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Global to Local Analysis of Systems Sustainability



MANAGING THE GLOBAL COMMONS: SUSTAINABLE AGRICULTURE AND USE OF THE WORLD'S LAND AND WATER RESOURCES IN THE 21ST CENTURY

**PI: Thomas W. Hertel, Co-PIs: Uris L.C. Baldos, Laura Bowling, Keith Cherkauer,
Matthew Huber, David R. Johnson, Carol X. Song, Dominique van der Mensbrughe**

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NEED



MEETING THE GLOBAL SUSTAINABLE DEVELOPMENT GOALS ON A CHANGING PLANET WITH LIMITED LAND AND WATER RESOURCES



TRANSFORMING OUR WORLD:
THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

development.un.org/post2015/transformingourworld



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**MANY GOALS RELATE TO LAND AND WATER RESOURCES,
SUGGESTING WE NEED A SYSTEMS APPROACH TO SEE COMBINED IMPACTS**



sustainabledevelopment.un.org/post2015/transformingourworld



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RESEARCH ON THE SUSTAINABLE DEVELOPMENT GOALS TYPICALLY FALLS INTO ONE OF THREE TRAPS

COMMONLY, SUSTAINABILITY RESEARCH IS TOO...

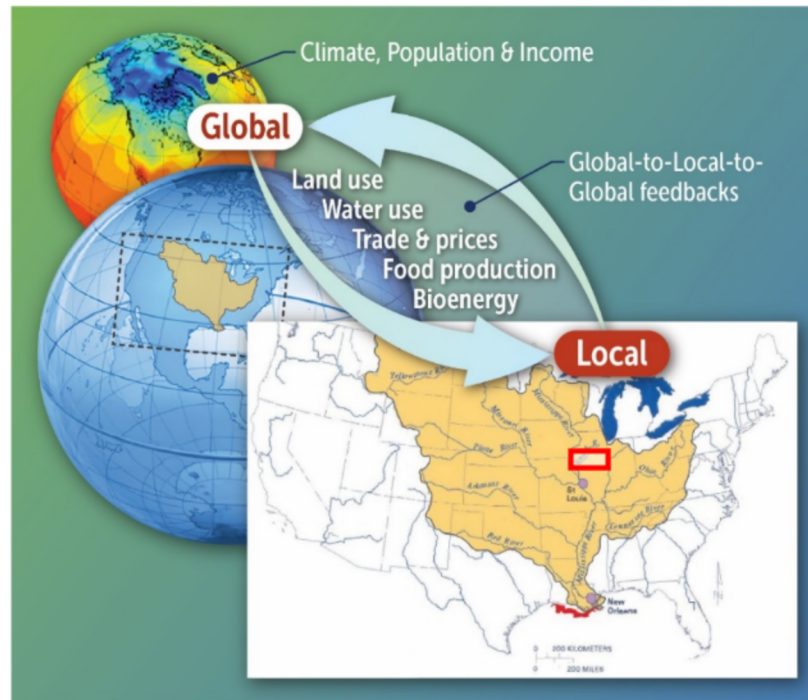
- 1) DISCIPLINARY, LIMITING THE VALIDITY OF FINDINGS
- 2) LOCAL, IGNORING GLOBAL CONTEXT & DYNAMIC FEEDBACKS
- 3) COMPLEX AND/OR PROPRIETARY, LIMITING THE REPLICABILITY AND TRANSPARENCY OF ANALYSES



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APPROACH

GLASS: GLOBAL-TO-LOCAL ANALYSIS OF SYSTEMS SUSTAINABILITY



- **SUSTAINABILITY STRESSES ARE OFTEN HIGHLY LOCALIZED**
- **BUT GLOBAL FORCES DRIVE THESE LOCAL STRESSES**
- **LOCAL RESPONSES TO SYSTEM STRESSES CAN HAVE GLOBAL CONSEQUENCES**

