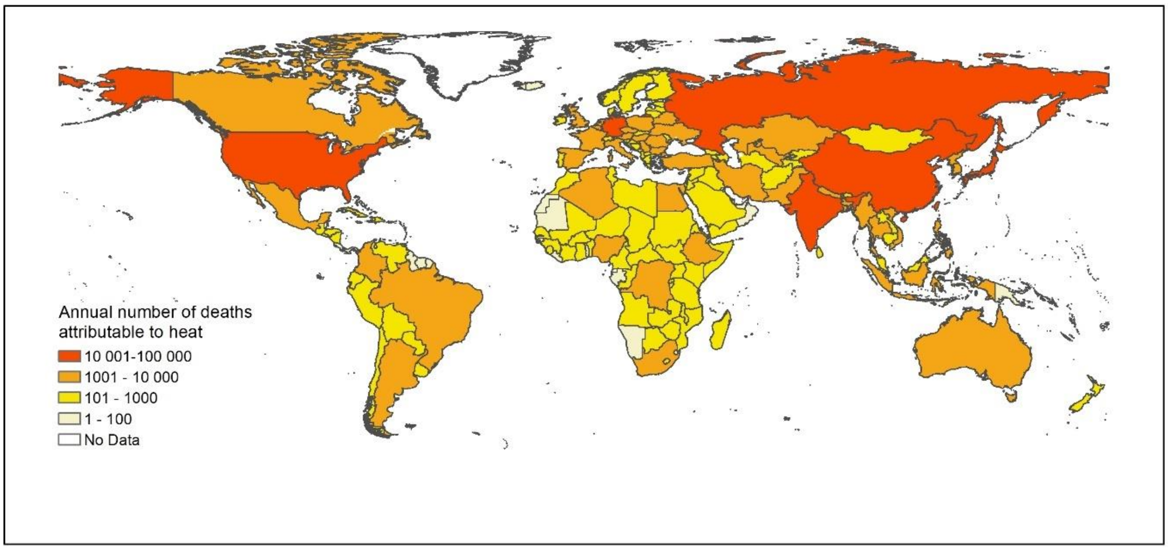


Figure 5. Heat-related mortality among the 65-and-older population in 2019, by country

1.2 Health and Extreme Weather Events

Indicator 1.2.1: Wildfires

Headline finding: nearly 60% of countries saw an increase in the number of days people were exposed to 'very high' or 'extremely high' fire danger in 2017-2020 compared to 2001-2004, and 72% experienced an increased human exposure to wildfires across the same period

Hotter and drier conditions caused by climate change increase the risk of wildfires and the extent of their damage.[77] As in previous years, this indicator tracks wildfire exposure by joining satellite-observed active fire spots,[78,79] as well as human exposure to high and very high climatological wildfire danger by combining areas with a Fire Danger Index score of over 5 and population data.[80] A full description of the methods can be found in the appendix (pp 22-23). This indicator does not yet quantify exposure to wildfire smoke, which can affect much greater populations and have large health consequences. For example, it is estimated that smoke from the 2019/2020 Australian fires affected 80% of Australia's population and resulted in hundreds of deaths and thousands of hospital presentations.[81]

Globally, in 2017-2020, there was an additional annual average of 215,531 person-days of wildfire exposure compared to 2001-2004. Overall, 72.4% (134 out of 185) of countries experienced an increase in wildfire exposure over this time. But the increase was unequal: 83% (27 out of 32) of low HDI countries experienced an increase in wildfire exposure compared with 62.5% (40 out of 64) of very high HDI countries. The largest increases were observed in The Democratic Republic of the Congo, India, and China. Over the same time period, the climatological danger of wildfire increased in 110 countries, with the largest growth occurring in Lebanon, Gambia, and Lesotho (Figure 6).

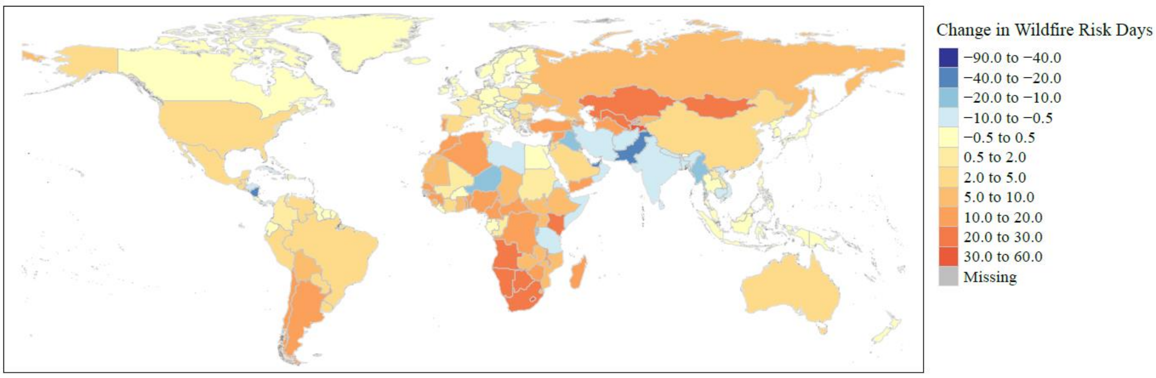


Figure 6. Annual population-weighted mean changes in days of very high and extremely high fire danger from 2001-2004 to 2017-2020 for each country/territory. Large urban areas with population density ≥ 400 persons/km^2 are excluded in the calculations of population-weighted mean values.

Indicator 1.2.2: Drought

Headline finding: in 2020, up to of 19% of the global land surface was affected by extreme drought in any given month

Climate change is driving an increase in the frequency, intensity, and duration of drought events. This is posing threats to water security, sanitation and food productivity, and increasing the risk of wildfires and exposure to pollutants.[32,82]

This indicator tracks the land area affected by extreme drought events using the Standardised Precipitation-Evapotranspiration Index (SPEI), capturing the changes in precipitation and the effect of temperature on evaporation and moisture loss.

The global land surface area affected by extreme drought conditions has consistently increased over the past 30 years. The percentage of the world's land surface experiencing extreme drought in a given month reached a maximum of 22% in the 2010-2019 decade, a value that had only ever reached 13% in 1950-1999 (Figure 7). Furthermore, the 5 years with the most area affected have all occurred since 2015, and the Horn of Africa, a region impacted by recurrent extreme droughts and food insecurity, [83] was one of the most affected areas in 2020.

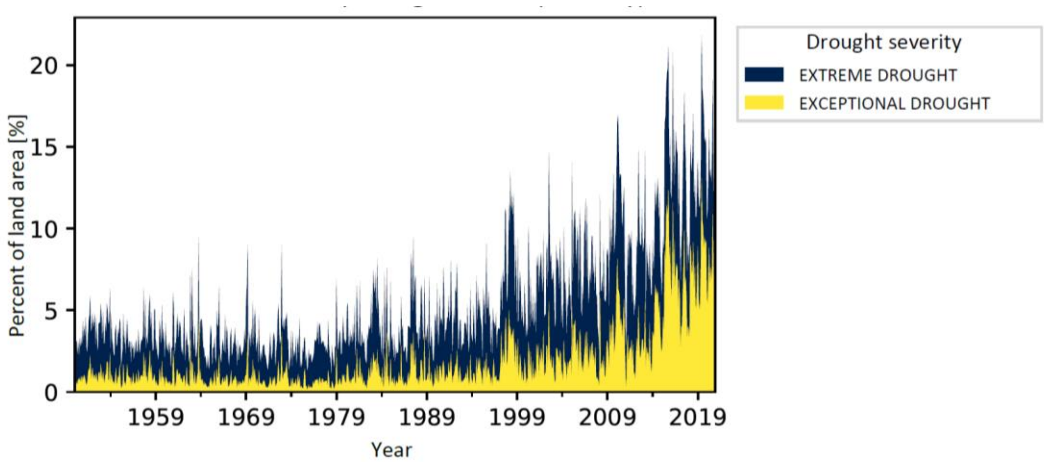


Figure 7. Percentage of land area affected by drought events per month

Indicator 1.2.3: Lethality of Extreme Weather Events

Headline finding: the last 30 years have seen statistically significant increases in the number of extreme weather events, yet only the low Human Development Index country group experienced a statistically significant increase in the number of people affected by these events

This indicator tracks the number of occurrences of climate-sensitive weather-related disasters, and the number of people affected and killed per event. Data is taken from the Centre for Research on the Epidemiology of Disasters, [84] and presented as standardised anomalies across the 1990-2020 period. The number of extreme weather events has seen a consistent and statistically significant increase in all HDI country groups over the last 30 years, with the very high HDI country group experiencing the highest increase (see appendix pp 27-31). However, only the low HDI country group experienced a statistically significant increase in the number of people affected per disaster event, a situation that might reflect greater population shifts to high-risk areas or inequities in adaptive capacity and preparedness to respond to worsening climate change hazards.

1.3 Climate-Sensitive Infectious Diseases

Indicator 1.3.1: Climate Suitability for Infectious Disease Transmission

Headline finding: in the last decade, the area of coastline suitable for Vibrio *bacterial transmission has increased by 35% in the Baltic, 25% in the Atlantic Northeast, and 4% in the Pacific Northwest. The number of months suitable for malaria transmission increased by 39% between 1950-1959 and 2010-2019 in highland areas of the low Human Development Index country group*

Climate change is affecting the distribution of arthropod-, food-, and water-borne diseases.[85,86] Together with global mobility and urbanisation, climate change is a major driver of the increase in dengue cases,[87] which have doubled every decade since 1990.[76] Other important emerging or re-emerging arboviruses, transmitted by the same vectors, are likely similarly responsive to climate change.[88] This indicator tracks the environmental suitability for the transmission of arboviruses (dengue, chikungunya and Zika) using an improved model to capture the influence of temperature and rainfall on vectorial capacity and vector abundance, and overlaying it with human population density data to estimate the R_0 (the expected number of secondary infections resulting from one infected person). The R_0 for all arboviral diseases tracked has increased rapidly from the 1950s, and, in 2020, was 13% higher for the transmission by *A. aegypti* and 7% higher for *A. albopictus,* than in baseline years (1950-1954). The largest increases in epidemic potential for dengue, Zika and chikungunya were in countries with very high HDI, mainly driven by the ongoing expansion of *Aedes* mosquitoes.

The influence of the changing climate on the length of the transmission season for *Plasmodium falciparum* malaria is also tracked, using a threshold-based model that incorporates precipitation accumulation, average temperature, and relative humidity.[36] There were significant changes in the number of months suitable for transmission of malaria in highland areas (≥1,500 m above sea level) between 2010-2019 compared to 1950-1959, with an increase of 39% in highlands within the low HDI country group, and an increase of 15% in those within medium HDI group. The difference between high and medium HDI areas is even more marked at a sub-national level. This suggests that climate change might make malaria eradication efforts increasingly difficult in already disadvantaged areas.

Finally, this indicator monitors the environmental suitability for the transmission of *Vibrio* bacteria in coastal waters. *Vibrio* pathogens can cause gastroenteritis and life-threatening cholera, as well as severe wound infections and sepsis.[37] Driven by changes in sea surface temperature and sea surface salinity, the environmental area of coastline showing suitable conditions for the transmission of non-*cholerae Vibrio* species at any one point during the year increased by 56% (from 7.0% to 10.9% of the coastline) in northern latitudes (40-70° N) in 2020 compared to a 1980s baseline. From the 1980s to the most recent decade, the area of coastline suitable for these bacteria at any point during the year has risen from 47.5% to 82.4% in the Baltic, 29.9 to 54.9% in the Atlantic Northeast, and 1.2 to 5.1% in the Pacific Northwest (Figure 8). Between 2003 and 2019, there was an increase in the proportion of coastline with suitable conditions for *Vibrio cholerae* across all HDI country groups, with the low HDI country group being having the highest suitability on average, at 98.6% of countries' coastlines in 2019. However, it was the high HDI country group that showed the biggest increase in suitable coastline area during this period, at a rate of almost an additional 1% of their coastline becoming suitable each year ($r2=0.78$, $df=15$, $p<0.01$).

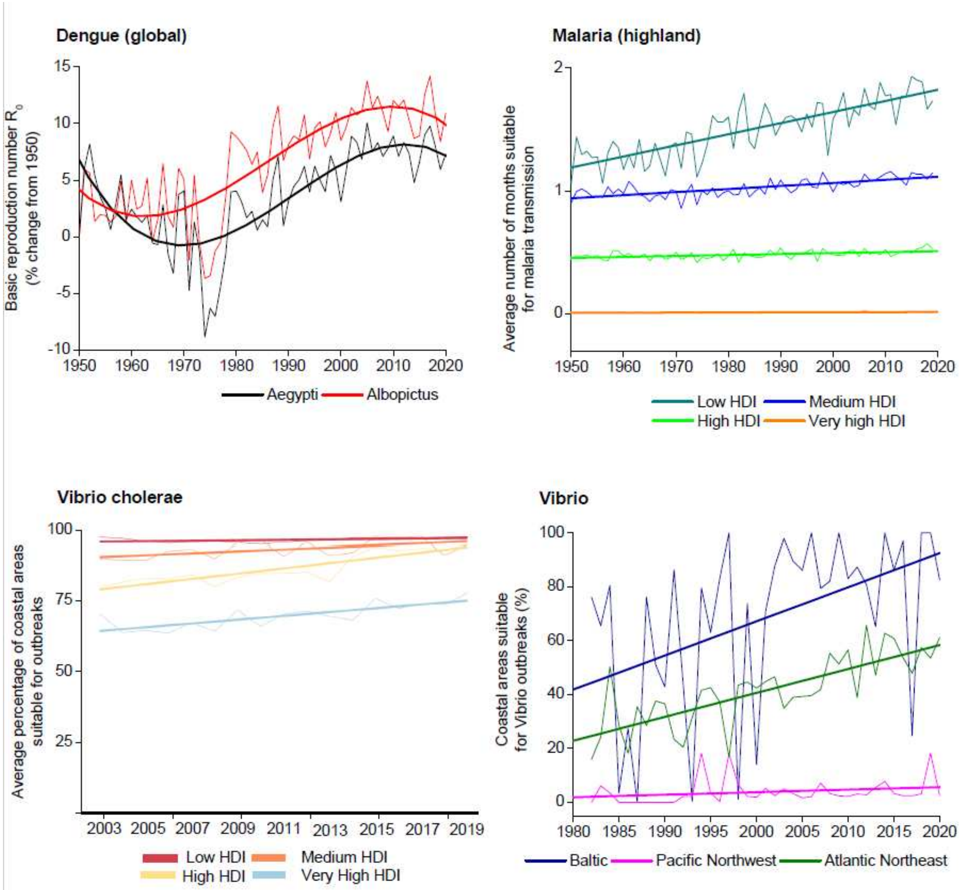


Figure 8. Change in climate suitability for infectious diseases. Solid lines represent the annual change. Straight lines represent the trend since 1950 (for dengue and malaria), 1982 (for Vibrio bacteria), and 2003 (for Vibrio cholerae)

Indicator 1.3.2: Vulnerability to Mosquito-Borne Diseases

Headline finding: while vulnerabilities to arboviruses transmitted by A. albopictus *and* A. aegypti *have decreased across all countries since the year 2000, countries in the low Human Development Index group remain on average the most vulnerable*

As demonstrated by indicator 1.3.1, climate change is making environmental conditions increasingly favourable for the transmission of certain arboviruses. While interventions to reduce vulnerabilities can partly counteract these threats, environmental pressures make this increasingly challenging. This indicator combines the environmental suitability for the transmission of dengue (as described in indicator 1.3.1) with key indicators of social vulnerability to this disease: access to sanitation and water services, income level, and healthcare quality.[89,90]

Due to improvements in sanitation, income and healthcare quality, vulnerability to mosquito-borne diseases is decreasing, even despite increases in their environmental suitability. However, improvements have been slower in the lower HDI country groups: while the vulnerability for transmission by *A. aegypti* has decreased by 34% in the low HDI country groups from 2000 to 2017, the reduction in the high HDI country groups has been of 61%. The vulnerability index remains inversely related to the level of HDI, with countries in the low HDI group having a vulnerability index over 360 time higher than countries in the very high HDI group in 2017 (appendix pp 45-46).

1.4 Food Security and Undernutrition

Indicator 1.4.1: Terrestrial Food Security and Undernutrition

Headline finding: crop yield potential continues to follow a downward trend, with 6.0% reduction in the crop yield potential of maize; 3.0% for winter wheat; 5.4% for soybean, and 1.8% for rice, relative to 1981-2010 levels

Food insecurity is on the rise and affected 2 billion people in 2019.[91] Climate change threatens to exacerbate this crisis, which will disproportionately affect the most vulnerable and those already facing undernutrition. Due to socially defined gender roles and lower empowerment, food insecurity disproportionately affects rural women, reinforcing their disadvantaged position through reduced educational attainment, income and socioeconomic status.[92]

This indicator tracks the change in crop yield potential resulting from rising temperatures using the same methods as for the 2020 report. Rising temperatures shorten the time taken for crops to reach maturity, thereby leading to reduced seed yield potential.[93] A reduction in crop yield potential can be considered an indicator of future crop yield reductions due to higher growing season temperatures (and therefore a shortened growing season). Crop yield potential continues to follow a consistently downward trend, adding extra pressure to already strained food systems around the world. Reductions in time to maturity are observed in all staple crops tracked, amounting to 6.0% reduction for maize, 3.0% for winter wheat, 5.4% for soybean, and 1.8% for rice, relative to 1981-2010 levels (Figure 9).

Data from the Food Insecurity Experience Scale of the United Nations' Food and Agriculture Organization (FAO) was used to assess self-reported experience of 'severe food insecurity', defined as a situation in which an individual went at least one whole day without eating as a result of lack of resources in the prior 12 months, in 83 countries. A fixed-effects, time-varying regression showed that every 1°C of temperature increase was associated with 1.4% increase in the probability of 'severe food insecurity' (95% CI: 1.3 to 1.47; p-value: <0.001) in 2014 and 1.64% (95% CI: 1.6 to 1.65; p-value: <0.001) in 2019, globally.

