The 2022 South America report of The *Lancet* Countdown on health and climate change: trust the science. Now that we know, we must act

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Executive summary

The health of South American populations is being severely impacted by increasing climate change-driven environmental changes. Exacerbated by increased social inequities and vulnerability, deforestation, land degradation, and global climate variabilities in sea temperature, can potentially lead to extreme weather and climate events, magnifying the negative effects of climate change on health. Understanding the direct and indirect exposure routes to climate hazards and the effects on health and wellbeing is critical to design successful and effective evidence-based adaptation and mitigation plans and policies.

This report is part of the *Lancet* Countdown's broader efforts to develop expertise and understanding of the links between health and climate change at the regional level. The *Lancet* Countdown South America (LCSA), a newly launched chapter of the *Lancet* Countdown, is an independent, multidisciplinary academic collaboration dedicated to tracking the links between public health and climate change in South America (SA). This collaboration brings together 21 academic institutions and UN agencies with 28 researchers representing various disciplines. The data and results provided in this report for the 12 countries of the region,* explore in regional detail the results of the 2022 global *Lancet* Countdown report and provide the evidence to support targeted response strategies for decision-makers. Its findings and conclusions represent the

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Note: This summary is available in Spanish and Portuguese in the Supplementary data.

*The 12 countries considered in this report are: Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Guyana, Paraguay, Peru, Uruguay, Venezuela, and Suriname. French Guiana has not been considered in this report, as it is an overseas department of France.

consensus of experts across multiple fields, covering 25 indicators summarised below in four key messages.

Climate change is harming the health of South Americans, it's time to take prompt action

The adverse health effects of climate change are accelerating and disproportionately affecting the most vulnerable populations in SA. For the past ten years, populations in every country in the region have seen their health increasingly affected by climate change-related hazards. This trend will only continue if prompt action is not taken.

In the last ten years, the more frequent and intense heatwaves have increasingly put the health and survival of children under one year old and adults above 65 years at risk. On average, children <1 year were exposed to 2.35 million more person-days of heatwaves each year, and adults above 65 years exposed to 12.3 million more person-days, as compared to a 1996–2005 baseline (indicator 1.1.1). Since the year 2000, the estimated number of heat-related deaths has increased continuously among people over 65 in almost all countries. Brazil, Argentina, Colombia, and Venezuela were the most affected countries in the region (indicator 1.1.2). The monetised value of this heat-related mortality of older adults in SA was estimated as the equivalent of the average income of 485,000 local workers in 2021 (indicator 4.1.1).

In addition, the high temperatures are increasingly limiting the productivity of labourers in SA, undermining people's livelihoods, and compounding the impacts of the economic crisis now affecting many countries in the region. Indeed, the potential regional income loss associated to heat-related reduction in labour productivity in 2021 was USD 22 billion with the construction and agricultural sectors being the most severely affected, incurring 68% of the total losses in the region (indicator 4.1.2).

Population exposure to wildfire danger has increased in the past decade driven by the high temperatures and increased incidence of drought in many areas, making wildfire occurrence and spread more likely, and hampering control efforts. This is particularly relevant in SA, which faces a dangerous interplay between intentional human-made wildfires -more closely linked to land use changes and deforestation, as in the Amazon, the Pantanal, and El Chaco -as well as climate-driven ones, such as the 2022's wildfire in Argentina, and Paraguay. Regionally, the population exposure to very high or extremely high wildfire danger in SA has increased in nine of out 12 countries, with a regional average increase of seven more days in 2018–2021 compared to the baseline. However, the number of exposure days across countries vary, Uruguay, Paraguay saw an increase of 3-4 exposure days, vs Argentina and Chile 14–20 days of exposure (indicator 1.2).

Of particular concern in SA, where 168.7 million people are affected by moderate or severe food insecurity, climate change will put additional pressure on food systems. The changing environmental conditions, including more intense and lengthy droughts, extreme weather events, higher temperatures, and increased atmospheric CO_2 concentrations, affect the growth, yield, and nutritional content of several crops, including four staple crops (wheat, rice, maize, and soybean). In 2021, the duration of the growth season of these four crops followed a downward trend, exposing potential threats to crop yields. The average duration of the growing season for spring wheat, winter wheat, maize, soybean, and rice had decreased by 2.5%, 2.2%, 1.6%, 1.3% and 0.4%, respectively, compared to a 1981–2010 baseline (indicator 1.4). These impacts threaten the livelihoods of people depending on the agricultural sector and, ultimately, pose an acute menace to food security in the region.

The changing environmental conditions are also affecting the geographical distribution of infectious diseases. The region is endemic for dengue, which is responsible for a high burden of disease and frequent epidemic cycles across the region. The climate suitability for dengue transmission reached its highest level in recent years, with an increase of 35.3% in 2012–2021 compared to the 1951–1960 baseline (indicator 1.3). Estimated fitness for dengue transmission between 1951 and 2021 increased over time in all countries where the mosquito is found (except Argentina and Suriname). Adding to climate-related pressures, urbanisation, and mobility in countries such as Brazil and Peru have increased dengue spread to higher latitudes and less populated areas. Climate change can also lead to viral sharing among previously geographically isolated wildlife species, leading to cross-species transmission and disease emergence. Compounding the increase in dengue risk posed by climate changes, temperate Southern Cone countries are highly vulnerable to severe dengue outcomes, mainly driven by rapid urbanisation. Argentina and Uruguay experienced increased vulnerability between 1990 and 2019 (indicator 2.3).

South American countries must increase their preparedness to protect populations from the health impacts of the climate crisis

Understanding, assessing, and tracking the health impacts of climate change and health co-benefits of climate actions is critical for the development of adaptation plans and policies that can protect the health of SA populations from the increasing climate-related health hazards, and maximise their positive impact.

With the health risks of climate change rapidly increasing, countries should focus efforts on identifying their climate change-related health risks and develop adequate adaptation plans. At the sub-national level, 205 city municipalities conducted city-level climate change risk assessments (indicator 2.1.3), raising concerns

about whether local-scale evidence, needs and within-country differences are being integrated into the National Adaptation Plans (NAPs).

Reflecting the insufficient planning for health adaptation, South American countries are not delivering adaptation responses proportionate to the rising risks their populations face. Adaptation actions, such as expanding urban green spaces (indicator 2.2.2), strengthening health systems (indicator 2.2.1), and building more resilient essential infrastructure, have the potential to reduce climate-related health impacts and promote health and wellbeing. However, of the 73 urban centres examined in 2021, 84% had very low or exceptionally low levels of green areas and only twelve (16%) had moderate levels of greenness. These findings reflect the limited progress in the implementation of an effective adaptation measure that can not only reduce exposure to health-threatening extremes of heat in urban areas, but also deliver major direct benefits through cleaner air, improved mental health and wellbeing from exposure to green space, and improved overall health outcomes from the provision of spaces for socialisation and recreation.

Enhancing health system capacity and resilience is essential, as the health risks associated with climate change increase and the population's healthcare needs rise. To enable this, efforts from government agencies must be focused on ensuring healthcare facilities have access to the essential services they need to provide adequate care, including, water and sanitation services, electricity supply and internet connectivity. Healthcare infrastructure must also be strengthened to cope with the increasing impacts of extreme weather events, and to be safe strongholds during climate-related emergencies. The capacity of the health system must be adjusted to be able to cope with the growing healthcare demand, and resources must be directed at empowering and training healthcare professionals to recognise, prevent, and treat the health impacts of climate change-related hazards. Finally, surveillance, early warning and early response systems must be implemented in collaboration with meteorological agencies and tailored to the local health risks, to inform the prevention and adequate response to climate change-related health hazards. Indeed, the call for universal coverage of early warning systems against extreme weather and climate change was enshrined in the agreement reached in the 2022 United Nations Climate Change Conference or Conference of the Parties of the UNFCCC (COP27). Yet only two countries in SA (Argentina and Brazil) report incorporating climate information for heat early warning systems in their health systems (indicator 2.2.1). The heat early warning system in Argentina was the only national early warning system that has been implemented and evaluated.

Strengthening health systems in SA to better prevent and respond to climate-related health risks will also deliver better overall health services, with overall gains to the health and wellbeing of SA populations. With the fragility of health systems exposed by the COVID-19 pandemic, strengthening local health services should be a priority in local governmental agendas.

SA must continue and accelerate efforts toward the race to zero-carbon transition

SA must continue and accelerate efforts to mitigate its GHG emissions, reduce land use change linked to deforestation, decarbonise its energy and transport system, and increase its use and production of renewable energies. Doing so will not only help the region meet its commitments under the Paris Agreement but will also deliver major health gains from improved air quality, reduced energy poverty, reduced inequities in access to transportation, and more active lifestyles.

While SA is responsible for only 6% of global GHG emissions, it must still join efforts to reduce global GHG emissions, and importantly to ensure it is not left behind in the global transformation towards a healthier, net zero emission human system. Emissions in SA are primarily linked to land use changes (24%), agriculture (28%) and energy production (39%). Given this, mitigation linked to land use and agricultural practices is particularly important, requires a long-term strategy, national and international incentive schemes, and strong governance and regulations, all of which are particularly challenging in SA countries (Panel 3). Climate change mitigation in the agricultural sector and in land use change linked to deforestation also hold the potential to deliver major simultaneous and immediate health benefits to local populations and promote healthier diets with additional benefits of reducing premature mortality from imbalanced diets. In SA, 23% of all deaths attributable to imbalanced diets have been linked to a high intake of red and processed meat and dairy products, the production of which is highly carbon intensive (mainly due to emissions associated with livestock feed production and ruminant enteric fermentation). Minimising red meat intake as per dietary guidelines would therefore not only help avert these deaths, but simultaneously lead to reduction in GHG emissions related to livestock rearing and the associated agricultural practices (indicator 3.4).

Turning to the energy sector, mitigation here can also provide substantial and immediate health co-benefits. The burning of fossil fuels not only contributes to increased GHG concentrations in the atmosphere but also leads to toxic levels of pollution in the air people breathe. In SA, exposure to harmful small particulate air pollution ($PM_{2.5}$) in the outdoor air resulted in 37,000 deaths in 2020 alone (indicator 3.2). The South American countries with the highest mortality rate attributable to exposure to $PM_{2.5}$ are Chile and Peru, with 230 and 176 deaths per million. The monetised costs of premature mortality due to air pollution in SA

were equivalent to the average income of 2.9 million people (indicator 4.1.3).

Switching to clean fuels can also significantly reduce exposure to household air pollution (HAP) and diminish urban-rural health inequalities. Despite the almost universal access to electricity in South American homes, only half is generated from clean sources such as solar, wind or hydropower. In addition, big urban-rural differences exist, with 23% of the rural populations still relying exclusively on biomass fuels for cooking, exposing them to high levels of air pollutants inside their homes (indicator 3.1.1). The annual average of exposure of a rural household is 171 μg/m^3 [95% CI 159–183] of $PM_{2.5}$, 34 times higher than the World Health Organization (WHO) recommended annual 5 μg/m^3 threshold (indicator 3.1.2).

Decarbonising road transport could also deliver major benefits to the health of SA populations. Reducing fossil-fuel based road travel can help avert the over 10,100 deaths that were attributable to exposure to $PM_{2.5}$ air pollution coming from the transport sector in 2020 (indicator 3.2). Expanding the access and use of safe, affordable, and reliable public transport networks would not only reduce the use of fossil fuels but would also deliver major co-benefits from reducing the socioeconomic inequalities associated with transport access. In addition, promoting modal shift to active forms of travel by providing incentives and safe infrastructure can simultaneously deliver major physical and mental health benefits associated with increased physical activity.

Despite these potential health gains, South American countries have increased the per capita use of energy for road transport by 138% between 1971 and 2019. Specifically, countries like Paraguay, Ecuador, Bolivia, and Guyana have tripled their per capita energy use in road transport since the 1970s. This happened parallel to a rapid urbanisation process and increased regional car sales. Fossil fuels are still the primary energy source for road transport in SA, accounting for 84% of it, followed by biofuels (16%). While often promoted as a sustainable alternative, biofuels do lead to net carbon emissions (especially first-generation biofuels), their production often results in net emissions from land use change, and importantly their burning emits air pollutants such as $PM_{2.5}$ that harm human health. And while Chile and Ecuador are leading the road travel electrification in the region, even in these two countries less than 1% of the road energy sources comes from electricity. In the region, electricity accounts for only 0.04% of the energy used in road travel (indicator 3.3).

As the global energy crisis drives sharp increases in international energy prices, and as the rising inflation threatens people's capacity to afford clean energy, energy poverty in the region is likely to increase—and with it, the use of dirty fuels in people's homes. Rapid action to move away from fossil fuel use in the region and increase the local production of renewable, clean energy at all levels (i.e., individual, household, community, and society) would not only contribute to meeting the commitments countries laid out in the Paris Agreement, but would also deliver more resilient, stable, and sovereign energy systems for South American populations. This, in turn, would reduce the region's dependence on volatile international fossil fuel markets and geopolitical conflicts, help reduce energy poverty and its associated health impacts, and improve the quality of the air people across the region breathe.

Concerningly, despite the harms of the continued overdependence on fossil fuels to SA populations, countries in the region keep providing financial incentives for fossil fuel consumption, hampering the transition to clean, renewable energy sources. Considering all subsidies and carbon pricing instruments, the region still effectively subsidies fossil fuel consumption, to a total value that is on average equivalent to 10.5% of governmental health spending in the region (indicator 4.2). Currently, Venezuela, Ecuador, Bolivia, and Argentina net fossil fuel subsidies are equivalent to 85.6%, 29.2%, 23.5%, 15.4% respectively, of their health budgets. These net subsidies equivalents range between 3.5% and 4.8% for Brazil, Chile, and Colombia. In total, the six countries spent USD 27.9 billion on fossil fuel subsidies in 2021. Redirecting such spending towards subsidising renewable energies, and towards protecting vulnerable populations from the rising energy costs and the cost-of-living crisis, would not only promote the transition to a healthy, low-carbon future, but also help reduce inequalities and energy poverty.

South American countries require serious financial commitments to respond to the challenges imposed by climate change

Implementing climate change adaptation policies and actions for the health and wellbeing of populations is a no-regrets investment that requires the support of governments, with transparent financial commitments and concrete budget allocation.

As South American governments start to submit their second round or updated versions of their Nationally Determined Contributions (NDCs), eight of the 12 countries with submitted revised NDCs by 2021. The percentage of change in the number of mentions of health-related terms from the first to the second NDC was 130.4%. The countries with the greatest number of mentions were Venezuela, Paraguay, and Colombia (indicator 5.3). This reflects the awareness of the links between health and climate change and the prioritisation of the national climate agendas. However, many of these NDCs are high-level commitments that consolidate a country's intention–in some cases, not fully detailing the activities, indicators to monitor its progress, the institutional roles, and responsibilities and/or a budget for its implementation. Usually, this more detailed description is developed in NAPs, and sectoral NAPs–in the case of health–a NAP for Health (or HNAP). Despite the high-level recognition of the

importance of having health-related activities in countries' NDCs, only Brazil has developed an HNAP up to 2021, while other countries–Argentina, Colombia, Chile, and Peru-report having them ready but not submitted or under development.

Despite the urgent need to protect the health of local populations from rapidly increasing health hazards, health adaptation is woefully underfunded in SA, with only 10% (USD 36 million) of approved adaptation-related funding dedicated to health in 2021 (indicator 2.2.3). However, the large sums of money allocated to subsidising fossil fuels show that funds are generally available, but they are not being allocated to activities that would enable a safe and healthy future.

Infrastructure and social spending needed to meet climate goals range between *"7% and 19% of gross domestic product (GDP) by 2030 (USD 470 billion to USD 1300 billion in 2030) depending on initial conditions and proposed economic and social targets"*.[†] Under this light, a just transition to a sustainable future requires enough funds to be made available to less industrialised countries, including many in SA. Less industrialised countries must be empowered to deliver a transition to zero-carbon, healthy, and resilient energy systems, and stronger, better prepared healthcare systems. In COP27, "developed" countries were urged to scale up their provision of climate finance, technology transfer and capacity-building to respond to the adaptation and mitigation needs of "developing" counterparts. The implementation of this ambition, to be progressed at COP28, is not only essential to deliver the goals of the Paris Agreement, but also to deliver better and more equitable global health.

The implementation of accelerated climate action requires support from key actors and sectors in society, including policy makers, scientists, the media, and the general public. Effectively communicating the science on the links between climate change and health is critical to changing public perceptions, generating public demand for action, and informing the implementation of evidence-based adaptation and mitigation policies that maximise health gains. Media coverage of the links between health and climate has been increasing in SA and reached its highest level in key newspapers from eight countries in SA in 2021 (Indicator 5.1). And while the health dimension of climate change remains understudied in the region, original research led by SA researchers has increased by more than 1000% since 2007. Yet, 94% of the health and climate change articles referred to climate impacts on health, while the number of articles regarding the effects of multisectoral action (health co-benefits and adaptation) on climate and health continues to be low (indicator 5.2). Research on the benefits of health -centred climate action is urgently needed in SA, to inform an evidence-based adaptation and mitigation response that maximises the benefits to local populations.

