Foresight, Climate Change and Agrifood Systems

IFPRI-CGIAR's modeling of climate risks and impacts

James Thurlow, Faaiqa Hartley, and others
CGIAR Foresight Initiative
IFPRI Foresight and Policy Modeling Unit

IFPRI Site Visit
AIM4C, Washington DC
9 May 2023

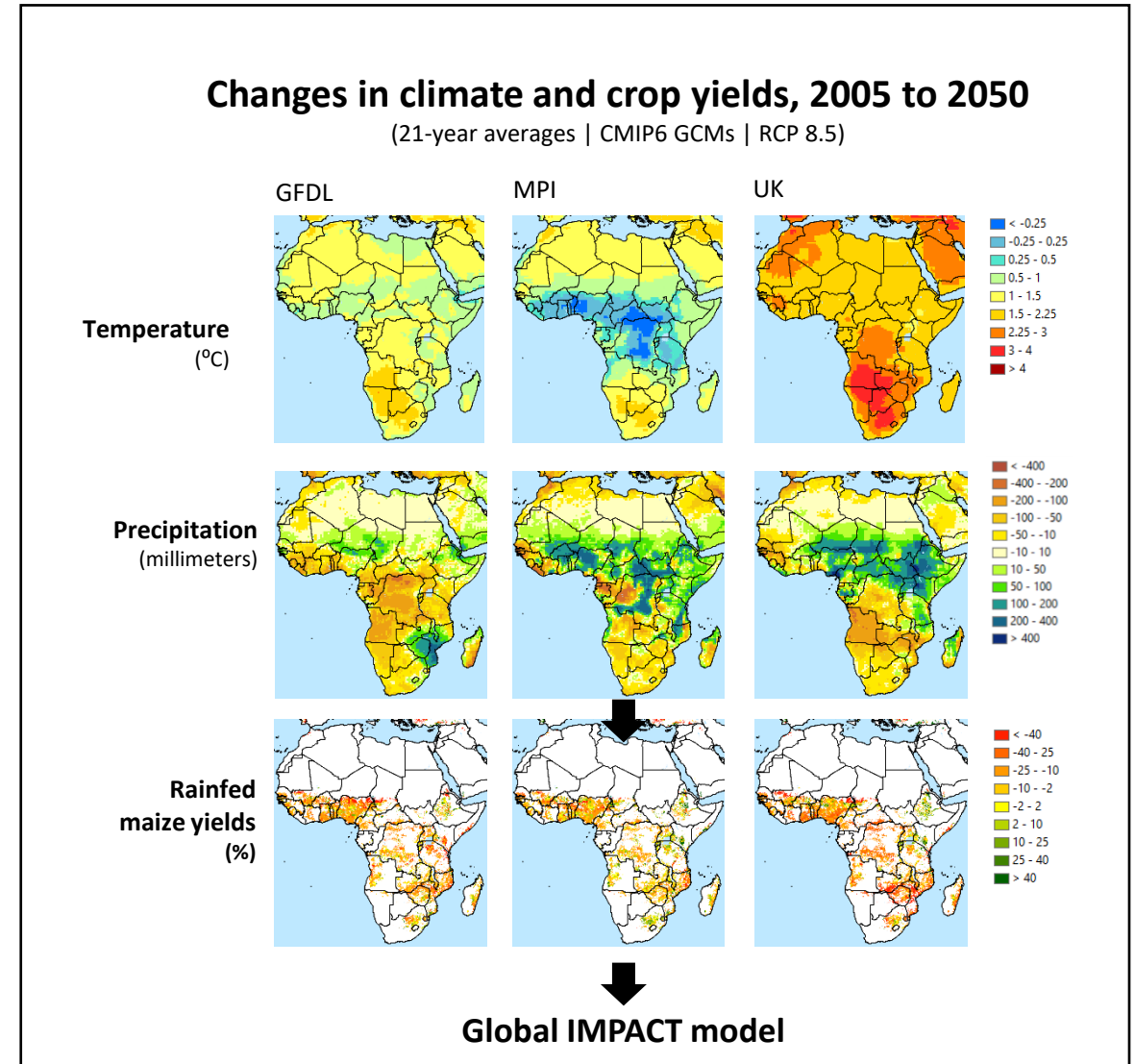# Analyzing Future Trends and Impacts

IFPRI-CGIAR is a leader in modeling climate change and global food systems

- Crop models (DSSAT), spatial production data (SPAM), and a global agriculture model (IMPACT)

- Global coverage, but developing country focus

- Contributing to AgMIP, EAT-Lancet, etc.

