

# Multiple hazards under UK Climate Projections: the future of UK agriculture



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# Strategic Priority Fund for UK Climate Resilience

- Jointly led by UK Research and Innovation (the body which funds UK research councils) and Met Office. Programme funds are ~22m euro over 4 years.
- Funds research & climate service development across UK universities & research institutes, with ~ ¼ of research embedded within the Met Office throughout.

***Vision*** *To enhance the UK's resilience to climate variability and change through frontier interdisciplinary research and innovation on climate risk, adaptation and services, working with stakeholders and end-users to ensure the research is useful and usable.*

## **Main objectives**

- Characterising and quantifying climate-related risks
- Managing climate-related risks through adaptation
- Co-producing climate services



# Thoughts on stakeholders and science-user interface

- Everyone we speak to in the user community agrees compound hazards are important to think about.
- However, emerging field of research which often relies on a high level statistical understanding, and many stakeholders do not consider it quantitatively.
- We are trying to identify key areas in which additional research perspective is useful – initial focus on UK agriculture.
- We are trying to work with stakeholders to co-develop products that will be useful and useable, and inform decision making.
- Making connections and building relationships with stakeholders takes time.

# Agriculture in the UK

- A survey suggests 75% of farmers say extreme weather costs them around £10,000 per year, on average (Farmers Weekly/Macleod Research 2020).
- 90,000 square kilometres of utilised agricultural land, just under half of which is used for arable crops, mostly cereals (wheat/barley) & oilseed crops.
- Around 5 million cattle, 4 million pigs, 15 million sheep, 33 million chickens.
- Beef and pork are the biggest agricultural exports from the UK.
- Over 300,000 people work on agricultural holdings in England.

**£10.7 billion**   
the contribution from  
agriculture and fishing  
to the economy (2014)

# Impact information to understand current risk

## How have we learnt about UK agriculture and impacts?

- Peer review literature
- Colleagues already working on agriculture questions at Met Office
- Conversations with Agricultural and Horticulture Development Board
- Communications from Department of Agriculture, Environment & Rural Affairs (Northern Ireland)
- Reading Farmers Weekly articles and other UK news
- Conversations with Department for Environment, Food and Rural Affairs (DEFRA).  
DEFRA are a link to the development of agricultural adaptation policy and planning, which is a proxy for direct integration with the agriculture sector.