This inaugural report from LCSA focuses on (i) the immediate health threats posed by climate change in SA, (ii) the limited health adaptation plans developed in the region, (iii) our need to accelerate efforts towards the race to zero-carbon transition and (iv) the existing financial gap to address the burden of climate change on health in SA. Additionally, this report brings to light the need to foster regional efforts towards building resilient health systems and reducing the converging effect of inequality, poverty, and vulnerability in the face of climate change. Never has it been more important to realise the ambition of the Paris Agreement to limit the global average temperature rise to 1.5 °C and to dispense the financial resources necessary for effective climate response. In addition, such climate action could deliver immediate and substantial benefits, saving millions of lives each year by improving air quality, diet and physical activity and generating more resilient health systems. The LCSA calls on the governments and multiple stakeholders of the region to initiate and accelerate a coordinated response, and to define and undertake clear actions that address the challenges posed by climate change while ensuring healthy lives, clean environments, ecosystem services and wellbeing for all South American peoples.

Introduction

People are living through an unprecedented public health and environmental crisis due to anthropogenic climate change, which is undermining the foundations of good health, livelihoods, ecosystem services and human rights globally. To face these challenges, the Paris Agreement set out an ambitious commitment to reduce greenhouse gas (GHG) emissions and limit global warming to well below a global average surface temperature rise of 2 °C above pre-industrial levels, even aiming to limit temperature increases to 1.5 °C. To meet this target, urgent and effective action must be taken: reduce GHG emissions by 45% by 2030, phase out fossil fuel burning by the middle of the century and stop deforestation. However, current partner countries' Nationally Determined Contributions (NDCs) fall short of the necessary reductions to meet this pathway by 2030, with present policies putting the world on track to a global temperature rise of 2.7 °C.[1]

South America (SA) is a distinctive region rich in culture, ethnicity and in biological diversity. Its surface area corresponds to 87% of Latin America and the

[†]Paliza LMG, Hoffman B, Vogt-Schilb A. How Much Will It Cost to Achieve the Climate Goals in Latin America and the Caribbean? 2022; published online July 11. https://halshs.archives-ouvertes.fr/halshs-03720397/document.

Caribbean (LAC) and roughly to one-eight of the land surface of Earth. The region hosts most of the LAC population (66%) and of roughly 6% of the global population. South American countries are responsible for 6% of all GHG emissions globally, mainly stemming from their high dependence on fossil fuels for energy (39% of the total in the region), which in turn is responsible for a high burden of disease from the associated air pollution and energy poverty. Equally important are the emissions stemming from land use changes and agriculture (24% and 28%, respectively, of the total in SA).[2] Despite this relatively low regional GHG emission, SA's highly vulnerable population is already seeing their health strongly impacted by climate change. These impacts are further compounded by oftentimes overloaded and fragmented local health systems (Panel 2). SA is a region already burdened by high inequality, poverty, population growth, increasing urban population density, high rates of land use change, biodiversity loss, land degradation, and an increasing dependence of national and local economies on natural resources to produce globally required commodities, including fossil fuels.[3] Despite its wealth in renewable energy resources, the dependence on international energy markets makes SA particularly vulnerable to volatile fossil fuel markets, and the energy poverty that arises from international fluctuations in energy prices.

Furthermore, South American countries are particularly exposed and vulnerable to climate-related hazards. The increased frequency and intensity of extreme weather events in SA, such as floods, droughts, and heatwaves, are impacting its communities disproportionately. In 2018, large parts of Brazil experienced year-round droughts.[4] The rapidly rising temperatures are also putting the health of local populations at risk, and in 2019, the Argentine, Chilean and Uruguayan populations were considered the region's most vulnerable to heat.[5] The changing climate is also becoming increasingly suitable for diseases like dengue, which are of particular public health concern in the region. Indeed, driven mainly by the climate, increased movement of people and urbanisation,[6] the incidence of dengue saw a substantial rise over the past four decades in SA, with almost 16 million cases in 2011–2021.[7] Coupled with the cyclical ENSO, the region is projected to face more extreme challenges in a changing climate.[8] However, the severe consequences of these hazards on SA's economies, energy security and the health and wellbeing of millions of people are still insufficiently quantified and researched.

Concerningly, climate change is not the only challenge SA faces. In the past three years, converging global health and geopolitical crises have further exposed, and even exacerbated, the sizable socioeconomic disparities and global health inequities in the region. In particular, the COVID-19 pandemic has brought to light the insufficient policy response in the health sector -mainly due to poor governance, a lack of integrated health surveillance, response systems and universal health coverage. Meanwhile, Russia's invasion of Ukraine, which made fuel and food prices soar and the export of key commodities from the SA region to drop, revealed the interdependencies of SA not only with its neighbours, but also with distant countries. The resulting global energy and economic crisis have disproportionately affected SA, and further affected the regional socioeconomic conditions that good health depends on. With the converging energy, economic, geopolitical and health crisis compounding the impacts of climate change on the local populations, it has never been more urgent to reduce social and economic inequalities and strengthen the health systems and their response mechanisms–which are essential to enhance community resilience to climate change.

Important questions remain. Is the implementation of adaptation and mitigation measures to avert and minimise the health impacts of climate change being unrolled in an efficient and timely manner in SA? Are the potential health gains of climate action being maximised in the region? What are the barriers and limitations towards a just transition for SA? SA would see substantial benefits from a quick transition to renewable energy, reduced dependence on fossil fuels, greening of SA's ever-growing cities, and enhancing carbon sinks, mainly in the Amazon, the Andes wetlands, and the southern temperate forests, by curbing land use change and deforestation. As the world gets dangerously close to climate change-triggered tipping points, and as the committed temperature increase gets dangerously close to 1.5 °C, climate action in SA can no longer be delayed.

Increased multisectoral capacity for preparedness and response to climate-related health emergencies, strengthened climate governance, and effective implementation of mitigation and adaptation measures are urgently needed across all South American countries. A better understanding, monitoring, and quantifying of the health impacts of climate change and the health co-benefits of climate change mitigation and adaptation strategies is also essential to ensure the health gains of the transition to a low-carbon, resilient future is maximised.

Responding to this challenge, the *Lancet* Countdown South America (LCSA) exists as a regional centre of the *Lancet* Countdown. LCSA is an independent, multidisciplinary collaboration that tracks the links between public health and climate change in SA. It brings together 21 academic institutions and UN agencies from the region, mirroring the global *Lancet* Countdown's methodologies and five key domains: health hazards, exposures, and impacts; adaptation, planning, and resilience for health; mitigation actions and health co-benefits; economics and finance; and public and political engagement.[1,9]

This is the first report of its kind in which the collaboration tracks 25 health and climate change indicators (Table 1) chosen according to their regional

Section	Indicator	
Health hazards, exposures, and impacts	1.1 Health and heat	1.1.1 Exposure of Vulnerable Populations to Heatwaves
		1.1.2 Heat-related mortality
	1.2 Wildfires	
	1.3 Climate suitability for infectious disease transmission	
	1.4 Food security and undernutrition	
Adaptation, planning, and resilience for health	2.1: Assessment and planning of health adaptation	2.1.1 National assessments of climate change impacts, vulnerability and adaptation plans
		2.1.2 National adaptation plans for health
		2.1.3 City-level climate change risk assessments
	2.2: Enabling conditions, adaptation delivery, and implementation	2.2.1 Climate information for health
		2.2.2 Urban green space
		2.2.3 Health adaptation-related funding
	2.3: Vulnerability to mosquito-borne diseases	
Mitigation actions and health co-benefits	3.1 Clean household energy	3.1.1: Access to clean fuels and technologies
		3.1.2: Exposure to household air pollution
	3.2 Premature mortality from ambient air pollution by sector	
	3.3 Sustainable and healthy transport	
	3.4 Diet and health co-benefits	
Economics and finance	4.1: The Economic impact of climate change and its mitigation	4.1.1 Costs of heat-related mortality
		4.1.2 Loss of earnings from heat-related labour capacity reduction
		4.1.3 Costs of the health impacts of air pollution
	4.2: Net value of fossil fuel subsidies and carbon prices	
Public and political engagement	5.1 Media coverage of health and climate change	
	5.2 Scientific engagement in health and climate change	
	5.3 Government engagement in health and climate change	
	5.4 Corporate sector engagement in health and climate change	

Table 1: **The indicators of the 2022 South America report of the Lancet Countdown.**

relevance and data availability for 12 South American countries.[‡] The report draws from the data and methods used for the 2022 global *Lancet* Countdown report[1] and other available data sources.[10,11] The LCSA has taken steps to ensure that it has the expertise, data, and representation of the entire South American region to create a monitoring system that fits the region's specific singularities. The LCSA has partnered with 11 South and Central American universities, four international and, at the same time, collaborates closely with UN institutions and other regional organisations that share the goal of bringing evidence to light and triggering health and climate change action. The findings and conclusions of this inaugural report are the cumulative result of the LCSA's collaborative work during the past year and represent the consensus of experts in environment, energy, food, transport, economy, social and political scientists, public health professionals, and medical doctors across the region.

Future work will fill critical research gaps by proposing and tracking new and relevant indicators for the South American region. LCSA will continue to focus on supporting regional and national efforts, building capacity for communications and engagement, guiding a data-driven policy dialogue with key stakeholders and policymakers, and further improving existing indicators. To this end, the ongoing growth of the LCSA depends on the dedication of the global *Lancet* Countdown team, the composite of experts and local partners, the continued support from the Wellcome Trust, and the time and effort that the academic institutions of the collaboration are willing to give to this initiative.

Section 1: health hazards, exposures, and impacts

Climate change is a global phenomenon, but its impacts are felt unequally around the world. In SA, over the past decades, mean ambient temperature has increased across the entire region, precipitation has decreased below normal in several locations, glaciers have rapidly retreated in the Andes region, and sea level has increased in the Pacific and Atlantic coastlines.[12] The

[‡]The 12 countries considered in this report are: Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Guyana, Paraguay, Peru, Uruguay, Venezuela, and Suriname. French Guiana has not been considered in this report, as it is an overseas department of France.

increase in climate hazards compounds with the El Niño-Southern Oscillation (ENSO) and with substantial population exposure and social vulnerabilities, to result in direct, indirect, multiple, and cascading effects that threaten the health and wellbeing of local populations. Heatwaves, wildfires, lower crop yields, climate change-driven threats to water and food security, and extended climate suitability for climate-sensitive infectious diseases, such as dengue, are only a few of many potential quantifiable and increasing climate-related hazards that have impact on population health.

Understanding the health hazards, population exposure and vulnerability, and the resulting health impacts of climate change, is critical for guiding climate policies that can improve population health and wellbeing. Based on the 2022 global *Lancet* Countdown report, this section tracks five indicators on the health hazards, exposures, and impacts of climate change of relevance to SA. First, it presents regional information on the exposure of vulnerable populations to heatwaves (indicator 1.1.1), heat-related deaths among people above 65 years old (indicator 1.1.2), and population exposure to very high to extreme high fire risk (indicator 1.2). Next, it explores the changing climate suitability for dengue transmission, an important vector-borne disease in the region (indicator 1.3), providing information that can help inform public health interventions. The last indicator monitors the impact of climate change on the agricultural cycles and potential productivity of different crops, providing an assessment of the potential risk to food insecurity in South American communities (indicator 1.4).

Health and heat

Indicator 1.1.1: exposure of vulnerable populations to heatwaves—headline finding: in the 2012–2021 period, on average, children younger than 1 year old were affected by 2.35 million more person-days of heatwave exposure each year, and adults older than 65 years were affected by 12.3 million more person-days of heatwave exposure compared to the 1986–2005 average

Increasing temperature has been recorded in every country in SA over time, with remarkable anomalies ranging from 1 °C to 2 °C in several parts of Brazil, Colombia, Chile and Argentina in 2021 relative to 1981–2010.[12] Heatwaves in the region were exceptionally intense and long in some countries, including Argentina, Brazil, Chile, Paraguay, and Peru.[12] This warming has led to higher population exposure to high and sustained ambient temperature, including heatwaves, which have been globally associated with health risks, especially among young and older people.[13]

Drawing on the 2022 global *Lancet* Countdown report, this indicator uses data from the European Centre for Medium-Range Weather Forecasts (ECMWF) ERA5 data,[14] NASA Gridded Population of the World version 4,[15] and United Nation World Population Prospects data,[16] to estimate the absolute difference in the number of days children younger than 1 year old and people older than 65 years old were exposed to life-threatening heatwave events (considered as 2 or more days where both the minimum and maximum temperatures were above the 95th percentile of the local climatology), compared to the 1986–2005 baseline.[17,18] The absolute number of person-days was obtained by subtracting the yearly estimates and the 1986–2005 average.[1]

Between 2010 and 2020, the number of person-days of heatwave exposure in almost all South American countries was consistently and substantially above the 1986–2005 baseline. Although the exposure to changes in the number of heatwaves was relatively low in 2021, that was not the trend from 2012 to 2021 (Fig. 1). In this 10-year period, children younger than 1 year old were affected, on average, by 2.35 million more person-days of heatwave exposure each year, and adults older than 65 years old were affected, on average, by 12.3 million more person-days of heatwave exposure each year compared to the reference period (1986–2005).

The magnitude of the changes in Fig. 1 is determined both by an increase in the number and length of heatwave events, as well as by changes in population size, age composition, and the latitude and geographical location of the population.[18,19] Noticeable high values in 2015, 2016, 2019, and 2020 were mostly driven by more frequent or lengthy heatwave events rather than unusual or sudden population changes. Increases in 1983 and 1998 coincided with the two significant El Niño events.[20]

Indicator 1.1.2: heat-related mortality—headline finding: the estimated number of heat-related deaths has increased, on average, by 160% in the 2017–2021 period compared to the 2000–2004 period

The exposure to extreme heat along with personal and social vulnerabilities increases the risk of death from all causes, particularly cardiovascular, cerebrovascular, and respiratory conditions amongst vulnerable people older than 65 years old.[21,22]

This indicator draws on data from the 2022 global *Lancet* Countdown report and estimates heat-attributable deaths of people older than 65 years old between 2000 and 2021,[1] following exposure-response functions proposed by Honda et al.[23] and by using data from ECMWF ERA5,[14] the NASA Gridded Population of the World version 4,[15] and the United Nations World Population Prospects.[24]

In SA, the estimated number of heat-related deaths has followed an upward trend between 2000 and 2021, with Brazil, Argentina, Colombia, and Venezuela the most affected in terms of total attributable deaths. The countries with the highest relative change are Ecuador (1477%), Guyana (328%), and Chile (225%), while the countries with the lowest increase are Paraguay (143.2%), Argentina (85.2%), and Uruguay (37.4%).

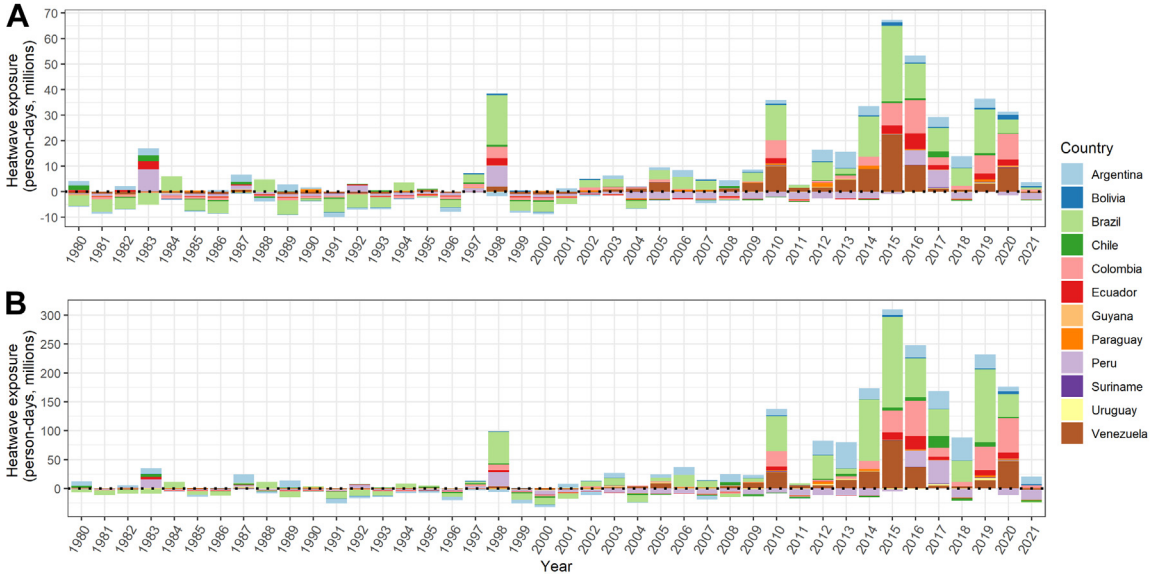

Fig. 1: Total exposure to change in the number of heatwave days relative to the 10-year average 1986–2005 baseline of **(A)** People younger than 1 year old and **(B)** people older than 65 years old. The dotted line represents no change.

