# Climate Change and It's Impacts in Burkina Faso

**THE CLIMATE OF THE PLANET IS CHANGING**, as is evident from steady increases in global temperatures and sea levels over the last 100 years. Scientists are clear that these changes are due to man-made emissions of greenhouse gases, notably carbon dioxide from fossil fuel burning. In spite of efforts by the United Nations Intergovernmental Panel on Climate Change (IPCC), emissions have continued to rise. How much the world will warm in the future is strongly related to how rapidly the global economy can decarbonise.

In this policy brief, we set out how the climate of the Sahel has changed in recent decades, what future changes are expected, and some implications of these changes for agriculture and flooding. There are many uncertainties when considering future impacts of global warming within a specific region. Here we present the range of plausible futures so that this uncertainty can be taken into account by decision-makers.

## Changes in temperature

Overall, West Africa has warmed by about 1.1°C since 1950, a period for which we have relatively good observations. Compared to the pre-industrial climate of 1850, it is estimated that temperatures have increased by 2.1°C, with the strongest warming in the northern Sahel and Sahara. The warming in the Sahel has not occurred equally across the year. In particular the pre-monsoon months of April to June have warmed most rapidly. For example temperatures have risen by 1.4°C in April, compared to 1.1°C averaged over the whole year. The pre-monsoon months are the hottest time of the year, and so the warming has produced record-breaking high temperatures. Night-time temperatures especially have increased.

To make projections of the future, climate centres around the world run complex computer simulations which depict the impact that greenhouse gases have on the climate system. They run these climate models for different scenarios of future greenhouse gas emissions, each producing a different 'projection' of the future climate. The high scenario assumes that emissions will continue to increase throughout the 21st Century and beyond. The intermediate scenario predicts a peak in greenhouse gas emissions around 2040, while the low scenario assumes that emissions will peak in 2020s.

