Met Office

Climate change and the UK food system

Climate change: UK and overseas

With current carbon commitments, we are on track to reach 3ºC of global warming by 2100[1], and future warming is generally greater over land than over the oceans, and greater over high latitude regions in the Northern Hemisphere[2]. Globally, annual average precipitation is expected to increase overall by 0-13% by the end of the century compared to the recent past, depending on future emissions scenarios[2]. Increases in annual average precipitation are projected over high latitudes, the equatorial Pacific and parts of the monsoon regions, with less precipitation over parts of the subtropics and some tropical areas[2].

We are expecting the UK to have warmer, drier summers, and warmer, wetter winters[3], along with an increase in the occurrence and intensity of extreme weather events such as high temperatures, heavy rainfall and drought. Annual average temperatures in the UK are projected to increase 20-25% faster than the global average, and extreme temperatures by 50-60%[4]. While changes in seasonal precipitation are expected all over the UK, they are projected to be larger in the North and West in winter precipitation (increasing by ~15-60%), and greater in the South for summer (decreasing by ~20-70%) for the 2070s relative to current climate[3].

For levels of future global warming from 1.5°C to 4°C above pre-industrial, the range of changes in high-impact weather hazards averaged over the UK include increases in the frequency of extremely hot days (of 5-39 additional days per year) and nights, a decrease in the frequency of very cold conditions (days below 0°C) of 10-49 days per year, increases in daily rainfall events that relate to increased flood risk by 1-8 days per year, changes in average drought severity from a 3% decrease to a 19% increase for 12-month drought and from a 2% decrease to a 54% increase for 36-month drought periods, along with an increase in cooling needs and decreases in heating requirements[5]. Coastal sea levels around the UK have risen by about 15 cm since 1900[6] and will continue to rise in the future[3] with the potential for storm surges to reach further inland.

Impacts of climate change on the UK food system

The changing climate will present both risks and opportunities to the UK food system and agriculture. These impacts could be wide-ranging[3], including:

- risks to soils from changing seasonal climate patterns,
- risks from sea-level rise to aquifers and agricultural land,
- risks and opportunities for agricultural productivity,
- risks to agriculture from pests, pathogens and invasive non-native species,
- Opportunities for growing new or alternative crops,
- Changes to landscape character,
- Risks to food safety, security and quality both in the UK and in overseas production regions, and
- Opportunities for UK food imports or exports as climate change alters the relative competitive advantage.

The wetter winter conditions in future are likely to lead to increased water-logging in wheat crops (the most extensively grown arable crop in the UK), but also reduce the risk of winter droughts[7]. The warmer winters lead to earlier harvesting times of UK wheat, thus avoiding summer droughts, but this may be offset by increased heat stress at the crop flowering time and problems of crop establishment in wetter

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sowing and germination conditions. As such, the changing climate may necessitate more heat-tolerant rather than drought-tolerant crops[8] and cultivars better suited to different sowing timetables.

Climate change is anticipated to make 44% of external agricultural imports to the EU highly vulnerable to drought with increases in drought severity in key import regions of 35% by 2050[9]. The UK sources a significant proportion of fruit and vegetable supplies from overseas, particularly from regions such as Southern Europe, South Africa and South America, that are vulnerable to climate hazards and water scarcity[10]. Evidence from the recent past suggests that maintaining geographically diverse food sources should increase resilience to supply-side shocks from extreme weather events[11].

