The 2018 Report of The Lancet Countdown on Health and Climate Change

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List of Abbreviations

A&RCC – Adaptation & Resilience to Climate Change
CO_2 – Carbon Dioxide
COP – Conference of the Parties
CPs – Communication of Progress Reports
DIMAQ – Data Integration Model for Air Quality
ECMWF – European Centre for Medium-Range Weather Forecasts
EJ – Exajoule
EM-DAT – Emergency Events Database
ERA – European Research Area
ETS – Emissions Trading System
EU – European Union
EU28 – 28 European Union Member States
FAO – Food and Agriculture Organization of the United Nations
FAZ – Frankfurter Allgemeine Zeitung
GBD – Global Burden of Disease
GDP – Gross Domestic Product
GHG – Greenhouse Gas
GW – Gigawatt
H-NAP – National Adaptation Plan for Health
IEA – International Energy Agency
IHR – International Health Regulations
IPCC - Intergovernmental Panel on Climate Change
IRENA - International Renewable Energy Agency
ISIMIP – Inter-Sectoral Impact Model Intercomparison Project
LMICs – Low- and Middle-Income Countries
MDGs – Millennium Development Goals
NAP – National Adaptation Plan
NHS- National Health Service
OECD – Organization for Economic Cooperation and Development
$PM_{2.5}$ – Fine Particulate Matter
PV – Photovoltaic
SDG – Sustainable Development Goal
SHUE – Sustainable Healthy Urban Environments
SIDs – Small Island Developing States
SPI – Standard Precipitation Index
SST – Sea Surface Temperature
tCO_2 – Tons of Carbon Dioxide
tCO2/TJ – Total Carbon Dioxide per Terajoule
TJ – Terajoule
TPES – Total Primary Energy Supply
TWh – Terawatt Hours
UN – United Nations
UNFCCC – United Nations Framework Convention on Climate Change
UNGA – United Nations General Assembly
UNGD – United Nations General Debate
UNGC – United Nations Global Compact
USD – United States Dollars
WBGT – Wet Bulb Globe Temperature
WHO – World Health Organization
WMO – World Meteorological Organization

Executive Summary

The Lancet Countdown: Tracking Progress on Health and Climate Change was established to provide an independent, global monitoring system dedicated to tracking the health dimensions of the impacts of, and the response to climate change. It tracks 41 indicators across five domains: climate change impacts, exposures, and vulnerability; adaptation planning and resilience for health; mitigation actions and health co-benefits; economics and finance; and public and political engagement.

This report is the product of a collaboration of 27 leading academic institutions, and United Nations and intergovernmental agencies from every continent. It draws on world-class expertise from climate scientists, ecologists, mathematicians, geographers, engineers, energy, food, livestock and transport experts, economists, social and political scientists, public health professionals, and doctors.

The Lancet Countdown's work builds on decades of research in this field, and was first proposed in the 2015 Lancet Commission, which documented the human impacts of climate change and proposed ten global recommendations to respond to this public health emergency and secure the public health benefits available (panel 1).[1]

These four key messages derive from the Lancet Countdown's 2018 report, with key findings summarised below.

- Present day changes in labour capacity, vector-borne disease, and food security provide early warning of compounded and overwhelming impacts expected if temperature continues to rise. Trends in climate change impacts, exposures, and vulnerabilities demonstrate an unacceptably high level of risk for the current and future health of populations across the world.
- A lack of progress in reducing emissions and building adaptive capacity threatens both human lives and the viability of the national health systems they depend on, with the potential to disrupt core public health infrastructure and overwhelm health services.
- Despite these delays, trends in a number of sectors see the beginning of a low-carbon transition, and it is clear that the nature and scale of the response to climate change will be the determining factor in shaping the health of nations for centuries to come.
- Ensuring a widespread understanding of climate change as a central public health issue will be vital in delivering an accelerated response, with the health profession beginning to rise to this challenge.

Climate change impacts, exposures, and vulnerability

Vulnerability to extremes of heat has steadily risen since 1990 in every region, with 157 million more people exposed to heatwave events in 2017 compared with 2000 and the average person experiencing an additional 1.4 days of heatwaves per year over the same period (Indicators 1.1 and 1.3). For national economies and household budgets, 153 billion hours of labour were lost in 2017 due to heat, an increase of more than 62 billion hours (3.2 billion weeks of work) since 2000 (Indicator 1.4). The direct effects of climate change extend beyond heat to include extremes of weather. In 2017, a total of 712 extreme weather events resulted in $326 billion in economic losses in 2017, almost triple the total losses experienced the year before (Indicator 4.1).

Small changes in temperature and precipitation can result in large changes in the suitability for transmission of important vector- and water-borne diseases. In 2016, global vectorial capacity for the transmission of dengue fever was the highest on record, rising to 9.1% and 11.1% above the 1950s baseline for *Aedes aegypti* and *Aedes albopictus*, respectively. Focusing on high-risk areas and diseases, the Baltic has observed a 24% increase in the area of coastline suitable for epidemics of *Vibrio Cholera*; and the highlands of Sub-Saharan Africa have experienced a 27.6% rise in the vectorial capacity for the transmission of malaria, from a 1950 baseline through to 2016 (Indicator 1.8). A proxy of agricultural yield potential shows declines in every region, with 30 countries currently experiencing downward trends in yields, reversing a decades-long trend of improvement (Indicator 1.9.1).

Falling labour productivity, increased capacity for the transmission of diseases such as dengue fever, malaria, and cholera, and threats to food security provide early warning of compounding negative health and nutrition impacts if temperatures continue to rise.

Adaptation, planning, and resilience for health

Global inertia in adapting to climate change persists, with a mixed response from national governments since the signing of the Paris Agreement in 2015. Over half of global cities surveyed expect climate change to seriously compromise public health infrastructure, either directly, with extremes of weather disrupting critical services, or indirectly, by overwhelming existing services with increased burdens of disease (Indicator 2.2).

Globally, committed spending for climate change adaptation remains well below the $100 billion USD per year committed to under the Paris Agreement. Within this, only 3.8% of total development spending committed through formal UNFCCC mechanisms is dedicated to human health (Indicator 2.8). This lack of investment in adaptive capacity is magnified in specific regions around the world, with only 55% of African countries meeting International Health Regulation core requirements for preparedness for a multi-hazard public health emergency (Indicator 2.3).

Mitigation actions and health co-benefits

Multiple examples of stagnated mitigation efforts exist, with a crucial marker of decarbonisation – the carbon intensity of total primary energy supply – remaining unchanged since 1990 (Indicator 3.1). One third of humanity, 2.8 billion people, live without access to healthy, clean, and sustainable cooking fuel or technologies, the same level seen in 2000 (Indicator 3.4). In the transport sector, per capita global road transport fuel use increased by 2% from 2013 to 2015, while cycling comprises less than 10% of total journeys taken in three quarters of a global sample of cities (Indicators 3.6 and 3.7).

The health burden of such inaction has been immense, with people in over 90% of cities breathing polluted air toxic to their cardiovascular and respiratory health. Indeed, between 2010 and 2016, air pollution concentrations worsened in almost 70% of cities around the globe, particularly in low- and middle-income countries (Indicator 3.5.1). In 2015 alone, some fine particulate matter (PM2.5) was responsible for some 2.9 million premature deaths, with coal comprising over 460,000 (16%) of these, with the total toll (including other particulates, and emissions such as NOx substantially higher (Indicator 3.5.2). Of concern, global employment in fossil fuel extractive industries actually increased by 8% between 2016 and 2017, reversing a strong decline seen since 2011 (Indicator 4.4). At a time when national health budgets and health services face a growing epidemic of lifestyle diseases, continued delay in unlocking the potential health co-benefits of climate change mitigation is short-sighted and damaging for human health.

Despite this stagnation, progress in the power generation and transport sectors provide some cause for optimism, with many positive trends observed in the 2017 report continuing in the 2018 report. Notably, coal use continues to decline (Indicator 3.2) and more renewable energy was installed in 2017 than energy from fossil fuels (Indicator 3.3). However, maintaining global average temperature rise to well below 2°C necessitates wide-reaching transformations across all sectors of society – power generation, transport, spatial infrastructure, food and agriculture, and the design of health systems. These transformations, in turn, offer levers to help tackle the root causes of the world's greatest public health challenges.

Finance and economics

Some 712 climate-related extreme events were responsible for 326 billion USD of losses in 2017, almost triple that of 2016 (Indicator 4.1). Crucially, 99% of the losses in low-income countries remained uninsured.

Indicators of investment in the low-carbon economy demonstrate that the transition is already underway, with continued growth in investment in zero-carbon energy, and growing numbers of people employed in renewable energy sectors (Indicators 4.2 and 4.4). Furthermore, investment in new coal capacity in 2017 was its lowest in at least 10 years, with 2015 potentially marking a peak in coal investment. Correspondingly, global subsidies for fossil fuels continued to fall, whilst carbon pricing currently only covers 13.1% of global greenhouse gas emissions, this number is expected to increase to over 20% when planned legislation in China is implemented in late-2018 (Indicator 4.6 and 4.7).

However, the rise of employment in fossil fuel industries in 2017 reversed a five-year downward trend, and will be a key indicator to follow closely.

Public and political engagement

A better understanding of the health dimensions of climate change allows for advanced preparedness, increased resilience and adaptation, and a prioritisation of mitigation interventions that protect and promote human wellbeing.

To this end, coverage of health and climate change in the media has increased substantially between 2007 and 2017 (Indicator 5.1). Following this trend, the number of academic journal articles published on these links has almost tripled over the same time period (Indicator 5.2). These figures often follow internationally significant events such as the UNFCCC's Conference of the Parties, along with temporary rises in mentions of health and climate change within the UN General Debate (Indicator 5.3). The extended heat waves across the northern hemisphere in the summer of 2018 may prove to be a turning point in public awareness of the seriousness of climate change.

2017 saw a dramatic rise in the number of medical and health professional associations actively responding to climate change. In the US, a new alliance of medical associations on health and climate change represents 500,000 physicians. This follows the formation of the UK Health Alliance on Climate Change, which brings together many of the UK's Royal Medical and Nursing Colleges and major health institutions. Organisations like the European Renal Association–European Dialysis and Transplant Association, and the UK's National Health Service are committing to reduce the contributions of their clinical practice emissions. The NHS achieved an 11% reduction in emissions between 2007 and 2015. A number of health organisations have divested, or are committing to divest their holdings in fossil fuel companies, including the Royal Australasian College of Physicians, the Canadian Medical Association, the American Public Health Association, and the World Medical Association (Indicator 4.5).

As the biggest global health threat of the 21st century, responding to climate change, and ensuring this delivers the health benefits available, is the responsibility of the health profession – indeed, such a transformation will not be possible without it.

Progress on the recommendations of the 2015 Lancet Commission

The 2015 Lancet Commission made ten global recommendations to accelerate the response to climate change and deliver the health benefits this could offer. Panel 1 presents a summary of the progress made against these recommendations using the 2018 Lancet Countdown's indicators. Here, global leadership is being provided by China, the European Union, and many of the countries most vulnerable to climate change.

Panel 1. Progress towards the recommendations of the 2015 Lancet Commission on Health and Climate Change

In 2015, the Lancet Commission made ten policy recommendations. Of these, the Lancet Countdown is measuring progress on the following recommendations.

Recommendation 1: invest in climate change and public health research
Since 2007, published articles on health and climate change in scientific journals has increased by 182% (Indicator 5.2).

Recommendation 2: scale-up financing for climate-resilient health systems
Spending on direct health adaptation as a proportion of total adaptation spend increased in 2017 to 4.8% (£11.68 billion), representing an increase in absolute and relative terms from the previous year (Indicator 2.7). Health-related adaptation spending (including disaster response, and food and agriculture) was estimated at 15.2% of total adaptation spend. Whilst this national-level spending is increasing, climate financing for mitigation and adaptation remains well-below the $100 billion per year committed to in the Paris Agreement (Indicator 2.8).

Recommendation 3: phase-out coal-fired power
Coal consumption remains high, but continued to decline in 2017, a trend which is largely driven by China's decreased reliance, and continued investment in renewable energy (Indicators 3.2 and 3.3). The "Powering Past Coal Alliance" – an alliance of 23 countries including the UK, Italy, Canada, and France – was launched at COP23 (December 2017), committing to phase-out coal use by 2030 or earlier.

Recommendation 4: encourage a city-level low-carbon transition to reduce urban pollution
In 2017, a new milestone was reached, with over 2 million electric vehicles now on the road, and global per capita electricity consumption for road transport increasing by 13% from 2013 to 2015 (Indicator 3.6). Here, China is responsible for more than 40% of electric cars sold globally.

Recommendation 5: establish the framework for a strong and predictable carbon pricing mechanism
Whilst a global carbon pricing mechanism has seen limited progress, the proportion of total greenhouse gas emissions covered by national and regional instruments is increasing from a low base. In 2017, 13.1% of greenhouse gas emissions were covered, a number that is expected to increase to 20% in 2018 with the implementation of the Chinese national Emissions Trading Scheme (Indicator 4.9).

Recommendation 6: rapidly expand access to renewable energy, unlocking the substantial economic gains available from this transition
Globally, 157 GW of renewable energy was installed in 2017, over twice as much as that installed 70 GW of fossil fuel capacity (Indicator 3.3), advancing mitigation efforts and improving local air quality. This trend was mirrored by a 5.7% increase in the number of people currently employed in renewable energy in 2017, reaching 10.3 million jobs (Indicator 4.4). From 2000 to 2016, the number of people without connection to electricity fell from 1.7 billion to 1.1 billion (Indicator 3.4).

Recommendation 9: Agree and implement an international treaty that facilitates the transition to a low-carbon economy
In response to the United States' announcement of its intention to withdraw from the Paris Agreement, the great majority of countries provided statements of support, re-affirming their commitment to hold global average temperature rise to well below 2°C. Nicaragua and Syria have both since signed the Paris Agreement. The UN Framework Convention on Climate Change requested the development of a formal report to be delivered at COP24, designed to provide recommendations on how public health can more comprehensively engage with the negotiation process.

Recommendation 10: Develop a new, independent collaboration to provide expertise in implementing policies that mitigate climate change and promote public health, and monitor progress over the next 15 years
The Lancet Countdown is a growing collaboration of 27 partners, committed to an iterative and open process of tracking the links between public health and climate change. In 2018, the Wellcome Trust announced its intention to continue funding the collaboration's work, supporting ongoing monitoring across its five domains, up to 2030.

Introduction

A rapidly changing climate has dire implications for every aspect of human life, exposing vulnerable populations to extremes of weather, altering patterns of infectious disease, and compromising food security, safe drinking water, and clean air (figure 1).[2] These impacts work to exacerbate transnational and intergenerational inequality, compromising many of the national and global public health imperatives that doctors, nurses, and allied health professionals have dedicated their lives to. The health, economic, and social implications of climate change provide justification-enough for the rapid acceleration of mitigation and adaptation efforts, and it is clear that successfully achieving the United Nations (UN) Sustainable Development Goals (SDGs) is dependent on a robust response to climate change.

At the broadest level, maintaining global average temperature rise to well below 2°C necessitates: a complete de-carbonisation of power generation away from fossil fuels, reversing a trend that began with the industrial revolution; a reorientation towards sustainable global food and agricultural systems; a re-thinking of the structure and function of spatial infrastructure and cities, and methods of transport within and between them; the safeguarding of other planetary boundaries and the reversal of deforestation and land-use change trends; and profound changes in the methods of delivery of healthcare.[3-6] These wide-reaching interventions dovetail with numerous public health priorities, providing opportunities to improve breathing conditions for the 90% of the global population exposed to polluted air; tackle the root causes of obesity, physical inactivity, and poor diet; alleviate social inequalities and promote social inclusion; improve workplace environments; and increase access to healthcare and other social services.[1]

Taken as a whole, the form and pace of the world's response to climate change will shape the health of nations for centuries to come.

The *Lancet Countdown: Tracking Progress on Health and Climate Change* is an international, politically-independent collaboration that exists to monitor this global transition from threat to opportunity. The partnership brings together 27 leading academic institutions, and UN and intergovernmental agencies from every continent, with expertise from climate scientists, ecologists, mathematicians, geographers, engineers, energy, food, livestock and transport experts, economists, social and political scientists, public health professionals, and doctors.

Its 2018 report tracks 41 indicators of impact and progress across five domains: climate change impacts, exposures, and vulnerability; adaptation planning and resilience for health; mitigation actions and their health co-benefits; economics and finance; and public and political engagement (table 1).

Working Group	Indicator	
Climate Change Impacts, Exposures and Vulnerability	1.1: Vulnerability to the heat-related risks of climate change	
	1.2: Health effects of temperature change	
	1.3: Health effects of heatwaves	
	1.4: Change in labour capacity	
	1.5: Health effects of extremes of precipitation (flood and drought)	
	1.6: Lethality of weather-related disasters	
	1.7: Global health trends in climate-sensitive diseases	
	1.8: Climate-sensitive infectious diseases	
	1.9: Food security and under-nutrition	1.9.1: Terrestrial food security and under-nutrition
		1.9.2: Marine food security and under-nutrition
	1.10: Migration and population displacement	
Adaptation, Planning, and Resilience for Health	2.1: National adaptation plans for health	
	2.2: City-level climate change risk assessments	
	2.3: Detection, preparedness and response to health emergencies	
	2.4: Climate change adaptation to vulnerabilities from mosquito-borne diseases	
	2.5: Climate information services for health	
	2.6: National assessments of climate change impacts, vulnerability, and adaptation for health	
	2.7: Spending on adaptation for health and health-related activities	
	2.8: Health adaptation funding from global climate financing mechanisms	
Mitigation Actions and Health Co-Benefits	3.1: Carbon intensity of the energy system	
	3.2: Coal phase-out	
	3.3: Zero-carbon emission electricity	
	3.4: Access to clean energy	
	3.5: Exposure to ambient air pollution	3.5.1: Exposure to air pollution in cities
		3.5.2: Premature mortality from ambient air pollution by sector
	3.6: Clean fuel use for transport	
	3.7: Sustainable travel infrastructure and uptake	
	3.8: Ruminant meat for human consumption	
	3.9: Healthcare sector emissions	
Finance and Economics	4.1: Economic losses due to climate-related extreme events	
	4.2: Investments in zero-carbon energy and energy efficiency	
	4.3: Investment in new coal capacity	
	4.4: Employment in renewable and fossil fuel energy industries	
	4.5: Funds divested from fossil fuels	
	4.6: Fossil fuel subsidies	
	4.7: Coverage and strength of carbon pricing	
	4.8: Use of carbon pricing revenues	
Public and Political Engagement	5.1: Media coverage of health and climate change	
	5.2: Coverage of health and climate change in scientific journals	
	5.3: Engagement in health and climate change in the United Nations General Assembly	
	5.4: Engagement in health and climate change in the corporate sector	

Table 1. The 2018 Lancet Countdown indicators.

A global monitoring system for health and climate change

Monitoring and tracking has long been an essential tool in the public health professional's arsenal, important in understanding and diagnosing the problem in question, predicting its future impact, identifying vulnerable populations, developing and prioritising responses, and evaluating interventions.

A 'good' indicator must be based on a credible link between public health and climate change, it must be sensitive to changes in the climate, and less sensitive to non-climate explanations, data must be available and reproducible across temporal and geographical scales, and it must provide actionable information to guide policy in a timely manner.[7] The Lancet Countdown has adopted an iterative and open approach to the development of indicators of the links between climate change and public health. Its 2016 report launched a global consultation, seeking input on what can and should be tracked, with a final set of indicators presented in its 2017 report. These were based on the above criteria and the collaboration's time and resource constraints.[8,9]

This 2018 report provides an additional year of data and presents the results of 12 months of work further developing and improving the methods and data sources for each indicator. These improvements include:

- New methodologies for indicators capturing: changes in labour capacity; future projections of dengue fever (an important climate-sensitive disease); terrestrial and marine food security; climate information provided to health services; the quality and comprehensiveness of health adaptation plans; and global access to clean energy.
- Expanded geographical and temporal coverage for indicators capturing: mortality from air pollution ($PM_{2.5}$) by sector; active transport uptake; employment in low-carbon industries; and engagement from governments, the scientific community, and the media, in health and climate change.
- New indicators of: vulnerability to extremes of heat; exposure to flood; exposure to drought; transmission suitability for malaria and pathogenic *Vibrio*; adaptive capacity to vector-borne disease; and corporate sector engagement in health and climate change.
- Proposals for future indicators looking to capture: the mental health effects of climate change; and the preparedness of healthcare infrastructure.

Every year until 2030, these indicators will be developed and improved, taking into account new methodologies, data sources, and resources as they become available. To this end, the collaboration continuously invites input from experts and academic institutions willing to support the further development of analysis presented here.

Health and climate change in 2017

This report presents 41 indicators of progress in health and climate change, with global- and regional-level results and analysis for each indicator. Detailed methodological descriptions, data sources, and discussion are included in the Appendices, which have been developed as an essential companion to the main report.

In 2017, a number of concerning trends continued, with vulnerable populations experiencing 157 million heatwave exposure events, and 153 billion hours of labour lost due to rising temperatures, representing increases from baseline levels (Indicator 1.3 and Indicator 1.4). Vectorial capacity for the transmission of dengue fever continued to rise, with 2016 being the most suitable year for transmission from *Aedes aegypti* and *Aedes albopictus* since the 1950 baseline studied. The carbon intensity of Total Primary Energy Supply (TPES) remained static at 55-57 tCO_2/TJ (where it has been since 1990), and 2.8 billion people still lived without access to healthy, clean, and sustainable cooking fuels and technologies (Indicator 3.1 and Indicator 3.4).

However, there are clear signs of progress both within, and beyond the health profession's response to climate change. Health systems' adaptive capacity remained robust, and the World Health Organization's (WHO) newly elected Director General listed health adaptation as among the agency's top priorities. TPES from coal-fired power continued to decline, with more than 20 countries (including the UK, Canada, Mexico, and France) committing to unilateral coal phase-out (Indicator 3.2). Renewable energy continued to grow rapidly, with 157 Gigawatt (GW) of new capacity installed (up from 143 GW in 2016), compared to 70 GW of fossil fuel capacity (Indicator 3.3). Health institutions, including the American Public Health Association, Medibank Australia, and the Hospitals Contribution Fund of Australia, announced their commitment to divest from fossil fuels, with funds totalling 33.6 billion USD (Indicator 4.5). The United States' announcement of its intention to withdraw from the Paris Agreement contrasted with the formation of a new alliance of US medical associations (including the American Medical Association, the American College of Physicians, and the American Academy of Paediatrics) representing 500,000 clinicians, dedicated to tackling climate change.[10]

The data presented in the Lancet Countdown's 2018 report provides ongoing reason for cautious optimism, with the continuation of important trends signalling the beginning of a broader transition. Despite this, substantially faster progress is required across the full range of indicators over the coming five years in order to meet the commitments made under the Paris Agreement.

Section 1: Climate Change Impacts, Exposures and Vulnerability

Introduction

This first section provides insights into the impact of anthropogenic climate change on human health, tracking along the many pathways elucidated in figure 1. These indicators follow numerous mechanisms and causal pathways, looking to describe underlying population vulnerabilities, human exposures, and ultimately, the health impacts that result from a changing climate. This narrative approach, built around quantitative indicators, allows the explicit exploration of the extent to which climate change is compromising public health globally.