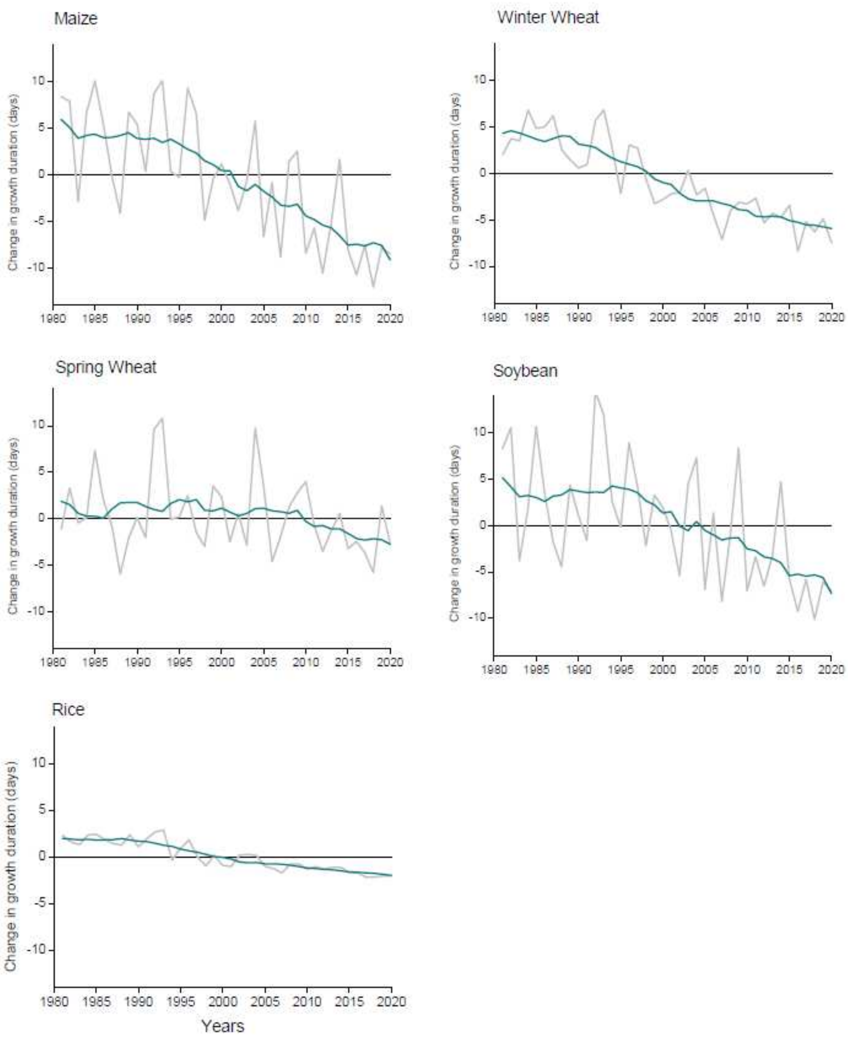


Figure 9. Change in crop growth duration relative to the 1981–2010 baseline. The grey line represents the annual global area-weighted change. The blue line represents the running mean over 11 years (5 years forward and 5 years backward).

Indicator 1.4.2: Marine Food Security

Headline finding: in 2018-2020, nearly 70% of countries showed increases in average sea surface temperature in their territorial waters compared to 2003-2005, reflecting an increasing threat to their marine food productivity and marine food security

Per-capita fish consumption has increased steadily since the 1960s.[94] About 3.3 billion people depend on marine food, with coastal populations in low and medium HDI countries, SIDS, and indigenous people in particular, relying on it for their nutrition and livelihoods.[94,95] Climate change is driving shifts in marine fish capacity and capture through increases in sea water temperatures (and the associated reduced oxygenation), ocean acidification, and coral reef bleaching. As a result of this, coastal tropical countries are facing the biggest reductions in marine yield potential, while also being the most vulnerable to the associated socioeconomic impacts.[95-97]

This indicator expands its geographical scope for 2021, tracking sea surface temperature in territorial waters of 136 countries to reflect the changing threats of climate change on marine productivity, and therefore on marine food security. It is complemented by reporting the changes in marine capture based-per-capita fish consumption, using data collected by FAO (see appendix pp 50-70).

Average sea surface temperature increased in the territorial waters of 95 out of 136 studied countries (70%) in 2018-2020 compared to 2003-2005, posing threats to marine food productivity. Marine capture-based fish consumption was also reduced since the 1990s, coupled with an increase in the consumption of farm-based fish products of lower nutritional quality and omega-3 content.[98] These trends expose the threats of climate change poses on marine food security around the world.

1.5 Migration, Displacement, and Rising Sea Levels

Headline finding: there are currently 569.6 million people settled below 5 metres above sea level, who could face risks from the direct and indirect hazards posed by the rising sea levels

Between 1902 and 2015, the global mean sea level increased by 0.12–0.21 metres.[99] If unabated, sea level rise is projected to reach up to 2 metres above current levels within 80 years, or even more in certain locations if considering ice sheet collapse, waves, and tidal contributions and other factors.[100-103] This indicator tracks the population settled in areas at risk of global mean sea level rise, based on coastal elevation and population distribution,[104,105] and national policies connecting climate change, human mobility, and health.

There are currently 146.6 million people living in coastal areas less than 1 metre above current sea levels, 27.3% of which reside in areas with low HDI levels. Further, the 569.6 million people settled below 5 metres above current sea levels could face rising risks of increased flooding, more intense storms, soil and water salinification,[106] and local emergence of infectious diseases,[107] as sea levels continue to rise; 26.6% of these people live in areas with low HDI levels. Where erosion occurs, dwellings and other infrastructure can be damaged.

Migration and mobility could be a response, which might be exacerbated through other impacts of climate change, like those described in other indicators in this section. This would affect livelihoods, access to essential services, and psychosocial wellbeing.[108-110] Up to December 31, 2020, 45 policies connecting climate change and migration were identified in 37 countries (see appendix pp 72-77), all of which mentioned health or wellbeing, but typically related to climate change impacts rather than to the potential health impacts of forced migration. Although they commonly accepted that mobility could be domestic and international, immobility was rarely acknowledged. National policies that recognise and respond to the health risks and health benefits of different mobility patterns will, in part, shape the overall health outcomes.[111]

Panel 2. Gender, Health and Climate Change

The health impacts of climate change are both underpinned and amplified by gender norms and gender inequities, with numerous examples cited throughout this report.[112] Gender also influences who sets the agenda and drives responses to climate change. Evidence shows that greater representation of women in parliament is associated with stronger climate change policies.[113-115] However, only 21% (41 out of 196) of the heads of delegation to the UNFCCC Conference of Parties in 2019 were women, and women headed just 29% of national delegations to the UNFCCC intersessional in June 2019. Moreover, of the 1,000 scholars listed by Reuters as the most influential on climate change, only 122 were women.[116]

There is an urgent need for gender-sensitive responses to the health dimensions of climate change. This must be underpinned by the collection and reporting of data that is sufficiently disaggregated, granular and intersectional to reveal local inequities – for example data disaggregated not only by gender but also by geography, age, ethnicity, class, and other markers of marginalisation and vulnerability.[117-121] However, in many cases a severe lack of standardised, gender-disaggregated data hampers these efforts,[122-126] and it is the very social structures that shape how gender is perceived and prioritised that undermine progress: cultural norms often translate into weak political and financial support, and limit the capacity of researchers to engage with gender inequities.[124,127] Only 6% of all scientific articles covering climate change and health in 2020 also considered gender (indicator 5.3), and despite a workstream established for this purpose, only 6 of the 44 indicators in the 2021 report of the *Lancet* Countdown provide data by sex or gender.

Starting to reverse this, the United Nations Entity for Gender Equality and the Empowerment of Women (UN Women) is leading global efforts to increase the availability of information on gender through its “Making Every Woman and Girl Count” flagship programme. Through this programme, UN Women supports countries with the development of priority indicators to capture gender inequities – both through indicator selection and through data collection.[128] A model questionnaire has been developed for that purpose, and several countries, including Bangladesh, Mongolia and several Pacific Island countries, have either begun (or are currently preparing for) their rollout. With the purpose of helping countries understand the connections between the environment and gender equality, the programme also supports data reprocessing, and the integration of geospatial information with demographic and health surveys. The importance of this work is already materialising: preliminary analysis demonstrates the accentuation of gender inequities as a result of weather events, including drought episodes driving spikes in child marriage for girls in almost all Asian countries analysed.

Gender, as a social construction, affects everyone in society.[9–13]A gender-sensitive response to climate change would generate benefits for the whole of society. Ensuring gender is represented in national statistical strategies and regular data collection processes will expose the true dimensions of the challenge. This, along with more diverse leadership, will inform and drive a commensurate response.

Conclusion

In this fifth iteration of the *Lancet* Countdown indicators, section 1 of the 2021 report highlights a continuous increase in the impacts of climate change on all monitored aspects of human health, providing further evidence that climate change is having quantifiably and increasingly negative impacts on human health.

While its health impacts are felt across the world, climate change disproportionately affects disadvantaged populations, exacerbating their vulnerabilities. The stratification of indicators by HDI groups reveals the higher risks faced by low and medium HDI countries, particularly with regards to labour capacity and livelihoods, food security, and vector-borne disease transmission. Capturing the health impacts on disadvantaged groups, necessary for adaptation responses (described in the following section), represents a major challenge, exacerbated by the lack of disaggregated data.[15] With respect to gender, this is further explored in panel 2. Moreover, although this section considers the impact of heat on sentiment, the difficulties of capturing the mental health impacts of climate change still remain. Work will continue to focus on addressing this gap.

Section 2: Adaptation, Planning, and Resilience for Health

The past year affirmed the centrality of health and wellbeing to socioeconomic development, illustrating how health risks can compound and cascade across other sectors and nations, and dramatically highlighting the potential consequences of chronic, limited investments into climate-resilient and environmentally sustainable health systems.[129,130] The COVID-19 pandemic also exposed stark differences in the capacity of health systems and the resilience of populations to health emergencies,[4,5] identifying the urgent need for health authorities to increase national and international coordination and preparedness. This should include integrated surveillance and monitoring of emerging health threats, developing and deploying early warning and response systems, and financially supporting low-resource nations and communities.[131] Importantly, for the public health response to be effective, it must address the needs of the most vulnerable – with the benefits of reduced inequities for the whole of society.

Building climate-resilient and environmentally sustainable health systems would not only help reduce the health impacts of climate change explored in the previous section, but also contribute to minimising the risk of future pandemics. This section reports eight indicators of adaptation, planning, and resilience, closely linked with the components of the WHO Operational Framework for Building Climate Resilient Health Systems: planning and assessment (indicators 2.1.1–2.1.3); information systems (indicator 2.2); delivery and implementation (indicators 2.3.1–2.3.3); and funding and spending (indicator 2.4). Each of these indicators provide insights into inequities. Data on health adaptation funding from global financing mechanisms – necessary to help low and medium HDI countries adapt to the worsening health impacts of climate change – have been reintroduced into this year's report (indicator 2.4).

A remaining challenge within section 2 is the scarcity of clear metrics to monitor adaptation progress. While efforts were made to validate the indicators, self-reported data for adaptation plans, assessments, and services may be subject to reporting bias, particularly where COVID-19 resulted in redeployment of public health resources, and where surveys experienced a decline in participation.

2.1: Adaptation Planning and Assessment

Indicator 2.1.1: National Adaptation Plans for Health

Headline finding: in 2021, 37 countries out of 70 reported having national health and climate change strategies or plans in place

Health systems are under pressure to respond to the acute and long-term threats from climate change, while simultaneously facing other critical public health risks. Comprehensive, implemented health adaptation plans can not only improve health resilience to climate change, but also contribute to broader health systems strengthening, and catalyse effective collaboration with other health-determining sectors.

Data for indicators 2.1.1 and 2.1.2 are sourced from the 2021 WHO Health and Climate Change Global Survey,[132] that provides self-reported data on health sector response to climate change from 70 governments (described in the appendix pp 78-79). This indicator tracks the development of national health and climate change strategies and plans and barriers to implementation.

In the 2021 survey just over half of countries (37 out of 70) reported to have a national health and climate change strategy or plan in place, comparable to the proportion reported in 2018. Implementation remains a challenge for countries from all HDI levels with less than a quarter of these countries reaching high or very high levels of implementation. Insufficient financing was identified as a main barrier to reaching full implementation by 73% of all responding countries with one-fifth (8 out of 37) reporting to have no current sources of funding available for taking action on priorities set out in their strategies/plans. Other key barriers to implementation were insufficient human resource capacity (59%), COVID-19 related constraints (54%), and a lack of research and evidence (49%).

A desktop review of National Adaptation Plans (NAPs) submitted to the UNFCCC found that four of the 19 NAPs considered gender in health adaptation actions. However, although NAPs may mention the principles of gender equality, they often fail to demonstrate mainstreaming gender in a way that challenges gender norms, power, and structures. The recommendations in the *WHO Guidance for Mainstreaming Gender in Health and Climate Change Programmes* provide countries with guidance for achieving gender mainstreaming, including through national health and climate change plans.[133,134]

Indicator 2.1.2: National Assessments of Climate Change Impacts, Vulnerability, and Adaptation for Health

Headline finding: 36 out of 70 countries in 2021 reported having conducted a climate change and health vulnerability and adaptation assessment

Evidence-based policy development and planning require a comprehensive evaluation of the climate change-associated health risks faced by populations and health systems. This indicator monitors the number of countries who report having conducted a climate change and health vulnerability and adaptation assessment. These assessments are critical, because they not only allow countries to establish and re-evaluate health risks, but also consider the vulnerabilities contributing to health outcomes.

While 36 out of 70 countries disclosed they had conducted a climate change and health vulnerability and adaptation assessment, only about one-third of these reported that the findings influenced the allocation of human and financial resources. However, 56% (20 out of 36) reported that the findings informed the development of their national health and climate change strategy/plan, suggesting evidence-based policy setting. Over two-thirds of countries specifically considered vulnerable population groups in their assessments, including children, women, the elderly, workers, rural/urban populations, those living in poverty and, to a lesser extent, indigenous groups, migrant or displaced populations. However, the comprehensiveness of these assessments varied widely.

As explored in section 1, health vulnerabilities to climate change are unevenly distributed and can exacerbate existing health inequities. As health vulnerability and adaptation assessments inform national health and climate change plans and programmes, it is essential that data gathered for these assessments are disaggregated according to social determinants of health. This will enable public health interventions to actively identify and support the most vulnerable communities, and proactively reduce sub-national health inequities relating to climate change.

Indicator 2.1.3: City-level Climate Change Risk Assessments

Headline finding: in 2020, 546 of 670 cities reported having completed or being in the process of undertaking climate change risk assessments. Heat-related illness was the most common climate-related health concern, identified by 169 out of 308 cities

The COVID-19 pandemic revealed the persistent health inequities and vulnerabilities of cities and urban sub-populations.[135,136] Home to over half the world's population (a proportion projected to increase to 70% by 2050), cities play a crucial role in leading local health adaptation to climate change.[137] Using data from the CDP's 2020 survey of global cities, this indicator captures the number of cities that report having completed a climate change risk or vulnerability assessment; and the climate-related health impacts and vulnerabilities that cities identified.

In 2020, 546 of 670 cities (81%) reported they had completed or were currently undertaking climate change risk assessments. For those cities who responded in both 2019 and 2020, an additional 45 (9%) reported having completed a climate change risk assessment in 2020. Importantly, however, 94% of responding cities belonged to countries with high or very high HDI, meaning that cities and countries of low and medium levels of HDI were underrepresented in the data. 308 cities identified that climate change poses a threat to one or more health areas. The most prominent perceived health concern pertained to heat-related illness, with 169 (55%) cities reporting this concern. The most vulnerable groups identified were the elderly (reported by 213 [69%] cities), children and youth (180 [58%]), and low-income households (170 [55%]), while 94 cities (31%) identified women as vulnerable to climate-related health impacts.

Indicator 2.2: Climate Information Services for Health

Headline finding: in 2020, national meteorological and hydrological services of 86 countries reported providing climate information to the health sector; only five out of the 86 indicated these climate services guide health sector policy and investment plans

Health adaptation to climate change relies on accurate meteorological data and forecasts for the integrated surveillance and monitoring of emerging health threats, the development and deployment of early warning and response systems, and the implementation of adaptation interventions. This indicator monitors the extent to which national health and meteorological services provide climate information services to the health sector, using data reported to the World Meteorological Organization (WMO).

In 2020, 86 national meteorological and hydrological services reported providing climate services to the health sector. In very high HDI countries, 50% of those providing services to the health sector reported that they were co-designing or providing tailored climate information services or products, in contrast with 36% of low HDI countries.

2.3: Adaptation Delivery and Implementation

Indicator 2.3.1: Detection, Preparedness and Response to Health Emergencies

Headline finding: 124 out of 166 countries reported medium-to-high implementation of a national health emergency framework in 2020; an increase of 14% compared to 2019

The International Health Regulations (IHR) are legally-binding instruments defining countries' rights and obligations in handling public health events and emergencies that could cross national borders.[11] Under the IHR, State Parties are required to provide self-evaluations of emergency response preparedness against 13 core capacities published in the State Party Annual Report (SPAR). Limitations of the IHR in ensuring an effective response to the COVID-19 pandemic were identified and continue to be evaluated, and reviews currently underway are discussed in the appendix (pp 89-90). Notwithstanding, countries with higher SPAR scores had lower incidence and mortality per 100,000 population within 30 days from first COVID-19 diagnosis, stressing the relevance of the IHR.[138]

This indicator tracks the degree to which countries have implemented a national health emergency framework under IHR core capacity eight, which includes emergency preparedness and response planning, emergency management structures, and mobilisation of resource. This assesses whether countries are prepared and operationally ready to respond to all public health events, including climate-related emergencies. In 2020, 166 (85%) of State Parties to the IHR completed the relevant section of the SPAR relating to capacity eight, and 75% of countries reported medium-to-high degrees of implementation of a national health emergency framework – a 14% increase compared to 2019. Importantly, however, only 37% of countries reported high implementation, indicated by a capacity score of 75% or greater. The level of implementation varied greatly by HDI, with 89% of very high HDI countries reporting medium-to-high implementation, compared to 55% of low HDI countries.

In preparing for future health crises, it is essential that global institutions improve emergency response preparedness, using lessons learned during the pandemic. The ongoing review of the IHR is an important step in this direction to ensure that the IHR is effective when faced with health emergencies associated with climate change.

Indicator 2.3.2: Air Conditioning: Benefits and Harms

Headline finding: use of air conditioning, a widespread technology for indoor cooling in some regions of the world, averted an estimated 195,000 heat-related deaths among people ≥65 years of age in 2019. However, it also contributed to greenhouse gas emissions, air pollution, peak electricity demand, and urban heat islands

Indoor cooling represents an effective strategy for preventing heat-related mortality.[139] In this year's report, this indicator combines the prevented fraction[140] and heat-related death estimates from indicator 1.1.6, to track the number of heat-related deaths averted by air conditioning in the 65-and-older population (methods described in appendix pp 91-101).

Applying country- and region-specific prevented fractions to the data from indicator 1.1.6 revealed that, in the absence of air conditioning, an estimated 195,400 heat-related deaths would have occurred globally in the 65-and-older population, in addition to the 345,000 heat-related deaths that are estimated to have occurred in 2019. In this age group. air conditioning averted an estimated 69,500 deaths in China (where 72,000 deaths attributable to heat exposure are estimated to have occurred; 65% of households had air conditioning), 47,800 in the USA (where 20,500 deaths are estimated to have occurred; 92% of households had air conditioning), 30,400 in Japan (where 12,400 deaths are estimated to have occurred; 93% of households had air conditioning), but only 2,400 in India (where 46,600 deaths are estimated to have occurred; 6% of households had air conditioning). These figures demonstrate the power of indoor cooling to prevent mortality, as well as the inequities in access to indoor cooling across countries.

Current air conditioning technology is unsustainable, and leads to adverse health outcomes from increased air pollution, urban heat, and greenhouse gas emissions (see panel 3).[141] In 2019, the number of premature deaths from $PM_{2\cdot5}$ exposure attributable to fossil-fuel powered electricity used for air conditioning is estimated (using the same approach as in indicator 3.3) to have been 21,000 globally. Between 2000 and 2019, the global proportion of households with air conditioning rose 57% and CO_2 emissions from air conditioning use rose 61% (Figure 10).

Sustainable indoor cooling approaches are urgently needed, including strong, enforced codes that mandate energy-efficient buildings,[141] a return to traditional tropical and sub-tropical building designs in these regions and elsewhere,[141] use of fans in climate zones where they provide effective cooling,[142] stringent minimum energy performance standards for air conditioners,[141] cool roofs (see panel 3), and increased urban green space (Indicator 2.2.3).

