AVOID 2
Can we avoid dangerous climate change?

What future global impacts on people could be avoided by limiting global warming to less than 2 degrees?

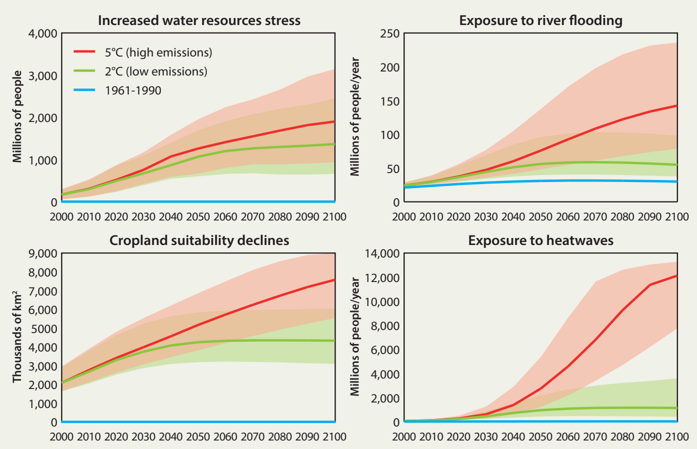
Without rapid and sustained greenhouse gas emissions reductions, the effects that the climate has on global society will be increasingly felt and could in some cases intensify by the end of the century. The AVOID 2 research programme has modelled how climate change will affect people across the globe, such as through water availability and exposure to flooding and heatwaves. If no mitigation efforts had been made, high greenhouse gas emissions would result in global warming of around 5°C by 2100. This would result in significant impacts. The research shows that limiting global warming to around 2°C by 2100, referred to here as a 'below 2°C future', could avoid a substantial proportion of the effects associated with a 5°C increase in temperature.

Climate change and projected population growth will lead to increasing numbers of people through the 21st century, and beyond, exposed to water stress, flooding, heatwaves and changes in food systems

As the climate changes in response to increases in greenhouse gas emissions, some of the impacts that the climate already exerts on society could increase substantially in some regions of the globe by 2100.

There are, of course, many other potential impacts of climate change beyond what are covered here. These include other impacts on society, and impacts on the natural environment. Many would also likely extend beyond 2100 even in a below 2 degrees future. Examples include the consequences of continued weather extremes, sea level rise, changes to ecosystems, ocean acidification and the melting of permafrost.

Figure 1: Global-scale impacts under a scenario that limits global warming to below 2°C and a high emissions scenario that reaches 5°C by 2100. Also displayed are impacts that would occur if the climate were held static at 1961-1990 levels.



Note: The solid lines show the median estimate, and the shaded areas the range between the 10th and 90th percentiles reflecting uncertainty in temperature change and the spatial and seasonal change in climate. Impacts are with SSP2 population projections. The impact indicators represent potential exposure to impact rather than actual impact, as they do not take into account either current or future management interventions, though these could be costly.

A climate impact modelling exercise within AVOID 2 projected exposure of people to a number of types of climate-related impact. Projections were made with high emissions and the impacts compared with those for an alternative future in which a less than 2 degrees warming pathway is achieved (Figure 1).

There is a large range in impacts, both for a below 2°C future, and a high emissions future. This is largely due to uncertainty around where the changes in temperature and rainfall would occur, according to projections from different climate models.

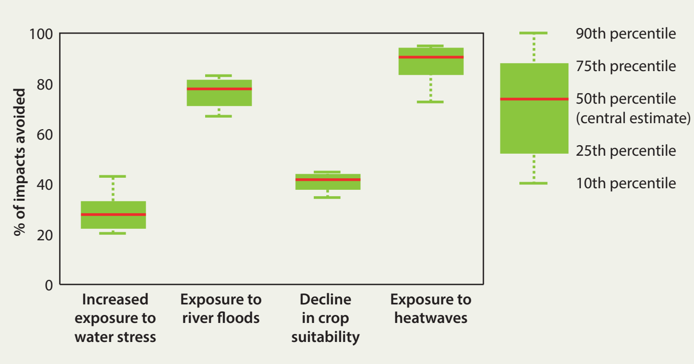
Future population and economic development influence human exposure to the climate-related impacts. For ease of comparison, the impacts shown in Figure 1 assume a 'middle-of-the-road' population change scenario, with a global population of 10 billion in 2100. The impacts under a higher population scenario (14 billion in 2100) are typically around 50-60% higher, while the impacts under a lower scenario (7 billion in 2100) are around 70% of the impacts presented here, though vary by type of impact.