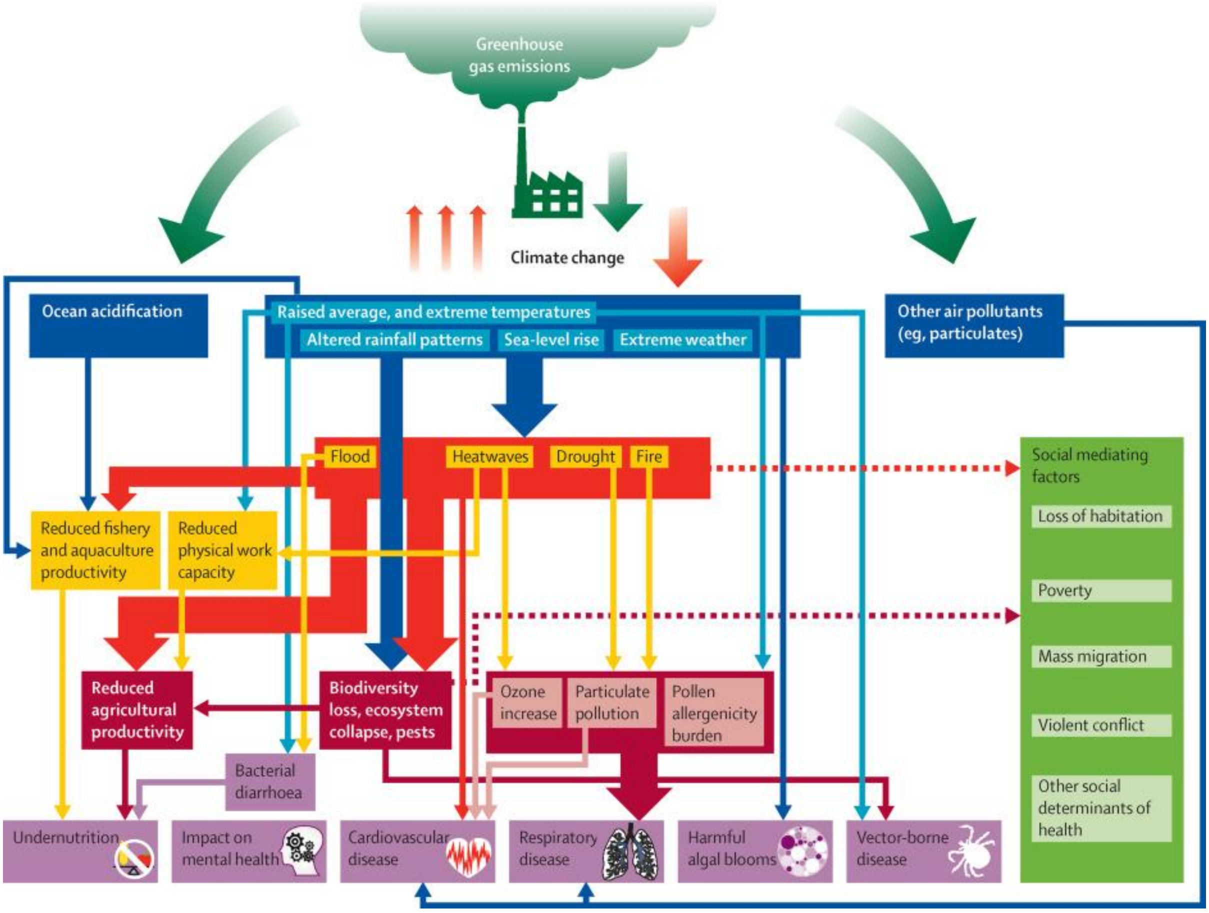


Figure 1. The pathways between climatic changes through to health impacts. (Source: Watts et al, 2015).[1]

The methods, data sources, and indicators selected for this year's Lancet Countdown report have been significantly improved. A number of new indicators have been developed, including metrics on vulnerability to heat exposure (Indicator 1.1); exposure to flood and drought (Indicator 1.5); and the climatic suitability for transmission of malaria and pathogenic *Vibrio* species (Indicator 1.8). Methodologies and data sources have also been updated and improved, with more sophisticated analysis conducted on labour capacity loss due to rising temperatures (Indicator 1.4); and the health implications of declining marine and terrestrial primary food productivity (Indicator 1.9).

Indicator 1.1: Vulnerability to the heat-related risks of climate change

Headline finding: *Rising ambient temperatures place vulnerable populations at increased risks across all WHO regions. Populations in Europe and the East Mediterranean are particularly at-risk, with 42% and 43% of their populations over 65 years of age vulnerable to heat exposure.*

Increasing temperatures as a result of climate change will continue to expose vulnerable populations to additional heat-related morbidity and mortality, including heat stress, cardiovascular disease, and renal disease.[2] Adults over 65 years are particularly vulnerable, as are individuals with underlying cardiovascular diseases, diabetes, and chronic respiratory diseases, and those living in urban areas.[11-13] These exact factors are used, with equal weighting, to develop an index of vulnerability to current and future heat-exposure as a result of climate change.

In all regions of the world, the proportion of populations vulnerable to heat exposure is rising. Europe and the Eastern Mediterranean demonstrate markedly higher vulnerability as compared to Africa and South East Asia, a finding that is most likely the result of a more elderly population living in urban areas. In addition, demographic transitions in low- and middle-income countries (LMICs) show accelerating trends in non-communicable diseases, especially in South East Asia, where vulnerability has increased by 3.5% since 1990 (see Appendix 2 for figure and further details).

This heat vulnerability index was compiled using data from the Global Burden of Disease (GBD) for trends in disease prevalence, and the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP), for GDP, population densities and demographics.[14,15] Full details of the methods, data sources and figures for this new indicator can be found in Appendix 2.

Indicator 1.2: Health effects of temperature change

Headline finding: *Mean global summer temperature change experienced by humans is more than double the global average change, rising 0.8°C versus 0.3°C, respectively.*

The rising vulnerability identified in Indicator 1.1 is mirrored by greater human exposures to higher temperatures. In 2017, the mean temperature increase relative to the 1986-2005 reference period, was 0.3°C, with human exposure more than double at 0.8°C (figure 2). This continues an accelerating trend globally, which was identified in the Lancet Countdown's previous report.[9]

The methods and data sources for this indicator remain unchanged, and are described in full in the 2017 Lancet Countdown report and in Appendix 2, with data sourced from the European Centre for Medium-Range Weather Forecasts (ECMWF).[9] [16]

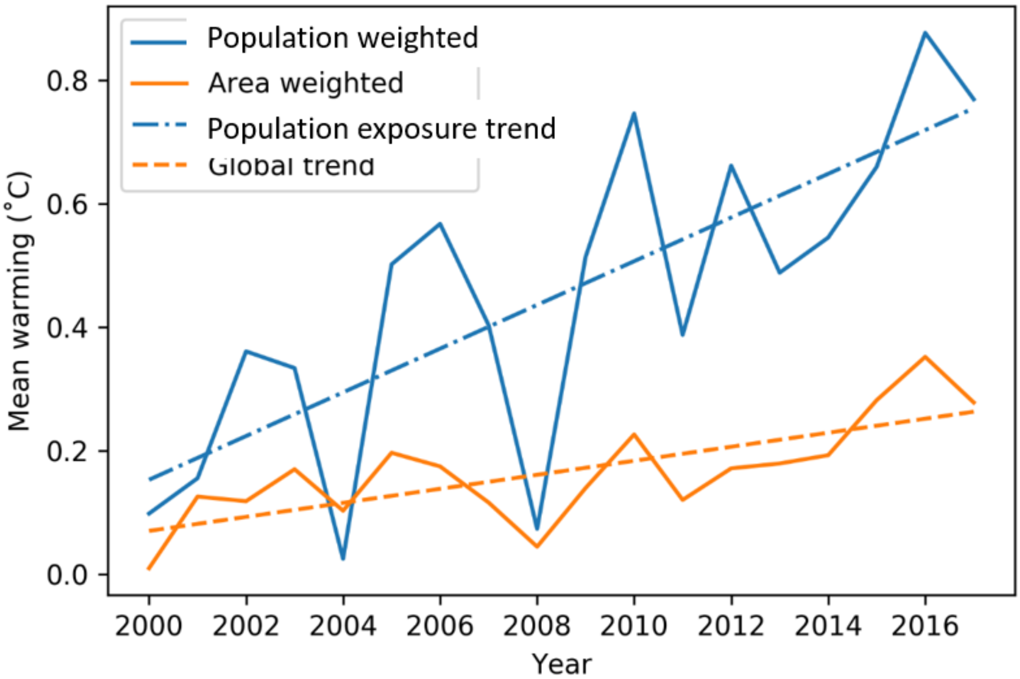


Figure 2. Mean summer warming relative to the 1986-2005 average.

Indicator 1.3: Health effects of heatwaves

***Headline finding**: In 2017, an additional 157 million heatwave exposure events occurred globally, representing an increase of 18 million additional exposure events compared with 2016.*

The strong upward trend observed in the 2017 Lancet Countdown report, with notable peaks in heatwave exposure observed in 2010 and 2015, continues in this 2018 report. On average, each individual experienced an additional 1.4 days of heatwave in 2017 since 2000 (as compared to the 1986-2005 baseline). Furthermore, in 2017, an additional 157 million exposure events occurred (one 'exposure event' being one heatwave, experienced by one person), 18 million more than in 2016 (figure 3). This continues to directly risk the health of those exposed populations, but also indirectly (for instance, food insecurity resulting from livestock exposure to heatwaves).

The methods and data sources (ECMWF) for this indicator are described in the 2017 Lancet Countdown report and in Appendix 2.[9,16]

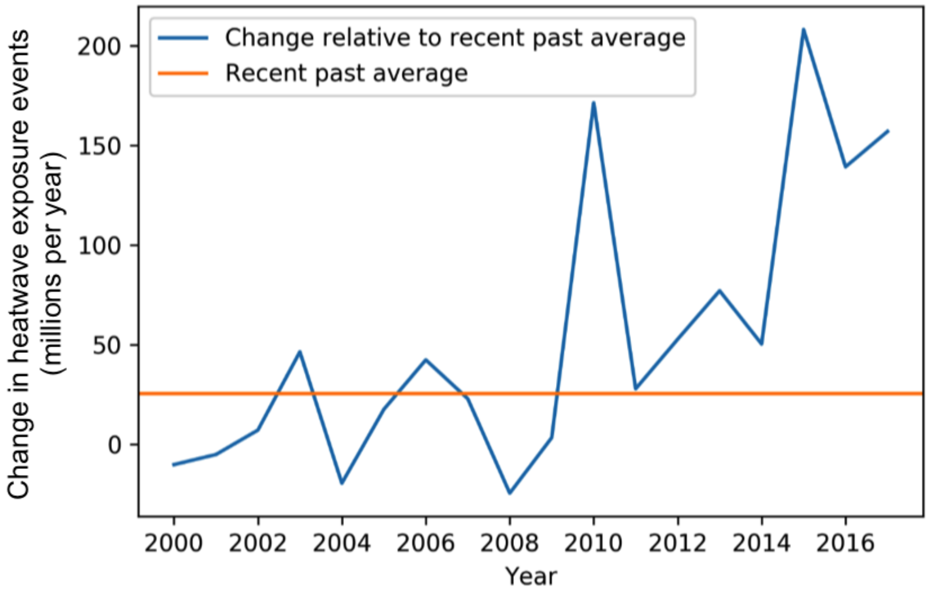


Figure 3. Change in heatwaves exposure events (with one exposure event being one heatwave experienced by one person) compared with the recent past (1986-2005 average).

Indicator 1.4: Change in labour capacity

***Headline finding**: In 2017, 153 billion hours of labour (3.4 billion weeks of work) were lost; an increase of 62 billion hours lost relative to 2000.*

Rising temperatures are a key risk for occupational health, with temperatures regularly breaching physiological limits, making sustained work increasingly difficult or impossible.[17] This indicator highlights the disproportionate impact of climate change and its labour capacity effects on vulnerable populations, with significantly improved methods deployed as described by Kjellstrom et. al.[17] This method assigns work fraction loss functions to different activity sectors in accordance to the power typically expended by a worker performing that activity; labour loss is calculated as a function of the Wet Bulb Globe Temperature (WBGT). Total global hours of labour loss are calculated by factoring in the working population distribution and distribution of activities across sectors in different countries. Labour is divided into three sectors: service (metabolic rate of 200W), industry (300W), and agriculture (400W), all assumed to be working in the shade. As with Indicators 1.2 and 1.3, weather data was obtained from ECMWF; details of the method and datasets used can be found in the Appendix 2.[16]

In total, 153 billion hours of labour were lost in 2017, an increase of 62 billion hours relative to the year 2000; notably, 80% of these losses were in the agricultural sector (see Appendix 2 for figure and further details). The areas most affected by these changes are concentrated in already vulnerable areas in India, South East Asia, and Sub-Saharan Africa (figure 4).

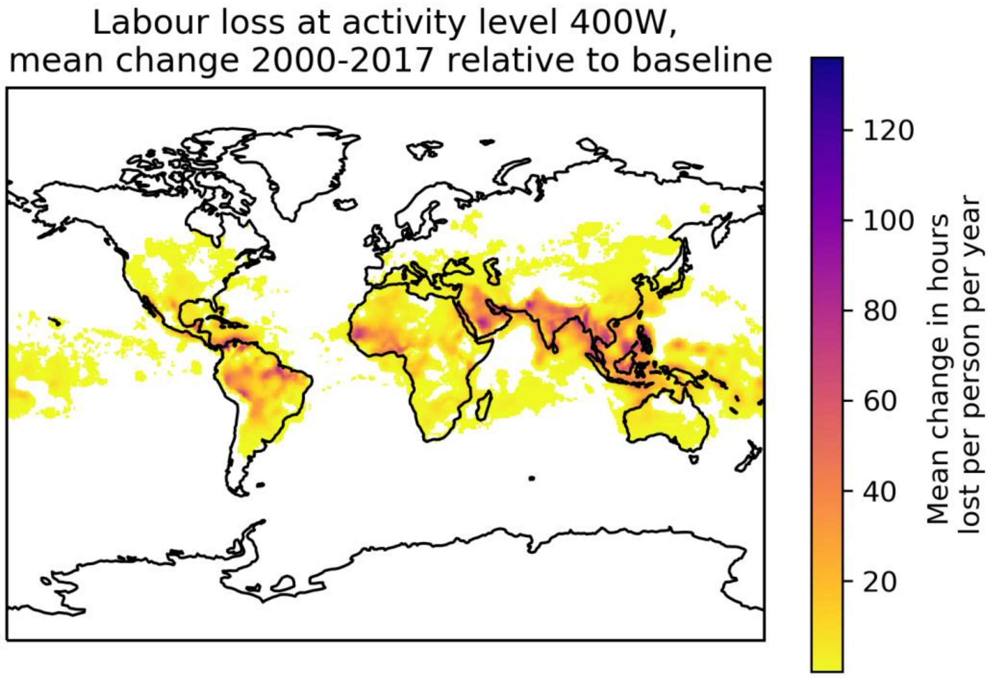


Figure 4. Map showing the mean change in total hours of labour lost at the 400W activity level over the 2000-2017 period relative to the 1986-2005 baseline. This activity level corresponds to manual labour in agriculture.

Indicator 1.5: Health effects of extremes of precipitation (flood and drought)

***Headline finding:** Changes in extremes of precipitation exhibit clear regional trends, with South America and South East Asia among the regions most exposed to flood and drought.*

This new indicator maps extremes of precipitation globally and is divided into two components; drought and extreme rainfall. The change in the mean number of severe droughts has been mapped for 2016 (figure provided in Appendix 2). This highlights increased exposures in large areas of South America, Northern and Southern Africa, and South East Asia, with significant areas experiencing a full 12 months of drought throughout the year. Prolonged drought remains one of the most dangerous environmental determinants of premature mortality, resulting in reduced crop yields, food insecurity, and malnutrition (which in turn, leads to life-long stunting, wasting and eventually death when experienced by young children).[2] The spread of water-borne disease, reduced availability of potable water, and migration as a result of reductions in arable and habitable land often compound to further wear away at the resilient capacity of populations.[18]

Meteorological drought trends can be used to track potential population exposures.[19] The World Meteorological Organization (WMO) recommends the use of the Standard Precipitation Index (SPI) to characterize meteorological droughts around the world, where a severe drought is defined as periods where SPI < -1.5.[20,21] A full description of methods and other data sources (ECMWF) can be found in Appendix 2.[16]

Floods and extreme precipitation also have severe health implications, and 15% of all deaths related to natural disasters are due to floods.[23] In addition to immediate injury and death from flood water, longer-term impacts on health include spread of infectious disease and mental illness, both of which are exacerbated by the destruction of infrastructure, homes and livelihoods.[24,25]

The second component of this new Indicator maps extreme rainfall events, as a proxy indicator of flood risk. In Watts et. al 2015, flood risk was estimated for 2090 by defining a flood event as a 5-day precipitation total exceeding the 10-year return level (a level of rainfall only expected once every ten years) in the reference period.[1] This method has been adapted here to produce extreme rainfall trends from 2000 to 2016. An extreme rainfall event is defined as commencing when the 5-day rolling sum of daily total precipitation exceeds the 10-year return level in the 1986-2005 reference period, and ending when it drops below this value. The return values and events were calculated using the ERA-Interim daily precipitation dataset from ECMWF.[16] Exposures were calculated as the sum of people at a location multiplied by the number of events at that location, measured in person-events. A full account of the methods and data can be found in Appendix 2.

As with drought, changes in extreme heavy rain vary regionally, with particularly significant increases in extreme heavy rainfall events evident in South America and South East Asia(see Appendix 2 for figure and further details) . Here, regional trends are more significant than global trends, reflecting the varying nature of climate change depending on the geographical region studied.

Indicator 1.6: Lethality of weather-related disasters

Headline finding*: Annual frequencies of floods and extreme temperature events have increased since 1990, with no clear upward or downward trend in the lethality of these events.*

Providing global estimates of human exposure, morbidity, and mortality associated with extreme weather events is fraught with methodological complexities and gaps in reliable data. Projections forward demonstrate that left un-mitigated, climate change is expected to result in an additional 1.4 billion drought exposure events per year and 2 billion flood exposure events per year, by the end of the century.[1] These projections are borne out in recent history, with clear increases in the annual frequencies of flood and temperature anomalies over the last 25 years. Whilst there are important trends within regions and income-groups in the lethality of weather-related disasters, no clear trend is seen at the global level, with the exception of a slight decline in the absolute numbers of those affected by floods. As section 2 of this report describes, governments and national health services are increasingly adapting to extreme weather events and climate change, with impressive results. These adaptation interventions and broader development initiatives present a plausible explanation for the results identified here. Crucially, Indicator 4.1 makes clear that health and human wellbeing is impacted indirectly through the economic and social losses that result from such events.

Indicator 1.6 makes use of the same methods and data sources (the Emergency Events Database (EM-DAT)) described in the 2017 Lancet Countdown report, and in Appendix 2.[9,26]

Indicator 1.7: Global health trends in climate-sensitive diseases

***Headline finding**: Although global health and development interventions have resulted in some impressive improvements in human health and wellbeing, mortality from two particularly climate-sensitive diseases - dengue fever and malignant skin melanoma – is still rising in regions most susceptible to both diseases.*

Climate change interacts directly and indirectly with a wide variety of disease processes, ultimately acting as a force multiplier for many of the existing challenges faced by the global public health community. Drawing out mortality estimates for climate-sensitive diseases calculated by the GBD helps to elucidate these macro-trends over time (figure 5).[14] Climate change's role in influencing these trends will vary depending on disease process, geography, and demographic profile of affected regions and populations.

The reference category – all-cause mortality – shows a strong improvement in mortality rates in Africa, and a significant reduction in South East Asia. Diarrheal diseases also show marked decreases, especially in Africa. In contrast to this, mortality from dengue fever is clearly increasing rapidly, especially in regions most susceptible to its spread - South East Asia and the Americas. Mortality rates for malignant melanoma, which notably has a decadal delay, from exposure to mortality, and is associated with exposure to ultraviolet radiation, have increased markedly in Europe, the Americas, and the Western Pacific. The methods for this indicator are described in full in the 2017 Lancet Countdown report, and in Appendix 2.[9]

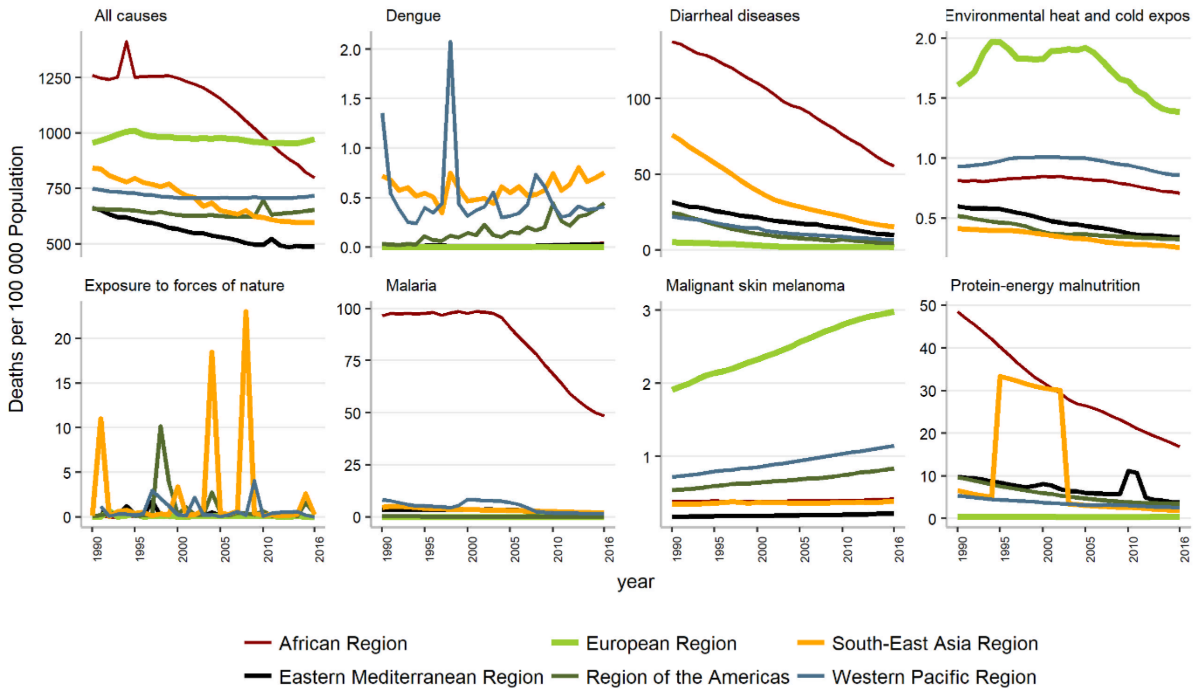


Figure 5. global trends in all-cause mortality and mortality from selected causes as estimated by the Global Burden of Disease 2017, for the period 1990 to 2016, by World Bank Regions. Source: Global Burden of Disease, 2016.[14]

indicator 1.8: Climate-sensitive infectious diseases

***Headline finding**: In 2016, global vectorial capacity for the transmission of dengue virus was the highest on record, rising to 9.1% and 11.1% above the 1950s baseline for Aedes aedypti and Aedes albopictus, respectively.*

Changing climatic conditions are a key determinant for the spread and impact of many infectious diseases. Understanding how climate change is altering the environmental suitability for disease vectors, pathogen replication and transmission is vital to understanding the consequences for human exposure. The 2017 Lancet Countdown analysis on dengue virus is expanded here, to include a seasonal analysis of dengue and global analysis of pathogenic *Vibrio* species and malaria. The second component of the indicator analyses publication trends of climate change-infectious disease research.