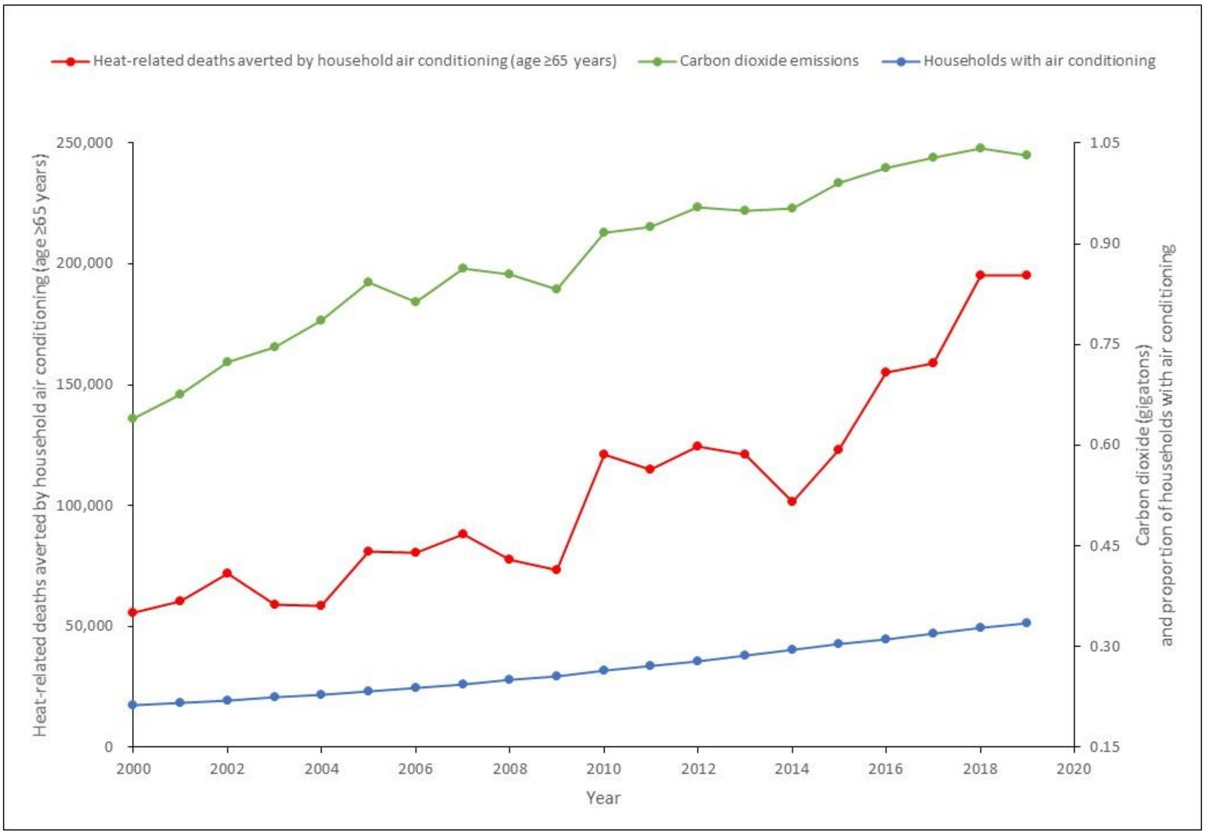


Figure 10. Global heat-related deaths averted by household air conditioning in the 65-and-older population (red line), proportion of households with air conditioning (blue line), and carbon dioxide emissions from air conditioning (green line), 2000-2019

Panel 3. The Urban Heat Island and the Impact of Cool Roofs

As a result of human activity and the urban fabric, cities tend to be hotter than surrounding rural or suburban areas, a phenomenon known as the urban heat island (UHI) effect.

With increasing temperatures and urbanisation, the demand for cooling mechanisms is on the rise. While offering protection from life-threatening extreme heat exposure, the use of air conditioning contributes to climate change through its energy consumption and its leakage of hydrofluorocarbons that act as powerful greenhouse gases; contributes to intensifying the urban heat island through its waste heat emissions; and contributes to increasing peak electricity demand and urban air pollution (see indicator 2.3.2).[143-145] Furthermore, its high costs are amplifying the energy poverty gap.[145,146] The development of sustainable and affordable cooling alternatives is therefore crucial to protect the health of urban populations, while keeping the world on track to meeting the Paris Agreement goals.

This case study explores the use of 'cool' (reflective) roofs as sustainable cooling mechanisms, ranging from specially designed roofing materials, to affordable alternatives such as light-coloured paint. Focusing on Birmingham and the West Midlands region of the UK, urban air temperatures were simulated at 1 km x 1 km horizontal resolution by combining detailed land use data with a building energy parameterisation scheme in a regional climate model (WRF).[147] To estimate the impact of the UHI, temperatures are compared with those from a simulated counterfactual scenario, with urban surfaces replaced by rural types.

The UHI intensity was found to be around 3°C during summer, and up to 9°C during heatwaves in this region. The resulting overheating was estimated to contribute to approximately 40% of mortality associated with UHI over a summer season, and up to 50% during heatwaves.[148-150] Spatial analysis further revealed that the most underserved population groups were particularly exposed to urban heat.[150]

Simulations introducing reflective surfaces found that cool roofs could reduce maximum daytime air temperatures by 0.5°C on average, and up to 3°C during heatwaves. This has the potential of reducing heat-related mortality due to the UHI by 18% over a summer season, and 23% during a heatwave.[151] Considering this assessment was done in a country with relatively cool climate, the impact of cool roofs might be even greater if applied in warmer parts of the world. Moreover, while the UHI can reduce cold-related mortality by around 15% in the winter, cool roofs were shown to have negligible effects in winter months, suggesting they would not contribute to increased mortality in the winter.[152,153]

Because roofs may affect other factors such as precipitation, their use must be assessed on a case-by-case basis.[154] However, with a net annual benefit on temperature-related mortality, adoption of cool roofs in the face of a warming world could provide a low-carbon cooling alternative, with health benefits to the whole urban population.

Indicator 2.3.3: Urban Green Space

Headline finding: globally in 2020, 27% of urban centres were classified as being moderately green or above, an increase from 14% in 2010. This level of greenness varied between 17% of urban centres in the low Human Development Index country group and 39% of urban centres in the very high country group

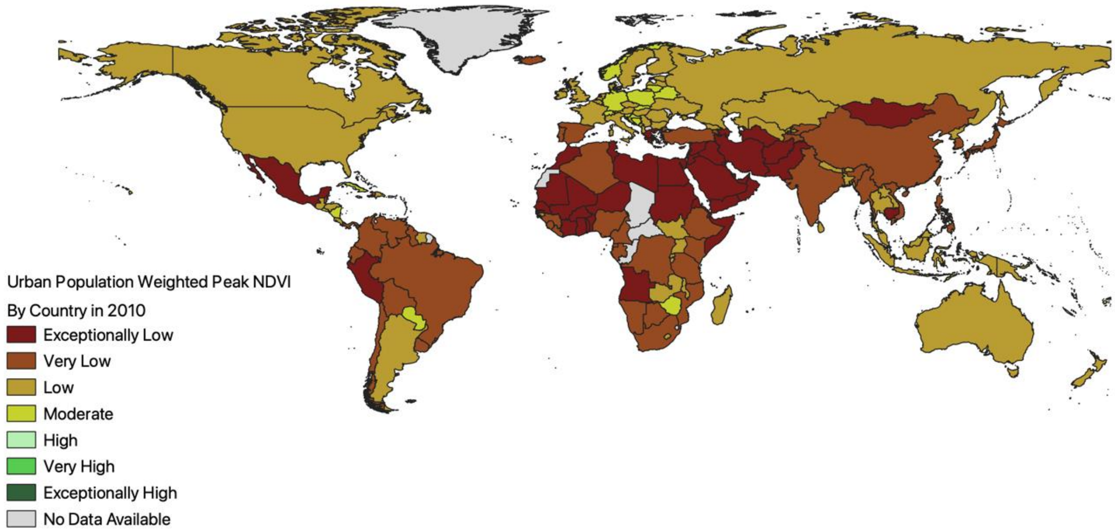
There is increasing evidence that access to urban green spaces provides benefits to human physical and mental health. This includes reducing exposures to air pollution, relieving stress, and increasing social interaction and physical activity, with overall improved general health outcomes and lower mortality risk.[155,156] Green space also helps climate change mitigation and adaptation by sequestering carbon and delivering local cooling benefits. However, urban green spaces must be carefully designed and managed to conserve biodiversity, and ensure they do not provide habitats and breeding sites for vectors of human diseases, or contribute to increased gender and other social inequities.[157-163]

Indicator 2.3.3 provides an estimate of the magnitude of green vegetation in urban centres, using the satellite-based Normalized Difference Vegetation Index (NDVI), with higher values indicating higher greenness levels. In the 2021 report, the sample size was increased to include 1,029 urban centres across 139 countries. These encompass all urban centres of over 500,000 inhabitants, as well as the most populated one in those countries that had no urban centre above this threshold. Full details are in the appendix (pp 102-106).

Averaged across all urban centres sampled, population-weighted peak NDVI increased 23% from 2010 to 2020 (mean NDVI 0.26 to 0.32), with 27% of urban centres being classified as moderately green or above (an NDVI ≥0.40) in 2020 (Figure 11). The level of greenness varies greatly by HDI level. In the very high HDI country group, 39% of urban centres have at least moderate levels of greenness (mean NDVI 0.34) in 2020, compared to 17% (mean NDVI 0.27), 36% (mean NDVI 0.33), and 15% (mean NDVI 0.30) in low, medium and high HDI country groups, respectively. This highlights the inequities in the availability of green spaces across urban centres.

With their potential to simultaneously improve health outcomes, reduce health inequities, and facilitate climate mitigation and adaptation, urban green space design must involve interdisciplinary experts to ensure the health and environmental benefits are maximised.[164] More broadly, with health at the centre of planning in areas such as housing, transport, energy, and water and sanitation, urban centres can be places that are safe, comfortable, and enjoyed by everyone.[165]

A



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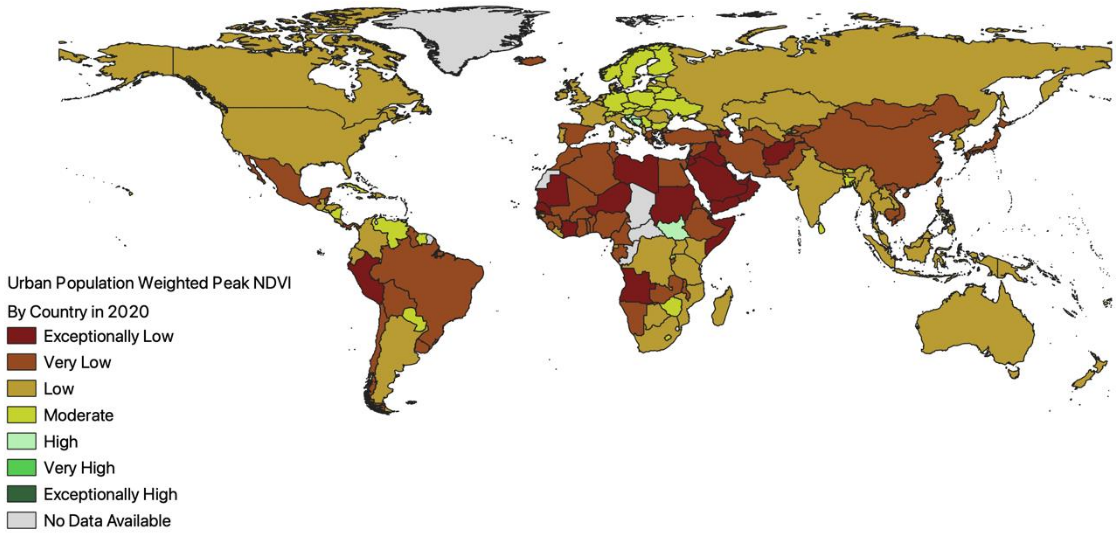

Figure 11. Average urban population-weighted peak Normalized Difference Vegetation Index (NDVI) in urban centres of >500,000 inhabitants by country, for 2010 (A) and 2020 (B). For countries without an urban centre of >500,000 inhabitants, the most populated urban centre was used in the analysis.

Indicator 2.4: Health Adaptation-Related Global Funding and Financial Transactions

Headline finding: globally, adaptation funding directed at health systems represents a small portion of total climate change adaptation funding (0.3%), and only 5.6% of all transactions with adaptation potential were relevant to health in 2019/20

This indicator monitors two elements of spending that could provide adaptation for health: 1) the global funding approved for health-related adaptation projects through multilateral funds, and 2) global financial transactions with the potential to deliver adaptation in the health and care sector, as well as in other sectors that are relevant to the determinants of health. The former draws on data from the Climate Funds Update Data Dashboard, while the latter uses the Adaptation and Resilience to Climate Change (A&RCC) dataset produced by kMatrix.[166,167] These complementary elements provide an evaluation of proactive adaptation funding potentially related to health, and of the global size of all economic transaction that can offer climate change adaptation potential for health.

Between 2018 and 2020, $5.1 billion of multilateral climate change adaptation funding was approved globally. Only $711 million (13.9%) was related to health. This consisted of $14.0 million (0.3%) of approved funding directed specifically at health systems, and $697 million (13.6%) with potential secondary benefits for health identified.

Meanwhile, the value of all financial transactions with the potential to deliver adaptation for health (adaptation-relevant transactions within the dataset-defined "health and healthcare" sectors) increased by 14.0% in 2019/20 compared with 2018/19, reaching 5.6% of total adaptation spending. Spending in other sectors that could be relevant to health (including in the waste and water management, built environment, or agricultural sectors, for example) is estimated to have increased by 7.6%, representing 28.6% of total transactions. Grouped by HDI, $234 million (1%) of spending was within low HDI countries (Figure 12). This compares to $1.8 billion (8%) in medium HDI countries, $5.7 billion (27%) in high HDI countries, and $13.3 billion (64%) in very high HDI countries. For spending in health-relevant economic sectors, a similar narrative emerges: $1.2 billion (1%) of spending occurred in low HDI countries, compared with 62% in countries with very high HDI. As the data covers financial years, the data up to 31st of March 2020 presented in this indicator are unlikely to reflect the anticipated economic impact of the COVID-19 pandemic on adaptation spending.

These findings highlight a growing global market for health-relevant adaptation transactions, but this has yet to translate into sufficient targeted health adaptation funding. As world economies recover from COVID-19, sufficient resources must be redirected towards health adaptation to build resilience to the increasing health threats of climate change.

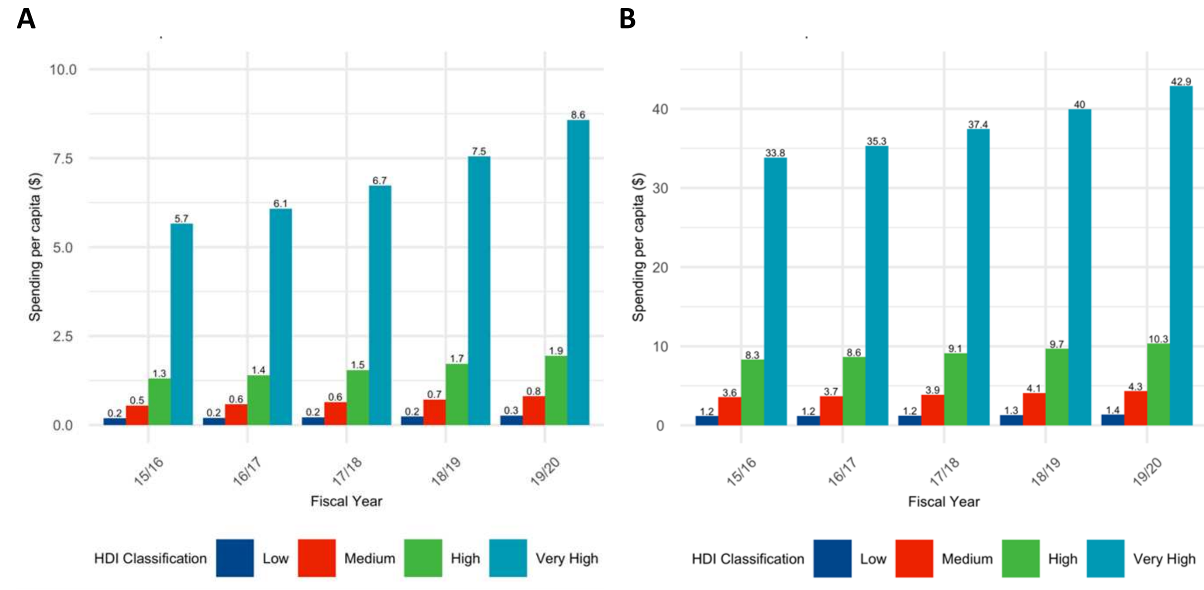

Figure 12. Per capita potential adaptation transactions in the health and health care sector (A) and health-relevant sectors (B) for financial years 2015/16 to 2019/20, by 2019 Human Development Index country group

Conclusion

The indicators in this section paint a complex landscape of adaptation, planning, and resilience for health in the past 12 months, where the small global improvements to adaptation planning and assessment (indicators 2.1.1, 2.1.2, and 2.1.3) and intersectoral collaboration (indicator 2.2) are overshadowed by slow progress in implementation (indicators 2.3.2, 2.3.3) and insufficient investment (indicator 2.4). A key theme across all the indicators is inequities, and while these indicators largely track inequities between countries, within-country inequities are significant for moving towards resilience and sustainability.

While the world economy and health systems are on the road to recovery from a significant acute global health crisis, climate change poses a much greater health threat in the coming decades. It is crucial that organisations and institutions capitalise on the insights generated from the pandemic to improve adaptability and resilience. Research is needed to identify current and future vulnerabilities; project risks from climate change at scales relevant for decision-making under different climate and development scenarios; and identify and evaluate adaptation options to prepare for and protect health in a changing climate. Adaptation plans should be reviewed and updated to consider medium and long-term risks of climate change for health, and to further build resilience. Greater collaboration and coordination are necessary across public and private sectors and global institutions, along with increasing investments in adaptation.

Section 3: Mitigation Actions and Health Co-Benefits

Global atmospheric CO_2 levels passed 415 ppm in January 2021 – continuing an unbroken upward trend – and for the first time, the concentrations for much of 2020 are expected to be 50% higher than the 1750-1800 average.[19] Total emissions of all greenhouse gases in 2019 were 59.1 $GtCO_2e$ (±5.9) including those generated by land-use changes. To limit warming to 1.5°C, annual global emissions must be reduced to 25 $GtCO_2e$ by 2030.[168]

COVID-19 and associated lockdowns across the globe have had profound impacts on the global economy – most significantly in the surface and air transportation, and industrial sectors.[169] Emissions from very high HDI countries, which account for 48% of the global total, were around 10% lower than 2019 levels.[169] However, without targeted intervention, emissions will rebound as the world recovers from the pandemic. Indeed, the 5.8% drop in energy-related CO_2 emissions seen in 2020 is forecast to be matched with an unprecedented 4.8% rise in 2021.[25]

The necessity of steering the economic recovery to a lower-emissions pathway has been well publicised but has yet to be well-integrated into recovery plans (see panel 4).[170] Nevertheless, the COVID-19 recovery presents the challenge and simultaneous opportunity to encourage action that yields benefits to health.