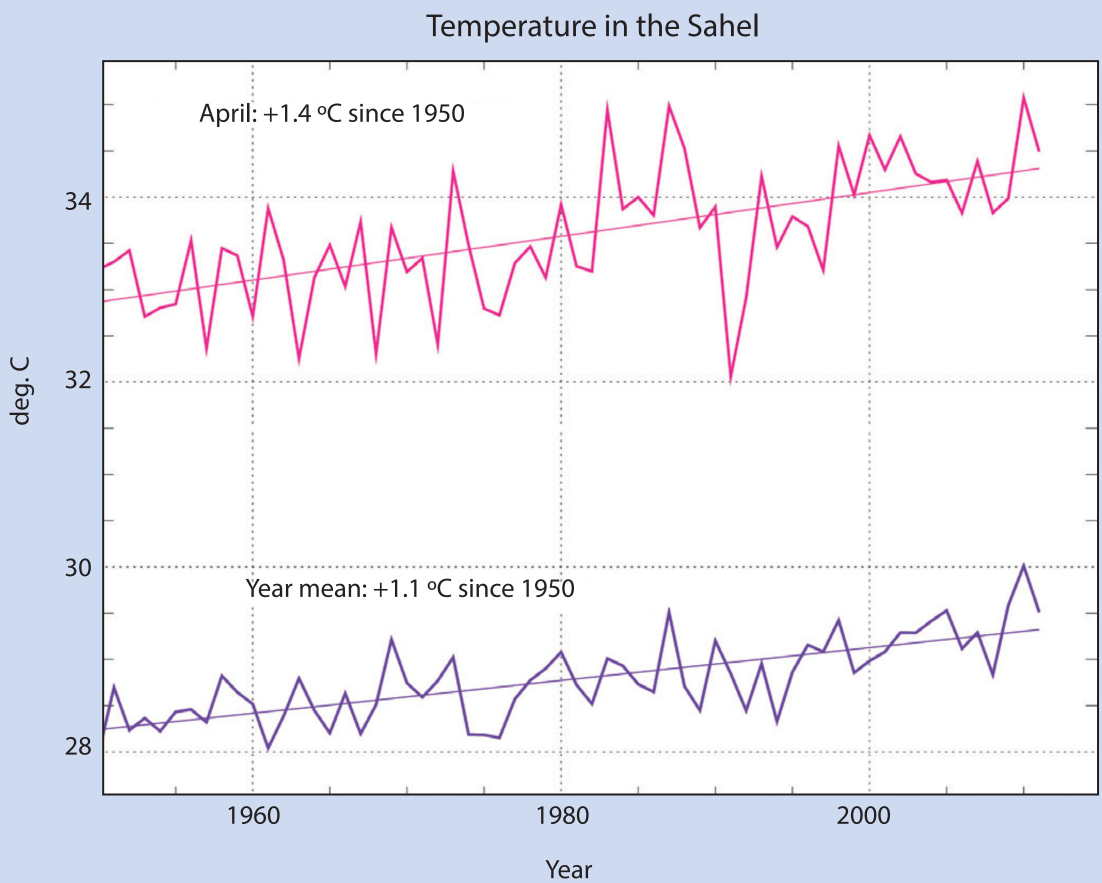


***Figure 1.*** Observed increases in temperature since 1950. There are individual warm and cool years throughout this period, but the overall trend (represented by the straight lines) show a clear warming.



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For a given emissions scenario, different climate models simulate different rates of warming. The map (Figure 2) shows the average warming across the different models over the first half of the 21st Century under a high emissions scenario. The African continent warms more than the surrounding oceans, with the most rapid warming in the more arid regions. The right-hand plot shows the simulated changes in temperature (compared to the mid 20th Century) in the Sahel. Overall, the models project that the Sahelian warming that has been observed over the last 60 years will continue at least until mid-century.

