Assessing Climate-Related Risks: Changes in the Mean & Variability

Paul West

CCAFS Science Meeting
Galway, Ireland, April 2017

INSTITUTE ON THE
ENVIRONMENT

University of Minnesota
Driven to Discover℠

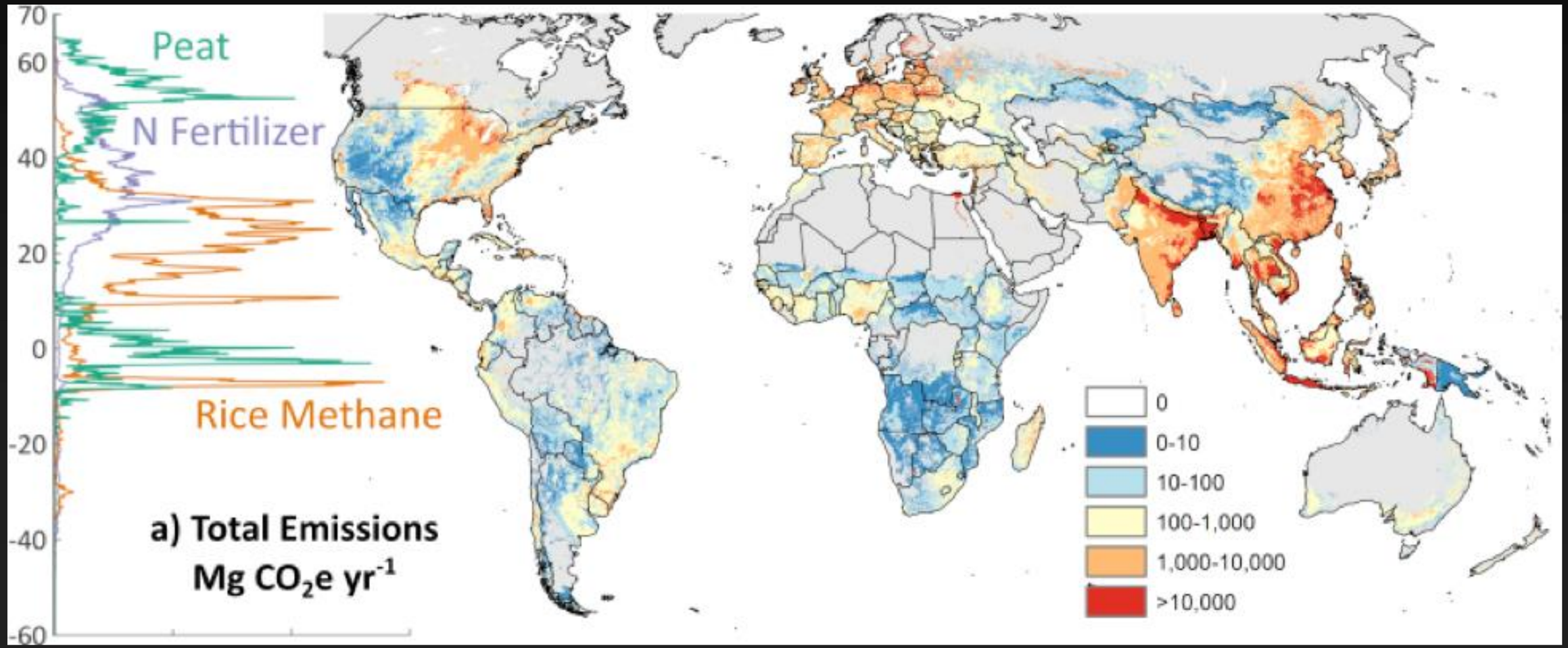
1. Estimating GHG emissions
2. Future climate change
3. Recent climate change

Agriculture = 20-30% Global GHGs

GLOBAL EMISSIONS

1945±720 Tg CO_2e yr^{-1}

50% Rice Methane
29% Peatlands
21% N Fertilizer



CARLSON ET AL 2015 *NATURE CLIMATE CHANGE*

Meeting the 2C target

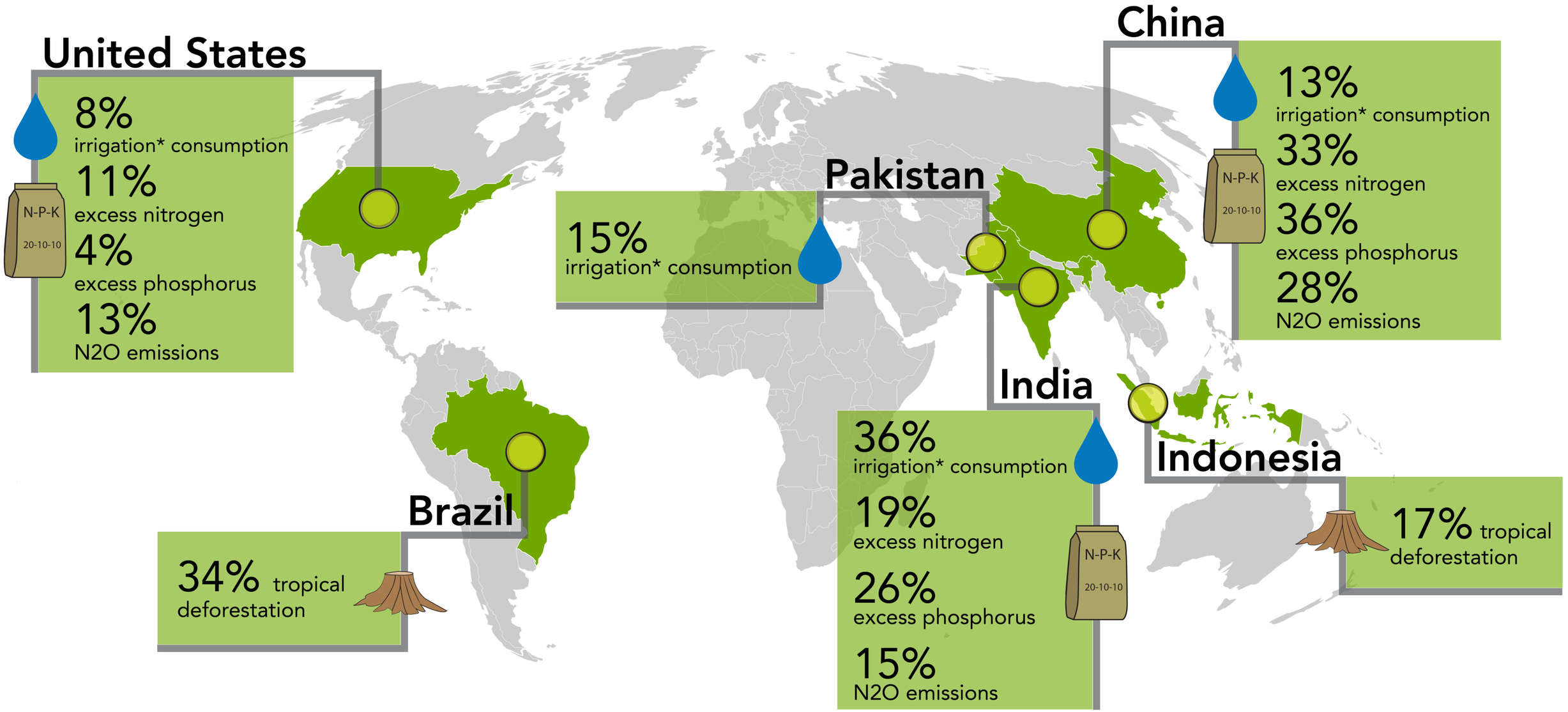
1. Reduce Energy & industry emissions by half, each decade