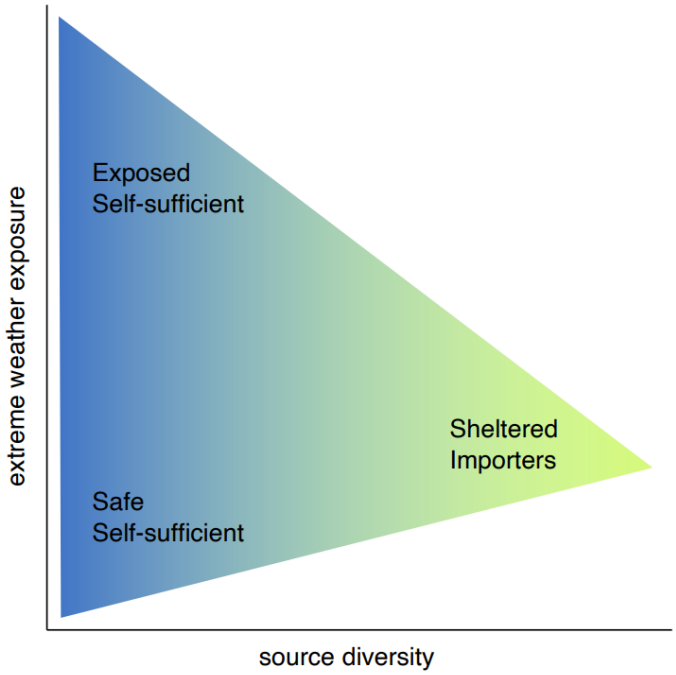

Figure 1: Schematic classification of countries by extreme exposure and source diversity (from[11]). Countries with low source diversity, which are almost always self-sufficient, experience a wide range of extreme exposure. As source diversity increases, extreme exposure tends towards intermediate levels.

Climate-driven changes in extreme weather events are one of the highest-risk future shocks to the UK food system[12] and could have impacts throughout the food chain from farm to fork[13]. For example, as well as increasing heat stress to crops, livestock and outdoor workforces, heatwaves and high temperatures could increase supply variability throughout the food chain, increase the need for cold-chain transport and storage, alter consumer demands and increase food waste where it is stored at room temperature.

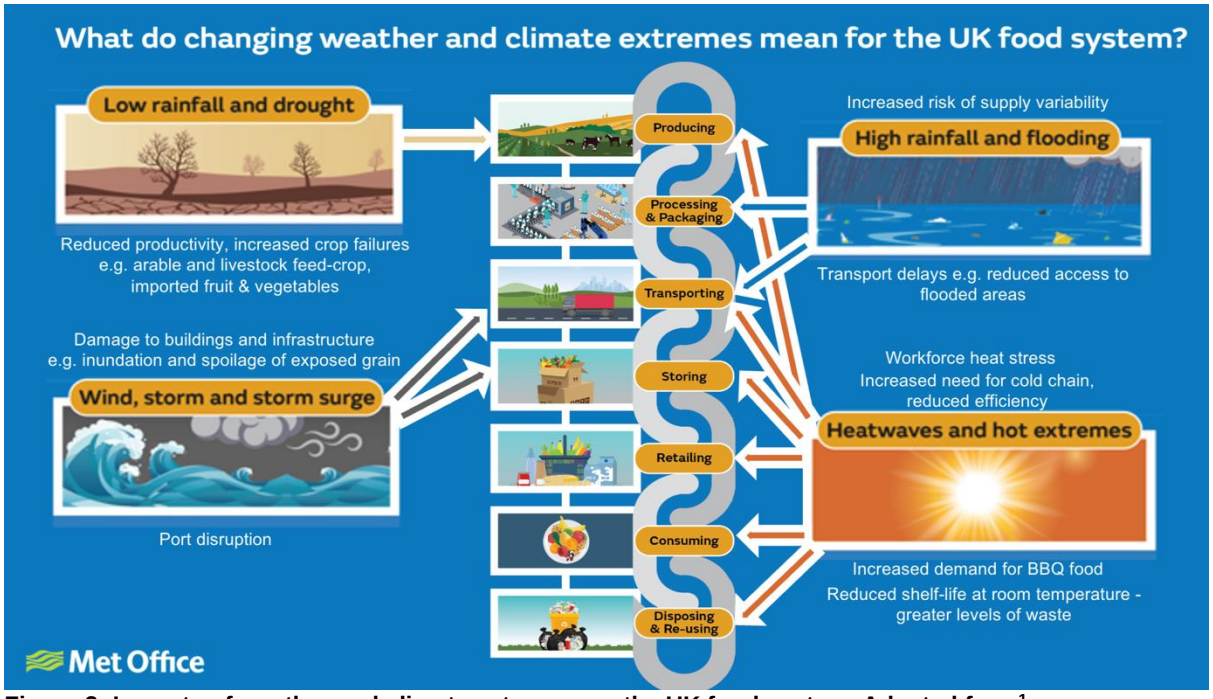

Figure 2: Impacts of weather and climate extremes on the UK food system. Adapted from[1]

The Climate Change Risk Assessment (CCRA) gives 'urgency scores' to the different risks identified above to help inform priorities over the next five years[3]. For agriculture and food, most of these recommend more adaptation action or underline the need for further scientific evidence to support robust decision-making; many are also assessed as high magnitude risks by 2050.