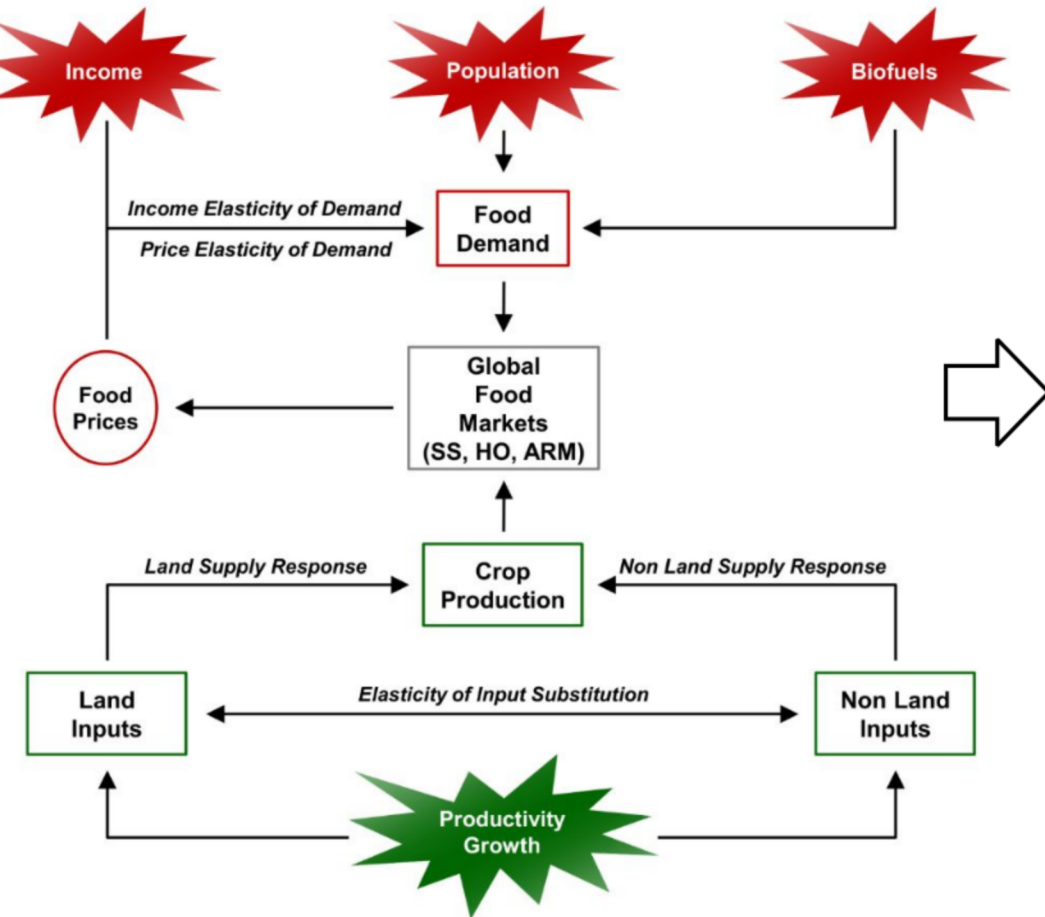


APPROACH

SIMPLE: A SIMPLIFIED INTERNATIONAL MODEL OF AGRICULTURAL PRICES, AND THE ENVIRONMENT



LONG-RUN DEMAND DRIVERS

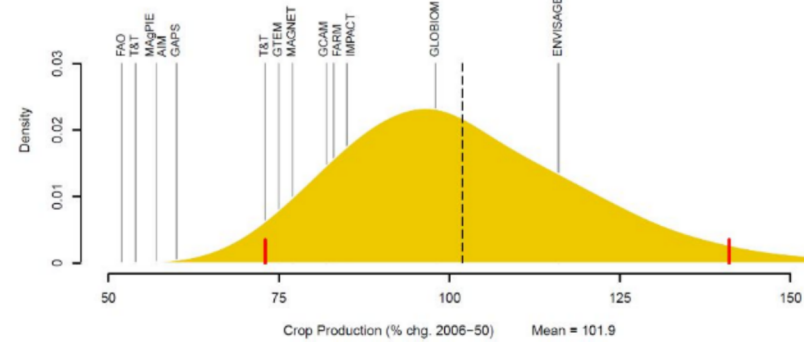


LONG-RUN SUPPLY DRIVERS

FOOD PRICES AND PRODUCTION PROJECTIONS

Predicting Long-Term Food Demand, Cropland Use, and Prices

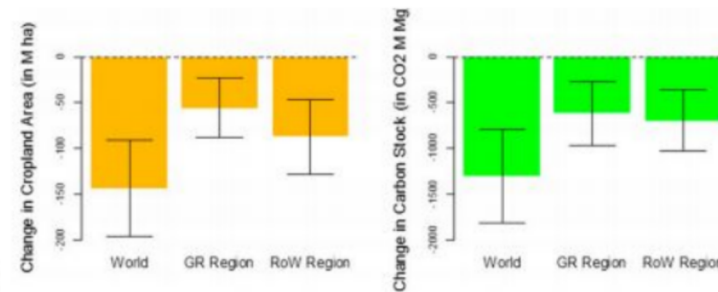
Annual Review of Resource Economics
 Vol. 6:127-141 (Volume publication date October 2018)
 doi:10.1146/annurev-resour-10-15-2016-1146
 Thomas W. Hertel, Uris Lantz C. Baldos, and Dominique van der Mensbrugghe
 Center for Global Trade Analysis, Department of Agricultural Economics, Purdue University, West Lafayette, Indiana 47907-1325, email: hertel@purdue.edu