Whilst the models agree that warming will occur, the range of warming simulated by the models (compared to pre-industrial times) is quite large (1.5 to 4°C). If emissions peak by the 2040s (intermediate scenario) then temperatures will start to stabilise.

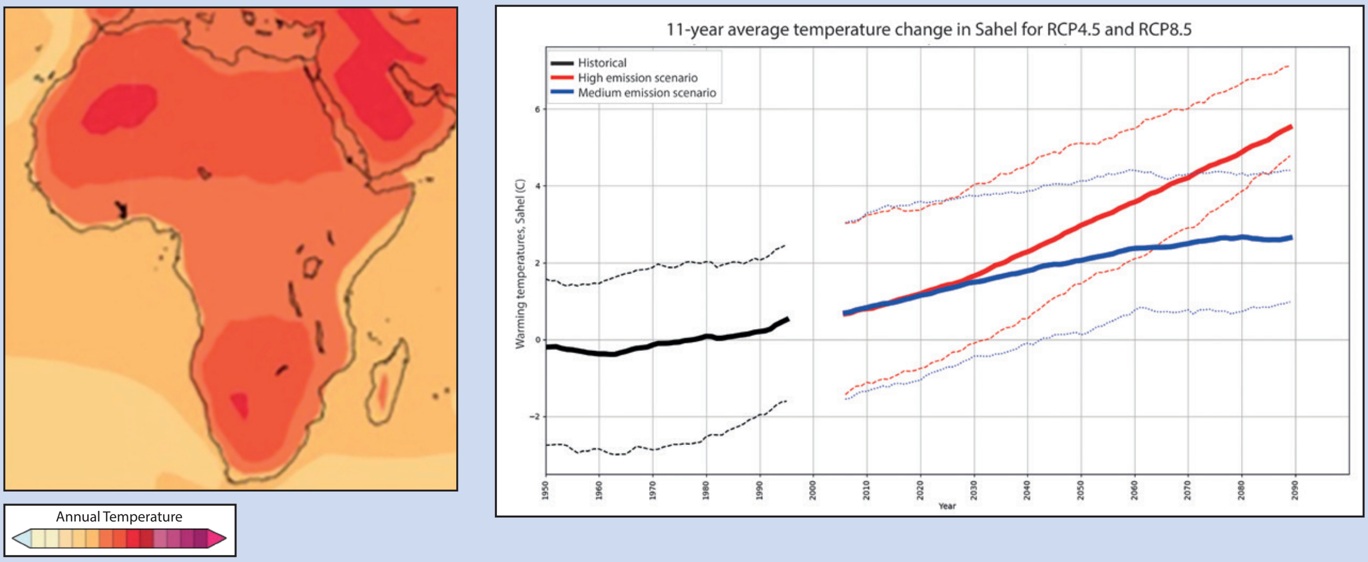


***Figure 2.***

**Left:** Change in temperature (°C) for the period 2040-2060 averaged across climate models assuming a high emissions scenario compared to the period 1986-2005

**Right:** Changes in Sahel temperatures relative to the period 1976-2005, based on historical (black) and future emissions. The future simulations assume either a medium (blue) or high (red) emissions scenario. The thick lines indicate the average warming, and the dashed lines illustrate the range of warming found in different models.

