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The U.S. Government's Global Hunger & Food Security Initiative

Aflatoxins and Climate Change:
Preliminary Results from a New Biophysical Model for Groundnuts and Selected FTF Countries

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BASIC INFORMATION ON AFLATOXINS

- Aflatoxins are fungal metabolites mainly produced by Aspergillus flavus and Aspergillus parasiticus
- Regarding groundnuts, Sanders et al. (1985) reported that the best conditions for pre-harvest contamination of aflatoxins is 20 to 30 days of drought stress with soil temperatures between 28 and 30.5^{0}C
- In addition to dryness and heat, insect damage also causes higher levels of contamination

WHY WE CARE ABOUT AFLATOXINS

- Aflatoxin exposure has been associated with childhood stunting, and that is associated with vulnerability to infectious diseases and cognitive impairment lasting beyond childhood
- High levels of aflatoxin contamination effect animal health, growth, and productivity
- Aflatoxin contamination keeps African farmers from exporting to the United States and Europe
- Aflatoxins are not destroyed in cooking processes or milk treatment processes

WHY WE CARE ABOUT AFLATOXINS - 2

- They contaminate foods (maize, groundnuts, and others) that make up a large percentage of a typical African diet
- They increase the rate of liver cancer
- High levels of contamination have led to aflatoxin poisoning, which often causes death

WHAT OUR AFLATOXIN WORK IS TRYING TO DO

- IFPRI and the University of Florida are developing and testing 2 models (one for groundnuts and one for maize) which use weather to predict aflatoxin concentration levels
- In today's presentation, we focus on the groundnut model applied to Niger and Burkina Faso
- Our immediate application is to anticipate how climate change will affect aflatoxin levels
- This could potentially be developed as an early warning tool for aflatoxin outbreaks, and could be used to identify hotspots

