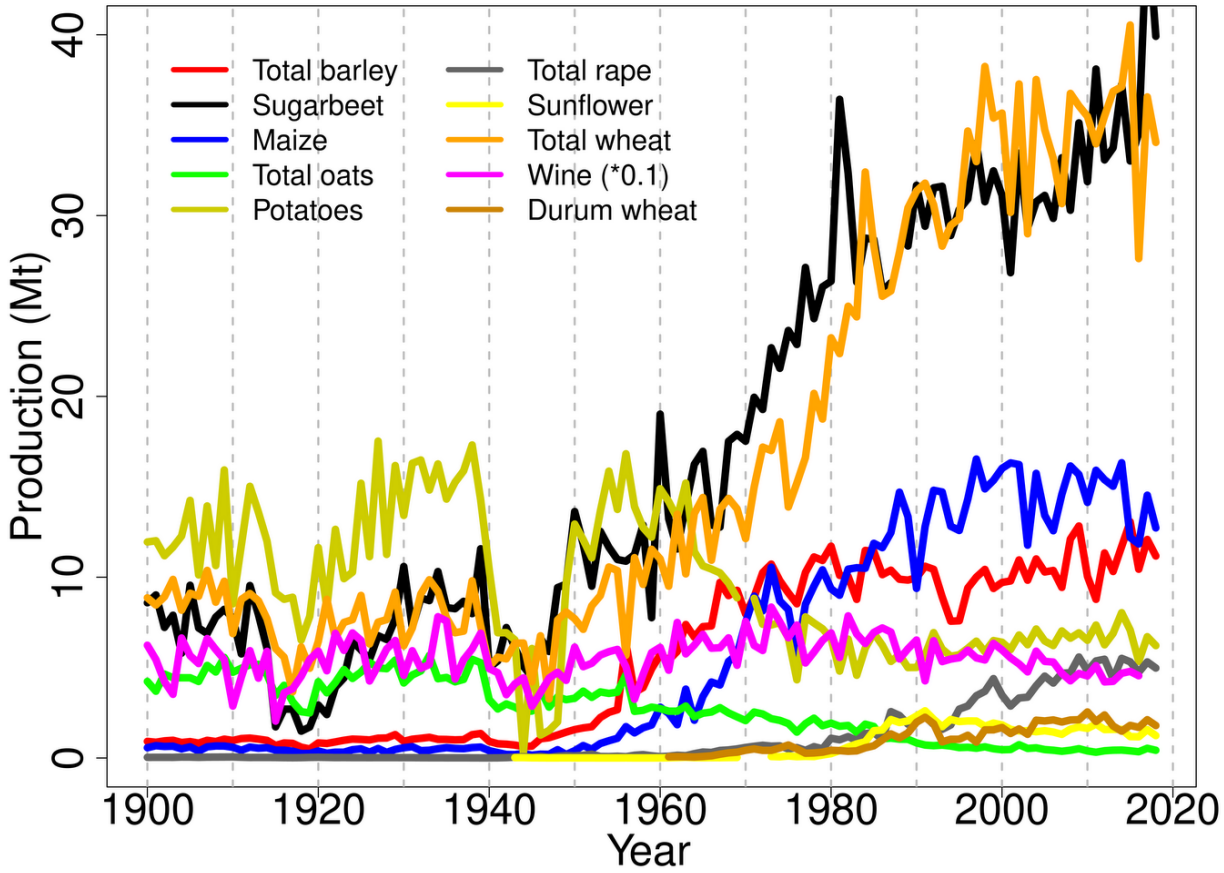
The decreasing vulnerability of French crop production to climatic hazards

