Impacts of climate change on global food trade networks

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Background

Higher temperatures will significantly modify crop production

(Parry et al 2004, Wheeler and Braun 2013, Bezner Kerr et al 2022).

Acceleration in countries’ dependence on overseas trade for food supply

(D’Odorico et al 2014, Janssens et al 2020)

Countries’ reliance on global food trade networks implies that climate change impacts on crop yields will be transmitted across borders

(Adams et al., 2022)
Food trade networks – what are systemic effects?

Wheat

Rice

Maize

Adams et al., 2021
Research design

Research question
How may trade patterns between countries be disrupted and reoriented under potential long-term climate change impacts on food production?

Data
• FAO production and bilateral trade data for wheat, rice and maize (corrected for re-exports)
• ISIMIP simulation phase 3b for climate impacts on crop production (five global climate models + five global gridded crop models) (RCP 8.5, 2070–2099)

Methods
• Network modelling: community detection (network communities)
• Network modelling: functional cartography (network roles)
• Distribution of impacts on combined supply (domestic production + imports) within communities
Minimal model of trade networks

a) Present-day network

b) Climate-projected network
Reoriented trade communities

5(a) Maize trade communities in 2018

5(b) Climate-projected maize trade communities (2070-2099)
More distributed trade by large producers

8(a) Present-day maize trade roles \( z = 1 \)

8(b) Climate-projected maize trade roles \( z = 1 \)

Role
- Ultra peripheral non-hub
- Peripheral non-hub
- Connector non-hub
- Kinless non-hub
- Large hub
- Provincial hub
- Regional hub
- Connector hub
- Kinless hub

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### Disruptions to combined supply

#### Table 1. (Continued.)

| Trade community | Community production—present-day climate conditions (tonnes) | Community production as % of world production | Climate-projected community production (tonnes) and change compared to present-day | Climate-projected total import (tonnes) and change compared to present-day | Total climate-induced change in production plus import |
|------------------|-------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------------------------------------------------------|
| 1                | 83,554,440                                                 | 7%                                           | 64,155,333                                                                 | 20,721,181                                                                      | −23%                                                  |
| 2                | 453,883,616                                                | 40%                                          | 340,857,118                                                                 | 61,495,385                                                                     | −25%                                                  |
| 3                | 192,959,809                                                | 17%                                          | 163,405,845                                                                 | 47,328,308                                                                     | −15%                                                  |
| 4                | 394,390,952                                                | 34%                                          | 330,618,348                                                                 | 40,392,955                                                                     | −16%                                                  |
| 5                | 197,570,003                                                | 2%                                           | 193,646,669                                                                 | 824,322                                                                        | −2%                                                   |
| 6                | 224,491                                                    | <1%                                          | 187,669                                                                     | 55,790                                                                         | −16%                                                  |
| TOTAL            | 1,146,791,311                                              | 100.0%                                       | 920,278,982                                                                 | 152,168,941                                                                    | −20%                                                  |
Conclusions

A country’s future trade-linked climate exposure - a **combined effect** of domestic yield change and the balance of production loss or gain among trade partners

**Few countries may be able to buffer production loss** with imports from existing, close trade partners if maintaining current consumption levels, especially for maize.

Trade as an adaptation mechanism may be **more viable for wheat and rice** than it is for maize.

Cross-border climate impacts likely to have disruptions on **national and global food supply**.
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