2020 was one of the three years with the most heat-related deaths for all countries, and seven out of 12 countries reached historical records. This record was partially triggered by the extended and intense heatwave in SA[25,26] and by the increase of the exposure in vulnerable populations (indicator 1.1.1). Interannual variations are expected to happen and might be driven by climatic factors and rapid-onset hazards, such as the COVID-19 pandemic.

Indicator 1.2 wildfires—headline finding: exposure of South American populations to very high or extremely high wildfire danger has increased in nine out of 12 countries, with an average increase of seven more days of exposure per person each year in 2018–2021 (35% of change), compared to the 2001–2004 baseline

The analysis of wildfires in SA is complex. The region combines unique and diverse biomes, with wildfires being an essential part of ecosystem dynamics, such as in the Brazilian Cerrado. However, as a biome, the Amazon rainforest, which is not adapted to exposure to fire during the life cycle of its plant species, has relatively low resilience to wildfires. This is becoming aggravated by land use change and deforestation.[27] Although most wildfires in SA originated from deliberate human activities, climatic changes can make climatological conditions more suitable for their start and spread, including through high ambient temperature, reduced precipitation, and humidity, making wildfires more frequent, extensive, and challenging to control.[28] This combination of factors results in amplified damage and more negative impacts on population health and wellbeing.

Wildfires pose a multilevel and systemic risk for human health and wellbeing through several pathways: (i) wildfires can cause direct physical harm or death[29]; (ii) smoke inhalation from wildfires poses several acute and chronic health threats, including increased morbidity and mortality[30]; (iii) the loss of assets and loved ones has an impact on mental health (Panel 1). In addition, wildfires can exacerbate environmental degradation and climate change, therefore worsening health risks. Characterising the climatological fire risk in SA, particularly in the Amazon, would help understand the phenomenon and inform potential adaptation and mitigation actions to reduce health hazards.

This indicator draws on data from the 2022 global *Lancet* Countdown report, to track population exposure to very high and extremely high fire danger based on meteorological conditions favourable to the start, spread, and sustainability of fires. Data from the Fire Danger Index (FDI) was obtained from the Copernicus Emergency Management Service for the European Forest Fire Information System (EFFIS)[31] and combined with the NASA Gridded Population of the World version 4 dataset,[15] and the United Nation World Population Prospects data.[24] To focus on wildfires as opposed to urban fires, urban areas with population density ≥400 persons/km^2 are excluded.

In the nine out of the 12 countries that saw an increase in very high or extremely high wildfire danger, people experienced an average of 7 more exposure days annually, as compared to the 2001–2004 baseline. However, there

were important differences in the number of exposure days across countries. Uruguay, Paraguay saw an increase of 3-4 exposure days, vs Argentina and Chile 14–20 days of exposure per year (Table 2).

Wildfires in SA, especially in Amazon, the Pantanal, and El Chaco, result in major forest and biodiversity loss,[32,33] because SA holds 21% of the world's remaining forests. Wildfires driven by deforestation and degradation processes have a double impact in the concentration of GHG emissions in the atmosphere as they decrease the ability of natural systems to act as GHG sinks[34]; and negative synergies between deforestation, climate change, and wildfires are leading to a non-reversible tipping point in the Amazon ecosystem to become a non-forest ecosystem with 20–25% deforestation, causing a massive effect in its hydrological cycle, fundamental for human wellbeing and agriculture in Brazil and adjacent South American countries.[34]

Indicator 1.3 climate suitability for infectious disease transmission—headline finding: climate-related suitability for dengue transmission has steadily increased in SA since 1951, rising by 35.3% in 2012–2021 compared to the 1951–1960 baseline

Climate change affects the transmission of vector-borne diseases, such as dengue, via increased temperatures, precipitation, extreme weather events, and other global climate variability phenomena such as ENSO. This is particularly important for highly endemic regions such as SA. This indicator focuses on monitoring the changing climatic suitability for the transmission of dengue, an infectious disease which has had a substantial rise in its incidence and severity during the last 30 years in SA.[35,36]

This indicator draws from the 2022 global *Lancet* Countdown report and tracks the climate suitability for dengue transmission by estimating its basic reproduction number (R_0) as a function of the vectorial capacity and abundance, and influenced by rainfall, temperature, and human population density. It focuses exclusively on transmission by *Ae. aegypti*, the primary dengue vector in the region, as the R_0 estimates for *Ae. aegypti* and *Ae. albopictus* are strongly correlated (>80%).

The estimated suitability for dengue transmission across 1951–2021 increased over time in all countries where the mosquito is found (except for Argentina and Suriname) (Fig. 2). On average, the R_0 in the region increased 0.53% annually, with the largest increases (>0.5%) in six Amazonian countries, some with highly linear yearly correlations (Determination coefficient R2 >50%). There were very low increases in Guyana, Paraguay, and Uruguay (0.17%–0.35% per year), and no significant linear trends in Suriname and Argentina.

The largest R_0 relative mean increases took place in the 1971–1980, 1981–1990 and 1991–2000 decades compared to the 1951–1960 baseline: 9.1%, 9.9% and 4.9%, respectively.[37] There were smaller (2.4–2.6%) increases in the two following decades. In 2012–2021, SA reached its highest climate suitability to dengue, rising by 35.7% compared to the 1951–1960 baseline, and then remained at a very high level in 2021. All countries, except Chile, showed important (>0.25) inter-annual R_0 variability at least once over consecutive years. Six countries had inter-annual changes >0.5, and the highest variability was observed in Peru and Ecuador, coinciding with El Niño years -the warmer phase of ENSO.

The sustained increase of dengue climate-related suitability until the 1990s is likely one of the drivers of the rapid expansion of dengue across SA,[35] with urbanisation and population movement also having strong influences.[37] Sizeable epidemics of dengue and the emergence of new *Aedes*-transmitted arboviruses have been repeatedly observed since. Understanding the lack of further suitability increases in the last 20 years in SA will help evaluating if more specific indicators are needed.

Country	2001–2004	2018–2021	Difference in days	% of change
Argentina	22.9	37.3	14.4	0.6
Bolivia (Plurinational State of)	23.1	30.8	7.6	0.3
Brazil	33.5	39.1	5.7	0.2
Chile	38.3	59.5	21.2	0.6
Colombia	10.6	12.3	1.7	0.2
Ecuador	0.9	0.7	−0.2	−0.2
Guyana	1.2	0.8	−0.4	−0.3
Suriname	0.4	0.1	−0.2	−0.6
Paraguay	4.2	8.7	4.5	1.1
Peru	7.3	10.6	3.3	0.5
Uruguay	0.7	3.9	3.3	5.0
Venezuela, Bolivarian Republic of	40.1	41.4	1.4	0.0

Table 2: **Population exposure to very high wildfire danger comparing 2018–2021 to the 2001–2004 baseline.**

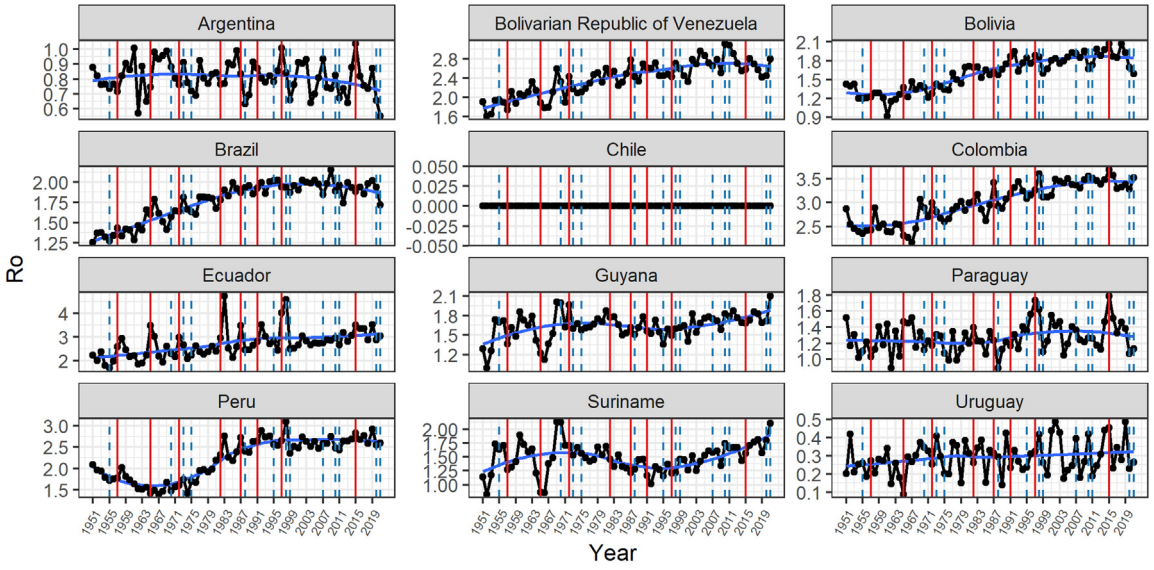

Fig. 2: Estimated R_0 for dengue (*Ae. aegypti*) by country in SA, from 1951 to 2021. Vertical lines in dashed light blue represent La Niña years and solid red lines represent El Niño years. The blue line represents a smooth local regression over time.

Indicator 1.4 food security and undernutrition—headline finding: on average, in 2021, the estimated duration of the growing season for spring wheat, winter wheat, maize, soybean and rice had decreased by 2.5%, 2.2%, 1.6%, 1.3% and 0.4%, respectively, relative to the 1981–2010 period

Changes in the climate affect the growth, yield, and nutritional content of several crops, including wheat, rice, maize, and soybean,[38] increasing the risk of food insecurity and its consequences on human health and wellbeing. Higher ambient temperatures during the crop growing season might shorten the time taken for crops to reach maturity, threatening crop growth and yield. In SA, where agriculture is a key sector (either for exports or internal consumption), tracking changes in potential crop yield is critical, as it can impact on economic and social development, food security, and human nutrition.

After remaining virtually unchanged for five years, world hunger increased in 2020. That year, the prevalence of undernutrition increased by 1.5 percentage points to 9.9% increasing the difficulties of achieving the second Sustainable Development Goal (Zero Hunger by 2030).[39] Populations in SA are highly vulnerable to food insecurity, and in 2020, 168.7 million people in SA suffered from moderate and severe food insecurity, Concerningly, the number of people suffering from food insecurity increased by 40 million in 2021, affecting more women than men.[40]

This indicator draws on data from the 2022 global *Lancet* Countdown report to estimate the reduction in crop growth duration, as a proxy for change in potential crop yield, and therefore for potential risks to agriculture and food security.

Crop growth duration is defined as the time taken in a year for crops to reach the accumulated temperature total needed to reach maturity, as defined in the reference period (1981–2010). In SA, crop growth duration has followed a downward trend for all crops since 1981. In 2021, the average duration of the growing season relative to the 1981–2010 period, decreased by 2.5% for spring wheat, 2.2% for winter wheat, 0.4% for rice, 1.6% for maize, and 1.3% for soybean (Fig. 3 and see Supplementary Material pp.1–4 for spring wheat, soybean, and rice figures). However, there are important differences between countries and the exact change depends upon the location and crop.

SA is currently experiencing a critical juncture, with a significant increase in food insecurity exacerbated by climate variability and extremes, conflict, economic downturns, and recessions, recently exacerbated by the COVID-19 pandemic. Considering these challenges, data collection on food insecurity is urgently needed, particularly to enable the development of more detailed indicators, and to help identify and characterise vulnerable populations. This can be a valuable tool to increase the knowledge about the relationship between food production, food insecurity, food nutritional potential, and the effects on human health and wellbeing, such as nutritional deficiencies, overweight, chronic diseases, and psychosocial consequences.

Conclusion

The evidence presented in this section shows that climate change is already threatening the health and wellbeing of South American populations. Increasing ambient temperature and heatwave events pose high risks to the health of the most vulnerable people,

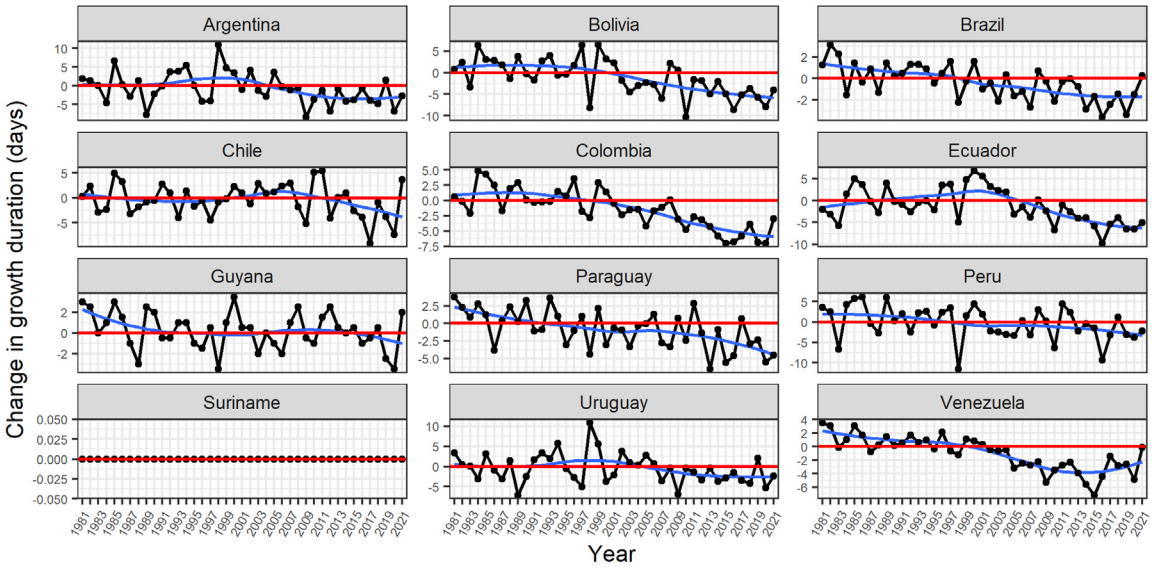

Fig. 3: Change in maize growth duration relative to the 1981–2010 average by country. The red line represents no change. The black line represents the annual area-weighted change in maize growth duration. The blue line represents a smoothing trend over time.

resulting in a rise in heat-related mortality. Importantly, much of this increase in mortality could today still be prevented through adequate adaptation measures. Increased exposure to days of high or extremely high meteorological fire danger is putting people at risk of life-threatening injuries, respiratory disease, and corneal injury from exposure to wildfire smoke, while the loss of infrastructure, disruption of essential services, and additional environmental degradation can have indirect health harms. Simultaneously, the climate-related suitability to dengue fever in the last decade has increased in key endemic regions, and severe dengue epidemics have been observed in recent years. Finally, high ambient temperatures are threatening crop yields, which might lead to negative effects in the agriculture sector, food security, and human nutrition. The ecological mega-diversity of SA and the special influence of cyclical climate variability lead to unique sub-regional scenarios dealing with very different climatic health hazards. Urgent adaptation and mitigation policies are critical to preventing the health risks of climate change to increase beyond our capacity to adapt and prevent the most extreme impacts to the health of local populations.

Panel 1: Mental health and climate change.

Climate change is eroding the social, economic, and environmental determinants for psychosocial wellbeing, and leading to multiple, interrelated, and wide-ranging mental health impacts.[41] These impacts vary from common mental disorders[42–44] to severe mental illnesses[45] and suicide,[46–48] and pose a greater threat to underserved populations[49–55] in the backdrop of historical social inequities. The burden that mental disorders have in the Latin American region is substantial, and frequently overlooked. e.g., The measured age-standardise disability-adjusted life-years (DALYS) associated to mental ill health from 1990 to 2019 in tropical Latin America was one of the highest worldwide[56]; the regional treatment gap for severe mental disorders have been estimated in 74.7% and 80% among indigenous groups[57]; (which accounts to 8% of the Latin American region' population).[58]

Estimates showed that only about 1 in 4 persons with any 12-month mental disorder in SA had received any kind of treatment.[59] Climate change threatens to further act as an amplifier of these existing mental health risks and interrupt the avenues for mental health and psychosocial support.[55] Those affected by structural and long-dating inequities and marginalised groups (e.g., indigenous population, women, and impoverished groups, among others) are most at risk for climate-related mental health impacts.

Despite the increase in the social, political, and environmental drivers of ill-mental health, and although public and political attention to the mental health impacts of climate change is increasing,[5,10,60] the understanding of the links between climate change and mental health is still limited. Data and indicators on mental health and climate change in Latin America and SA specifically, are particularly scarce. Lack of awareness, stigma, and misconceptions also impair the accessibility and registry of mental health data.[61–63] An added complexity concerns the different timings, severity, and persistence of exposures, including regional availability of research (indicator 5.2) and data on mental health impacts.[64,65] There is an urgent need to develop and track reliable global and regional indicators. These could focus on the effect that extreme weather events and heatwaves have on common mental disorders (e.g., depression, anxiety) and reported suicides across publicly available national level datasets.

Section 2: adaptation, planning, and resilience for health

With the health hazards and impacts of climate change rapidly increasing and temperatures bound to continue to rise even under the most ambitious climate change mitigation scenarios,[66] rapid, targeted, and efficient adaptation is essential to prevent the most extreme health impacts.

