

# Water Scarcity and International Agricultural Trade

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# Background

- World's looming water challenge
  - 1/3 of the world's population living in basins with a water deficit of larger than 50% by 2030 ([Addams et al., 2009](#))
- Water is an essential input for agriculture
  - 42% of global production and 23% of harvested area are irrigated ([Bruinsma 2009](#))

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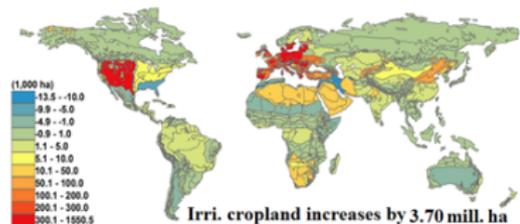
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- Water is an essential input for agriculture
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- Increasing competition for water (ag. vs. non-ag.)
- Water availability can be a serious constraint on agriculture and other economic activities.



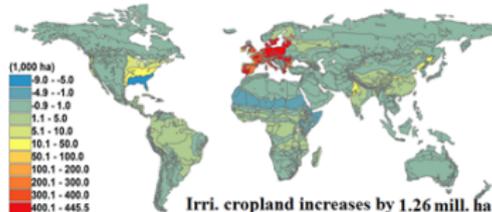
# The role of irrigation in determining the global land use impacts of biofuels

 Farzad Taheripour<sup>\*</sup>, Thomas W Hertel and Jing Liu

## No irrigation constraint



## With irrigation constraint



The 2<sup>nd</sup> generation biofuels will cost the world **0.68 million ha.** more land if irrigation is constrained.

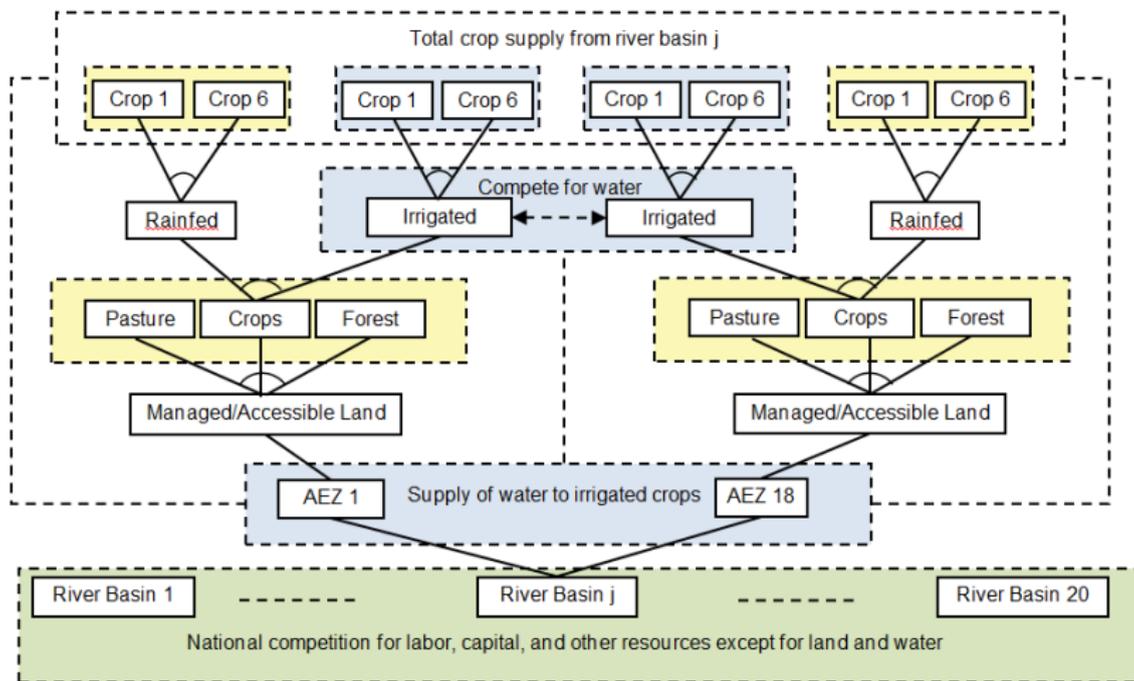
## Incorporating water into GTAP

	Implicit water (Irrigated land)	Explicit water, Fixed water supply	Explicit water, Expandable water supply	Non-ag. water uses
Benchmark	NO	NO	NO	NO
I	YES	NO	NO	NO
II	YES	YES	NO	NO
III	YES	YES	YES	NO
IV	YES	YES	YES	YES