Vectorial capacity is a measure of the capacity for vectors to transmit a pathogen to a host and is influenced by vector, pathogen and environmental factors. Compared to a 1950s baseline, climatic changes have increased global vectorial capacity for dengue in the 2010s (2011-2016 average) by 7.8% and 9.6% for *Aedes aegypti* and *Aedes albopictus*, respectively (figure 6). For both vectors, 2016 was the most suitable year on record. In addition, the seasonal dynamics of vectorial capacity for dengue from both vectors have lengthened and strengthened (Appendix 2). Model projections suggest this rise will continue for both vectors in step with GHG emissions (Appendix 2). The contribution of mobility and globalisation to the expansion of the dengue vector and dengue disease burden is important to note, alongside the impact of climate change.

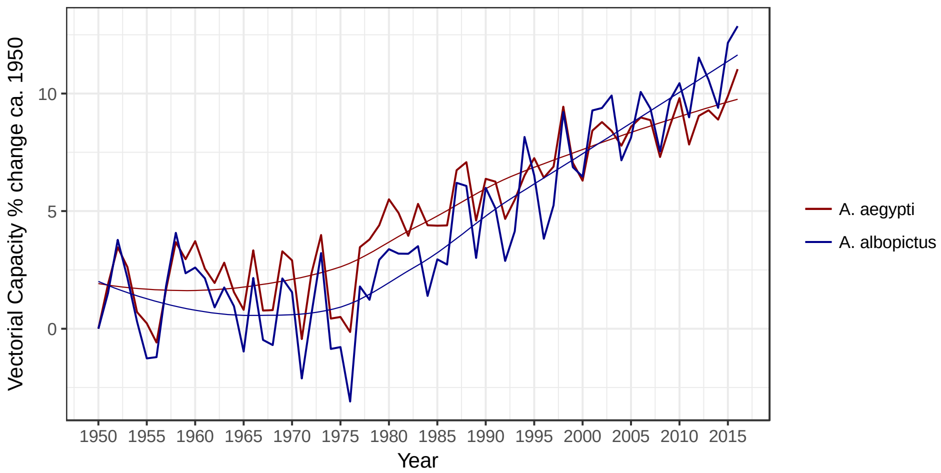


Figure 6. Changes in global vectorial capacity for the dengue virus vectors *Aedes aegypti* and *Aedes albopictus* since 1950 (see Appendix 2 for projections to 2050).

Turning to water-borne infectious diseases, in regions with suitable salinity conditions a consistent association between sea surface temperature (SST) anomalies and cases of pathogenic *Vibrio* infections has been reported.[27-29] In 2018, a *Vibrio* indicator has been added to track the environmental suitability of coastal regions for *Vibrio* infections on the basis of SST and salinity. This was developed for *Vibrio* species that are pathogenic to humans, including *V. parahaemolyticus, V. vulnificus* and non-toxigenic *V. cholerae* (non-O1/non-O139); *Vibrio*-caused illnesses (vibriosis) include gastroenteritis, wound infections, and septicemia and can be transmitted in brackish marine waters. A clear trend of rising suitability for *Vibrio* infections is observable globally (notably the Northern hemisphere), with 2017 being a particularly abnormal year of decreased suitability (figure 7). The percentage of coastal area suitable for *Vibrio* infections in the 2010s has increased at northern latitudes (40-70°N) by 3.5% compared to a 1980s baseline. In two higher risk focal regions, the Baltic and US northeast, increases of 24.0% and 27.0% have been observed in the area of coastline suitable over the same period (figure 7b and 7c). Similarly, the number of days suitable per year has almost doubled in the Baltic, extending the highest risk season by around 5 weeks (figure 7b).

a) b) c)

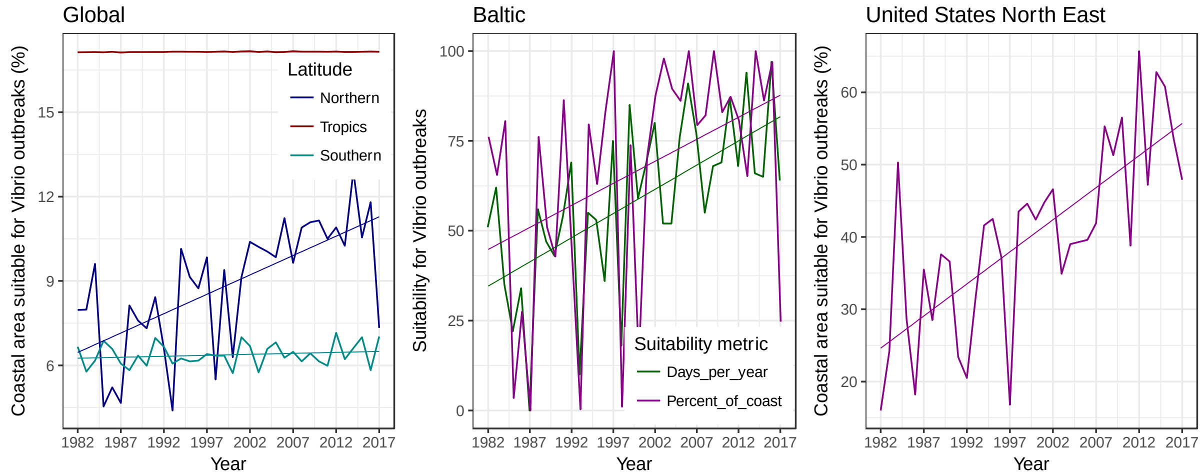


Figure 7. Change in suitability for pathogenic Vibrio outbreaks as a result of changing sea surface temperatures a) globally, divided into three latitudinal bands (northern latitudes = 40-70°N; tropical latitudes = 25°S-40°N; and southern latitudes = 25-40°S); b) the Baltic and c) United States North East coast.

A second new indicator addresses the changing suitability for the transmission of malaria. The indicator focuses on environmental suitability for *Plasmodium falciparum* (African continent) and *P. vivax* (other regions), the two dominant parasites causing disease worldwide. The indicator shows significant changes in suitability in highland areas of Africa, which has increased by 20.9% in the 2010s when compared to a 1950s baseline, with 2016 being the fourth most suitable year (after 2002, 1997 and 2006) since the beginning of the time series (27.7% rise ca. 1950s baseline). The expanded methods for all disease indicators are in Appendix 2.

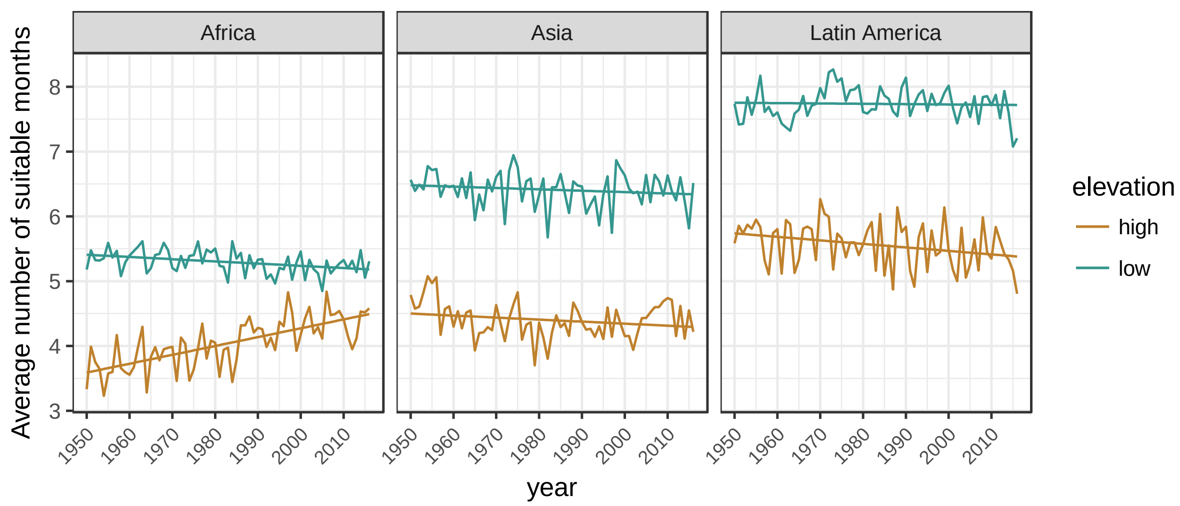


Figure 8. Environmental suitability for malaria 1950 to 2016, grouped by continent and elevation (high >=1500m, low <1500m). Results are for the dominant malarial parasite in each region. (*P. falciparum* in Africa; *P vivax* in other regions).

The final component of this indicator tracks research and published literature on climate change and infectious diseases. Overall, the number of publications in the previous 12 months remains high compared to historical levels, with a slight decrease in 2017 (75 publications) from a peak in 2016 (89 publications). A clear majority of papers continue to report on positive associations (see Appendix 2 for figure and further details).

Indicator 1.9: Food security and under-nutrition

Indicator 1.9.1: Terrestrial food security and undernutrition

***Headline finding**: 30 countries are currently experiencing downwards trends in yields, reversing a decade-long trend that had previously seen global improvement. Yield potential is estimated to be declining in every region, as measured by accumulated thermal time.*

Worldwide, there is more than sufficient food produced to feed the global population. The causes of food insecurity and undernutrition are hence both complex and multi-factorial, driven by factors beyond total food availability.[30,31] However, food production is already being compromised by extremes of weather that are predicted to become more frequent and extreme; yield potentials are falling globally and many countries are already experiencing falling yields.[32,33]

A multi-level indicator is presented, linking climate hazards and trends, crop yields and harvests, and undernutrition. Overall trends are tracked using globally-aggregated and country-level data, highlighting the extent to which negative impacts of climate change outweigh potential positive impacts on national nutrition and food security through varietal breeding, improved farming practices, and reductions in poverty.

First, global grain potential is represented by current and future predictions of Accumulated Thermal Time (ATT) for maize, which acts as a proxy for yield potential, and in turn, food security. As ATT declines, so too does the viability of a given crop, resulting in failed harvests. Falling ATT for maize in each region suggests declining maize yield potential in each region and globally (figure 9 and Appendix 2).[34] Second, the number of countries for which yields are trending downwards is tracked. This number fell from 56 to 32 between 2000 and 2010, but has scarcely fallen since, reaching 30 in 2016. For some countries, where the yield gap (the difference between actual and maximum potential yield) is small, falling yields reflect the negative impact of climate change already outweighing any technological improvement.[35] The third component of this indicator tracks undernutrition, aggregated at a global scale. Although rates and absolute numbers of undernutrition had declined over the past decade, a reversal of this trend and consequent rise in undernutrition is evident in recent years.

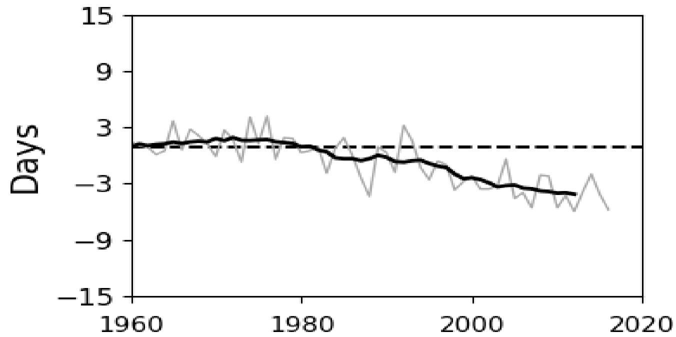


Figure 9. Accumulated Thermal Time as a proxy for maize yield. The dashed line is the average over the period 1961-1990, and the solid black line is an 11-year moving average.

The methods and data sources utilised for this indicator have been improved on and expanded significantly since the 2017 Lancet Countdown report, to incorporate potential crop yield and actual crop production data, and are presented in full in Appendix 2; additional figures for this analysis are also available in Appendix 2.[9,36]

Indicator 1.9.2: Marine food security and under-nutrition

***Headline finding**: Sea surface temperatures (SST) have risen significantly in 16 of the 21 key fishing basins analysed, resulting in coral bleaching in many of these basins and threats to marine primary productivity expected to follow.*

This indicator on marine food security has been further developed since the 2017 Lancet Countdown report. Here, 21 basins have been analysed, selected for their geographical coverage and importance to marine food security.[36] A multi-layered indicator is tracked for each basin, monitoring changes in SST and subsequent coral bleaching from thermal stress (abiotic indicators), alongside per-capita capture-based fish consumption (biotic indicator). The data presented is sourced from NASA and the US Environmental Protection Agency, with all methods described in full in Appendix 2.[37,38]

Between 2003 and 2015, SST rose in 16 out of the 21 basins analysed, rising by 1.59^{o}C globally in 2015 when compared with 1950 (figure 10 and additional figures in Appendix 2). Rising SST coincides with an increase in coral bleaching thermal stress (increased stress and risk of bleaching to corals resulting from prolonged rising temperatures) levels across many of these basins, further threatening marine primary productivity and a key source of protein for many populations. A full breakdown of coral bleaching thermal stress levels by basin is provided in Appendix 2.

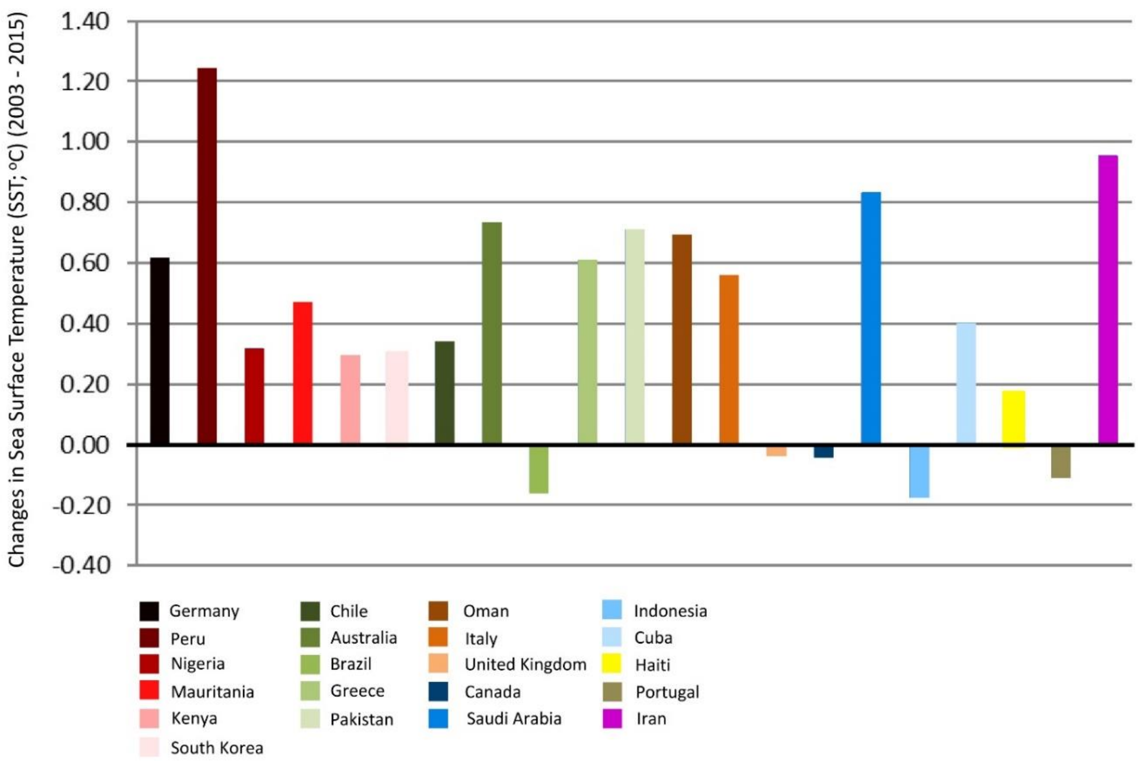


Figure 10. Changes in Sea Surface Temperature (°C) for countries adjacent to and reliant on key FAO fishing basins from 2003 to 2015, using NASA Sea Surface Temperature (MODIS) data. (Source: NASA, 2017)[37]

Indicator 1.10: Migration and population displacement

Headline finding: *Climate change is the sole contributing factor for thousands of people deciding to migrate and is a powerful contributing factor for many more migration decisions worldwide.*

Measuring the net migratory impact of climate change will always be one of the most methodologically complex aspects of this indicator. This is in large part due to the multiple factors that comprise any individual or community's decision to migrate, as described by the extensive migration and mobilities literature. Attribution to climate change of forced migration or non-forced migration is complicated by the lack of support mechanisms to deal with climate change typically being more influential on population dynamics than climate change per se. Then, attributing health outcomes to migration-related decisions or lack of such options is another difficult step, although the forthcoming Lancet Commission on Migration and Health is elucidating aspects of the health effects of migration.

Here, Appendix 2 re-analyses the work conducted in the 2017 Lancet Countdown report, following the definitions, scoping, and method described in Watts et al. (2017).[9] It provides a lower bound of several thousand people who are now migrating with climate change as the sole contributing factor. Future projections are highly uncertain due to challenges in projecting how society, technology, and politics will change over the coming decades. Nonetheless, in the absence of planning and interventions, several hundred million people could end up being vulnerable to forced migration, with climate change as the sole contributing factor.

To improve estimates, further research suggestions are summarised in Appendix 2.

Conclusion

Section 1 presents indicators on the vulnerability, exposure, and impact of climate change for human health. Overall, they provide clear evidence of the existing health effects of climate change. Notably, vulnerability to heat has increased across all regions, exposures to heatwaves have risen further, vectorial capacity for disease vectors continues to increase, and terrestrial and marine food security threats have grown. The regional health impacts of climate change and health vary by geography, as demonstrated clearly in the above indicators on flood and drought, highlighting the need for more granular, national- and local-level analyses. The indicators presented in section 1 will therefore continue to be improved, with significant developments already in place. Work also continues on the development of a proxy indicator for the crucial, and under-researched area of mental health and climate change, with preliminary national-level results.

Climate change aggravates risks to mental health and wellbeing when the frequency, duration, intensity and unpredictability of weather-related hazards change.[9] The resultant weather impacts increase the number of people (re-)exposed to extreme events and their consequent psychological problems, with suicide an extreme manifestation of trauma.[39,40] Because of their rapidly growing frequency, duration, and intensity, heatwaves are of particular concern, with strong evidence linking their occurrence to increases in population-level distress, hospital psychiatric admissions and suicides.[41-44] Less obvious impacts of weather-related hazards can be especially perilous, creating food shortages, homelessness and displacement, and damaging public infrastructure, power and connectivity, agricultural land and sacred places.[45] These pressures can impair social cohesion, undermining critical supports for mental health. Recent analysis examining the relationship between hot years and suicide rates in Australia has been provided in Appendix 2.

It is clear that the adaptation and mitigation efforts of governments and health professionals matter immensely in determining the scale of the eventual health impacts of climate change. Progress in these two areas, and on the economic, financial, and political context on which they depend, is the focus of the remainder of this report.

Section 2: Adaptation, planning, and resilience for health

Introduction

With the observed and future health impacts of climate change becoming increasingly evident, and emissions trajectories committing the world to further warming, accelerated adaptation interventions are needed to safeguard populations' health. As the 2030 Agenda demonstrates, strategies to improve community resilience often dovetail with poverty reduction and broader socio-economic development imperatives creating the possibility of 'no regret scenarios'.[1]

The health sector must be at the forefront of adaptation efforts, ensuring health systems, hospitals, and clinics remain anchors of community resilience. This under-recognised, yet growing area of practice, is the focus of section 2. Data availability is incomplete, providing more insight into adaptation than resilience, and are predominantly allowing for process-based indicators. However, a number of the indicators have been improved on since 2017: qualitative analyses of the content and quality of national adaptation strategies and vulnerability & adaptation assessments in the health sector are included to complement previous quantitative findings (Indicators 2.1 and 2.6); and the inclusion of health-specific adaptation questions in survey tools and questionnaires for climate services (Indicators 2.2 and 2.5). In addition, this year's report includes a new indicator assessing the adaptive capacity to vector borne disease (Indicator 2.4). The indicators presented in this report, show an overall trend of increased uptake of adaptation measures. However, whilst adaptation activities may have increased, they do not guarantee resilience against future climate change, and hence efforts to adapt to climate change must be redoubled. This is largely dependent upon sufficient spending on adaptation (Indicator 2.7), funding availability for adaptation (Indicator 2.8), and an improved understanding of how to most effectively deliver resilience within health systems.

Indicator 2.1: National adaptation plans for health

Headline finding: *In 2015, 30 out of 40 countries responding to the WHO Climate and Health Country Survey reported having national health adaptation strategies or plans approved by their respective health authority.*

This indicator tracks the policy commitment of national governments on health adaptation to climate change. Revised data, based on the biennial WHO Climate and Health Country Survey will be presented in the 2019 Lancet Countdown report. In the interim, a qualitative analysis of 16 national health adaptation strategies and plans is presented here. Of note, as the most current and available country strategies/plans were collected for this review, the documents included may not correspond exactly to those reported on in the 2015 survey findings.[9] A full description of the methods used in this qualitative review can be found in Appendix 3.

Out of the 16 national health adaptation strategies/plans reviewed, only six were identified as being the formal health component of a National Adaptation Plan (NAP) of the United Nations Framework Convention on Climate Change (UNFCCC) process, referred to as an H-NAP.[50]

The goal of a national health adaptation strategy or plan should be to build the resilience of the existing health system. Encouragingly, three-quarters of the countries (12 out of 16) had established institutional arrangements to integrate climate change adaptation planning into existing health-related planning processes. Almost all countries (15 out of 16) prioritized their most critical climate-sensitive health outcomes in the national health adaptation strategy/plan. Water-, food- and vector-borne diseases were the most widely considered climate-sensitive health outcomes, followed by direct injuries and deaths due to extreme weather events (figure 11). Nearly two-thirds of countries (10 out of 16) outlined adaptation measures to address specific health impacts, particularly for integrated risk monitoring, early warning and climate informed health programs. Yet less concrete measures were proposed for mental health, noncommunicable diseases, respiratory diseases and heat stress. Most countries (12 out of 16) detailed a monitoring and evaluation process for the implementation of their strategy/plan with ten of these countries proposing specific indicators for each adaptation activity.