## Changes in seasonal rainfall

The Sahel has always experienced large variations in rainfall from year to year and decade to decade. During the 1950s and 60s, there was generally very strong rainfall, followed by an intense period of drought during the 1970s and 1980s (Figure 3). Since then annual rainfall has increased, but remains well below the levels seen during the 1950s.

The large natural rainfall fluctuations from decade to decade in the Sahel make it difficult to draw strong conclusions about whether man-made climate change has already affected rainfall. Some climate models suggest that man-made emissions of particulates and greenhouse gases influenced the drought of the 1970s and 1980s and the subsequent recovery, but there is no consensus on the relative importance of the different effects.

We are much less certain about how average rainfall totals will change by 2050 than we are about future temperature changes (Figure 4). For any given emissions scenario, some models depict increases in rainfall over Burkina Faso, and others suggest decreases, or little change. Considering a high emissions scenario, the majority of models indicate increases of between 5 and 20%. However, there remains a reasonable chance of a drier climate by 2050 under all emissions scenarios.

An example of climate resilient crops *(Photo: AMMA-2050)*

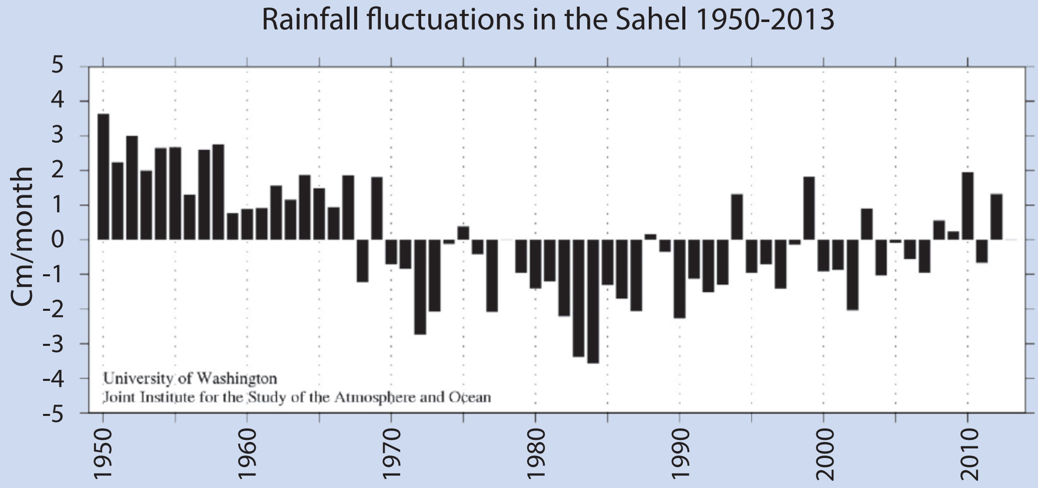


***Figure 3.*** Observed fluctuations in wet season rainfall relative to the long-term average across the Sahel.

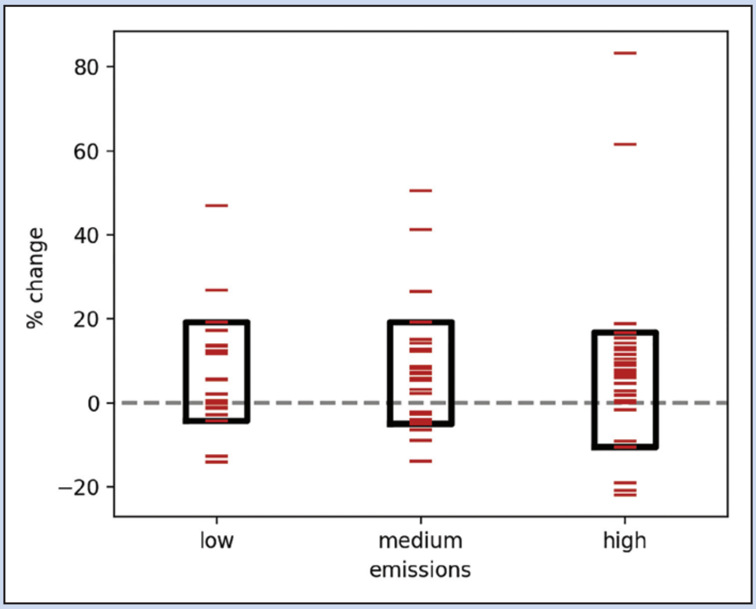


***Figure 4.*** Changes in rainfall over Burkina Faso by 2050, as simulated by climate models under low, medium and high emissions scenarios. Each red line indicates the projection from one model. There is a 90% chance that the changes will be within the range covered by the rectangles. The rainfall reductions are below the dotted line and the increases are above.