LAND USE AND GHG EMISSIONS

Global market integration increases likelihood that a future African Green Revolution could increase cropland use and CO₂ emissions

PNAS
 Thomas W. Hertel^{1,2}, Navin Ramankutty^{3,4}, and Uris Lantz C. Baldos¹
¹Department of Agricultural Economics, Purdue University, West Lafayette, IN 47907; and ²Department of Geography, McGill University, Montreal, QC, Canada H3A 0B9
 Edited by S. L. Turner, Arizona State University, Tempe, AZ, and approved August 8, 2014 (received for review February 25, 2014)

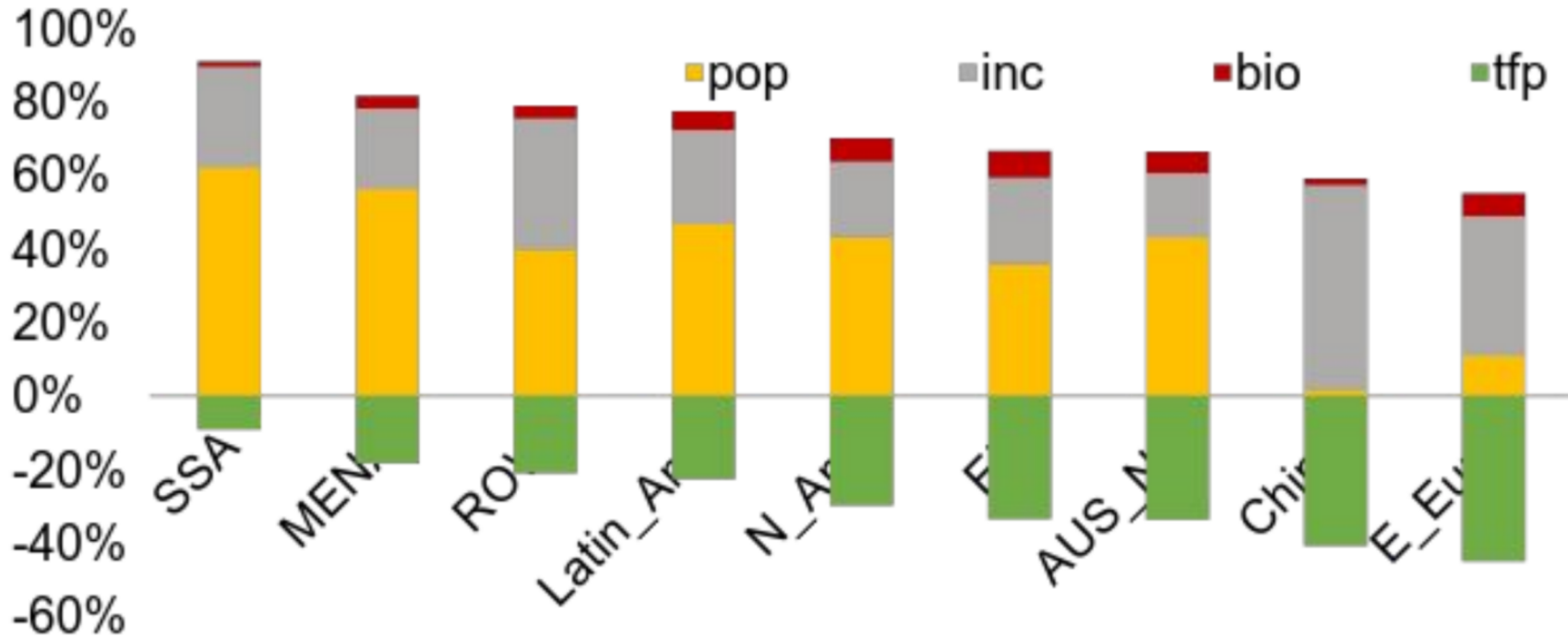


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DRIVERS OF GLOBAL IRRIGATION DEMAND GROWTH: 2006-2050

using SIMPLE-G

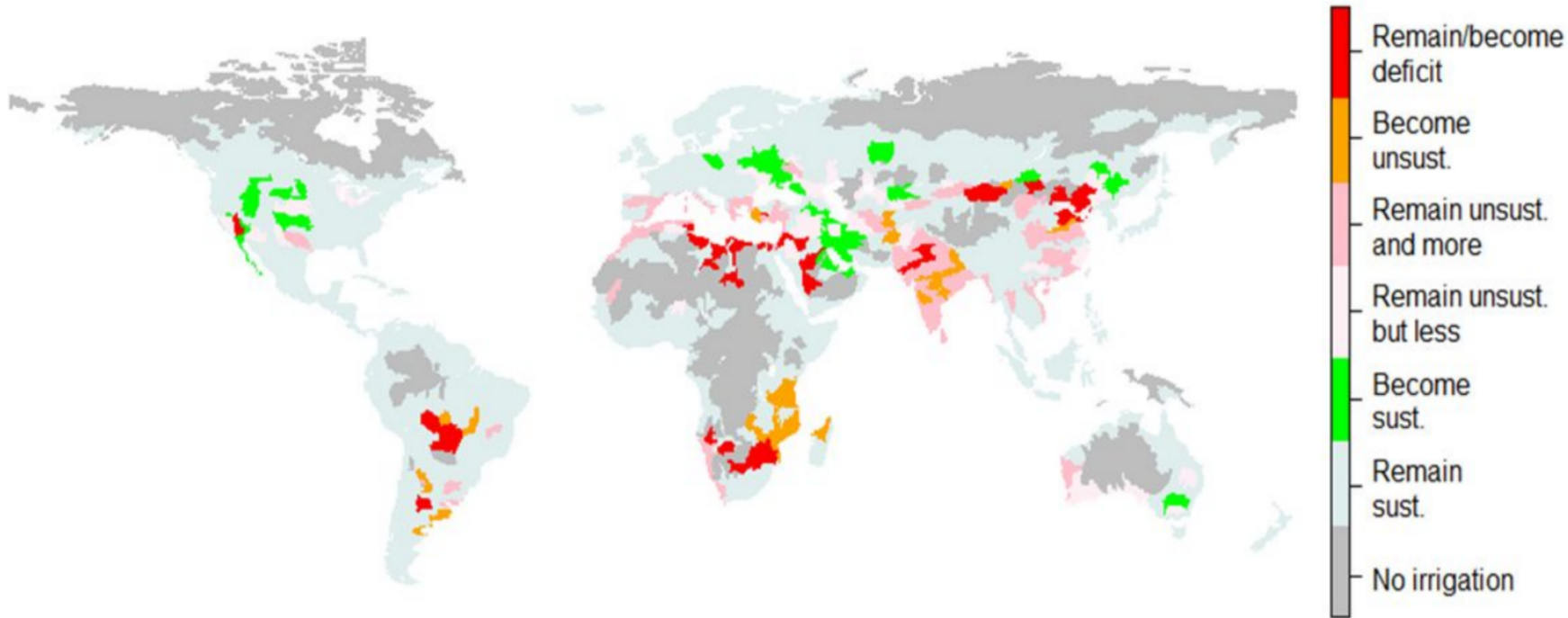


Source: Liu et al., 2017 ERL



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GLOBAL DRIVERS INCREASE LOCAL STRESSES: UNSUSTAINABLE IRRIGATION

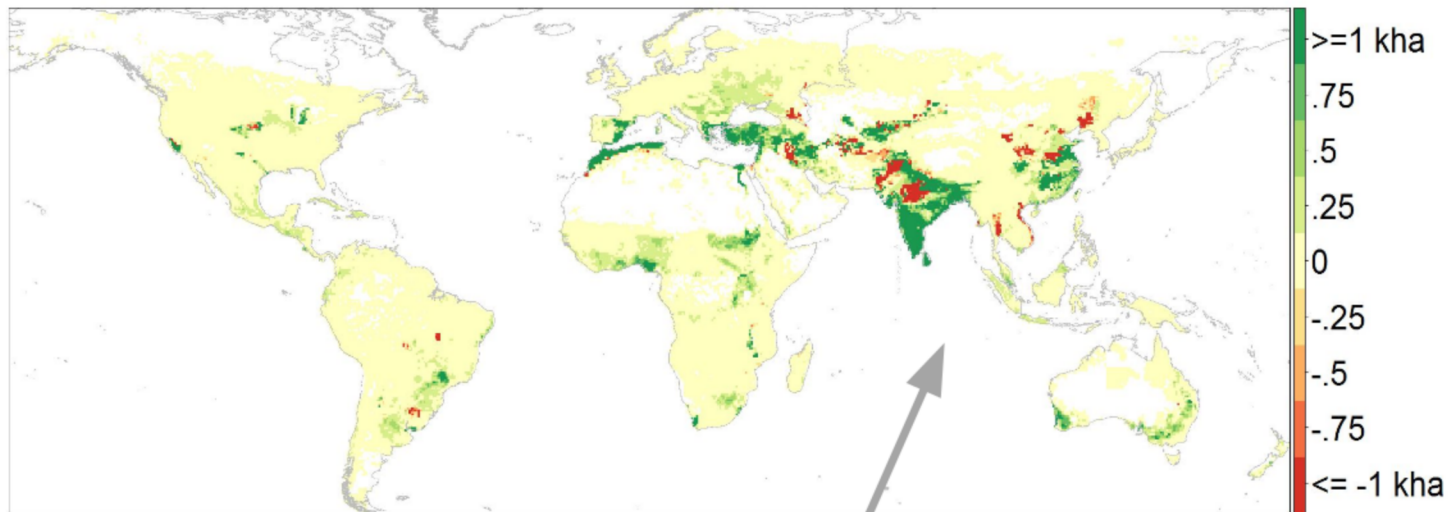


Source: Liu et al., 2017 ERL