Tracking this global challenge, section 3 covers the relationships between climate change mitigation actions and health. It provides an overview of the global energy system (indicator 3.1) alongside associated global exposure to ambient $PM_{2.5}$ air pollution and its health impacts (indicator 3.3). Energy use in the home is also reported, with new detail on fuels used and estimates of indoor air pollution concentrations (indicator 3.2). Following this, individual sectors are examined: transport (indicator 3.4); food and agriculture (indicators 3.5.1 and 3.5.2); and the global healthcare sector (indicator 3.6). Where possible, the ways in which relationships between health and climate change mitigation both influence and are influenced by societal inequities are explored.

Indicator 3.1: Energy System and Health

Headline finding: from 2014 to 2018, despite strong growth in renewables in very high Human Development Index countries, the carbon intensity of the global energy system has seen an annual average decline of just 0.6% - a rate incompatible with meeting the ambitions of the Paris Agreement

Fossil fuel combustion within the energy system is the largest single source of greenhouse gas emissions, with a global share of 65%.[168] The rapid shift from coal to renewable energy use is crucial, not only to mitigate these emissions, but also to prevent deaths due to ambient air pollution (indicator 3.3) and eliminate other harmful pollutants related to coal mining and combustion.[171] Drawing data from the IEA, this indicator tracks three components: the carbon intensity of the global energy system; coal phase-out; and zero-emission electricity. Full details are described in the appendix (pp 110-115).

The carbon-intensity of the global energy system fell slightly for the fifth year in a row, to 56.0 tCO_2e/TJ (excluding land use emissions) in 2018. However, progress remains very limited, with an annual rate of decline of just 0.6% from 2014 to 2018. At this rate it would take over 150 years to fully decarbonise the energy system – far from the 2040 deadline required to keep temperature rise to 1.5°C.[172] Progress has been made in the very high HDI country group since 1970 and carbon intensity in the high HDI country group could be at a possible peak. However, driven by the need to develop, the low and medium HDI country groups have shown sustained growth in emissions per unit of energy over the period (Figure 13).

China continues to dominate global coal consumption – although it represents 18.1% of the world's population, it accounted for 53% of global coal use in 2019. While global coal use for all activities fell 1.2% in 2019, including a fall of 13.4% in the USA and 21% in Europe, China's usage grew by 1.1%.

For the five years until 2018, electricity generation from renewable wind and solar increased by an annual average of 17%, with its global share of electricity generation reaching 7.2% in 2018. While energy demand for coal, gas, oil and nuclear fell in 2020, renewables demand grew by a small amount (0.9%).[173]

Concerningly, global coal demand is expected to rise by 4.5% in 2021, although at the same time demand for renewables is set to expand by over 8%.[25] A redirection of efforts towards the decarbonisation of the energy system (see panel 4), could put the world on track to meet the 1.5°C temperature goal and prevent deaths associated with climate change and air pollution.

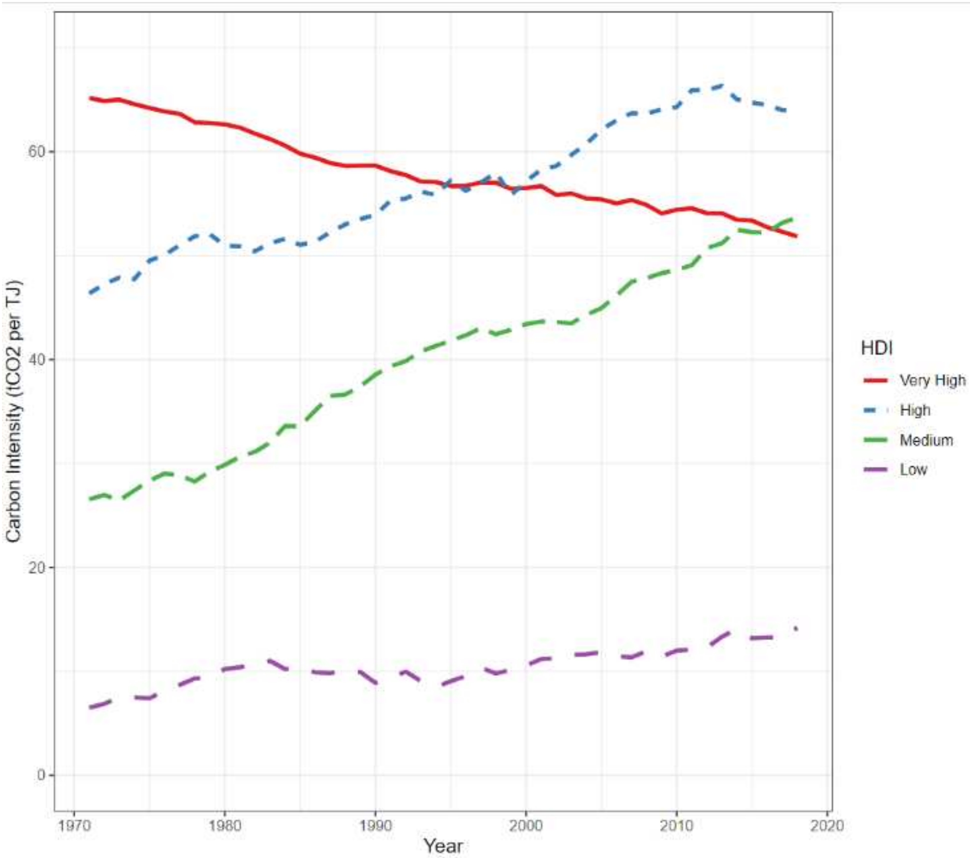

Figure 13. The carbon intensity of the energy system for 1970-2018, by 2019 Human Development Index country group

Indicator 3.2: Clean Household Energy

Headline finding: in 2019, only 5% of rural households in countries in the low Human Development Index country group relied primarily on clean fuels and technologies for cooking (up from just 2% in 2000) – putting them at risk of morbidity and mortality due to exposure to household air pollution

Around 10% of the world's population, three quarters of whom live in sub-Saharan Africa, lack access to electricity for any service provision, and 2.6 billion people continue to lack access to clean fuel for cooking.[173,174] COVID-19 poses further impediment to achieving the energy access goal (SDG7), with 2020 seeing a 2% rise in lack of access to electricity in sub-Saharan Africa,[175] driving low-income communities in places such as Nairobi, Kenya to increase their usage of wood and kerosene.[176] Energy poverty remains a concern even in high and very high HDI countries – around 7% of people in the EU struggle to afford sufficient heat for their homes,[177] putting them at risk of cold-related adverse health outcomes.[178] Here, and around the world (as highlighted in panel 3), energy poverty related to excess heat is also an important issue.[179]

This indicator tracks energy usage in the home, using data from both the IEA and the WHO.[174,180-182] The WHO household energy database compiles data from national surveys, collected up to 2017 and projected to 2019, presenting information on fuels and technologies used for cooking, heating, and lighting. Using these data, this indicator also presents an estimation for household air pollution concentration for 29 countries. A full description of the methods, data, and caveats is given in the appendix (pp 116-119).

In the low HDI country group, domestic energy use is dominated by bio-fuels. Primary reliance on clean fuels and technologies for cooking in households in the low HDI country group is estimated at only 12% in 2019. The share is even lower in rural households of this HDI group, with only 5% relying on clean fuels and technologies – a marginal increase from 2% in 2000 (Figure 14). In homes in the medium and high HDI country groups, the share of solid biofuel use has fallen more rapidly, and clean cooking fuel and technology use has risen substantially – although in rural areas it remains at 54% for the high HDI group and 39% for the medium HDI group.

These patterns of energy use, as well as the infiltration of air from outside, have implications on household air pollution concentrations. In rural households in several low and medium HDI countries the average $PM_{2.5}$ concentration in the main indoor cooking area is estimated to be above 500µg m^{-3}. In Ethiopia it is over 1200 µg m^{-3} – 120 times the WHO threshold of 10 µg m^{-3}.[183] Exposure to these harmful air pollutants in the home results in an estimated 2.31 million deaths per year.[184]

While gender-differentiated impacts might change across different geographies and cultures,[185] exposure to household air pollution is estimated to be around 40% higher for women than for men.[186] In many places women are also at higher risk of musculoskeletal injuries and violence that result from their domestic role in collecting and using fuels for cooking and heating, which further poses risks to their physical and mental wellbeing.[187-190] Thus, progress towards meeting the SDG7 would improve health and reduce gender inequities.

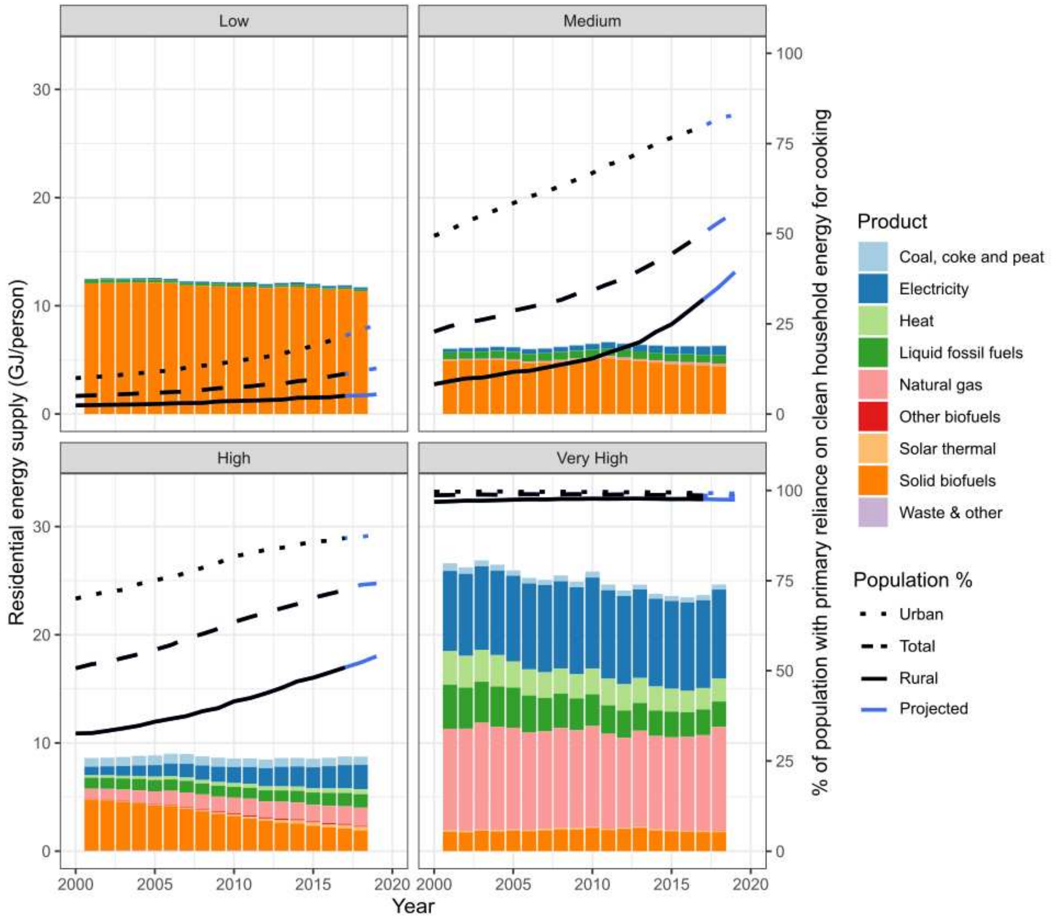

Figure 14. Residential energy supply by 2019 Human Development Index country group for 2000 to 2019. Primary axis: per capita fuel type (coloured bars). Secondary axis: percentage of population with primary reliance on clean fuels and technology for cooking. Data taken from the WHO and IEA. [180-182]

Indicator 3.3: Mortality from Ambient Air Pollution by Sector

Headline finding: 3.3 million deaths were attributable to ambient $PM_{2.5}$ pollution from human sources in 2019 – a third of which were directly related to fossil fuel combustion. The medium and high Human Development Index country groups suffered the highest mortality rates

Awareness of the health impacts of air pollution has increased over the past years, with legislation shifts such as the proposed revision of the EU Ambient Air Quality Directives[191] and a landmark ruling on the death of nine-year-old Ella Adoo-Kissi-Debrah in 2020 in the UK thought to be the first time air pollution was listed as a cause of death in a death certificate.[192] This indicator estimates ambient $PM_{2.5}$ exposure and the resulting attributable deaths from different economic sectors. For the 2021 report, the methods have been updated to use the integrated exposure-response functions (MR-BRTs) used by the 2019 GBD study.[193]

In total, 4.0 million deaths were estimated to be attributable to exposure to ambient $PM_{2.5}$ in 2019 – 3.3 million of which were from anthropogenic sources and 1.1 million were directly related to fossil fuel combustion. Deaths due to coal combustion have decreased from 620,000 in 2015 to 507,000 in 2019, largely due to strict air pollution control measures in China, including the reduction of coal for residential heating.

Ambient concentrations of $PM_{2.5}$ differ strongly across world regions and between urban and rural areas. As a result of higher industrial activity, poorer emissions controls, and the continuing use of solid fuels in the domestic sector, countries in medium and high HDI groups face the highest rates of air pollution-related mortality (60 deaths per 100,000 inhabitants, and 65 deaths per 100,000 inhabitants, respectively) (Figure 15). Deaths are lower in both the low and very high HDI country groups (at 34 deaths per 100,000 inhabitants, and 40 deaths per 100,000 inhabitants, respectively). This is due to lower industrial activity and younger populations in low HDI countries; and cleaner electricity generation, industrial production, and end-of-pipe emission controls in very high HDI countries.

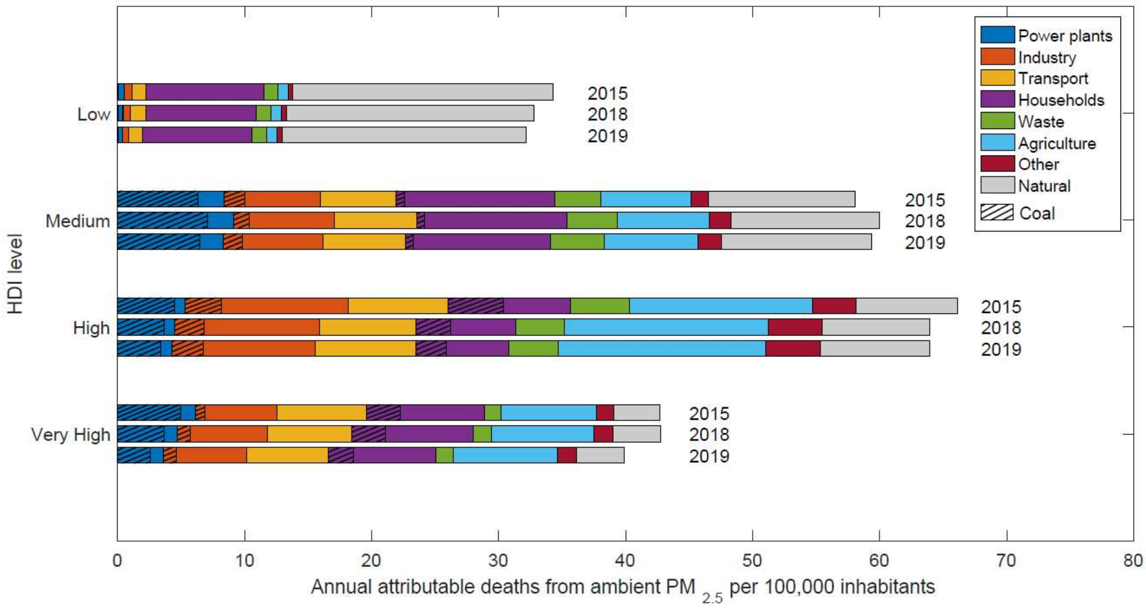

Figure 15. Mortality attributable to ambient $PM_{2.5}$ in 2015, 2018 and 2019 by source and by 2019 Human Development Index country group.

Indicator 3.4: Sustainable and Healthy Road Transport

Headline finding: electricity use in transport rose by 15% from 2017 to 2018 and the global electric vehicle fleet topped 7.2 million cars in 2019. However, emissions from road transport also continued to increase

With road transport accounting for nearly 18% of global CO_2 emissions in 2019, the shift to electric vehicles is an important mitigation measure.[194] Beyond this, the promotion of walking and cycling (active travel) could not only cut emissions, but also provide enormous health dividends through the increase of physical activity.[195] The mode share of cycling varies greatly between and within countries of different levels of HDI – ranging from 0.3% and 0.6% of all trips in São Paulo and Cape Town, to 1.1-1.9% in USA and Australian cities, to 4.8% in Delhi, to 14.1-28.7% in cities in Germany, Japan and the Netherlands – with a higher mode share being associated with more equal gender representation in cycling.[196] Unless active travel infrastructure is rolled out with consideration of sociocultural inequities, the benefits may not be equally manifested across all groups.[197-201]

This indicator uses data from the IEA to monitor fuels used for transport and electric vehicles, with full details provided in the appendix (pp 122-123).[202-204] The global number of electric vehicles (EVs) rose from 5.1 million in 2018 to 7.2 million in 2019. However, EVs still only represent 1% of global car stock, and road transport emissions also increased in 2019, as demand for larger vehicles grew in the USA, Europe, and Asia, in tandem with increasing demand for transport in low and medium HDI countries. Overall, total direct use of fossil fuels for road transport increased by 0.7% whereas the use of electricity in transport rose by 15% from 2017 to 2018, although it remains just 0.27% of total road transport energy use.

With respect to the same period in 2019, the COVID-19 pandemic led to a nearly 50% decrease in global road transport demand by the end of March 2020.[205,206] However, while the use of fossil fuels for road travel has largely rebounded, many public transport networks now face critical decreases in ridership.[207] City governments around the world implemented measures to promote active travel during their lockdowns, many of which are intended to be permanent.[205,206] As cities emerge from the COVID-19 crisis, implementing policies to reinforce positive shifts in travel modality presents a triple opportunity to promote physical activity, reduce urban air pollution, and mitigate climate change.[208]

3.5: Food, Agriculture, and Health

Indicator 3.5.1: Emissions from Agricultural Production and Consumption

Headline finding: mostly driven by high levels of red meat consumption, per capita emissions from food consumption are considerably greater in of the very high Human Development

Index country group – 61% higher than in those in the low Human Development Index group in 2018

Food systems, including agricultural production, are responsible for 21-37% of all greenhouse gas emissions, while also holding high carbon sequestration potential.[209] This makes them key to limiting global warming to 1.5°C. This indicator tracks emissions from agricultural production and consumption of food products, combining modelling and FAO data.[210]

Despite moderate improvements in efficiency, total agricultural production emissions continued to grow, reaching 5.6 $GtCO_2e$ in 2018 (1.5% higher than in 2017). Of this total, cattle products (mainly meat and milk) contributed 52% of global agricultural production emissions.

Data reveal stark differences in per-capita consumption-based agricultural emissions across countries in different levels of HDI: per capita emissions in the very high HDI country group are 39% above those of the high HDI group, and 45% higher than those of the low HDI group (Figure 16). This is despite a high emission-intensity for beef products in the low HDI group (around three times higher than in the very high HDI group), which is mitigated by a much lower per capita consumption of beef. Importantly, 68% of the total consumption-based agricultural emissions in the very high HDI country group are attributable to cattle products, mainly beef production, which is slightly down from 71% in 2000.

