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The impact of climate change on future mortality in South Africa

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Introduction

Recent estimates from the World Economic Forum (WEF), made in collaboration with Oliver Wyman, suggest that, cumulatively by 2050, climate change could lead to an extra 14.5 million deaths worldwide under a “middle of the road” greenhouse gas emissions scenario, driven by floods, droughts, heatwaves, and tropical storms.[1]

To a first-order approximation, the WEF/Oliver Wyman estimates imply that annual average global mortality rates could increase by around 1% by 2050.

Vulnerability to these climate change risks varies by region, and so it is to be expected that if the average impact is 1%, then some regions may see a significantly higher increase in mortality rates.

Africa is expected to be affected by most risks associated with climate change. The WEF analysis points to the vulnerability of middle Africa in relation to floods, southwestern Africa in relation to droughts, and southern and western Africa in relation to heatwaves.

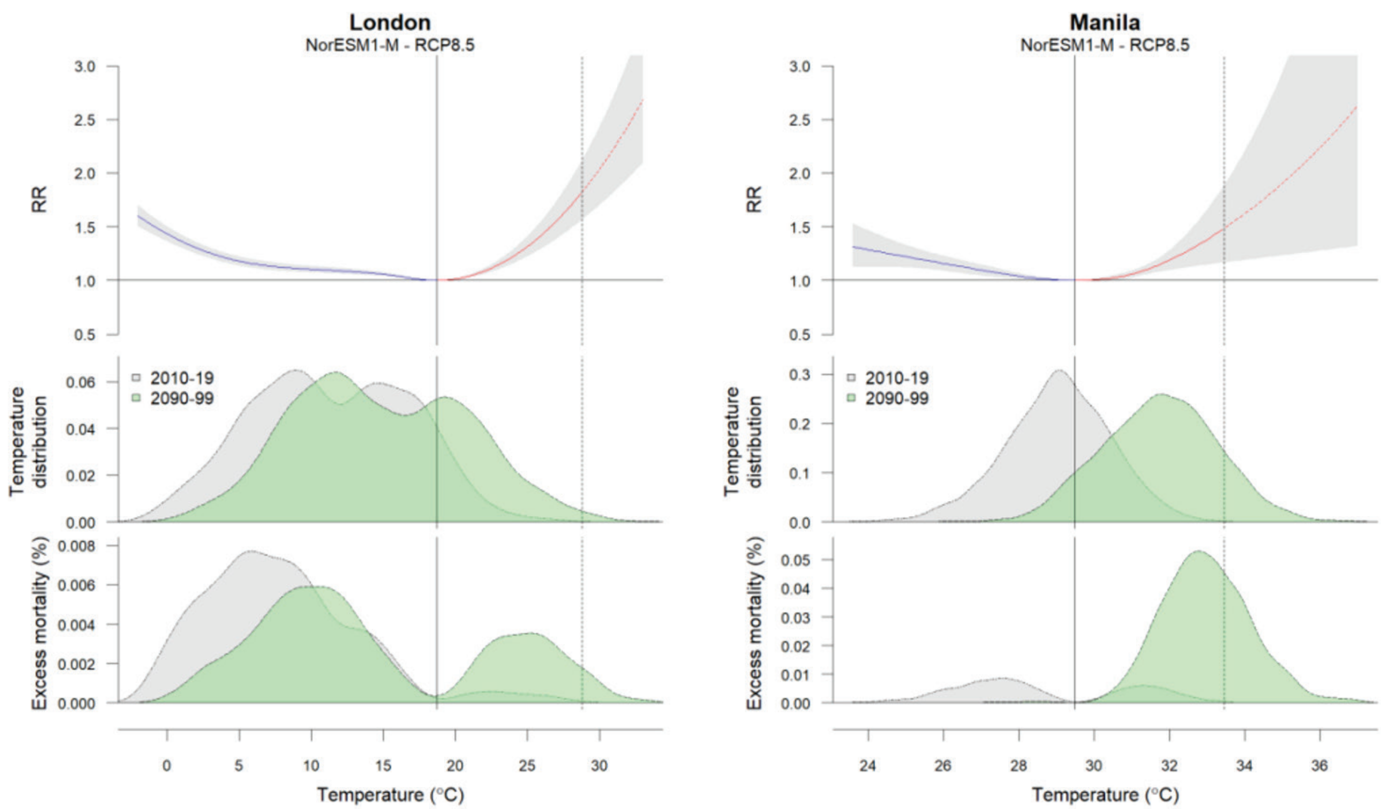
Given the importance of the insurance market in South Africa, RGA reviewed the academic literature to assess the possible impact climate change could have on future mortality in South Africa by 2050 under the SSP2-4.5 “middle of the road” emissions scenario.

Average temperatures

The general U-shaped temperature-mortality relationship illustrated in Figure 1 is now well established in the academic literature. Relative mortality risk is minimised at a location-specific optimum temperature. When temperatures fall below the optimum level, relative mortality risk increases, and these are ‘cold-related’ deaths. When temperatures rise above the optimum level, mortality risk increases, and these are ‘heat-related’ deaths.

The optimum temperature varies by location and is generally higher in warm regions and lower in cold regions because populations acclimatise to local temperatures.

Figure 1: Temperature and excess mortality in different climates, illustrated using estimates for London (left panels) and Manila (right panels).



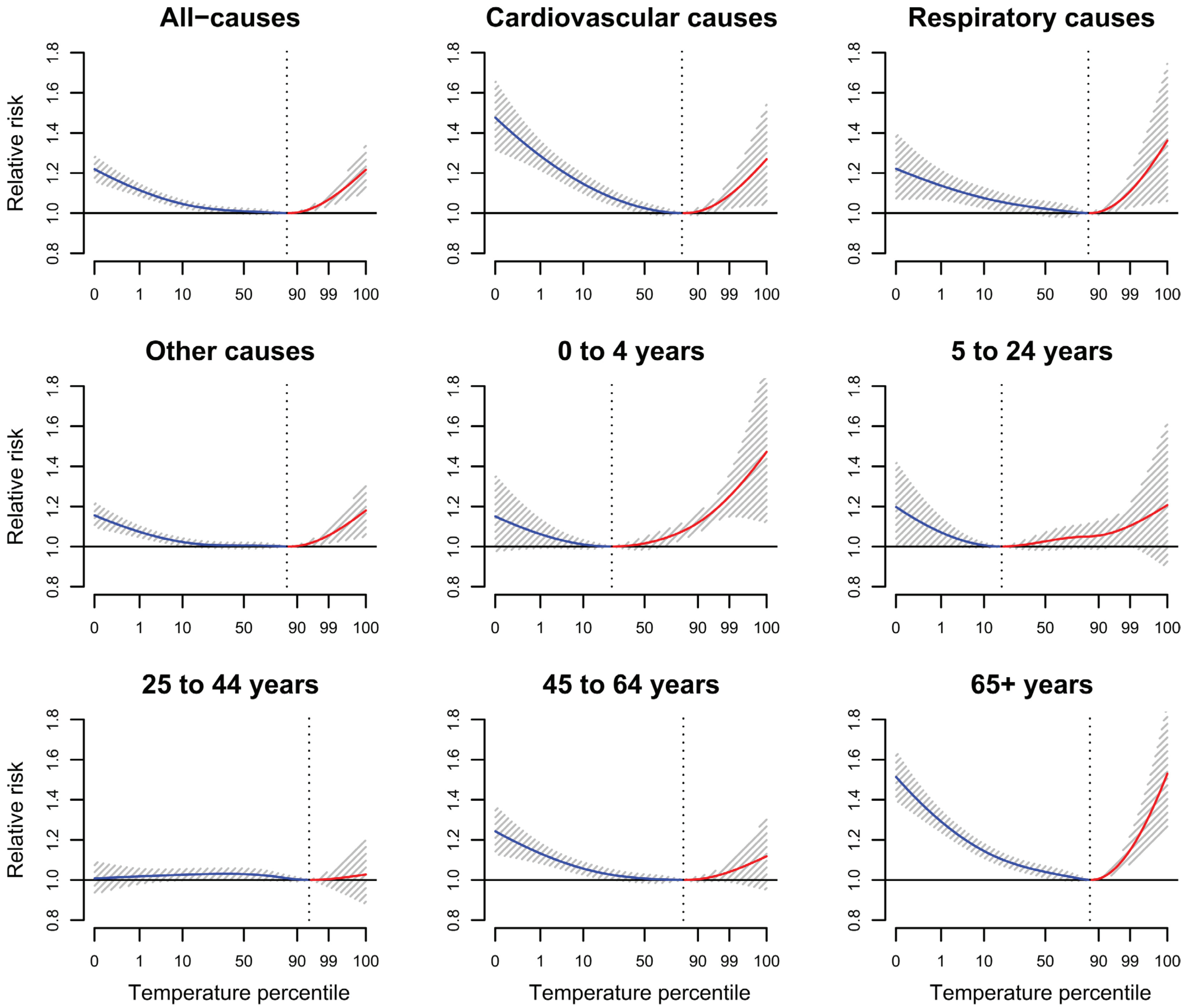
Extracted from Gasparrini et al. (2017), available under CC BY 4.0. No changes have been made.

The top graphs illustrate the temperature-mortality relationship in each city, with the solid vertical line indicating the temperature at which mortality risk is minimised. The middle graphs show the temperature distribution for the period 2010-19 (in grey) and projected over 2090-99 (green). The bottom graphs show the resulting distribution of excess mortality arising from non-optimal temperatures relative to the minimum risk temperature.

With rising temperatures, it is to be expected that we will see fewer cold-related deaths but more heat-related deaths.

Scovronick et al. (2018) have estimated the current temperature-mortality relationship in South Africa. This is illustrated in Figure 2.

Figure 2: Temperature-mortality relationships in South Africa for different cause and age groups. See Scovronick et al. (2018) for full description.



Extracted from Scovronick et al. (2018), available under CC BY 4.0. No changes have been made.

The top left panel of Figure 2 shows the relationship between temperature and all-cause mortality in South Africa over the period 1997-2013. Figure 2 also shows the relationship between temperature and mortality from cardiovascular causes, respiratory causes, and other causes. Both cold- and heat-related mortality risk is greater for those with pre-existing cardiovascular and respiratory disease than for those with other diseases.

The remaining panels of Figure 2 show the relationship between temperature and all-cause mortality for different age groups. The oldest age group – ages 65 and over – shown in the bottom right panel sees the greatest risk of both cold- and heat-related mortality. In contrast, the 25-44-year age group, shown in the bottom left panel, sees very little variation in mortality risk with temperature.

Scovronick et al. (2018) estimate that approximately 3.4% of the total mortality burden of South Africa is related to non-optimal temperatures. This breaks down as approximately 3% related to cold-related mortality and 0.4% related to heat-related mortality.

In the context of around 500,000 population deaths per year in South Africa, this is broadly equivalent to around 17,000 deaths per year that are due to non-optimal temperatures, of which around 15,000 are cold-related deaths and 2,000 are heat-related deaths.