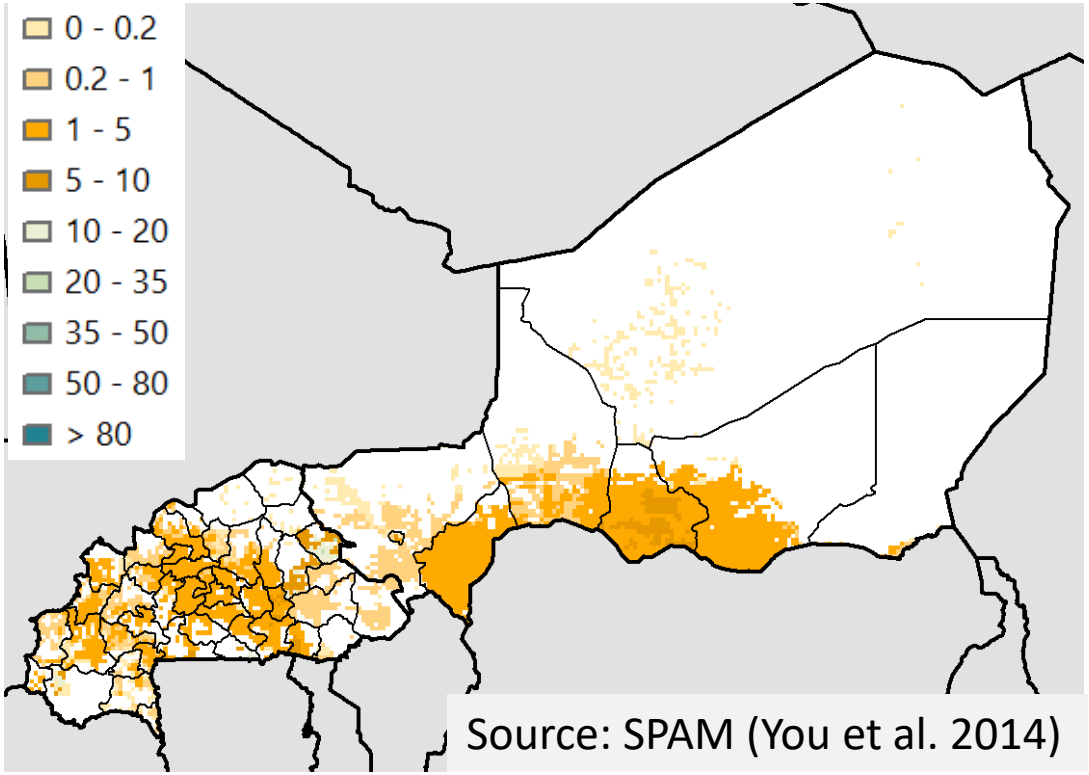
DSSAT CROP MODEL

- Simulates the growth of a given plant one day at a time
- Takes daily inputs of temperature, precipitation, and solar radiation
- Accounts for fertilizer input and farming methodologies including row spacing and plant spacing
- Keeps track of soil temperature, soil nutrients, and moisture, at multiple layers
- Determines yield as well as weight of residue portion
- Calibrated for 30 different crops

NEW AFLATOXIN MODULES INSIDE DSSAT FOR PEANUT & MAIZE ONLY

- Run seamlessly with the DSSAT model
- Outputs aflatoxin concentration and percent infection
- Peanut: Prediction of aflatoxin contamination is highly dependent on the prediction of soil temperature, crop water stress, and pod-zone soil water status
- Maize: Prediction of aflatoxin contamination is highly dependent on air temperature and predicted crop water stress.

RAINFED GROUNDNUT CONCENTRATION IN NIGER AND BURKINA FASO (PERCENT)



Source: SPAM (You et al. 2014)

PRELIMINARY RESULTS SHOWING PROBABILITY OF DANGEROUS AFLAXTOXIN CONCENTRATIONS (> 20 PPB) IN GROUNDNUTS

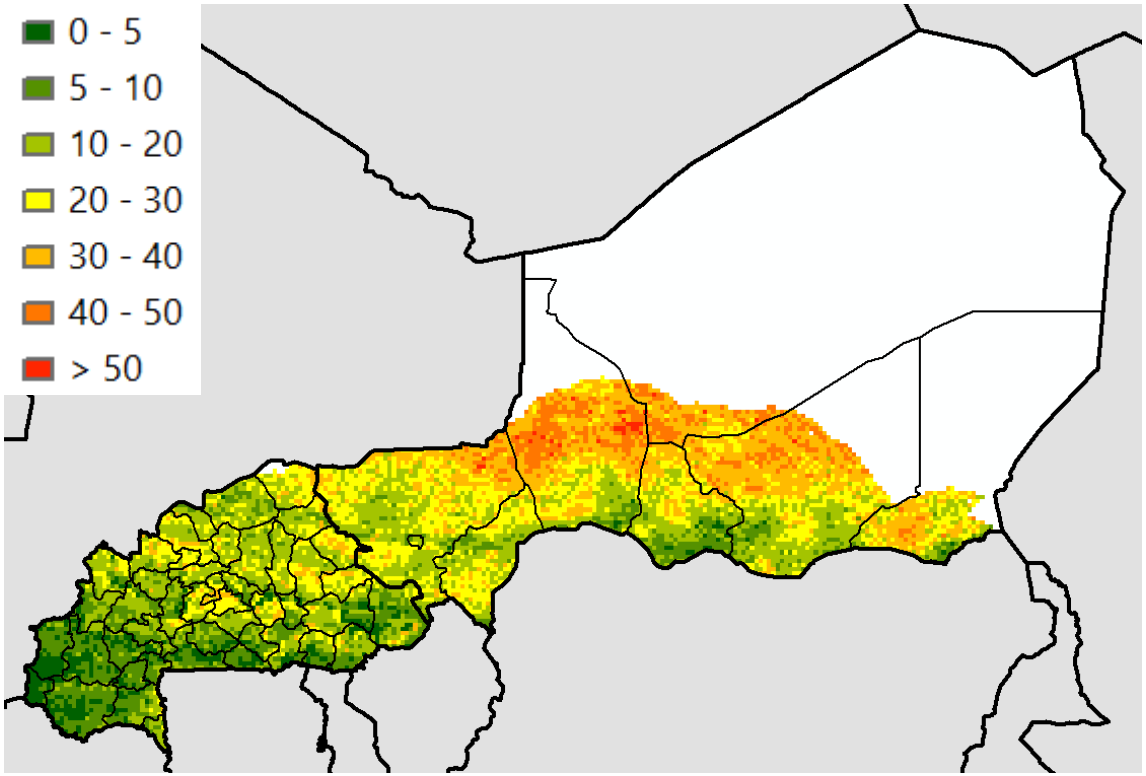
% of years and area that contamination was > 20 ppb