Progress towards zero hunger (SDG2) will likely be associated with increases in consumption-based agricultural emissions in low and medium HDI countries. In order to meet emission reduction goals, consumption of red meat should be safely reduced in relevant population groups, especially in very high HDI countries.[211] This would also deliver substantial health co-benefits, as indicator 3.5.2 shows. Further scope to reduce emissions from the food production system comes from waste reduction, deforestation curtailment and yield improvement.[212]

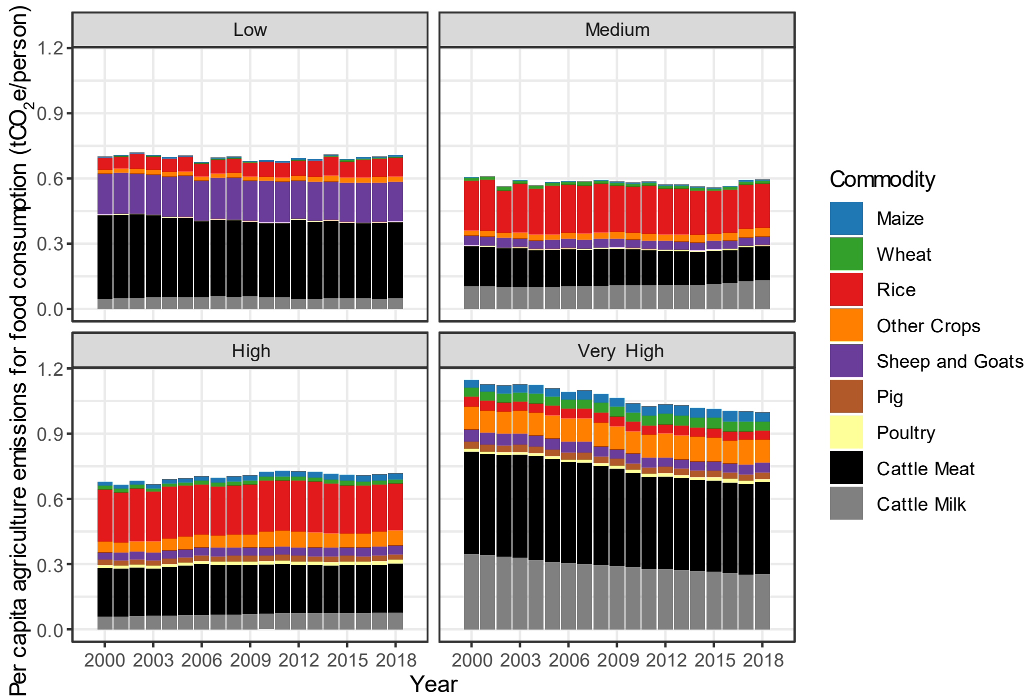

Figure 16. Per capita yearly greenhouse gas emissions associated with consumption of agri-food products, by 2019 Human Development Index country group and commodity, 2000-2018.

Indicator 3.5.2: Diet and Health Co-Benefits

Headline finding: between 2017 and 2018, estimated deaths due to excess red meat consumption rose by 1.8% to 842,000

With current production efficiency interventions failing to curb or reduce agricultural greenhouse gas emissions, dietary shifts – greatly reducing red meat and increasing plant-based foods – are necessary, particularly in the very high and high HDI countries.[195] For the low and medium HDI countries, sustainable farming and agricultural practices will help keep agricultural emissions low while efforts are made to meet the nutritional requirements of populations.[213] Monitoring this dietary transition, this indicator models deaths attributable to dietary risk factors, using updated data on food consumption and mortality rates by sex, age and country.[214,215]

In 2018, 9.6 million deaths were attributable to imbalanced diets (both dietary composition and caloric intake). Although dietary risks and baseline mortality rates declined, there was an overall increase compared with 2017 (see appendix, pp 130-138). Diets in the high and very high HDI country groups contain 4 to 7 times more red meat than in the low and medium HDI groups. Together with greater non-communicable disease-related mortality rates, this translates to a rate of red meat-related mortality almost nine times greater in the very high HDI country group (19 deaths per 100,000) compared with the low HDI group (2 deaths per 100,000).

Diets and the associated health impacts differ across sexes. In general, male diets tend to be less healthy than those of females, containing fewer fruits (-6% on average globally), vegetables (-1%), and legumes (-10%), and more red meat (+4%).[216-219] The differences in risks resulted in an estimated 455,000 (10%) more men dying from preventable, diet-related diseases than women – a pattern reflected across each of the HDI country groupings (Figure 17).

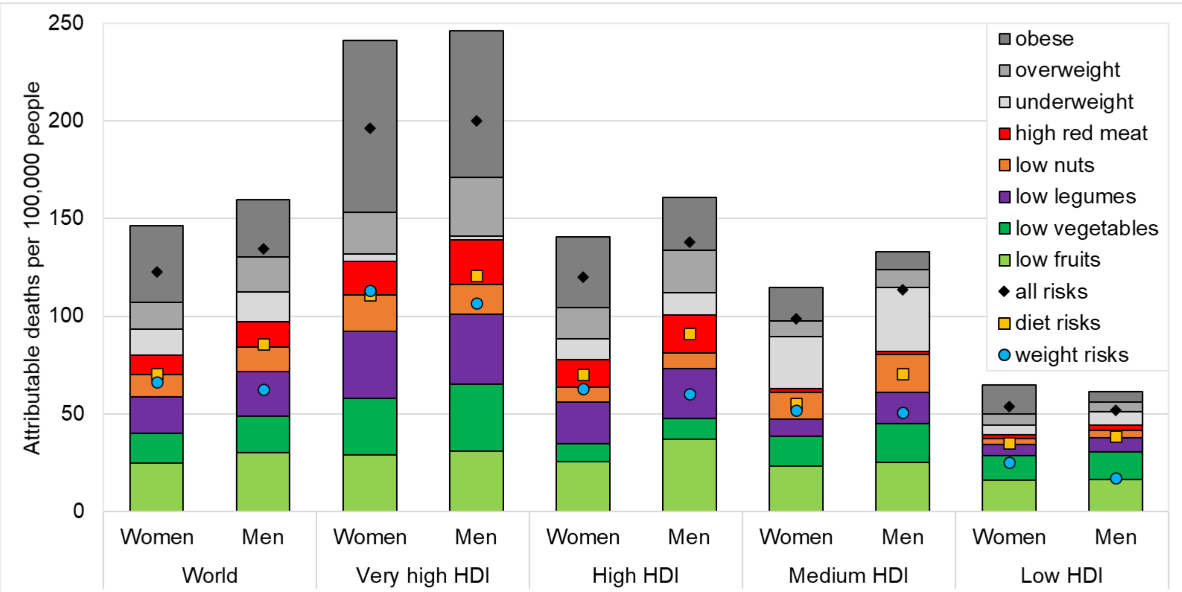

Figure 17. Deaths attributable to imbalanced diets and weight in 2018 by risk factor, sex, and 2019 Human Development Index country group. The size of each component in the stacked bar represents its individual contribution to attributable deaths. Since these contributions cannot be summed directly, the overall contribution by diet and weight components are represented by the dots as given in the key.

Indicator 3.6: Healthcare Sector Emissions

Headline finding: in 2018, emissions from the healthcare sector increased slightly to 4.9% of global greenhouse gas emissions. Healthcare emissions are positively associated with Human Development Index levels, largely through health spending, but minimal association is seen after 400 kg CO_2e per capita

The healthcare sector is central to improving human development. In providing services, healthcare systems mobilise a vast array of products and use energy in various forms, all of which result in emissions of greenhouse gases and other pollutants that can be calculated throughout global supply chains. With this contribution to greenhouse gas emissions and their important leadership role in improving patient care in the face of climate change,[220] healthcare institutions are beginning to seriously commit to reducing emissions.[221]

In this indicator, both direct and indirect emissions from the global healthcare sector are modelled using environmentally extended multi-region input-output (EE-MRIO) models, combined with annual WHO data on national healthcare expenditure, with a full description in the appendix (pp 139-140).

In 2018, the global healthcare sector contributed approximately 4.9% of global GHG emissions, a rise of 5.2% from 2017. Expansion of healthcare services in China was responsible for more than half of this global increase. Although its national healthcare emissions are now 35% greater than those of the USA, on a per-capita basis, China ranks 21st among all major economies assessed.

Per-capita comparisons do not account for differences in healthcare access and quality, specifically measured through health outcomes, such as life expectancy, which is one of the components of the HDI. Plotting per capita healthcare emissions against HDI (Figure 18) reveals that emissions are positively associated with HDI, an association strongest for lower emissions levels. A wide range of HDI levels are associated with per capita healthcare emissions of 500-600 kgCO_2e, reflecting both differences in health system efficacy and other development indicators, but also in emissions intensities. Above these levels, additional emissions are not associated with improved HDI.

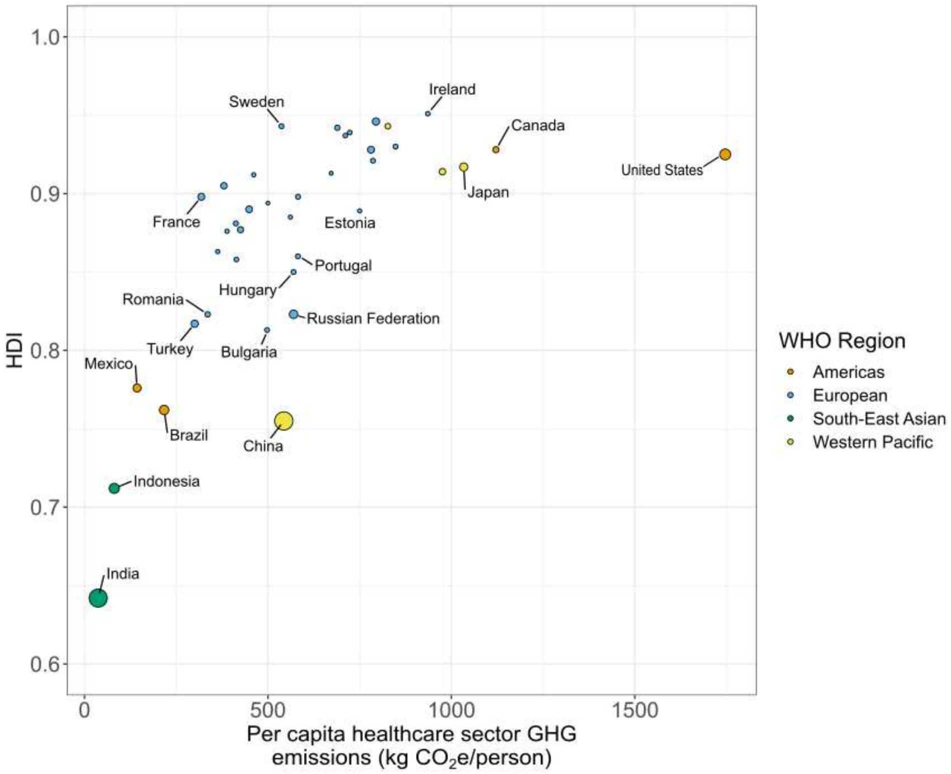

Figure 18. National per capita healthcare greenhouse gas emissions for 2018 against 2019 country Human Development Index level. Dot size is proportional to population

Conclusion

Prior to the pandemic, the rapid rate of growth in renewable electricity generation was insufficient to counteract the sluggish decline in coal use. The result of this was that the carbon intensity of the global energy system remained virtually unchanged. At the same time, there has been very little progress in increasing the use of clean household energy. These delays are costing millions of lives each year, from both household and ambient air pollution. Food-related agricultural emissions continue to rise and so too do deaths attributable to dietary risk factors.

Across this section, many inequities can be highlighted. Low HDI countries have the highest use of dirty fuels in the home, putting them at greater risk of morbidity and mortality from exposure to household air pollution. Countries of medium and high levels of HDI have the highest carbon intensity of energy and the greatest burden of deaths due to ambient air pollution, as a result of higher industrial activity and inadequate emissions controls. People in very high HDI countries have the most carbon intensive diets, and, with high levels of red meat consumption, they also have the most to gain from a shift towards more plant-based foods.

Although the impacts of the COVID-19 pandemic are not yet fully captured, there was a temporary, but significant drop in emissions due to lockdowns, and the associated reductions in economic activities and international travel. However, emissions are already rebounding. The challenge moving forward will be to adopt measures that provide near-term economic relief, whilst building towards long-term emission reductions and protecting future health – a challenge further explored in the following section.

Section 4: Economics and Finance

Avoiding the worst of the climate change impacts described in section 1 will require both sustained adaptation efforts (section 2), as well as a rapid transformation of the world's economies to cut greenhouse gas emissions (section 3). Section 4 examines the economic and financial implications of this transition.

First, this section explores the economic impact of climate change and its mitigation (indicators 4.1.1 to 4.1.4). The indicators use a range of methods to estimate some of the costs that climate change may already be imposing on society through its impacts on human health. Then, the economics of the transition to zero-carbon economies (indicators 4.2.1 to 4.2.5), which are fundamental to the improvement of human health and wellbeing are investigated. The indicators consider whether investments and jobs are beginning to move away from fossil fuels, and if the appropriate economic signals are encouraging this. A new indicator for this year's report (indicator 4.2.5) explores the effect of global trade on greenhouse gas and $PM_{2.5}$ emissions associated with economic activities, highlighting that harms may occur in countries different from the demands that drive them.

Achieving the required investments in the low-carbon transition requires clear and committed action from both governments and private sector actors and could result in both health and economic benefits. Aiming for a green global recovery from COVID-19 over 'business as usual' economic growth will ensure that the economy recovers through the generation of new jobs in low-carbon industries, as well as accelerate progress towards the Paris Agreement goals and the SDGs – yielding health gains through the prevention of further climate change and through the co-benefits of climate change mitigation.[222] International economic cooperation will be essential to ensure global emission targets are met, and to prevent the widening of inequity gaps.[13] This section also therefore reflects on the extent to which post-COVID-19 recovery spending has prioritised green investment (panel 4), and the alignment of fossil fuel companies' strategies with the requirements of the transition (panel 5).

4.1 The Economic Impact of Climate Change and its Mitigation

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

*Headline finding**:** when normalised by GDP, economic losses from climate-related extreme events in 2020 were collectively three times greater in with the medium Human Development Index country group compared with the very high Human Development Index group*

The loss of physical infrastructure and resulting economic losses due to climate-related extreme events can further exacerbate the health impacts described in section 1. This indicator tracks the total annual economic losses (insured and uninsured) that result from climate-related extreme events, using data provided by Swiss Re, with methods described in the appendix (pp 141-143).[223,224]

In 2020 there were 242 recorded climate-related extreme events, with absolute economic losses totalling US$178 billion. Although two-thirds of these losses occurred in very high HDI economies, when normalised by GDP, losses the medium HDI country groups are around three times greater. Importantly, while two-thirds of losses in the very high HDI country group are insured, almost 93% of losses were uninsured in the high HDI group. This number rises to 97% and 100% of measurable losses in the medium and low HDI country groups, respectively – creating a bigger economic burden for these disadvantaged countries, as uninsured losses are either not replaced, or are replaced through out-of-pocket expenses, reinforcing inequities.

Indicator 4.1.2: Costs of Heat-Related Mortality

Headline finding: the monetised value of global heat-related mortality increased by 6.7% from 0.27% of gross world product in 2018, to 0.28% in 2019. Europe continued to be the worst affected region, facing costs equivalent to the average income of 6.1 million of its citizens

The increase in morbidity and mortality due to extremes of heat represents a high cost to all of society. This indicator uses data on years of life lost due to extremes of heat from indicator 1.1.6 to provide a measure of the costs of global deaths attributable to heat.[74] Improved in the 2021 report, it combines a value of statistical life-year (VSLY) with years of life lost (YLLs), to monetise the loss caused by premature mortality. The valuation of life across varying HDI levels presents a methodological and ethical challenge, which this indicator addresses by presenting costs as the proportion of GDP and the equivalent annual average income.

The monetised value of global heat-related mortality in the 65-and-over population increased by 6.7%, from 0.27% of gross world product in 2018 to 0.28% in 2019 (Figure 19). Reflecting the distribution of impacts found in indicator 1.1.6, the costs of heat-related mortality for the low, medium, high, and very high HDI country groups, were found to be equivalent to the average income of 0.94, 4.80, 8.20, and 7.52 million of their citizens, respectively. As in indicator 1.1.6, the WHO's European region was the worst affected in 2019, with costs equal to the average income of 6.1 million of its citizens and 0.66% of regional GDP. However, the costs were lower than the year before, due to fewer estimated heat-related deaths in 2019 compared to 2018 in this region (indicator 1.1.6). On the other hand, costs increased in other regions, especially the WHO's South-East Asia region.

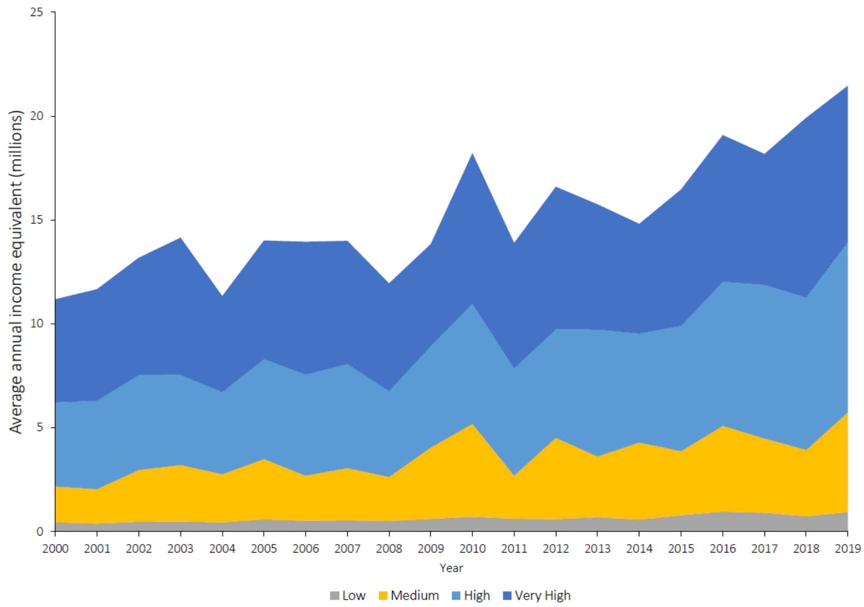

Figure 19. Monetised cost of heat-related (in terms of expressed as the number of people whose average income the loss is equivalent to) by 2019 Human Development Index country group for 2000-2019

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

Headline finding: working in conditions of extreme heat is a health risk. Such conditions could reduce the capacity for paid labour, with an impact on workers' earnings equivalent to 4-8% of GDP in the low Human Development Index country group in 2020

As reflected in indicator 1.1.4, higher temperatures, driven by climate change, are affecting people's ability to work. This indicator considers the loss of earnings that could result from such reduced capacity, Such earnings losses could further compound the health impacts through effects on the socioeconomic determinants of good health.[225] It combines the outputs of indicator 1.1.4 with data on average earnings by country and sector held in the International Labour Organization (ILO) databases, with methods and additional analysis described in the appendix (pp 146-151).[226] In this year's report, the number of countries covered in this indicator has been increased from 25 to 183.