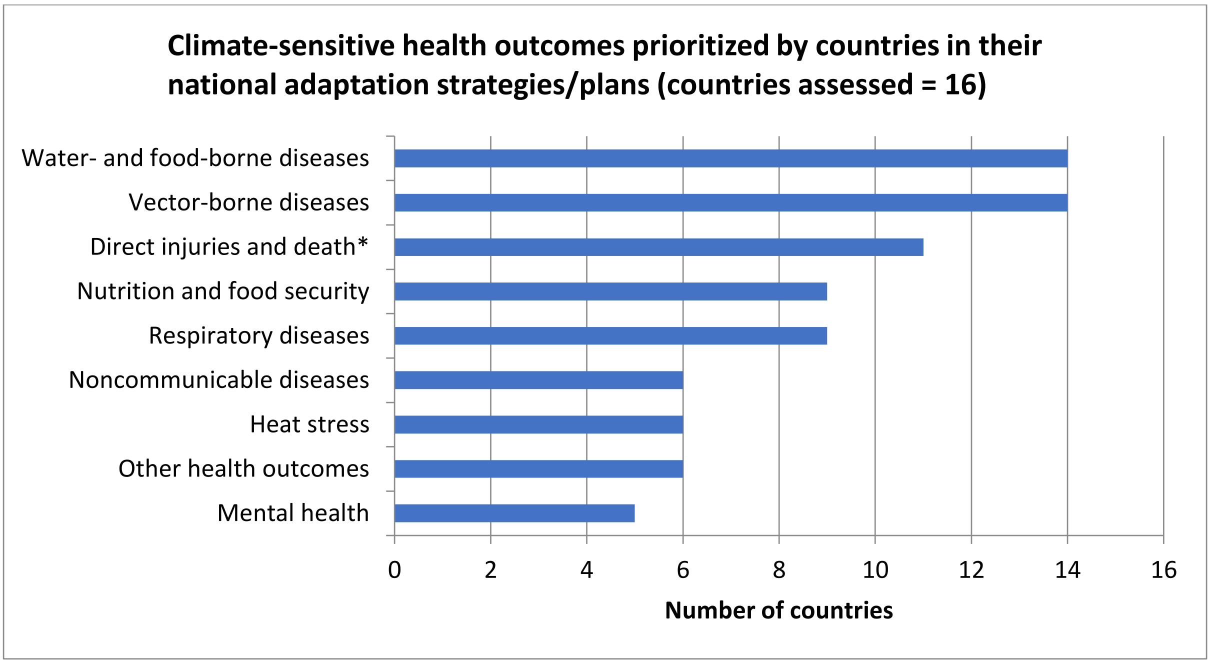


Figure 11. The climate-sensitive health outcomes prioritized by the countries in their national health adaptation strategies/plans. *Direct injuries and death due to extreme weather events.

Indicator 2.2: City-level climate change risk assessments

***Headline finding**: Of the 478 global cities surveyed, 65% have either already completed or are currently undertaking climate change risk assessments, with 51% of cities expecting climate change to seriously compromise their public health infrastructure*.

Over 50% of the world's population live in cities, generating 80% of global GDP and consuming 60% of energy.[47] Cities' independent political and legal status often affords them flexibility in developing a comprehensive adaptation response to climate change. This indicator captures both the extent to which cities have developed their own climate change risk assessments, and their own perception of the vulnerability of their public health infrastructure to these threats.

Globally, 48% of cities had completed a climate change impact assessment, with 17% currently in progress. As part of these assessments, 51% of cities identified public health infrastructure as being particularly vulnerable to climate change, and needing additional and rapid intervention. Global inequalities in the capacity to conduct such assessments are evident, with only 25% of cities in low-income countries doing so, as compared to 57% of cities in high-income countries (see Appendix 3 for additional figures and further details). Regional trends are similarly correlated with development.

Data for this indicator is sourced from the Carbon Disclosure Project's 2017 survey of 478 global cities, and is described in full in the 2017 Lancet Countdown report and Appendix 3.[9]

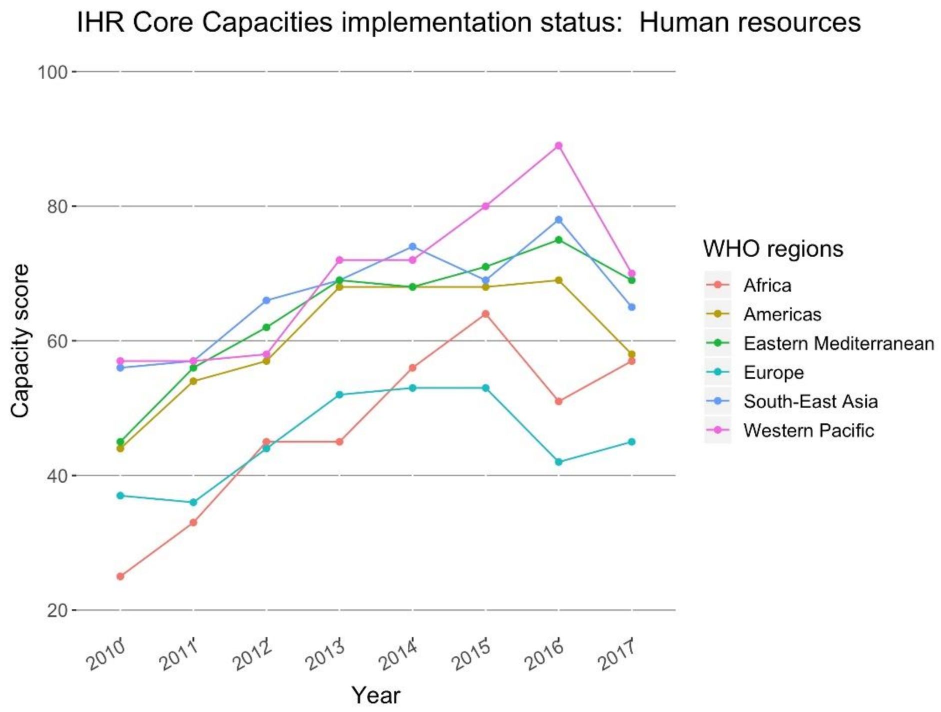
Indicator 2.3: Detection, preparedness and response to health emergencies

Headline Finding: *Despite a previous marked increase, a significant decline in national IHR capacities, relevant to climate adaptation and resilience, has been observed in most of the WHO world regions in 2017.*

In total, 85% of the WHO Member States responded to the 2017 International Health Regulations (IHR) Monitoring questionnaire (see panel 6 of Watts et al., 2017 for details).[9,48] Overall capacity scores have decreased for all four capacities in 2017 as compared to 2016: human resources (9.9%), surveillance (5.3%), preparedness (8.5%) and response (7.8%). Figure 22 presents progress in capacity scores from 2010 to 2017 by WHO region.

The first of these capacities, human resources, has seen the most heterogeneous change across WHO regions (figure 12a). Two regions experienced an increase in their capacity score: Africa (11.8%) and Europe (7.1%); while the rest of the regions experienced a decrease in their capacity score: Western Pacific (-21.3%), South East Asia(-16.6%), the Americas (-15.9%) and the Eastern Mediterranean region (-8.0%).[49] All regions experienced a decrease in Surveillance capacity score (figure 12b), with Africa, the region experiencing the greatest decrease (-8.4%), followed by the Eastern Mediterranean region (-8.1%), the Americas (-6.7%), South-East Asia (-6.5%,), Europe (-1.2%) and the Western Pacific region (-1.1%).[50] All regions except for Africa have seen a decrease in their preparedness capacity score.[51] The Africa region has maintained its capacity score from 2016 (figure 12c). The greatest decrease was experienced by South-East Asia (18.3%), followed by the Western Pacific (12.1%), the Eastern Mediterranean region (6.9%), the Americas (5.3%) and Europe (4.9%)). Similar to Surveillance capacity, all regions have experienced a decrease in their Response capacity score (figure 12d), with the greatest decrease experienced by the Eastern Mediterranean region (-12.6%), followed by South-East Asia (-11.1%), the Americas (-10.2%), Africa (-6.8%), the Western Pacific (-3.3%) and Europe (-2.4%).[52] Importantly, these figures are affected by a significant improvement in reporting rates, with full details in Appendix 3.

A)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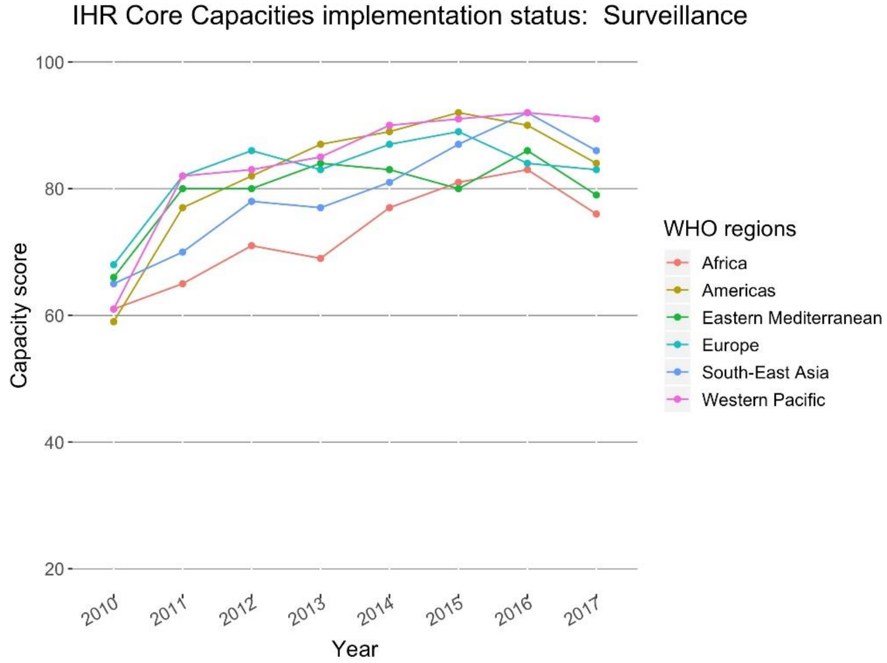
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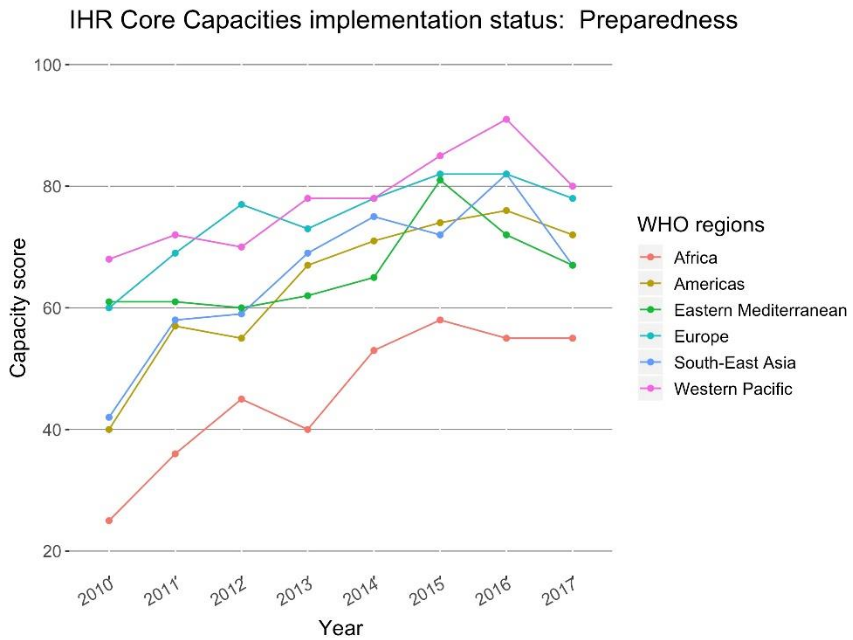

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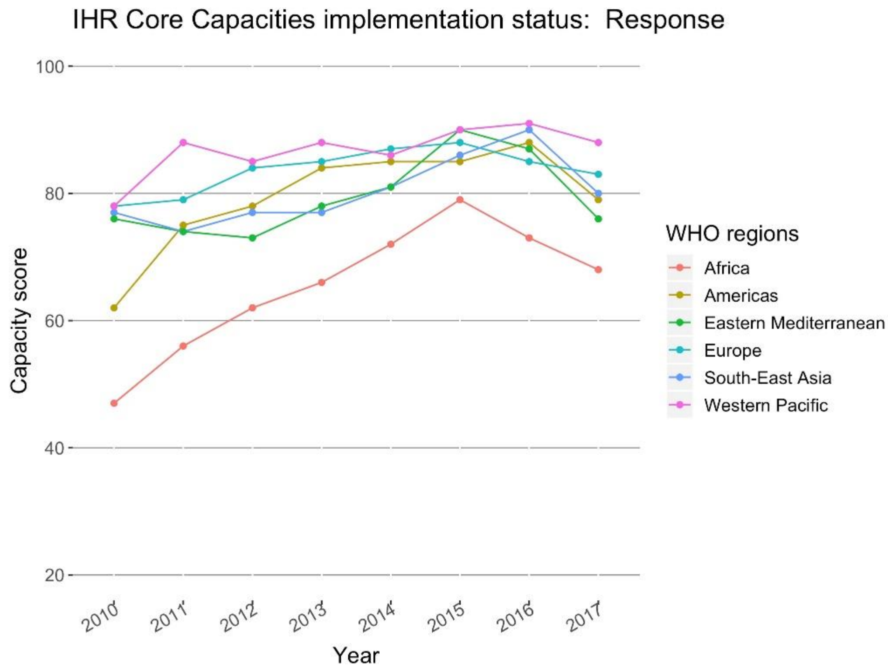

Figure 12 International Health Regulations capacity scores by WHO regions. A) Human Resources capacity score, B) Surveillance capacity score, C) Preparedness capacity score, D) Response capacity score. (Source: World Health Organization, 2018).[49-52]

Indicator 2.4: Climate change adaptation to vulnerabilities from mosquito-borne diseases

***Headline finding:** Globally, improvements in public health have reduced vulnerability to mosquito-borne diseases, with a 28% fall in global vulnerability observed from 2010-2016.*

As Indicator 1.8 makes clear, climate change is already contributing to changing patterns of burden of disease from vector-borne illnesses, such as dengue fever and malaria. Robust public health adaptation strategies can help to reduce these risks. This new indicator is the first set in a suite that is in development, assessing current adaptive capacity to specific climate-related risks. It maps the preparedness and response capacity of government institutions to prevent, prepare for, cope with, and recover from these climate change impacts. Using a process-based mathematical model, relevant country-level core capacities (drawn from the WHO IHR, describing states of surveillance and response to infectious disease outbreaks) were inversely related to the hazard of being exposed to the dengue vector *Aedes aegypti*.[53]

The index combines estimates of risk of exposure to *Aedes aegypti* that a population may face, with the adaptive capacity of the public health system. Improvements in relevant areas of core capacity over the study period translates into increased adaptive capacity (decreased vulnerability) from mosquito-borne diseases. The largest decrease in vulnerability was observed in the Western Pacific and the Americas. The only region to experience an increase in vulnerability was the Eastern Mediterranean. Vitally, as exposures to climate-sensitive diseases change (Indicator 1.8), the existing adaptive capacity reported here may be threatened and thus vulnerability to such diseases could increase in future. The data and methods for this new indicator are described in full in Appendix 3, where figures are also available.

Indicator 2.5: Climate information services for health

***Headline Finding:** The national meteorological and hydrological services of 53 countries report providing climate services to the health sector.*

This indicator has been enhanced since 2017, with the original survey now replaced by the WMO Country Profile Database Integrated questionnaire.[54] Not only does this provide greater insights into the nature of the provision of climate services to the heath sector, but it also allows for continuous updating of this indicator. A snapshot of responses as of May 2018 were used; the methods and data for this indicator are presented in full in Appendix 3, with a full list of reporting countries described to provide climate services to the health sector included.

Of the 55 national meteorological and hydrological services of WMO Member States providing climate services to the health sector, 14 were from Africa, 4 from the Eastern Mediterranean, 18 from Europe, 11 from the Americas, 3 from South East Asia, and 5 from the Western Pacific. Furthermore, services from 47 countries provided additional detail on the status of climate service provision to the health sector: 10 reported to have initiated engagement with the health sector, 13 reported to be undergoing health sector needs definition, 7 reported to be co-designing climate products with the health sector, 14 reported that tailored products are accessible to the health sector, and 3 reported that climate services are guiding health sector's policy decisions and investments plans. For the remaining countries, it is unknown if they did not respond to this section of the survey or they are not providing services.

Indicator 2.6: National assessments of climate change impacts, vulnerability, and adaptation for health

***Headline finding**: In 2015, more than two thirds of countries responding to the WHO Climate and Health Country Survey reported having conducted a national assessment of climate change impacts, vulnerability and adaptation for health.*

To design a comprehensive health adaptation plan to effectively respond to climate risks and reduce adverse health outcomes, a thorough assessment of a country's potential health impacts, vulnerability and adaptation needs is critical.[55] Similar to indicator 2.1, revised data from the WHO Climate and Health Country Survey is not available for this report. In the interim, WHO has conducted a qualitative analysis of the nature and quality of 34 national assessments. A brief summary is presented here, with methodological details presented in Appendix 3. Of note, as the most recent and available country assessments were collected for this review process, the assessments included may not correspond exactly to those reported on in the 2015 survey findings.

More than two thirds of countries that conducted national assessments (26 of 34) anticipated the integration of these findings into the national climate change adaptation strategy and would use the assessments to provide evidence-based policy options for health systems and public health. Thirty-one countries evaluated the adaptive capacity of the health sector to some extent with the highest number of countries assessing adaptive capacity in the areas of programmes (28 countries), infrastructure (28 countries) and human resources (25 countries). By comparing the countries' assessments of vulnerability and adaptive capacity with their proposed adaptation measures, 23 countries demonstrated a corresponding needs-to-actions translation, according to the established criteria for the analysis (Appendix 3). Detailed specifications of how adaptation measures would be implemented, however, were often lacking and resource constraints, data availability and capacity continue to be factors limiting the scope and coverage of national assessments. Mirroring national adaptation actions, it is equally important to capture and better understand how individual health systems are preparing and adapting to climate change (panel 3).

Panel 2. Health system climate change risk assessment, preparedness and resilience

Future iterations of the Lancet Countdown will aim to understand the extent to which individual hospitals and health systems are adapting to climate change. A regular survey conducted as part of the Health Care Climate Challenge (HCCC) is attempting to gather such information.[56] Whilst the data availability currently lacks sufficient global coverage and annual reproducibility, it provides some insight in to measures taken at the health system level, and is a potentially promising source of data for a future indicator.

Participants include health centers, hospitals and health systems, answering questions related to climate change risk assessment and preparedness activities. Respondents to the survey are currently only based in the US, UK, Australia, Brazil, France, Canada, New Zealand and South Africa, with the vast majority in high-income countries. They also represent the most engaged health systems, introducing an element of bias into any analysis. Both adaptation engagement (respondents who have completed a vulnerability and adaptation assessment), and adaptation activity (respondents who have begun to implement preparedness activities) provide potentially useful sources of data going forward.

While the level of engagement rose somewhat between 2015 and 2016, adaptation activity is much lower, with only 57% of health systems, 22% of hospitals and 20% of health centers having developed a plan to address future healthcare services delivery needs resulting from climate change. Within this sample, this suggests that there may be more capacity to undertake risk assessments than to plan and implement adaptation activities, or this may suggest a delay between risk assessment and risk reduction efforts.

Indicator 2.7: Spending on adaptation for health and health-related activities

Headline finding: *Globally, spending on adaptation for health is estimated at 4.8% (£11.68 bn) of all adaptation spending, and health-related spending is estimated at 15.2% (£32.65 bn).*

This indicator tracks global adaptation spending on “health” (spending directly within the formal healthcare sector) and “health-related” spending (spending in healthcare, disaster preparedness, and agriculture). Such spending can significantly reduce the mortality of climate-related disasters and so is important to monitor over time (panel 4). Using the Adaptation and Resilience to Climate Change (A&RCC) data reported last year, health adaptation spending increased by 8.2% in 2016/17, compared to 2015/16. This percentage increase is larger than the change in total adaptation spending over the same period (5.01%).

Globally, relative health adaptation spending has grown slightly from 4.6% of all adaptation spending estimated by the A&RCC dataset in 2015/16, to 4.8% of all spending in 2016/17 (a percentage change of 3.1%). For the wider health-related values, relative spending increased from 13.5% to 15.2% of total A&RCC spending Grouped by World Bank Income Group, the highest percentage change in health adaptation spending was in lower middle-income countries, followed by low-income countries, although the differences at this level of aggregation are small (figure 13). Grouped by WHO Region, the highest percentage change is observed in in Europe and South East Asia. However, it is important to note the much lower spending in LICs and so despite large percentage changes, the total spending in LICs is still far too low to meet needs in these countries.

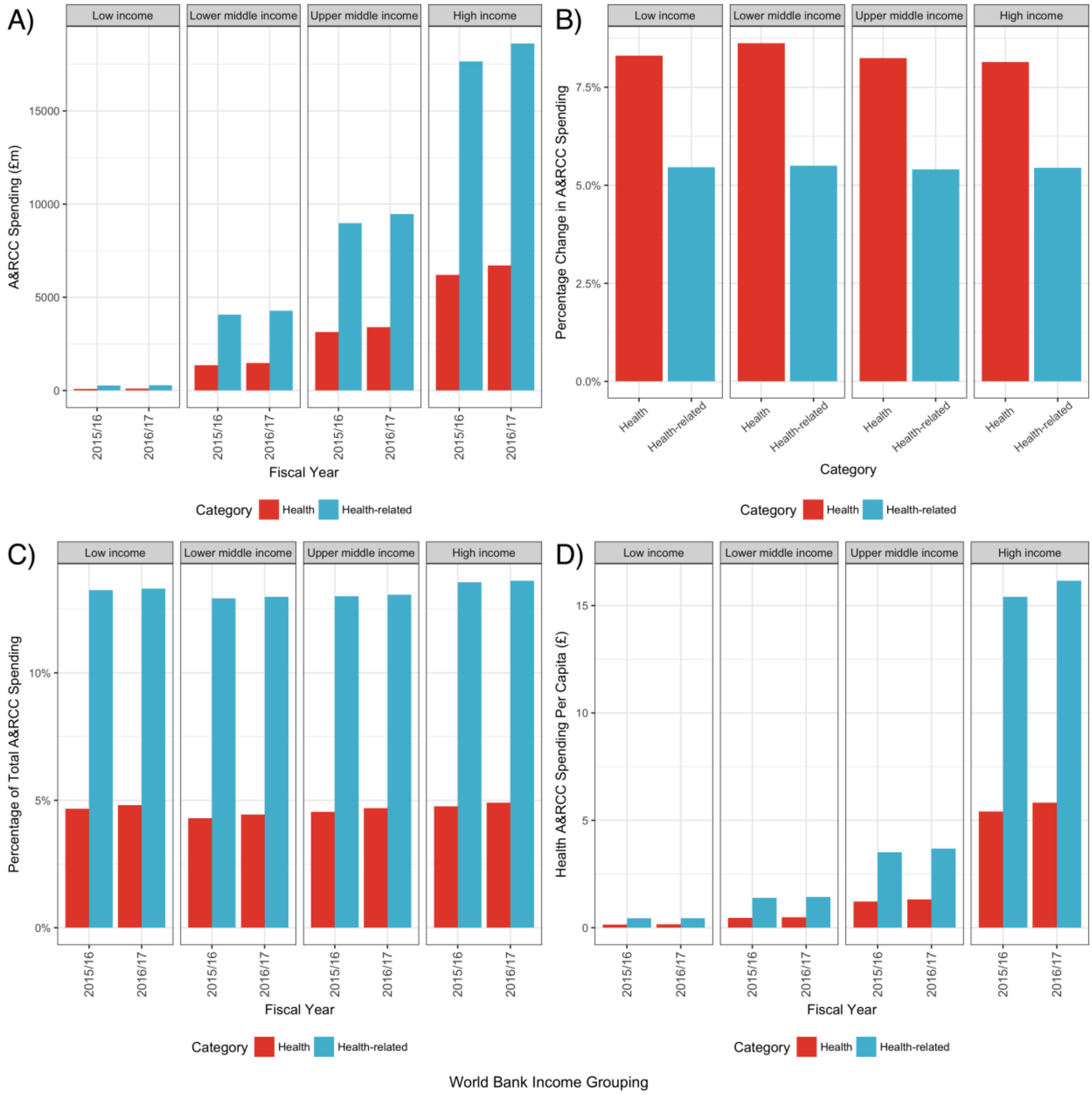

Figure 13. For the Financial Years 2015/16 and 2016/17. A) Total health and health-related A&RCC spending (£m), B) Percentage change in health and health-related A&RCC spending from 2015/16 to 2016/17 (%), C) Percentage of health and health-related A&RCC as a proportion of total spend (%), D) health and health-related A&RCC per capita (£). All plots are disaggregated by World Bank Income Grouping.[57]

This indicator uses 2015/16 and 2016/17 data from the A&RCC dataset produced by kMatrix, as used in last year's report.[9]

Panel 3. Deaths from climate-related disasters versus health spending

The number of people killed in climate-related disasters is a function of the strength of the climate hazard; the exposure of the population to the hazard related to the numbers of people in the hazard location; and the underlying vulnerability of the population. Governments can reduce deaths to climate-related disasters through disaster preparedness measures, such as early-warning systems and via enhanced health services for those affected by a disaster. While it is recognised that generally, countries with higher GDPs have lower numbers of disaster fatalities than countries with lower GDPs, this relationship does not necessarily hold when also accounting for the numbers of people exposed to climate hazards (see Appendix 3, supplementary figures).