2. Reduce agriculture & deforestation emissions to zero by 2050

3. remove 5GT CO2 each year through negative emissions technology by 2050

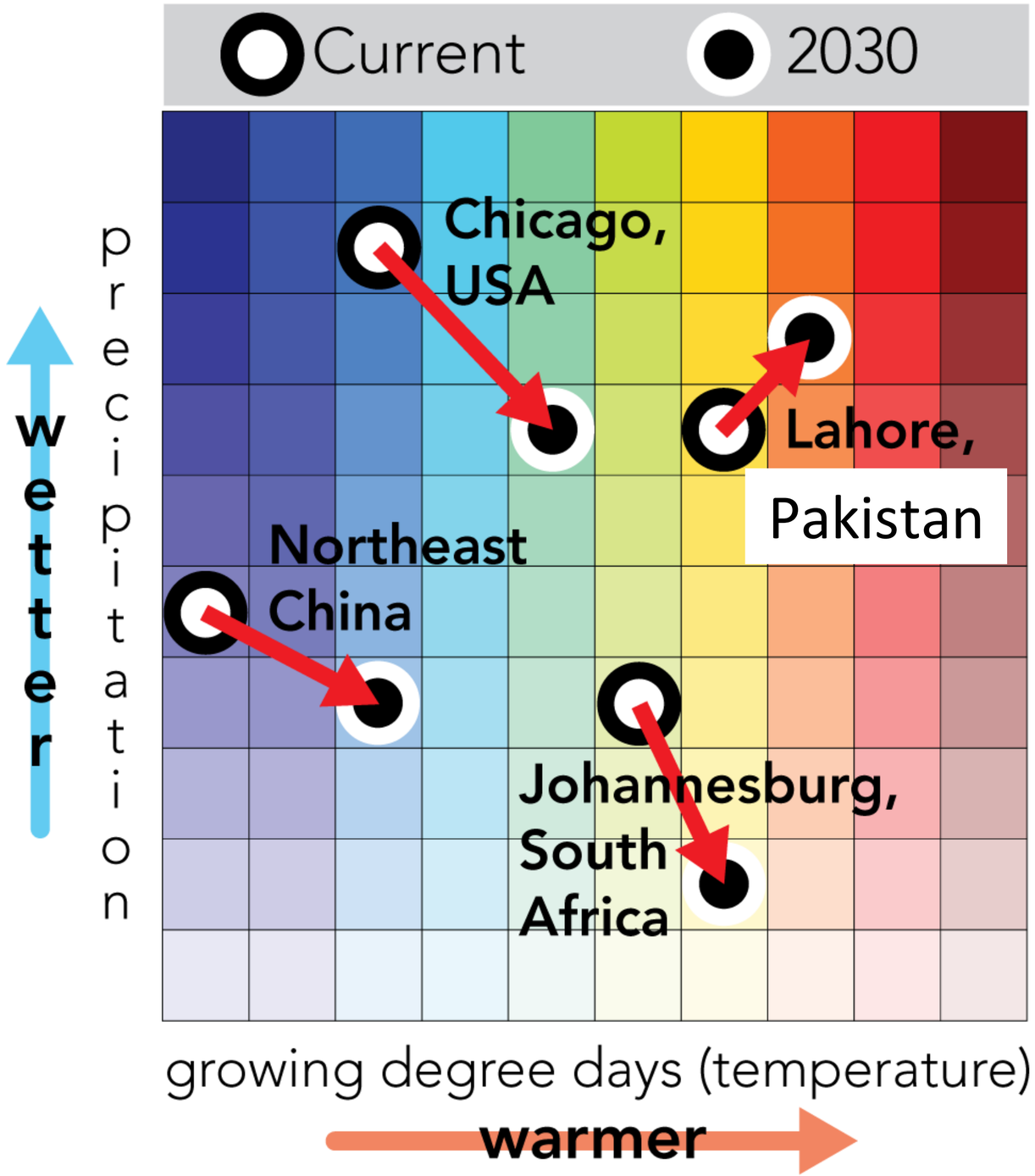