This is particularly important in SA, where inequalities, limited resources, and relatively weak health and health-relevant systems make local populations particularly vulnerable to climate change-related health hazards. While the region has experienced improvements in health systems and infrastructure over the past decades, reducing rates of mortality and morbidity,[67] much is yet to be done in building climate resilience to local health systems. Moreover, the COVID-19 pandemic triggered social and economic crises, leading to a rise in poverty and social inequalities,[68] presenting additional challenges for the health response to climate change. Importantly, climate change adaptation actions, such as expanding urban green spaces, strengthening health systems, and building more resilient essential infrastructure, not only have the potential to minimise climate-related health impacts, but can also offer broader benefits to the health and wellbeing of populations in SA.

This section reports on six indicators related to climate change adaptation, including national and city-level plans and assessments (indicators 2.1.1–2.1.3), climate-health information systems (indicator 2.2.1), urban greenspace (indicator 2.2.2), health adaptation funding (indicator 2.2.3), and vulnerability to mosquito-borne diseases (indicator 2.3). In addition, Panel 2 describes the importance of adopting indicators to track the resilience of health systems in the region.

Assessment and planning of health adaptation

Indicator 2.1.1: national assessments of climate change impacts, vulnerability and adaptation plans—headline finding: up to October 2021, Brazil was the only country in SA that reported having completed a climate change and health vulnerability and adaptation assessment

Climate change impacts and risks are becoming increasingly complex and more challenging to manage, which adds to the overall risk they pose across sectors. The level of risk will depend on the vulnerability, exposure, level of socioeconomic development, and adaptation measures of each country, making it urgent for countries to develop effective climate change adaptation measures targeting specific risks that contribute to health outcomes. The SA region has made progress as the countries adhere to the Paris Agreement, Cancun Adaptation Framework,[69,70] and regional health and climate agreements adopted by the Andean Community and Mercosur countries. As vulnerable people and systems are disproportionately affected, national climate change risk assessments can assist decision-makers in allocating human and financial resources more effectively, prioritising those who bear the biggest burden.[71–74]

This indicator monitors self-reported data countries, in which health sector representatives report on the state of national climate change health vulnerability assessments. It uses data from the 2021 WHO Health and Climate Change Global Survey,[10] which has responses from 91 governments, including nine countries from the South American region.

Brazil was the only country that reported having conducted a climate change and health vulnerability and adaptation assessment, and that it was completed in 2020. Brazilian authorities reported that results of the latest assessment informed the development of a new health policy or the revision of an existing one but did not influence the allocation of human or financial resources within the ministry of health to address health risks of climate change. Argentina and Peru reported having assessments under development. Bolivia, Colombia, Guyana, Suriname, and Uruguay informed they have not conducted an assessment, and data for Paraguay is unknown. Chile, Ecuador, and Venezuela did not participate in the survey. Additional review of national and regional documents on adaptation showed that Argentina developed a climate change and health assessment in 2019.[75]

Indicator 2.1.2: national adaptation plans for health—headline finding: up to 2021, Brazil was the only country in SA that self-reported having a national health and climate change strategy or plan in place

To protect their populations from the worst health impacts of climate change, every country will need to define how to integrate climate change adaptation and mitigation measures with health co-benefits in specific public health programmes within the health sector development plans. National Adaptation Plans for Health (HNAPs) can provide clear ministerial mandates for coordination, implementation, monitoring and evaluation, where roles and responsibilities are properly delimited, and which guide the allocation of adequate human and financial resources. Following these plans, the health sector can set the foundation for the broader climate-resilience-building process across other sectors.[76]

The indicator tracks the development of national health and climate change strategies and plans, and the barriers to implementation. The data comes from the 2021 WHO Health and Climate Change Global Survey,[10] which provides self-reported data on health sector responses to climate change from 91 governments. Nine out of 12 countries from SA completed the survey. Chile, Ecuador, and Venezuela did not participate.

Brazil was the only country that reported having developed a HNAP up to 2020. However, Brazil's level of implementation was moderate, with action reported against only on some of the plan/strategy priorities. Argentina, Colombia, and Peru reported having plans under development. Bolivia, Guyana, Suriname, and Uruguay do not have an HNAP in place, and data for Paraguay is unknown.

An additional review of national and regional documents on adaptation was performed to complement the information countries provided through the WHO's survey. This showed that Chile already had adopted an HNAP in 2016,[77] and Argentina adopted its first action plan on health and climate change in 2019.[78] The development of an HNAP is also underway in Uruguay and is anticipated for 2025.[79]

Despite advances in the region, South American countries continue to lag in the creation of HNAPs, limiting the ability of governments to adequately address health issues related to climate change, procure funding, and identify solutions to strengthen the resilience of health systems.[80] In future iterations of this indicator, in addition to tracking HNAPs, this indicator will track the health mentions in the national adaptation plans by sector to monitor if health is being including in the adaptation planning in SA.

Indicator 2.1.3: city-level climate change risk assessments—headline finding: in 2021, two-thirds (65.3%) of 205 SA cities surveyed had either already completed or were in the process of undertaking climate change risk and vulnerability assessments

Four-fifths of the South American population currently live in urban areas.[76] According to WHO, unplanned urbanisation led to new health challenges, such as pollution, increased vulnerability to climate hazards, inequity and even led to cities becoming epicentres of disease transmission. Climate change risk and vulnerability assessments can inform city-level adaptation measures to address environmental issues, reduce the harmful impacts of climate change, build resilient societies, and improve overall quality of life. This indicator uses the CDP Annual Cities Survey which reports on cities that voluntarily have conducted climate change city-level risk and vulnerability assessments.

In 2021, 205 city municipalities from ten countries in the SA region voluntarily completed the survey. Guyana and Suriname are the only countries with no assessments. Of the 205 SA cities responding to the survey, only 107 (52.1%) had a complete climate change city-level risk and vulnerability assessment; 27 (13.1%) had them in progress and 47 (22.9%) intended to undertake them in the next two years. The countries with the highest number of city municipalities responding to this assessment were Argentina, Brazil, and Colombia. Countries with one completed assessment included Uruguay, Venezuela, and Paraguay. The main hazards identified in the CDP survey vary by city municipality. The hazards most frequently identified by city municipalities in Brazil and Argentina were extreme precipitation and flooding as the main hazards, cities in Peru most frequently identified water scarcity and extreme temperatures as a hazard of concern, while those in Chile and Colombia identified wildfires. Cities in a few countries (Colombia and Brazil) identified mass movement or climate migration as potential climate hazards.

This indicator suggests that promising advances in climate change assessments are occurring in city municipalities. Assessments are an important early step towards effective adaptation to climate change. This indicator will continue to evolve to include information on specific risks across the region, allowing city-level decision-makers to identify common hazards and plan accordingly.

Future iterations of the indicator will explore implementing planned adaptation solutions to the identified risks and vulnerabilities. There is a need for more municipalities to develop climate change adaptation plans that take health impacts into account based on evidence of climate change risks and vulnerabilities. The results will also be analysed and presented based on a percentage of the total number of municipalities of each country to provide comparable representations on the assessments undertaken in countries with different numbers of urban centres.

Enabling conditions, adaptation delivery and implementation

Indicator 2.2.1: climate information for health—headline finding: in 2021, only two countries of SA reported that their health systems incorporated meteorological information. The heat early warning system in Argentina was the only national early warning system that has been implemented and evaluated

With climate-related health hazards on the rise, the provision of climate services tailored to the health sector is essential to the development of early warning systems to climate-related health hazards, and climate-related risk surveillance. These tools can support public health decision-makers in the implementation of early interventions and response systems that can reduce or prevent the health impacts of climate change on local populations.[10]

This indicator monitors the extent to which health surveillance systems and early warning systems (EWS) incorporate climate information, based on the results of the WHO Health and Climate Change Global Survey, a global survey of health focal points conducted in 2021.[10] Data was reported by nine SA countries (no data for Chile, Ecuador, and Venezuela).

Argentina and Brazil were the only countries that reported that their health systems incorporated meteorological information. Argentina was the only country to report a health EWS already in place. This EWS was

based on epidemiological information and was evaluated.[81–83] Initially set up a city-level for Buenos Aires, it was later implemented at the national level.

Beyond EWS, other efforts to implement climate services for health in SA include climate and health observatories, integrated climate and health surveillance systems, and vulnerability maps.[3] Examples from the region include an experimental monitoring and forecasting system for environmental suitability of *Aedes*-borne disease transmission in northern SA,[84] heatwave and extreme cold monitoring and alert systems in Argentina,[85] and a climate and health observatory in Brazil.[86] Advances in surveillance systems, modelling, and computing tools in the last decade have increased the availability of digital climate and health records and the accuracy of predictions of climate-related health risks. In some places with scarce climate information, satellite imagery can help to fill data gaps.[87,88] However, as climate change-related threats increase, the region will need to invest more efforts in implementing climate services for health, to minimise the adverse impacts on local populations.

Indicator 2.2.2 urban green space—headline finding: in SA, 84% of urban centres were classified as having low, very low, or exceptionally low greenspace coverage in 2021. No urban centres had levels of greenspace classified as high or above. However, urban centres classified as having moderate greenspace increased by 9.6% since 2010

Preserving and expanding greenspace is an important climate adaptation and mitigation strategy which has been adopted by several cities across the world. Increasing greenspace in urban areas can additionally provide substantial health co-benefits, as it is linked with improved human physical and mental health, and the reduction of general and cause-specific mortality and morbidity.[89] Although the mechanisms of such beneficial effects are still not completely understood, it has been hypothesised that it could be mediated by the effect of greenspaces in reducing air and noise pollution, their local cooling effect, as well as by urban greenspaces providing appropriate spaces for physical activity and social interaction, all of which has positive impacts in physical and mental health. But despite their recognized health and climate benefits, there are still enormous disparities in the quantity, accessibility, and quality of greenspace within and between cities and countries, with the most vulnerable populations often having less access to greenspace,[90,91] as demonstrated in Argentina[92] and Peru.

A sample of large urban areas in 12 countries in SA was examined, and the vegetation coverage was estimated using the satellite-based normalised difference vegetation index (NDVI).[1] Population-weighted NDVI was calculated as an estimate of exposure to greenspace. The level of Greenness was defined as "exceptionally low" (Population-Weighted Peak NDVI <0.20); "very low" (0.20–0.29); "low" (0.30–0.39); "moderate" (0.40–0.49); "high" (0.50–0.59), "very high" (0.60–0.69) and "exceptionally high" (≥0.70). The analysis was performed for the years 2010 and 2021.

Of the 73 urban centres examined, only 12 (16%) presented moderate levels of greenspace in 2021 (i.e., NDVI ≥0.40 and <0.49), representing an increase of 9.6% since 2010. The mean urban population weighted peak NDVI in SA was 0.31 and the maximum value observed was 0.45. The overall mean exposure to green areas increased by around 12% between 2010 and 2021, although about 18% of urban centres experienced a decrease in their green areas during the same period (Fig. 4). Most countries presented an increase in mean levels of urban greenspace between 2010 and 2021 but Paraguay and Chile showed a decrease in the period.

The availability of green spaces in urban areas in SA is still amongst the lowest levels in the world, and the growth of these areas in recent years has been quite modest.[91] Increasing urban greenspace in the region is an important and low-cost measure that would deliver major health benefits to local populations.

Indicator 2.2.3: health adaptation-related funding—headline finding: health adaptation is woefully underfunded in SA, with only 10% (US$36 million) of approved adaptation-related funding dedicated to health adaptation in 2021

Implementing climate change adaptation policies and actions for the health and wellbeing of populations requires transparent financial commitments with budget allocation and securing and facilitating access to international funds.[60] Given the present and expected future impacts of climate change in the region, and the economic situation of most SA countries, access to international funding for climate change adaptation, particularly with a focus on health outcomes, is an urgent need in the region. This indicator tracks overall and health-specific spending in adaptation and cross-cutting projects.

Climate change funding in SA has largely focused on mitigation projects aligning with global efforts towards a global carbon-zero transformation. However, the region is in urgent need for adaptation actions that are properly funded and implemented. In the broader Latin America and the Caribbean (LAC) region, most climate funding comes from the Green Climate Fund, with additional funding from the Clean Technology Fund, the Amazon Fund, the Pilot Programme for Climate Resilience, the Global Environmental Facility, the Forest Investment Program, among others.[93] Only 18% of LAC climate funds are allocated to adaptation projects, with almost two-thirds of funding allocated to mitigation projects.

This indicator draws from the 2022 global *Lancet* Countdown report and monitors the allocation of

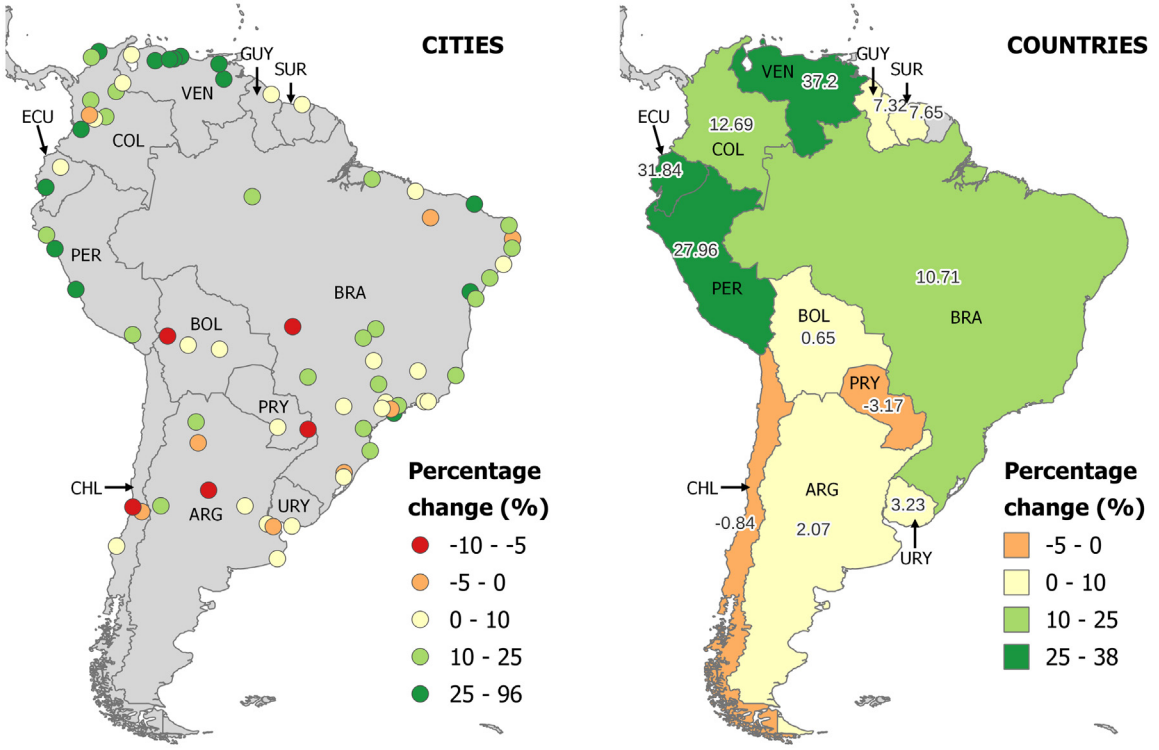

Fig. 4: Percent change in urban levels of greenness in cities (left) and countries (right) in SA, 2010–2021.

approved funds for health-related adaptation projects within the Green Climate Fund (GFC) by analysing and reviewing Project Approval Documents from the Project Portfolio.[94]

In 2021, approximately US$365 million were approved by the GCF for three projects related to climate change adaptation in SA. The approved projects in the database focused mostly on funding for adaptation technologies, bioeconomy products and services and coral reef protection. Only US$36.25 million, in two projects alone, were dedicated to health adaptation, specifically, representing just 10% of total approved funding. Furthermore, neither of these projects identified health benefits of adaptation actions or focused on health system resilience. The three projects were unequally distributed across the region, with all of them focused mostly on Brazil. No projects were approved in Argentina, Bolivia, Chile, Paraguay, Uruguay, and Venezuela.

With health adaptation woefully underfunded in the region, South American populations remain at high risk from climate hazards. Meanwhile, high-income countries have thus far not delivered US$100 billion a year by 2020 committed in the 2009 Copenhagen Accord, to support climate action in "developing nations".[95] Long-term financial investments, backed by political mandates on climate and health, are needed to strengthen the resilience of health systems and avoid the worst health impacts of climate change,

Indicator 2.3: vulnerability to mosquito-borne diseases—headline finding: average national vulnerability to severe dengue outcomes decreased in SA by 11% between 1990 and 2019. Bolivia experienced a reduction of 30%, whereas Argentina and Uruguay, located in the temperate Southern Cone, experienced increases in vulnerability

Changes in precipitation patterns, increases in temperature, and growing urban populations have favoured the distribution and expansion of mosquito-borne diseases globally, including dengue fever, which is of particular importance for SA.[96] Dengue is rapidly spreading to higher latitudes and less populated areas in Brazil and Peru.[6,8,97] While Argentina, one of the most urbanised countries in the world[98] has experienced the emergence and re-emergence of dengue in temperate regions, such as Cordoba,[96,99] Santa Fe,[100] and Buenos Aires.[101] In addition, Uruguay registered its first confirmed case of autochthonous dengue transmission in 2016.[96]

Vulnerability to mosquito-borne diseases, including the dengue virus, is influenced by biophysical, social, and economic factors and local coping and adaptive capacities.[102] Reductions in healthcare access and quality, urbanization, high population density, and low

socioeconomic status are societal factors that can potentially increase population vulnerability to severe outcomes from dengue fever.[102–104] In a region with a high climatic suitability variance for the transmission of *Aedes*-borne diseases (indicator 1.3), information on vulnerability to dengue, combined with changes in the environmental suitability for its transmission, can assist countries of the region in investing in resilience and adaptation actions.