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Chen et al. (2024) estimated how future temperature-related excess mortality might change under different levels of global warming if the impact of population ageing were allowed for. Allowing for the ageing of the population is important because older people see higher risk of both cold- and heat-related mortality. They considered a high emissions scenario (SSP5-8.5), so we would expect their results to show a slightly greater mortality impact than might be seen in the "middle of the road" emissions scenario (SSP2-4.5) we are considering.

Chen et al. (2024) estimated that under 2°C warming relative to the pre-industrial (1850-1900) average, which would be reached between 2032-2051:

- When considering only the impact of rising average temperatures, cold-related mortality in South Africa would reduce by a little over 1% of annual population deaths whereas heat-related mortality would be unchanged
- When also allowing for anticipated population ageing by 2050, both cold- and heat-related deaths would increase by around 0.1% of annual population deaths, meaning the net impact of non-optimal temperatures would be a small increase of around 0.2% of annual population deaths

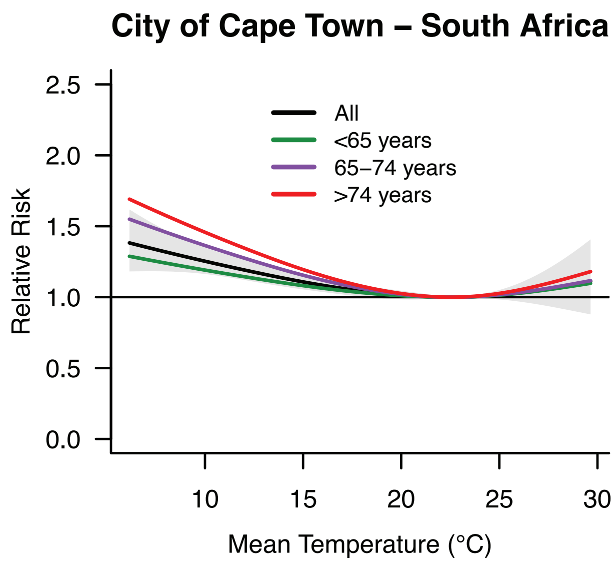
Table 1: Estimated current population mortality impact from non-optimal temperatures and how this may change by 2050 under a 1°C warming scenario

	Estimated Current Population Impact	Potential Change in Population Impact by 2050 in 1°C Warming Scenario
Physical Risk	*Current annual population deaths estimated to be attributable to risk*	*Increase/(reduction) in annual deaths estimated to be attributable to risk*
Average temperatures		
Cold-related	3.0%	0.1%
Heat-related	0.4%	0.1%

This slightly surprising result could be partly due to an unusual temperature-mortality relationship Chen et al. (2024) found for some locations in South Africa. This is illustrated in Figures 3 and 4, comparing the temperature-mortality relationship for Cape Town and Johannesburg.

Figure 3 shows the temperature-mortality relationship for Cape Town. This shows a minimum mortality temperature of around 22-23°C. Above this minimum temperature, mortality risk increases, as expected.

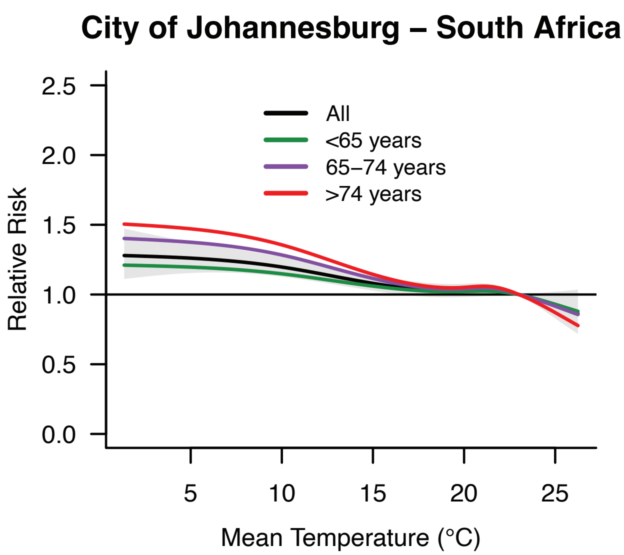
Figure 3: Temperature-mortality relationship by age group in Cape Town



Extracted from Chen et al. (2024), available under CC BY 4.0. No changes have been made.

Figure 4 shows the temperature-mortality relationship for Johannesburg. It appears that the minimum mortality temperature would have been at around 19°C. However, unlike the temperature-mortality relationship seen in Cape Town, as temperatures increase above around 22-23°C in Johannesburg, mortality risk decreases (the relative risk dips below 1). It is not clear what might cause this unexpected result, and this may be an artefact of the data rather than a true reflection of the mortality risk associated with high temperatures in Johannesburg.

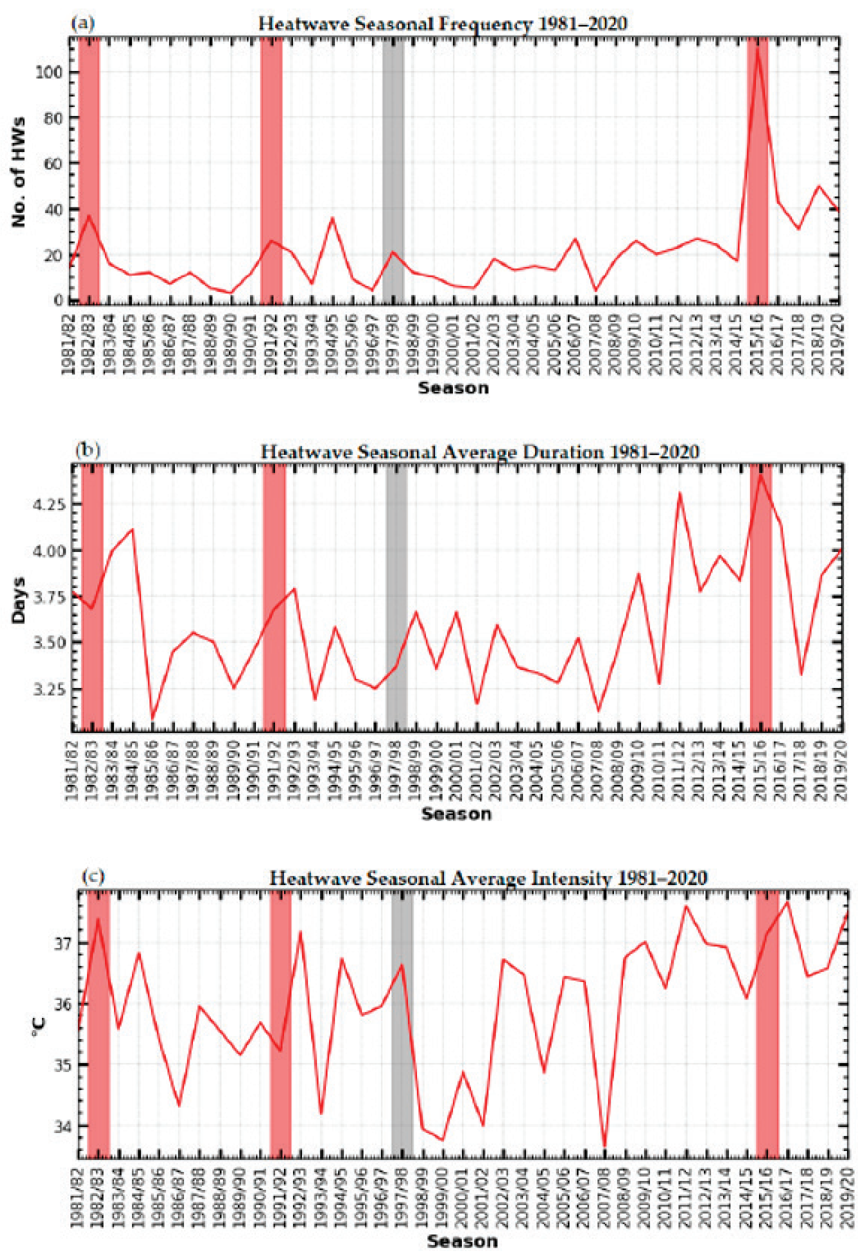
Figure 4: Temperature-mortality relationship by age group in Johannesburg



Extracted from Chen et al. (2024), available under CC BY 4.0. No changes have been made.

It is worth noting that the temperature-mortality relationships estimated by both Scovronick et al. (2018) and Chen et al. (2024) are based on South Africa temperature and mortality data over the period 1997 to 2013. However, as shown in Figure 5, since 2013 South Africa has generally seen a higher frequency of heatwaves, of greater average duration and of greater intensity. Therefore, it is possible that the temperature-mortality relationships of Scovronick et al. (2018) and Chen et al. (2024) underestimate the mortality impact at higher temperatures.

Figure 5: Heatwave frequency (top chart), average duration (middle chart), and average intensity (bottom chart) in South Africa from 1981 to 2020. See Mbokodo et al. (2023) for full description.



Extracted from Mbokodo et al. (2023), available under CC BY 4.0. No changes have been made.

One of the limitations acknowledged by Chen et al. (2024) is that their analysis did not consider potential population adaptation to heat. Adaptation can be achieved in several different ways:

- Acclimatisation: Through repeated exposure to heat, individuals develop a more efficient and effective cooling response, leading to improved thermal comfort.
- Aerobic training: The cooling response can place strain on the cardiovascular system; improved fitness achieved through aerobic training can help individuals cope with this strain.
- Adjusting behaviours: The impact of periods of extreme heat can be mitigated by reducing physical activity, increasing water intake and seeking refuge in cool places.
- Technology: External cooling can be achieved through the use of air conditioning or electric fans.

Table 2 illustrates the estimated number of heat-related deaths that were averted by air conditioning (AC) in several countries or regions in 2019.

Table 2: Estimates by country or region of the percentage of households with AC, heat-related deaths in 2019 (* indicates average over 2014-2019), heat-related deaths averted by AC, and additional deaths associated with AC through using electricity generated using fossil fuels and the associated PM2.5 air pollution.

Country or Region	Households with AC	Heat-related deaths	Heat-related deaths averted by AC	AC-related PM2.5 deaths
Japan	93%	12,400	30,415	162
South Korea	89%	2,500*	5,416	89
China	65%	72,000	69,476	5,027
ASEAN	24%	11,840*	2,678	560
U.S.	92%	20,500	47,807	557
U.K.	3%	5,600*	126	46

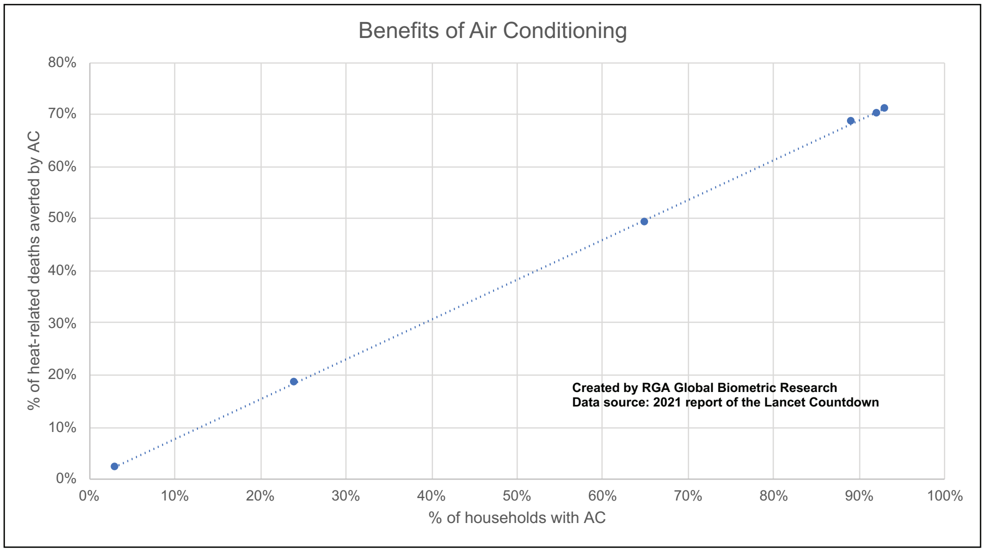
Data source: 2021 report of The Lancet Countdown.