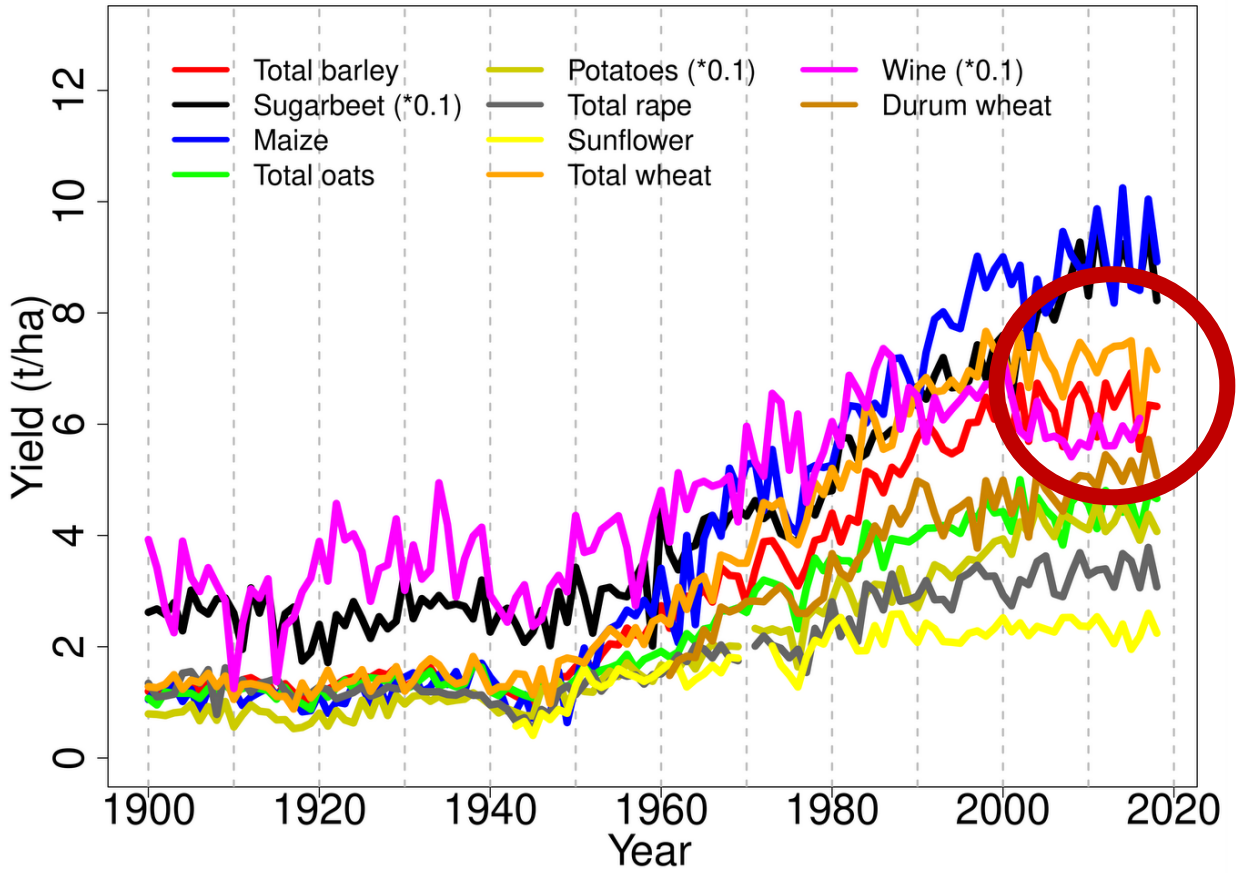
EGU 2022, Session NH1.7

Bernhard Schauberger, David Makowski, Tamara Ben-Ari, Julien Boé, Philippe Ciais
University of Applied Sciences Weihenstephan-Triesdorf &
Potsdam-Institute for Climate Impact Research (PIK)
bernhard.schauberger@hswt.de; schauber@pik-potsdam.de