# Examples of compound events impacting UK agriculture

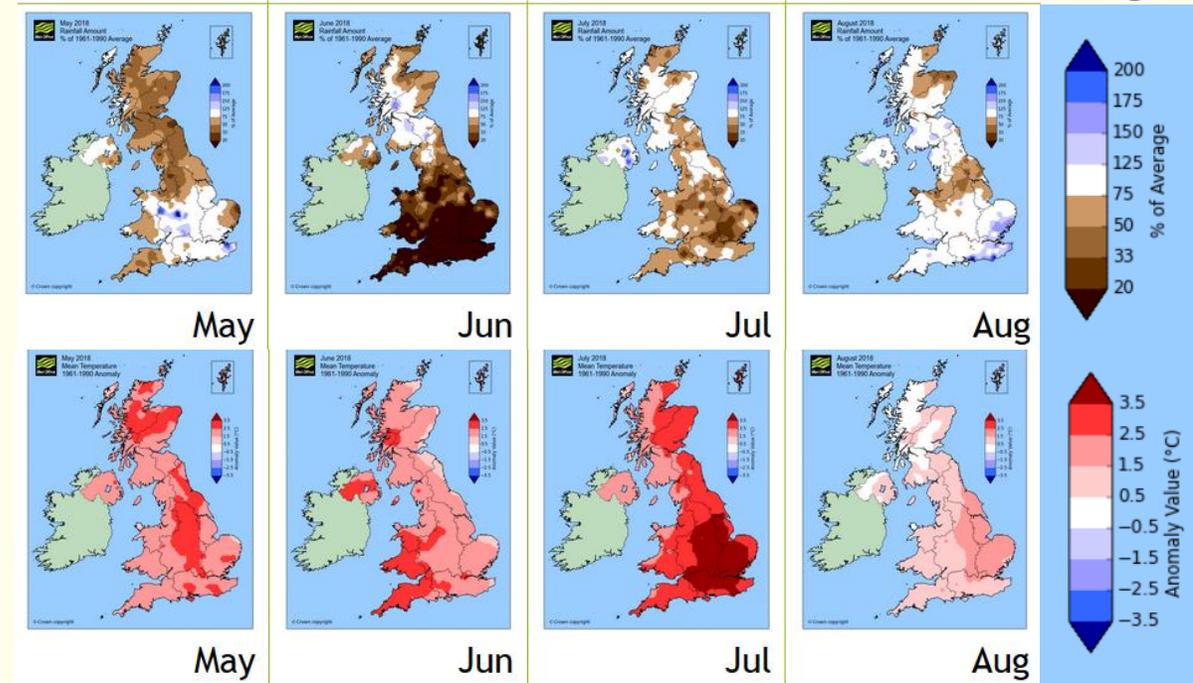
## Multivariate event

Hot dry weather in 2018 led to wheat yields being 6% down on the 5 year average (as reported in Farmers Weekly).

Also temporally and spatially compounded event, because it was so widespread.

Imported wheat largely from France and Germany, and they may experience similar conditions, so import prices could be high in future similar events.

Rainfall Amount  
% of 1961-1990 Average



Mean temperature (°C)  
1961 – 1990 Anomaly

# Examples of compound events impacting UK agriculture

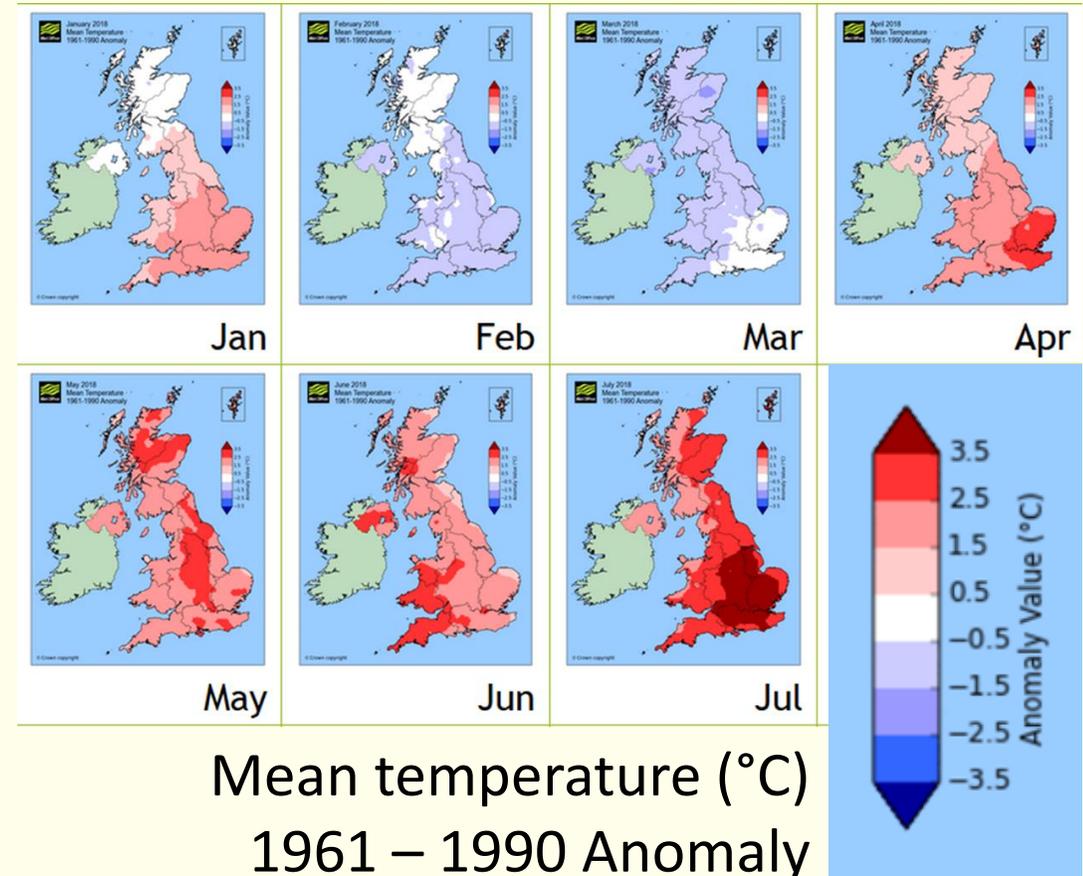
## Preconditioning

Hot dry summer in 2018 was preceded by a cold wet spring.