Figure 6 shows a plot of this data with:

- The estimated % of households with AC on the x-axis
- The estimated % of heat-related deaths averted by AC on the y-axis

The data points lie on a line with gradient 75%, implying that AC reduces heat-related deaths by around 75%.

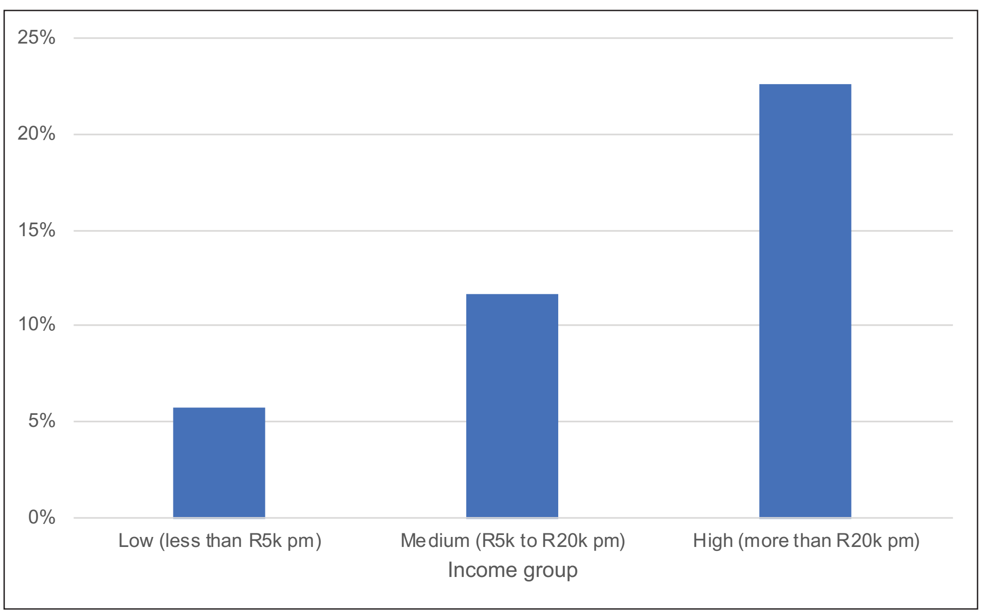
Figure 6: Plot of data from Table 2 and best-fit line



As might be expected, AC ownership in South Africa correlates with monthly income. Figure 7 shows that for those on low monthly incomes, AC ownership is a little over 5%, whereas for those on high monthly incomes, AC ownership is more than 20%.

As a result, those on higher incomes will see greater protection from heat-related deaths through AC ownership than those on lower incomes.

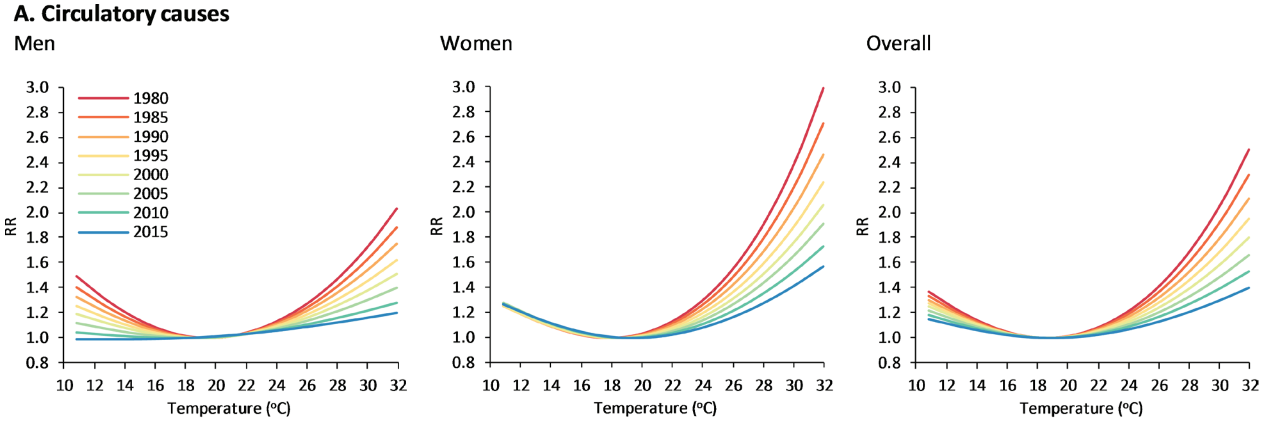
Figure 7: AC ownership in South Africa by monthly income band



Created by RGA Global Biometric Research. Data source: Residential Energy Consumption online survey 2020

The impact of adaptation on the temperature-mortality relationship can be significant. Figure 8 shows results from Achebak et al. (2018) and illustrates how the modelled temperature-mortality relationship for circulatory causes of death has changed over time in Spain. The top line (red) in each chart shows the estimated relationship in 1980, and the bottom line (blue) shows the estimated relationship in 2015. Although average temperatures increased over this period, due to adaptation, the temperature-mortality risk relationship has reduced for both cold- and heat-related mortality.

Figure 8: Estimated temperature-mortality relationships by calendar year for circulatory causes of death. See Acheback et al. (2018) for full description.



Extracted from Achebak et al. (2018), available under CC BY 4.0. No changes have been made.

Heat stress

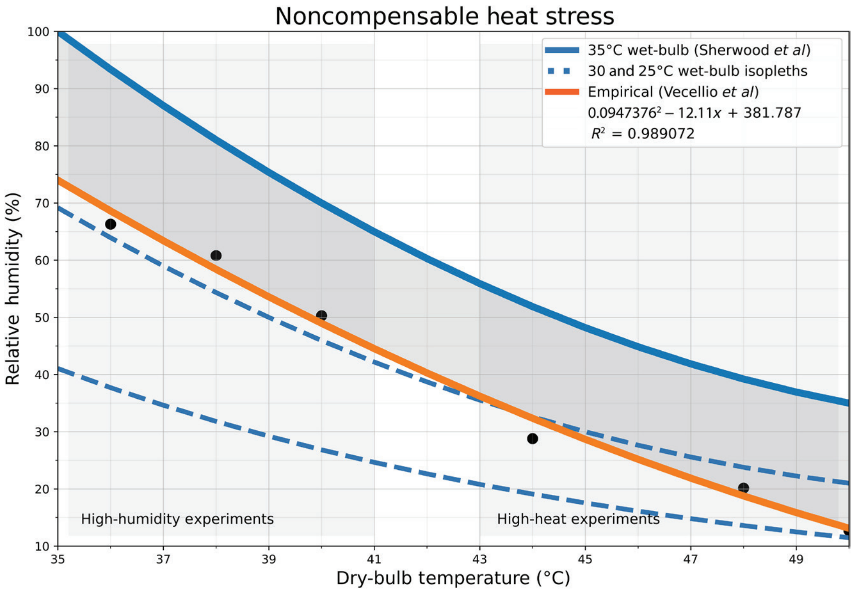
Healthy human core body temperature is in the range 36-37°C. If core body temperature reaches 43°C then there is a very high risk of death.

Noncompensable heat stress refers to environmental conditions of temperature and humidity under which a healthy human can no longer maintain a stable core body temperature without the assistance of external cooling.

In such conditions, without external cooling, core body temperature rises by around 1°C per hour. Therefore, around six hours of exposure to such conditions will lead core body temperature to rise from the normal healthy range to the dangerous 43°C level.

Noncompensable heat stress conditions are represented by the orange line in Figure 9.

Figure 9: Noncompensable heat stress occurs in environments where the combination of dry-bulb temperature and relative humidity lies above the orange line. See Powis et al. (2023) for full description.



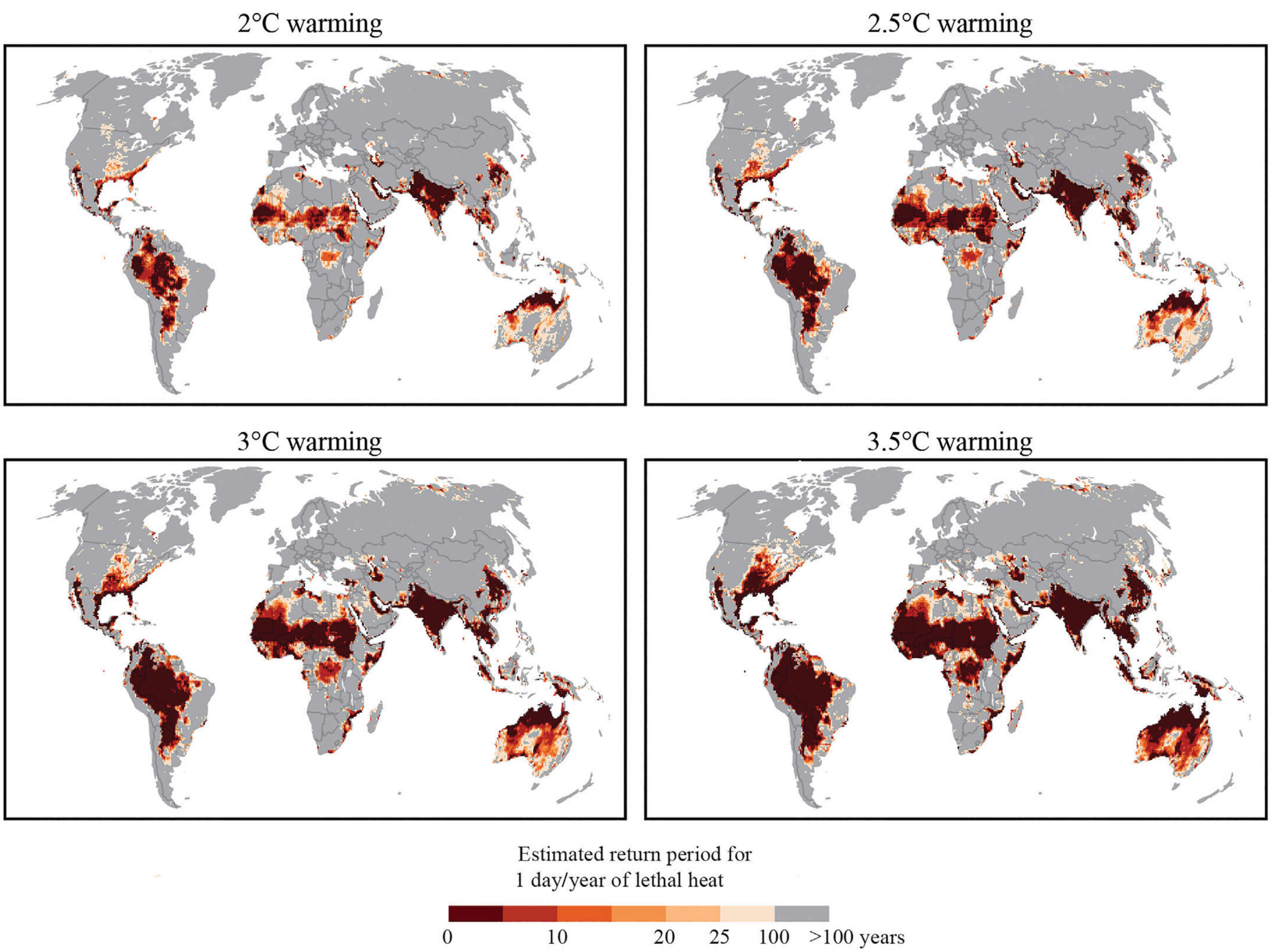
Extracted from Powis et al. (2023), available under CC BY 4.0. No changes have been made.