# Wet season duration

Alongside large changes in the amount of rainfall within a season, the central Sahel experiences large fluctuations in the length of the growing season from year to year (Figure 5). During the 1950s, on average the season lasted for 101 days. This fell to 88 days in the 1980s but has since increased to about 93 days. As with total rainfall, the large natural fluctuations in rainy season length from decade to decade make it difficult to draw strong conclusions about whether man-made climate change has already affected wet season length.

Future projections of wet season length are rather uncertain. Each red line in Figure 6 shows the change in length for an individual climate model for a given greenhouse gas emissions scenario. There is a wide range of projected changes in season length and it is therefore not possible to say with any certainty how the season length will change. For example under a high emissions scenario, there is a 90% chance of changes lying between a decrease of 12 days and an increase of 12 days. For comparison, the drop in season length experienced between the 1950s and 1980s was 13 days.

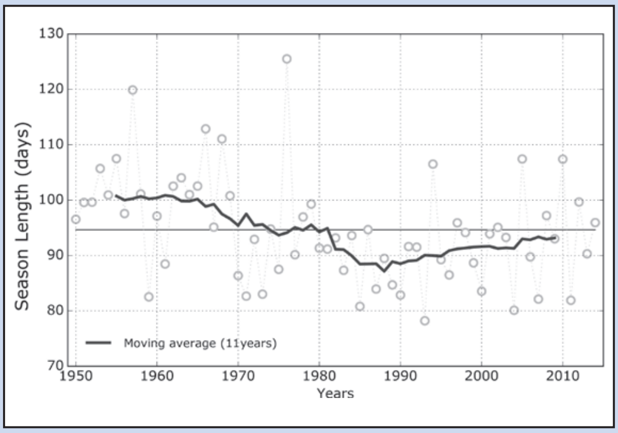


***Figure 5.*** Observed growing season length (in days) in the Central Sahel (including Burkina Faso and South-West Niger) since 1950. Following the AGRHYMET definition, the season starts when there is sufficient rain in 3 consecutive 10 day periods for crops to grow. Similarly, the season ends when there are 3 consecutive 10 day periods without sufficient rain. Each circle on the graph shows an individual year, and the solid line shows the average of the data over 11 years making it easier to see longer-term trends in growing season length.

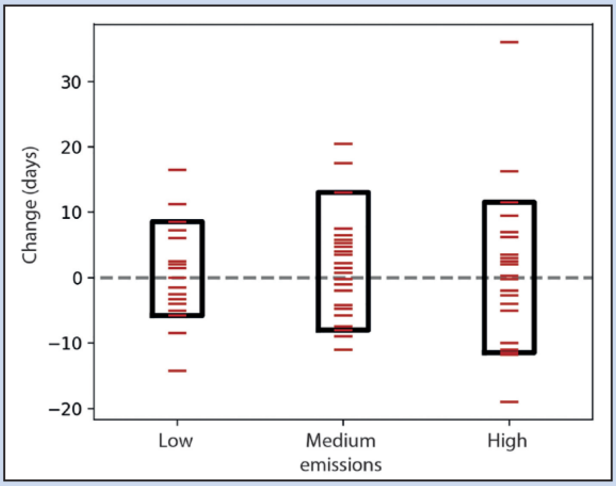


***Figure 6.*** Changes in the wet season length (in days) by 2050 over Burkina Faso, as simulated by climate models under low, medium and high emissions scenarios. Each red line indicates the projection from one model. There is a 90% chance that the changes will be within the range covered by the rectangles. By way of comparison, the average decrease in the length of the rainy season recoded in Senegal between the 1950s and 1980s was 19%.