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RESTRICTING UNSUSTAINABLE IRRIGATION AT SUBBASINS HAVE BROAD IMPACT ON GLOBAL MALNUTRITION AND LAND USE



Globally,

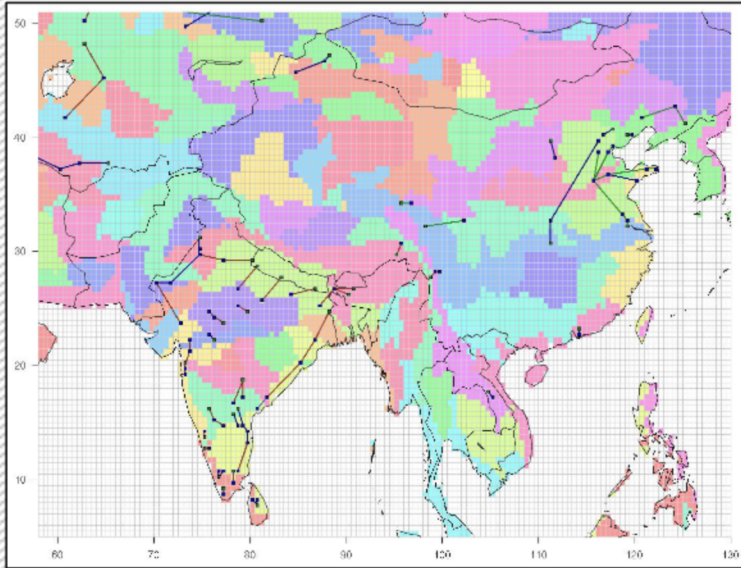
- Crop output **-16 MMT**
- Undernourished pop. **+800k**
- Cropland area **+12 Mha**
- CO₂ emissions **+0.87GtC**

Source: Liu et al., 2017 ERL

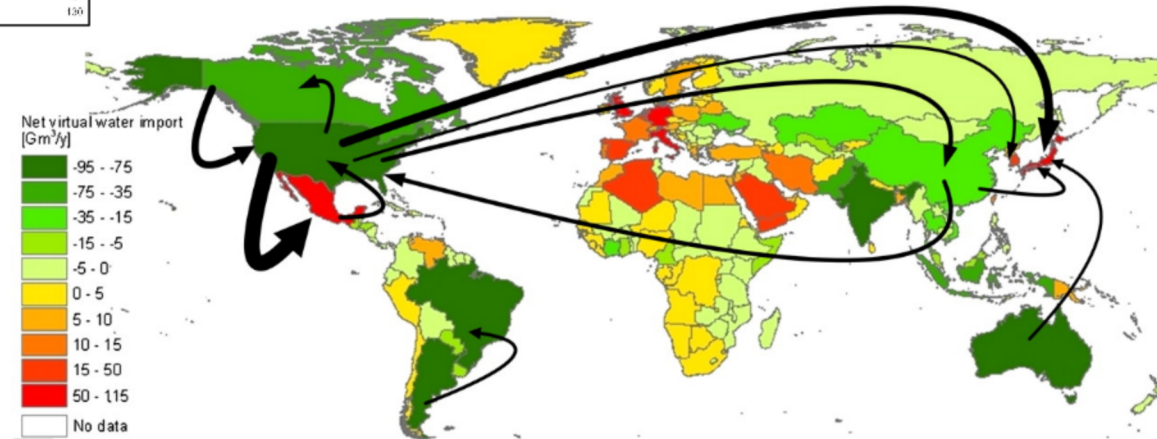


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LOCAL WATER STRESSES CAN BE ALLEVIATED BY MOVING PHYSICAL OR VIRTUAL WATER