Rockstrom et al. 2017, Science

Focus on Leverage Points



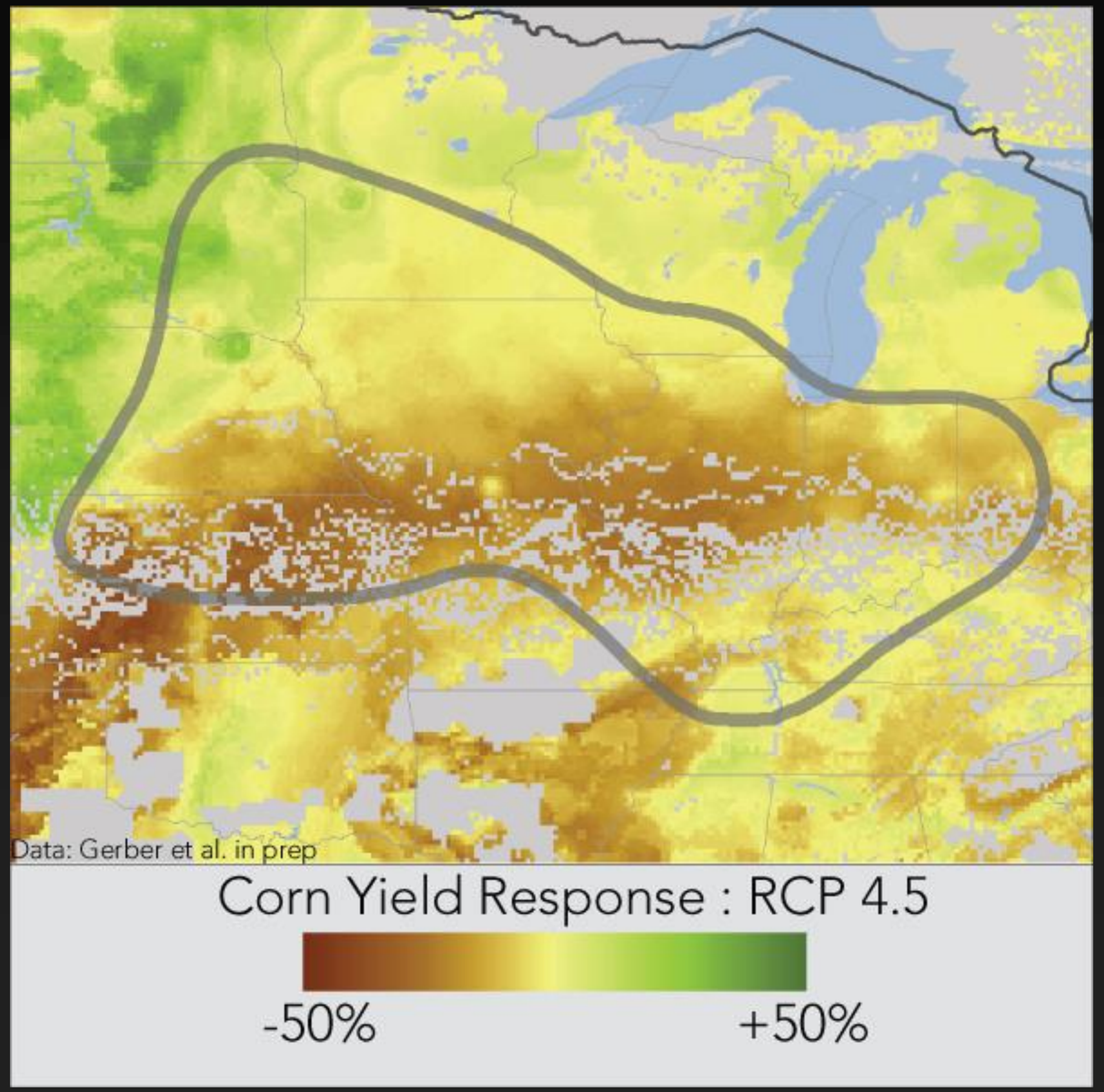
SOURCE: WEST ET AL. 2014, *SCIENCE*

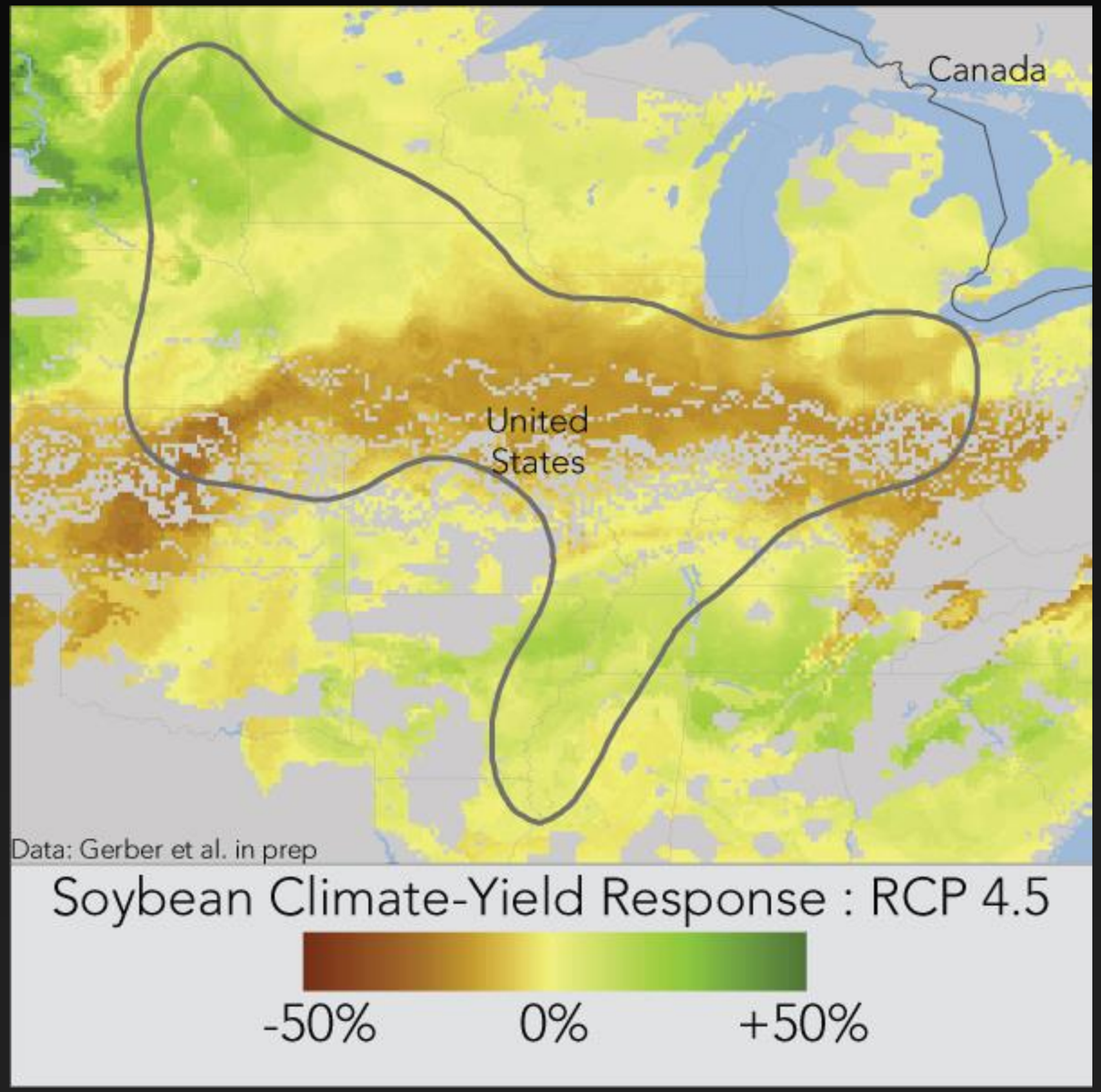