The Met Office are working collaboratively with Defra, academia and industry partners through the Defra funded Food Farming and Natural Environment Climate Service to help answer the question of how do we ensure a climate resilient agri-food system? The service focuses on understanding adaptation and resilience options for UK food and agriculture by addressing evidence gaps to support Defra policy and decision making. This work has helped inform the third CCRA and the 2021 UK Food Security Report, as well as providing support to the Third National Adaptation Programme.

Adapting to climate change – opportunities and challenges

There are many potential ways in which the UK food system could build resilience and adapt to climate change. Examples of quick wins (high impact, easy to implement measures) in agriculture to cope with high temperatures and drought could include improving water management, increasing crop irrigation, or choosing slower maturing and/or heat and drought tolerant crop varieties[14]. Quick wins for coping with heavy rainfall and flooding could include improving runoff containment and drainage, flood contingency plans, ensuring spare grazing areas are available during wet periods or in arable systems increasing soil organic matter[14].

Recent climate science has, however, highlighted that the future evolution of extreme events (particularly for heavy rainfall) may not be a smooth trend, but instead consist of clusters and long periods with very few new records being broken[15]. This volatility will be challenging to adapt to. To date, progress in climate adaptation plans and policies, their delivery and implementation for UK food security has been assessed as insufficient or limited[16].

There are also opportunities to learn from our past experiences. The 2022 heatwave, which saw temperatures over 40ºC for the first time in the UK, resulted in poultry meat production being 9% lower in July 2022 compared to the previous year, increased energy costs in production and refrigeration failures in retail facilities[16]. Poultry sector adaptation measures might therefore include transitioning to more heat tolerant breeds, reducing stocking densities, improving poultry housing climate control, and improving retail refrigeration resilience and efficiency.

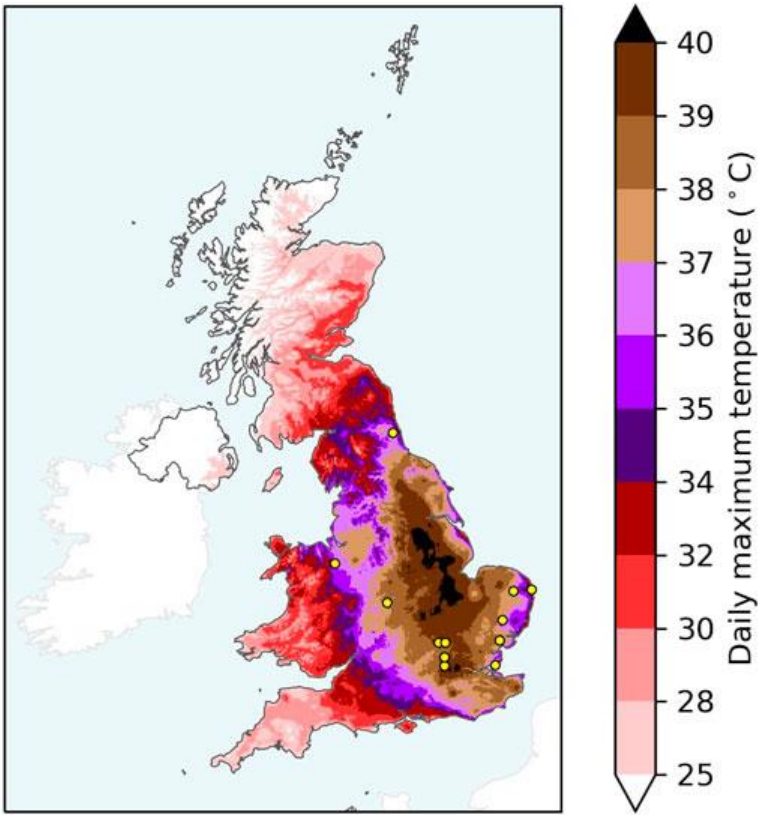

Figure 3: UK maximum temperatures on 19 July 2022. Yellow dots represent supermarket stores that experienced refrigeration system issues during the summer 2022 heatwave. From[16].