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## Changes in intense rainfall

Climate change is expected to make the strongest rain storms more intense. There is now good evidence from observations that this intensification is already taking place in the Sahel. The frequency of intense storms across the region has tripled since the 1980s (Figure 7). A larger proportion of the season's rain is now arriving in heavy storms than at any time since 1950. This trend has contributed to the increase of flood events reported in Burkina Faso, particularly in rapidly expanding urban areas where drainage may not be adequate. Whether seasonal rainfall totals increase or decrease, more intense rain from individual storms can be expected in the future. This will further increase the frequency and extent of flash flooding (Figure 8). For agriculture, rainfall intensification will also increase soil erosion, and reduce the fraction of rainfall which crops can use to grow.

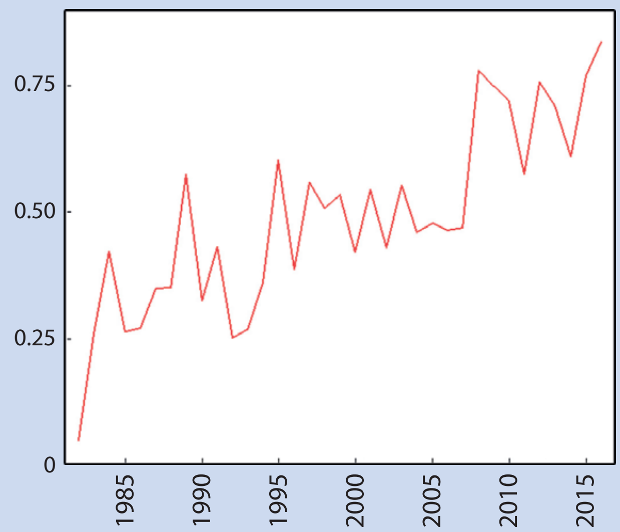


***Figure 7.*** Average number of intense storms per day observed across the Sahel since 1982.

After the rain
*(Photo: Chris Lloyd, UKCEH)*

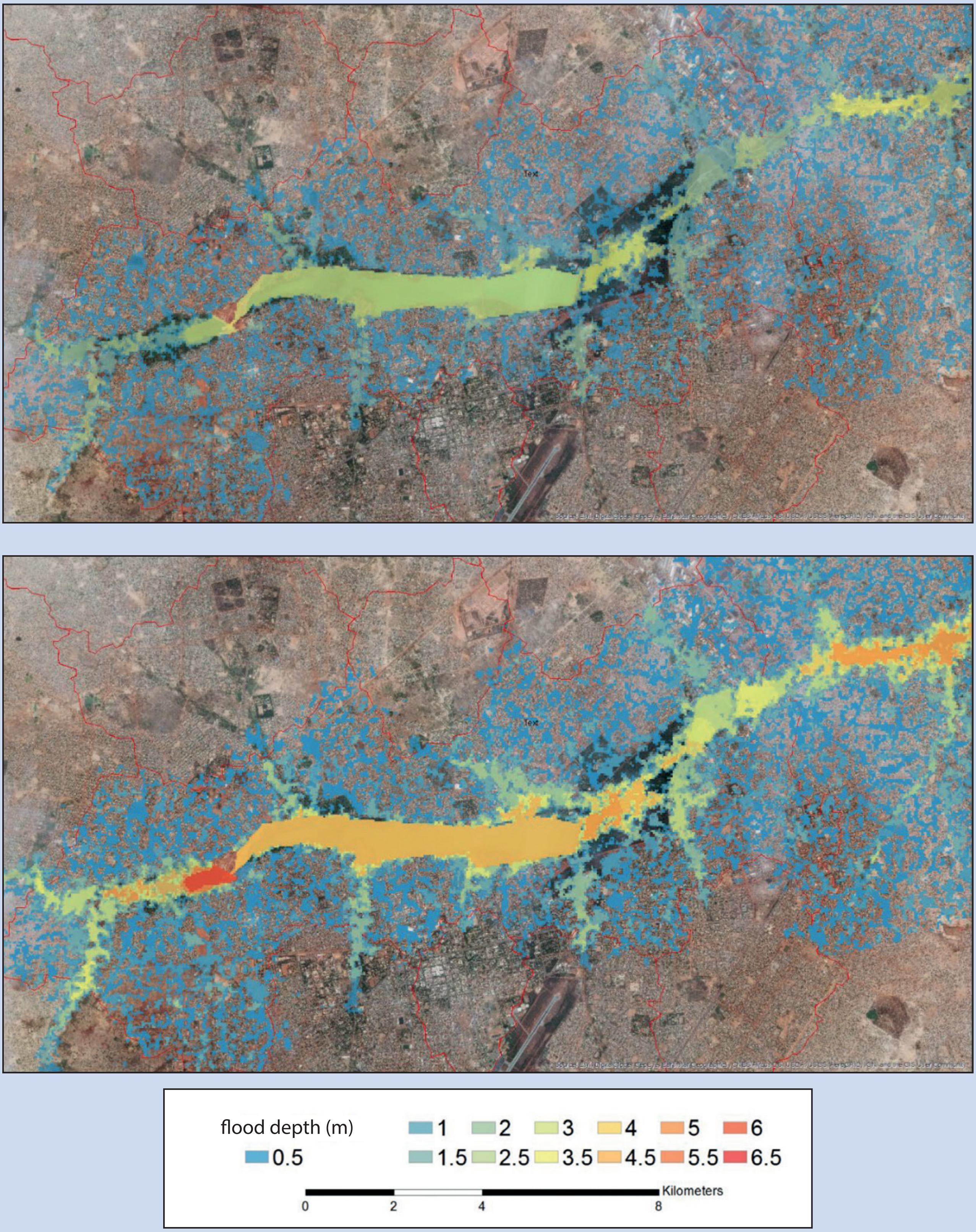


***Figure 8.*** Maps illustrating how the changes in intense rains and land use from 2016 (above) to 2050 (below) will affect the depth of the floods in the city of Ouagadougou for a particularly extreme thunderstorm (expected only once in 100 years). More of the city will be flooded and areas already prone to flooding will experience higher levels of flooding for a longer period of time.

# Impacts on agricultural production

Global warming has been affecting agricultural production negatively in West Africa over the past 20 years. While many studies have indicated a drop in regional agricultural yields of 10 to 15% by 2050 due to the future rise in temperatures, none have considered the impact of historical warming. Figure 9 shows the effect of anthropogenic global warming on agricultural production between 2000 and 2009 based on 200 simulations of a climate model. The result is unambiguous; anthropogenic activities have caused a drop in yields of 10-20% in millet, and of 5-15% in sorghum. From an economic point of view, the losses for the countries involved range from 2 to 4 billion dollars for millet and 1 to 2 billion dollars for sorghum. These losses in yield will grow in the future if global greenhouse gas emissions are not reduced, and if adaptations to higher temperatures are not implemented.