FUTURE MEAN CLIMATE



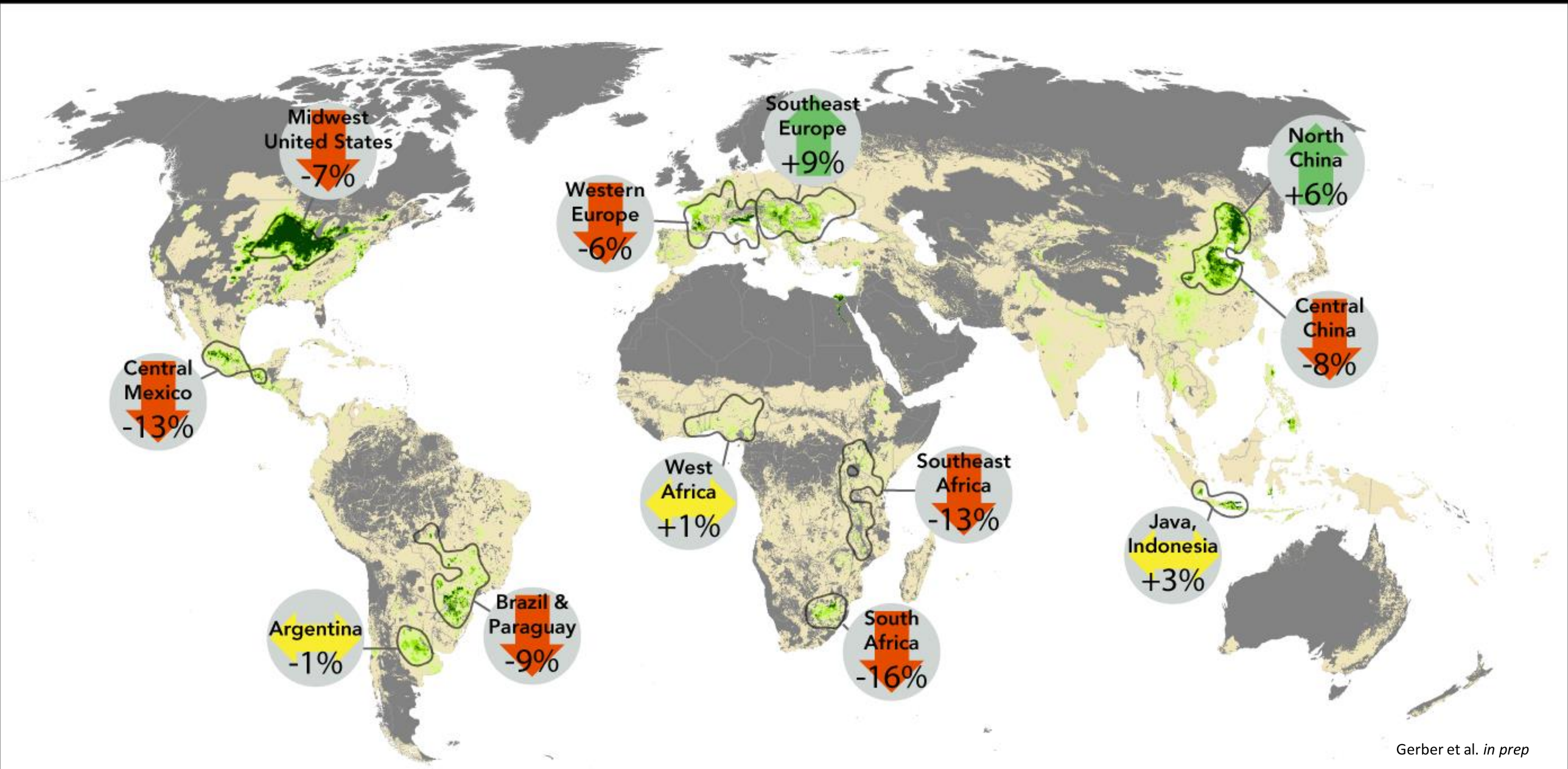
SOURCE: INSTITUTE ON THE ENVIRONMENT

Midwestern USA maize vs. soy in 2030