Instead, there is a clear relationship between deaths per capita from climate-related disasters and per capita health national spending. Countries that spend more on health tend to have fewer deaths from such disasters. While health spending (per capita) is related to the GDP (per capita) the relationship is not one to one (see Appendix 3 supplementary figures). Most notably, when ranking countries by the percentage of GDP that is spent on health, for the first three quartiles of countries, there is a decrease in deaths per capita from disasters related to climate hazards as the percentage increases. This would appear to support the notion that as governments allocate more of their GDP to health spending, per capita, they decrease the numbers of deaths (per capita) from climate-related disasters for all countries, except those in the highest percentage in health spending quartile. This raises serious questions as to which elements of health spending are most effective at reducing climate-related disaster deaths; for example, whether preparedness or primary health and/or response play the greatest role in minimising mortality.

Indicator 2.8: Health adaptation funding from global climate financing mechanisms

Headline finding: *The levels of adaptation funding fall far short of the commitments made in the Paris Agreement, with just 472.82 million USD of adaptation funding for development in 2017; only 3.8% of the funding in 2017 was allocated for health adaptation.*

This indicator makes use of the same data source (Climate Funds Update) and methods as described in the 2017 Lancet Countdown report.[9,58] The last 12 months saw the approval of a new health adaptation programme in East Asia and the Pacific to scale up health system resilience in Pacific Island Least Developed Countries. At $17.85 million USD, this was the only health-focused project approved in 2017, and represented 3.8% of the total 2017 adaptation spend for development ($472.82 million USD) – far less than the $100b USD annually for adaptation efforts by 2020 promised at the 2010 Cancun Agreements under the UNFCCC (see Appendix 3 for further details and a figure of these trends).[59]

Conclusion

The data presented in section 2 suggests that health professionals and health systems are increasingly considering and responding to the health effects of climate change. There appears to be more and earlier engagement in higher-resource settings, although there is evidence of adaptation activity in health sectors across the development and geographic spectrum. There is evidence of health adaptation occurring incidentally, through broader development initiatives, such as the IHRs (Indicator 2.3 and Indicator 2.4), and directly through specific climate change adaptation initiatives (Indicators 2.1, 2.2 and 2.6). Whilst absolute preparedness remains low, most trends followed here are moving in the right direction, and where vulnerability has been tracked, risks related to climate change appear to be decreasing. Despite this, absolute funding available for health adaptation remains particularly low, limiting further progress on this issue. Furthermore, powerful technological and financial limits to adaptation exist that necessitate a joint-focus on mitigation as part of the global response to climate change.[2]

Measuring health adaptation and resilience to climate change presents numerous methodological challenges, with most available metrics being proxy indicators of progress. These measures must be interpreted with caution and applied to climate change, rather than solely in their original context. This section has worked to present findings of indicators for adaptation assessments, planning, implementation, and financing.

Section 3: Mitigation Actions and Health Co-Benefits

Introduction

This section presents evidence relating to climate change mitigation and associated near-term consequences for health. The health impacts of climate change, and communities' ability to adapt to it, both depend on the success of global mitigation efforts. But there are also more immediate co-benefits of mitigation arising from the changes in harmful exposures (e.g. reductions in particle air pollution) and health-related behaviours that mitigation actions entail. The pace of the low-carbon transition therefore determines the degree to which such benefits are realised.

The changes since the 2017 report mostly reflect continuing trends or modest incremental shifts. There continues to be a shift of investment towards clean energy technologies, with accelerating growth in new low-carbon power generation (Indicator 3.3), and a downward trend in global demand for coal (Indicator 3.2). However, global energy sector carbon emissions remain largely unchanged (Indicator 3.1) and ambient air pollution levels remain generally poor (Indicator 3.5), with estimated contributions of different sectors to $PM_{2.5}$-attributable mortality presented in Indicator 3.5.2. There is accelerating uptake of electric vehicles, but the electricity they use is still largely derived from fossil fuels (Indicator 3.6), and they account for only a very small fraction of the vehicle fleet.

Indicator 3.1: Carbon intensity of the energy system

Headline Finding: *Since 1990, the carbon intensity of TPES has remained static with no reduction, at 55-57 tCO_2/TJ.*

This year's report includes four years of additional data to 2015, and shows that the global trend in carbon intensity remains broadly flat. This means an ever-widening gap from the path of rapid reduction towards zero emissions by 2050 is needed to fulfil the Paris Agreement – which would require a decline in carbon intensity approximately equivalent to an average reduction of 1.0-1.6 tCO_2/TJ per year (this carbon intensity metric estimates the tonnes of CO_2 for each unit of total primary energy supplied (tCO_2/TJ).

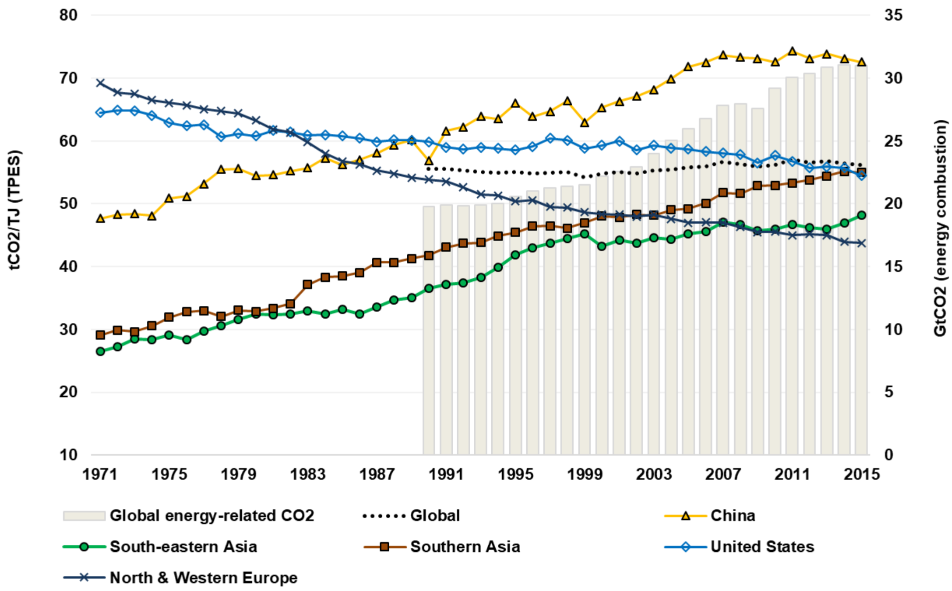

Figure 14. Carbon intensity of Total Primary Energy Supply (TPES) for selected regions and countries, and also global energy-related CO_2 emissions. This carbon intensity metric estimates the tonnes of CO_2 for each unit of total primary energy supplied (tCO_2/TJ). For reference, carbon intensity of fuels (tCO_2/TJ) are as follows: coal 95-100, oil 70-75, and natural gas ~56. (Source. IEA, 2017)[60]

Carbon intensity remains high despite the continued growth in renewable electricity (Indicator 3.3), and the slowdown in coal demand (Indicator 3.2), in large part because the growth in the use of other fossil fuels, such as oil and natural gas, has continued apace, especially in the rapidly growing economies of Asia (figure 14). Growth in renewables still has a long way to go to begin bending the intensity trend downwards, currently accounting for only 24% of total electricity generated of which 16% is hydro-electricity. In final energy terms, these sources only met 4.5% of global demand in 2015.[60]

Figure 14 suggests that CO_2 emissions levelled off from 2014, however recent analysis by the Global Carbon Project suggests that emissions have begun rising again, with a projected 1.5% increase between 2016 and 2017.[60] This rise, due to stronger economic growth in China and other developing regions, highlights that further structural change in the energy system is needed to safeguard gains. In addition to the demand side 'pull' for clean energy investments, policies are also needed that provide a supply side 'push' of existing fossil-based infrastructure out of the system to ensure a timely transition.[61] The methods and data sources for this indicator are described in full in the 2017 Lancet Countdown report, and Appendix 4.[9,60]

Indicator 3.2: Coal phase-out

Headline Finding: *Since 2013, coal use has declined, resulting largely from reductions in consumption in China, enhanced efficiency in coal-fired power generation, and continued increase in use of shale gas in the US. In 2016, this downward trend continued, however preliminary data suggests it may increase slightly in 2017.*

Accelerating the downward trend in coal demand will be critical to meeting the climate goals embodied in the Paris Agreement. For example, to push towards the 1.5°C target, coal use levels need to be at 20% of 2010 levels by 2040, or around 30 Exajoules (EJ) (figure 15).[62] While there is optimism that coal can be significantly reduced, particularly in China, the question is whether it can be achieved quickly enough to meet climate goals and whether this overall trajectory will also follow for countries with high growth demand.[63] For example, growth in India in 2016 was 2.4% (down from previous years), but consumption in member states of ASEAN (the Association of South East Asian Nations) , where coal is playing a small but growing role in electricity production, increased by 6.2% in 2016. Furthermore, recent estimates suggest a 1% increase in coal use in 2017.[64]

If coal phase-out can be sustained, it is likely to have significant air pollution co-benefits (Indicator 3.5), which in turn help offset the policy costs of mitigation.[65,66] Crucially, renewable generation has become increasingly cost-competitive, with recent auctions in India placing solar as the cheapest available form of electricity generation.[67,68]

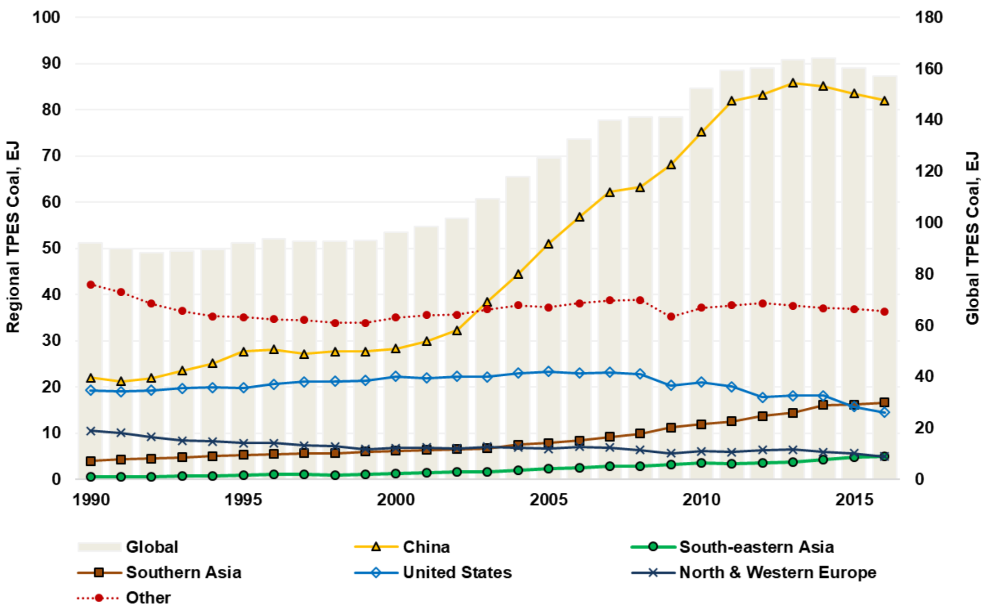

Figure 15 TPES coal use in selected countries and regions, and global TPES coal. (Source. IEA, 2017).[60]

There has also been strong political momentum since COP23 (December 2017), with a number of countries pledging to phase-out coal use (for instance, the UK, France, and Canada), forming the "Powering Past Coal Alliance".[70] Further, twenty additional countries committed at the most recent UN climate summit to phase-out the use of coal fired power generation by 2030, with a few countries, including France, Italy and the UK, aiming to phase-out coal earlier.[71] Other countries have included coal reduction targets in their Nationally Determined Contributions (NDCs) of the Paris Agreement.[72] For instance, Indonesia has stated that coal will make up no more than 30% of their energy supply by 2025 and 25% by 2050. Such commitments are crucial given coal demand continues to increase, particularly across Asia (figure 15); of the 60 GW of new coal plants installed globally in 2017 (100 GW in 2015), two thirds were in India and China.[73] Additional figures and details are available in Appendix 4.

Indicator 3.3: Zero-carbon emission electricity

***Headline Finding:** In 2017, 157 GW of renewable energy was installed (143 GW in 2016) compared to 70 GW (net) of fossil fuel capacity installation, continuing the trajectory of the trend reported last year.*

Low carbon electricity is booming, with strong prospects for displacing fossil fuels, such as coal, in the electricity generation sector due its cost-competitiveness. Globally, this is playing out with much more investment in renewable than fossil-based capacity, with renewable capacity installations in 2017 being more than double that of fossil fuel capacity.

Approximately 30% of current global generation is from zero-carbon sources, with the majority coming from hydro and nuclear. In 2015, 5% was from 'new' renewables (solar and wind), rising from 0.5% in 2000. This growth is particularly evident in the US, China, North West Europe, and India, all of which are expanding their renewables deployment (figure 16a and 16c). The increasing shares of renewable generation result in either displacing fossil generation or meeting a portion of new demand growth, reducing the need for investment in fossil fuels (figure 16d). The data and methods for this indicator are reported in the 2017 Lancet Countdown report and Appendix 4.[9,69]

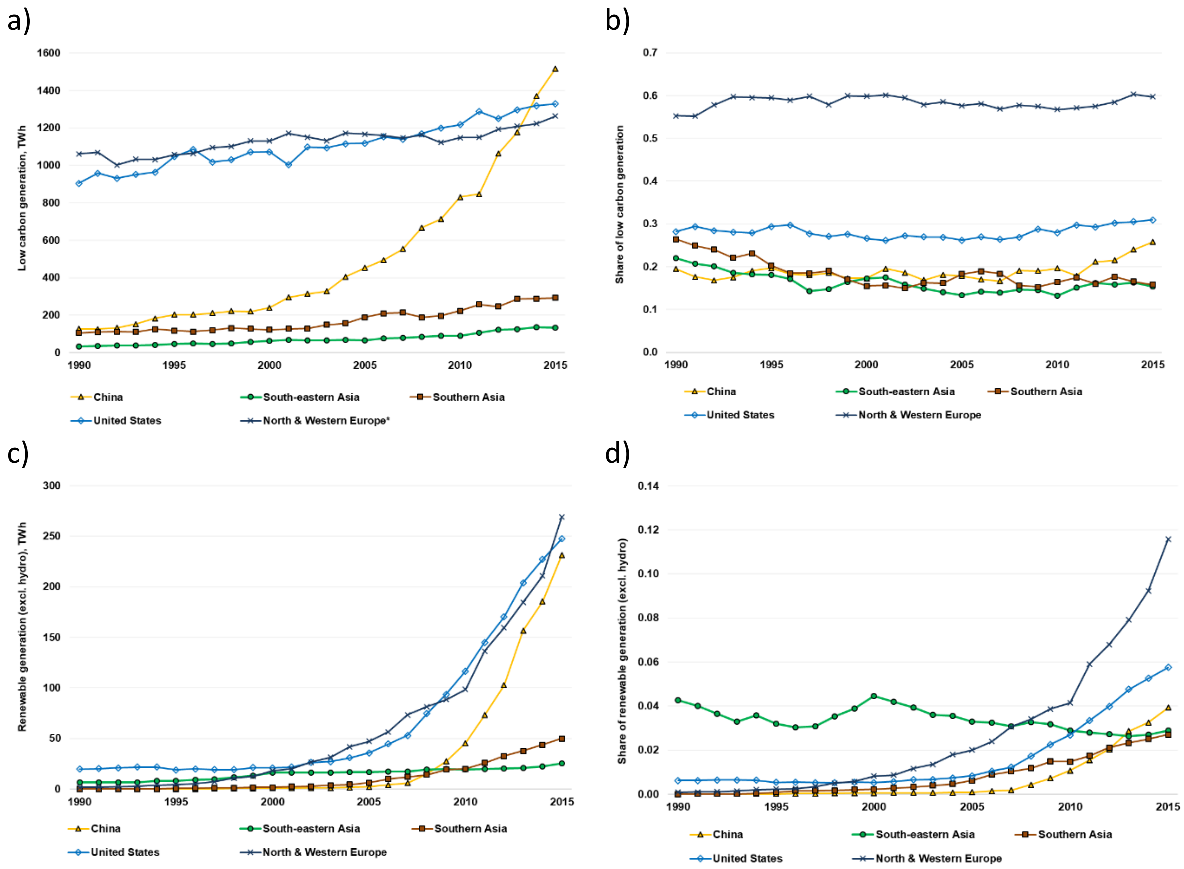

Figure 16. Renewable and zero-carbon emission electricity generation. a) Electricity generated from zero carbon sources, TWh; b) Share of electricity generated from zero carbon sources; c) Electricity generated from renewable sources (excl. hydro), TWh; d) Share of electricity generated from renewable sources (excluding hydro). (Source: IEA and IRENA, 2017)[69]

Indicator 3.4: Access to clean energy

Headline finding: *The number of people without connections to electricity fell from 1.7 billion in 2000 to 1.1 billion in 2016, and many countries will achieve electricity for all by 2030, with the greatest gains coming in East and South East Asia. Conversely, over 2.8 billion people still go without healthy, clean and sustainable cooking fuel or technologies; the same level as in 2000.*

The reduction in the number of people without access to electricity from 1.7 billion in 2000 to 1.1 billion in 2016 is primarily due to an increase in new connections made to a centralised grid, though modest gains continue for decentralised or micro-grids. Most new access was achieved using electricity generated with fossil fuels, highlighting a key challenge in moving towards a decarbonised energy system. Much of this growth has been driven by coal-generated power stations in India, China and South East Asia; at 37%, coal remains the main fuel used in global electricity production.[60] Although strong economic, health and social benefits come from increased use of electricity, there are costs (such as exacerbated outdoor ambient air pollution and GHG emissions) that will vary depending on how electricity is provided (Indicator 3.5). The residential sector's energy mix has changed over 15 years alongside access to electricity, which has been driven largely by fossil fuel generation. The complicated nature of the relationship between energy access and health is fraught, with local synergies and trade-offs (see panel 5).

Access and use of clean fuels and technologies for cooking has seen limited improvement since 2000 and in a number of countries negative trends have been observed as the access gap increases. Access to clean cooking remains an intransigent problem, with around 3 billion people (1.9 billion in developing Asia and 850 million in sub-Saharan Africa) without clean cooking fuel or technologies in 2016, exposing vulnerable populations to high levels of harmful indoor air pollution, estimated to cause 3.8 million deaths per year.[74] Biomass remains the single largest fuel source in the residential sector, which outlines the challenge of access to clean and modern fuels. Appendix 4 provides further details and a figure on the proportional national share of energy types for the residential sector for selected countries.

Panel 4. Energy, health and the Sustainable Development Goals

The 2030 UN Agenda for Sustainable Development is a comprehensive global plan of action for people, planet and prosperity, comprised of 17 SDGs and 169 Targets to be achieved by 2030. SDG 7 aims to ensure access to affordable, reliable, sustainable and modern energy, and provides an example of a Goal which delivers supporting infrastructure that underpins the achievement of other SDGs.

In recognition of these interactions, recent analysis of efforts to achieve SDG 7 and the delivery of the 169 Targets reveals evidence of 143 synergies and 65 trade-offs.[76] There are many interdependencies between energy and SDG 3 on health (ensure healthy lives and promote wellbeing for all at all ages), including evidence of synergies with eight of the thirteen targets, and trade-offs with five. Synergies exist, for instance, with Target 3.2 (end preventable deaths of children and newborns). Access to electricity supports using medical equipment at health centres, ensuring good surgery/delivery conditions, for pre-natal and neo-natal care, and for storage of medical supplies. Yet, there are potential trade-offs where, for example, electricity access (7.1) is provided with non-carbon neutral sources, with likely detrimental impacts on human health through air pollution (Targets 3.4, 3.9) and climate change (SDG 13).

The SDGs provide an important opportunity to realise the positive interactions between goals such as energy and health, and to minimise the negative outcomes. However, these relationships are often context-specific, requiring consideration of how actions to achieve one SDG may reinforce or undermine progress towards another. For energy and health, the needs will differ according to scale: for instance, communities cooking with firewood will require different solutions than cities dealing with high levels of ambient particulate matter from wood burning from heating homes.

Indicator 3.5: Exposure to ambient air pollution

An estimated 7 million people die each year from air pollution, 4.2 million of which results from ambient air pollution.[77] Much of this pollution is related to combustion processes, which would be substantially reduced by the achievement of climate change mitigation targets to phase-out dependence on fossil fuels. Yet rural areas are not spared, facing significant health burdens and air pollution from agricultural practices and household fuel use.

Indicator 3.5.1: Exposure to air pollution in cities

Headline finding: *From 2010 to 2016, air pollution concentrations have worsened in almost 70% of cities around the globe, particularly in LMICs. Populations in 90% of cities now experience air pollution levels above the WHO's guideline of 10 µg/m^3.*

Trends between 2010 and 2016 in urban concentrations of fine particulate matter ($PM_{2.5}$) were analysed from the Data Integration Model for Air Quality (DIMAQ) for 308 globally-representative cities of the Sustainable Healthy Urban Environments (SHUE) database.[78,79] Annual average levels of $PM_{2.5}$ increased in 208 (67.5%) of these cities and decreased in 100 (32.5%), with an average increase of 3.6 µg.m^{-3} a year (unweighted by population) (figure

17). The number above the WHO's annual guideline of 10 µg.m^{-3} increased from 254 (82.5%) to 268 (87.0%).