		2050				
Country	No climate change	GFDL	HadGEM	IPSL	MIROC	NoRESM
Burkina Faso	15.3%	27.5%	13.0%	14.1%	0.9%	11.7%
Niger	18.2%	23.0%	12.0%	8.6%	0.3%	8.5%

Source: Authors

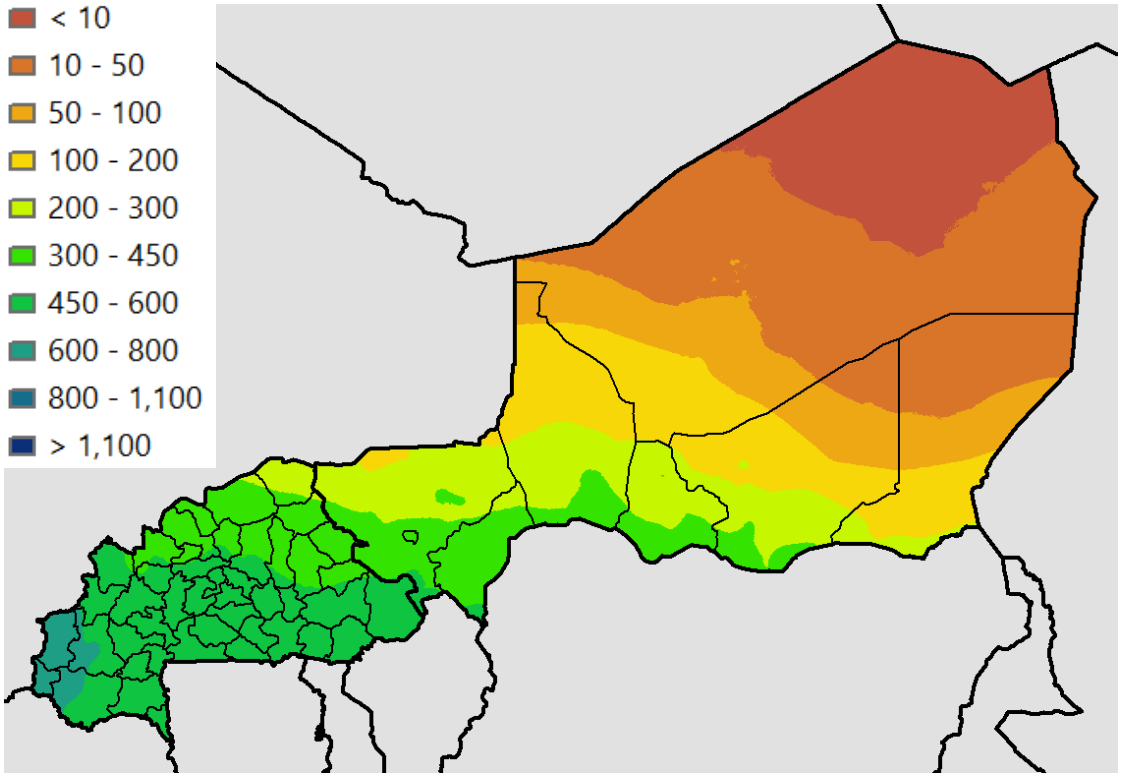
Notes: The change is from the baseline climate of 1960-1990 to the climate of 2041-2070. The base climate and the 2050s climate were simulated with 50 different weather realizations at each pixel. Aggregation was done using SPAM weighting.