French crops – a story of performance and stagnation

French agriculture has strongly increased production and yield since 1900

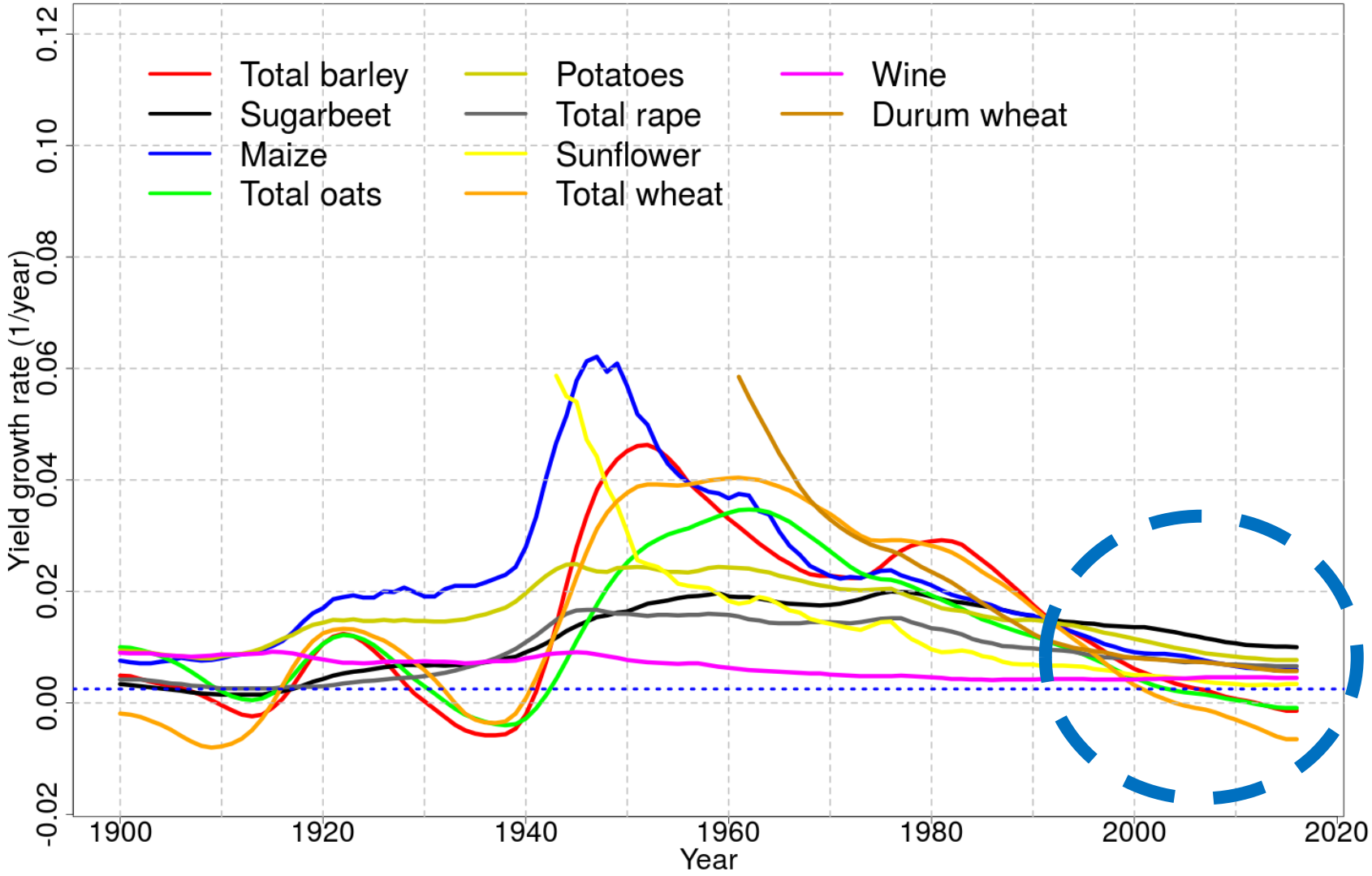




The graphs show the increase of production (*left*) and yield (*right*) for France since 1900, for ten different staple crops. Some are scaled to fit. There was a very clear increase in both production and yield, particularly after 1950.

Schauberger et al., Scientific Reports (2018)

Yet, some crop yields in France have recently been stagnating

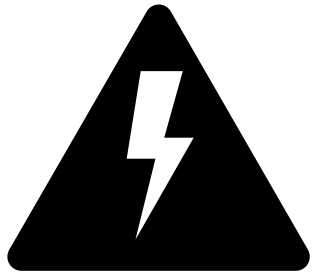


The plot shows annual **yield growth rates** of major French crops from 1900 to 2016. Growth rates recently became negative for some crops, particularly wheat.