Generate agricultural projections under different GCM and emissions scenarios

- Useful for our local and international partners

But it is difficult to use wide ranging scenarios to make planning decisions

Changes in climate and crop yields, 2005 to 2050
(21-year averages | CMIP6 GCMs | RCP 8.5)

GFDL   MPI   UK

Temperature (°C)

Precipitation (millimeters)

Rainfed maize yields (%)

Global IMPACT model

Shifting Focus to Climate Uncertainty

IFPRI and MIT are working together to adopt an uncertainty approach

- Model full range of climate projections
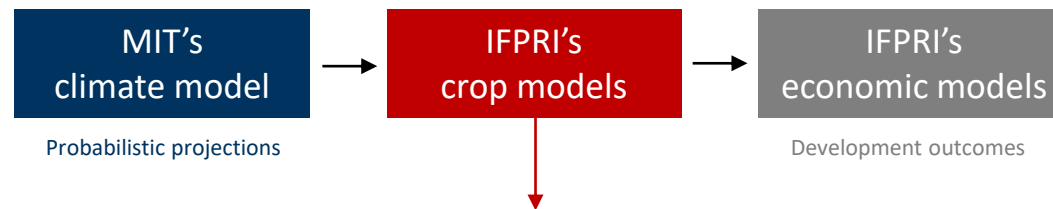- Estimate impacts on developing countries

MIT's model emulates a range of climate data and assumptions

- Generates probabilistic projections (720,000 per emissions scenario)

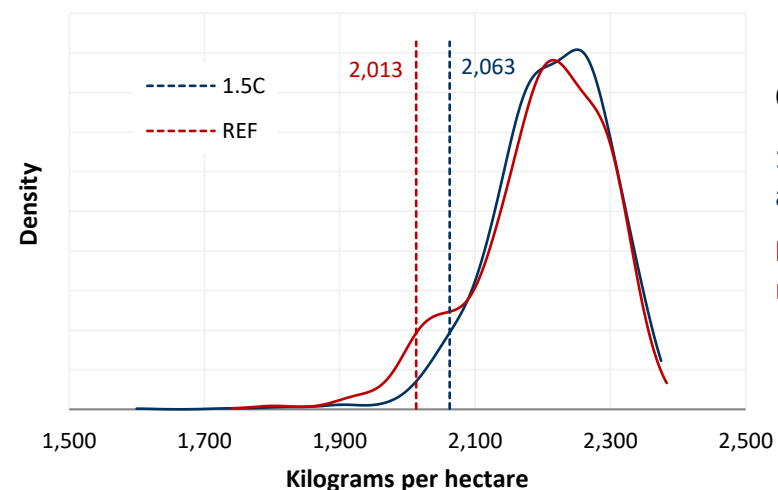## IFPRI's models track agricultural, economic, and household impacts

- GDP, jobs, poverty, food security, diets, etc.

Modeling framework

MIT's climate model	→	IFPRI's crop models	→	IFPRI's economic models
Probabilistic projections				Development outcomes

Projected maize yields in Malawi (2040s)

(dashed lines show 5th percentile)