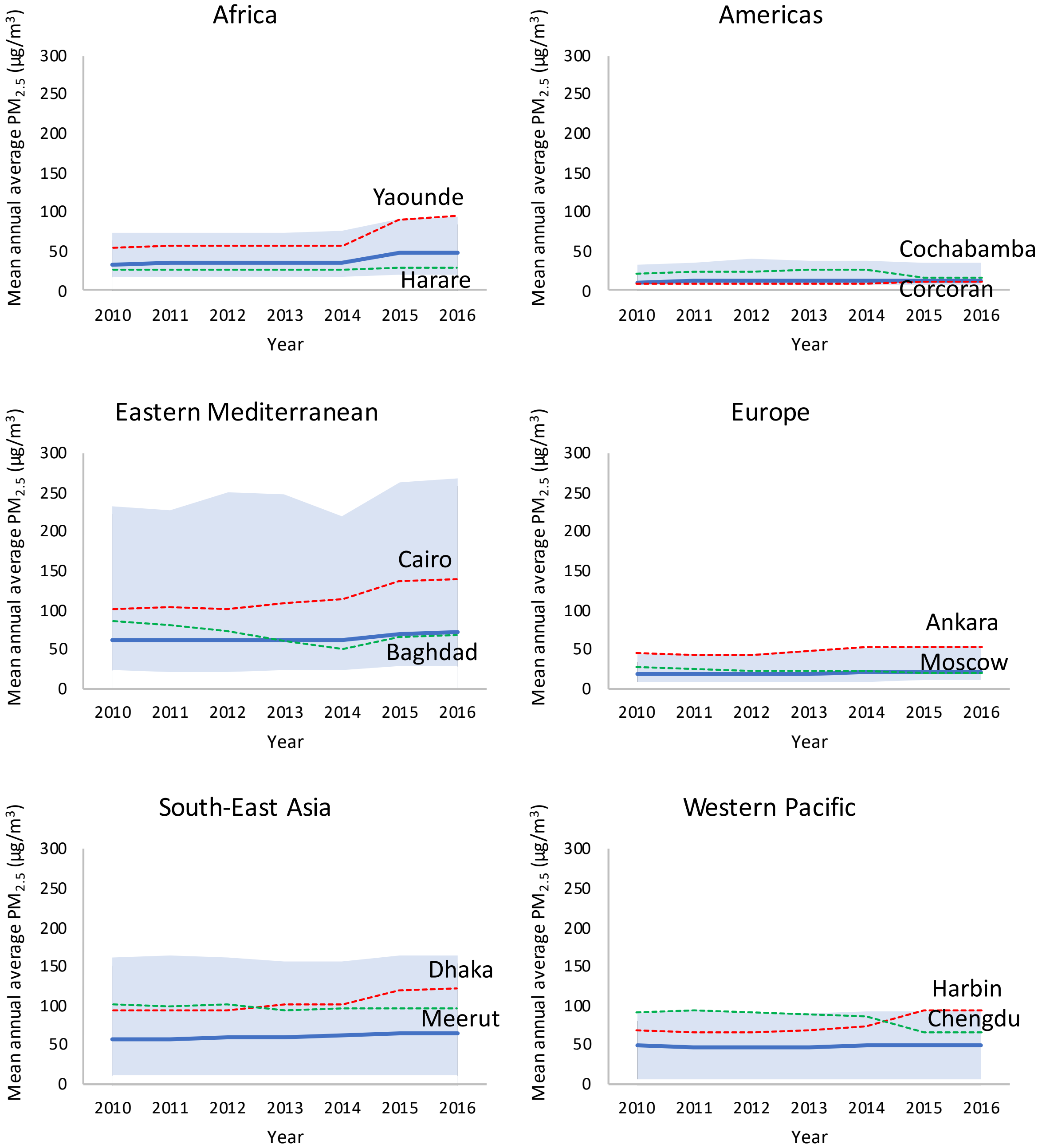

Figure 17. Mean of annual average $PM_{2.5}$ concentrations over the period 2010-2016 for SHUE cities by WHO region (blue lines) estimated using DIMAQ.[78] Also shown are the range for all cities (light blue shaded area) and cities with the largest decrease (green dotted lines) and increase (red dotted lines) over the period based on linear trends.

These estimates are consistent with those in 4,000 cities covered by the most recent update of the WHO's air pollution database.[80] Concentrations in the majority of cities remain well above recommended targets, especially in low- and middle-income settings,[81] and in part reflect the slow pace of change towards a low carbon world.

Indicator 3.5.2: Premature mortality from ambient air pollution by sector

***Headline Finding**: Ambient air pollution resulted in more than 2 million premature deaths globally in 2015 from fine particulates alone. Coal use accounts for approximately 16% of air pollution related premature mortality globally, making its phase-out a crucial 'no-regret' intervention for public health.*

Indicator 3.5.2 reports premature mortality from ambient $PM_{2.5}$, attributed to individual emission sectors by region. It is derived from calculations with the GAINS model, which calculates emissions of all precursors of $PM_{2.5}$ on a detailed breakdown of economic sectors and fuels used. Underlying activity data are based on statistics by the International Energy Agency (IEA).[82]

Emissions and concentrations correspond to the year 2015 and are calculated from updated statistics of the World Energy Outlook 2017. The geographical coverage has been expanded since the 2017 report to global coverage, and the breakdown refined to quantify contributions from coal combustion in all sectors (figure 18). Although the analysis is performed by country, results are aggregated to regions for clarity.

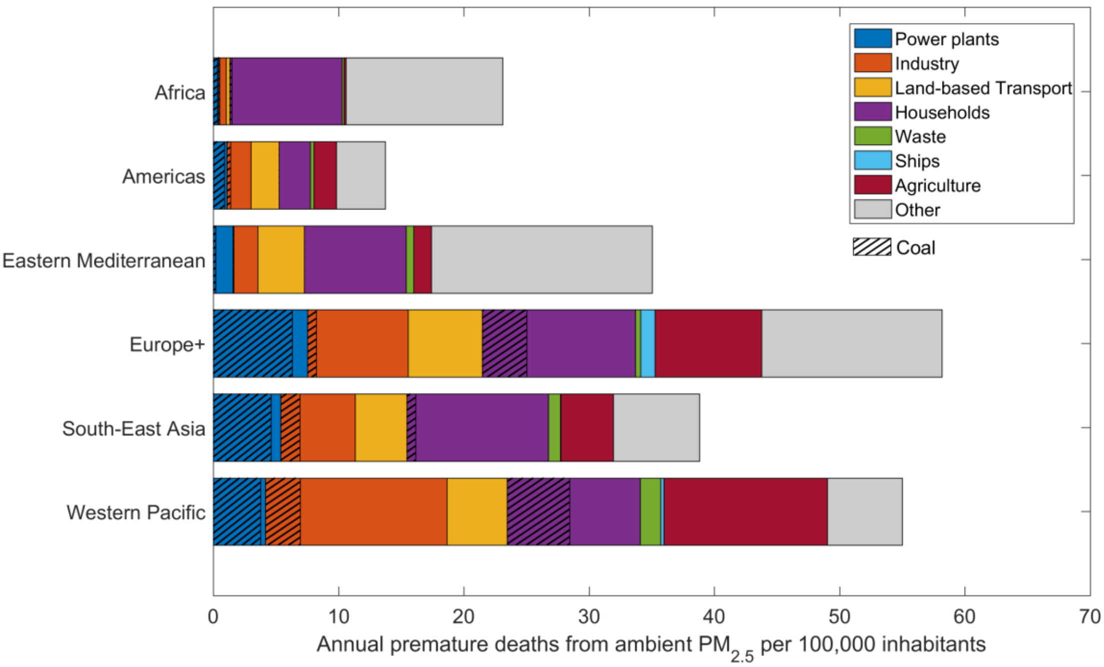

Figure 18: Health impacts of exposure to ambient fine particulate matter ($PM_{2.5}$) in 2015, by key sources of pollution by WHO region. Coal as a fuel is highlighted by hatching. Country aggregations see text.

The contribution of individual sectors to the total air pollution related premature mortality varies regionally, but multiple sources contribute in each region. Large contributions come from the residential sector (much from solid fuel (biomass and coal) and kerosene used for household heating and cooking); industry (dominant in East Asia), electricity generation, transport, and agriculture (from burning of agricultural waste and secondary inorganic aerosol formation). Coal is a key target for early phase-out because it is particularly polluting regarding both CO_2 and particulate matter. It is mainly used in electricity generation, industry, and (in some countries) households.

In total, exposure to ambient air pollution is estimated to have contributed to almost 3 million premature deaths globally (almost 2 million in Asia, 130,000 in the Americas, more than 300,000 in Africa, and almost 500,000 in Europe) in 2015. On average, globally more than 460,000 premature deaths from air pollution are related to coal combustion (about 16% of premature deaths); this rises to about 18% of premature deaths in Asia. Regional contributions vary from 9% in Southeast Asia, 14% in South Asia, to almost 30% in China and more than 40% in Mongolia, indicating large potentials for direct health benefits of coal phase-out. China and India are particularly affected, with an estimated 911,000 and 525,000 premature deaths from ambient air pollution, respectively; coal accounts for approximately 204,000 and 107,000 of these deaths, respectively. In the EU-28, premature mortality from ambient air pollution totalled about 310,000 in 2015; 54,000 premature deaths were from coal and 42,000 from the transport sector. Household fuel combustion is also a significant contributor, accounting for a total of 678,000 premature deaths globally in 2015 from ambient air pollution (136,000 from coal) and many more from indoor air pollution, and hence even larger reductions in premature mortality could be achieved through a transition to clean household fuels.{World Health Organization, 2016 #399}

Indicator 3.6: Clean fuel use for transport

Headline Finding: *Global road transport fuel use (TJ) increased 2% from 2013 to 2015 on a per capita basis. While fossil fuels continue to dominate, the growth in use of non-fossil fuels outpaced fossil fuels in recent history, rising by 10% over the same period.*

Fuels used for transport currently produce more than half the nitrogen oxides emitted globally and a significant proportion of particulate matter, posing a significant threat to human health.[83] These pollutants are predominantly urban in their nature and persist as a significant contribution to urban ambient air pollution and of pollutant related deaths (indicator 3.5), of which two-thirds are related to air pollution. This indicator monitors global trends in levels of fuel efficiency and the transition away from the most polluting and carbon-intensive transport fuels; it follows the metric of fuel use for road transportation on a per capita basis (TJ/person) by type of fuel.[84,85]

Globally, despite notable gains for electricity and biofuels, road transport continues to be powered almost exclusively by fossil fuels (figure 19). Since the previous publication, the use of non-fossil fuels (electricity and biofuels) has continued to out-pace fossil fuel energy rising over 10% on a per capita basis compared to an overall growth of 2% for fossil fuels from 2013 to 2015. This trend had a small, but notable, impact on the overall share of non-fossil fuel energy for road transport, which rose from 3.9% to 4.2% over these two years.

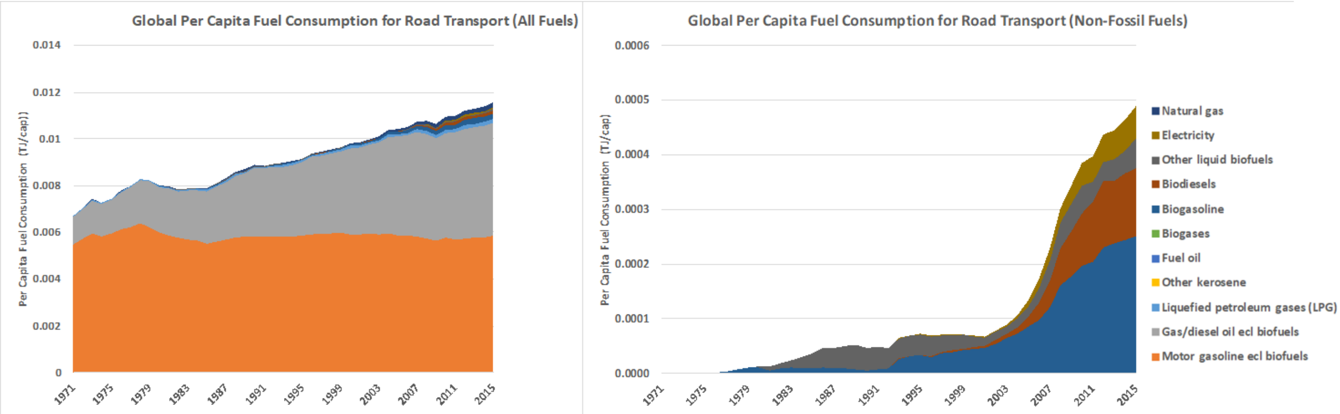

Figure 19. Per capita fuel use by type (TJ/person) for road transport with all fuels (left) and non-fossil fuels only (right). (Source: IEA, 2016) [86]

The take up of electric vehicles across the global motor vehicle stock has increased by a further 1 million vehicles, or 50% from 2016.[87] There are now more than 2 million electric vehicles on the road and global per capita electricity consumption for road transport grew by 13% from 2013 to 2015.[88] In OECD countries, per capita electricity consumption for transport more than doubled compared to a 10% increase in non-OECD. In China, per capita electricity use was five times the global average due to its high market share of electric vehicles. In 2016, China accounted for more than 40% of the electric cars sold globally (see Appendix 4 for further details and figure of these trends).[88]

Indicator 3.7: Sustainable travel infrastructure and uptake

Headline Finding: *Cycling comprised less than 7% of total modal share for one fifth of global cities sampled from the SHUE database and stratified by income, population size, and geography.*

Whilst the shift to clean fuels is imperative, GHG emissions and those of air pollutants can also be reduced by moving from private motorized transport to more sustainable modes of urban travel (such as public transport, walking and cycling). This reduces emissions from vehicles, crucial for addressing urban air pollution (Indicator 3.5.1) and has several health co-benefits. Focusing on sustainable travel infrastructure and uptake in urban areas, this section focuses on cycling modal share, presenting the data collected over the last decade from 48 of all the randomly sampled cities across the world (stratified by national wealth, population size, and Bailey's Ecoregion) in the SHUE database.[89] Mode share data come from travel surveys of individual cities, national census data, governmental and non-governmental reports (Appendix 4).

Within the sample, most cities have low cycling levels, with less than 10% of trips made by cycling. However, cycling levels are high in some Western Pacific cities, notably in Cambodia and China, and European cities, such as Copenhagen. Nonetheless, relatively low levels of cycling persist in the Americas, Eastern Mediterranean and many European cities (see Appendix 4 for figure on proportion of trips made by cycling vs per capita GDP for 48 cities)

Increasing the level of cycling in some settings is challenging, but there is room for improving cycling mode shares in many cities. Evidence suggests that good cycling infrastructure, integration with public transport, training of both cyclists and motorists, as well as making driving inconvenient and expensive, may help make cycling more attractive.[90,91] A full description of the data and methods for this indicator is available in Appendix 4.

Indicator 3.8: Ruminant meat for human consumption

***Headline Finding:** The amount of ruminant meat available for human consumption worldwide has decreased slightly from 12.09 kg/capita per year in 1990, to 11.23 kg/capita per year in 2013. The proportion of energy (kcal/capita per day) available for human consumption from ruminant meat decreased marginally from 1.86% in 1990 to 1.65% in 2013.*

Defining and tracking meaningful changes in sustainable, healthy food production presents multiple challenges. The 2017 report presented ruminant meat for human consumption (which decreased slightly from 12·09 kg/capita per year in 1990, to 11·23 kg/capita per year in 2013) because the production of ruminant meat, from cattle in particular, dominates GHG emissions from the livestock sector (estimated at 5·6–7·5 gigatonnes of CO_2e per year).[9] Although meat is a highly nutritious food, consumption of red meat, particularly processed red meats, has known associations with adverse health outcomes.[92,93] The major limitation of this indicator is that it reflects only one aspect of sustainable diets, which is unlikely to have equal health implications for high-income countries with excessive ruminant meat consumption and low-income countries with low ruminant meat consumption. Tracking progress towards more sustainable diets requires standardised and continuous data on food consumption and related GHG emissions throughout food product life cycles. This would require annual nationally representative detailed dietary survey data on food consumption. Efforts to compile data and ensure comparability are underway, but their current format is not suitable for global monitoring of progress towards optimal dietary patterns. The collaboration will continue to work on developing a standardised indicator on sustainable diets.

Indicator 3.9: Healthcare sector emissions

***Headline finding:** No systematic global standard for measuring the GHG emissions of the healthcare sector exists, but a number of healthcare systems in the UK, US, Australia and around the world are working to measure and reduce their GHG emissions.*

Comprehensive national GHG emissions reporting by the healthcare system is currently only routinely performed in the UK, where NHS emissions reduced by 11% from 2007 to 2015, despite an 18% increase in activity.[94] In Australia, CO_2 emissions of the health care sector were estimated at 35,772 kilotons in 2014-15, representing 7% of Australia's total emissions.[95] In the US, recent work has estimated the GHG emissions of the health care sector at 655 million metric tons, representing nearly 10% of US emissions.[96] Elsewhere, selected healthcare organisations, facilities, and companies provide self-reported estimates of emissions, however this is rarely standardized across sites. The Lancet Countdown will continue to work on developing a standardised indicator on health sector emissions.

Conclusion

The indicators presented in this section provide an overview of activities relevant to public health from climate change mitigation in the energy, transport, food and healthcare sectors. The indicators present a mixed picture. Positive trends include ongoing commitments to the phase-out of coal in many countries, the fact that renewable energy continues to account for most added capacity annually, and the increasingly rapid uptake of electric vehicles. However, the scale of the challenge in reversing the past trend and rapidly reducing GHG emissions is immense. Mitigation action to-date is still far short of the level required to meet the aspirations of the Paris Agreement to keep warming "well below" 2°C. Not only is this a concern for limiting the future harms of climate change, but it means many near-term benefits for health, such as those from improved air quality, are not being realised. Rapid acceleration of action in almost all sectors and across all regions is still needed.

Section 4: Finance & Economics

Introduction

So far, indicators in the first section of the Lancet Countdown's 2018 report have highlighted the health impacts of climate change, whilst those in sections 2 and 3 detail the adaptation and mitigation interventions deployed to respond to this public health challenge. Section 4 focuses on the financial and economic enablers of a transition to a low-carbon economy, and the implications of inaction. Although on the face of it, some of the indicators presented do not have an immediately obvious link to human wellbeing (for example, Indicator 4.3 - 'investment in coal capacity'), they are often important up-stream determinants and drivers of the processes described in Sections 1 to 3.

The consequences of climate change come with clear costs, both to human health and the economy, including through increased healthcare costs and decreased workforce productivity. However, there are also health and economic benefits to be gained from tackling climate change, beyond avoiding the potential costs of inaction. Markandya et al (2018) estimate that the global cost of reducing GHG emissions in line with the aims of the Paris Agreement could be offset by the economic value of improved health associated with the co-benefit of reduced air pollution alone, by a ratio of 2:1.[97]

The eight indicators in this section fall into four broad themes: the economic costs of climate change; investing in a low-carbon economy; economic benefits of tackling climate change; and pricing GHG emissions from fossil fuels. The methodologies and datasets used here closely mirror those from the 2017 Lancet Countdown report, with no significant changes to the indicators in this year's report.[9] The nature of economic and financial data allows for significant updates despite the regular annual update cycle of the Lancet Countdown. Appendix 5 provides a more detailed discussion of the data and methods used, as initially described in the 2017 Lancet Countdown report.[9]

Indicator 4.1: Economic losses due to climate-related extreme events

***Headline Finding:** In 2017, a total of 712 events resulted in $326 billion in overall economic losses, with 99% of losses in low-income countries remaining uninsured. This is almost triple the total economic losses experienced in 2016.*

The economic costs of extreme climate-related events, borne by individuals, communities, and countries, often compounds the direct health effects described in Indicators 1.2 – 1.6. These economic costs often result in insidious, indirect effects on health and wellbeing in the subsequent months-to-years. With projections suggesting the frequency and intensity of these events will increase significantly, this indicator tracks the present-day total annual economic losses (insured and uninsured) across country income groups relative to GDP, resulting from climate-related extreme events (figure 20).

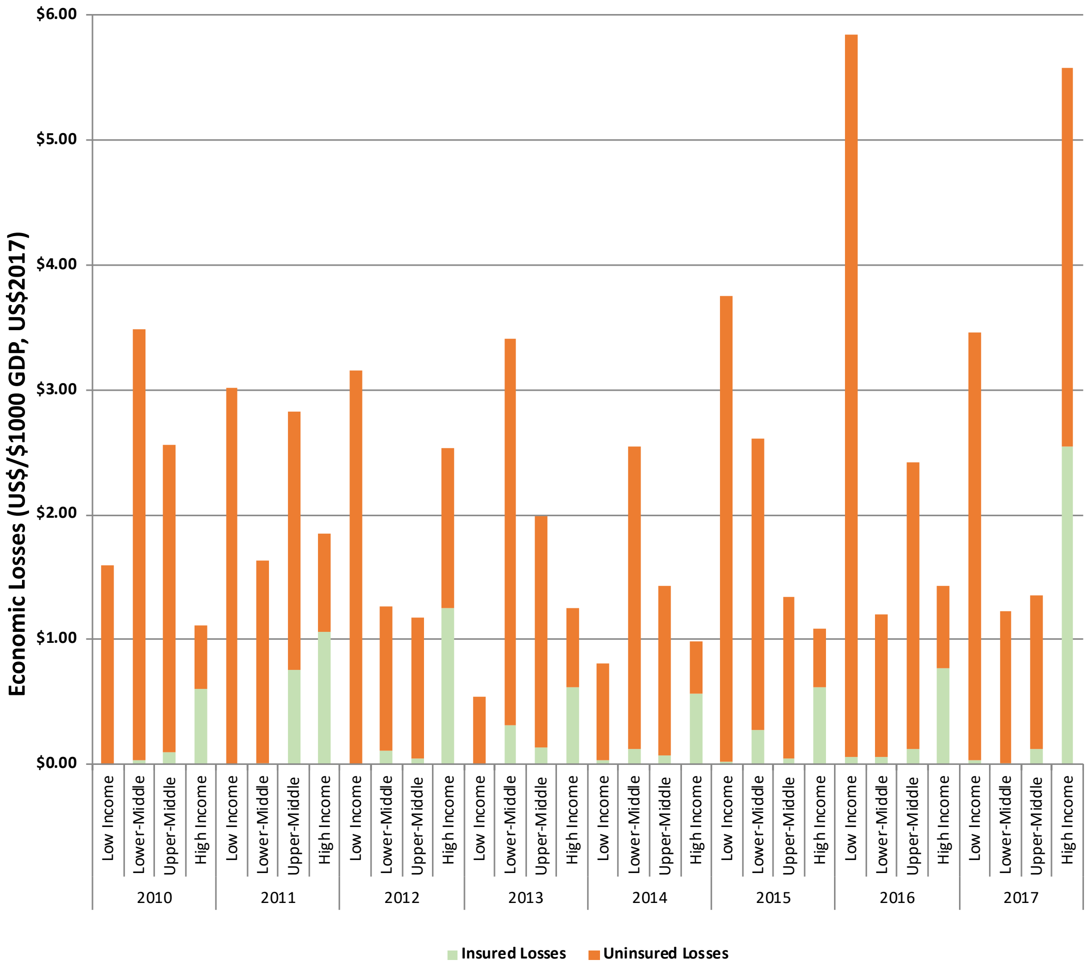

Figure 20. Economic Losses from Climate-Related Events Relative to GDP.