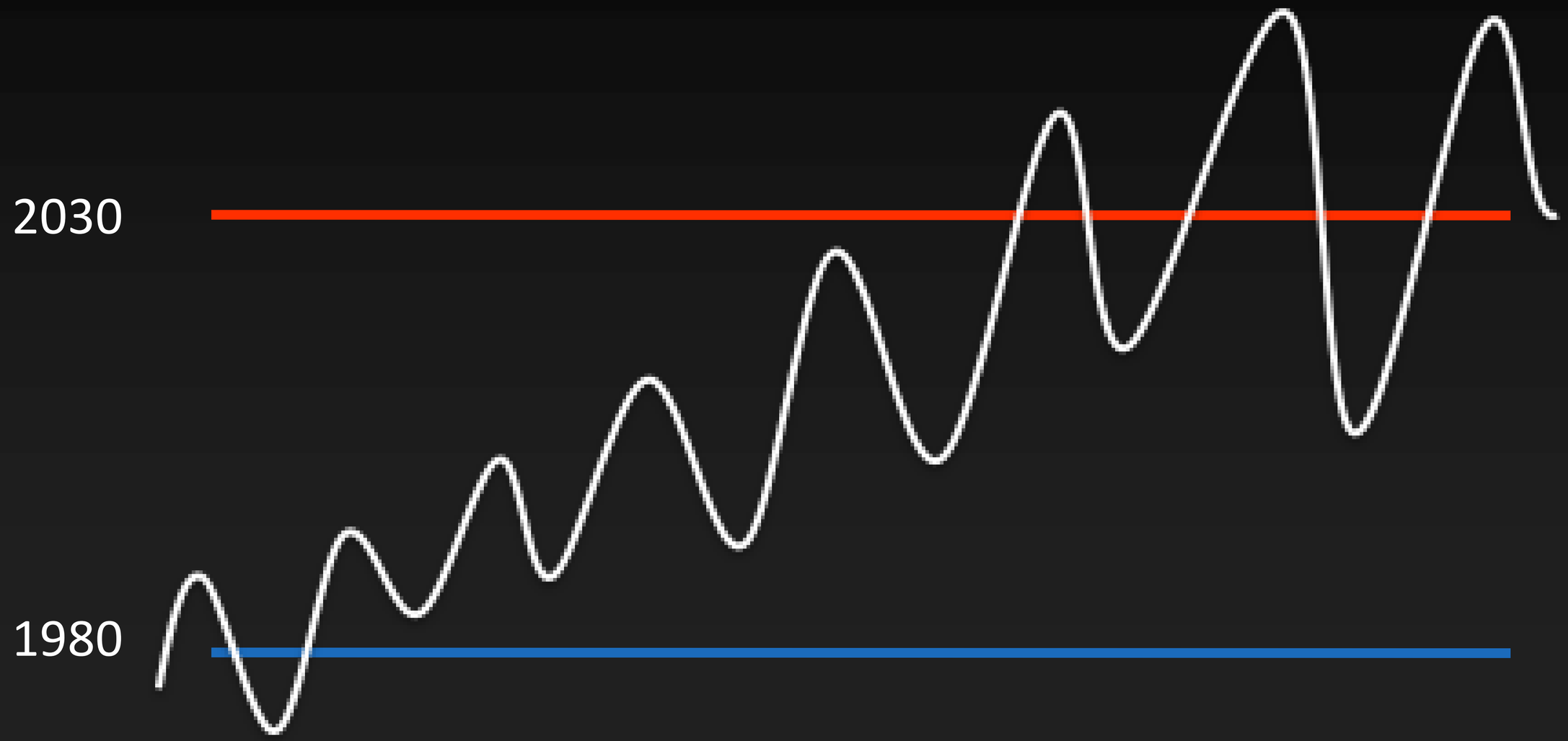
MAIZE YIELD RESPONSE TO 2030 MODERATE CLIMATE CHANGE



Gerber et al. *in prep*

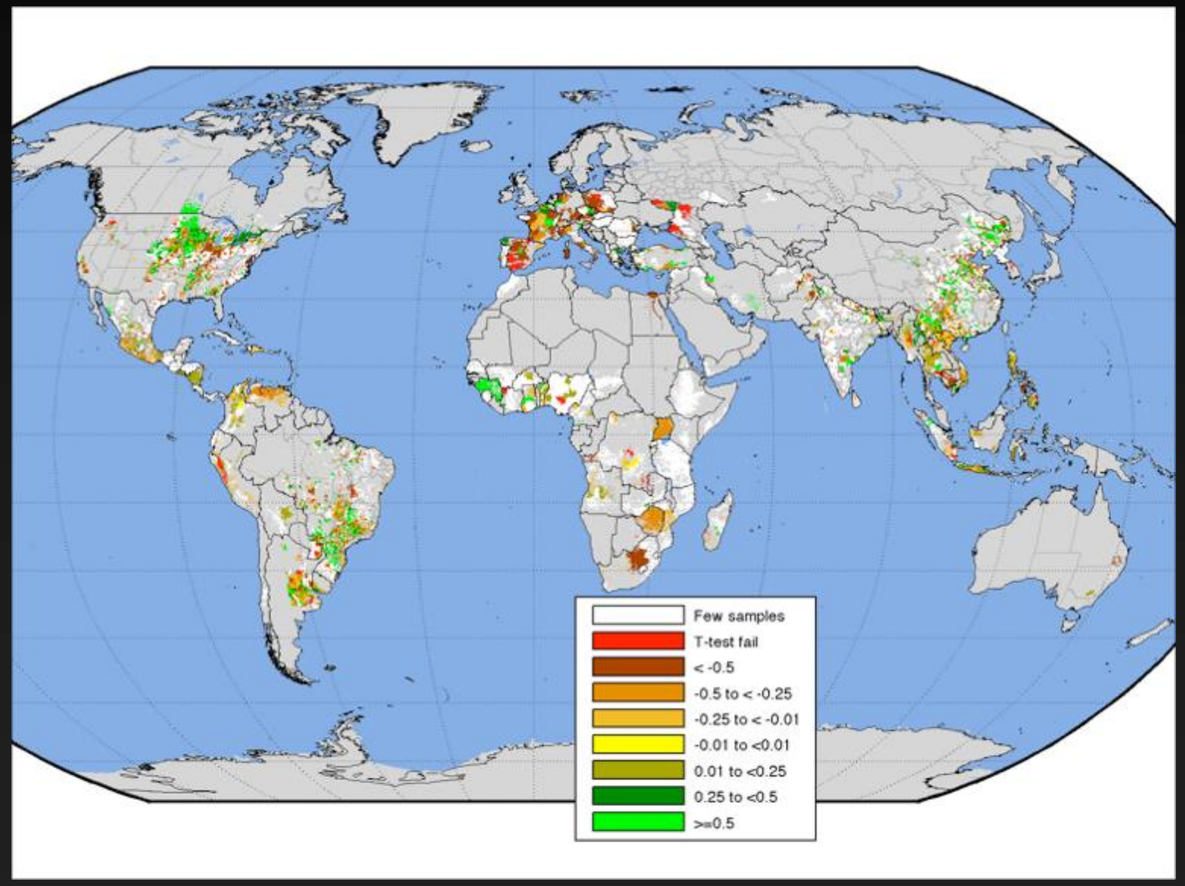
ADAPT TO WHAT?