- - - - 1.5C
- - - - REF

2,013   2,063

Density

Kilograms per hectare

1,500   1,700   1,900   2,100   2,300   2,500

Climate scenarios

1.5°C = global warming above pre-industrial levels

REF = No explicit climate mitigation policies

Assessing Policy Implications

Climate change slows development

- Disrupts agrifood system transformation
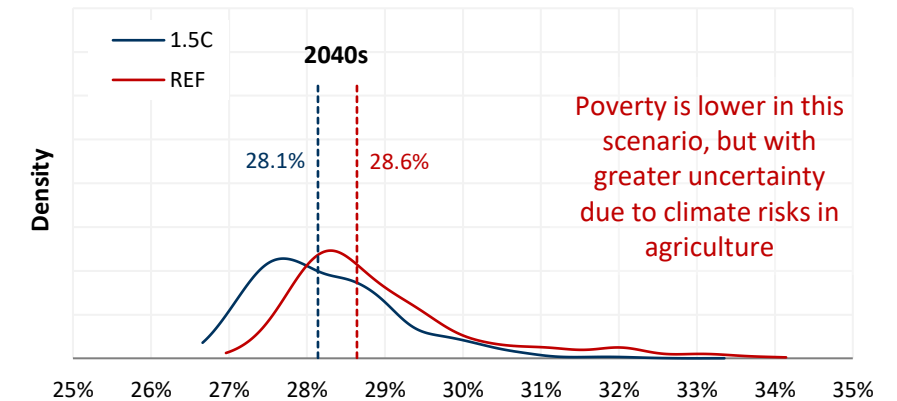- Complicates policy decisions

May not change development policy priorities, even if now more urgent

- Agriculture's is exposed to climate risks
- Agrifood systems likely to remain a major source of growth and poverty reduction in many low-income countries
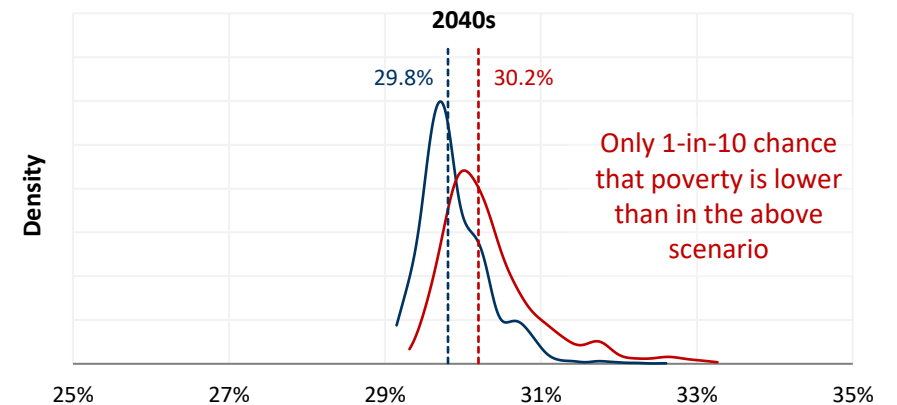

Agriculture remains most effective at reducing poverty in Malawi

Poverty Headcount Rate (population below $2.15 per day)

Scenario 1: Faster growth driven by the agrifood system

1.5C
REF
2040s
28.1%   28.6%

Poverty is lower in this scenario, but with greater uncertainty due to climate risks in agriculture

25% 26% 27% 28% 29% 30% 31% 32% 33% 34% 35%

Scenario 2: Faster growth outside the agrifood system

2040s
29.8%   30.2%

Only 1-in-10 chance that poverty is lower than in the above scenario

25% 27% 29% 31% 33% 35%

Evaluating Risks Outside Agriculture

Impacts extend beyond agriculture

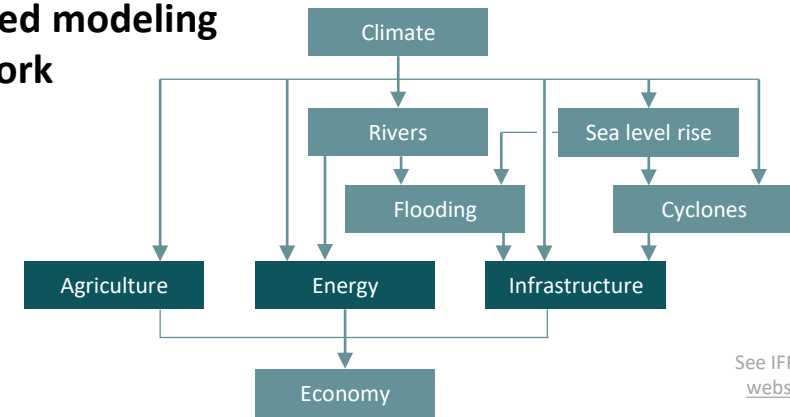- e.g., river basins, floods, cyclones, sea levels