Limiting global warming to below 2°C could avoid a substantial proportion of the global-scale impacts on people

Early and rapid emissions reductions that result in a below 2°C future lead to substantially lower impacts than would be experienced in a high emissions future (that reaches around 5°C warming by 2100). The model outputs indicate that **25-90% of the global-scale impacts that would occur with high emissions could be avoided in a below 2°C future by 2100** (Figure 2).

The absolute amount of impacts avoided (e.g. millions of people) depends on assumptions about future population growth. However, the proportion of impacts avoided (as shown in Figure 2) is little affected by different assumptions about future population change. The proportion of impacts avoided varies by type of impact. Around 70-80% of river flooding-related impacts and 80-90% of heatwave-related impacts are avoided. On the other hand, around 25% and 40% of impacts are avoided for water stress and crop suitability respectively.

Figure 2: The proportion of impacts that would occur in a world with high emissions that could be avoided in 2100 by limiting global warming to below 2°C.



Note: SSP2 population. The percentiles are derived from using different climate models.

The likelihood of people experiencing impacts of critical significance to their wellbeing are often much lower in a 2°C world

AVOID 2 compared the chances of defined impact values of significance to people being exceeded under high emissions with those in a below 2°C future. This is an alternative way of assessing risk to the traditional approach of projecting average annual changes to regional climate in any location (e.g. Figure 1), which can mask daily and seasonal variability over time.

Using this approach, the models show that globally, for every risk, **the chance of people being exposed to potentially life-changing impacts is lower with stringent mitigation than with high emissions** (Figure 3). Regional differences in risk are largely due to spatial patterns of change in temperature, rain or snowfall and the sensitivity of systems in each region to change.

Considering impacts at the global scale in 2100, the models show that the chance of an increase in exposure to flooding is greater than 50% in most regions, if there are high emissions. The risk is significantly lower in the below 2°C future: it is instead around 20-40% in many regions.