## Impact

Livestock were kept inside for longer during the cold spring, requiring more food. It became too hot for them in the summer, so they were moved back inside after only a short period grazing outside.

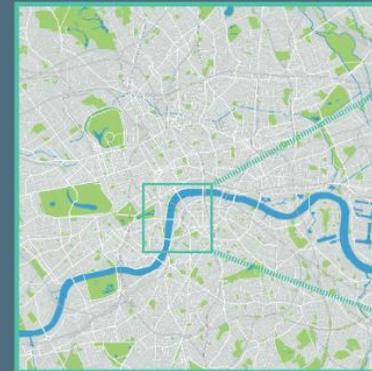
Therefore, their feed (hay and silage) was in short supply and became very expensive in parts of the country. It also exposed cattle to additional health risks.



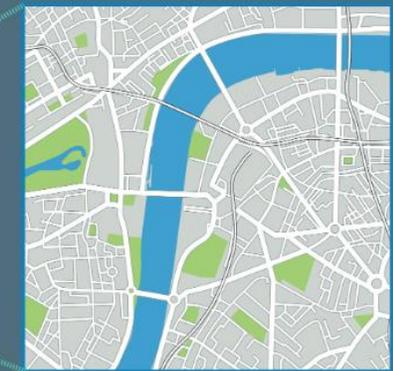
# Tool: UK Climate Projections (1980 to 2080)

- Very high spatial resolution over UK. 
- Perturbed parameter ensemble - 12 future projections of each model, assuming different but plausible climate behaviour over spatial scales below the model resolution (here 12km and 2.2km).
- Same emissions forcing in each projection (RCP 8.5 'business as usual', but emissions forcing doesn't affect projections much until you go beyond 2050).
- Other models are likely to project different magnitudes of trends to any of the simulations here (all 12 projections are using the same model – HadGEM3 GC3.05 ).

12 km model grid

London area covered  
by 12 km grid box

2.2 km model grid

London area covered  
by 2.2 km grid box

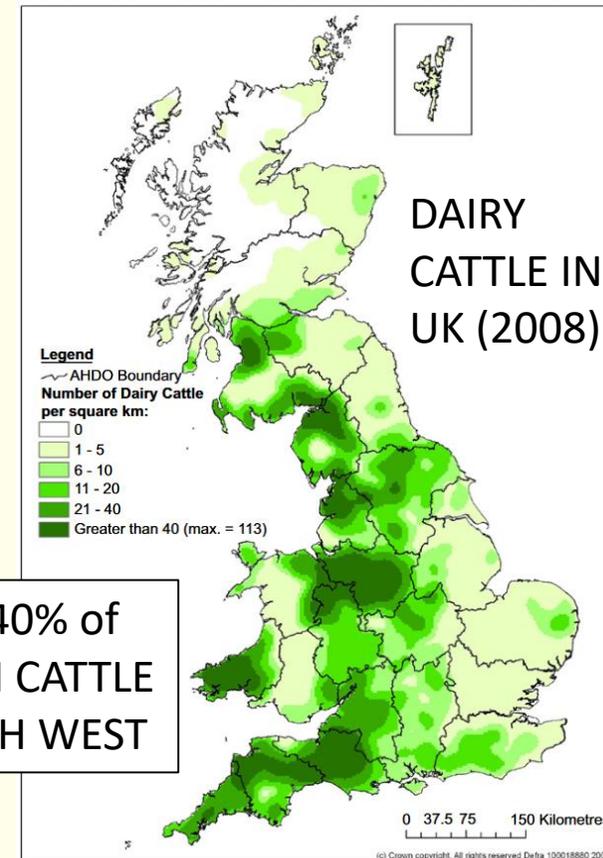
# Future compound events using UK Climate Projections

- Look at how hazard and risk of compound events changes over time in UK Climate Projections Perturbed Parameter Ensemble