Could this be due to **adverse climate conditions?**

To approach the problem, we used a rich data base of French agriculture and a vulnerability concept.

How we measured crop vulnerability



We studied whether the vulnerability of crops to climate hazards has changed

Vulnerability := [Exposure to hazards] o [Sensitivity to hazards] o [Adaptive capacity]

(IPCC 2014)

The frequency how often a crop experiences dangerous climate regimes

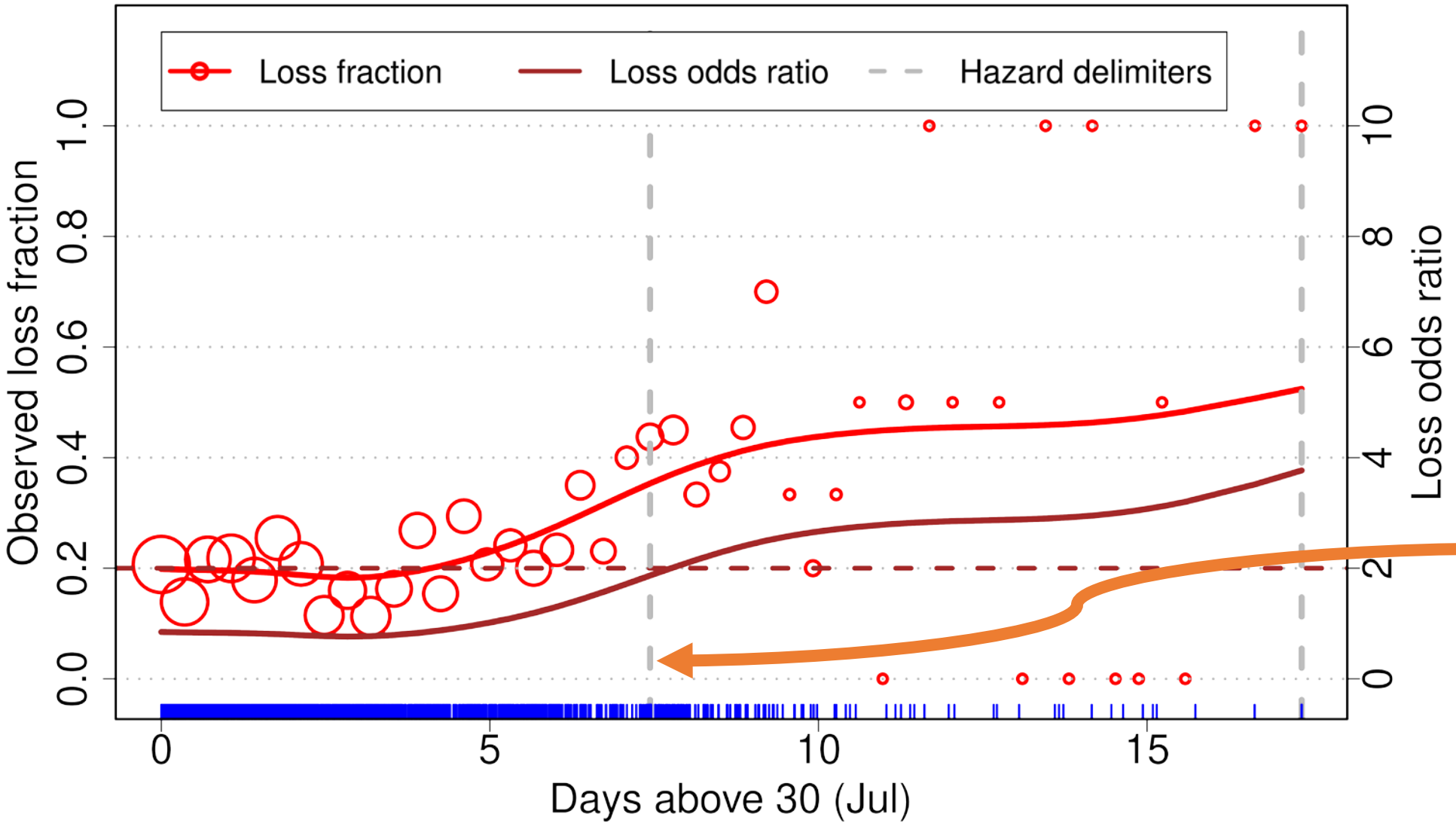
The yield loss when a dangerous climate regime occurs

The long-term capacity of farmers to implement counter-measures

[not considered here]

We defined the vulnerability as the exposure-weighted yield loss in % of expected yield.