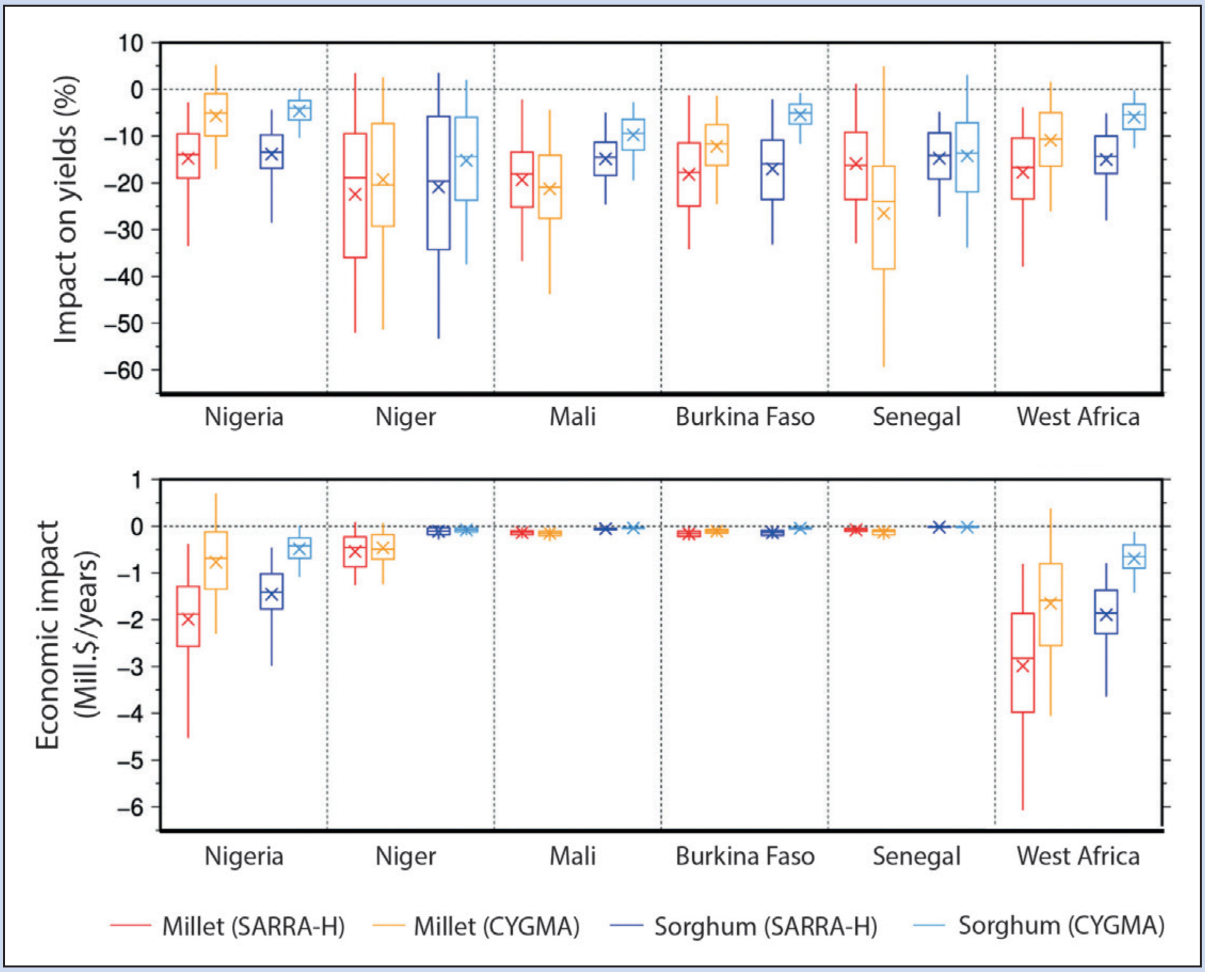


***Figure 9.*** Impact on agricultural production of millet and sorghum (as a percentage) and associated economic losses (in billions of dollars) due to global warming during the decade 2000-2009, as simulated by two crop models SARRA-H and CYGMA. The weighting of harvested areas was taken into account when calculating the impacts on the average yield of countries and West Africa. Boxplots indicate the mean (cross), with confidence intervals of 25-75% (top and bottom of the box) and 5-95% (vertical line) derived from the entire simulation of culture. Horizontal lines indicate the median. Average regional data for West Africa were calculated by averaging data for Benin, Burkina Faso, Gambia, Guinea, Guinea Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. The simulated yield variation range has been limited to the range of -100% to +100% to avoid unrealistic yield impacts on sites where the current yield is very low.

Global warming is a threat to grain production in West Africa. Indeed, many studies, such as the one illustrated in Figure 10, have shown that increasing temperatures are detrimental for millet, sorghum and/or maize because they shorten crop cycles and increase evapotranspiration. Negative effects on crops are expected by 2050 and 2100, especially in scenarios with high greenhouse gas emissions.