CHANGE IN THE MEAN VS. VARIABILITY

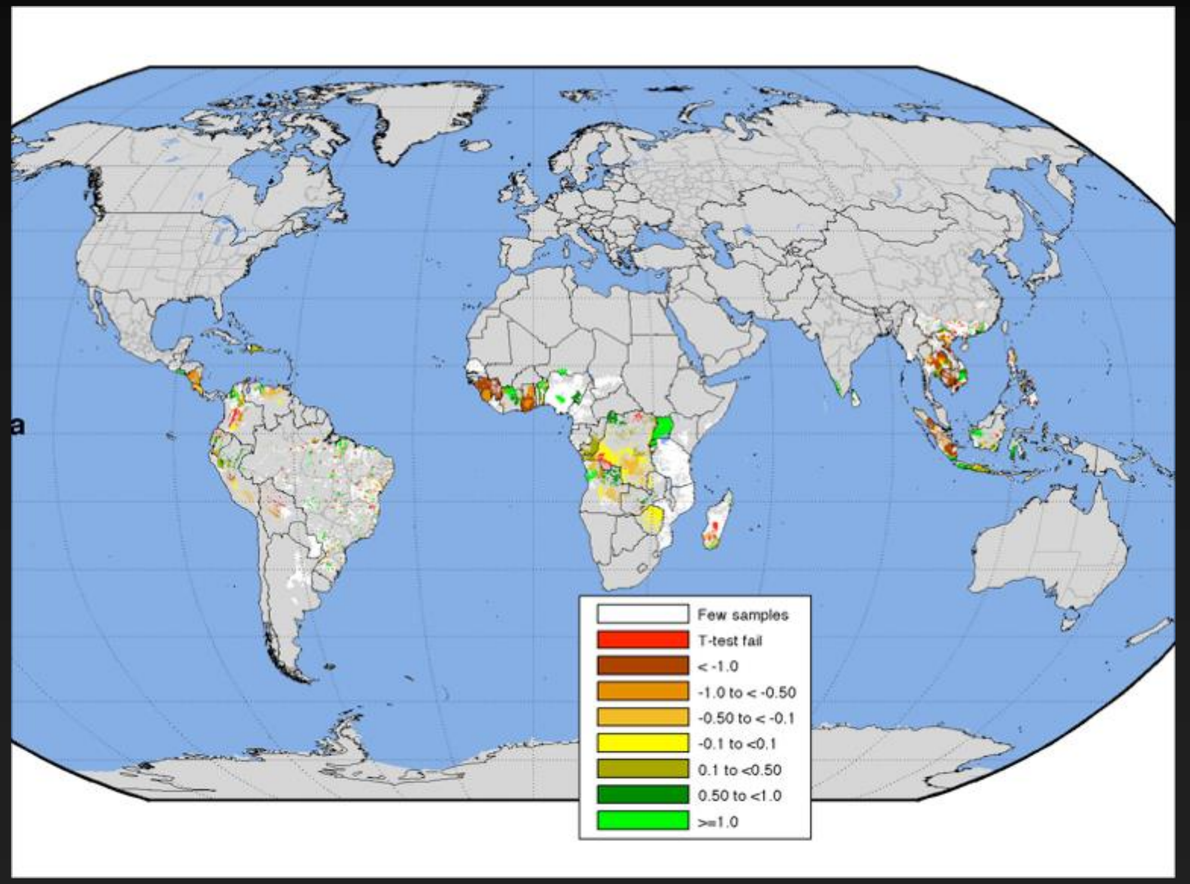


CLIMATE CHANGE(D)