UK wheat yields were 8% higher in 2022 than the 2017–2021 average, but the increases were smallest in the South and East where the heatwave intensity was strongest[17]. The exceptionally warm conditions of 2022 seem to have occurred too late in the crop lifecycle to have a significant impact, while summer 2022 was dry for the UK with 64% of average rainfall, May to early July did not experience significant prolonged dry spells so there was sufficient rainfall during the period when winter wheat is particularly vulnerable to avoid significant yield impacts. Future adaptation measures to avoid negative impacts of summer heat stress on winter wheat could therefore include earlier maturing and heat/drought tolerant varieties, earlier autumn sowing, targeted irrigation during sensitive crop growth periods, and soil and water conservation measures.

Bringing together state-of-the-art climate science with agricultural knowledge and expertise can also support effective adaptation. For example, combining climate projections with an understanding of the timing and thresholds for heat stress to crops during sensitive periods such as anthesis (around flowering) can support genetic improvement and breeding of heat tolerant varieties[18].

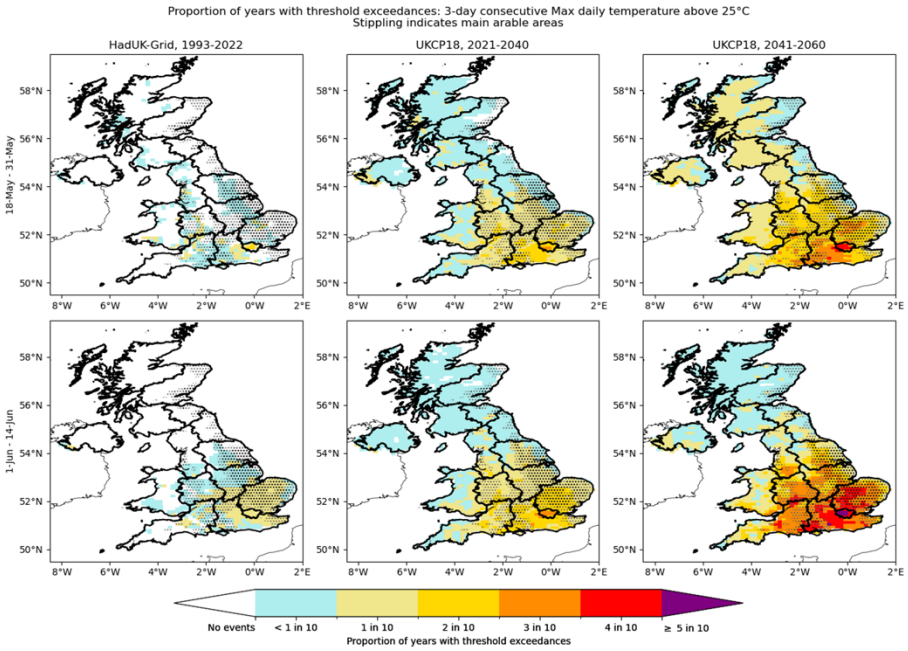

Figure 4: Frequency of heat stress events during wheat anthesis (flowering). Plots show the proportion of years experiencing 3-day periods with temperatures above 25ºC for the present day (left), 2030s (middle) and 2050s (right). The bottom row is for current flowering dates, while the top row is two weeks earlier, given that crops may develop faster in a warmer climate.[18]

Summary

The changing climate will pose both risks and opportunities to UK food security, and both on domestic and overseas fronts. The most prominent underpinning evidence gaps are around post-farm gate aspects, the 'missing middle' of the food chain between production and food safety, future scenarios/planning and modelling – and taking a whole food systems approach.

To ensure future resilience, and avoid negative downstream impacts, there is a need for whole food chain, systemic approaches and evidence that consider implications for adaptation and resilience, net zero goals and the broader win-wins, trade-offs and consequences of making changes in the food system. Supporting effective adoption and implementation of climate adaptation amongst farmers and the wider food industry will require working together across a range of stakeholders (business, policy and academia) coupled with effective dialogue and co-design of solutions.

Critically, this needs to focus on social innovation, pilot studies and in-practice measures, building on existing and new academic research and underpinning evidence.

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