As an example, if the dry-bulb temperature – the temperature a thermometer would show if held up in the air – showed 45°C and the relative humidity of the environment was 30% or higher, then this combination of conditions would be in the noncompensable heat stress danger zone.

Powis et al. (2023) have estimated which regions of the world are expected to experience days including six hours of continuous noncompensable heat stress conditions, together with the expected period between such days, under different scenarios of global warming.

Their results are shown in Figure 10. Darker shades of orange and red indicate areas that would see shorter periods between days including six hours of continuous noncompensable heat stress conditions.

Figure 10: Estimated return periods between days with at least six hours of continuous noncompensable heat stress in a given year. See Powis et al. (2023) for full description.

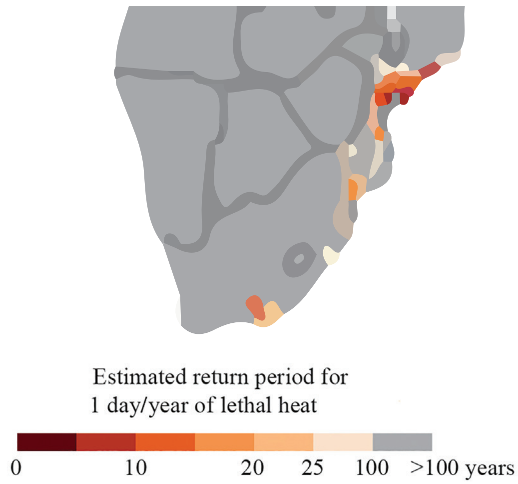


Extracted from Powis et al. (2023), available under CC BY 4.0. No changes have been made, although results for 1°C and 1.5°C warming have been omitted.

Zooming in on South Africa in the scenario of 2°C warming relative to pre-industrial average temperatures, there are areas that might be expected to see days that include six hours of noncompensable heat stress, but the period between such days is expected to be 10-20 years.

Therefore, while noncompensable heat stress could be a significant issue for regions such as India, northern Australia or areas of South America, it is not expected to be a significant issue for South Africa.

Figure 11: Estimated return periods between days with at least six hours of continuous noncompensable heat stress in a given year in South Africa under scenario of 2°C increase in global average temperature above pre-industrial baseline.



Extracted from Powis et al. (2023), available under CC BY 4.0. Image has been smoothed for clarity.

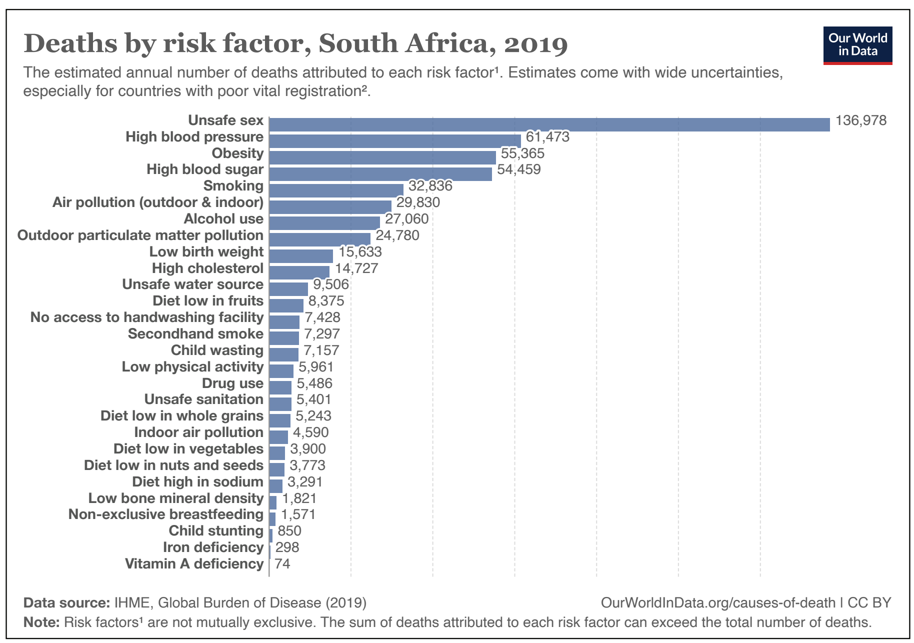
Air pollution

The Institute for Health Metrics and Evaluation (IHME) has estimated that indoor and outdoor air pollution led to around 30,000 deaths in South Africa in 2019, equivalent to around 6% of annual population deaths.

Death rates linked to air pollution have reduced significantly since the late 1990s, driven by a reduction in deaths linked to indoor air pollution. The rate of deaths due to outdoor particulate matter air pollution has remained relatively flat.

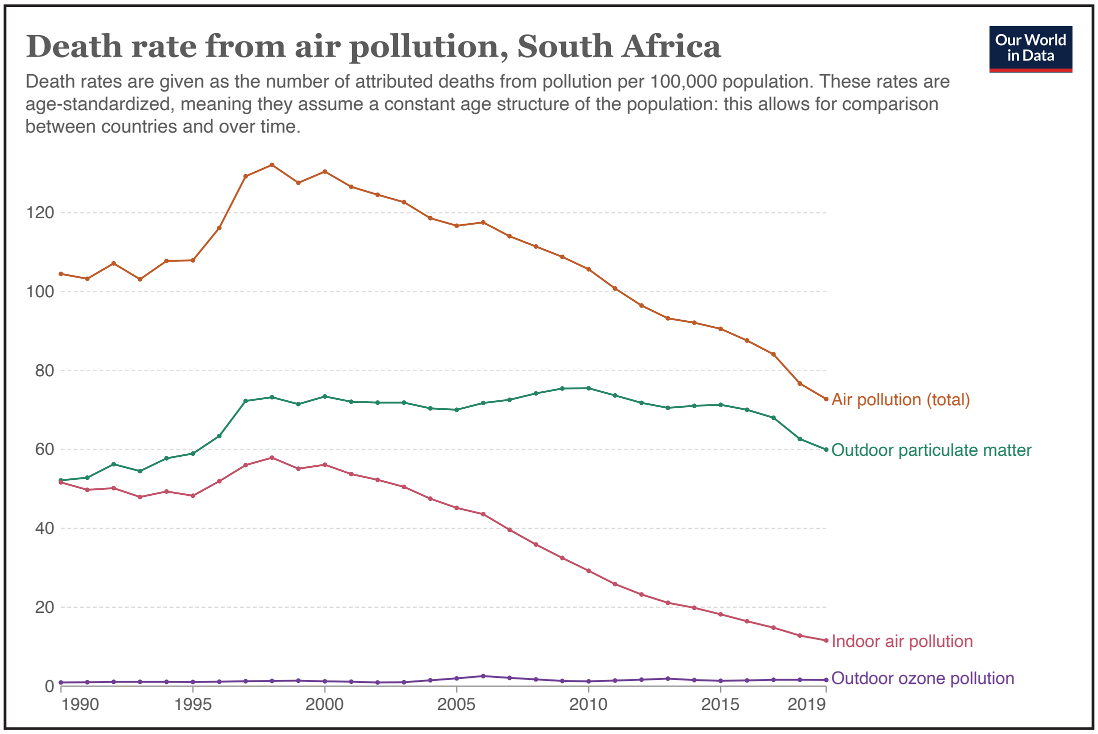
Two sources of air pollution in South Africa that are linked to climate change are burning coal to produce electricity, and wildfires.

Figure 12: Estimated deaths by risk factor, South Africa, 2019



Source: Our World in Data, available under CC BY CC BY 4.0. No changes have been made.

Figure 13: Estimated death rates from air pollution, South Africa, 1990 to 2019



Source: Our World in Data, available under CC BY 4.0. No changes have been made.
Data source: IHME, Global Burden of Disease (2019)

Air pollution from burning coal to generate electricity

In 2022, South Africa was the sixth-largest coal-consuming country in the world, and around 85% of its electricity is generated via coal-fired power stations.[3]

Holland (2017) estimated that air pollution from burning coal leads to around 2,200 deaths each year in South Africa, or around 0.4% of annual population deaths. This expert study was based on two earlier studies, which found that annual deaths associated with burning coal were in the range 700-5,000.

These deaths are concentrated in the ‘coal belt,’ which is broadly Mpumalanga and surrounding areas.

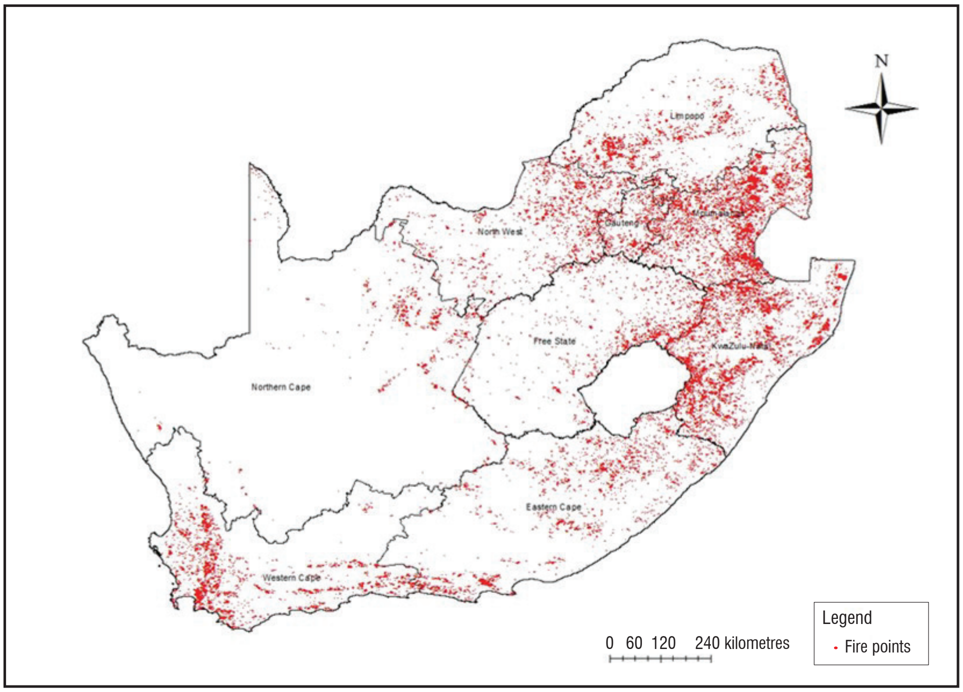
Under the Just Energy Transition, South Africa intends to transition away from coal toward cleaner sources of energy. Under these plans – see Myllyvirta and Kelly (2023) – coal power plant capacity is expected to reduce by around 80% by 2050. We can make the broad assumption that current annual deaths linked to air pollution from burning coal will reduce by a similar percentage by 2050, which is equivalent to a reduction of around 0.3% of annual population deaths.