Inter-basin water transfers,
(Water Balance Model, UNH)



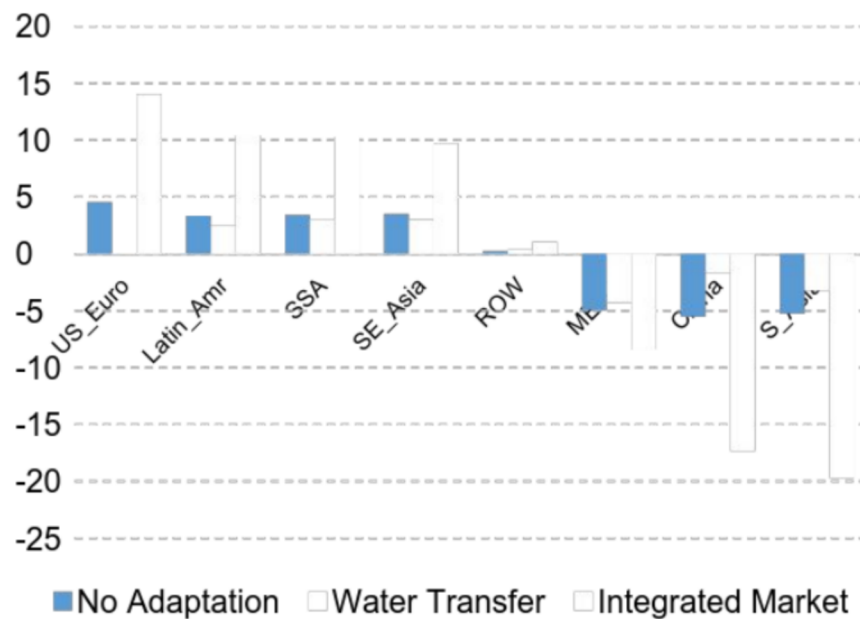
Virtual water balance 1996-2005 (Hoekstra and Mekonnen, 2011)



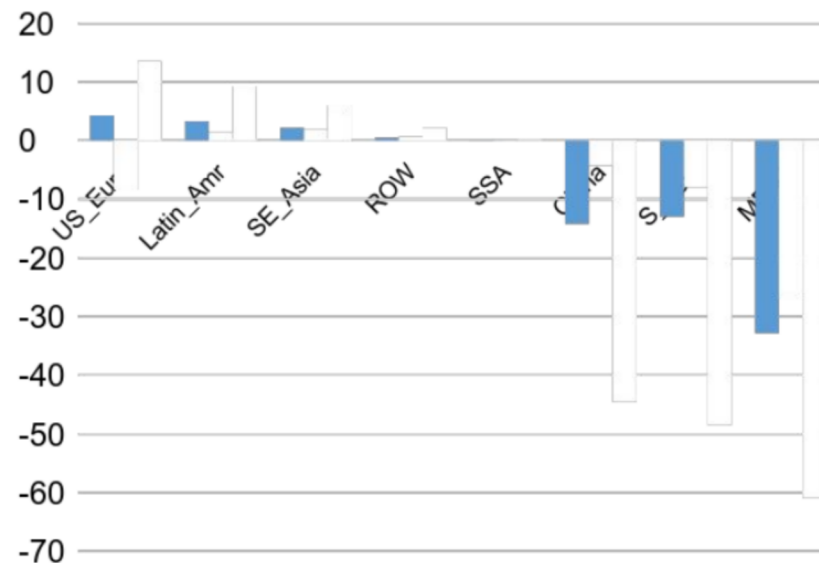
IMPACT OF ELIMINATING UNSUSTAINABLE IRRIGATION IN 2050



