Climate change impacts on vulnerability to food insecurity at 1.5°C, 2°C and 4°C global warming

Comparing countries at risk of food insecurity: the Hunger and Climate Vulnerability Index (HCVI)

The HCVI is an indicator developed in collaboration with the World Food Programme to compare the vulnerability to food insecurity in different developing countries[1]. The HCVI combines measures of exposure to climate-related hazards from climate model simulations with food security relevant measures of sensitivity and adaptive capacity using national-level socio-economic data (Table 1). The exposure metric consists of proxies for drought and heavy rain events.

Exposure	Sensitivity	Adaptive capacity
▪ Average length of flood and drought events	▪ Forest cover ▪ Rainfed agriculture ▪ Cereal crop yield	▪ Rural water access ▪ Urban water access ▪ Paved roads ▪ Government effectiveness ▪ Decadal population growth ▪ Poverty ▪ Vulnerable employment ▪ Rural population

Table 1 - Components of the HCVI

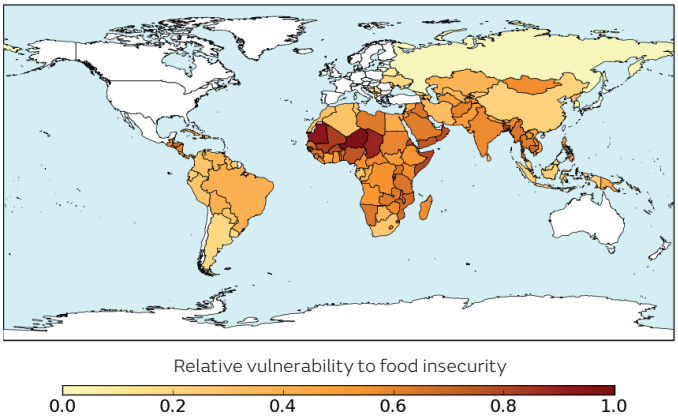

Figure 1 - HCVI for developing countries: current climate

Projections of climate change and the HCVI

We used a new model of the global atmosphere (HadGEM3-GC2), at a higher level of detail (60km resolution) than models previously used in reports by the Intergovernmental Panel on Climate Change. We simulated drought and heavy rain events and used these to calculate HCVI values for the current climate (Figure 1) and at 1.5°C, 2°C and 4°C global warming[2]. Since a range of regional climate changes are possible at any level of global warming, we made calculations with 4 different climate model simulations and checked how well they agreed.

Increases in vulnerability to food insecurity at 2°C global warming

Without adaptation, climate change at 2°C global warming increases the vulnerability to food insecurity in nearly all developing countries. Between 93% and 98% of developing countries are calculated to have a higher HCVI than under the current climate (Figure 2). In some countries, the vulnerability reaches unprecedented levels - between 2% and 13% have an HCVI higher than any present-day value for any country (Figure 3).

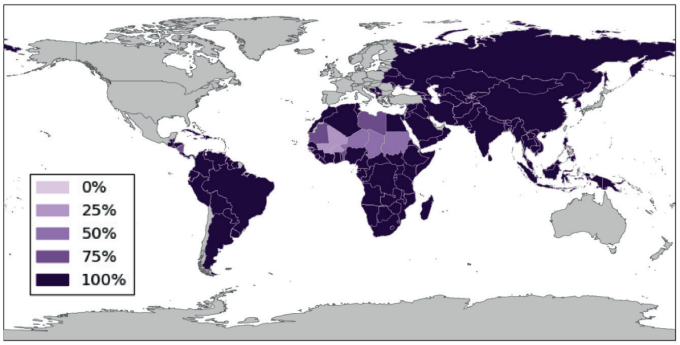

Figure 2 - Agreement between simulations on where HCVI is higher at 2°C than the current climate.

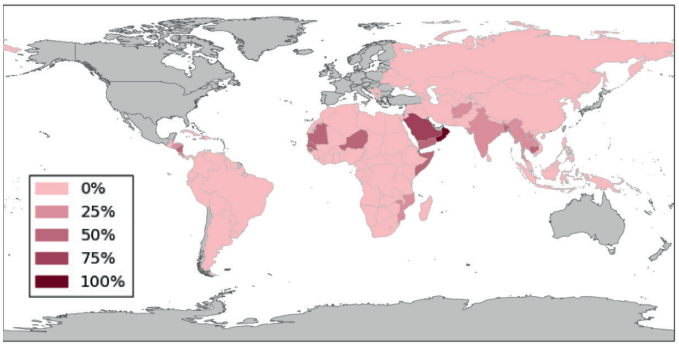

Figure 3 - Agreement between simulations on where HCVI at 2°C global warming is higher than any current value.

Reducing vulnerability to food insecurity by limiting global warming to 1.5°C

62% - 75% of countries were calculated as less vulnerable at 1.5°C than 2°C global warming (Figure 4), due to reduced floods and/or droughts.