IFPRI's modeling framework captures multiple impact channels

- **Agriculture**: crops, livestock
- **Energy**: hydropower
- **Infrastructure**: roads, ports, housing

Off-farm impact channels can be worse for rural households

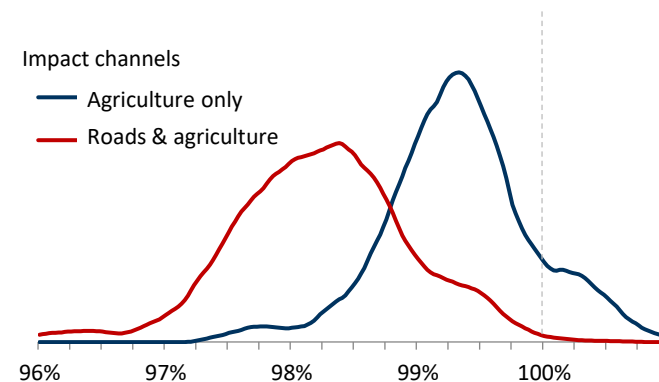- Economywide food systems approach is key

Integrated modeling framework

See IFPRI website

Multisector GDP impacts in Malawi
(GDP in 2050 relative to "no climate change" baseline)

Impact channels
- Agriculture only
- Roads & agriculture

Impacts of climate change on agriculture are mostly negative

Much larger losses when road damages (flooding) are included
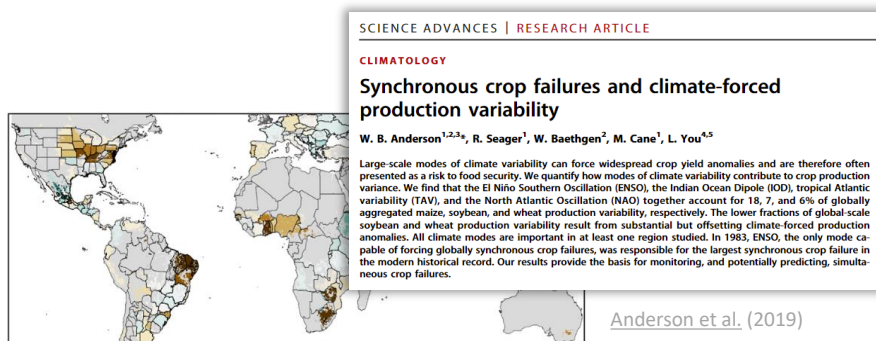
Arndt et al. (2014)

Emphasizing Extreme Events

Frequency of extreme events is likely to increase (e.g., droughts)

- For many, extreme events are the clearest manifestation of climate change

- "Stress testing" policies under extreme events is becoming crucial (both current and future climates)

Impacts of concurrent crises are particularly concerning for food systems

- Studying multi-breadbasket failures (likelihood and impacts on developing countries)


SCIENCE ADVANCES | RESEARCH ARTICLE

CLIMATOLOGY

Synchronous crop failures and climate-forced production variability

W. B. Anderson[1,2,3]*, R. Seager[1], W. Baethgen[2], M. Cane[1], L. You[4,5]

Large-scale modes of climate variability can force widespread crop yield anomalies and are therefore often presented as a risk to food security. We quantify how modes of climate variability contribute to crop production variance. We find that the El Niño Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), tropical Atlantic variability (TAV), and the North Atlantic Oscillation (NAO) together account for 18, 7, and 6% of globally aggregated maize, soybean, and wheat production variability, respectively. The lower fractions of global-scale soybean and wheat production variability result from substantial but offsetting climate-forced production anomalies. All climate modes are important in at least one region studied. In 1983, ENSO, the only mode capable of forcing globally synchronous crop failures, was responsible for the largest synchronous crop failure in the modern historical record. Our results provide the basis for monitoring, and potentially predicting, simultaneous crop failures.

