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Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed. We post it as supplied by the authors.

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Appendices

Appendix 1: Re-considering the health and climate indicators using an adaptation of the DPSEEA Framework:

Red indicates available data, orange data which can be obtained by data processing or are available only for selected sites and blue markers which require modelling or special data gathering. Related Sustainable Development Goals are indicated where relevant.

Driving Forces	Pressures	States/Exposures	Effects	Actions (Responses)	
				Specific	General
Dependence on energy from combustion of fossil fuels; other human activities leading to emissions of climate active pollutants (CAPs), including agriculture and land use change	*Emission of CAPs → altered concentration in the atmosphere*	*Increased radiative forcing → global warming, with regional variations*	*Impacts on:* • *health* • *productivity*	*(1) Measures to adapt to the effects of climate change* *(2) Measures to mitigate climate change*	
MARKERS					
• *Per capita* use of energy (kw.hr.person^{-1}) [national, reported data] • Per *capita energy* use per US$ GDP (kw.hr.US$M^{-1}) [national, reported data]	• Annual total and *per capita* emissions of climate active pollutants (Gtonne CO_2.e) [country,] • CO_2 concentrations in atmosphere (ppmv) [global, monitored data Mauna Loa]	Mean of (warm season) daily maximum or mean temperatures [city, observed series]	Heat- (and cold-) related mortality/ morbidity [city, requires epi modelling]	• Implementation of heatwave plans [national] • Building regulation for protection against heat risks [national]	• Health and climate change in the UNFCCC and UNGA high-level statements • Academic publication and funding on health and climate change • Integration of health in national adaptation plans • Direct and indirect fossil fuel subsidies [national] • Adaptation finance for health [definition] • Change in annual investment in energy efficiency • Public opinion on health and climate change [national, needs definition] Note SDG 12.c.1 Fossil-fuel subsidy per unit GDP SDG 13.2.1 Operationalization of adaptation plan
		Annual mean of wet bulb globe temperatures for working hours [city, derived variable]	Reduction in labour productivity from excess heat [national, model-based from WBGT]		
		Annual total population and proportion affected by flooding [national]	Flood-related mortality and morbidity (including mental health) [national, immediate observed deaths estimable only]		
		Periods of low rainfall resulting in reduced crop yields [national]	Nutrition-related growth and mortality impacts in children [national, requires modelling]		
		Warm season mean of ozone concentrations? [city, not specific to climate change]	Deaths/ morbidity from ozone concentrations [city, modelled]		
		Transmissions potential for specific vector-borne diseases (malaria, dengue) [sentinel sites, modelled from weather data only]	Burdens (cases) of specific vector-borne diseases [national, sentinel sites]		
Fossil fuel combustion for electricity generation (Tera-joule per million population) [national, reported data]	• Number (net capacity in Gigawatts) of coal fired power stations [national, reported data] • Emissions of CAPs	Ambient concentration (annual mean) of $PM_{2.5}$ from coal fired power generation [city, requires modelling or method of source apportionment]	Mortality/ morbidity attributable to ambient $PM_{2.5}$ derived from coal fired generation [city, model based]	• Growth in renewable energy resources [national, reported data] • Renewable energy patent	• Cost-savings from the health co-benefits • Coverage and strength of carbon

	from coal fired electricity production [national]		Note: SDG 3.9.1 mortality attributable to household and ambient AP SDG 11.6.2 annual mean $PM_{2.5}$ in cities	generation and innovation [national, requires definition] Note: SDG 7.1.2 proportion of population with primary reliance on clean fuels SDG 7.2.1 renewable energy as share of final energy consumption	pricing Note SDG 13.a.1 Mobilized US$/year towards $100 billion commitment for CC mitigation
Per capita energy consumption, housing sector [national, reported data] Proportion of housing which is energy inefficient [national, requires definition]	Energy efficiency of housing stock (mean energy requirement to maintain standardized heating and/or cooling regime, as well as cooking and other household needs) [national, housing survey + modelling]		Ancillary effects on deaths/ morbidity relating to exposures of the indoor environment [national, model-based in selected locations only]	Building regulation for energy efficiency [national]	
• Mean *per capita* energy use for transport (kj.person^{-1}.year^{-1}) [national, reported data] • Transport: *per capita* distance travelled by motorized transport [national or city, survey data]	Transport-related emissions of Climate Active Pollutants and ambient air pollutants [city, emissions inventories (where available)]	Ambient air $PM_{2.5}$ concentrations attributable to transport-related emissions [city, requires modelling or method of source apportionment]	Reduction in deaths/morbidity from (transport-related contribution to) physical activity [national or city, definition of counterfactual] Deaths from transport-related $PM_{2.5}$ exposure [city, model-based]	• Deployment of low-emission vehicles • Active transport infrastructure and uptake [city, definition]	
Per capita energy consumption, food and agriculture sector [national, reported data]		*Per capita* consumption of red meat & dairy products (kilojoules per person) [national, survey based]	Mortality/ morbidity attributable to consumption of red meat and dairy products [national, modelled and setting specific]	Note SDG 12.3.1 Global food loss index	
[Carbon footprint of healthcare systems]				Implementation and health benefits of the NDCs [national, requires special data gathering and modelling]	