PERCENT OF YEARS AFLATOXIN CONCENTRATIONS ABOVE 20PPB, 1960-1990



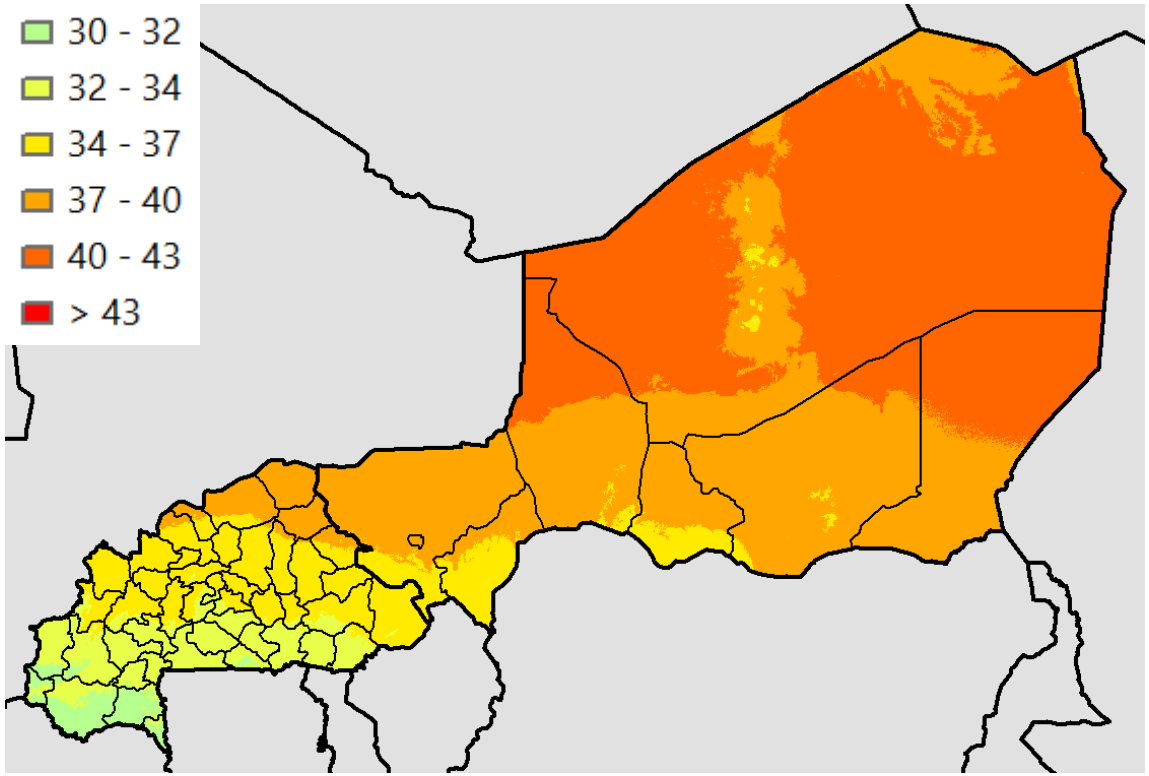
Source: Authors

PRECIPITATION IN JUNE THROUGH AUGUST, 1960-1990



Source: WorldClim 1.4.