This indicator tracks the average national vulnerability to serious dengue-related adverse outcomes between 1990 and 2019. It combines the proportion of the population in urban environments,[105] with mortality of key preventable deaths (deaths by communicable diseases and maternal, prenatal and nutrition conditions) as a proxy indicator of healthcare access and quality.[106]

From 1990 to 2019, endemic countries in SA (Bolivia, Brazil, Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela, and Suriname) experienced an overall 16% decrease in vulnerability to dengue, although this outcome varied by country. Bolivia had a 30% reduction in dengue vulnerability, driven by improvements in healthcare access and quality, which rose by 55% since 1990. On the other hand, countries from the Southern Cone, where dengue is epidemic or emerging, experienced increases in vulnerability. For instance, Uruguay saw an increase in vulnerability (7%), mainly driven by the growth of the population living in urban settings (7% growth since 1990).

Argentina is the country that has experienced the highest increase in vulnerability to dengue (11%), mostly due to its large urban population (9 out of 10 people in Argentina live in urban areas) coupled with declining healthcare access and quality (3.4% decrease in 2019 compared to the 1990 baseline). In Argentina, this could be further exacerbated by healthcare provision and access inequities through its three coexisting healthcare subsystems (private, public, and social security).[107,108] Ensuring equitable access to healthcare is essential to provide early diagnosis and timely treatment during a dengue epidemic, thereby reducing the individual risk of the most severe dengue outcomes.[109] As metrics become available, future improvements in this indicator could include data on socio-economic status and context-specific climate variabilities such as those triggered by El Niño and La Niña events.

Conclusion

In SA, climate change adaptation for health is insufficient, putting local populations at acute risk of the most severe health impacts of climate-related hazards. Few countries in the region have conducted vulnerability assessments or developed HNAPs to guide adaptation interventions, limiting the articulation of specific health policies and interventions, and the capacity to guide resource allocation. As a result, there is a profound lack of financing at national levels and limited implementation of adaptation actions, as evidenced by few countries using climate information to guide health sector decision-making. Accordingly, the IPCC Sixth Assessment reports that the feasibility of implementing climate-informed tools for the health sector in Central and SA is limited due to political and institutional factors and financing.[11] Implementation science can support health adaptation planning by identifying best practices and bottlenecks in implementing adaptation actions, and the benefits of allocating further research resources to this area could cascade through broad areas of society.[115]

Despite these challenges, some signs of progress exist, particularly at the city level. Vulnerability to dengue fever, a disease that mostly affects urban populations, has declined in most South American countries, such as Bolivia, due to rising access to healthcare. Many cities are engaged in climate change risk assessments, and the region saw a 10% increase in the number of cities with moderate levels of urban greenspaces between 2010 and 2021. These incipient actions suggest that climate adaptation may be slowly occurring in urban areas in SA, but further efforts should be allocated to promoting evidence-based national-level adaptation action.

Panel 2: Resilient health systems.

Ensuring equitable access to high-quality healthcare services is a fundamental human right.[110] However, this right is threatened by social inequalities and healthcare disparities between and within South American countries, affecting vulnerable people such as indigenous peoples, women, children, elderly, migrants, and impoverished groups.[111] The growing burden of climate-sensitive diseases and health outcomes is straining already overloaded and fragmented healthcare systems in the region.[111,112] As the world aims to create climate-resilient healthcare systems, inter-ministerial action on social determinants of health and health information systems is urgently needed.[113,114] A priority in SA is to ensure universal healthcare access; securing essential services in health facilities such as water and sanitation services, electricity supply and internet connectivity; ensuring an adequate number of health professionals per capita and securing access to local healthcare for all; building climate-related technical capacities in local healthcare providers and providing climate change education to local healthcare professionals; investing in strengthening healthcare infrastructure and adaptation to climate change.

Section 3: mitigation actions and health co-benefits

Mitigation, or the reduction of GHGs in the atmosphere, can be achieved both via reduction of GHG emissions and via increases in carbon sequestration. Although SA is a relatively minor contributor to cumulative GHG emissions, a just implementation of mitigation actions is urgently needed in the region, to achieve global climate goals and to ensure the SA is not left behind in the global zero-carbon transformation. Moreover, SA is also home to important natural resources, such as the Amazon rainforest, an essential component of global carbon sequestration and sink. In agreement with this, SA countries have committed to meeting the Paris Agreement 2030 climate goals.[5]

Effective mitigation requires coordinated action by multiple actors, including the private sector, national and local governments, international organisations, and community members–and should involve all areas of the economy. Accelerated mitigation would not only avert the worst future health impacts of climate change, but also because many mitigation strategies have the potential to provide major and immediate health co-benefits. Focusing on these potential health gains, this section summarises the findings of indicators relevant to climate change mitigation and its associated co-benefits in the SA region and aims at providing better understanding of the local needs and support for planning climate actions.

For this inaugural report of the *Lancet* Countdown in South America, five indicators are presented: clean household energy, covering both access to clean fuels and technologies and exposure to household air pollution (HAP) (indicators 3.1.1 and 3.1.2); mortality from ambient air pollution by sector (indicator 3.2); sustainable and healthy road transport (indicator 3.3); and diet and health co-benefits (indicator 3.4). These will be further expanded in subsequent years.

Clean household energy

Indicator 3.1.1: access to clean fuels and technologies—headline finding: despite improved access to clean fuels and technologies for cooking, 23% of SA's rural population continue to use biomass fuels

Transitioning to clean fuels in the domestic sector is essential to meet the 7th Sustainable Development Goal (Ensure access to affordable, reliable, sustainable, and modern energy) and improve people's lives and livelihoods by reducing energy poverty. In turn, this is essential to meet countries' decarbonization commitments. According to the World Bank Global Electrification Database, more than 90% of the population in SA has access to electricity.[116] However, according to the International Energy Agency, a large percentage of this electricity is still produced from oil, gas and coal sources, showing the high dependency of the region on fossil fuels.[117] Biomass fuels are still used for cooking in many SA countries, resulting in high levels of air pollution in people's homes. Due to gender differences in cooking and time spent in the home in SA, the continued exposure to household air pollutants primarily affects women and children in the region, leading to various adverse health outcomes, from eye conditions to respiratory and cardiovascular illnesses and cancer.[118]

This indicator draws on data from 194 countries from national surveys provided by WHO. The surveys track the proportion of the population who use cleaner fuels and technologies for cooking, defined as those that have emission rate targets meeting WHO guidelines for air quality.[119,120]

In 2020, more than 90% of the SA population relied primarily on clean fuels and technologies for cooking, an increase of 15% since 2000 (Fig. 5). However, differences between countries in the region still exist. The data shows an upward trend in the last 20 years in all SA countries. Chile is the only country that has had universal access to clean cooking fuels and technologies since 1990, while Paraguay still lags, with just 69% of the population having access in 2020. The countries with the highest growth in clean household fuels for cooking are Guyana and Peru, with an increase from 35.6% and 43% in 2000, to 80.6% and 85% in 2020, respectively.

Nevertheless, these data do not account for regional differences between rural (23%) and urban (4%) settings. In the past two decades, urban populations in SA have had systematically greater access to clean fuels and technologies for cooking than those in rural regions. Despite the progress seen in countries such as Brazil, Colombia, and Guyana, disparities between rural and urban communities still exist. In 2020, the countries with the lowest use of clean fuels in rural areas were Paraguay, Peru, and Bolivia, with 40%, 42%, and 58%, respectively. All other SA countries' rural populations show percentages higher than 60% in clean fuels and technologies used for cooking.

This indicator will continue to evolve to better highlight rural communities' reality regarding clean fuel and technology use. It is important to note that the observed increase in clean cooking fuels and technologies in the past 20 years is mostly linked to liquified petroleum gas (LPG) subsidies. While LPG contributes substantially less to air pollution than solid fuels, it still contributes to GHG emissions. Moreover, as the current global energy crisis has exposed, LPG is subject to the price and supply fluctuation of the global fossil fuel industry, keeping families vulnerable to the health harms of energy poverty. On the contrary, new renewable technologies today offer a healthier source of energy in the domestic sector, which can be made available at the local level, independently of access to national grids or to volatile international fossil fuel markets. To have a real and just energy transition, the region needs to move away from fossil fuel use and start introducing renewable options.

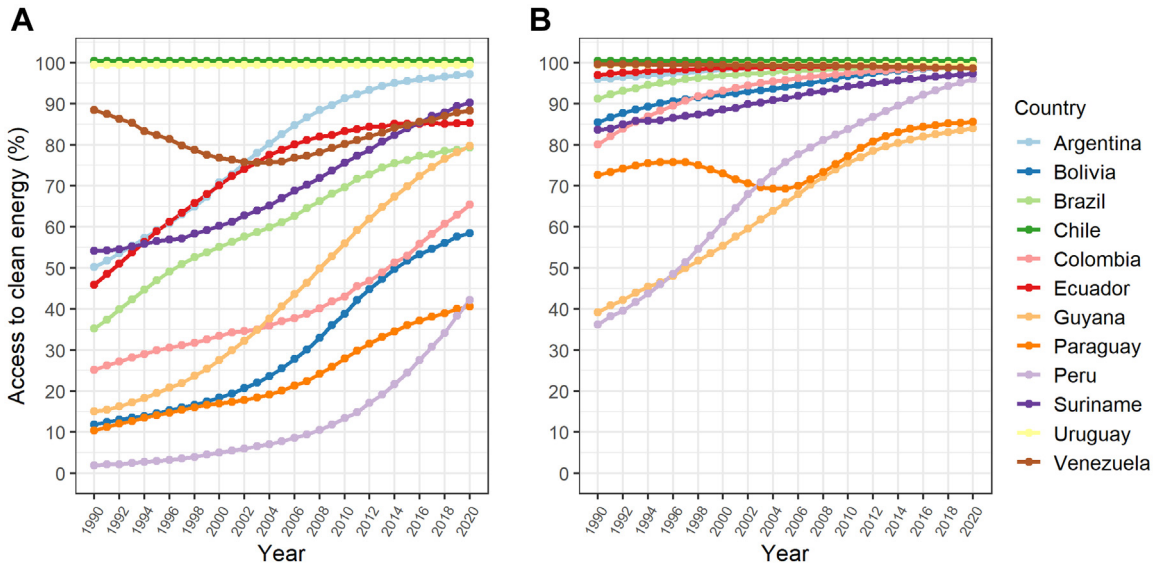

Fig. 5: Percentage of the **(A)** rural and **(B)** urban population with primary reliance on clean fuels for cooking, by country. Chile (green line) and Uruguay (yellow) have the same values.

Indicator 3.1.2: exposure to household air pollution (hap)—headline finding: exposure to HAP has a significant impact on public health in the South American countries. Transitioning from polluting fuels to clean fuels can reduce HAP for $PM_{2.5}$ personal exposure by 64%

Around 2.4 billion people worldwide[118] (nearly a third of the global population) use polluting fuels and low-quality (traditional) stove technologies for house heating and cooking. These fuels generate high levels of HAP as well as GHG emissions. There is, in addition, a significant inequality in access to cleaner fuels and technology between urban and rural areas. The same is observed for South American countries where 23% of its rural population continue to use biomass fuels exclusively (indicator 3.1.1).

For the purpose of analysing the HAP, a Bayesian hierarchical model was developed using sample data from an updated WHO Global Household Air Pollution database[119] to estimate an annual average 24-h HAP-$PM_{2.5}$ personal exposure for users of different fuel types (biomass, charcoal, coal, gas, and electricity) and stove technologies (traditional, improved) in rural and urban settings.[121]

Exposure to HAP from polluting solid fuels (biomass, charcoal, and coal) has a major impact on public health. There is, however, a large difference between the exposure level of polluting solid fuels and clean fuels (electricity and gas) in urban and rural settings in SA. In 2020, the estimated national-level 24-h weighted average HAP-$PM_{2.5}$ personal exposure in six SA countries (Argentina, Bolivia, Colombia, Ecuador, Peru, and Venezuela) showed that the use of polluting solid fuels for cooking and heating exposed populations to average values of 154 $\mu g/m^3$ [95% CI 111–191] of $PM_{2.5}$. More specifically, rural households have an annual average of 171 $\mu g/m^3$ [95% CI 155–187] of HAP-$PM_{2.5}$ and urban households 120 $\mu g/m^3$ [95% CI 48–191] (Fig. 6).

Switching to clean fuels can greatly reduce exposure to HAP and diminish the urban-rural health inequalities. The use of clean fuels, however, yields a national-level weighted annual average exposure of 53 $\mu g/m^3$ [95% CI 29–78], with rural households having an annual average of 65 $\mu g/m^3$ [95% CI 35–94] and urban households an annual average of 45 $\mu g/m^3$ [95% CI 21–69]. Transitioning from polluting fuels to clean fuels for heating and cooking can thus reduce the HAP-$PM_{2.5}$ personal exposure by 64% (62% in rural settings and 65% in urban settings). The annual average estimated HAP-$PM_{2.5}$ personal exposure for all fuel types exceeds the annual 5 $\mu g/m^3$ threshold recommended by the WHO.[122] The results thus indicate that policy interventions are needed to rapidly increase the proportion of the population with access to clean fuels and improved stove technologies by 2030 so as to address health inequities and mitigate climate change globally and, in particular, in SA.

Indicator 3.2: premature mortality from ambient air pollution by sector—headline finding: in 2020, about 37,000 premature deaths in SA were associated with ambient $PM_{2.5}$ pollution. Chile and Peru have the highest mortality per million of all the countries in the region

Air pollution is an environmental health risk factor, associated with seven million premature deaths every year worldwide.[123] In addition to this, $PM_{2.5}$ exposure leads to a high burden of disease through associated

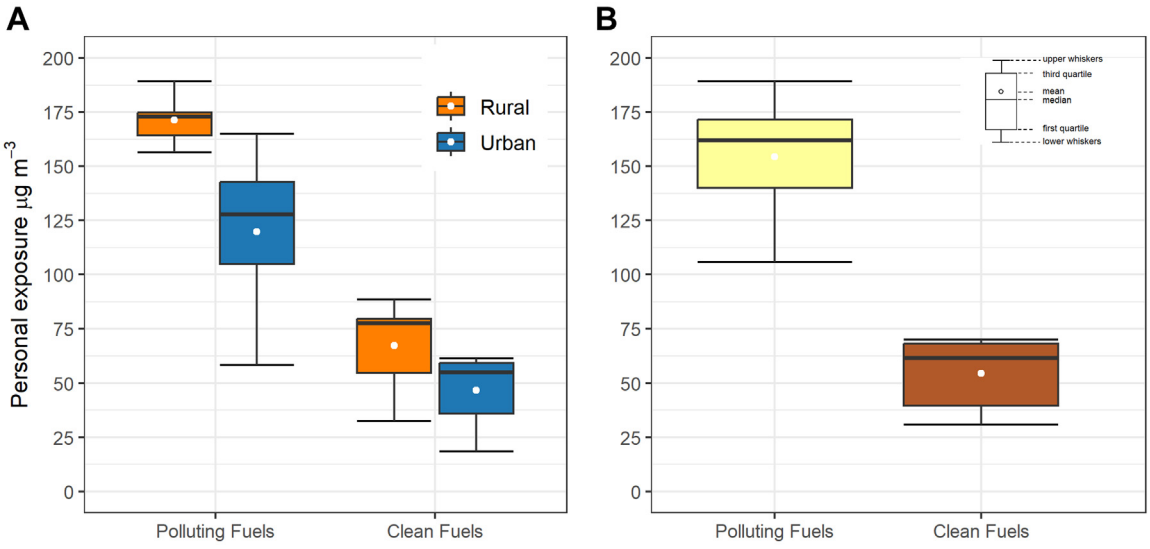

Fig. 6: Estimated weighted average of 24-h HAP-PM2.5 personal exposure due to polluting solid fuels and clean fuels for **(A)** urban and rural, and **(B)** national level. Also shown are the median, upper, and lower quartiles.

morbidity, as it increases the risk of stroke, heart, lung, lower respiratory diseases (such as pneumonia), cancer, among others. The SA region is one of the most urbanised areas of the world, with 80% of the population living in urban areas. Yet, most SA countries have set air-quality standards at WHO interim targets; thus, none are currently putting efforts towards ensuring the air their populations breathe meets the WHO's $PM_{2.5}$ maximum threshold of 5 µg/m^3.[122]

Urban residents are generally the most exposed to air pollution, due to the emissions of mobile and stationary air pollution sources (i.e., electricity generation, transportation, waste burning, and agriculture). In addition, air quality can be worsened by increased temperatures, highlighting the urgency of responding to these challenges as the planet heats. Importantly, since pollution and climate change share common emission sources, effective climate mitigation measures could lead to direct health co-benefits from short and long-term improvements in air quality, contributing to saving millions of lives, and substantially reducing the burden of disease, each year.