The greater the emissions, the greater the impacts on agricultural production, which justifies the effor to be made on mitigation and adaptation to reduce risks.

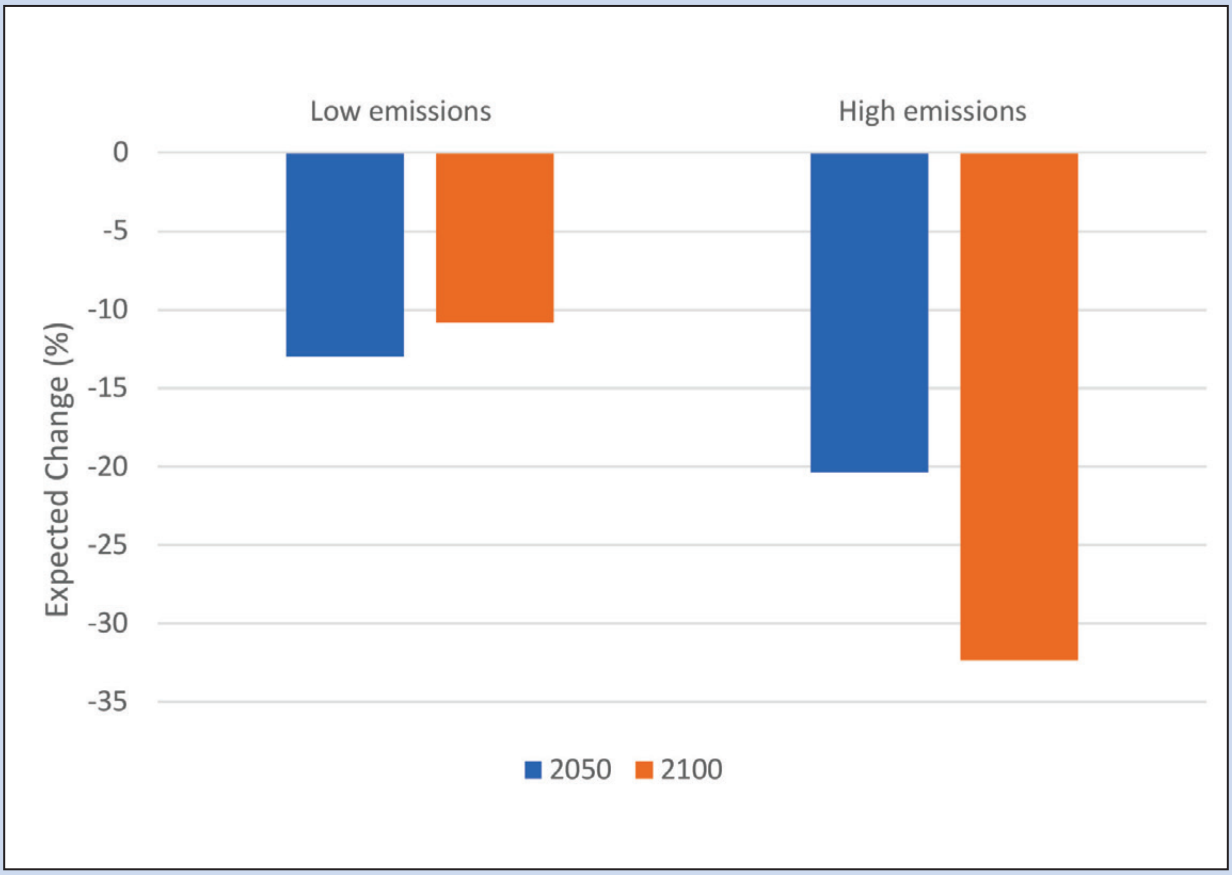


***Figure 10.*** Expected changes in the agricultural yield of millet in Burkina Faso simulated with the SARRA-H agronomic model and 30 CMIP5 models compared to the period 1975-2004 (without effect of CO2 on plants).

Stakeholder Group,
Somone, Senegal, 2019
*(Photo: AMMA-2050)*

Debriefing session for
Ministry representatives, 2018
*(Photo: AMMA-2050)*

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