Appendix 2: Indicators from other monitoring processes relevant to the Lancet Countdown

The table below maps the Lancet Countdown's indicators with those used for the Sustainable Development Goals, Sendai Framework for Disaster Risk Reduction, ClimateWorks Foundation Carbon Transparency Initiative, and WHO Climate and Health Country Profiles. It is important to note that while the intent of these initiatives is for eventual global coverage, they are still in development and so currently their implementation is limited to some countries. For example, the ClimateWorks Foundation Carbon Transparency Initiative has currently used their indicators for China, the EU, India, Mexico, and the US and WHO have Climate and Health Country Profiles for 40 countries.

Working Group	Lancet Countdown Indicator Domains	Sustainable Development Goals	Sendai Framework for Disaster Risk Reduction	ClimateWorks Foundation Carbon Transparency Initiative	WHO Climate and Health Country Profiles
Health Impacts and Climate Change	Track populations' exposure to heat	1.5.1 Number of deaths, missing persons and persons affected by disaster per 100,000 people 1.5.3 Number of countries with national and local disaster risk reduction strategies 6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	A-1. Number of deaths and missing due to hazardous events per 100,000. A-2. Number of deaths due to hazardous events. A-3. Number of missing due to hazardous events. B-1. Number of affected people per 100,000. B-2. Number of injured or ill people due to hazardous events. B-3. Number of people who left their places of residence due to hazardous events. B-3a. Number of evacuated people due to hazardous events. B-3b. Number of relocated people due to hazardous events. B-4. Number of people whose houses were damaged due to hazardous events. B-5. Number of people whose houses were destroyed due to hazardous events. B-6. Number of people who received food relief aid due to hazardous events.		Warmer and/or fewer cold days and nights over most land areas. Warmer and/or more frequent hot days and nights over most land areas. Heat-related mortality.
	Track changes in labour productivity				Heat stress and work productivity.
	Track populations' exposure to heatwaves				Warm spells/heatwaves. Frequency and/or duration increases over most land areas. Heat-related mortality.
	Track populations' exposure to floods				Heavy precipitation events. Increase in the frequency, intensity, and/or amount of heavy precipitation. Increases in intense tropical cyclone activity. Increased incidence and/or magnitude of extreme high sea level. River flooding. Exposure to flooding due to sea level rise.
	Track populations' exposure to droughts				Increases in intensity and/or duration of drought.
	Track the spread of infectious diseases	3.3.3 Malaria incidence per 1,000 population 3.3.5 Number of people requiring interventions against neglected tropical diseases			Populations at risk of infectious and vector-borne diseases for malaria and dengue fever.

	Track populations' food security	2.1.1 Prevalence of undernourishment 2.1.2 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES) 2.2.1 Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age 2.2.2 Prevalence of malnutrition (weight for height >+2 or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight) 2.4.1 Proportion of agricultural area under productive and sustainable agriculture	C-2. Direct agricultural loss due to hazardous events.		
Health Resilience and Adaptation	Track the integration of health in National Adaptation Plans	3.d.1 International Health Regulations (IHR) capacity and health emergency preparedness 11.b.1 Proportion of local governments that adopt and implement local disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030 13.2.1 Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other) 13.3.2 Number of countries that have communicated the strengthening of institutional, systemic and individual capacity-building to implement adaptation, mitigation and technology transfer, and development actions	E-3. Number of countries that integrate climate and disaster risk into development planning.		Governance and policy. Vulnerability, impact and adaptation (health) assessments. Health adaptation strategies and action plans. Preparedness, risk management and integrated risk monitoring. Awareness raising and capacity building. Financing.
	Track climate services for health		D-2. Number of health facilities destroyed or damaged by hazardous events.		
	Track adaptation finance for health				