IMPACTS OF CLIMATE CHANGE…THAT ALREADY HAPPENED



MAIZE



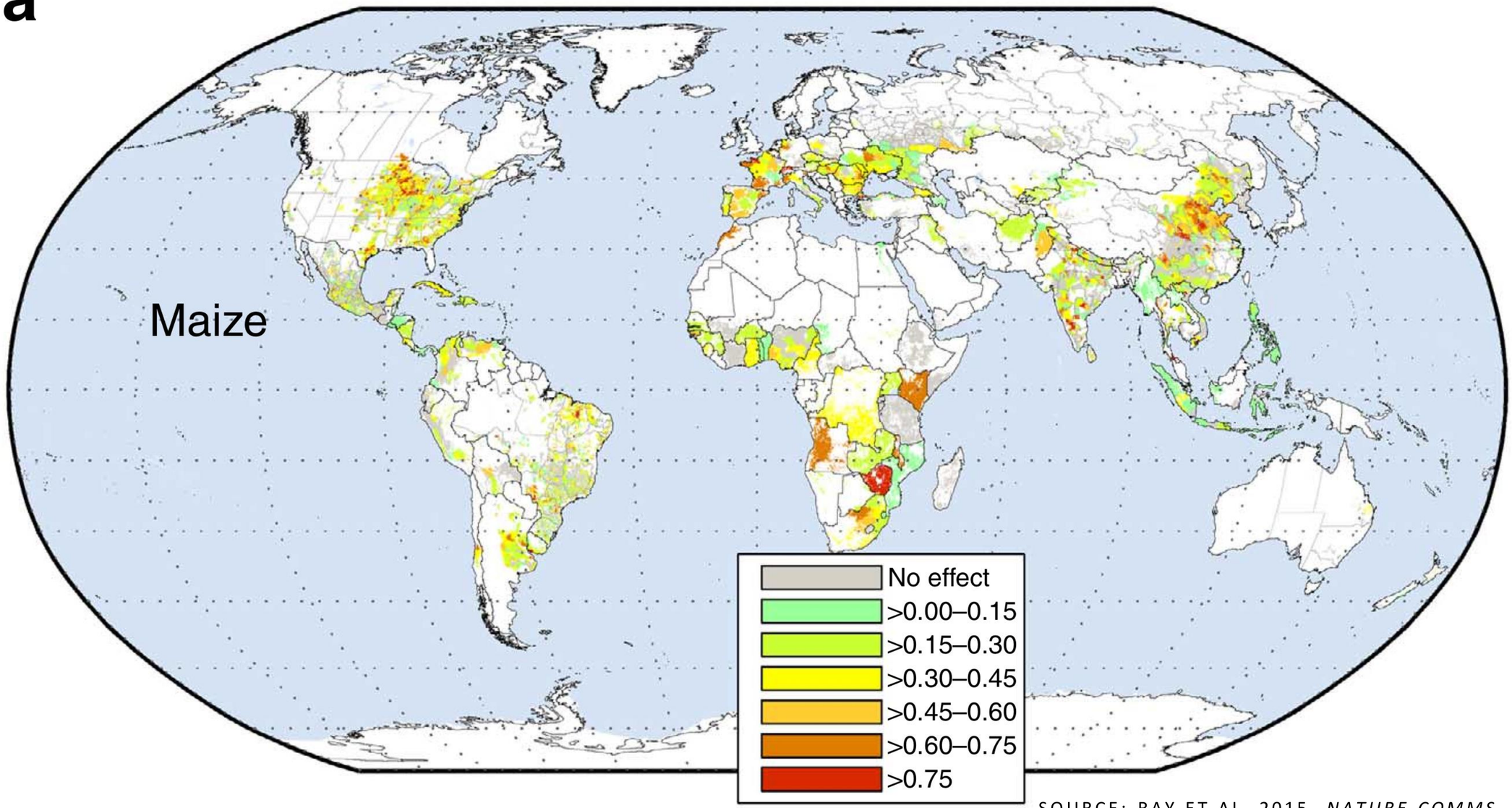
CASSAVA

+ 8 ADDITIONAL CROPS

SOURCE: RAY ET AL. *IN PREP*

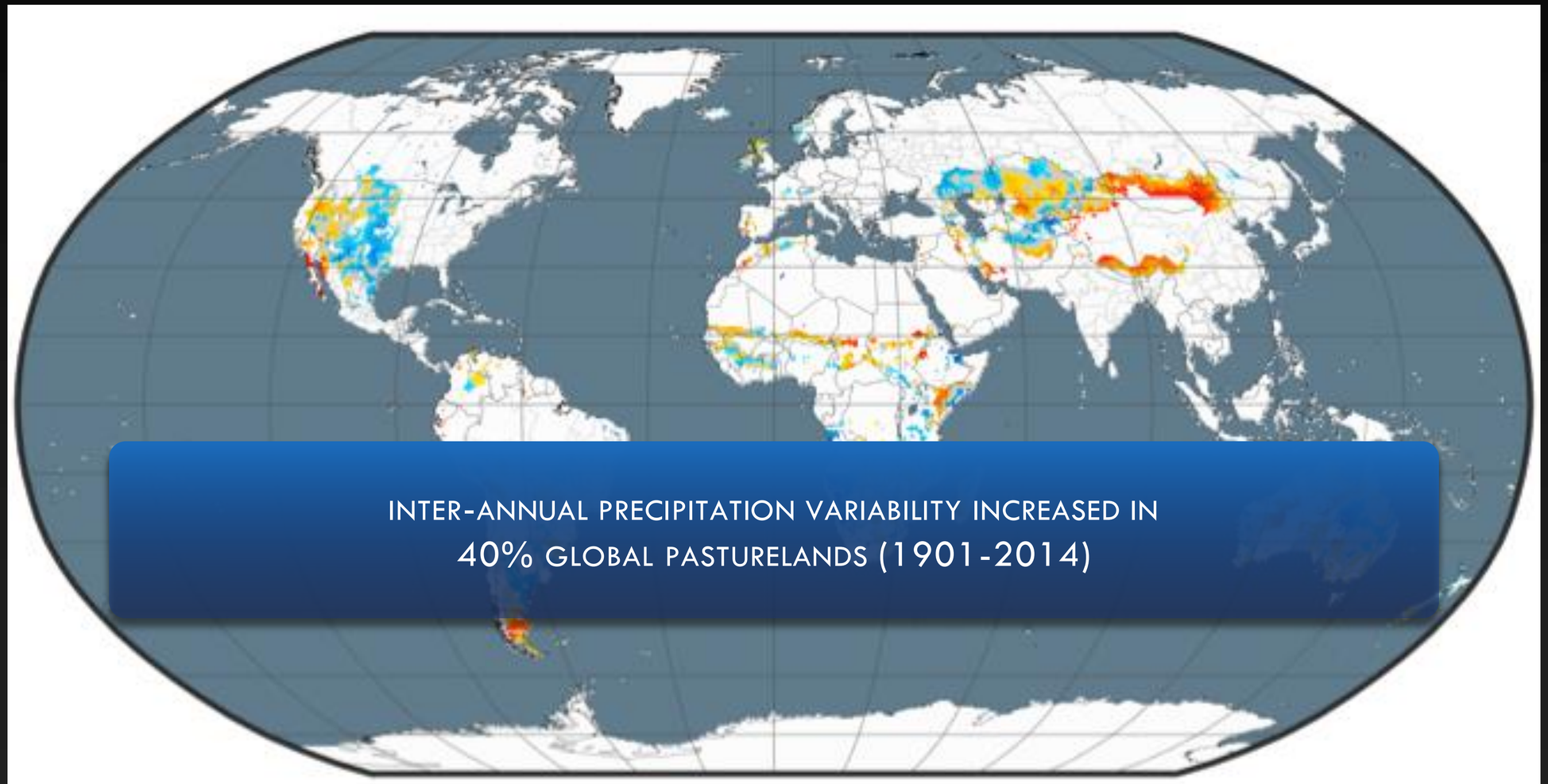
PHOTO: FLICKR.COM/CHANC
CREATIVE COMMONS V2.0, 2008