PM2.5 air pollution linked to wildfires

PM2.5 is particulate matter air pollution with diameter less than 2.5 micrometres. These particles are small enough to pass through the lungs and into the blood stream, where they can then cause organ damage and significant health problems.

Figure 14 shows the distribution of fires in South Africa over the period 2003 to 2013, although when conditions are conducive, wildfire smoke can travel hundreds of kilometres, and so the effects of air pollution are not restricted to the areas highlighted on this chart.

Figure 14: Fire distribution in South Africa between 2003 and 2013



Extracted from Strydom and Savage (2016), available under CC BY 4.0. No changes have been made.

Chen et al. (2021) have estimated that the PM2.5 air pollution arising from wildfires is associated with over 5,000 deaths per year in South Africa, equivalent to around 1% of annual population deaths.

The United Nations has estimated that wildfires could increase by up to 14% by 2030 and up to 30% by 2050,[4] driven by increased temperatures and droughts that make conditions more conducive for wildfires.

If wildfires in South Africa increased by, say, 20% by 2050, we can make the broad assumption that annual deaths linked to PM2.5 air pollution from wildfires could increase by a similar percentage. This would be equivalent to an increase of around 0.2% of annual population deaths.

Note that if total deaths linked to air pollution account for around 6% of annual population deaths, then around 4.6% of annual population deaths are linked to causes of air pollution other than coal power stations and wildfires. We do not know how deaths linked to these other causes of air pollution will change over the period to 2050. We might reasonably assume they will reduce, given general efforts to reduce air pollution, but we are unable to say by how much they may reduce.

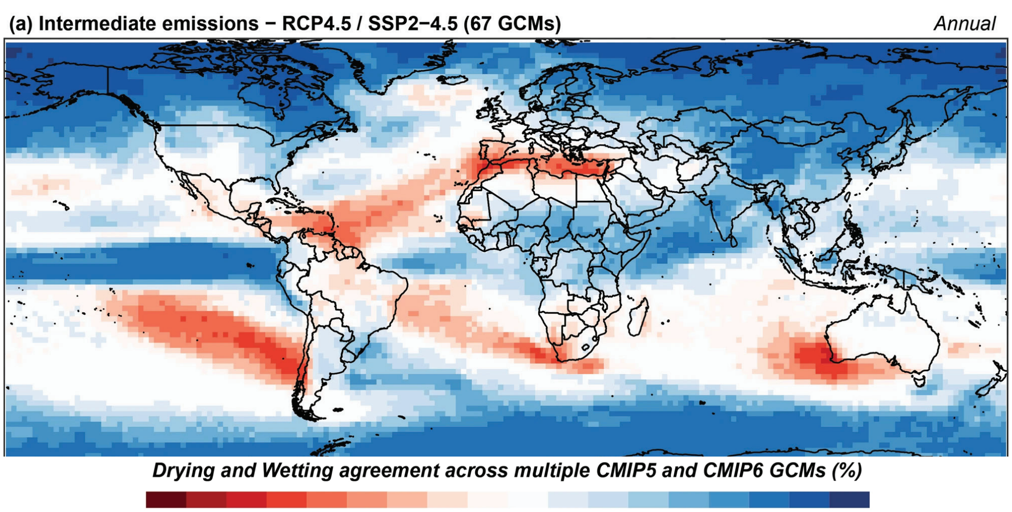
Table 3: Estimated current population mortality impact from air pollution and how this may change by 2050 under a 1°C warming scenario

	Estimated Current Population Impact	Potential Change in Population Impact by 2050 in 1°C Warming Scenario
Physical Risk	*Current annual population deaths estimated to be attributable to risk*	*Increase/(reduction) in annual deaths estimated to be attributable to risk*
Air pollution		
• Coal power stations	0.4%	(0.3)%
• Wildfires	1.0%	0.2%
• Other	4.6%	?

Droughts

Projecting future precipitation levels is difficult, and there are large areas of the world where global climate models (GCMs) don't necessarily agree whether the future will be wetter or drier. This is illustrated in Figure 15.

Figure 15: The colours of this map indicate the level of agreement among 67 global climate models as to whether the future will be dryer (red) or wetter (blue). See Trancoso et al. (2024) for full description.

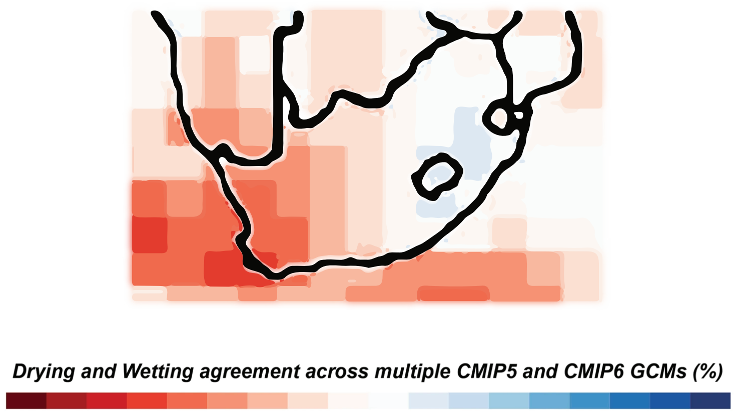


Extracted from Trancoso et al. (2024), available under CC BY 4.0. No changes have been made.

Trancoso et al. looked at 67 GCMs and identified areas where the models agreed the future under the SSP2-4.5 scenario would be drier (coloured red on the map) or wetter (coloured blue). The darker colours indicate where there was a greater level of agreement among the 67 GCMs.

Zooming in on South Africa, we can see that there is relatively good agreement among the models that the west of the country will see a drier future under the SSP2-4.5 scenario. To give an indication of the reduction in precipitation, by 2099 Northern Cape would see rainfall around 15% lower than 1980 levels, and Western Cape around 17% lower.

Figure 16: The colours of this map indicate the level of agreement among 67 global climate models as to whether the future will be dryer (red) or wetter (blue) for South Africa. See Trancoso et al. (2024) for full description.



Extracted from Trancoso et al. (2024), available under CC BY 4.0. Image has been smoothed for clarity.

The worst drought that South Africa has experienced over at least the last 30-40 years (and possibly much longer) was the 'Day Zero' drought in Western Cape over 2015-2018.[5] This was caused by very low rainfall during the austral winters of 2015-2017.

Consistent with the expected drier future of western South Africa, Pascale et al. (2020) estimated that the probability of experiencing another three-year period with winter rainfall at or below the 2015-17 threshold would increase approximately 3x by the middle of the century and approximately 6x by the end of the century.

However, while the 'Day Zero' drought had a significant impact on daily lives, it did not have a significant mortality impact.

This is consistent with research carried out by Salvador et al. on the impact of droughts on mortality in Spain over the period 2000-09. Salvador et al. (2020)[1] found that during periods of drought, mortality increased by around 1% to 6%, depending on the region of Spain, the cause of death, and the definition of 'drought'. Salvador et al. (2020)[2] found that, for many provinces of Spain, what appears to be an impact of droughts largely reflects the impact of heatwaves and air pollution, and after accounting for those drivers of mortality, little drought impact remained.

However, droughts may worsen food insecurity, which is a bigger issue in South Africa compared to Spain, and so we will consider food security shortly.

Floods

The province of South Africa that has the highest risk of flooding is KwaZulu-Natal (KZN).

As shown in Figure 16, there is some agreement among global climate models that this area of South Africa could see higher rainfall in future, which would increase flooding risk.

The KZN floods of April 2022 are an example of a severe flooding event that had a significant mortality impact. Around 40,000 people were affected by the floods and associated landslides, leading to 435 reported deaths, around 1% of those affected.[6] This is the second-highest death toll associated with a flood event after the 1987 floods, in which more than 500 people died.[7]

The April 2022 floods were assessed to have been a relatively rare event, in the sense that the extreme rainfall that led to the flooding is expected to occur only once every 20 years or so, and only once every 200 years in the most affected areas. It has been estimated that climate change approximately doubled the probability of experiencing such extreme rainfall.

Yang et al. (2023) considered the link between floods and mortality, looking at both direct deaths such as drowning and indirect deaths caused by food and water contamination. They found that, in South Africa, during the period up to 60 days after exposure to floods, all-cause mortality risk increased by 13%, although this result was not statistically significant.

The 435 deaths from the April 2022 KZN floods were reported during the flood or shortly afterward, and so they are likely to relate to direct deaths only, and not indirect deaths caused by food and water contamination. However, even if we applied the findings of Yang et al. (2023) to this event, the overall number of deaths would still be below 500.

We will assume that all floods across South Africa cause fewer than 1,000 deaths on average per year, equivalent to around 0.2% of annual population deaths.

Even if climate change were to double the risk of extreme rainfall by 2050 in a 1°C warming scenario and we make the broad assumption that this would lead to a proportionate increase in the number of deaths, the increase in deaths would be less than 0.2% of annual population deaths.

Table 4: Estimated current population mortality impact from floods due to extreme rainfall and how this may change by 2050 under a 1°C warming scenario

	Estimated Current Population Impact	Potential Change in Population Impact by 2050 in 1°C Warming Scenario
Physical Risk	*Current annual population deaths estimated to be attributable to risk*	*Increase/(reduction) in annual deaths estimated to be attributable to risk*
Floods (extreme rain)	< 0.2%	< 0.2%

Food security

Food security refers to having access to sufficient, nutritious food for a healthy life.

While South Africa is food secure at a national level, in the sense that it is a net exporter of food products, high levels of poverty and inequality resulted in around 20% of households being food insecure in 2017.[8]

Food insecurity can increase mortality risk, as shown in Table 5, which is based on research from Ma et al. (2024) using data for the United States.

Table 5: Hazard ratios for categories of food security and premature mortality. See Ma et al. (2024) for full description.