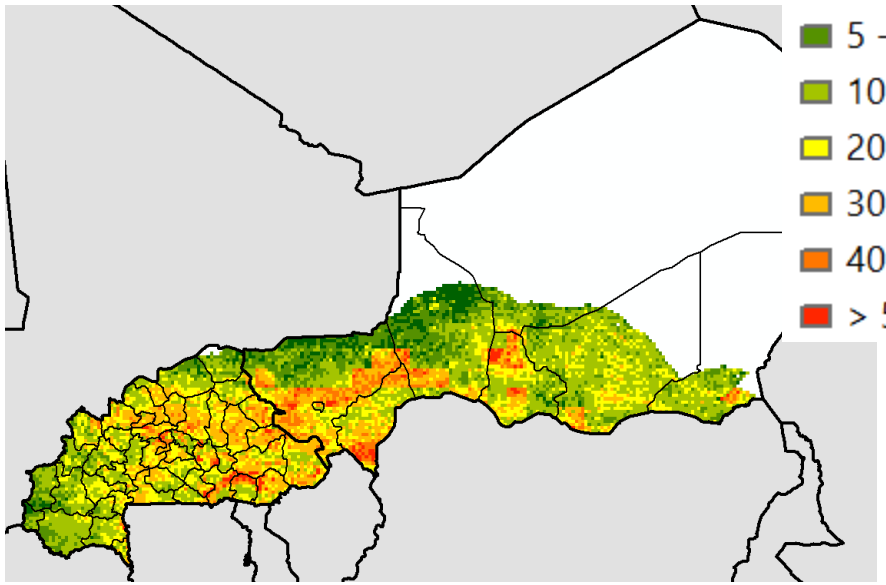
MEAN DAILY MAXIMUM TEMPERATURE IN JUNE THROUGH AUGUST, 1960-1990

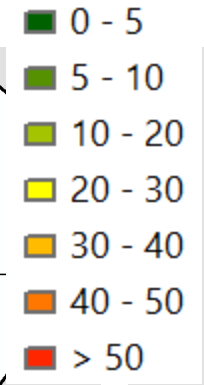


Source: WorldClim 1.4.