This indicator, adapted from the 2022 global *Lancet* Countdown report, presents an estimation of the source contributions to ambient $PM_{2.5}$ and their health impacts by country, and by individual economic sectors. Estimates of sectoral source contributions to annual mean exposure to ambient $PM_{2.5}$ were calculated using the Greenhouse gas–Air pollution Interactions and Synergies (GAINS) model[124] which combines bottom-up emission calculations with atmospheric chemistry and dispersion coefficients.

This indicator estimates that, in 2020, 37,100 premature deaths were attributable to ambient $PM_{2.5}$ in SA, a slight increase from the 36,600 deaths estimated to have occurred in 2015. Of the deaths estimated in 2020, 10,100 (27%) were attributed to transport, 6600 (18%) to industry and 5100 (14%) to the waste sectors. The SA countries with the highest mortality rate attributable to exposure to $PM_{2.5}$ are Chile and Peru, with 230 and 176 deaths per million. In SA, Peru and Bolivia have the worst air quality. Peruvians are exposed to an ambient air pollution average of 31 µg/m^3 a year and Bolivians to 27 µg/m^3, more than five times higher than the WHO guidelines.[125]

Despite the health impacts of exposure to ambient air pollution in SA, and the substantial potential for immediate health benefits of accelerated climate change mitigation, implementation barriers, capacity gaps and limited air quality monitoring networks hinder progress towards clean air. This poses the challenge that the potential co-benefits of the climate mitigation interventions on air quality might not be maximised, nor adequately accounted for in the cost-benefit analysis of local climate action. Expanding air quality monitoring networks will become increasingly relevant to track and ensure the maximisation of the health gains of climate action, especially as countries in the region work to implement the ambitions laid out in their HNAPs and NDCs.

Indicator 3.3: sustainable and healthy road transport—headline finding: between 1971 and 2019, SA has increased the per capita use of energy for road transport by 138%, and in 2019 fossil fuels were 84% of their energy used for this purpose

Transportation is an essential part of the economy and daily activities. Motorised road transport allows access to goods, services, and jobs to support social and economic wellbeing. At the same time, motorised road transport is also responsible for multiple health risks, such as air

pollution, traffic injuries, and physical inactivity. Climate mitigation strategies have focused on increasing access to public transportation, active forms of travel, and electrifying road transport to reduce direct emissions of GHG from engine exhaust. These transitions also have the potential to improve air quality, increase physical activity, and provide just access to public transport systems, directly impacting public health. As mentioned in indicator 3.2, it was estimated that in 2019 SA lost more than 10,000 premature deaths due to air pollution from transport sources.

This indicator describes the trend in per capita energy use for road transport in SA and delineates the changes in fuel type used by the country. It was derived by combining the fuel use data (by fuel type) reported by the IEA, World Extended Energy Balances,[117] with the country population reported by the United Nations population estimates in 2019.[24]

Since 1971, SA has increased the per capita use of energy for road transport by 138%. Specifically, countries like Bolivia, Ecuador, Guyana, and Paraguay, have tripled their per capita energy use in road transport since the 1970s. This has happened in parallel with a rapid urbanisation process and increased car sales in the region.[126,127] Fossil fuels in 2019 were the main energy source for road transport in SA, accounting for 84% of the road transport energy, followed by biofuels (16%). Electricity accounted for only 0.04% of all the energy used for road travel in the region.[5] Since 1971, fossil fuel use from road traffic has decreased by 5% in SA, primarily at the expense of biofuels that have grown by 200%.

Countries like Argentina, Brazil, Colombia, Paraguay, Peru, and Uruguay have been the region's main users of biofuel for road travel. However, biofuels still emit GHGs, and contribute to health-harming air pollution. In contrast, other countries like Chile and Ecuador are leading the road travel electrification in the region. Yet, in both countries electricity accounts for less than 1% of the road energy usage.

In SA, climate mitigation strategies that focus on reducing road traffic energy consumption, dependency on motorised transport, electrifying road transport, transitioning to clean energies, and shifting to public and active modes of transport are needed to achieve the Paris climate commitments in the region. Implementing these climate mitigation policies will also offer great opportunities to improve public health priorities such as air and noise pollution, traffic safety, physical activity, and equitable access to transport services.[128]

Indicator 3.4: diet and health co-benefits—headline finding: in SA, 638,000 premature deaths were attributable to imbalanced diets in 2019, 23% of those have been linked to a high intake of red and processed meat and dairy products

Food consumption is one of the most important determinants of health. Diets rich in whole grain cereal, legumes, vegetables, and fruits can reduce non-communicable diseases and expand life expectancy. On the contrary, high meat, sugar, or fat consumption can increase disease incidence and premature mortality.[129] Food production also impacts the environment and the climate, and the global food system is responsible for about one-third of all global GHG emissions.[130] Cattle and cattle feed production are major contributors to agricultural emissions, mostly driven by land use changes and ruminant fermentative processes.[27] In addition, the associated soil degradation and deforestation can contribute to increased droughts, land erosion and loss of carbon sinks.

SA is one of the most important producers of livestock and soybeans globally.[131] However, when it comes to public health, the scenario needs attention and changes, especially those related to the incidence of non-communicable diseases associated with the excessive consumption of red meat, processed meat, and dairy products. It is worth noting that cultural and eating habits in the region favour unhealthy patterns of food consumption and a high associated burden of disease in the region.[132] Strategies for change have been proposed at all levels, from civil society to government agencies, through the public and private sector.[133]

This indicator draws from the 2022 global *Lancet* Countdown report and assesses deaths attributable to dietary risk factors using data on food consumption and mortality rates by country. The baseline food consumption was assessed based on the estimates from the Food and Agriculture Organization (FAO) food balance sheets and adjusted for the amount of food wasted at the point of consumption.[134] Attributable premature mortality from high consumption of red meat was estimated by a comparative risk assessment approach, using dose–response functions for food consumption and health outcomes reported in the scientific literature.[1]

Across SA in 2019, approximately 150,100 deaths were attributable to high consumption of red meat, processed meat and dairy products. Argentina and Brazil have the highest number of premature deaths attributed to high red meat, processed meat and dairy products consumption with 26,600 and 91,300 respectively. Overall, since 2010, there has been a 28% increase in premature deaths attributed to high consumption of red meat, processed meat, and dairy products in SA. In parallel, GHG emissions related to red meat and dairy production in the region have increased 28% since 2000.

Understanding that food is the single strongest lever to optimise human health and environmental sustainability on earth,[135] this indicator highlights the need for a dietary transition aimed at reducing food sector emissions, while simultaneously and delivering the health co-benefits of increasing in plant-based food consumption, and reducing the consumption of animal-source food.[135] A more conscious evaluation of food groups,

their nutritional characteristics, and their best use could guide policymakers, companies, and consumers about their shared responsibility in promoting healthier diets, considering the multiple implications of food choices for health and the environment.[136]

Conclusion

Accelerating action toward a low-carbon transition could yield major benefits to SA in the long and immediate term. The health gains from climate mitigation are a major component of this and include improved health from net zero-carbon and healthier diets; sustainable agricultural, and land management practices; better, people-centred, and healthier urban planning and reduced dependency on motorised transport; improvements in air quality; and less reliance on volatile international fossil fuels markets and reduced energy poverty. SA also has important natural resources that, if preserved and supported, could help sink and sequester GHG faster than only relying on reducing carbon emissions. Preserving SA natural resources will also support healthier communities, improve food security, and provide cleaner environments for indigenous, local, and regional communities. If the economic development proposed by governments and private sectors in the SA region prioritises climate actions, it will support healthy communities, less stress on local health systems, a better environment, and job creation, in parallel to supporting the regional commitments to the Paris Agreement goals.

Section 4: economics and finance

Section 1 described the health impacts of climate change in SA, while sections 2 and 3 outlined efforts to minimise impacts through health-centred climate adaptation and mitigation. Designing cost-effective policies to protect human health from changing climatic conditions requires understanding the costs these health effects entail, and any sustained investment needed to reduce or avoid them (Panel 4). Investments that positively impact health require considering the costs and opportunities of transitioning to zero-carbon economies. Infrastructure and social spending needed to meet climate goals in LAC has been estimated to range between "*7% and 19% of gross domestic product (GDP) by 2030 (US$470 billion to US$1300 billion in 2030) depending on initial conditions and proposed economic and social targets*".[140]

However, benefits are expected to be greater than this spending; reducing dependence on fossil fuels and their subsidies is consistent with promoting health and wellbeing. However, transitioning to a zero-carbon economy requires political will and careful consideration of how to implement it without undermining the socio-economic determinants of health and deepening inequalities in an already highly unequal region.

This section tracks the economic costs of the health impacts of climate change and the economics of transitioning to zero-carbon economies in SA. The first three indicators estimate the economic costs that climate change's health impacts might already be

Panel 3: Tree cover loss and climate change.

The South American region is known for its important natural areas like the Amazon rainforest or the Patagonian ecosystems. Trees and vegetation are key components of the carbon cycle and can help reduce the accumulation of CO_2 in the atmosphere by transforming it into biomass through photosynthesis. Acting this way as "carbon sinks," they are an essential resource in climate change mitigation. Brazil is one of five countries that collectively contain 49% of the world's total biomass.[137] From 2001 to 2021, Brazil lost 62.8 Mha of tree cover, equivalent to a 12% decrease in tree cover and 34.5 Gt of CO_2e emissions.[137,138] This deforestation was mostly driven by land clearing for the intensive production of commodity goods (e.g., soy, beef, logging).[137,138] Findings are similar in other countries. For example, the tree cover in Paraguay has decreased by almost 27% (equivalent to 1.61 Gt of CO_2e emissions) since 2000.[137]

Deforestation is a driver of health risks. It can lead to an increased risk of spread of infectious diseases; exacerbate food insecurity of nearby communities, with indigenous communities particularly at risk; reduce local availability of clean drinking water; increase soil degradation and erosion, in turn exacerbating dust pollution, or the increased risk of floods; and other hazards. Furthermore, the intense production of commodity goods associated with deforestation also leads to increases in health risks, including those stemming from the use of agrochemicals or the displacement of indigenous and local communities. Policies and behavioural changes that support more healthy diets relying less on red meat or crops monoculture, could help reduce deforestation in the region while simultaneously minimising the associated health harms.[139]

Strategic improvements in land management and economic development focusing on sustainable agricultural patterns can deliver better use of local land and water resources. Other causes of tree loss, such as wildfires, have been related to climate events like droughts and extreme heat. SA will benefit from climate mitigation actions that help minimise the risk of such climate events.[138] Finally, urbanisation and sprawl are other drivers of forest loss in the region, and policies that prevent sprawl and support sustainable urban planning can benefit climate mitigation and health co-benefits.[128,138]

imposing on society. The fourth indicator analyses the net value of fossil fuel subsidies and carbon prices in SA countries.

The economic impact of climate change and its mitigation

Indicator 4.1.1: costs of heat-related mortality—headline finding: the monetised value of heat-related mortality of people aged 65 and older in SA was estimated as the equivalent of the average income of 485,000 local workers in 2021

Heat-related mortality is a major threat to South American communities. This indicator uses data from the 2022 global *Lancet* Countdown report to estimate the monetised value of heat-related deaths of senior inhabitants (i.e., aged 65 and older), as defined in indicator 1.1.2. This estimate provides a comparative monetised value of the health impacts of heat exposure and can justify the need for a cost-benefit analysis for climate action. For comparison purposes, the indicator expresses the cost of deaths in terms of an average local person's annual-income equivalent.

The total monetised value of heat-related deaths in South American countries has steadily increased since 2000, peaking in 2020 with a monetised loss equivalent to the income of 700,000 people on average (Fig. 7). The annual average monetised losses in the period 2016–2021 in SA were 150% higher than the baseline average for the period 2000–2005. This represents over twice the global average, with global monetised losses associated with heat-related mortality increasing by 73% over the same period. Specifically, Brazil reports the highest total monetised losses from heat-related mortality in 2021, followed by Argentina and Colombia. For most countries in the region, heat-mortality costs have more than quadrupled over the past 20 years, with Colombia and Ecuador leading the path.

These monetised values should be interpreted as a lower bound, as they only consider heat-related mortality from senior citizens. Given the socio-economic and environmental characteristics of the region, it can be expected that other age groups (especially children under 5) will be affected by increasing temperatures and heatwaves through different pathways. Higher temperatures translate into more deaths due to vector-borne diseases such as dengue, and other causes such as accidents, homicides, and conflict.[141,142] These events primarily affect children and young adults.

Indicator 4.1.2: loss of earning from heat-related labour capacity reduction—headline finding: in SA, the construction and agricultural sectors are the most affected by the potential loss of earnings from heat-related labour capacity reduction. Each sector represented 34% of the US$22 billion in total potential income losses from labour capacity reduction due to extreme heat for the region in 2021

Heat not only affects workers' health but also their labour productivity, generating potential income losses that could affect the wellbeing of themselves and their families. It also affects the overall productivity of a country and its development capacities. This indicator, drawn from the 2022 global *Lancet* Countdown report, uses country-level heat-related labour capacity loss (expressed as potential work hours lost) across four sectors (services, manufacturing, construction, and agriculture), and estimates the potential loss of earnings by multiplying this labour capacity loss with the average earnings per hour for each country, sector, and year.

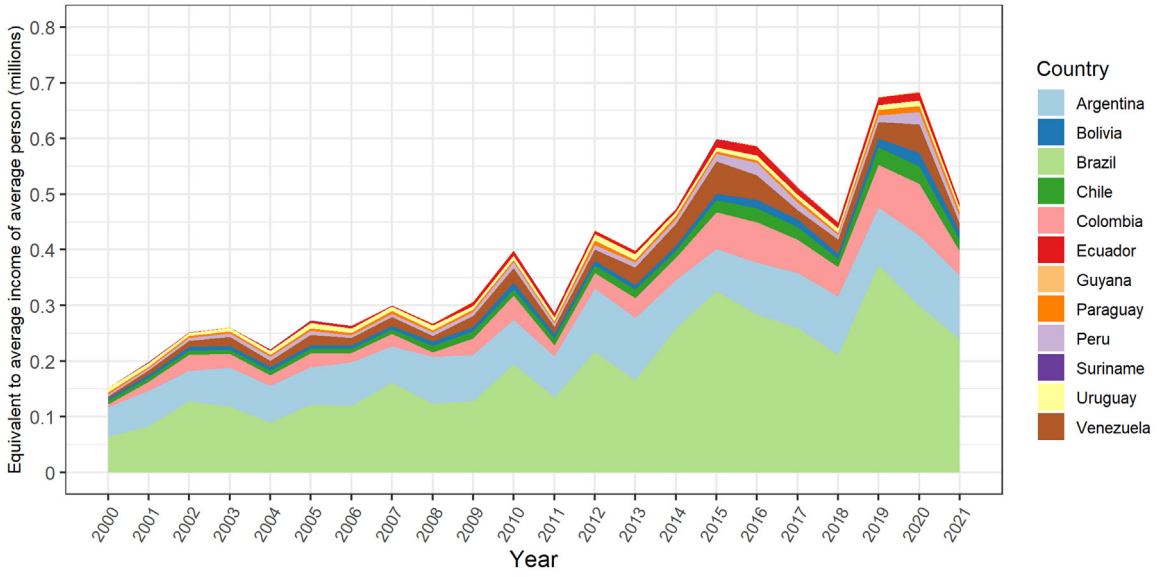

Fig. 7: The monetised value of heat-related mortality in SA from 2000 to 2021 (in average income equivalent).

In 2021, average potential income loss from heat-related labour capacity reduction represented 1.60% of national GDPs in SA, with Venezuela having the highest total potential loss as a proportion of GDP (10.6%) and Chile the lowest (0.02%) (Fig. 8). Total potential income losses that year amounted to US$22 billion (0.68% of the regional GDP). The highest potential income losses are estimated to occur in the construction and agriculture sectors, where the work demands more physical power, and where workers are the most exposed to the elements and have limited capacity to shelter. In 2021, the countries with the highest total losses were Brazil and Venezuela with US$11.2 and US$4.8 billion, respectively.

In most countries of the region, the losses as share of GDP have declined over time, reflecting mainly the growth of GDP and probably a decrease in the contribution of outdoor activities. When comparing the results of 2020, it is relevant to recall that many countries had a sharp fall in their GDP due to the COVID-19 pandemic. In some countries, potential income losses increased for that year and then decreased in 2021 (Bolivia, Colombia, Chile, Ecuador).

Indicator 4.1.3: costs of the health impacts of air pollution—headline finding: the monetised value of premature mortality due to air pollution in SA was equivalent to the average income of 2.9 million people in 2020

Air pollution is closely related to GHG emissions; thus, its mitigation will also reduce the costs of the health impacts of mobile emission sources such as transportation, and stationary sources like power plants, refineries, and industries.[143] This indicator draws from the 2022 global *Lancet* Countdown report and tracks the mortality cost due to ambient $PM_{2.5}$ air pollution by providing a monetised valuation of the years of life lost (YYLs) that result from exposure, as per indicator 3.2.