## Example case study:

Dairy cattle susceptible to heat-stress due to **high temperature** and **relative humidity** (Johnson et al. 1963) leading to reduced weight gain, decreased fertility and milk yield. Follows work by Dunn et al. (2014), where thermal heat index is calculated using:

$$THI = (1.8T + 32) - (0.55 - 0.0055RH) \times (T - 26.8)$$

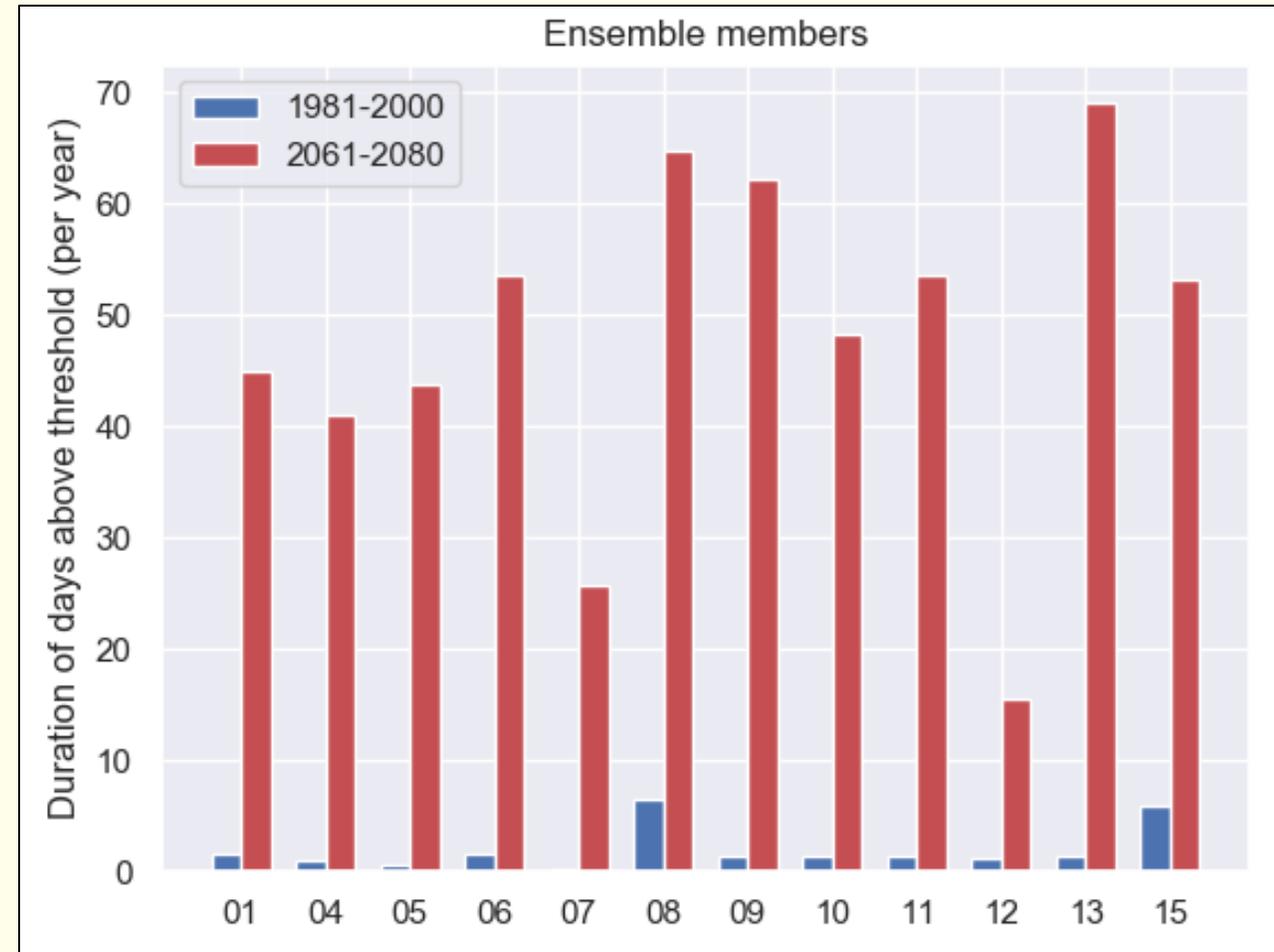


## Example: risk of stress to dairy cattle in South West England

We show duration (days/year) above the threshold of stress (70) for all the 12 km ensemble members.

Suggests that there are likely to be many more days where cattle are stressed during 2061-2080 than during 1981-2000 in South West England (as a regional average).

Range of ensemble members reveals inherent uncertainty due to model parameters.



# Hazard to Risk

- As well as characterising future changes to compound hazards, we aim to combine this information with exposure and vulnerability generate risk projections where possible.
- We are using a case study approach to study compound hazards.
- We are trying to work with stakeholders as much as possible, to ensure our work is useful and useable.
- We hope that our projections will be used in decision making for UK climate adaptation.

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