We derived yield hazards based on relevant weather variables

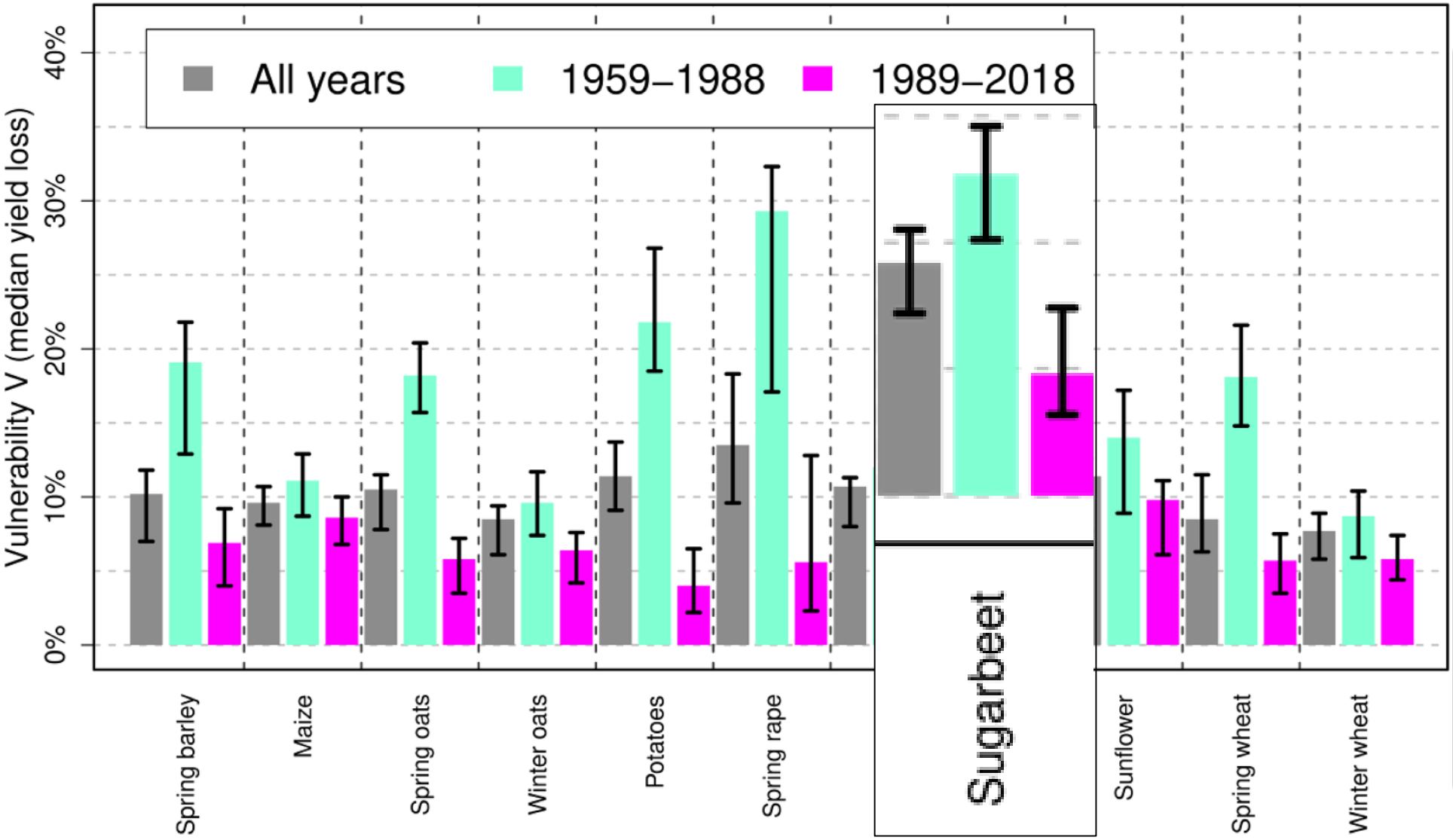


The graph shows the fraction of crop losses for spring wheat (*y-axis*; at least 10% below trend) vs. the number of days above 30°C in July (*x-axis*).

The gray dashed line marks a hazardous threshold: *"more than 7.4 days above 30°C in June double the chance for yield losses"*.

We found that...