Net export of crops, million tons



Net export of virtual water, million m3



Source: Liu et al., 2017 ERL

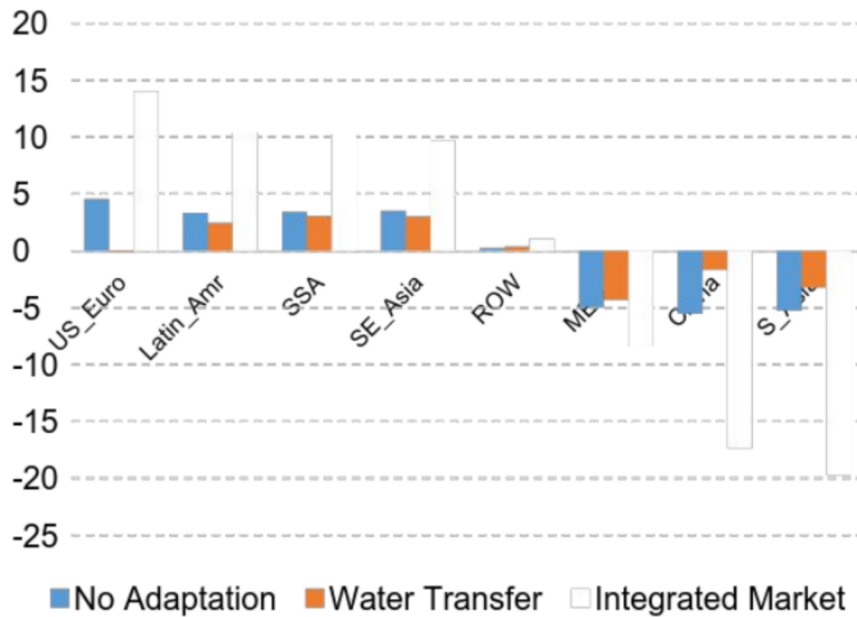


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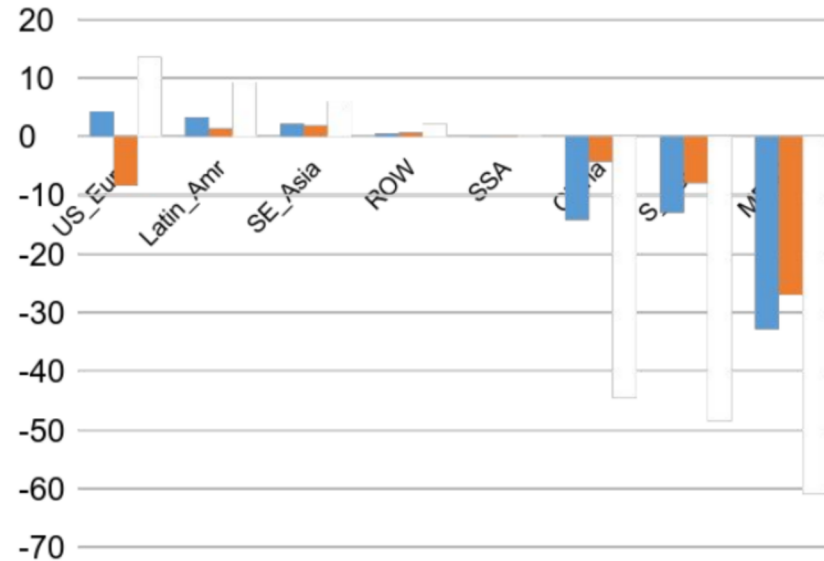
IMPACT OF ELIMINATING UNSUSTAINABLE IRRIGATION IN 2050 IN THE PRESENCE OF IBTs