In 2020, the monetised costs of premature mortality due to air pollution in SA were equivalent to the average income of 2.9 million people. Chile and Peru registered the highest losses, equivalent to 1.57% and 0.83% of their GDP, respectively (or the equivalent average income of 300,000 and 275,000 people, respectively).

Beyond these direct impacts, air pollution leads to additional economic losses indirectly, including through increased morbidity, reduction in labour capacity, or economic disruption from exposure control measures. Quantifying these losses is essential for an adequate cost-benefit analysis of climate action.

Indicator 4.2 net value of fossil fuel subsidies and carbon prices—headline finding: the seven countries reviewed in SA had a net-negative carbon price in 2019, reflecting an overall subsidy on fossil fuels that represented a large proportion of the national health budget

Carbon pricing and fossil fuel subsidies can provide financial incentives that promote or hamper transitions towards renewable energy sources. Not all countries in SA set a carbon price or provide information to explore these dynamics; however, the available data in SA suggests that, even in the cases in which countries implemented carbon pricing instrument is available, these are undermined by substantial subsidies to fossil fuels.

This indicator draws from the 2022 global *Lancet* Countdown report and combines data on carbon taxes and fossil fuel subsidies, to estimate a net carbon price at a country level. It uses information from IEA and

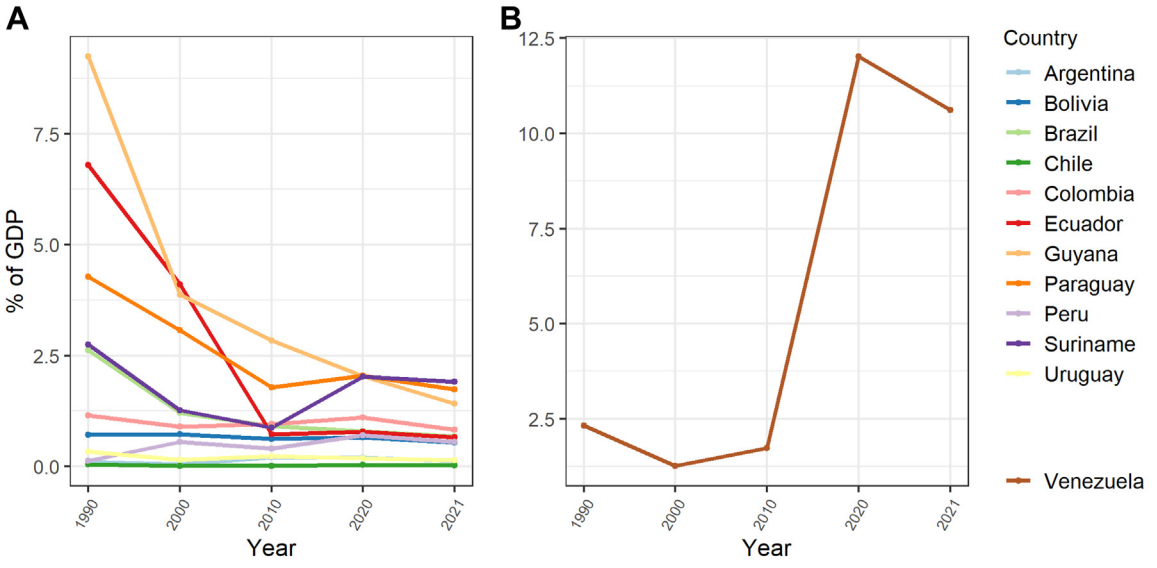

Fig. 8: Potential income loss from heat-related labour capacity reduction in **(A)** SA countries, except Venezuela and **(B)** Venezuela as a percentage of their GDP.

OECD on fossil fuel consumption subsidies and the World Bank Carbon Pricing Dashboard on carbon prices to estimate net-economy-wide average carbon prices and revenues. For carbon taxes, data is available for only seven out of the 12 countries in SA, namely Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, and Venezuela.

Information from 2019 reveals that, considering all subsidies and all carbon taxes, all these countries have net negative carbon prices, indicating a net subsidy of fossil fuels. Venezuela, Argentina, and Bolivia providing the largest net subsidies per unit of carbon (–96.2, –42.2, and –33.4 real 2021 US$/tonne, respectively). Though subsidies have fallen for all countries except for Venezuela since 2010, the average net-carbon price remained at –41.6 real 2021 US$/tonne for the region in 2019 (Fig. 9). These net subsidies were equivalent to an average of 10.5% of health spending in the region in 2019. For Venezuela, Ecuador, Bolivia, and Argentina these net subsidies are equivalent to 85.6%, 29.2%, 23.5%, and 15.4% of their health expenditure, respectively. These net subsidies equivalents range between 3.5% and 4.8% for Brazil, Chile, and Colombia.

Removing fossil fuel subsidies and implementing carbon taxes is essential to ensure their price reflects the true costs of fossil fuel burning to health, to the broader economy, and to promote a low-carbon, healthy transition. Countries in SA collectively spent US$27.9 real billion on net fossil fuel subsidies in 2019. Such spending could be redirected towards health-related actions, education, zero-carbon energy, or to a different use, with focus on supporting vulnerable households that might be overburdened by any potential increase in energy prices. Such approach has the potential of enhancing overall health and wellbeing.[144]

Ensuring robust support to those who might be overburdened by the elimination of fossil fuels is essential in SA, as both the general public as well as interest groups are very sensitive to changes in the price of fuels. Energy represents a large share of the expenditures of lower income families. For other fossil fuel users, like taxis, or trucks, and other energy intensive activities, an increase in prices can translate into significant income reductions. Increases in the price of energy can therefore undermine the socioeconomic determinants of health and translate into substantial social costs that trigger political demands difficult to ignore by governments. Thus, a successful reduction in fossil fuel use needs to be accompanied by a set of policies that would prevent negative immediate socioeconomic consequences. Any policy aimed at removing fossil fuel subsidies in SA should therefore consider implementing transfer programs to vulnerable populations that depend on fossil fuel subsidies, and improving access to affordable clean energy, public transport and zero-carbon transport technology that allows substitution away from fossil fuel-based energy.

Conclusion

The data available for South American countries suggests that the health costs of climate change have increased over the past 20 years. The monetised value of heat-related and ambient air pollution deaths in SA have risen at faster rates than the world averages. Transitioning to a zero-carbon economy, which is essential, to protect human health, requires political will. But the

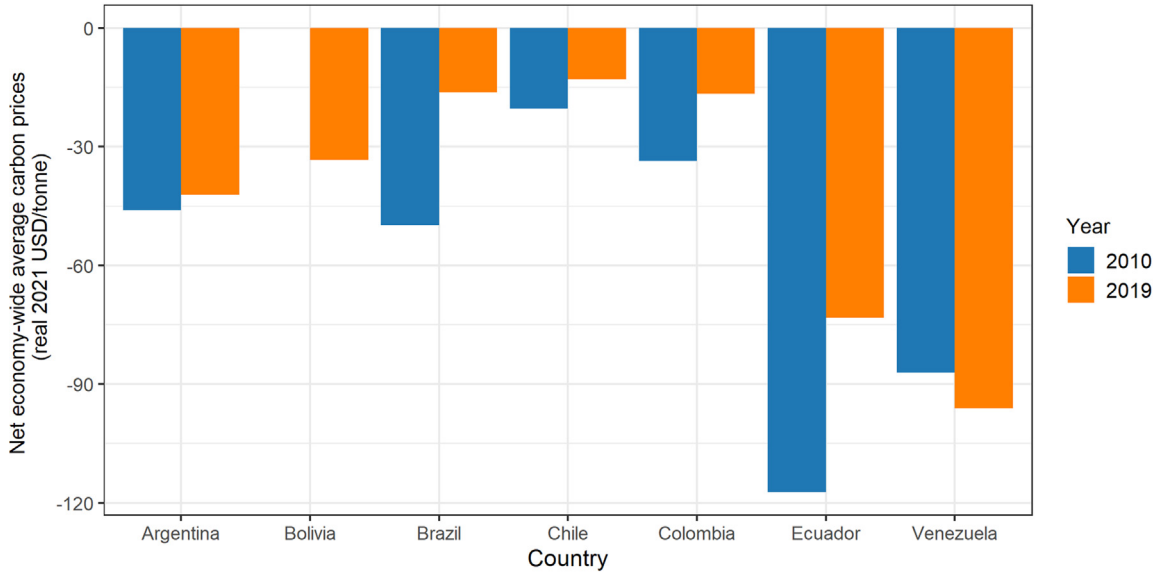

Fig. 9: Net economy-wide average carbon prices (real 2021 USD/tonne).

removal of fossil fuel subsidies should be accompanied by well-planned policies to prevent any potential increase in energy prices from affecting vulnerable populations. Such policies could include, redirecting spending, implementing green tax reforms, generating new income sources to replace revenues from fossil fuel sales, and increasing the availability and access to affordable and zero-carbon energy sources. Although many South American countries such as Brazil, Colombia, Chile, and Ecuador rely on hydroelectric power for generation and are including solar and wind in their energy mixes as alternatives, further efforts should be promoted so that the region as whole transitions towards a net zero-carbon economy. For SA, there is also a need to implement policies to reduce air pollution from transportation, forest fires, deforestation emissions, and land use changes, all of which would not only render health benefits, but also reduce economic losses. It should be noted that this section did not use all the global indicators, because of the lack of data limiting the indicators to the ones available. Further work is needed on identifying and collecting data for the region, that can produce more precise and detailed analyses.

Panel 4: Understanding the costs linked to dengue fever transmission.

Dengue fever is endemic in most of SA, with 16 million cases registered in 2011–2021.[145] Dengue epidemics are frequent across many South American countries, and the emergence of dengue in countries from the Southern Cone has also been recorded in recent years.[96,99,101] Indicator 1.3 shows that the climate suitability for the transmission of dengue in SA has increased by 35.3% over the past decade and that highly urbanised countries from the Southern Cone (Argentina and Uruguay) have experienced increases in the vulnerability to severe dengue outcomes (indicator 2.3). Dengue outbreaks and epidemics disproportionately affect children, increase mortality and morbidity, and overburden local health systems. The economic costs and societal burden this disease entails is substantial and often underestimated in countries of the region, like Brazil and Argentina.[146–148]

Understanding and quantifying the economic costs of dengue in terms of the value of dengue-related mortality and the cost of treatment, is essential to the development of accurate cost-benefit analysis that can guide preventive public health policies and interventions that reduce the propagation of the disease and its socioeconomic burden. It can also support South American countries in the design and implementation of adaptation measures to this public health threat which is exacerbated by a changing climate. Countries would therefore benefit from tracking premature mortality and treatment costs associated with dengue in the region and incorporating this evidence in their policies to reduce the burden of this climate-sensitive disease.

Section 5: public and political engagement

Climate change is the biggest global health threat of the 21st century, and climate action could be the biggest global health opportunity we face.[9,149] Mitigation and adaptation actions aligned with the commitments under the Paris Agreement essential to protect people's health and wellbeing in the context of a changing climate and ensure no one is left behind in the zero-carbon transition. Such actions must be underpinned by awareness and commitment from policy makers, private organisations, and the general public, all of which are informed and influenced by the media and scientific publications. Despite the inextricable links between health and climate change, and the high stakes involved, awareness of these links among South American populations is still relatively low. Reduced media coverage, and a limited number of scientific publications in Spanish, making misinformation at different levels of the population one of the most urgent problems in the Global South. Measuring public and political engagement across time can help identify current barriers and limitations in the understanding of the links between health and climate change in SA (Panel 5), as well as monitor changes in such understanding as the global conversation evolves. This in turn can help tailor engagement campaigns towards ensuring relevant stakeholders can be informed to enable the zero-carbon transition.

This section tracks engagement in health and climate change by news media, scientists, governments, and the corporate sector. Indicator 5.1 tracks news coverage of health and climate change across eight newspapers in SA. Scientific publications are one of the main sources of the evidence used by governments, corporations, and civil society to inform priorities and action on climate change (indicator 5.2). Governmental engagement (indicator 5.3) is tracked with mentions on the health and climate change intersection in the 2021 UN General Debate (UNGD) and South American governments' mentions of health-related terms in NDC. Finally, engagement of the corporate sector (indicator 5.4) is tracked by examining the mentions of health-related terms in United Nations' Global Compact Communication of Progress (GCCOP) reports.

Indicator 5.1: media coverage of health and climate change—headline finding: in 2021, coverage of health and climate in key newspapers from eight countries in SA reached its highest level since 2007 and continued a three-year upward trend. However, it did not match the relative increase in overall coverage of climate change from 2020

News coverage can place key issues on the public and political agendas. Thorough and frequent coverage of health and climate change would suggest it is an issue that needs to be addressed by governments and society. It can also help promote a better understanding around

the urgency and potential benefits of accelerating health and climate action. This indicator draws from the 2022 global *Lancet* Countdown report, and tracks news coverage of health and climate change in newspapers from eight countries in SA (no data were available for Guyana, Paraguay, Suriname, and Venezuela). The searches were conducted using a set of keywords in Spanish (for Argentina, Bolivia, Chile, Colombia, Ecuador, Peru, and Uruguay) and Portuguese (for Brazil) in three news article databases (Nexis Uni, Proquest, and Factiva).

The results for co-coverage of health and climate were compared to searches for general coverage of climate change in the selected newspapers, although the number of newspapers included in the analysis is limited. The data might therefore not accurately represent how SA media more generally covers health and climate change, nevertheless, this indicator helps to monitor trends in leading newspapers in each of the eight countries included in the analysis (*La Nación* in Argentina, *La Razón* in Bolivia, *O Globo* in Brazil, *El Mercurio* in Chile, *El Tiempo* in Colombia, *El Comercio* in Ecuador, *El Comercio* in Perú, and *El País* in Uruguay).

Co-coverage of health and climate change reached a record of 672 articles during 2021 in the leading newspapers of the eight South American countries analysed, which represents an increase of 156% from 2007 to 32% when compared to the previous year. Also, a three-year upward trend has been observed in articles mentioning both health and climate change-related keywords (377 in 2019; 508 in 2020; 672 in 2021). At the same time, an upward trend has been observed throughout 2021, with an increase of 121% from the first quarter to the fourth quarter (107 first quarter vs 236 fourth quarter) across all sources.

However, the increase of 32% in co-coverage of health and climate change for 2020–2021 did not match the relative increase in general coverage of climate change (86%), which reached its highest level since 2007 in all sources combined (2384 articles). Moreover, the relative attention that health is getting in the broader media coverage of climate change is decreasing. In 2021, the number of articles of health and climate change represented 28% of total climate change coverage in all sources combined, while it represented 40% during the year before.

These trends in news coverage in SA could be a function of obstacles related to journalists' working routines, limited access to data or sources, lack of specialisation, among others. An analysis of a more diverse group of sources per country (more than one newspaper, or also TV sources, which have more reach), and the inclusion of newspapers and other media from countries that are not currently being monitored, could also help to identify trends that could be more representative.

Considering the analysed newspapers, *El Mercurio* from Chile published the highest number of articles on health and climate change in 2021 (184), although it represents a 1% decrease from the previous year (186 articles) and it did not match the paper's increase in general coverage of climate change (29%) (Fig. 10). The two newspapers which showed the most significant increase in health and climate change coverage in the 2020–2021 period were *O Globo* from Brazil (557%) and *La Nación* in Argentina (293%), which also showed an increase in general coverage of climate change (733% and 461% respectively). At the same time,

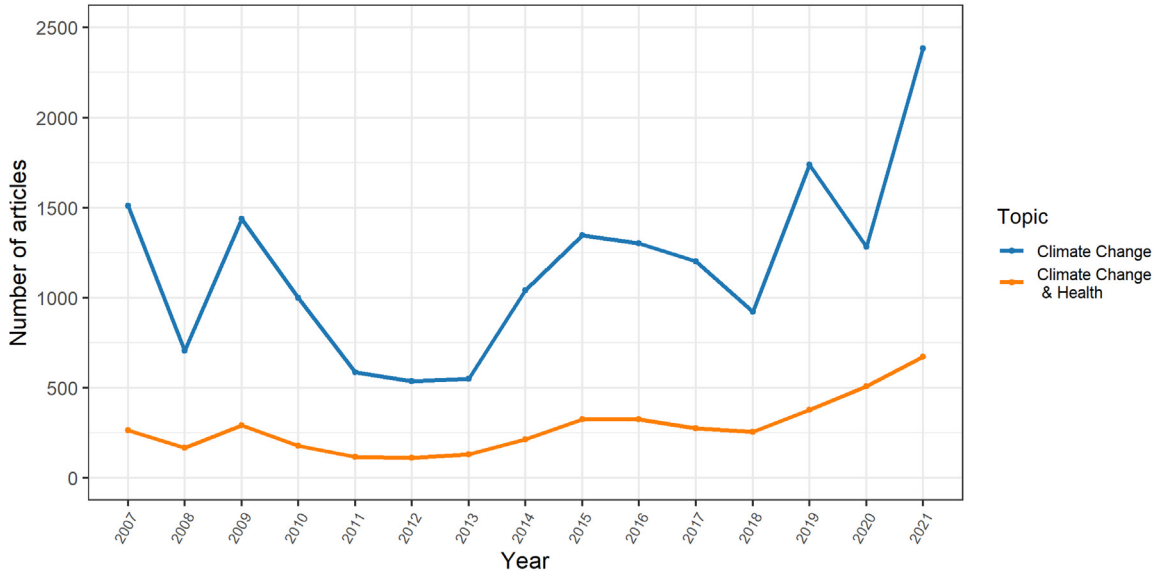

Fig. 10: Newspaper engagement measured by total coverage of climate change, and health and climate change co-coverage, in eight key newspapers from eight countries in SA (2007–2021).

although the general coverage of climate change remained similar in *El Tiempo* from Colombia between 2020 and 2021 (with a 4% decrease), it showed a higher decrease (28%) in co-coverage of health and climate change for the same period (153 articles in 2020, 110 in 2021). This indicator will continue to evolve, with future iterations of the report aiming to add more relevant media outlets and main topics covered for each South American country.