Hazard ratio	Full food security (Reference)	Marginal food security	Low food security	Very low food security
All	1.00	1.26	1.19	1.35
Women	1.00	1.34	1.24	1.61
Men	1.00	1.23	1.15	1.14

Data source: Ma et al. (2024)

Data on deaths due to food insecurity in South Africa is unavailable. However, if 20% of the population of South Africa had 25% higher mortality risk due to food insecurity, which doesn't seem unreasonable based on the results from Ma et al. (2024), then this would be equivalent to around 25,000 population deaths per year in South Africa that are linked to food insecurity. This estimate would seem broadly consistent with the results from Figure 12, noting that risks such as low birth weight or child wasting could be linked to food insecurity.

Climate change risks such as increasing temperatures, droughts, floods, and storms are all expected to negatively affect crop yields, which could worsen food insecurity. Unfortunately, there is little research quantifying this negative impact.

Table 6: Estimated current population mortality impact from food insecurity and how this may change by 2050 under a 1°C warming scenario

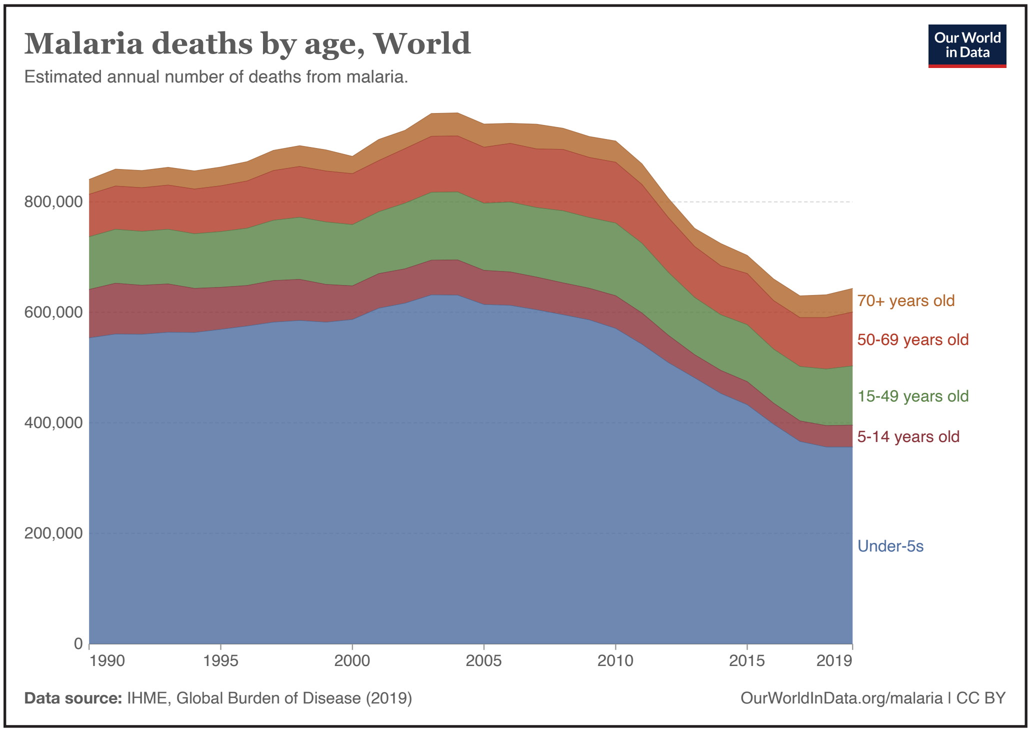
	Estimated Current Population Impact	Potential Change in Population Impact by 2050 in 1°C Warming Scenario
Physical Risk	*Current annual population deaths estimated to be attributable to risk*	*Increase/(reduction) in annual deaths estimated to be attributable to risk*
Food insecurity	5%	?

Vector-borne diseases

Vector-borne diseases are diseases such as Zika and Lyme disease that are transmitted by vectors such as mosquitoes, ticks, and flies. The two key vector-borne diseases in terms of mortality impact are malaria and dengue, and of those, malaria has the biggest global impact.

As shown in Figure 17, IHME estimates that more than 600,000 people died globally of malaria in 2019, driven by deaths of children under age 5.

Figure 17: Malaria death by age, World, 1990 to 2019

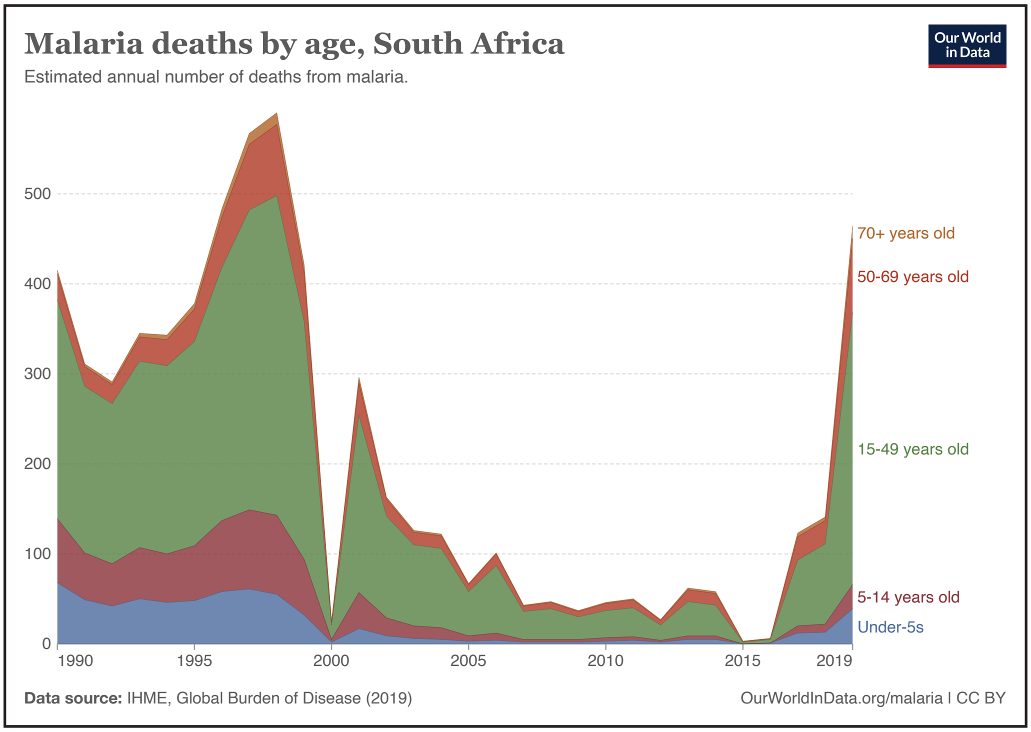


Source: Our World in Data, available under CC BY 4.0. No changes have been made.

IHME estimates for malaria deaths in South Africa, as shown in Figure 18, indicate that efforts to reduce malaria deaths had been very successful up to 2015, but since then, malaria deaths have rebounded significantly, driven by deaths in the 15-49 age group.

As of 2019, malaria deaths in South Africa were a little under 500, equivalent to around 0.1% of annual population deaths.

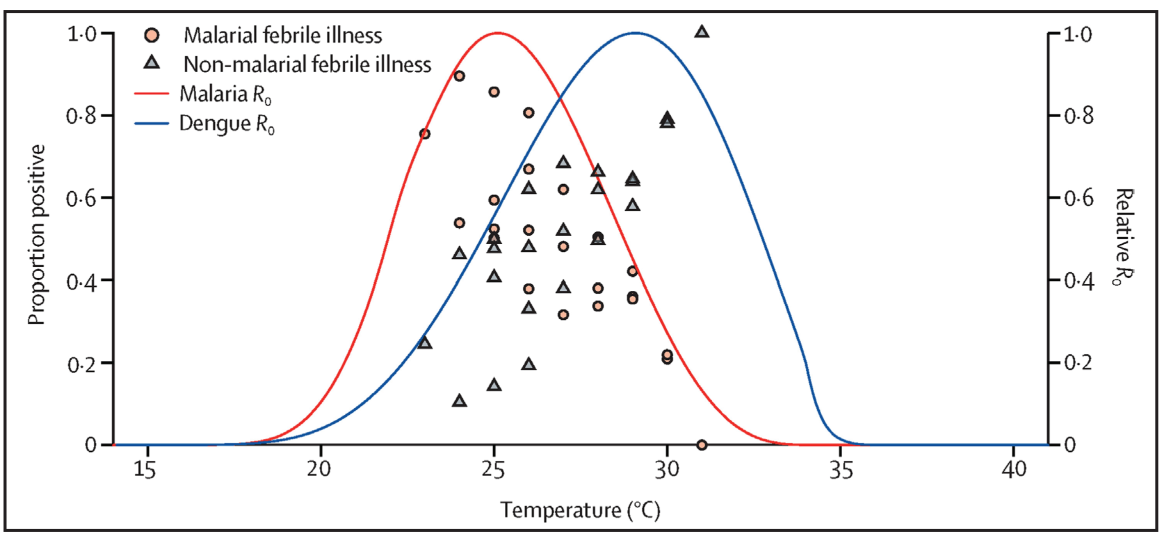
Figure 18: Malaria deaths by age, South Africa, 1990 to 2019



Source: Our World in Data, available under CC BY 4.0. No changes have been made.

Temperature has a significant effect on malaria and dengue transmission. The red line in Figure 19, from Mordecai et al. (2020), shows how malaria transmission varies with temperature, with a peak in transmission at around 25°C. The blue line in Figure 19 shows how dengue transmission varies with temperature, with a peak at just under 30°C. With increasing average temperatures, many areas of Africa will see malaria transmission reducing but dengue transmission increasing.

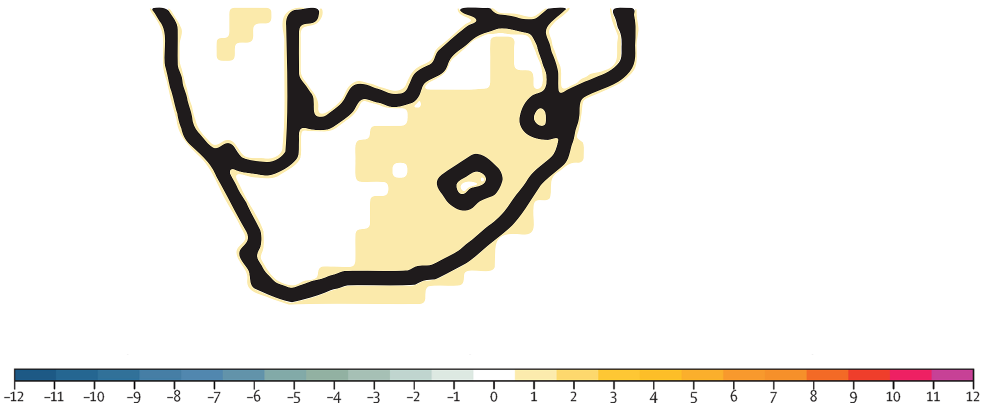
Figure 19: How temperature affects malaria (red line) and dengue (blue line) relative transmission. See Mordecai et al. (2020) for full description



Extracted from Mordecai et al. (2020), available under CC BY 4.0. No changes have been made.