Indicators 1.1.6 and 4.1.2 found Europe to be the region most affected by heat-related mortality in populations aged 65 and over. In contrast, this indicator focusses on working age populations and, in alignment with the outputs of indicator 1.1.4, finds that greater loss of earnings due to labour capacity loss occur in low and medium HDI countries. Countries with lower HDI levels tend to experience greater proportional losses of earnings, emphasising the impact of climate change on deepening inequities. In the low HDI country group, potential income losses in 2020 were equivalent to 4-8% of GDP, depending on the degree of shade or sun exposure during agricultural and construction work (Figure 20). The ranges for the medium, high, and very high HDI country groups in 2020 were 2-4%, 1-2% and 0.3-0.5% of GDP, respectively. The impacts will mainly affect men in sectors such as construction, where they represent more than 90% of the workforce globally, and in manufacturing and agriculture where, where they represent more than 60% of the workforce.[63] However, the data does not account for informal or unpaid domestic and agricultural work, in which women are often overrepresented.[227-229] The indirect economic impacts from reduced labour capacity extend well beyond the loss of earnings. For example, modelling both direct and indirect impacts, the heat-related economic cost of labour loss in 2020 was estimated at 1.36% of China's GDP and 6.75% of GDP in Hainan Province.[30]

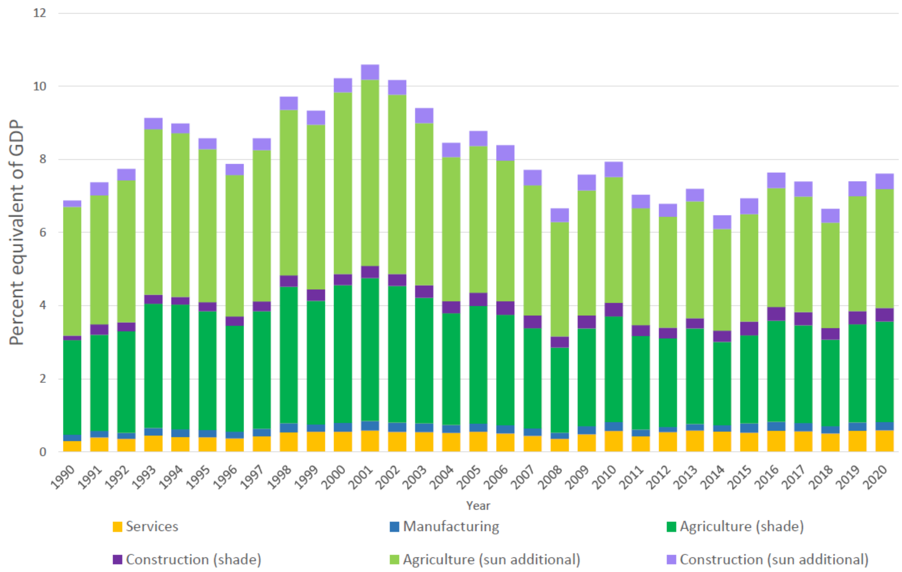

Figure 20 Average potential loss of earnings in the low Human Development Index country group as a result of potential labour loss due to heat exposure. Losses are presented as share of GDP, by sector of employment,. The agriculture and construction (sun additional) blocks represent the losses that would have been incurred in addition to those from agriculture and construction (shade) if all of the activities in these sectors had been carried out in direct sunlight.

Indicator 4.1.4: Costs of the Health Impacts of Air Pollution

Headline finding: equivalent to the annual income of 71.1 million and 99.1 million people, the greatest economic costs of mortality due to air pollution fall on countries in the medium and high Human Development Index country groups. Costs relative to GDP decreased between 2015 and 2019 globally, with the exception of costs in South-East Asia

As described in indicator 3.3, global mortality due to ambient $PM_{2.5}$ pollution has increased. This indicator captures the cost of this mortality by placing an economic value on the YLLs that result from exposure to anthropogenic ambient $PM_{2.5}$. This indicator has been expanded for the 2021 report, from a European-only focus to global coverage, and with a revised definition of YLLs. The methods, data and further analysis are described in full in the appendix (pp 152-154).

Figure 21 presents the economic value of YLLs in 2015 and 2019 by country HDI groups, relative to both total GDP and the annual income of the average person in these categories. The greatest relative costs fall on the medium and high HDI country groups, equivalent to the annual income of 74.6 million and 99.1 million people, respectively. Costs relative to average income increased between 2015 and 2019 in the low and medium HDI country groups. However, with rates of growth of GDP outpacing those of population, costs relative to total GDP have decreased in all HDI groups.

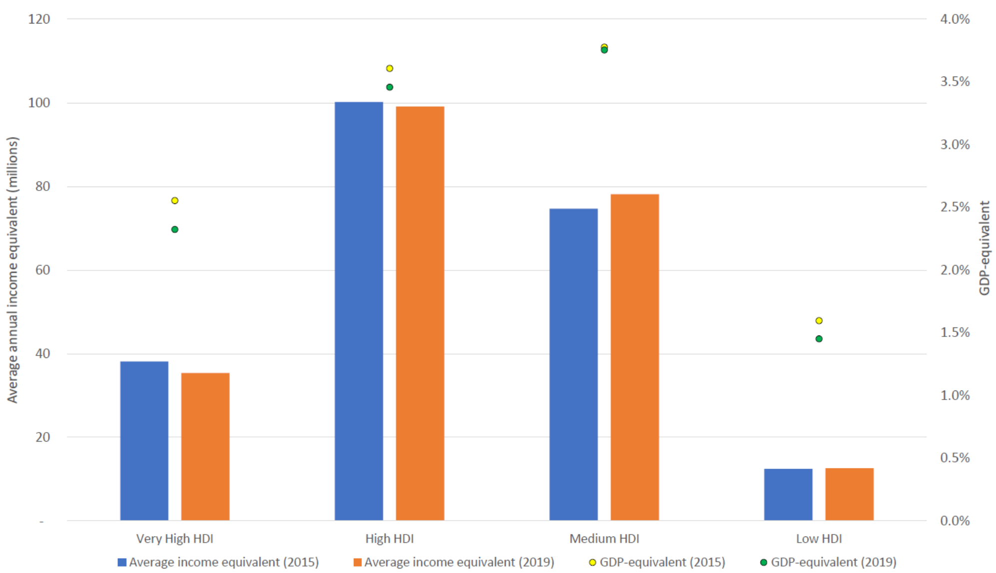

Figure 21. Economic cost of YLLs in 2015 and 2019, relative to the annual income of the average person and total GDP, by 2019 Human Development Index country group

4.2 The Economics of the Transition to Zero-Carbon Economies

Panel 4. Recovering from Covid-19: Stimulus Measures for a Sustainable Economy

The COVID-19 pandemic, and measures to tackle it, triggered a global recession of a depth only exceeded in the last 150 years by two World Wars and the Great Depression of the 1930s.[230] Governments with the fiscal capacity have responded with massive spending packages; by the end of 2020, the world's 50 largest economies had committed USD 14.6 trillion in fiscal measures (many times higher than the value of global stimulus measures following the 2008-09 financial crisis). Although 87% of this was designed to prevent an even deeper health and economic crisis (USD 12.7 trillion), rather than encourage recovery (USD 1.9 trillion),[231] as time goes by and further measures are announced, promoting recovery will come to the fore.

How these measures are designed and targeted will determine whether this spending entrenches existing technical, economic, and social structures and systems, or promotes those that are more sustainable, healthy, and equitable. Evidence from stimulus measures introduced following the 2008-09 financial crisis shows that 'green' stimulus measures often have advantages over 'brown' or 'colourless' measures.[222]

So far, the signs are not encouraging. Of the USD 1.9 trillion directed toward recovery by the end of 2020, just 18% is expected to reduce greenhouse gas emissions (or 2.5% of the value of all fiscal measures), while the overall impact on air pollution, and particularly on natural capital – through the expansion of road transport and defence services in particular – is likely to be negative. Positive measures are highly concentrated in just a few nations, particularly in Europe,[231] although measures announced so far in 2021 indicate some movement towards greater consideration of sustainability in other countries.[232,233] However, despite global CO_2 emissions dropping by a record 6% in 2020 overall, they have rebounded quickly, with global CO_2 emissions in December 2020 around 2% higher than in December 2019.[234] The urgency with which the trillions of dollars for stimulus measures yet to be announced must be oriented toward a green and healthy recovery is therefore great.

In May 2020, the WHO published six prescriptions for a healthy and green recovery: (1) Protect and preserve the source of human health: Nature; (2) Invest in essential services, from water and sanitation to clean energy and healthcare facilities; (3) Ensure a quick, healthy energy transition; (4) Promote healthy, sustainable food systems; (5) Build healthy, liveable cities; and (6) Stop using taxpayers money to fund pollution (particularly through fossil fuel subsidies).[235] If governments are serious about their commitments under the Paris Agreement and SDGs, they must take note of these priorities, plan ahead, and learn from both their own previous experience and from that generated elsewhere, to implement them using well-designed and context-appropriate policy. Where necessary, multilateral institutions, processes and instruments should be galvanised in support of a global recovery that is both sustainable and equitable.[231]

Indicator 4.2.1: Coal and Clean Energy Investment

Headline finding: global investment in energy supply and energy efficiency reduced 13% between 2019 and 2020. Investment in renewable energy and energy efficiency increased by 3%, but investment in new coal capacity reduced by 13%

Coal combustion has been responsible for over 30% of the global average temperature increase above pre-industrial levels and for 491,000 deaths from $PM_{2.5}$ exposure in 2019 (indicator 3.3).[236] Therefore, coal phase-out is essential for both mitigating climate change and for reducing premature mortality due to air pollution. At the same time, it is necessary to invest in renewables, energy efficiency, and the electricity grid in order to reduce the carbon intensity of energy supply, as described in indicator 3.1. Taking data from the IEA, this indicator tracks global investment in energy supply and energy efficiency, and highlights ongoing capital spending in new coal-fired power generation, globally and for key countries and regions. The data, presented as an index, represents ongoing capital spending.

Between 2019 and 2020 investment in global energy supply and energy efficiency reduced from nearly $2 trillion to around $1.7 trillion, almost entirely due to declining investment in fossil fuels, following reduced demand as a result of the pandemic (investment in coal power capacity declined by 13%). In parallel, investment in renewables and energy efficiency increased by 3%, with their share of total investment in global energy supply increasing from 33% to 39%. However, for a pathway consistent with 1.5°C of warming this century, annual investments in clean energy must at least triple over the 2020s.[237]

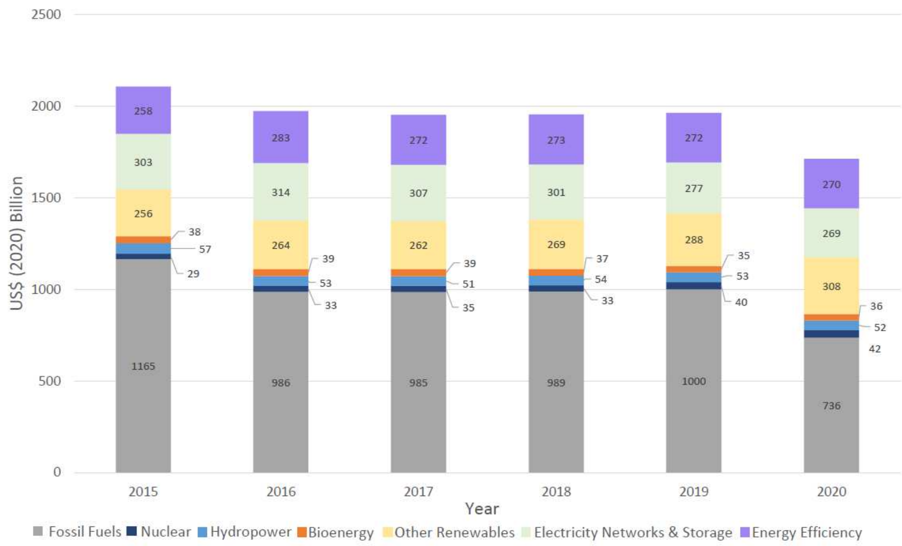

Figure 22. Economic value of annual investment in renewable and fossil fuel energy supply and energy efficiency, 2014-2020

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

Headline finding: direct employment in fossil fuel extraction declined by 14% from 13.1 million in 2019 to 12.7 million in 2020

Evidence suggests that employees in some fossil fuel extraction industries, particularly coal mining, and their local communities, suffer a greater incidence of cardiovascular and cerebrovascular disease, respiratory disease and cancers.[238] Investments in renewable energies and energy efficiency are estimated to create almost three times more jobs per unit of spend than those in fossil fuel industries.[239] Along with strong labour and environmental standards, investment and employment in renewables present an opportunity to improve health and livelihoods. This indicator tracks global direct employment in fossil fuel extraction industries and direct and indirect (supply chain) employment in renewable energy, with a full description available in the appendix (pp 158-159).

Around 11.5 million people globally were employed directly or indirectly by the renewable energy industry in 2019, representing an increase of 4.2% from 2018. At the time of writing data for 2020 was unavailable, although due to the pandemic, the extent to which such data will be indicative of a long-term trend is currently unclear. Fossil fuel extraction industries continue to employ more people globally than all renewable energy industries combined, although the number of jobs in 2019 are slightly lower than in 2018, at 12.7 million compared with 13.1 million.

While men are still overrepresented in the energy sector, the field of renewable energy employs a considerably higher share of women (32%) than the oil and gas industry (22%).[240] With adequate policies in place, the transition to a low carbon economy therefore represents an additional opportunity to reduce gender inequities and empower women.

With trillions of dollars earmarked for COVID-19 recovery, investments in the renewable fuel industry could offer a triple gain in terms of better health through safer jobs and improved livelihoods, climate change mitigation, and more employment opportunities.

Indicator 4.2.3: Funds Divested from Fossil Fuels

Headline finding: the global value of funds committing to fossil fuel divestment between 2008 and 2020 is US$14.52 trillion, with health institutions accounting for US$42 billion

By reducing financial interests in the fossil fuel industry, divestment both reduces the 'social licence to operate' of fossil fuel companies, and hedges against investors' risk of losses due to 'stranded assets' in an increasingly decarbonising world (panel 5).[241,242] Investors can also effect change through shareholder action, exemplified recently by activist hedge fund Engine No 1 taking seats on ExxonMobil's board.[243] Concerned with the immediate and long-term damages of continued fossil fuel use, health institutions have the imperative to lead the way in divesting, to ensure they 'first, do no harm'. This indicator tracks the total global value of funds divested from fossil fuels, and the value of funds divested by health institutions, using data provided by 350.org.[244]

From 2008 until the end of 2020, 1,398 organisations, with assets worth at least US$14.52 trillion, have committed to divestment. Of these, only 25 are health institutions, with assets totalling US$42 billion. The value of new funds committed to divesting in 2020 was US$2.5 trillion, with health institutions accounting for US$47 million of these.

Panel 5. Compatibility of fossil fuel company strategies with well below 2°C-consistent emissions trajectories

Globally, carbon dioxide (CO_2) from the combustion of fossil fuels represents 65% of total greenhouse gas emissions.[168] In the 2015 Paris Agreement, countries agreed to reduce their emissions to keep global warming to 'well below 2°C' with respect to pre-industrial levels. The carbon budget for a 66% probability of limiting global warming to 1.5°C has been estimated at 420 $GtCO_2$[14] However, the potential CO_2 emissions from reserves held by the 200 largest public fossil fuel companies is at least 1,541 $GtCO_2$, [245] whilst the carbon contained in global resources of fossil fuels is estimated at about 11,000 $GtCO_2$,[246] well beyond the maximum that can be used if the world is to meet the Paris Agreement goals. A third of oil reserves, half of gas reserves and over 80 per cent of coal reserves worldwide should remain unused to keep global warming below 2°C,[246] representing stranded assets and unburnable carbon.[233,247] Future energy system scenarios with strict carbon constraints, low fossil fuel demand, high capital costs projects and carbon-intensive reserves increase the risk of stranding assets,[248] with considerable financial consequences for their owners and industry stakeholders.[249]

Although the fossil fuel industry has begun to acknowledge that the energy system is transitioning away from unabated oil, gas and coal, countries' fossil fuel production plans to 2030 could exceed levels consistent with limiting warming to 2°C by 50%, and by 120% in relation to 1.5°C.[250] Companies are following diverging business strategies,[251] with most of them falling short of what is required to mitigate transition risks. While an increasing number of oil and gas companies are announcing net-zero commitments, for these to be consistent with climate ambitions they must be framed on the basis of their total emissions rather than on their emission intensities, cover scope 1, 2 and 3 emissions, and account for activities based on a company's full equity share.[62,252] Those companies who better understand systemic risks, stress-test potential scenarios, and develop business strategies with interim targets and investments that align adequately with well below 2°C targets (and preferably 1.5°C) are likely to become more resilient over the coming years, as climate-risk scrutiny from investors and financial regulators increases.

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

Headline finding: 77% of the 84 countries reviewed had a net-negative carbon price in 2018. The resulting net loss of revenue was in many cases equivalent to substantial proportions of the national health budget

Placing a carbon price on fossil fuel use helps to reflect more accurately its negative externalities, including its impact on health, and to encourage the transition away from fossil fuels. However, not all countries set carbon prices, and where they are imposed, they can be undermined by subsidies provided for fossil fuels.

This indicator compares carbon prices and fossil fuel subsidies to calculate 'net' economy-wide average carbon prices and revenues. It covers 84 countries, which are responsible for around 92% of global CO_2 emissions. The indicator is based on data from the IEA,[253] OECD,[254] the World Bank,[255] and the WHO, with methods and further analysis in the appendix (pp 162-165).[256]

In 2018, 65 out of the 84 countries analysed (77%) had net-negative carbon prices, reflecting an overall subsidising of fossil fuels. The median value of the subsidy in these countries was US$1 billion, with some countries providing net subsidies to fossil fuels in the tens of billions of dollars each year. 42 countries had a carbon pricing mechanism in place, but only 19 succeeded in discouraging fossil fuels with net-positive carbon prices – all of which were very high HDI countries. Nonetheless, most very high HDI countries still had net-negative carbon prices (Figure 23). These net subsidies are equivalent to substantial proportions of national health spending in many countries.

With low-income populations vulnerable to energy costs, removing subsidies can be a challenge, but redirecting spending from fossil subsidy to healthcare and health-related services would most likely deliver net benefits to their wellbeing.[257] Furthermore, international financing mechanisms to support low-income countries in their transition to sustainable energy sources are essential to safeguard all dimensions of human health.[258]

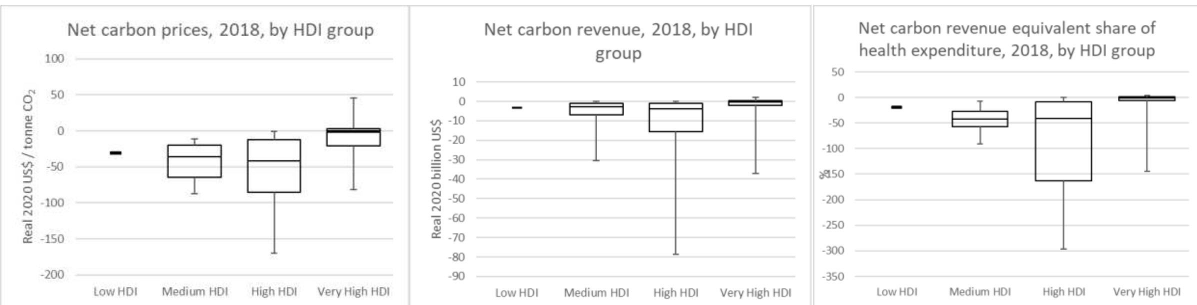

Figure 23. Net carbon prices (left), net carbon revenues (centre), and net carbon revenue as a share of current national health expenditure (right), across 84 countries in 2018, arranged by 2019 Human Development Index country group: low (n=1), medium (n=7), high (n=23) and very high (n=53). Boxes show 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 Attribution of CO_2 and $PM_{2.5}$ Emissions

Headline finding: in 2019, 18% of CO_2 and 17% of $PM_{2.5}$ global emissions were embodied in trades between countries of different Human Development Index levels

The production of goods and services often drives both greenhouse gas and $PM_{2.5}$ emissions, thus contributing to impacts on health and wellbeing. Emissions from local production ('production-based emissions') occur within the geographical territories of nations through the local production of goods and services. An alternative way of accounting for the burden of pollution is to assign the emissions to the country which is the final consumer of the products that are made – known as 'consumption-based emissions'. A comparison of production- and consumption-based emissions gives a better understanding of how emissions are embodied in global trade, which is essential to enable better international policy formulation that protects human health in all geographies.