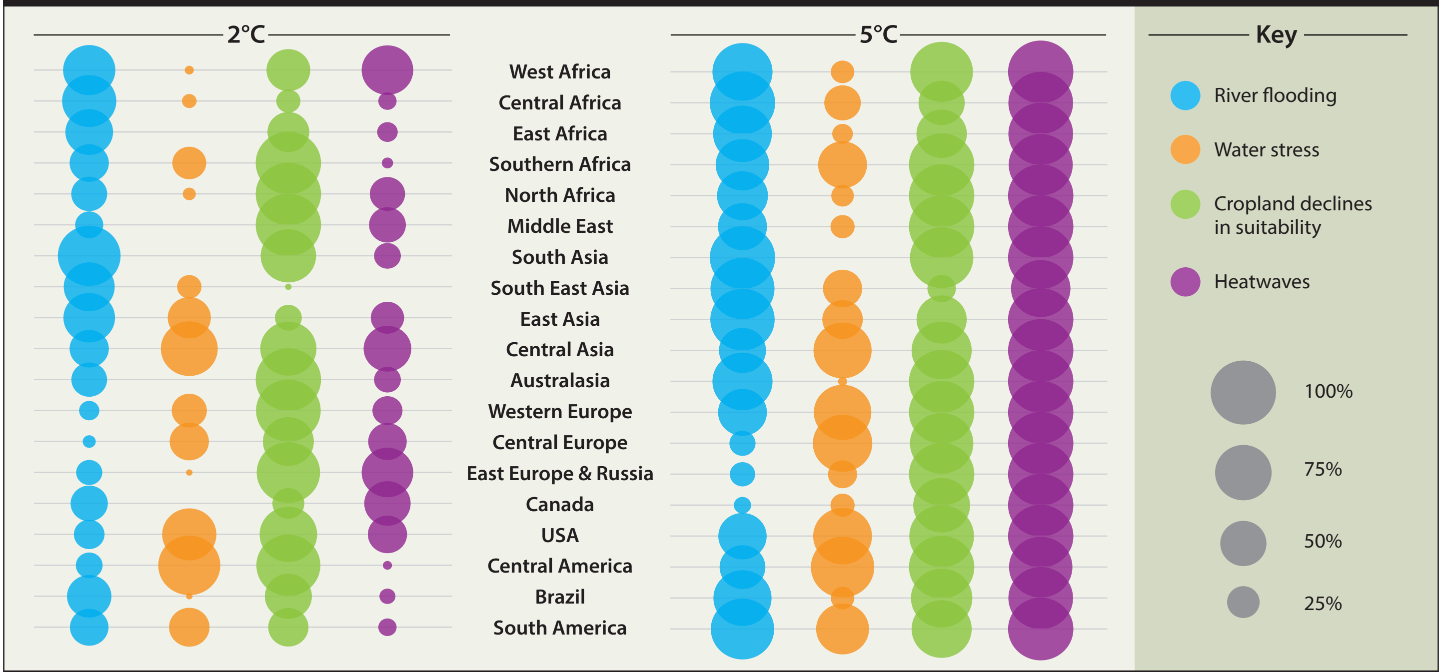
Likewise, there is a much lower chance of adverse effects on the suitability of cropland for agriculture for many regions in the below 2°C future than with high emissions. Central and west Africa, Canada, Brazil and South America are particularly sensitive regions.

There is a very high and increasing risk of exposure to health-threatening heatwaves across the globe throughout the 21st century, under a high emissions pathway. By 2100, the chances are over 90% in all but one region. In a below 2°C future, however, the risk is around 10-30% for most regions.

There are significant chances of increased exposure to water resources stress with high emissions. Risks are highest in western and central Europe, central Asia, USA and central America. Greenhouse gas reductions do lower the risks in some regions, but only slightly, in part due to a projected rise in global population.

Climate change is projected to have other impacts on society (e.g. on infrastructure), ecosystems (e.g. animals and plants) and the physical environment (e.g. see the AVOID 2 Policy Card on Tipping Points). In reality, different impacts could interact with each other, broadening their overall effects in size and space, e.g. flooding affecting crop yields, which in turn affects food security and global supply chains (see forthcoming AVOID 2 Policy Card on supply chains), or heatwaves driving up energy demand for cooling, which in turn has implications for meeting energy efficiency goals (see AVOID 2 Policy Card on reducing energy demand). The next generation of impacts models are exploring such complex interactions, and whilst no projections are available on this, it is clear that stringent mitigation could lower the risk of them occurring.

Figure 3: The chances (%) of impacts of critical significance to people occurring in different regions in 2100.



Note: Chances are derived from the regional spatial distribution of impacts in 2100 from multiple input climate models to impact damage functions and assuming population follows SSP2 (the chances would be different under different population scenarios). The chances are for defined impact values being exceeded. These are all expressed as percentages of some measure of exposure, based upon King et al. (2015) *Climate Change: A Risk Assessment*: population exposed to river flooding increases by over 25%, population in water stress increases by over 10%, over 20% of cropland experiences a decline in suitability, and more than 25% of population is exposed to heatwaves. The impact values exceeded are represented as percentages to enable comparisons between regions and therefore to illustrate the regional variation in impact, but the same percentages translate into different absolute values in different regions.

Read more

AVOID 2 report B2b (forthcoming): *Global and regional impacts of climate change under Representative Concentration Pathways (RCPs)* available soon on our website *www.avoid.uk.net*.