CLIMATE VARIABILITY EXPLAINS 1/3 OF YIELD VARIABILITY



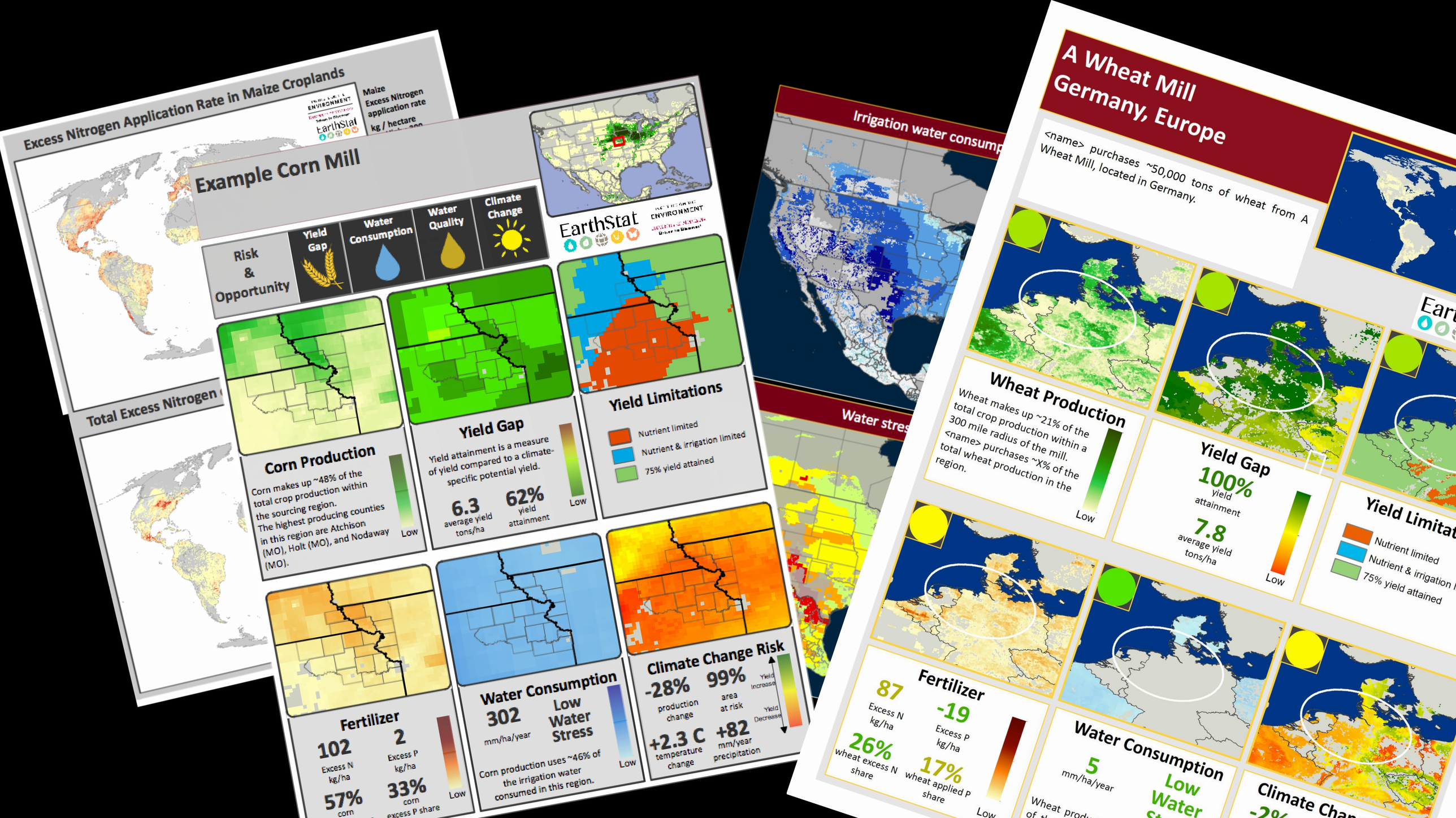
SOURCE: RAY ET AL. 2015, *NATURE COMMS.*

INTER-ANNUAL PRECIPITATION VARIABILITY



SLOAT ET AL. *IN REVISION*

Image: NASA, ASTER Science Team


Excess Nitrogen Application Rate in Maize Croplands
Maize Excess Nitrogen application rate kg / hectare
Total Excess Nitrogen
Example Corn Mill
Risk & Opportunity
Yield Gap
Water Consumption
Water Quality
Climate Change
EarthStat
Corn Production
Corn makes up ~48% of the total crop production within the sourcing region. The highest producing counties in this region are Atchison (MO), Holt (MO), and Nodaway (MO).
Low
Yield Gap
Yield attainment is a measure of yield compared to a climate-specific potential yield.
6.3
average yield tons/ha
62%
yield attainment
Low
Yield Limitations
Nutrient limited
Nutrient & irrigation limited
75% yield attained
Fertilizer
102
Excess N kg/ha
2
Excess P kg/ha
57%
corn
33%
corn
Low
Water Consumption
302
mm/ha/year
Low Water Stress
Corn production uses ~46% of the irrigation water consumed in this region.
Low
Climate Change Risk
-28%
production change
99%
area at risk
Yield Increase
Yield Decrease
+2.3 C
temperature change
+82
mm/year precipitation
Irrigation water consump
Water stres
A Wheat Mill
Germany, Europe
<name> purchases ~50,000 tons of wheat from A Wheat Mill, located in Germany.
Wheat Production
Wheat makes up ~21% of the total crop production within a 300 mile radius of the mill. <name> purchases ~X% of the total wheat production in the region.
Low
Yield Gap
100%
yield attainment
7.8
average yield tons/ha
Low
Yield Limitat
Nutrient limited
Nutrient & irrigation
75% yield attained
Fertilizer
87
Excess N kg/ha
-19
Excess P kg/ha
26%
wheat excess N share
17%
wheat applied P share
Low
Water Consumption
5
mm/ha/year
Low Water
Wheat produ
Climate Chan
-2%

How Does Agriculture Change Our Climate?

Continue reading

Thank You

Paul West

INSTITUTE ON THE
ENVIRONMENT

University of Minnesota
Driven to Discover℠