This indicator captures the pollution burden from a country's local production, as well as that driven by a nation's domestic final consumption, including the burden embedded in its imports. It uses an EE-MRIO model and the EXIOBASE database, to estimate CO_2 emissions,[259,260] and the GAINS model to produce a $PM_{2.5}$ emission inventory.[261] More details on the methodology, and further analysis, can be found in the appendix (pp 166-172).

In 2019, 18% of CO_2 (of 35.6 Gt world total) and 17% of $PM_{2.5}$ (of 37.4 Mt world total) global emissions were embodied in trades among countries of different HDI levels. The largest contributors to global consumption-based CO_2 and $PM_{2.5}$ emissions were China (28 % and 18%), the USA (17% and 5%), the EU (10% and 6%), and India (7 % and 16%). The USA did the most 'outsourcing' of emissions, with 21% CO_2 (of 5.9 Gt total) and 49% $PM_{2.5}$ (of 1.7 Mt total) emissions resulting from the production of goods it consumed, actually occurring in other countries. In contrast, 16% of CO_2 (of 10.8 Gt total) and 13% of $PM_{2.5}$ (of 6.8 Mt total) emissions that occurred in China resulted from the local production of goods that were ultimately exported to consumers in other countries.

The very high HDI country group contributed the most production-based (45%) and consumption-based (49%) CO_2 emissions in 2019. However, the high HDI country group was the biggest contributor to both production-based (38%) and consumption-based (35%) $PM_{2.5}$ emissions (Figure 24), with the very high HDI country group the lowest emitter of $PM_{2.5}$, partly as a result of stricter local air pollution regulations. Importantly, the very high HDI country group was the only group with higher consumption-based emissions than production-based emissions, i.e. a net 'outsourcing' in terms of their consumption-related emissions.

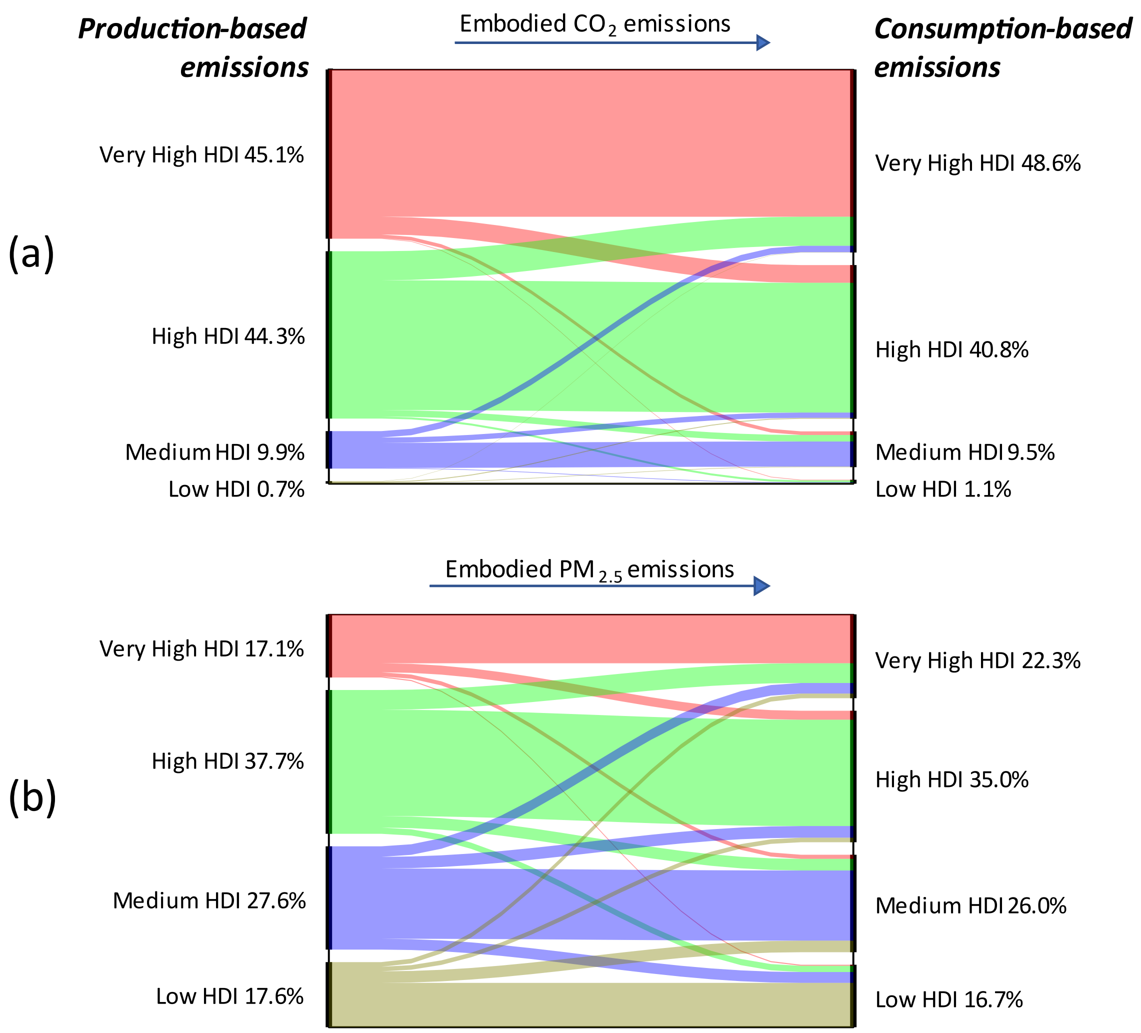

Figure 24. The flows of embodied CO_2 and $PM_{2.5}$ emissions among different Human Development Index country groups in 2019

Conclusion

The impacts of climate change on health are already having significant economic consequences and fall in different ways across countries of all levels of HDI. The economic losses of climate-related extreme events are three times higher in medium HDI countries than in very high HDI countries. However, the monetised value of global heat-related deaths is highest in Europe, and the greatest costs of premature mortality due to air pollution fall in countries with medium and high HDI levels. South-East Asia was the only region with increasing air pollution mortality costs between 2015 and 2019, relative to GDP. Extreme heat can create economic impacts by reducing labour capacity. In this case, those employed in low-wage, outdoor work in low HDI countries are likely to be most affected.

Because of the potentially large and unequally distributed impacts of climate change on human health, incomes and wellbeing, substantial and sustained investment in the low carbon transition is required. Overall, global investments in coal power continue to decline, although with worrying counter-trends in certain countries. Investments in renewables and energy efficiency continue to grow, as do divestments from fossil fuel assets, however a considerable increase in the pace of change is required.

Both governments and the private sector have crucial roles to play in bringing about the required transition. Governments across all HDI groups must address fossil fuels subsidies in countries. Although withdrawing energy subsidies is challenging when it affects people on low incomes, other forms of government spending, including on health services, can provide better and more targeted support to decrease inequities and maximise wellbeing. The global trade system means that almost a fifth of CO_2 and $PM_{2.5}$ emissions occur in the production of goods that are subsequently traded between countries of different HDI levels. This underlines the importance of inclusive global agreements that facilitate cooperation on policies for the reduction of both production and consumption emissions.

As governments begin to invest in recovery from COVID-19, there is a crucial window of opportunity to reduce fossil fuel subsidies, invest more in clean energy, and support a green recovery. Policies and regulations must be developed that subject fossil fuel companies to greater scrutiny and ensure their alignment with a world well below 2°C.

Section 5: Public and Political Engagement

As the preceding sections make clear, climate change is damaging people's health and widening the fault lines of inequality, with the human costs amplified by COVID-19.[28,262,263] Those least responsible for climate change are most exposed to impacts that are 'hitting harder and sooner' than climate assessments indicated even a decade ago.[264] Action at the speed and scale needed to meet the ambitions of the Paris Agreement requires public and political engagement, particularly in industrialised countries where 'the major part of emissions originate'.[265] This section tracks engagement in health and climate change in the media as well as by individuals, scientists, governments and the corporate sector.

The mainstream media is a major platform for public engagement. It remains the most widely-used source of information,[266] shaping public perceptions[267-269] and influencing the social media agenda.[270] Indicator 5.1 tracks coverage of health and climate change in 67 newspapers from 37 countries, including the *People's Daily* (*Renmin Ribao)*, China's longest-running national newspaper and the official outlet of government.[271,272] The indicator also includes a content analysis of coverage in India and the USA, focusing on 'prestige' newspapers with influence on the countries' political and economic elites.[273-275]

Individual engagement (indicator 5.2) is tracked through individuals' searches on Wikipedia, the online information source with wider reach and coverage than traditional encyclopaedias.[276-278] The third indicator (Indicator 5.3) tracks engagement in peer-reviewed journals, the primary source of scientific evidence for the media, government, and the public.[279]

Government engagement (indicator 5.4) is tracked by statements made by national leaders at the UN General Assembly, the policy-making body of the UN. The annual meeting opens with the General Debate where heads of government, or their high-ranking representatives, address the global community on issues they consider important.[280,281] Indicator 5.4 also considers engagement with health in the enhanced NDCs, submitted in compliance with the 2015 Paris Agreement.[282-284] Panel 6 compares health engagement in the initial and enhanced set of NDCs held on the UNFCCC NDC registry on 1 April 2021.

Action by the corporate sector will be decisive in moving societies away from dependence on fossil fuels.[285-287] Indicator 5.5 tracks engagement in health and climate change by companies within the UN Global Compact, the world's biggest corporate sustainability initiative.[288,289] Companies commit to shared principles of sustainable behaviour and submit annual reports on progress.

With increasing acknowledgement of the need to recognise and investigate gender inequities in the representation, communication, and governance of climate change,[290-293] engagement with gender is incorporated where appropriate. Engagement with health, climate change and

COVID-19, and analyses by WHO region and HDI country group are also included. Details of data sources and methods for all indicators are provided in the appendix, along with additional analyses.

Indicator 5.1 Media Coverage of Health and Climate Change

Headline finding: in 2020, the upward trend in coverage of health and climate change continued, but failed to match the increase seen in 2019. In 2020, most of the coverage of health and climate change referred to COVID-19

Newspapers provide an important forum for public engagement. They shape public understanding of climate change, both through their influence on their readers and on the wider political agenda.[268,294] This indicator tracks coverage of health and climate change from 2007, the year before the WHO World Health Assembly made a multilateral commitment to protect people's health from climate change.[295] The indicator includes 66 newspapers spanning 36 countries and four languages, together with an additional analysis of China's People's Daily. The indicator also examines the content of 2020 coverage in newspapers in India and the USA. Methods and further analysis are provided in the appendix (pp 172-195)

Across the 36 countries, the upward trend in newspaper coverage of health and climate change continued, reaching 11,371 articles in 2020. However, the rate of increase was lower than that of 2019 – 6% from 2019 to 2020, compared with 96% from 2018 to 2019. As in 2019, coverage was greatest in the WHO America and Europe regions and lowest in the African region.

Engagement with gender and with COVID-19 was examined in English language newspapers across 23 countries. While the proportion of articles referring to gender increased between 2007 and 2020 (from 97 (2%) of 6,044 articles to 573 (6%) of 10,092), gender remains marginal to the representation of health and climate change in the mainstream press. In 2020, over 60% (6,238) of the 11,371 articles referring to health and climate change also referred to COVID-19; in April and May 2020, it was over 80%.

In China's *People's Daily*, the limited coverage of health and climate change noted in earlier *Lancet* Countdown reports was again evident in 2020. Of the 1,106 articles discussing climate change, 2% were related to human health. Across the 2008-2020 period, no articles related to health and climate change engaged with gender issues. In 2020, no articles discussed the relationships between climate change and COVID-19, or how they together influenced health.

Analysis of the content of coverage of health and climate change focuses on India (medium HDI) and the USA (very high HDI). The selected newspapers, the *Times of India* and *Hindustan Times* along with the *New York Times* and *Washington Post*, form part of the 'prestige' press, seen to exercise influence on political and economic elites and on the wider policy agenda.[275,296]

One set of themes related to the health impacts of climate-related hazards, including heatwaves and wildfires. For example, the *New York Times* (18 June), noted that “people with health issues, older people and young children are especially susceptible to the effects of extreme heat [and…] it’s a threat that grows as climate change continues”.[297] Another set of themes related to the spread of infectious disease, including COVID-19. For example, the *Hindustan Times* (25 February) reported that “climate change may revert back successes of controlling infectious diseases” with “consensus among scientists that there has been a rise in zoonotic diseases - Nipah, Ebola, Zika, Corona viruses - in recent decades … driven by biodiversity loss and climate change”.[298] As this last comment indicates, climate change and environmental change are often linked together; scientific reports (including the *Lancet* Countdown reports) are cited as evidence that “we are close to running out of time — approaching a point of no return for human health, which depends on planetary health” (*New York Times*, 28 April).[299]

Indicator 5.2: Individual Engagement in Health and Climate Change

Headline finding: individual information-seeking about health and climate change decreased overall by 15% from 2019 to 2020; spikes in engagement in mid-2020 were almost exclusively due to interest in pandemic-related content

Individual engagement in climate change and health is tracked through the digital footprint of users of the online encyclopaedia, Wikipedia. Wikipedia has outpaced traditional encyclopaedias in terms of reach, coverage, and comprehensiveness and is one of the most-visited websites worldwide.[276,300,301] The analysis is based on the English-language Wikipedia which represents around 50% of global traffic to all Wikipedia language editions.[302,303]

The indicator focuses on ‘clickstream’ activity, where an individual clicks between an article on health and climate change (or vice versa). Because clickstream activity captures only pairs of sequential visits, for the 2021 report, the set of articles was extended to include a wider range of health and climate change articles. In 2020, as in previous years, individuals seldom moved between health and climate change; instead, co-click activity was predominantly within the set of articles on health or climate change.

Figure 25 tracks co-click activity from 2018 to 2020, looking separately at the volume generated by clicks on a climate-related link in a health-related page, vice versa, and the sum of both. Overall numbers are very low, confirming that engagement in either climate change or health rarely triggers engagement in the other topic. Further, the volume of health-climate co-views fell in 2020 by 15%, reversing the upward trend evident in 2019. When co-clicks to an article relating to COVID-19 are excluded, the downward trend in 2020 becomes even more pronounced. The spike in co-clicks in mid-2020 was almost exclusively due to interest in pandemic-related content, which then sparked interest in climate change, whereas the rise over September/October was generated by an initial interest in climate change.

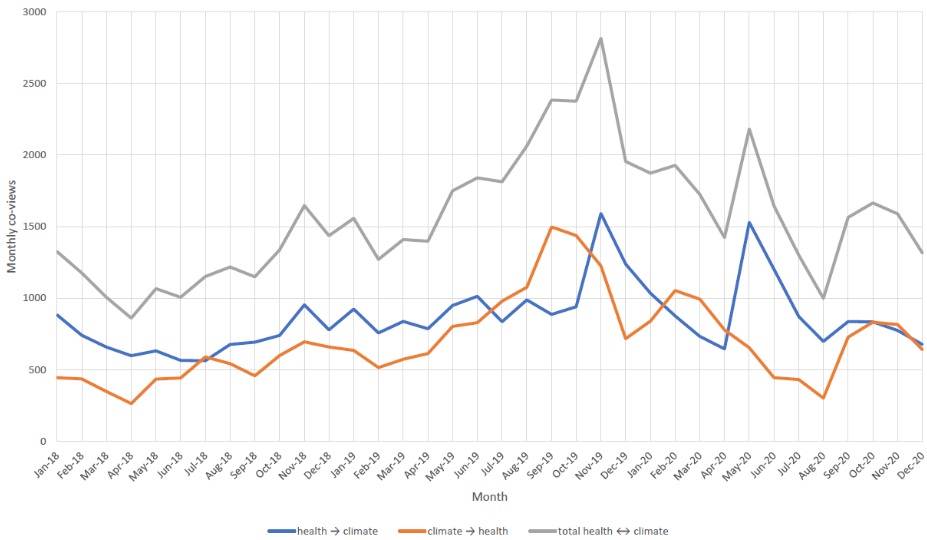

Figure 25. Aggregate monthly co-clicks on Wikipedia articles related to human health and climate change, 2018—2020. Blue: co-click from health-related page to climate-related page. Orange: co-click from climate-related page to health-related page. Grey: sum of all health and climate co-click activity.

Indicator 5.3: Coverage of Health and Climate Change in Scientific Journals

Headline finding: original research on health and climate change increased eleven-fold between 2007 and 2020, driven primarily by scientists in countries of the highest Human Development Index levels. Gender remained marginal to research on health and climate change across the period. In 2020, 7% of health and climate change articles referred to COVID-19

Scientific evidence is a key resource for the media, individuals and governments, and is playing a critical role shaping public and political engagement in health and climate change.[278,304] The indicator is based on searches in OVID Medline and OVID Embase, using references to health and climate change in article titles and abstracts, with methods and further analyses provided in the appendix (pp 218-231).

The upward trend in scientific engagement in health and climate change noted in previous *Lancet* Countdown reports has been maintained, with the number of articles on health and climate change increasing by 28% between 2019 and 2020, to reach its highest recorded level of 858 articles. The trend is driven by the rapid increase in original research (primary studies and systematic reviews), which increased by 32% between 2019 and 2020. Research-related articles (e.g. evidence reviews, editorials, letters) also increased, but at a lower rate.

Increasing scientific engagement in health and climate change is driven by very high HDI countries (Figure 26); 76% of the total output in 2020 was led by researchers in this group. In contrast, scientists in low HDI countries were lead authors of just 1% of journal articles.