Net export of crops, million tons



Net export of virtual water, million m3



Source: Liu et al., 2017 ERL

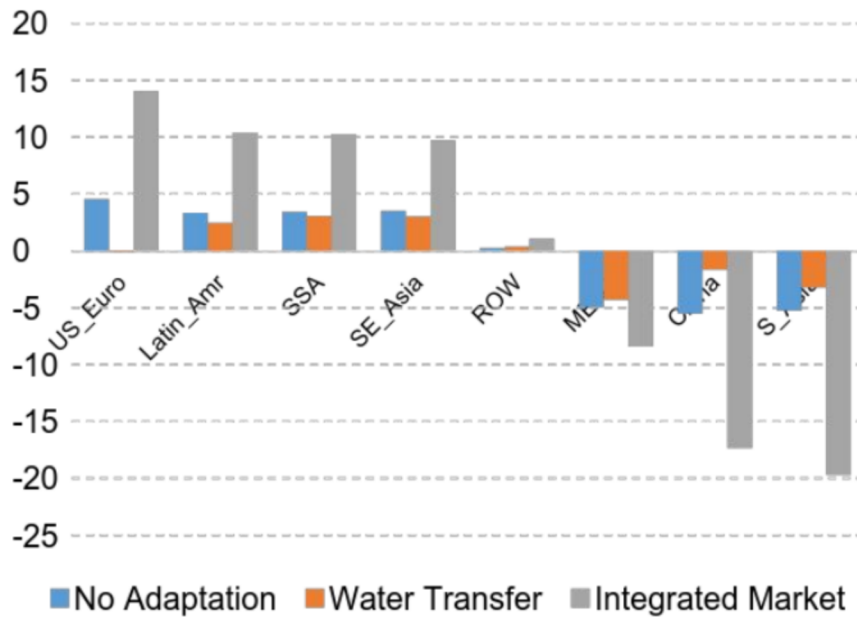


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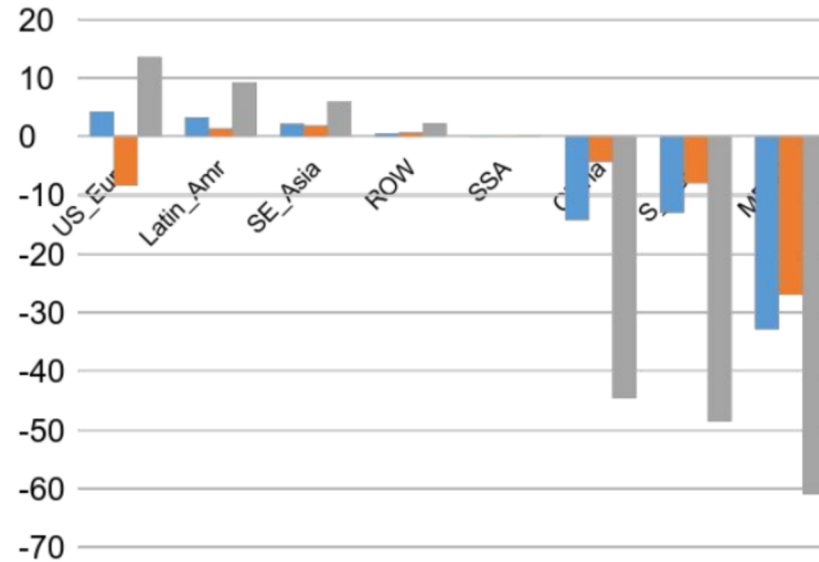
IMPACT OF ELIMINATING UNSUSTAINABLE IRRIGATION IN 2050 IN THE PRESENCE OF ENHANCED COMMODITY TRADE



Net export of crops, million tons



Net export of virtual water, million m3



Source: Liu et al., 2017 ERL



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APPROACH

CREATE THE INFRASTRUCTURE AND OPEN-SOURCE TOOLS NECESSARY TO DEVELOP A SELF-SUSTAINING COMMUNITY OF PRACTICE



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BENEFITS

AN APPLIED RESEARCH CONSORTIUM FOCUSED ON THE SUSTAINABLE DEVELOPMENT GOALS *WILL* BENEFIT A *WIDE* ARRAY OF STAKEHOLDERS



INVESTORS SEEKING TO UNDERSTAND FUTURE INFRASTRUCTURE NEEDS



LOCAL COMMUNITIES DEVELOPING CLIMATE ADAPTATION PROJECTS AND ASSESSING RISK MANAGEMENT OPTIONS



NATIONAL POLICY MAKERS EVALUATING THE CONSEQUENCES OF LOCAL ACTIONS, INCLUDING TRADE-OFFS (E.G., USDA, DOE, EPA, FAO) AND ADAPTATION OPTIONS (E.G., TRADE, TECHNOLOGY INVESTMENTS, WATER GOVERNANCE)



SCIENTIFIC COMMUNITY OF PRACTICE COMPILING A SHARED REPOSITORY OF BOUNDARY CONDITIONS, DATA AND SCENARIOS TO MEDIATE BETWEEN GLOBAL AND LOCAL STUDIES



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THE PURDUE TEAM IS A MICROCOSM OF THE LARGER COMMUNITY



HYDROLOGY



Laura
Bowling

CLIMATE SCIENCE



Matt
Huber

CLIMATE IMPACTS ON CROPS



Keith
Cherkauer

**GLOBAL TRADE &
SUSTAINABILITY**



Tom
Hertel

**POLICY DESIGN,
IMPLEMENTATION**



David
Johnson

CLIMATE MITIGATION



Dominique van
der

ECONOMIC MODELING



Mensbrugghe
Uris
Baldos

COMMUNITY INFRASTRUCTURE



Carol
Song

ENVIRONMENTAL ECONOMICS



Jing Liu



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