The data for this indicator is sourced from Munich Re's NatCatSERVICE, with climate-related events categorised as meteorological, climatological, and hydrological events (geophysical events are excluded). The methodology used has not changed since 2017, and is described in-full there, and in Appendix 5, along with data for 1990-2017.[9,98]

Global economic losses due to extreme climate-related events in 2017 were $327 billion, around triple the value for 2016. The vast majority of this increase in economic losses is in high-income countries, where losses relative to GDP increased from $1.44/$1000 GDP to $5.58/$1000 GDP. Economic losses in low-income countries decreased slightly between 2016 and 2017 in both absolute terms and per unit GDP. However, whereas nearly half of the losses in high-income countries were insured, it remains that just 1% of low-income country losses were insured.

Indicator 4.2: Investments in zero-carbon energy and energy efficiency

Headline Finding: *In 2017, proportional investment in zero-carbon energy and energy efficiency decreased as a proportion of total energy system investment, whilst fossil fuels increased. However, this is in part due to the declining costs of renewables.*

Indicator 4.2 monitors global investment in zero-carbon energy, and in energy efficiency (both as a proportion of the total energy system, and in absolute terms). All values reported are in US$2017, with data sourced from the IEA.[99-101]

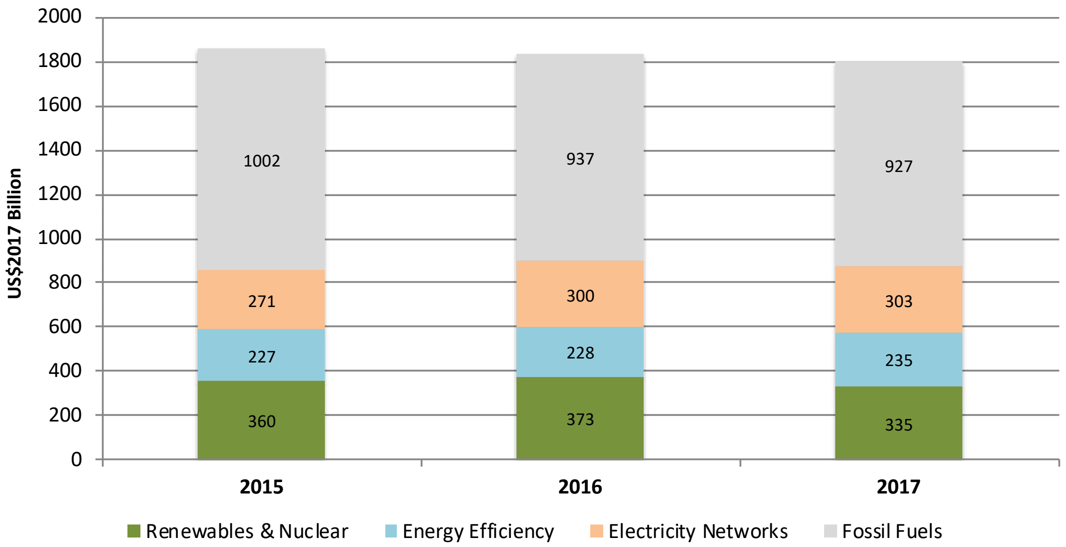

Figure 21. Annual Investment in the Global Energy System.

The methods and data sources for this indicator have not changed since the 2017 Lancet Countdown report, and are outlined in detail there, and in Appendix 5. The IEA estimated that in order to maintain a 50% chance of limiting global average temperature rise to 2°C, cumulative investment in the energy system from 2014 to 2035 must reach $53 trillion, with 50% of this invested in zero-carbon energy and energy efficiency.[102]

Total investment in the global energy system reduced by 2% in real terms between 2016 and 2017. Investment in fossil fuels reduced slightly, due to lower investment in coal electricity generation capacity (see Indicator 4.3), but offset to a large degree by increased investment in upstream oil and gas. Investment in zero-carbon energy also decreased due to a substantial reduction in new nuclear investment, but also due to a continuation of declining unit costs for renewables (e.g. solar PV reduced in cost by 15% between 2016 and 2017). Investment in energy efficiency continued to increase. However, overall, between 2016 and 2017, fossil fuels increased slightly as a proportion of total energy system investment, whilst zero-carbon energy and energy efficiency decreased (from 33% to 32%).[104]

Indicator 4.3: Investment in new coal capacity

Headline Finding: Investment in new coal capacity reduced substantially in 2017, reaching its lowest level in at least 10 years, from a possible all-time peak in 2015.

Indicator 4.3 tracks global annual investment in the most CO2-intensive method of generating electricity – the combustion of coal in coal-fired power plants. Figure 22 makes use of data from the IEA to present an index of annual investment in new coal capacity from 2006 to 2017.

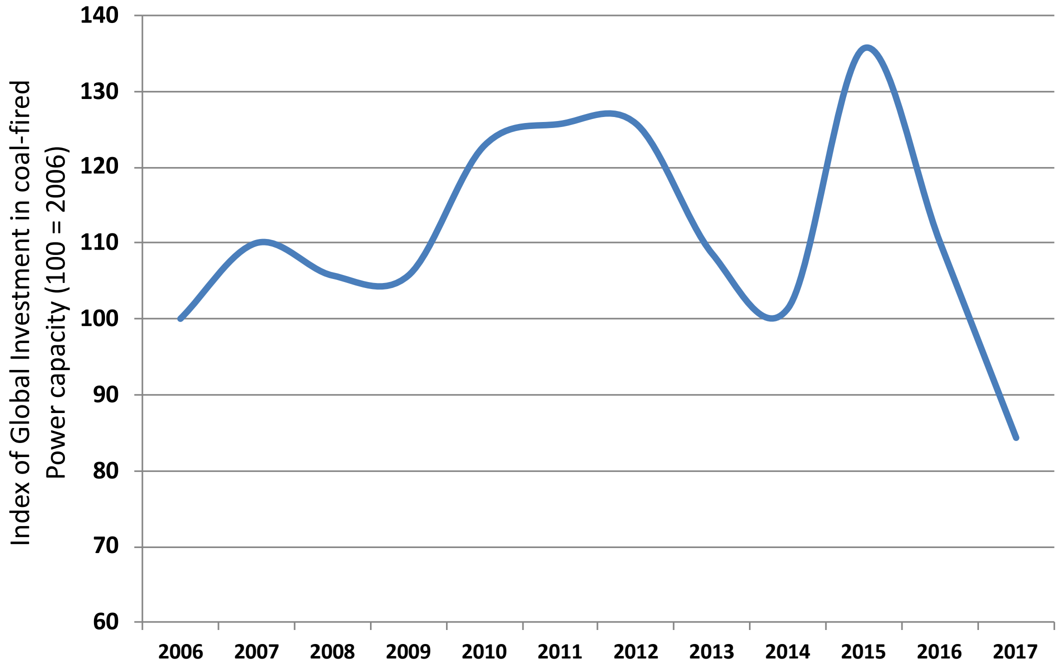

Figure 22. Annual investment in coal-fired capacity from 2006 to 2017 (an index score 100 corresponds to 2006 levels). (Source: IEA,2018)[100,101]

The methods and data sources (IEA) for this indicator have not changed since the 2017 Lancet Countdown report, and are outlined in detail there, and in Appendix 5.[9,100]

As illustrated in Figure 22, investment in new coal-fired electricity generating capacity reduced substantially in 2017, continuing the experienced in 2016. This is largely a result of fewer new plants being commissioned in China and India. Investment in new coal capacity is at its lowest in over 10 years, with the IEA suggesting that investment in coal-fired capacity having reached an all-time peak in 2015.[103] In addition, the retirement of existing coal-fired capacity offset nearly half of new capacity additions in 2017.[104]

Indicator 4.4: Employment in renewable and fossil fuel energy industries

Headline Finding: *In 2017, renewable energy provided 10.3 million jobs – an increase of 5.7% from 2016. Employment in fossil fuel extraction industries also increased to 11 million – an 8% increase from 2016.*

As the low-carbon transition gathers pace, fossil fuel energy industries and associated jobs will decline. Employment in some key fossil fuel industries, such as coal mining, have well documented impacts on human health.[9] However, in their place new low-carbon industries and employment opportunities, such as in the renewable energy sector, will be stimulated. With appropriate planning and enabling policy, the transition of employment opportunities between high and low-carbon industries may yield positive consequences for both the economy and human health.

This indicator tracks global direct employment in fossil fuel extraction industries (coal mining and oil and gas exploration and production) and direct and indirect (supply chain) employment in renewable energy, presented in figure 23. The data for this indicator are sourced from the International Renewable Energy Agency (IRENA) (renewables) and IBIS World (fossil fuel extraction).[104-106]

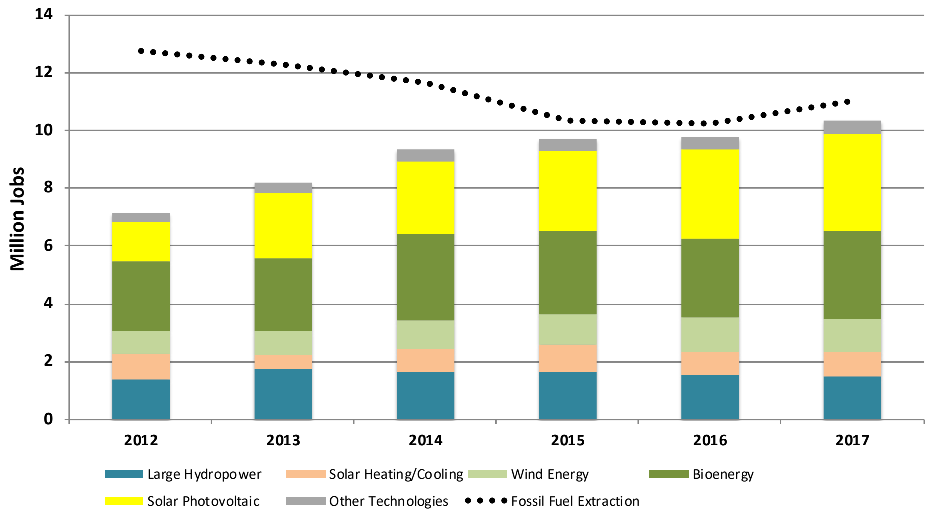

Figure 23. Employment in Renewable Energy and Fossil Fuel Extraction Sectors.

The number of direct and indirect jobs in the global renewable energy industry continues to increase, reaching 10.3 million in 2017 (a 5.7% increase from 2016). Solar photovoltaic (PV) overtook bioenergy to become the largest employer in 2016, and saw a further 9% growth in 2017 (driven by China and India). Employment in biofuels increased for the first time since 2014 (a 12% increase in 2017 from 2016 levels), due to increased production of ethanol and biodiesel (particularly in Brazil and the USA).[106]

Bucking the trend of decreasing employment in the global fossil fuel extractive industries (particularly in coal mining) established in 2011, driven by reducing prices, industry consolidation and the rise in automation, employment rose by around 8% between 2016 and 2017.[9] This rise is also driven by the coal mining sector, reflecting expansion due to a double-digit price increase. However, it is likely that the decreasing trend will return, as the low-carbon transition progresses.[104]

The data for fossil fuel extraction employment for 2012-2016 differs significantly from that presented in the 2017 Countdown report, due an improved methodology in the data collection and estimation methodology for global coal mining employment by IBIS World. Further detail on this indicator is in Appendix 5.

Indicator 4.5: Funds divested from fossil fuels

Headline Finding: *In 2017, the global value of funds committed to fossil fuel divestment was $428 billion, of which health institutions accounted for $3.28 billion; this represents a cumulative sum of $5.88 trillion, with health institutions accounting for $33.6 billion.*

Indicator 4.5 tracks the total global value of funds committed to divestment from fossil fuels, and the value of funds committed to divestment by health institutions. This recent and evolving movement seeks to both "remove the social license" of the fossil fuel industry and guard against the risk of losses due to 'stranded assets' by encouraging institutions and investors to commit to divest their assets invested in the industry. This approach is often contrasted with an approach that sees investors actively engage with the fossil fuel industry, for example by looking to mandate a reduction in high-carbon activities through shareholder resolutions. These two approaches may not be mutually exclusive, and may be most effective when employed in tandem.[107]

By the end of 2017, 826 organisations with cumulative assets worth at least $5.88 trillion, including 17 health organisations with assets of around $33.6 billion, had committed to divest, including the World Medical Association, Royal Australasian College of Physicians, and the Canadian Medical Association.[108] Between 2016 and 2017, the annual value of new funds committing to divesting slowed from $1.24 trillion in 2016, to $428 billion in 2017. However, health institutions have divested at an increased rate, moving from $2.4 billion in 2016 to $3.28 billion in 2017, with the American Public Health Association, the Hospital Contributions Fund, and Medibank Australia as notable contributors.

In the context of this indicator, divestment is broadly defined, and includes organisations that have committed to divest from one form of coal, through to those which have actively divested from all fossil fuel industries. Ultimately, the Lancet Countdown aims to analyse levels of divestment from different sectors. The methodology and data for this indicator has not changed since the 2017 Lancet Countdown report; further details are available in Appendix 5.[108]

Indicator 4.6: Fossil fuel subsidies

Headline Finding: *In 2016, fossil fuel consumption subsidies continued to follow the trend established in 2013, decreasing to $267 billion – a 15% reduction on 2015 levels.*

Section 3 of this report makes some of the cardiopulmonary consequences of fossil fuel combustion clear. Fossil fuel subsidies (both consumption and production) artificially lower prices, promoting overconsumption, further exacerbating air pollution and its consequences for human health.

This indicator tracks the global value of fossil fuel consumption subsidies. Whilst these are intended to moderate energy costs for low-income consumers, in practice, 65% of such subsidies in LMICs benefit the wealthiest 40% of the population.[109] Figure 24 demonstrates a continuation of a downwards trend that began in 2013, with global fossil fuel consumption subsidies reaching $267 billion in 2016.[60]

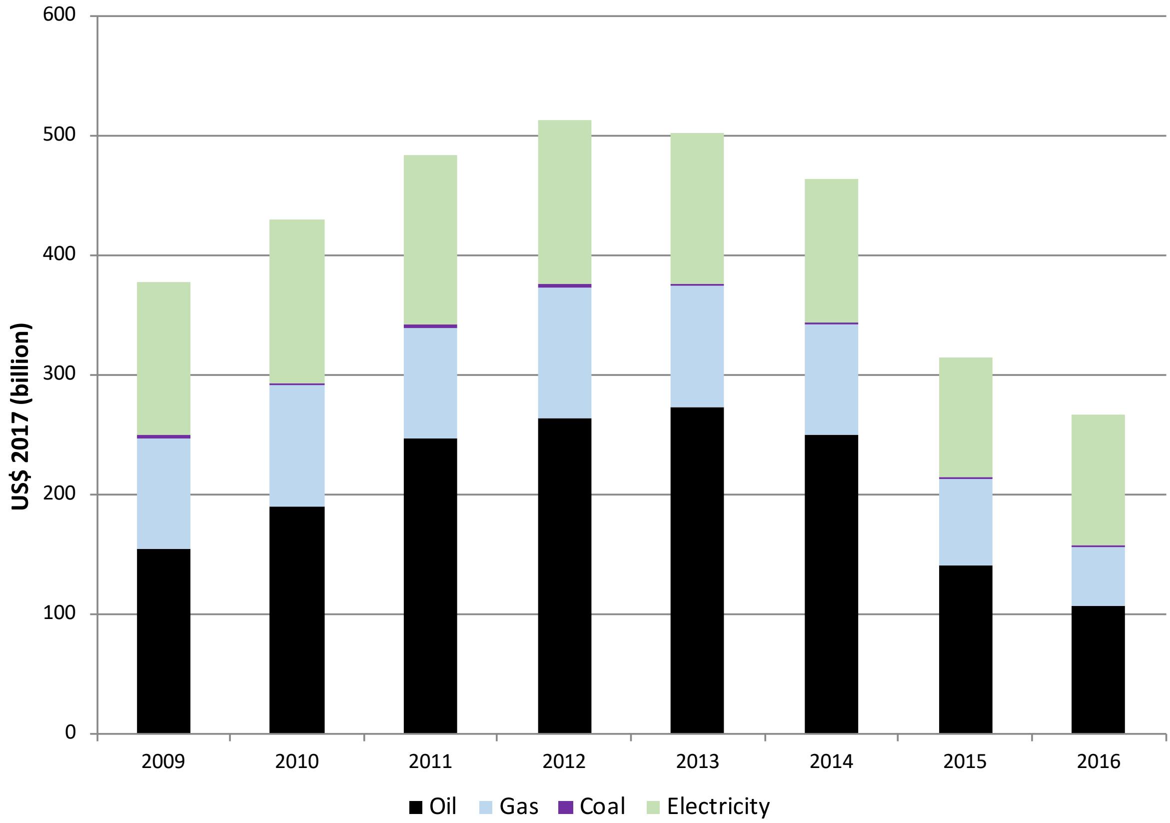

Figure 24. Global Fossil Fuel and Electricity Consumption Subsidies – 2009-2016.

Increasing fossil fuel prices tend to increase subsidy levels as the difference between the market and regulated consumer price increases. For example, the doubling in oil price between 2009 and 2012 was the principal driver behind the increase in subsidies in these years. However, when fossil fuel prices reduce, the gap between market and regulated prices also narrows, allowing governments to review the use of such subsidies while keeping overall prices largely constant.[60]

Both factors were responsible for the declining trend experienced between 2012 and 2015, continuing to be the case into 2016 with a further decrease in oil prices (to levels not seen since 2002), and continuing subsidy reforms in the Middle East in particular.[9,110] Although the Middle East continues to provide around 30% of total subsidies, their value decreased from around $120 billion in 2015 to $80 billion in 2016. As a result, subsidies to electricity consumption in 2016 were – for the first time since such data was collected – larger than those provided to oil consumption.[60]

The methodology and data source (IEA) for this indicator has not changed since the 2017 Lancet Countdown report, and is described there and in Appendix 5.[9,60] However, the breakdown by fuel for 2009-2013, which was previously not available, is now included.

Indicator 4.7: Coverage and strength of carbon pricing

***Headline Finding:** Carbon pricing instruments in early 2018 continue to cover the 13.1% of global anthropogenic GHG emissions reached in 2017, but with average prices around 20% higher than experienced in 2017.*

Adequately pricing carbon (both in terms of strength, coverage, and integration of varying mechanisms) could potentially be the single-most important intervention in responding to climate change. This indicator tracks the extent to which carbon pricing instruments are applied around the world as a proportion of total GHG emissions, and the weighted average carbon price instruments provide (table 2). The same methodology and data source (World Bank Carbon Pricing Dashboard) were used for this indicator as the 2017 Lancet Countdown report and is further detailed in Appendix 5.[9,111]

	2016	2017	2018
Global Emissions Coverage*	12.1%	13.1%	13.1%
Weighted Average Carbon Price of Instruments (*current prices, US$*)	$7.79	$9.28	$11.58
Global Weighted Average Carbon Price (*current prices, US$*)	$0.94	$1.22	$1.51

Table 2. Carbon Pricing – Global Coverage and Weighted Average Prices per tCO2e. * Global emissions coverage is based on 2012 total anthropogenic GHG emissions.

The coverage of carbon pricing instruments remained at 13.1% of global anthropogenic GHG emissions between 2017 and 2018, implemented through 42 national and 25 sub-national instruments (see Appendix 5 for global map of carbon pricing instruments).

The range of carbon prices across instruments remains vast (from <$1 /t$CO_2$e in Poland and Ukraine, to $139 /t$CO_2$e in Sweden), although weighted-average prices in early 2018 were 20% above 2017 levels (both across instruments, and total global anthropogenic GHG emissions). For example, the price under the EU Emissions Trading Scheme (ETS) (the largest carbon pricing instrument in the world) rose by $10 /t$CO_2$e between 1st December 2017 and 1st April 2018.

With the addition of instruments currently scheduled for implementation, including the Chinese national ETS (replacing the existing sub-national 'pilots'), around 20% of global anthropogenic GHG emissions will be subject to a carbon price.[112] Further carbon pricing instruments are under consideration in several other national and sub-national jurisdictions.

Indicator 4.8: Use of carbon pricing revenues

***Headline Finding:** Revenues from carbon pricing instruments increased 50% between 2016 and 2017, reaching $33 billion, with $14.5 billion allocated to further climate change mitigation activities.*

Indicator 4.8 tracks the total government revenue from carbon pricing instruments and how such income is subsequently allocated. Government revenue from carbon pricing instruments may be put to a range of uses. Revenue may be invested in climate change mitigation or adaptation activities, be explicitly recycled for other purposes (such as enabling the reduction of other taxes or levies), or simply contribute towards general government funds.

Government revenue generated from carbon pricing instruments in 2017 totalled nearly $33 billion; a 50% increase from the $22 billion generated in 2016. This is driven by a combination of increasing carbon pricing coverage in 2017 (with the introduction of the Ontario ETS and carbon taxes in Alberta, Chile and Colombia), an increase in average prices, and an increasing share of ETS permits bought at auction (rather than distributed for free).[112]

The absolute value of allocated funds has increased in all four categories, with the proportional share remaining largely stable between 2016 and 2017. The most marked change is a shift of approximately 4% of total revenue from 'revenue recycling' to 'mitigation' (see Appendix 5 for a description of the four categories). This is in part driven by Colombia and particularly Ontario, committing to allocate all revenues from their newly-introduced instruments to further mitigation action.
Data on revenue generated are provided on the World Bank's Carbon Pricing Dashboard, with revenue allocation information obtained from various sources. Only instruments with revenue estimates and with revenue received by the administering authority before redistribution are considered. The methodology and principle data source (World Bank) for this indicator has not changed since the 2017 Lancet Countdown report, and is described there and in Appendix 5, along with further detail on the various sources used to obtain this global picture of carbon pricing revenues, and data for individual instruments.[9,111,112]

Conclusion

Section 4 has presented indicators on the costs of the broader impacts of climate change, and the economics and finance that underpins climate mitigation. The results of these indicators suggest that the beginning of an economic transition towards a low-carbon economy is underway, with many of the trends identified in the 2017 report continuing. These trends can be interpreted as early signs of a broader transformation, with important health benefits to follow, as a result of growing investment in low-carbon technology and employment, a transition away from fossil fuels, and strengthened and expanded pricing of GHG emissions.

However, the indicators presented here also make clear that meeting the Paris Agreement will require significant further engagement from government, the private sector, and the general public to increase the pace and scale of action. This broader engagement is described in detail in the final section of the report.

Section 5: Public and Political Engagement

Introduction

As earlier sections make clear, "climate change is still moving much faster than we are" and its negative impacts on human health continue to multiply.[113] The impact (section 1) and response (sections 2-4) sections of this report highlight the fact that action to date remains insufficient to achieve the ambitions of the Paris Agreement.[114] Public and political engagement is central to increasing the speed and scale of action.

Four domains of engagement are the focus of this final section: media, science, government and corporate sector. Indicators have been identified for which annual and global data are available. Trends are largely reported from 2007, the year before the 2008 World Health Assembly where member states of the UN resolved to protect human health from climate change.[115]

The media play a central role in public understanding and perceptions of climate change.[116] The public rely on the news media to communicate and interpret climate change science, as well as to make sense of extreme weather events and assess actions by businesses and governments.[117,118] The first indicator enriches the methods deployed in 2017, providing a global overview of media coverage of health and climate change from 62 newspapers, which is then complemented with expanded in-depth analysis of three national newspapers: the New York Times (US), Le Monde (France) and *Frankfurter Allgemeine Zeitung* (Germany).