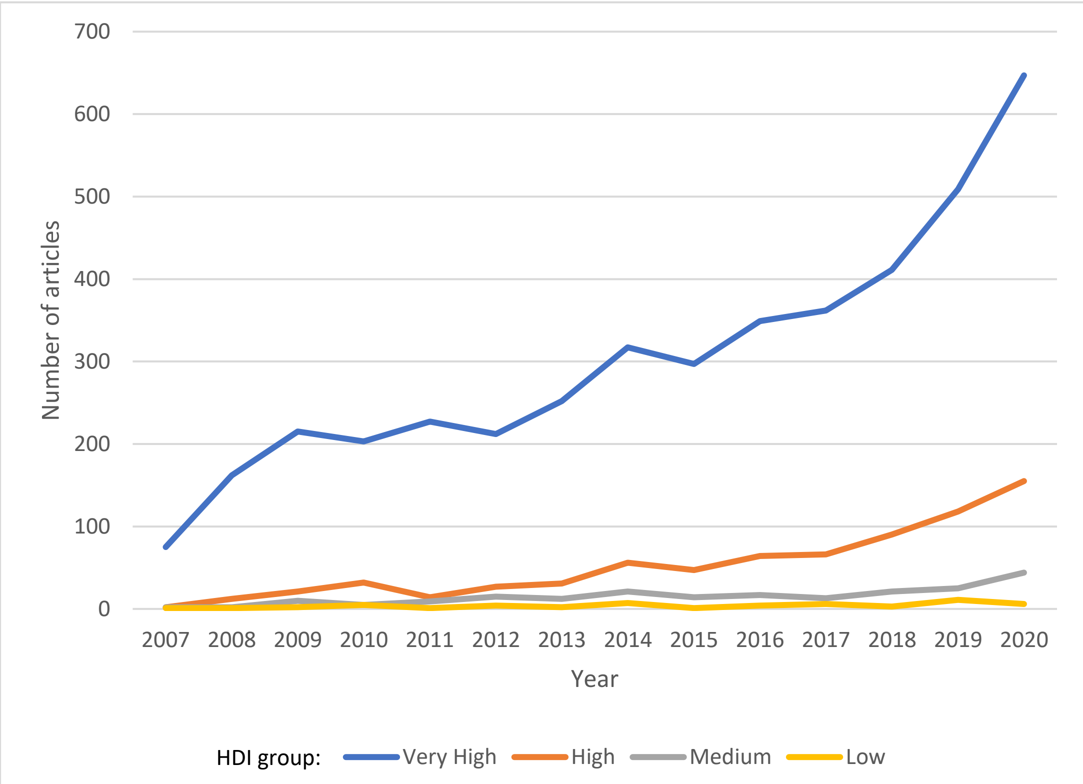

Figure 26. Scientific journal articles relating to health and climate change, 2007-2020, by 2019 country Human Development Index country group

In 2007/08, under 2% of health and climate change articles engaged with gender in some way; in 2020, the proportion was 6%. Similarly, 2020, only 7% of the articles on heath and climate change addressed COVID-19, suggesting this rise in scientific research in health and climate change is independent of the concurrent global health crisis. Articles engaging with gender and with COVID-19 were predominantly led by scientists in the very high HDI countries.

Indicator 5.4: Government Engagement in Health and Climate Change

Headline finding: in 2020, 47% of government leaders engaged with the health dimensions of climate change in their statements at the UN General Debate, more than double the proportion in 2019. The increase was linked to engagement with the COVID-19 pandemic

Government leadership, backed by strong near-term policies, is required if the increase in global temperature is to be halted.[168] This indicator examines government engagement with health and climate change in the UN General Debate (UNGD). Engagement with health in commitments to emissions reduction made by governments under the 2015 Paris Agreement is also considered in panel 6.

The UNGD opens each new session of the UN General Assembly. It provides all UN member states with an opportunity to address the global community on priorities for action. Among many global challenges, including economic recession and social conflict, the indicator captures whether government leaders draw attention to health and climate change. Analysis is based on the application of a key word search in the United Nations General Debate corpus using natural language processing,[305,306] with 8,288 statements analysed across 1970-2020.

Figure 27 tracks the proportion of countries referring to health and climate change in their UNGD statements between 1970 and 2020. In 2020, the proportion of countries engaging with the health dimensions of climate change reached the highest recorded level, increasing from 22% (43 countries) in 2019 to 47% (91 countries) in 2020. Additionally, and for the first time in the UNGD, every member state referred to health in their 2020 address – a reflection of the ongoing global pandemic.

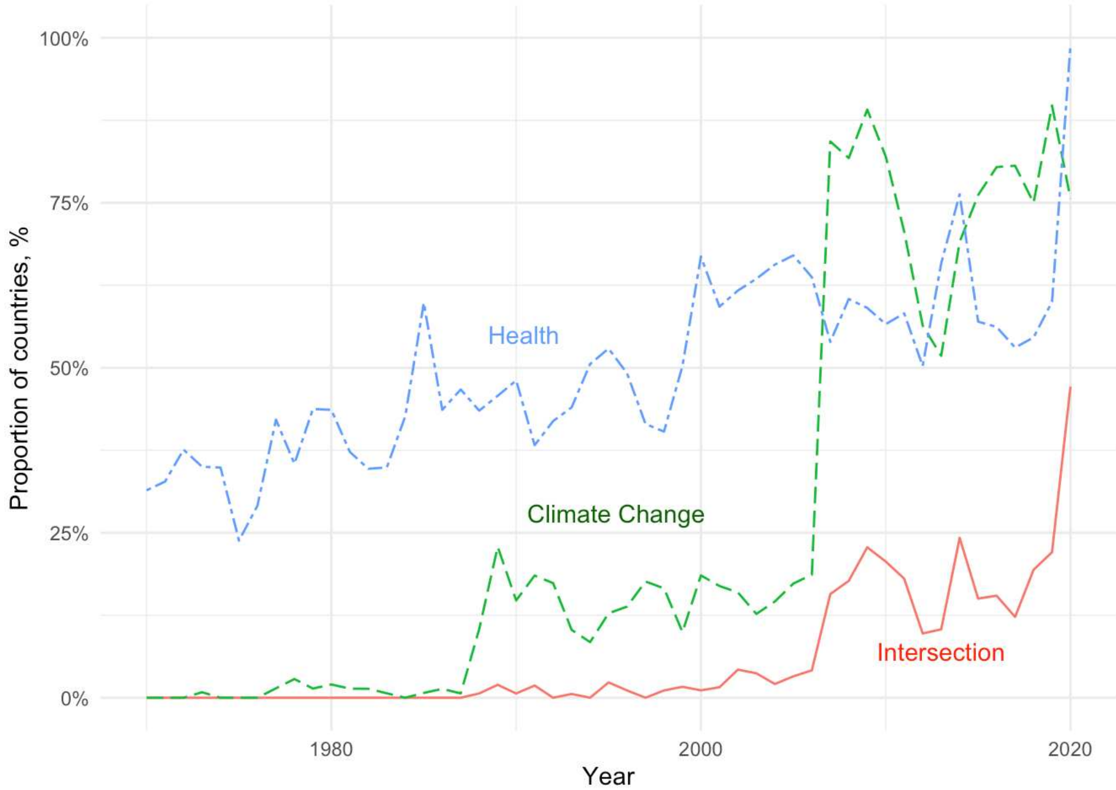

Figure 27. Proportion of countries referring to climate change, health, and the intersection between the two in their UNGD statements, 1970-2020

Increased engagement in health and climate change is linked to discussion of the COVID-19 pandemic, represented by government leaders as both a threat and an opportunity. The pandemic highlights "the vulnerabilities of our societies [to]…global disasters…lurking just around the corner… [like] climate change" (Austria). It also presents an opportunity to tackle the climate crisis: "our recovery from this pandemic must mark a transition to a decarbonized, climate-resilient economic system" (Fiji).

Engagement in health and climate change continues to be led by countries in the low HDI group and, in particular, by the SIDS.[283,284] For the SIDS, COVID-19 has amplified the risks of climate change: "our unique circumstances and consequent vulnerabilities have left us exposed to the ravages of the twin crises of the pandemic and climate change" (St Lucia). In 2020, 75% of the SIDS discussed health and climate change in the 2020 UNGD. However, 2020 also saw greater engagement among higher-income countries. A key issue is whether this pandemic-related increase in engagement among richer countries will be maintained in future years.

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Panel 6: The place of health in the enhanced NDCs

The 2015 Paris Agreement is the only global framework for reducing greenhouse gas emissions to protect people's health.[307] Countries committed to emissions reductions via Nationally Determined Contributions (NDCs), to be enhanced every five years. In 2015/16, 185 countries, including an EU submission for 27 countries, submitted initial NDCs. By July 2021, 87 countries, including an EU submission for 26 countries, had submitted enhanced or new NDCs.[308]

Compared with their initial NDCs, the proportion of countries referring to health increased, from 56% (49) to 91% (79). However, health engagement remained low. Overall, in both initial and enhanced NDCs, under 3% of the text related to health; in the enhanced NDCs, this represented an average of 240 of 10466 words. Of the references to health, 30% (249 references) noted health impacts, challenges or risks; for example, "the Kenyan economy is dependent on climate-sensitive sectors, such as rain-fed agriculture, water, energy, tourism, wildlife, and health, whose vulnerability is increased by climate change" (Kenya, updated submission). A further 25% (210) related to health sector adaptation; for example, climate change "threatens the ability of health institutions and organizations to maintain and improve health services into the future" (Marshall Islands, second submission).

The enhanced NDCs demonstrate an increased engagement with gender, health, and climate change with 9 (10%) NDCs making a meaningful connection compared with just 2 (2%) in their initial contributions. The majority of these are references to the specific impact of climate change on women; for example, "further strain on the workload of women and climate change related stress during pregnancy could contribute to low birth weight, leading to increases in risks of undernutrition and non-communicable diseases" (Cambodia, updated submission).

In summary, while health engagement remains low, there is greater recognition that climate change takes a disproportionate toll on women.

Indicator 5.5: Corporate Sector Engagement in Health and Climate change

Headline finding: in 2020, engagement in health and climate change increased to its highest level among companies in the UN Global Compact. Over a third (38%) of companies referred to the health dimensions of climate change in their 2020 progress reports

The indicator tracks engagement in health and climate change among companies signed up to the UN Global Compact, established to promote corporate social and environmental responsibility,[288] although its effectiveness has been critiqued, with the suggestion that membership could be a form of 'greenwashing' and 'bluewashing' for some companies.[309] The Compact represents over 12,000 companies from 160 countries, with each submitting an annual Communication on Progress (GCCOP) against a set of social and environmental principles.

The indicator is based on the application of a key word search in the text corpus of 17,984 GCCOP reports submitted in English between 2011 and 2020.[288] In the 2019 and 2020 *Lancet* Countdown reports, the focus was on the healthcare sector. This report considers corporate engagement across all sectors.

Figure 28 tracks engagement in health and climate change in annual GCCOP reports from 2011 to 2020. As it indicates, the large majority of reports refer to health (84% of 2029 reports in 2020) and climate change (75%) as separate topics. In contrast, only a minority made reference to the health dimensions of climate change (38% in 2020). However, it represents a large increase from 2014, the low point of engagement, when only 21% of corporations made reference to the intersection between climate change and health. Three sectors stand out for their high levels of engagement in health and climate change: food and drug retailers, oil and gas producers, and alternative energy. In 2020, over 70% of corporations in these sectors made reference to health and climate change; in the healthcare sector, the proportion was only 37%.

Additional analyses examined references to gender in the GCCOP reports engaging with health and climate change. Only a minority additionally referred to gender. However, the proportion increased from 2014 to 2019, with a particularly sharp rise (to 19%) in the 2019 report. In 2020, gender engagement fell to 13% (see appendix pp 249-264).

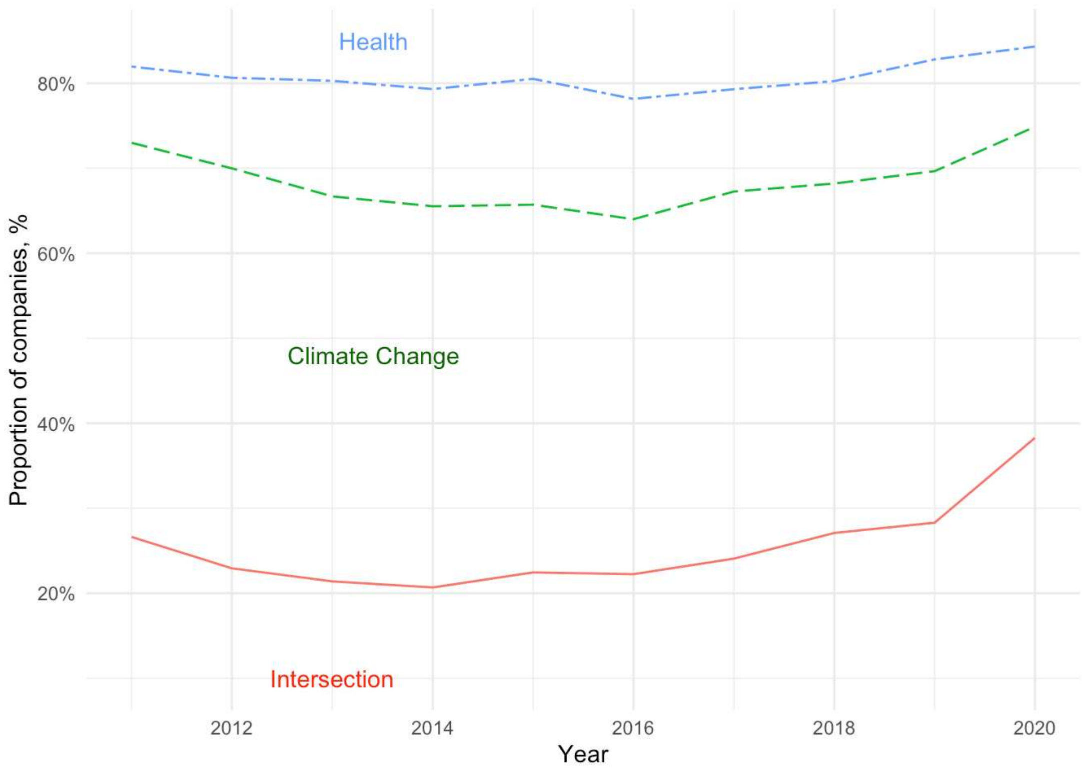

Figure 28. Proportion of companies referring to climate change, health, and the intersection of health and climate change in their UN Global Compact Communication on Progress (GCCOP) reports, 2011-2020.

Conclusion

Public and political engagement is essential if the ambitions of the Paris Agreement are to be realised.[168] Section 5 has focused on five areas of engagement: the media, the public, the scientific community, national government and the corporate sector. Three conclusions can be drawn.

Firstly, health and climate change are increasingly addressed together. The trend is particularly pronounced for indicators relating to the media, science, government and the corporate sector. In all these areas, engagement with health and climate change reached its highest recorded level in 2020. Gender is rarely integrated into engagement within the health-climate change nexus, although there is increased recognition in countries' enhanced NDCs.

Secondly, the COVID-19 pandemic appears to be a major driver of engagement in 2020. For example, over half of newspaper coverage of health and climate change was linked to COVID-19 and individual engagement in health and climate change was largely sustained by searches for articles related to COVID-19. Government engagement in the health dimensions of climate change was similarly underpinned by engagement in the pandemic. It remains to be seen if the heightened engagement in health and climate change will be maintained if and when the pandemic-related crises are contained.

Thirdly, social inequities remain deeply etched into public and political engagement. In the media and in science, coverage of health and climate change engagement is greatest in the very high HDI countries, the group exerting the greatest pressure on the planet but relatively protected from the health impacts of climate change. Meanwhile, medium and low HDI countries have much smaller carbon and environmental footprints – yet, are shouldering the immediate burden of climate change, and are far less represented in the scientific literature. As in previous years, the SIDS are leading global engagement with the health impacts of climate change at the UN General Debate. What is required is for their leadership to be matched by a decisive break with 'business as usual' by countries and communities contributing most to climate change.

Conclusion: the 2021 Report of the *Lancet* Countdown

The 2021 report of the *Lancet* Countdown finds a world overwhelmed by an ongoing global health crisis, while it has made little progress to protect its population from the simultaneously aggravated health impacts of climate change. The inequities of these impacts and the response, including those of gender, are brought into sharp focus within each of the indicators presented. This exposes the urgent need for collection of standardised data to capture inequities and vulnerabilities (panel 2).

Climate-sensitive infectious diseases are of increasing global concern and the environmental suitability for the transmission of all infectious diseases tracked is rising (indicator 1.3.1). For non-cholerae *Vibrio* bacteria, the environmental suitability for transmission in northern latitudes increased by 56% since the 1980s. The number of months suitable for malaria transmission has increased by 39% in highland areas of the low HDI country group and, over the past 5 years, the environmental suitability for the transmission of emerging arboviruses – dengue, chikungunya and Zika –was between 7% and 13% higher than in the 1950s.

The high temperatures in 2020, a year that tied with 2016 as the hottest year on record, resulted in extreme heat-related health impacts, affecting the emotional and physical wellbeing of populations around the world (indicators 1.1.1-1.1.6). These higher temperatures and altered weather patterns are also leading to more frequent extreme weather events and increased wildfire exposure (indicators 1.2.1, 1.2.2 and 1.2.3), and are putting years of progress on food and water security at risk in many parts of the world. The five years with the greatest area of the world's surface affected by droughts have all occurred since 2015 (indicator 1.2.2), the yield potential of all major staple crops continues to fall as a result of the rising temperatures (indicator 1.4.1), and 79% of all potential work hours lost to extreme heat in low HDI countries occurred in the agricultural sector in 2020 (indicator 1.1.4).

However, measures to curb emissions have been grossly inadequate. Emissions are declining too slowly or heading in the wrong direction in the highest emitting sectors (indicators 3.1, 3.4 and 3.5.1). This delay in progress is contributing to millions of deaths each year due to exposure to indoor and ambient $PM_{2.5}$ pollution, and due to high-carbon, unhealthy diets (indicators 3.2, 3.3 and 3.5.2). Importantly, these impacts manifest differently between HDI country groups and genders, underscoring profound inequities.

Despite years of scientific reporting on climate change impacts, efforts to build resilience have been slow and unequal, with countries of low levels of Human Development Index the least prepared to respond to the changing health profile of climate change, and funding remaining a consistent challenge (indicators 2.1.1, 2.3.1, and 2.4). At the same time, 65 out of 84 countries reviewed continue to provide subsidies for fossil fuels that outweigh any revenue received from carbon pricing instruments. The resulting 'net carbon subsidy' is in many cases equivalent to substantial proportions of countries' national health budgets (indicator 4.2.4).

Governments with the fiscal capacity have responded to the COVID-19 pandemic with massive spending packages, to cushion the impacts of the crisis and start to bring about economic recovery. But as the world approaches COP26, the response to climate change, and commensurate investment, remains inadequate. The opportunity for the green recovery is in danger of being missed. A fossil-fuel driven recovery, whilst potentially meeting narrow and near-term economic targets, could push the world irrevocably off course for the ambitions of the Paris Agreement, with enormous costs to human health.

With government leaders more engaged with the health dimensions of climate change than ever before (indicator 5.4), countries across the globe must pursue low carbon economic recovery pathways, implementing policies that reduce inequities and improve human health. The *Lancet* Countdown indicators show the evidence to support the urgency and opportunity of this transition, and that none of us is safe until everyone is safe.

Contributors

The Lancet Countdown and the work for this paper was conducted by five working groups, which were responsible for the design, drafting, and review of their individual indicators and sections. All authors contributed to the overall paper structure and concepts, and provided input and expertise to the relevant sections.

ER, CDN, NA, SA-K, JC, LC, SD, LEE, SHG, IK, TK, DK, BL, JKWL, YL, ZL, RL, JM-U, CM, KMi, MM-L, KAM, NO, MO, FO, MRa, JCS, LS, MT, JTr, BV, and MY contributed to Working Group 1. KLE, MN, LJ, DC-L, RD, LG, DG, CH, JH, MPJ, PLK, MM, KMo, TN, MOS, JR, and JS-G contributed to Working Group 2. TO, IH, HK, KB, CD, MD, PD-S, ME, SH, S-CH, GK, ML, NM, JM, DP, JS, MS, JTa, PW, and MW contributed to Working Group 3. PE, PD, NH, BSR, WC, KH, ZM, FW, and SZ contributed to Working Group 4. HG, PL, WC, SC, ND, SJ, LM, SM, and OP contributed to Working Group 5. AC, HM, PG, IH, MRo, AM and RS provided coordination, strategic direction, and editorial support.

Declaration of interest

We declare no competing interests.

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