Indicator 5.2: scientific engagement in health and climate change—headline finding: original research on health and climate change focusing on South American countries increased by 1107% between 2007 and 2021, driven primarily by interest in Brazil. In 2021, 93.9% of the health and climate change articles referred specifically to impacts on health, while 6.1% focused on mitigation and 5% addressed adaptation actions with some scientific papers covering both topics

Scientific evidence is an essential asset for media outlets, individuals, and governments that shapes public, private, and political engagement with health and climate change and, importantly, which can inform local and global change.[150,151] A broad scientific, political, and civic input and effort is required to maximise the diversity of knowledge and support multiple pathways of transformation toward a healthy, sustainable compatible future.[152] Strong informational, technological, and scientific capacity to produce scientifically sound evidence is needed to guide appropriate policies and interventions and protect people's health from climate change-induced risks.

This indicator measures scientific engagement on health and climate focusing in the 12 countries in SA by tracking the number of scientific publications. A machine-learning approach was used to explore developments across major research domains (mitigation, adaptation, impacts), the health impacts covered, locations studied, and the authorship patterns. Only English-language peer-reviewed articles were collected from the scientific databases Web of Science, Scopus, or MEDLINE.

In 2021, 181 articles in SA covered health and climate change, which has been the highest recorded number since 2007 (Fig. 11). An upward trend in scientific engagement related to health and climate change in SA has been maintained, with the number of articles related to these topics increasing by 1107% between 2007 and 2021. Most of the health and climate articles focused on impacts (94%), rather than mitigation and adaptation. Brazilian institutions have driven the overall increase in publication since 2007. 57.5% of the publications mentioned or were carried out in Brazil. Moreover, 64.7% of the overall publications had authors affiliated with a Brazilian university.

Publications since 1990 were analysed and grouped into five topics: health impacts (45.7%), exposure (20%), intervention options (5.3%), mediating pathways (vulnerabilities and social determinants of health) (7.3%), and other method topics (21%). Regarding health impact-related publications, 21.4% focused on vector-borne and infectious diseases -such as dengue, malaria, and leptospirosis-followed by respiratory diseases (7.1%), water, sanitation, and hygiene (4.5%). Only 1% focused on the mental health impacts of climate change.

Strengthening climate change education for health professionals is critical to scale research and action regionally.[152] Health professionals are yet to link climate change effects to health outcomes. Furthermore, scientific production in this field is still limited compared to

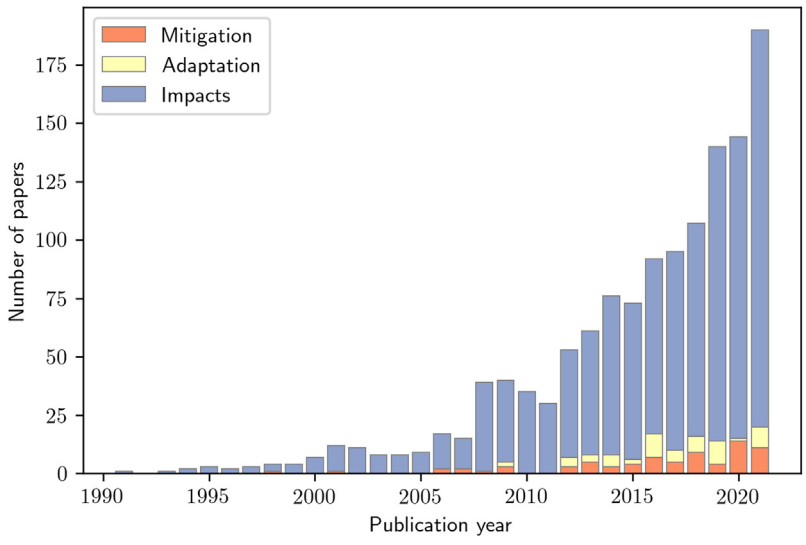

Fig. 11: The number of academic papers published on the nexus of climate and health in SA.

other regions or the Global North.[153] Given the urgent needs and potential benefits of health-centred climate action in the region, local research should focus on addressing the regional research gaps and meeting policymakers' needs.[154] In particular, there is an urgent need to increase research on the health co-benefits and health impacts of mitigation and adaptation measures in SA. This can help guide decisions tailored to local populations and maximise health gains.[155]

Indicator 5.3: government engagement in health and climate change—headline finding: in 2021, the proportion of countries referring to the association between health and climate change increased in the 2021 UN General Assembly (to 58%), and in updated NDC submissions the proportion of sentences that mentioned health terms increased by 396.87%

Governmental action is needed to halt GHG emissions, to maximise the health co-benefits of mitigation interventions, and to implement adaptation strategies designed to minimise the health impacts of climate change. This requires strong engagement of government leaders on health and climate change.

This indicator draws from the 2022 global *Lancet* Countdown report and monitors governmental engagement on climate change and health through two components. Its first component tracks the mentions of climate change-related and of health-related terms in statements made by national leaders at the UN General Debate (UNGD), in which governments communicate their political priorities. The second component monitors the inclusion of health terms in the first or updated NDCs submissions of South American countries, in which countries lay out their self-determined commitments towards delivering the collective commitments laid out in the Paris Agreement. Analysis of both first and updated NDCs submissions provides an indication of the changing prioritisation of health and climate-related priorities over time. The health-related search terms considered for the analysis of NDCs includes health, disease, and illness, death, malnutrition, medical, and injury.

In 2021, seven national leaders mentioned the intersection of health and climate change in the UNGD, an increase from 2020′s mentions (four countries). On the other hand, countries like Brazil, Ecuador, Paraguay, Uruguay, and Venezuela did not mention the health and climate change nexus during their interventions. In total, 26 individual references address health and climate change. Argentina is the country that leads health and climate change engagement with seven mentions, followed by Chile and Colombia, with five individual references at the UNGD.

The analysis of the first NDCs includes all 12 South American countries. Ecuador, Guyana, and Uruguay have not yet presented their updated NDCs, and Bolivia presented their updated NDC submission after the period of data collection was finalised, (as of March 2022). Hence, the analysis of the update NDCs submission includes eight South American countries. The percentage of change in the number of mentions of health-related terms from the first to the updated NDC submission was 396.87% The countries with the greatest number of health mentions in the updated submissions were Colombia, Paraguay, and Venezuela, accounting for 87% of all mentions across the eight countries.

Additional analyses examined specific health-related terms, their mention in sections of NDCs (e.g., context, adaptation, impacts, mitigation, finance, executive report). Additionally, the inclusion of gender-related terms was tracked, to monitor engagement and awareness of the gender inequities linked to the impacts of climate change, and of climate action. The results show that, although publication of the updated NDCs submission mostly happened during the COVID-19 pandemic, COVID-19 was only mentioned seven times in 3 s round NDC reports. Health terms are most frequently mentioned in the adaptation sections of NDCs. Across both rounds of reports, this section contains 118 sentences with health-related terms, which is 4.53 times higher in the context section, the second section with the highest frequency of these keywords. Finally, gender was mentioned only twice in first round NDCs and four times in the second round.

Despite government engagement in health and climate change is becoming more pronounced in the region, with health and climate change being more prominent at the 2021 UNGD debate and in the updated NDCs submissions compared to first round reports, it still represents a relatively minor topic. This suggests that the acute threat that climate change represents for health, and the enormous health opportunities of climate action, are still not being adequately acknowledged by the ones in charge of devising a response to climate change.

Indicator 5.4: corporate sector engagement in health and climate change—headline finding: in 2021, engagement among South American companies in health and climate change reached its highest level since 2011, with 33% of companies referring to the health dimensions of climate change in their 2021 UN Global Compact Communication of Progress reports

Corporations can play a key role in curbing global emissions, reducing local pollution, and improving health outcomes. Transnational corporations have the potential to play a leading role as stewards of the biosphere.[156] Within this context, many corporations have voluntarily signed up to the UN Global Compact to demonstrate their commitment to sustainability and social and environmental responsibility.

This indicator tracks mentions of health-related terms in the Global Compact Communication of

Progress (GCCOP) reports in ten South American countries considering corporate engagement across all sectors (Guyana and Suriname data were not available and data for Venezuela were missing for 2011 and 2014). Bolivia, Uruguay, and Venezuela include fewer than 10 corporations on average across the timeframe of analysis, so the indicator reports only regional trends.

The number of companies submitting GCCOP reports has increased from a low of 317 in 2011 to a high of 756 in 2021, a 138% change. The indicator shows that most South American companies mention climate change and almost all of them mention health in their reports. However, most reports refer to health (663 [88%] of 756 reports in 2021) and climate change (499 [66%] reports in 2021) as separate topics. But although a smaller number of reports referred to the intersection of health and climate change (252 [33%] in 2021), this proportion represents a large increase from 2015, the lowest point of engagement, when only 11% of corporations referred to the intersection between health and climate change. It also represents a sixth consecutive year of incremental growth since 2015.

Non-equity investment instruments (75%), household goods and home consumer goods (52%), industrial metals and mining (51%), and equity investment instruments (50%) are the sectors with the highest proportion of reports discussing the intersection of health and climate change in SA. Only 8% of GCCOP reports made mentions of gender in the intersection of health and climate change. More gender representation in the report would be important for South American women, since it could incentivize more women participation and leadership in business contributing to Sustainable Development Goals.[157]

While the increased corporate engagement in health and climate change is positive, this indicator reflects how only a minority of corporations engage in this crucial link, which suggests the need for more engagement in the future by this group of key stakeholders. Moreover, concerns exist about the effectiveness of the UN Global Compact, and the true intentions of sustainability actions that might transcend greenwashed claims. For this engagement to be meaningful, corporations must step up to the challenge, delivering real, meaningful, and rapid reduction in their own direct and induced GHG emissions.

Conclusion

Engagement of multiple stakeholders, with the health dimensions of climate change, particularly governments, corporations, news media, the scientific community, and citizenry, is paramount to generate demand for action that is commensurate to the risks and opportunities, acceptance of climate interventions, and prevent and lessen current and projected health impacts. In this regard, public opinion plays a key role in influencing policy decision making.[162] Engagement with the health dimensions of climate change has increased in SA across news media, science, national governments, and corporations. News media coverage, scientific production, and corporate engagement reached their highest level in 2021. Governmental engagement also saw its peak between 2019 and 2022, compared to one previous measure (first NDCs). Despite the progress, the level of engagement still does not match the magnitude of the challenge. The intersection of health and climate change represents a small proportion of news coverage of climate change, adaptation-focused scientific research, NDC reports, and a minority of corporations' mention such an intersection in their reports to the UN Global Compact. The indicators used to measure public and governmental engagement represent a first step in understanding the South American context. However, the lack of specific public engagement information from different contexts -urban/rural and indigenous peoples and gender intersectionality- undermines the capacity to understand the priorities and perceptions of key sectors of society. Access to information, especially for specific groups, is a key steppingstone towards reducing social inequities and empowering the most neglected population into action. The current four indicators will be improved to better capture public engagement in the region.

Panel 5: Public engagement with the health dimensions of climate change.

Measuring public engagement is paramount to understanding how people interact with the crucially important health and climate change issues. However, quantifying public engagement presents unique challenges due to cultural and regional differences inherently linked to how the general public engages with these issues. Moreover, public engagement can also be present in multiple approaches, from direct action such as pacific protests and civil engagement[158] to online participation in social media platforms or petitions and behavioural shifts such as using non-motorized transportation.[159] Tracking public engagement on health and climate change in SA could include monitoring online interactions—specifically in the context of social media. Currently, Facebook is the most used platform in the region, with approximately 360 million subscribers representing over 80% of the population in the region.[160] Past research suggests online activism is a factor that increases the chances of offline protests in the region.[161]

Conclusion of the 2022 South America report of the *Lancet* Countdown on health and climate change

This inaugural report of the LCSA tracks 25 health and climate change indicators for 12 countries of the South American region. This first report of the *Lancet* Countdown focuses on systematically tracking the health effects of climate change in SA and the region's response level. Still, there remains much to do. As the LCSA team expands, researchers from other academic institutions and disciplines in the region are invited to join the team, expanding the understanding and insights into the health implications of climate change in SA. Following the global *Lancet* Countdown's approach, indicators will be iteratively refined on an annual basis. This will include the use of new and improved databases and methodologies, and wherever necessary incorporating new indicators to cover key topics identified by each of the workstreams of the LCSA.

The health hazards from climate change affecting SA include rising temperatures, more frequent and intense heatwaves and wildfires, lower crop yields, and increased exposure to climate-sensitive diseases. And these are only those risks that have thus far been identified. In the last ten years, there was an increase of 12.3 million person-days of heatwave exposure in older adults above 65 in SA, an increase in heat-related mortality of 160%, economic losses associated with the mortality are equivalent to the average income of 485,000 local workers. SA also experienced a sharp increase in climate suitability for dengue, a disease that entails a major public health concern in the region, with a 35.3% increase for all countries except Chile. Countries like Peru and Ecuador show the highest variability regarding this indicator in close association with "El Niño" events that must be understood as a potential added risk to that posed by climate change alone. Although the entire population will be affected to some degree, those households already living in poverty or under current duress are more vulnerable, less resilient, and therefore more affected by these and other health risks.

Thus far, awareness of the quantifiable health effects of climate change on the South American populations is limited among policy makers and the general public. Even in cases in which the knowledge existed, action has not been proportional to the threats and opportunities. Most countries in SA are not delivering an adaptation response proportionate to the now known risks. On the one hand, we see that several NDCs have included health in their new iterations; however, Brazil is the only that have developed an HNAP up to 2020, allocated the appropriate funds to implement them, or carried out climate and health risk assessments -national and city level-to generate accurate data for evidence-based decision-making regarding health and climate change. In the NAPs, adaptation-related funding dedicated to health adaptation is still not enough. And while several NDCs have included health in their new iterations, action is too slow, if existent at all. Specific climate change mitigation strategies -that could bring massive health co-benefits- are not yet being implemented in the region. This delay contributes to thousands of deaths related to indoor and ambient $PM_{2.5}$ pollution, and to carbon intensive and unhealthy diets across the region. The delay also continues to perpetuate, and even exacerbate, the profound inequities between urban and rural areas.

The slow progress in action on health and climate change is reflected by meagre levels of engagement with these interconnected topics by key actors in society. Engagement and coverage of health and climate change in the media-which is crucial to promote change at the individual and at the political level-is still too low. SA has one of the lowest engagement levels in the world.

Overall, the health trends and regional response observed in this report are grim and of genuine concern. The report highlights the immediate health threats, the lack of health adaptation plans, and the inadequate funding allocated in the different countries to confront the burden of climate change. SA must vamp its effort to create resilient health systems and prepare to change its future. Its current trajectory of climate inaction will only lead to more inequality, poverty, and vulnerability. The LCSA calls on local governments to build a concerted response and define clear pathways to address the challenges that are about to come. SA governments must carry out tangible mitigation strategies to secure one of the world's most significant carbon sinks, while focusing on concrete adaptation measures for the highest climate-related risks in our region, and ultimately improve the health and wellbeing of local populations. The message from the 28 researchers that make the LCSA is clear. Trust de Science: Now that we know, we must act.

Contributors

The 2022 South America Report of the *Lancet* Countdown on health and climate change is an academic collaboration which builds on the work of the *Lancet* Countdown. The work of this paper follows the Global structure of five working groups, which were responsible for the design, drafting and review of their individual indicators and sections.

All authors contributed to the overall paper structure and concepts and provided input and expertise to their relevant sections. Authors contributing to Working Group 1: AGL, YKP, EF, TSC, RS. Authors contribution to Working Group 2: ASI, ZM, DB, NG, FC, MYG, SH. Working Group 3: DRR, SH, RS, TSC, NM. Working Group 4: OM, JH, CP, LO, and Working Group 5: BT, CGP, MS, MFS, MC, SJ. SH, MYG, LBV, DB, AVV, MR provided coordination, strategic direction, and editorial support.

Data sharing statement

Data will be made available from the corresponding author upon reasonable request.

Editor's note

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Declaration of interests

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Appendix A. Supplementary data

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