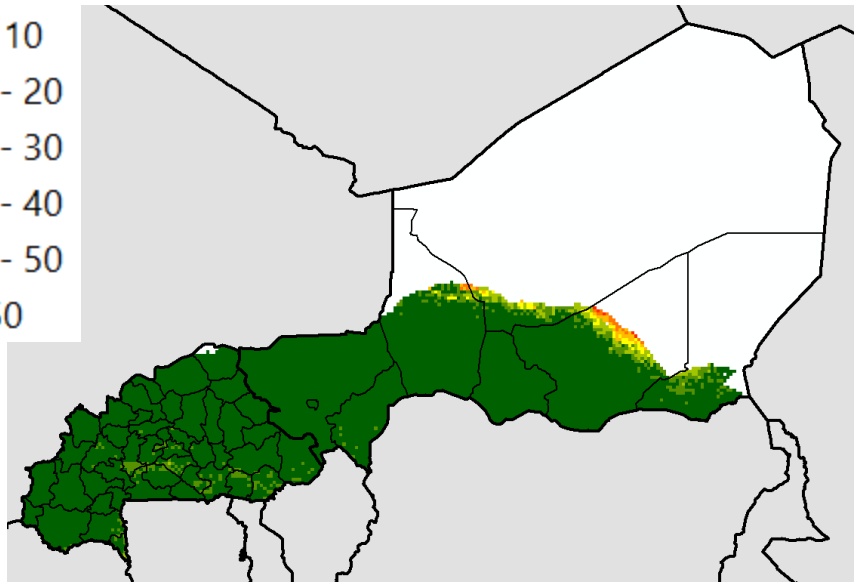
PERCENT OF YEARS AFLATOXIN CONCENTRATIONS ABOVE 20PPB, 2050

GFDL





MIROC

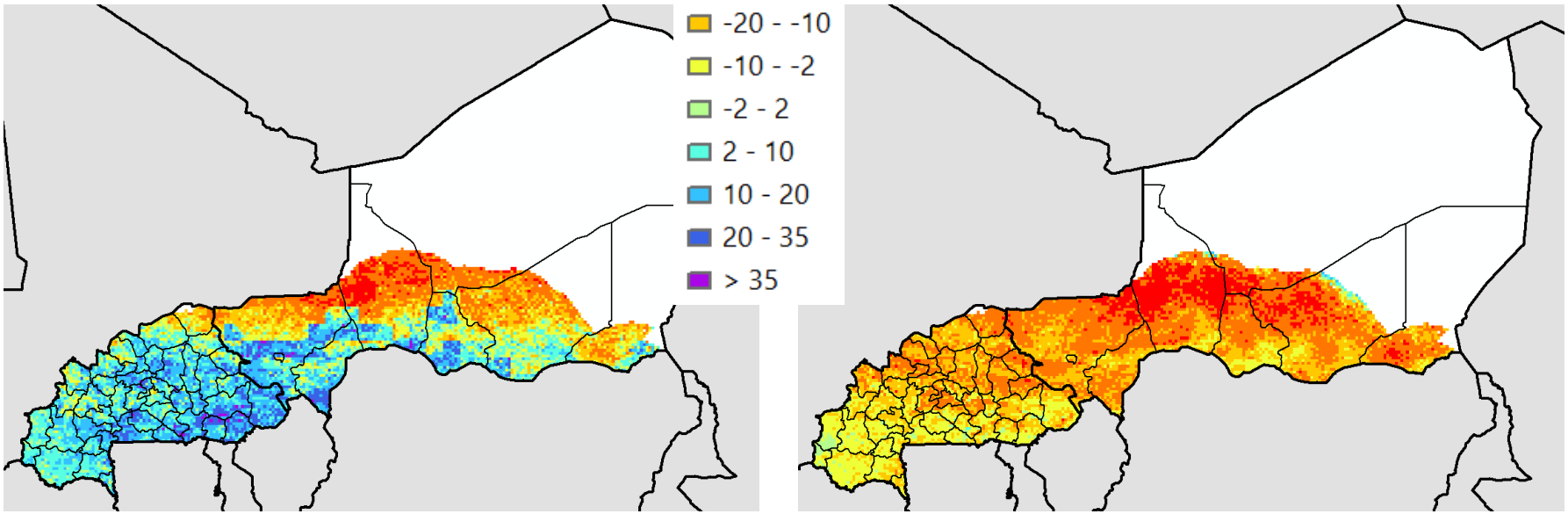


Source: Authors

CHANGE IN PERCENT OF YEARS AFLATOXIN CONCENTRATIONS ABOVE 20PPB, 2000-2050

GFDL

MIROC

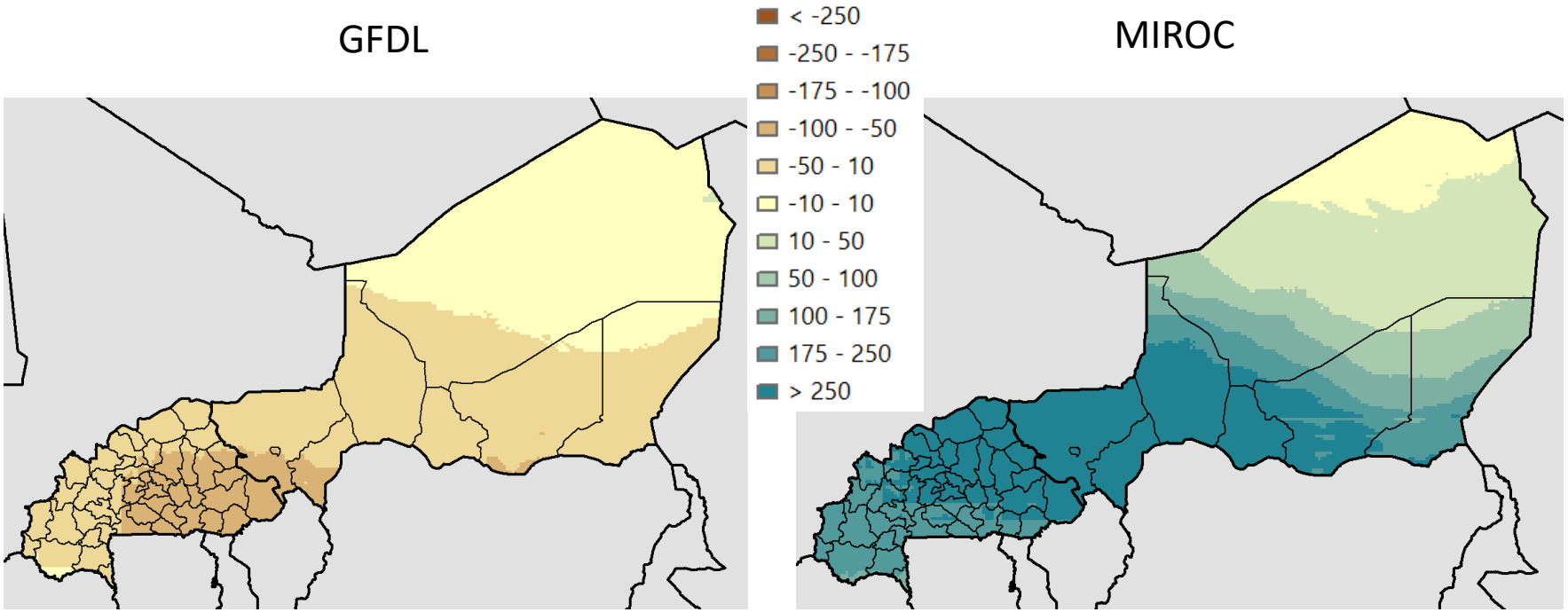


Source: Authors

CHANGES IN PRECIPITATION DUE TO CLIMATE CHANGE IN JUNE TO AUGUST

GFDL

MIROC



Source: CMIP5 data (Taylor, Stouffer, and Meehl 2012), downscaled for Müller and Robertson (2014).

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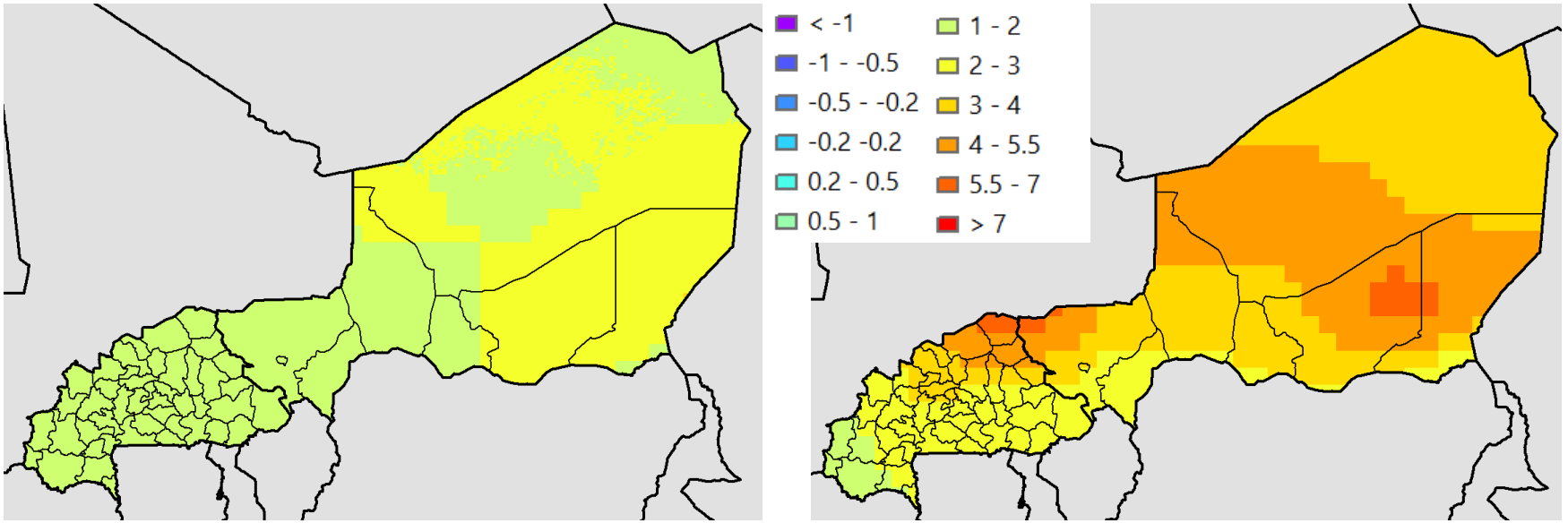
CHANGES IN DAILY MAX TEMPERATURES DUE TO CLIMATE CHANGE IN JUNE TO AUGUST

GFDL

MIROC



Source: CMIP5 data (Taylor, Stouffer, and Meehl 2012), downscaled for Müller and Robertson (2014).

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CONCLUSIONS AND NEXT STEPS

- Climate change might have vastly different effects on aflatoxin levels, with some improving and some getting worse
- Receive feedback on how this model seems to be performing and potential applications
- Compute changes by FTF Zones of Influence
- Do similar exercise for maize in these 2 countries as well as Nepal, Guatemala, and Honduras
- Seeking funding for developing use as early warning tool