The second indicator focuses on science journals, the major source of evidence on health and climate change for the public, policymakers and business sector. The third indicator focuses on government engagement in health and climate change. Surveys point to widespread public concern about climate change and its health-related risks, with most people believing that their country has a responsibility to take action on climate change and that their government is not doing enough.[119-121] This indicator captures high-level government engagement by tracking references to health and climate change in the statements made by national governments at the annual United Nations General Debate (UNGD) of the United Nations General Assembly (UNGA). The UNGD is a unique international forum that provides all UN member states with the opportunity to address the UNGA on issues they consider important.[122]

The corporate sector is integral to the transition to a low-carbon economy, both through their business practices and by influencing political responses to climate change.[123,124] Data for this new indicator comes from the United Nations Global Compact (UNGC), where companies report annually on their progress on embedding environmental sustainability and the SDGs into their business plans and activities.[125,126]

Indicator 5.1: Media coverage of health and climate change

***Headline Finding:** Coverage of health and climate change in the media increased substantially between 2007 and 2017, a trend evident in both the global indicator and in-depth analysis of leading global newspapers.*

This indicator tracks coverage on health and climate change in the global media and provides insight into the content of media coverage through analysis of selected leading newspapers.

Global media coverage of health and climate change increased by 42% between 2007 and 2017 (figure 25). This increase contrasts with global newspaper coverage of climate change alone. While climate change coverage declined at an average rate of 1.25% per year, coverage of health and climate change increased by an average of 4% per year. There are marked regional differences, with more extensive media coverage in South East Asia driving the global trend (figure 25). South East Asian coverage accounts for a large proportion (42%-64%) of global coverage across the period. Moreover, the overall increase in global coverage is driven by increased coverage in this WHO region, with the Times of India, India's largest English-language newspaper, contributing disproportionately to the global total.[127] English-language newspapers occupy a particularly central place in the Indian media by communicating the perspectives and priorities of political and business elites.[128,129]

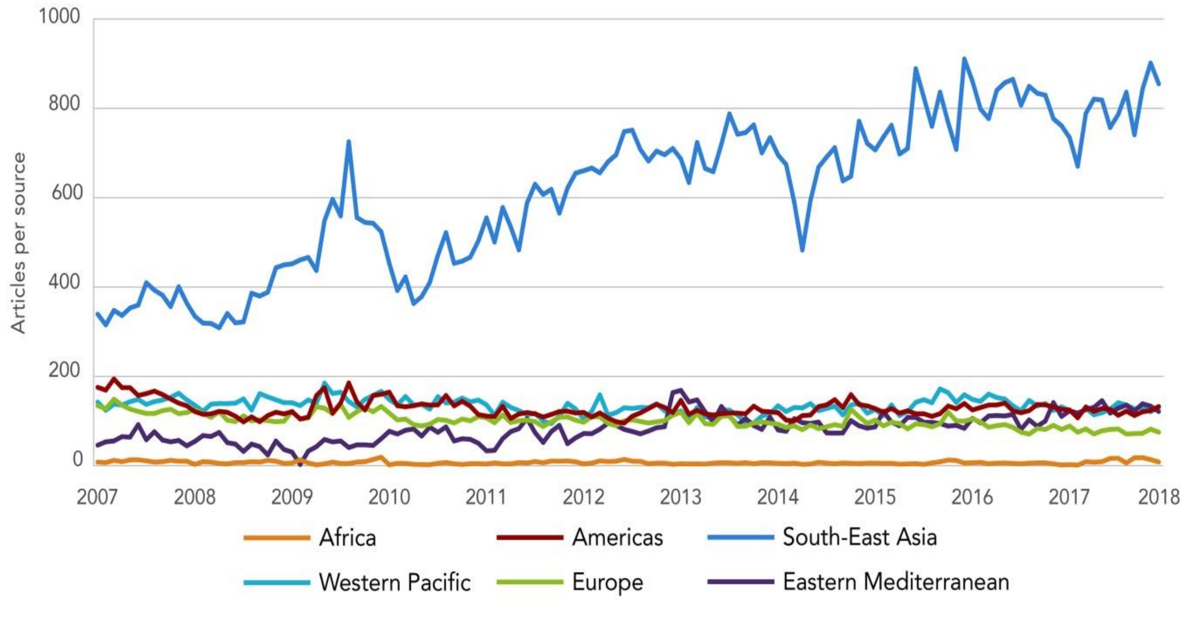

Figure 25. Newspaper reporting on health and climate change (for 62 newspapers), by WHO region, 2007-2017

Methods and data sources for this indicator are described in full, in the Lancet Countdown's 2017 report and in Appendix 6.[9] Analysis has been expanded significantly, from 24 newspapers in 2017, to 62 newspapers in 2018.

The second component of Indicator 5.1 focuses on three major national newspapers that form part of the 'élite' news media seen to play a pivotal role in shaping public and political responses to climate change.[130] Coverage of health and climate change increased in all three newspapers (figure 26). Between 2009 and 2017, the number of articles increased by 200% in *Frankfurter Allgemeine Zeitung (FAZ)*, 133% in *The New York Times (NYT)* and 18% in *Le Monde*. However, as figure 26 indicates, health remains marginal to wider climate change coverage. Of the climate change articles published in 2017 in the *NYT* and in *FAZ*, only 2% referred to health and climate change; in *Le Monde*, the proportion was slightly higher, at 8%. Media attention has been characterised by peaks linked to climate change action at the global level, and to the UNFCCC COPs in particular.[9]

Content analysis of the three newspapers points to marked national differences in coverage. In the European newspapers, the proportion of articles explaining and justifying why climate change is a public health issue declined over the period, with a parallel increase in those highlighting the health dimensions of national climate change interventions. In contrast in the *NYT*, most (92%) articles referring to both health and climate did so without linking them; for example, they referred separately to US healthcare reforms ('Obamacare') and to US disengagement from the Paris Agreement. Such articles are therefore not included among those linking health and climate change in figure 26. In the European newspapers, health and climate change are most frequently covered in the news sections; for example, as an environmental issue (*Le Monde*) and an economic issue (*FAZ*). However, in the *NYT*, health and climate change appear less frequently as news items and more frequently within the Opinions section. The distinctive patterns of US media coverage of climate change have also been noted elsewhere.[131]

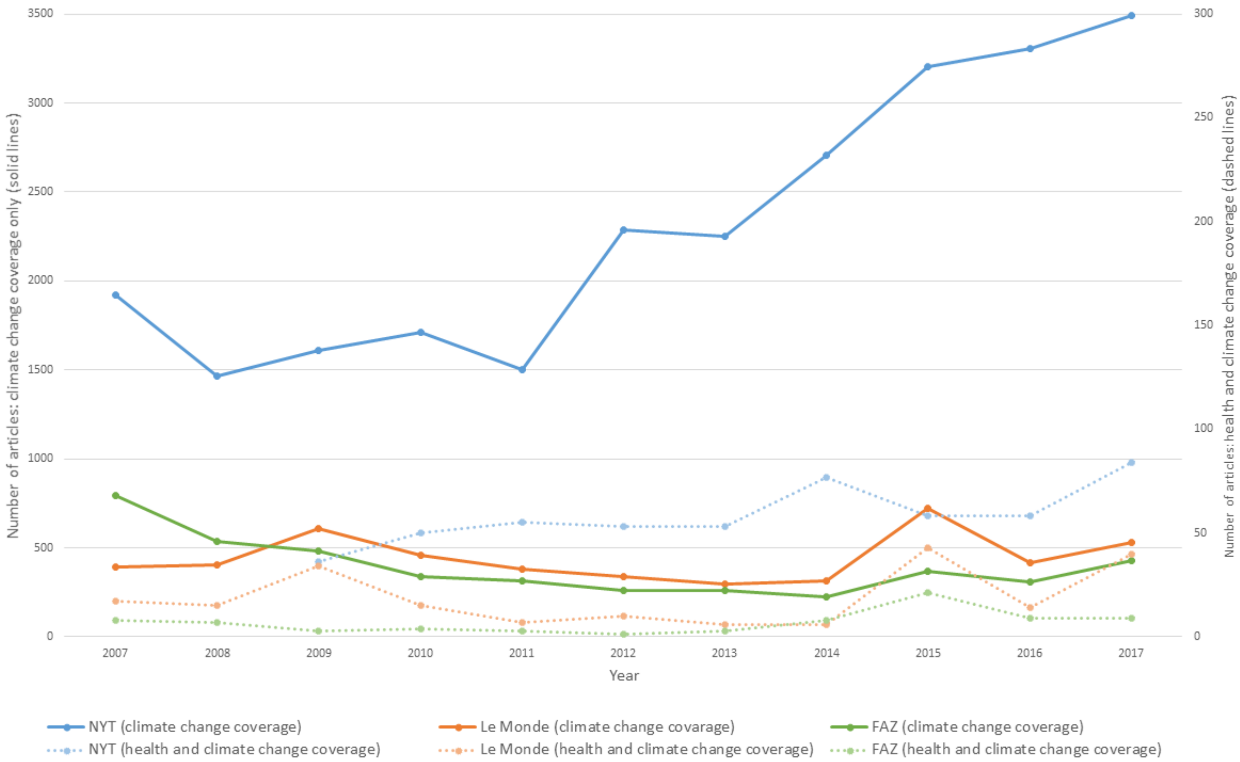

Figure 26. Newspaper reporting of a) climate change, and b) health and climate change, in the *New York Times* (NYT), *Le Monde*, and *Frankfurter Allgemeine Zeitung* (FAZ), from 2007-2017.

Methods and data sources are described in full in the 2017 Lancet Countdown report and in Appendix 6.[9] The analysis here has been enhanced both by the addition of a third national newspaper (*NYT*) and by examining media engagement in health and climate change in the context of wider coverage of climate change; further analyses are also presented in the Appendix 6.

Indicator 5.2: Coverage of health and climate change in scientific journals

Headline Finding: *Coverage of health and climate change increased by 182% in scientific journals between 2007 and 2017.*

Between 2007 and 2017, over 2,500 scientific articles examined the links between climate change and health. Just under half (47%) presented new research. The remainder comprised research-related articles (research reviews, editorials, comments, viewpoints etc.), with research reviews making up the majority (55%) of these. The slight decline in scientific output on health and climate change between 2016 and 2017 is the result of fewer research-related publications (see Appendix 6 for figure showing these trends).

As in previous years, scientific interest in health and climate change in 2017 was focused on America and Europe. Over a third (35%) of the papers concentrated on climate change and health in America, with just under 30% of all papers concerned with North America only. A further 25% focused on countries in Europe. Of the 20% of articles relating to the Western Pacific region, half focussed solely on China. Less than 10% of papers related to health and climate change in Africa (n=23) and South East Asia (n=18), a region that includes India and Bangladesh. With respect to health outcomes, infectious diseases (particularly dengue fever and other mosquito-borne diseases) were the most common health focus (24%).

While this analysis points to increasing scientific engagement in health and climate change over the last decade, the area is marginal to climate change science. Of the 43,000 articles published in 2017 in the general area of climate change, only 4% made any link to health and <1% (n=265) had a specific focus on health and climate change.

Methods and data sources are explained in full, in the Lancet Countdown's 2017 report, and in Appendix 6.[9] In addition to updating the analysis to include 2017, this year's report also explores the type of scientific output (research or research-related) and the volume of outputs relating to climate change more broadly.

Indicator 5.3: Engagement in health and climate change in the United Nations General Assembly

Headline Finding: *From 2007 to 2017, national statements in the UN General Debate have increasingly linked climate change and health.*

Figure 27 presents trends from 1970 to 2017, looking separately at references to health, to climate change and to health and climate change. Whilst both health, and climate change, have been central focuses of the UNGD for an extended period, joint references to health and climate change did not truly begin to rise until 2000. Since 2007, trends in engagement in health and climate change have broadly matched the separate trends for climate change and health.

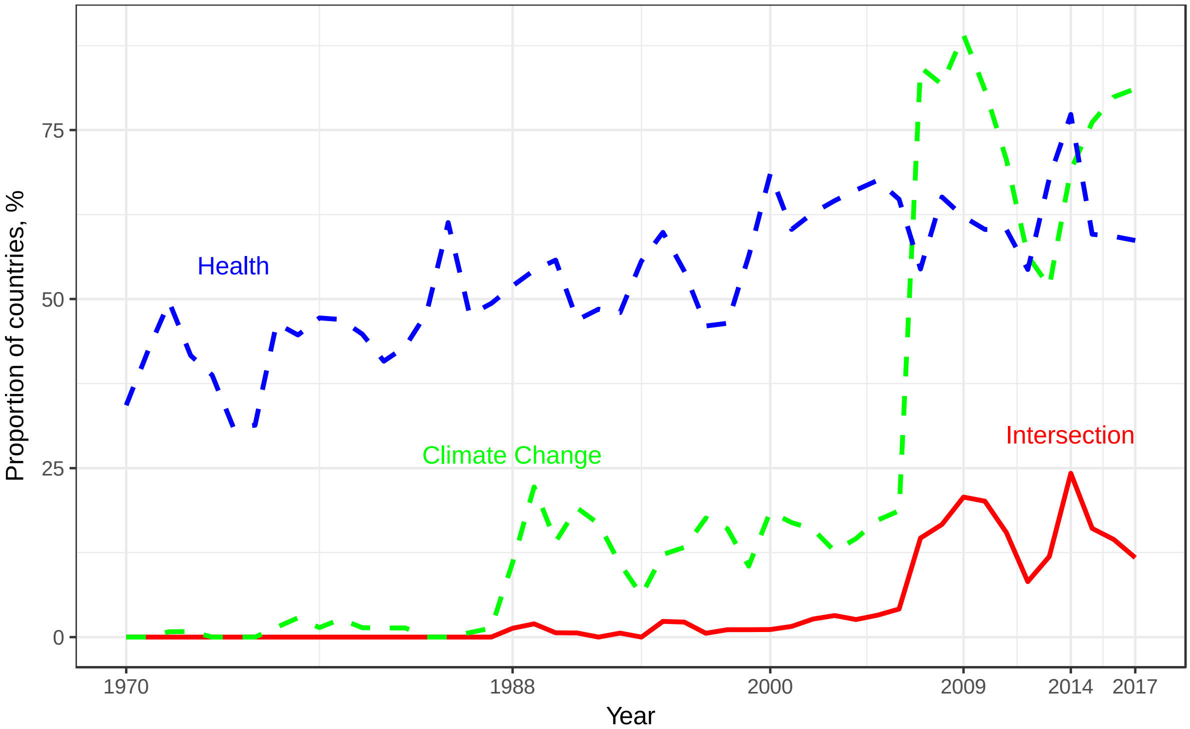

Figure 27. Proportion of countries referring to climate change, to health and to health and climate change in the United Nations General Debates, 1970-2017.

Two spikes in engagement are apparent. In 2009-10, 20% of countries referenced health and climate change as linked issues, a spike associated with the build-up to the UNFCCC's COP15. The second, and larger, spike in 2014 coincided with the transition from the Millennium Development Goals (MDGs) to the SDGs and the lead-up to the UNFCCC's COP21. In that year, almost a quarter of all governments referenced the health impacts of climate change. Since 2014, there has been a decline in engagement with health and climate change in the UNGD, with only 12% of the 196 UN member states referring to the two issues together in 2017. In contrast, a significant majority referred to climate change (over 75%) in their 2017 UNGD statement.

There are marked global and national differences in the attention given to health and climate change. Countries in the Western Pacific region are most likely to refer to climate change-health links in their UNGD statements, with around 40% doing so in 2017. For example, Tuvalu's statement notes that, *'the impacts of climate change pose the most immediate, fundamental and far-reaching threat… to the right to the highest attainable standard of physical and mental health'.* The Australian statement discusses how the SDGs, the Paris Agreement, and the Sendai Framework provide a blueprint for global action in areas such as '*climate change, diseases, including malaria, the management of our precious resources…'*. Cambodia also stated that *'the 2030 Agenda is inextricably linked to many of* *the issues that perturb the world today, the most pressing being climate change, which is not only a direct threat in itself but is also a multiplier of many other threats – from poverty, diseases and food insecurity, to mass migrations and regional conflicts'.*

Western Pacific regional engagement is driven by the Pacific Island states. In 2017, as in previous years, the Small Island Developing States (SIDS) were prominent among the countries referring to health and climate change in their UNGD addresses. Nauru, the Maldives, the Marshall Islands, Tuvalu, St Kitts and Nevis, and Vanuatu all discussed climate change-health links. In contrast, engagement was lowest in Europe and North America.

Methods and data sources are explained in full in the Lancet Countdown's 2017 report, and in Appendix 6.[9] This year's analysis reports on the proportion of countries referring to health and climate change rather than the number of references; for continuity with the 2017 report, trends relating to the number of references are provided in the appendix, together with additional analyses.

Indicator 5.4: Engagement in health and climate change in the corporate sector

Headline Finding: *Engagement with health and climate change has remained limited among companies within the UN Global Compact.*

This new indicator tracks engagement with health and climate change among the 12,000 companies signed up to the UNGC, the world's largest corporate sustainability initiative.[132] Established to address gaps in the global governance of corporations, it seeks 'a more sustainable and inclusive global economy'.[133] Its ten principles relate to human rights, working conditions and environmental responsibility. Companies report annually on their implementation in Communication of Progress reports (CPs) that are made publicly available. Our analysis focuses on 2011-2017 as very few CPs are publicly available before 2011 (Appendix 6).

The proportion of companies referring separately and jointly to health and climate change in their annual CPs indicates relatively high levels of engagement in health and in climate change as separate issues: across the period, 55-60% of the reports engage with health and around 45% with climate change. By contrast, less than one in seven reports refer conjointly to health and climate change (Appendix 6 provides a figure of these trends).

There are no spikes in engagement related to other UN initiatives, including the launch of the SDGs, COP21 or the 2015 Paris Agreement. There are, however, marked differences in engagement by corporate sector. Engagement is highest among telecommunication companies, where over 40% of CPs made reference to the intersection of climate change and health (Appendix 6).

The UNGC has been subject to critique, including of its voluntary status, limited participant base and inability to control the environmental externalities generated by the corporate sector.[134-136] Nonetheless, as a platform for developing and promoting sustainable policies and practices, it represents the largest corporate citizenship programme to date.[133]

The new indicator is based on the application of a key word search in the text corpus of CPs submitted in English; in total, 48% (n=15,220) of CPs from 129 countries were analysed. Climate change related terms were searched for the 25 words before and after a reference to a public health-related term. Methods and data sources are explained in full in Appendix 6. Because companies are listed in one country, but often operate across multiple countries both directly and via subsidiaries, analyses by the WHO region are not given here; however, they can be found in Appendix 6.

Conclusion

Section 5 of this report has presented indicators of public and political engagement, which is vital to transformational action on climate change. The barriers to action on health and climate change are predominantly societal and not technical, with public and political engagement therefore holding the key to accelerating the pace and scale of action.[1] Three conclusions can be drawn from this analysis of engagement in the media, science, UN and corporate sector.

Firstly, engagement in health and climate change has increased in the media, science and the UNGD over the last decade. The upward trend underlines the role of the UN, particularly through the UNFCCC and its COPs, in mobilising engagement. For example, there are spikes in the indicators around COP15 (2009) and COP21 (2015). Years that follow tend to see a decline in engagement. The exception to this broad pattern is the corporate sector, where evidence for companies within the UNGC points to little change in engagement in health and climate change.

Secondly, while overall engagement has increased over the last decade, it remains partial and uneven. Rather than reflecting a process of global mobilisation, the upward trend is being driven by individual regions and countries. The increase in global media attention is the result of increased coverage by newspapers in South East Asia and by the Indian press in particular. With respect to political engagement, it is SIDs that are using the global platform of the UNGD to draw attention to the health impacts of climate change. Within the scientific domain, overall trends again reflect uneven engagement. Here, however, increased engagement has been driven by research focusing on health and climate change in high-income and high-emitting countries. By contrast, very few studies focus on Africa and South East Asia, regions bearing the brunt of the health impacts of climate change.

Thirdly, while engagement in health and climate change has increased over the last year, it represents a very small part of public and political engagement in climate change. Across the media, science, government and the corporate sector, climate change is being framed in ways that largely ignore its health dimensions. Thus, analyses of national newspapers and scientific journals indicate that less than 5% of climate change coverage relates to health; analysis of the inter-governmental forum of the UNGD suggests that climate change and health are largely represented as separate issues, with much less attention given to them as inter-connected phenomena. Similarly, a high proportion of companies within the UNGC refer separately to health and climate change in their annual reports; however, only a small minority make links between health and climate change.

Taken together, these conclusions point to increasing engagement in the health impacts of climate change – and to the challenge of making health central to climate change action.

Conclusion – the Lancet Countdown in 2018

The *Lancet Countdown: Tracking Progress on Health and Climate Change* monitors progress on the health and climate change along 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 collaboration is committed to an iterative and open process, and will continue to develop the methods and data sources its indicators draw on, publishing annually in The Lancet through to 2030.

In 2018, many of the global trends previously identified accelerated – both in terms of the health impacts of climate change, and the mitigation and adaptation interventions being implemented around the world. The first section of the report made clear that vulnerable populations are continually exposed to more severe climate hazards, with indicators reporting 157 million heatwave exposure events for such groups in 2017, over 153 billion hours of labour lost due to rising temperatures, and that climatic conditions are at their most suitable for the transmission of dengue fever since 1950. Section 2 explored the various ways in which ministries of health, cities, and health systems are planning to enhance resilience and adaptation, providing more detailed insight into the quality and comprehensiveness of these strategies, highlight the fact that only 3.8% of adaptation funds available for development were allocated specifically for public health. Whilst there were over 2.9 million premature deaths due to ambient pollution from PM2.5 globally in 2015, promising trends in sections 3 and 4 demonstrated a continued phase-out of coal-fired power, accelerated deployment of renewable energy, and continued divestment from fossil fuels, which should help to reduce premature mortality from air pollution. Indicators in the final section pointed to the same conclusions – that engagement in health and climate change is increasing, enabling it to be an important driver of policy change globally.

Four key messages emerge from the 41 indicators of the Lancet Countdown's 2018 report:

- Present day changes in labour capacity, vector-borne disease, and food security provide early warning of compounded and overwhelming impacts expected if temperature continues to rise. Trends in climate change impacts, exposures, and vulnerabilities demonstrate an unacceptably high level of risk for the current and future health of populations across the world.
- A lack of progress in reducing emissions and building adaptive capacity threatens both human lives and the viability of the national health systems they depend on, with the potential to disrupt core public health infrastructure and overwhelm health services.
- Despite these delays, trends in a number of sectors are helping generate the beginning of a low-carbon transition, and it is clear that the nature and scale of the response to climate change will be the determining factor in shaping the health of nations for centuries to come.

- Ensuring a widespread understanding of climate change as a central public health issue will be vital in delivering an accelerated response, with the health profession beginning to rise to this challenge.

Taken as a whole, the indicators and data presented in the Lancet Countdown's 2018 report provide great cause for concern, with the pace of climate change outweighing the urgency of the response. Despite this, exciting trends in key areas for health, including the phase-out of coal, the deployment of healthier, cleaner modes of transport, and health system adaptation, giving justification for cautious optimism.

Regardless, it is clear that how these indicators of impact and response progress up until 2030 will shape the health of nations for centuries to come.

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