Health Co-Benefits of Mitigation	Track the phase-out of coal			Share amount of coal in total final energy consumption—that is, the share of an economy's energy derived from coal. Share of electricity from coal generation.	
	Track the growth in renewable energy resources	7.1.2 Proportion of population with primary reliance on clean fuels and technology 7.2.1 Renewable energy share in the total final energy consumption		Share amount of renewable energy in total final energy consumption—that is, an economy's share of energy derived from renewable sources. Share of electricity from renewable energy generation.	
	Track energy access	7.1.1 Proportion of population with access to electricity			
	Track energy access for health facilities	3.8.1 Coverage of essential health services (defined as the average coverage of essential services based on tracer interventions that include reproductive, maternal, newborn and child health, infectious diseases, non-communicable diseases and service capacity and access, among the general and the most disadvantaged population) 3.b.1 Proportion of the population with access to affordable medicines and vaccines on a sustainable basis			
	Track ambient air pollution exposure	3.9.1 Mortality rate attributed to household and ambient air pollution 11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted)			Current exposures and health risks due to air pollution, including outdoor air pollution exposure, short-lived climate pollutants, and household air pollution.
	Track the deployment of low emission vehicles			Share of new vehicles in a particular geography that are electric drive rather than internal combustion engine vehicles. Share of electric drive vehicles for the light-duty fleet in a particular year.	
	Track active transport infrastructure and uptake	11.2.1 Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities		Total terrestrial passenger kilometers, meaning the total number of kilometers that a population travels, including on private, public, and passenger rail. Number of kilometers travelled in terrestrial modes—private, public, and rail—on a per capita basis. Total number of kilometers travelled in private modes—light-duty vehicles, two wheelers, and three-wheelers. Total number of kilometers travelled in	

				private modes—light-duty vehicles, two wheelers, and three-wheelers—on a per capita basis. Total number of kilometers travelled in public modes—bus and rail. Total number of kilometers travelled in public modes—bus and rail—on a per capita basis. Total number of vehicle kilometers travelled in private modes—light-duty vehicles, twowheelers, and three-wheelers. Share of passenger kilometers associated with public transport—bus and rail. Total share of electricity in the energy mix for all terrestrial transport—private, public, and freight modes. Share of kilometers associated with private modes of transport—light-duty, two wheelers, and three-wheelers.	
	Track food consumption and production	11.3.1 Ratio of land consumption rate to population growth rate 12.1.1 Number of countries with sustainable consumption and production (SCP) national action plans or SCP mainstreamed as a priority or a target into national policies 12.3.1 Global food loss index		Total amount of greenhouse gas emissions associated with the Agriculture Sector. Total amount of greenhouse gas emissions associated with the Agriculture Sector from direct sources in production and onsite energy use. Total amount of greenhouse gas emissions associated with the Agriculture Sector from electricity. Size of a herd of cattle in a given geography and year on a per capita basis. This metric does not include dairy cattle. Share of agricultural emissions associated with non-dairy cattle. Share of agricultural emissions associated with fertilizers. Greenhouse gas emissions intensity associated with agriculture on a per capita basis.	
	Track the carbon footprint of healthcare				Annual greenhouse gas emissions by sector (metric tonnes in CO2-equivalent)

	systems				– although not for healthcare.
Finance and Economics	Track change in annual investment in renewable energy	7.2.1 Renewable energy share in the total final energy consumption 7.a.1 Mobilized amount of United States dollars per year starting in 2020 accountable towards the $100 billion commitment for climate finance			
	Track change in annual investment in energy efficiency				
	Track low-carbon technology patent generation and innovation				
	Track the value the health co-benefits of climate change mitigation				
	Track direct and indirect fossil fuel subsidies	12.c.1 Amount of fossil-fuel subsidies per unit of GDP (production and consumption) and as a proportion of total national expenditure on fossil fuels			
	Track the coverage and strength of carbon pricing				
	Equity of the low-carbon transition				
Political and Broader Engagement	Track public, civil society and community mobilisation on health and climate change				
	Track academic publications on health and climate change				
	Track health and climate change in the UNFCCC and UNGA high-level statements				Governance and policy.
	Track the inclusion of health and climate change within medical and public health curricula	12.8.1 Extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed in (a) national education policies; (b) curricula; (c) teacher education; and (d) student assessment 13.3.1 Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula			
	Track the implementation and estimated health benefits of the Nationally Determined	13.2.1 Number of countries that have communicated the establishment or operationalization of an integrated policy/strategy/plan which increases their			Governance and policy.

	Contributions	ability to adapt to the adverse impacts of climate change, and foster climate resilience and low greenhouse gas emissions development in a manner that does not threaten food production (including a national adaptation plan, nationally determined contribution, national communication, biennial update report or other)			