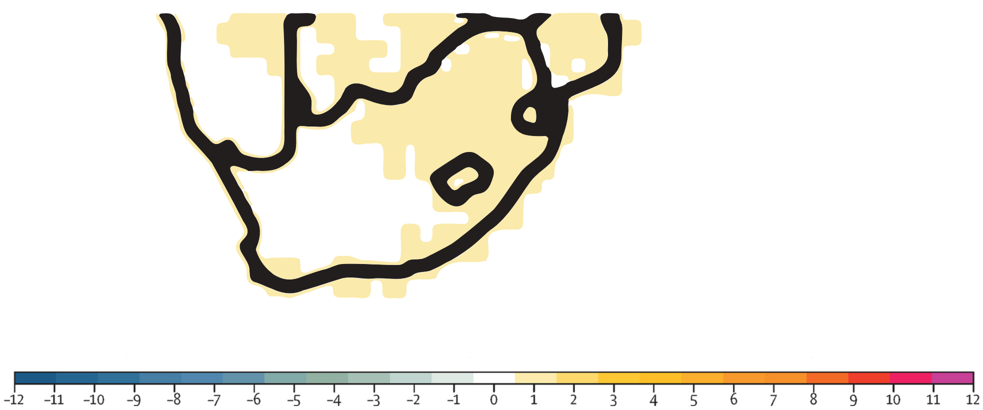
Colon-Gonzalez et al. (2021) have estimated that over the 100-year period to 2070-2099, many areas in the east of South Africa will see the transmission season for both malaria (see Figure 20) and dengue (see Figure 21) increase by 1-2 months.

Figure 20: Simulated change in length of transmission season (LTS) for malaria under RCP4.5-SSP2. See Colon-Gonzalez et al. (2021) for full description.



Extracted from Colon-Gonzalez et al. (2021), available under CC BY 4.0. Image has been smoothed for clarity.

Figure 21: Simulated change in length of transmission season (LTS) for dengue under RCP4.5-SSP2. See Colon-Gonzalez et al. (2021) for full description.



Extracted from Colon-Gonzalez et al. (2021), available under CC BY 4.0. Image has been smoothed for clarity.

Note that the areas of increased transmission are broadly consistent with the areas expected to see increased rainfall in future, as revealed by Figure 16.

The malaria transmission season currently runs over nine months, from September to May, so allowing for, say, a one-month increase by 2050 may not seem like a significant proportionate increase, but many of these areas do not currently experience malaria infections and so the mortality impact is likely to be greater than this suggests.

Up to now, dengue has not been detected in South Africa.[9]

We will make the broad assumption that increased transmission seasons might broadly double deaths from vector-borne diseases by 2050 in a 1°C warming scenario, resulting in a change of less than 0.1% of annual population deaths.

Table 7: Estimated current population mortality impact from vector-borne diseases and how this may change by 2050 under a 1°C warming scenario

	Estimated Current Population Impact	Potential Change in Population Impact by 2050 in 1°C Warming Scenario
Physical Risk	*Current annual population deaths estimated to be attributable to risk*	*Increase/(reduction) in annual deaths estimated to be attributable to risk*
Vector-borne diseases	< 0.1%	< 0.1%

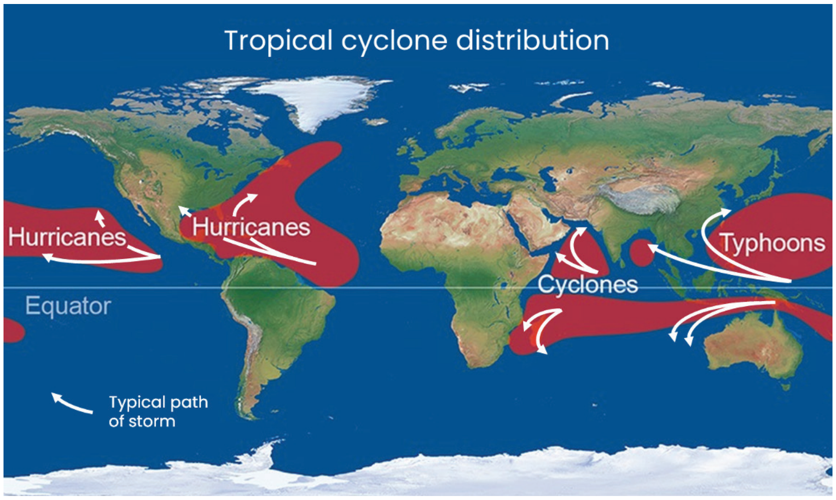
Tropical cyclones

Tropical cyclones are powerful storms that form over warm, tropical oceans that can cause significant damage when they make landfall. They may be called typhoons in Southeast Asia or hurricanes when they form in the western Atlantic or eastern Pacific oceans.

Figure 22 shows in red the areas in which these tropical storms typically form. White arrows show the typical paths the storms take.

Tropical cyclones can form in the southern Indian Ocean and move toward South Africa. However, as these storms get their energy from being over warm seas, and this energy dissipates when they move over land, South Africa is relatively protected from tropical cyclones by Madagascar and Mozambique. While those two countries regularly see tropical cyclones making landfall and causing significant damage, the storms rarely make landfall in South Africa.[10]

Figure 22: Global distribution of tropical cyclones showing, in red, areas where tropical cyclones typically form. White arrows show typical paths taken by tropical cyclones.



Adapted from https://www.metoffice.gov.U.K./weather/learn-about/weather/types-of-weather/hurricanes/location. Contains public sector information licensed under the Open Government Licence v3.0 (https://www.nationalarchives.gov.U.K./doc/open-government-licence/version/3/). Use of this material does not imply endorsement by the Met Office.

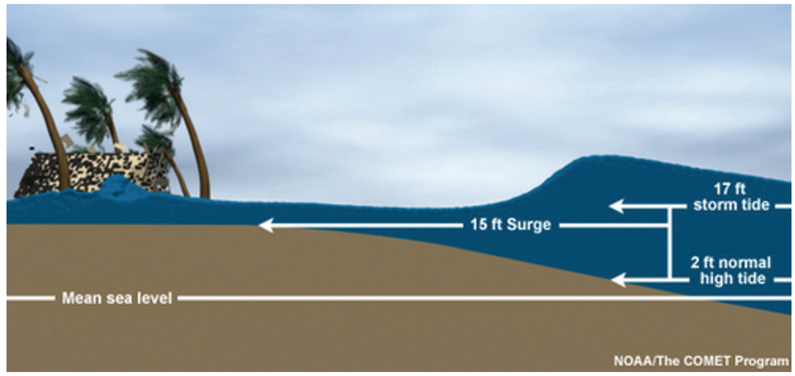
Storm surges

While South Africa may not experience tropical cyclones making landfall, it still experiences significant storms.

Of the mortality hazards associated with storms, storm surges that cause coastal flooding present perhaps the greatest risk[11]

Storm surges occur when strong storm winds push sea water toward the coast, causing sea levels to bulge up. There is also a smaller contribution from the low pressure associated with the storm pulling up the sea level.

Figure 23: Storm surge vs storm tide



Source: National Weather Service (NWS)/National Oceanic and Atmospheric Administration (NOAA); use of this material does not imply endorsement by the NWS/NOAA.

As Figure 23 shows, storm surges can raise the water level by 15 feet. This can happen on top of a normal high tide, causing a storm tide to surge 17 feet, or around 5 metres.

This is what happened in September 2023 along the coast of Western Cape, Eastern Cape, and KZN, when a storm surge combined with a spring high tide to create a surge that led to widespread coastal flooding. However, while the damage from the floods was significant, the mortality impact was low.[12]

This is partly because warnings were given by the SA Weather Service but also because only a relatively small proportion of the population is exposed to the risk of coastal flooding. This is due to a combination of the geography of SA and where people live. An assessment carried out in 2010 estimated that only around 0.16% of the population of South Africa (roughly 100,000 people) live within 5m of sea level.[13]

Contrast this with around 30% of the population of Florida in the United States (around 7.4 million people) living less than 2m of sea level.[14]

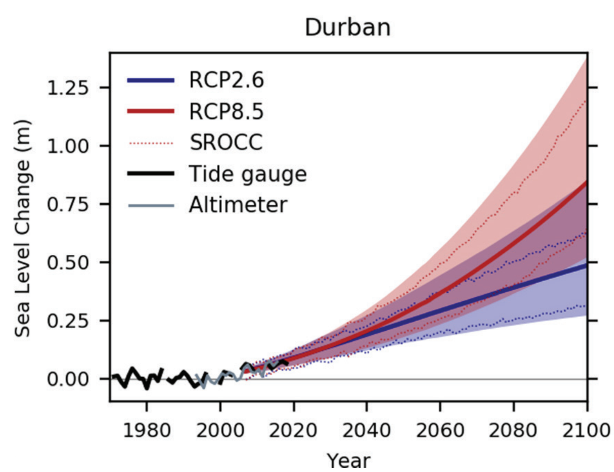
While storm surges may have a significant mortality risk in some regions of the world, South Africa is relatively protected.

Sea level rise

The low proportion of the population of South Africa that lives within 5m of sea level also protects against the worst mortality impacts of sea level rise.

As Figure 24 shows, under both low and high emissions scenarios, sea level rise off the coast of Durban is estimated to be around 25cm by 2050. Sea level rise of this magnitude is not expected to significantly affect the number of people exposed to the mortality risks associated with coastal flooding.

Figure 24: Projections of mean sea level change for the 21st century (2007-2100), Durban. See Allison et al. (2022) for full description.



Extracted from Allison et al. (2022), available under [CC BY 4.0.](#) No changes have been made.

Summary of physical risk impacts

Table 8 summarises how the mortality impact of physical risks related to climate change might change by 2050 in a 1°C warming scenario in South Africa.

Table 8: Estimated current population mortality impact from physical risks associated with climate change and how this may change by 2050 under a 1°C warming scenario

	Estimated Current Population Impact	Potential Change in Population Impact by 2050 in 1°C Warming Scenario
Physical Risk	*Current annual population deaths estimated to be attributable to risk*	*Increase/(reduction) in annual deaths estimated to be attributable to risk*
Average temperatures		
• Cold-related	3.0%	0.1%
• Heat-related	0.4%	0.1%
Air pollution		
• Coal power stations	0.4%	(0.3)%
• Wildfires	1.0%	0.2%
• Other	4.6%	?
Droughts	-	-
Floods (extreme rain)	< 0.2%	< 0.2%
Food insecurity	5%	?
Vector-borne diseases	< 0.1%	< 0.1%
Tropical cyclones	-	-
Storm surges (coastal floods)	-	-
Sea level rise	-	-
Overall physical risk impact (for quantified risks)		**< 0.4%**

Based on around 500,000 annual population deaths currently experienced in South Africa, physical risks associated with climate change under this scenario would account for fewer than an additional 2,000 annual population deaths. However, this does not capture anticipated population growth over the period to 2050 and, except for the impact on average temperatures, the anticipated ageing of the population.

We are unable to quantify the potential change in relation to other sources of air pollution (which we might expect to reduce annual population deaths) and the impact of food insecurity (which we might expect to increase annual population deaths), which are the two risks with the largest estimated current population impact.