Crop vulnerability to climate hazards has substantially decreased since 1958

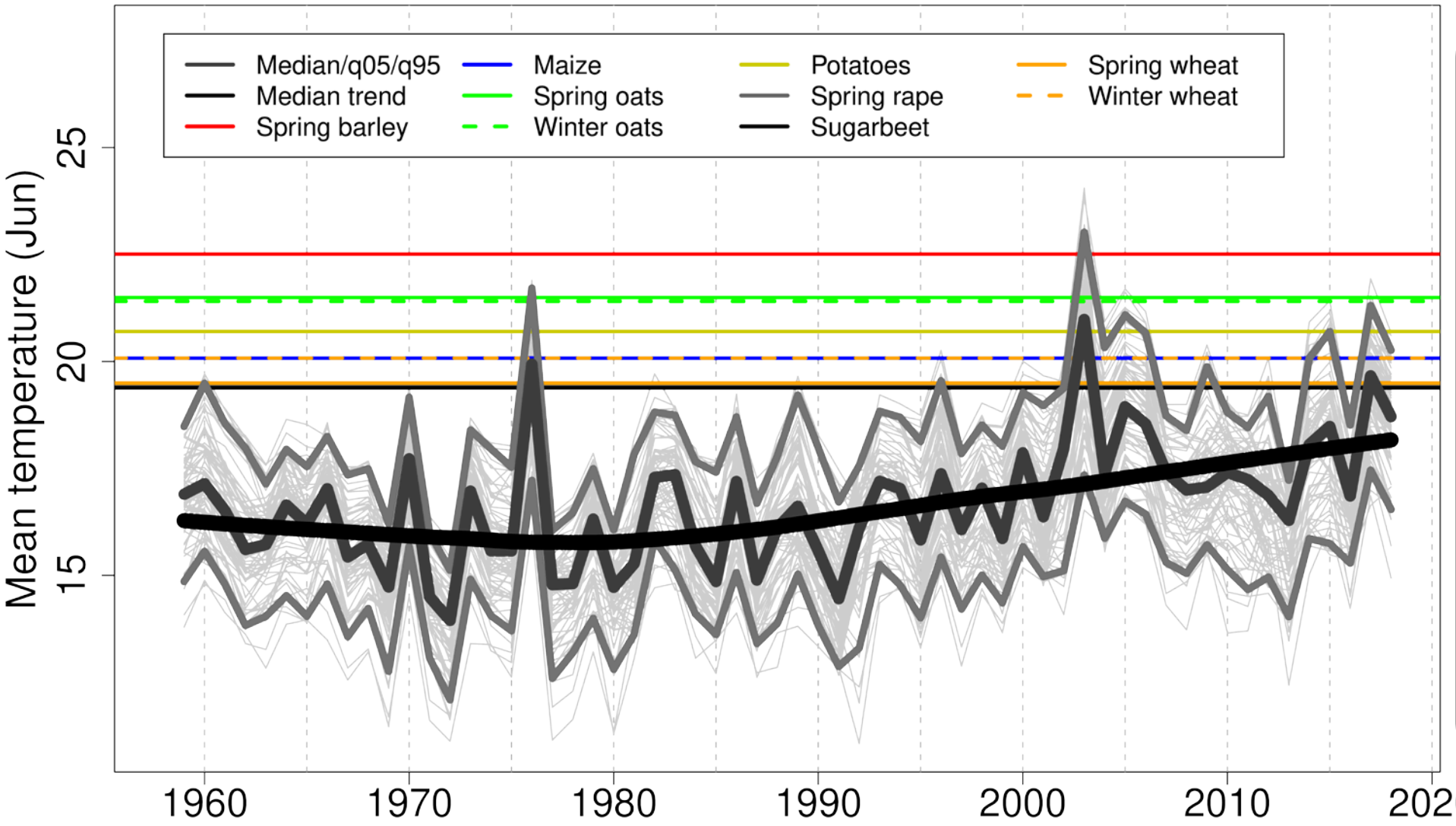


The graph shows the vulnerability of crop production to weather hazards for three time frames: 1959-2018, 1959-1988 and 1989-2018.

Black lines denote bootstrapped uncertainty.

Vulnerability has not increased for any of the crops, but rather **decreased for many**.

But yield-reducing hazards are rising



The graph shows trends in mean temperature in June. The coloured lines represent hazard thresholds for different crops.

Light grey lines denote the trajectories for individual departments. Darker shades of grey indicate the 5%, 50% and 95% quantiles. The solid bold black line is the smoothed trend.

A rise in June temperature is apparent, and consequently a more frequent crossing of hazardous thresholds.

Compound hazards can be particularly damaging for crops

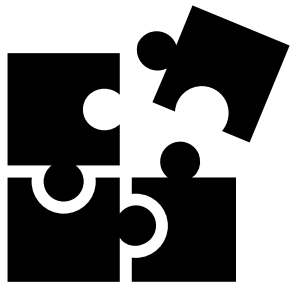
The example of spring barley shows that compound extremes – i.e. occurring at the same place in the same season – can be particularly damaging for crops, as the observed yield declines show.

Spring barley in France is usually sown in May and harvested in September. It is a major crop, grown on more than 500 kha.

Weather index	**Yield losses**
Too many days above 30°C in June	-19%
Too many days above 30°C in July	-9%
Mean temperature in June too high	-17%
Precipitation in May too high	-8%
Precipitation in May too low	-7%

Weather indices combined (i.e. compound)	**Yield losses**
June & July too hot	**-22%**
July too hot & May too wet	**-46%**
June too hot & May too dry	**-34%**

Conclusion



French yields have gained stability – but the future is not the past