Anderson et al. (2019)

New frequency of 20-year low-yield event by 2060s
(Relative to 2020s reference scenario | Rainfed maize)

1.5°C scenario
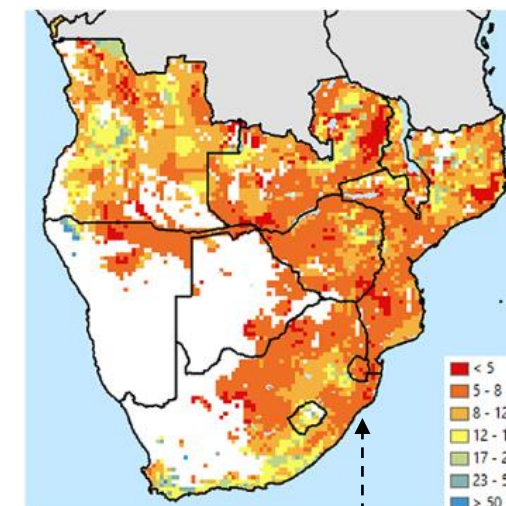(Global warming above pre-industrial levels)
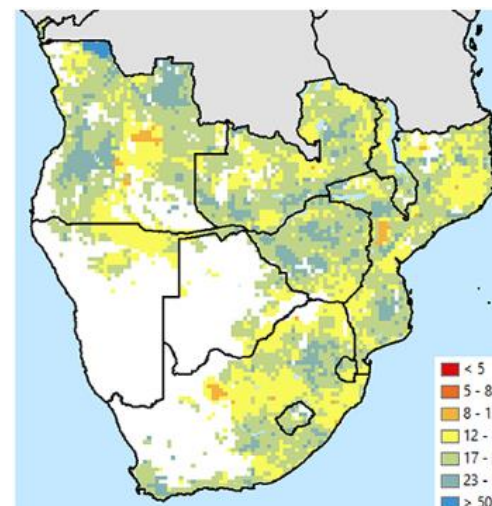
Reference scenario
(No explicit climate mitigation policies)

Thomas et al. (2021)

1-in-20-year event becomes a 1-in-5-year by 2060s

Broader Research and Policy Engagement

Other climate change research areas

Youth employment and livelihoods
(with IFAD)

Brooks et al. (2019)

Mitigation and energy policy
(with South African National Treasury)

Merven et al. (2021)

Arndt et al. (2016)
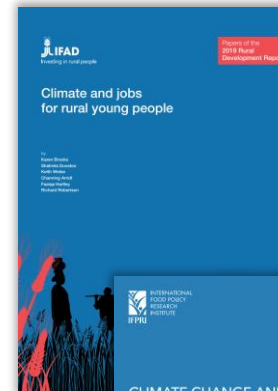
Hunger and dietary change

Sulser et al. (2021)

Visit IFPRI's "Climate Change" website
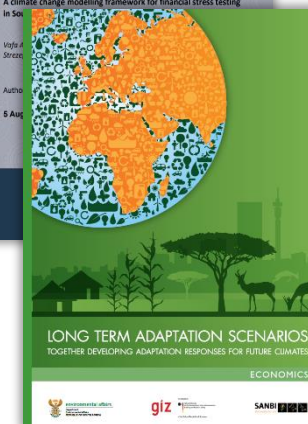
Impacting policy
Examples from South Africa

Nationally Determined Contribution
(with Univ. of Cape Town)

Climate risks for central banking
(Reserve Bank)

Adaptation Scenarios
(National Treasury)

For more information

Keith Wiebe (k.wiebe@cgiar.org)
Lead, CGIAR Foresight Initiative

James Thurlow (j.thurlow@cgiar.org)
Director, IFPRI Foresight and Policy Modeling Unit

INITIATIVE ON
Foresight

CGIAR