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Transition risks

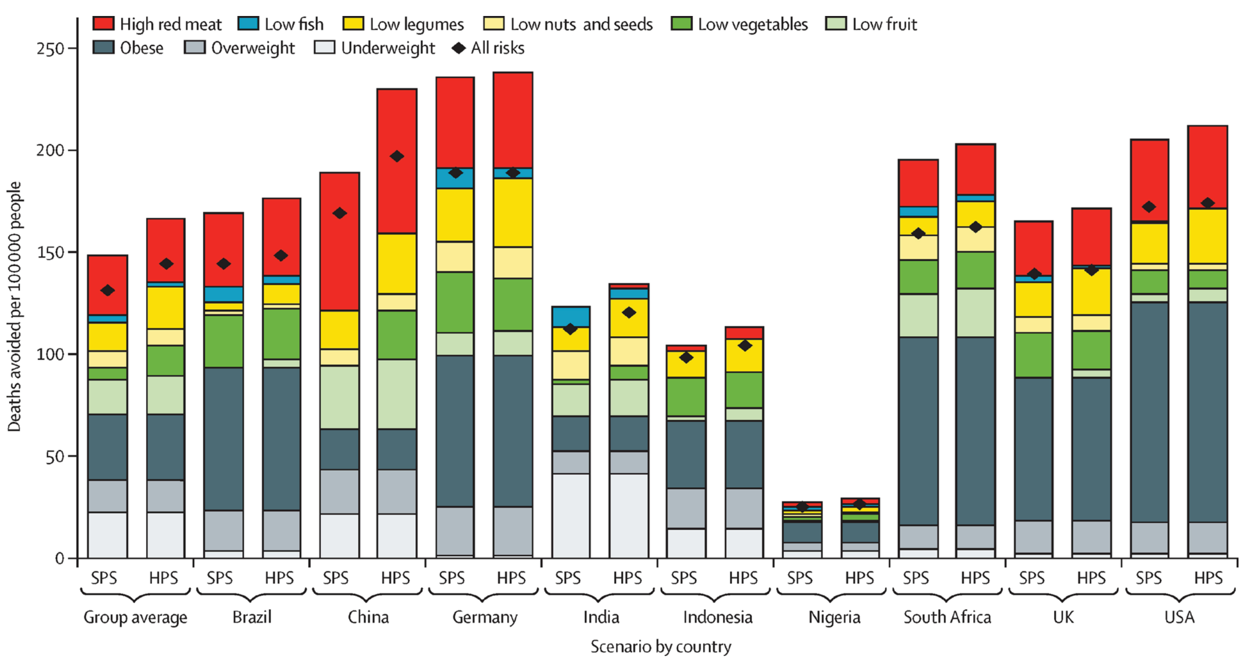
Transition risks are risks associated with the transition to a lower carbon economy. Depending on how transition policies are implemented, they have the potential to improve health in the following scenarios:

- Sustainable food and agriculture policies may, if designed and implemented appropriately, encourage people to eat a calorie-balanced diet that is high in plant-based nutrition.
- Sustainable travel and transport policies may encourage people to walk or cycle instead of using their cars.

Hamilton et al. (2021) estimated the potential deaths that could be avoided if these health benefits could be achieved.

Figure 25 shows the diet-related deaths that could be avoided. The x-axis shows two scenarios for various countries: a sustainable pathway scenario (SPS) that is broadly equivalent to the 2015 Paris Agreement; and a more optimistic 'health in all climate policies' scenario (HPS). Each bar shows the deaths avoided per 100,000 population, colour-coded to

Figure 25: Number of deaths avoided attributable to dietary risks in the year 2040, relative to the current pathway scenario, per 100,000 population, by scenario and country. See Hamilton et al. (2021) for full description.



Extracted from Hamilton et al. (2021), available under CC BY 4.0. No changes have been made.

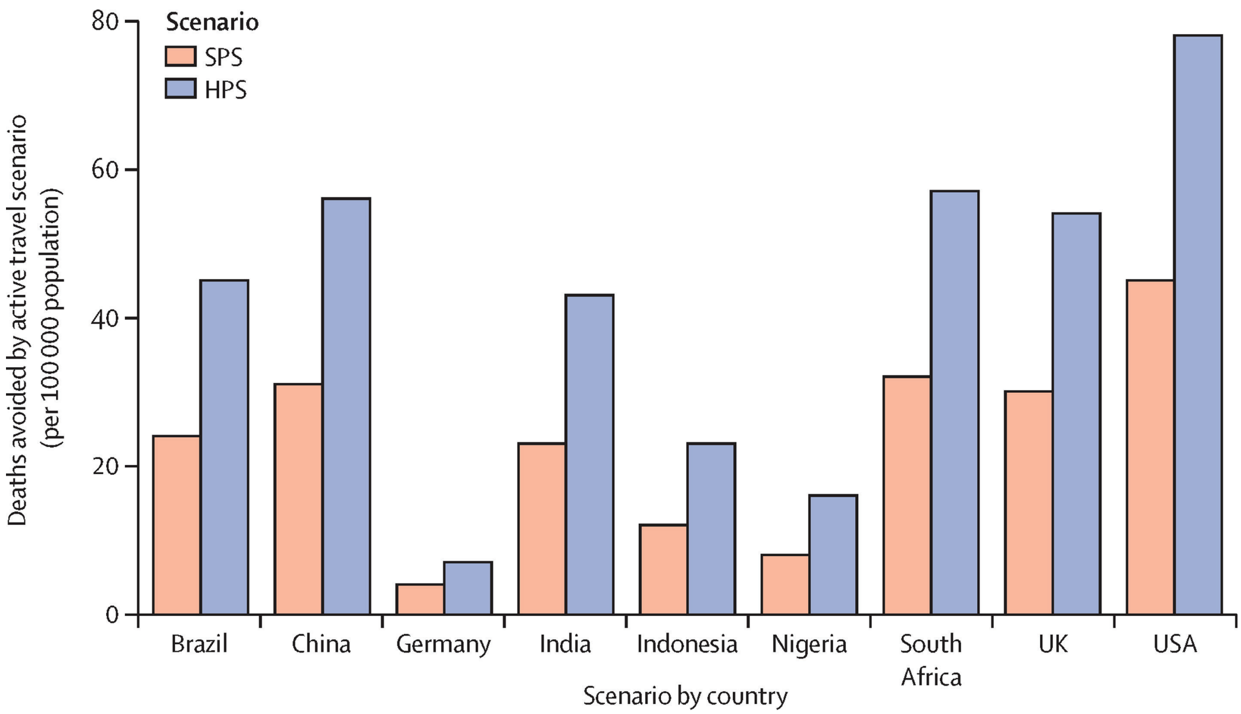
represent the key dietary risks. As individuals may be subject to more than one risk, the overall total deaths avoided per 100,000 population is shown by the black diamond toward the top of each bar.

For South Africa, in the SPS scenario, around 150 deaths per 100,000 population could be avoided. This is equivalent to 90,000 avoided deaths for a population of 60 million.

Figure 26 shows the deaths that could be avoided if active travel (walking and cycling) were increased. Again, the x-axis shows the two SPS and HPS scenarios for various countries. The bars show the deaths that could be avoided per 100,000 population in each scenario.

For South Africa, in the SPS scenario, around 30 deaths per 100,000 population could be avoided. This is equivalent to some 18,000 avoided deaths for a population of 60 million.

Figure 26: Number of deaths avoided in the year 2040 under the SPS and the HPS per 100,000 population, relative to the current pathway scenario. See Hamilton et al. (2021) for full description.



Extracted from Hamilton et al. (2021), available under CC BY 4.0. No changes have been made.

Caveats and other considerations

Climate science has improved significantly over recent decades, but significant uncertainty remains. That said, even doubling the impacts of each risk to account for uncertainty would still lead to a relatively modest overall physical impact: A 0.8% increase in annual population mortality in 2050 is equivalent to a 3-basis-point reduction in annual mortality improvements over a 25-year period.

Most research on the impact of climate change on mortality does not allow for the adaptation we will likely see as society works to lessen the impacts of these negative risks. An example of this would be the rollout of new malaria vaccines,[15] which if successful could mitigate the impact of climate change on the spread of vector-borne malaria. Note that scope for adaptation against climate-related physical risks is generally greatest for higher socioeconomic groups.

We have concentrated on the direct mortality impacts of physical risks in this paper, but these physical risks could cause new-onset morbidity, and there could be negative mortality impacts from this further into the future. An example of this would be the negative mental health consequences of extreme weather events, such as flooding for those who lose their homes or livelihoods and are displaced.

We have concentrated on the direct mortality impacts of physical risks in this paper, but these physical risks could cause new-onset morbidity, and there could be negative mortality impacts from this further into the future.

Severe weather events that do not have a significant direct mortality impact can still have significant negative economic impacts and severely damage infrastructure, both of which could lead to negative health consequences and, ultimately, higher mortality.

Although the impact of climate change on future mortality looks to be relatively modest for South Africa, other countries in southern Africa may see greater impacts, which may lead to inward migration into South Africa that could put strain on public services such as healthcare.

We have considered a "middle of the road" emissions scenario over the period to 2050. Over longer periods and in higher emissions scenarios, the mortality impact could be greater.

We have considered each physical risk in isolation, but reality is more complex and interactions between risks increases uncertainty. There is also the risk of reaching climate tipping points, which could lead to a self-reinforcing cycle of increased greenhouse gas emissions and warming.

Some of the actions that have led to climate change, such as deforestation, bring humans and animals closer into contact, which increases the risk of zoonotic disease transmission and increases the risk of future pandemics.

Conclusion

This paper set out to review the academic literature to assess the possible impact climate change could have on future mortality in South Africa by 2050 under the SSP2-4.5 "middle of the road" emissions scenario.

For those physical risks where the change could be estimated, the overall impact was relatively modest, with annual population deaths potentially increasing by less than 0.4%. In addition, this impact would be reduced by adaptation measures taken to mitigate the mortality impact of these physical risks. This potentially surprising result may be counter to expectations of a more significant impact, although we need to recognise the uncertainties involved.

Beyond the modest negative mortality impact from physical risks, there is the potential for significant positive impacts to population health if suitable transition policies covering food/agriculture and travel/transport are implemented. These could significantly reduce future annual population deaths. However, these health benefits are likely to be difficult to achieve, given they require population behaviour change and likely significant infrastructure investments.

The modest negative mortality impact from physical risks in South Africa outlined in this paper does not absolve society from taking action – both in South Africa and globally – to limit greenhouse gas emissions and future climate change impacts. Climate change remains a significant risk factor and a priority issue that must be addressed through collective action at the governmental, corporate, and individual levels. The insurance industry has an opportunity to play a leadership role in combatting the climate crisis by promoting awareness, providing education, and inspiring, motivating, and incentivizing populations to modify behaviors in ways that will benefit their own health and the planet's health. ■

The modest negative mortality impact from physical risks in South Africa outlined in this paper does not absolve society from taking action – both in South Africa and globally – to limit greenhouse gas emissions and future climate change impacts.

Limitations

The information provided in this paper is intended for general discussion and education purposes only and should not be relied upon for making specific decisions. The potential change in annual population deaths in 2050 under a 1°C warming scenario is based on the assumptions specified, and different assumptions would give rise to different results.

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Notes

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