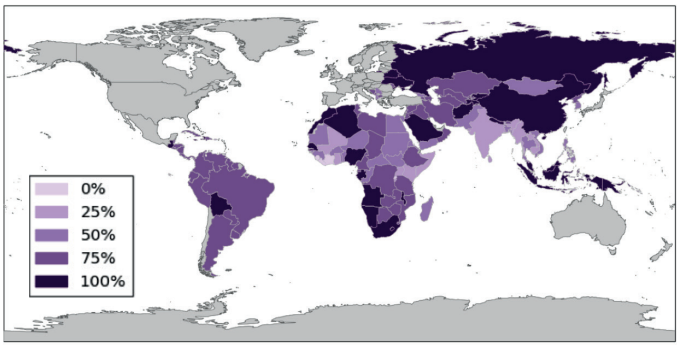

Figure 4 - Agreement between simulations on where HCVI is lower at 1.5°C than 2°C.

Reducing vulnerability to food insecurity: adaptation and increased resilience

Vulnerability to food insecurity would also be reduced through the sensitivity or adaptive capacity components of the HCVI. Reduced sensitivity could result from increased irrigation or increased crop yields due to improved farming practices. Improved adaptive capacity could arise from, for example, reduced poverty or vulnerable employment, or increased access to water or paved roads.

Impacts of elevated CO_2 and climate change on crop yields

Yields of some crops could be increased under the elevated CO_2 concentrations driving higher global temperatures, but could also decrease if local climate changes led to heat or water stress. These factors were not included in the this study.

Further increases in vulnerability to food insecurity at 4°C global warming

Approximately 84% - 91% of countries were calculated as more vulnerable at global warming of 4°C than 2°C (Figure 5). 10% - 32% of countries reach unprecedented levels of vulnerability at 4°C (Figure 6).

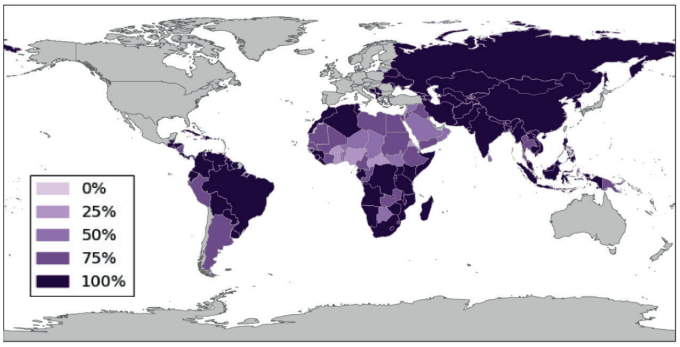

Figure 5 - Agreement between simulations on where HCVI is higher at 4°C than 2°C.

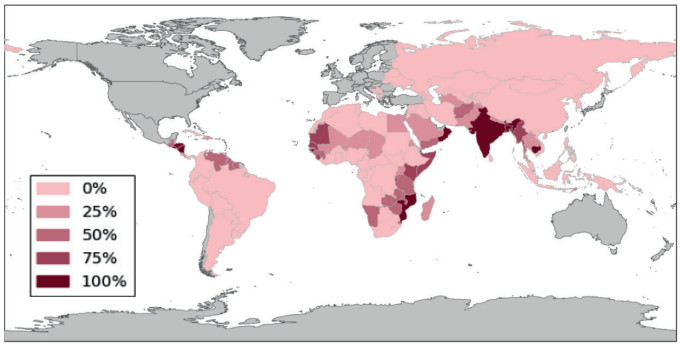

Figure 6 - Agreement between simulations on where HCVI at 4°C is higher than any country at present day.

Conclusions

For the countries considered for which the HCVI has been calculated:

- Vulnerability to food insecurity mostly increases with warming but also depends on non-climatic factors
- Between 93% and 98% of countries are projected to be more vulnerable to food insecurity at 2°C global warming than now.
- Between 4% and 13% of countries are projected to reach unprecedented levels of vulnerability at 2°C.
- Limiting global warming to 1.5°C keeps the increase smaller in 62% to 73% of countries
- Global warming of 4°C leads to between 84% and 91% of countries becoming more vulnerable to food insecurity compared to 2°C, with between 10% and 32% of countries reaching levels of vulnerability which are unprecedented in the current climate.

1. Richardson K. et al. (2018) Food security outcomes under a changing climate: impacts of mitigation and adaptation on vulnerability to food insecurity. Clim. Change, 147, 327–341, doi:10.1007/s10584-018-2137-y; https://www.metoffice.gov.uk/food-insecurity-index/
2. Betts, R. A., et al. (2018) Changes in climate extremes, fresh water availability and vulnerability to food insecurity projected at 1.5°C and 2°C global warming with a higher-resolution global climate model. Phil. Trans. R. Soc. A, doi: 10.1098/rsta.2016.0452