French crops have strongly risen since 1900, and particularly so since 1950. Yet recent years show stagnating yields for several key crops like wheat.

More adverse climate conditions could be one possible reason.

We tested this hypothesis of climate-driven stagnation with a vulnerability framework.

Our results point to the opposite, that climate vulnerability of crops has strongly decreased since the 1960s.

Yet this is no wild card for the future, as some climate-related hazards are on the rise.

Compound extremes, moreover, may cause severe losses of yields already today.

Literature and image references

Literature references

- Schauberger B, Makowski D, Ben-Ari T, Boé J, Ciais P: No historical evidence for increased vulnerability of French crop production to climatic hazards. **Agricultural & Forest Meteorology** (2021)
- Schauberger B*, Kato H*, Kato T, Watanabe D, Ciais P: French crop yield, area and production data for ten staple crops from 1900 to 2018 at county resolution. **Scientific Data** (2022)
  - *shared first authorship
  - Accompanying data set at GFZ Data Services: https://doi.org/10.5880/PIK.2021.001
- Schauberger B., Ben-Ari T., Makowski D., Kato T., Kato H., Ciais P.: Yield trends, variability and stagnation analysis of major crops in France over more than a century. **Scientific Reports** (Nov 2018)

Image sources

- http://www.photo-paysage.com/displayimage.php?album=65&pid=4261
- https://get.pxhere.com/photo/landscape-nature-plant-field-barley-wheat-prairie-summer-france-food-crop-pasture-agriculture-plain-cereal-fields-grassland-rye-epi-cereals-cultures-flowering-plant-commodity-triticale-wheat-fields-ear-of-corn-grass-family-land-plant-food-grain-589160.jpg