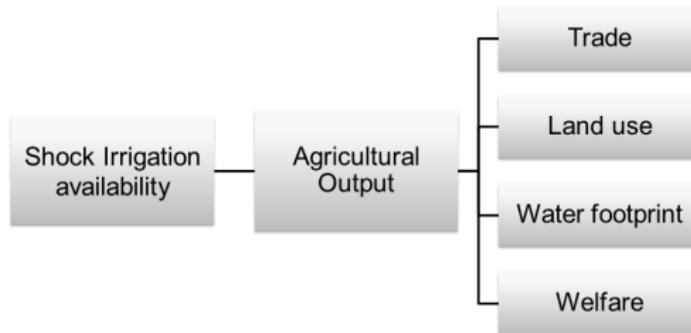
 NO

 YES

# Schematic of crop production in the GTAP-BIO-W model



# An application: Global water shock and its impacts on agriculture



# Experiment

- Shock: change of irrigation availability in 2030
  - The evolving of irrigation availability depends on
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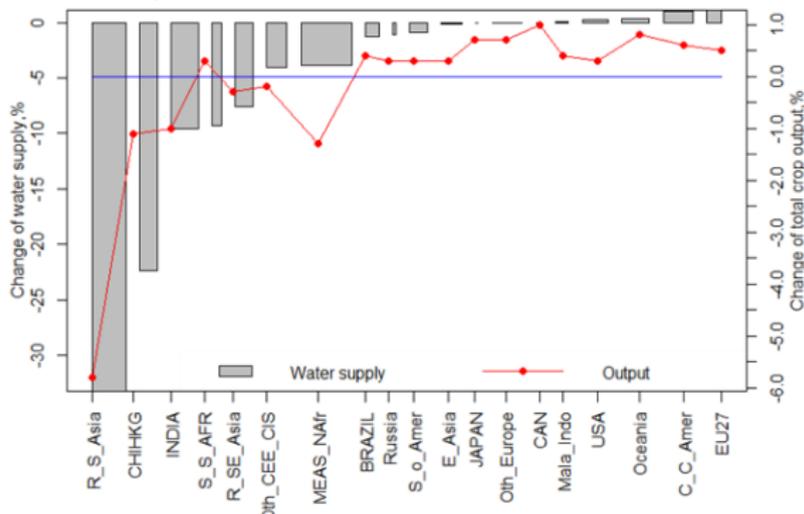
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- Closure
  - Exogenous population and endowment (land and water)
  - Endogenous prices and quantities



## Result 1: Crop output

More severe water scarcity



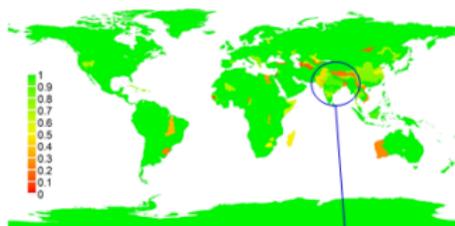
Bar width → share of irrigated output

- Largest decrease occurs in regions that anticipate severe water scarcity and rely highly on irrigation;
- Output loss in Asian and MENA countries outweighs output gain from American and European countries. The world will produce less.



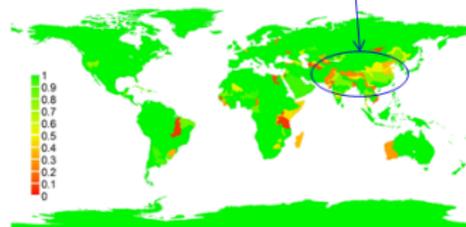


## Result 3: Bilateral trade

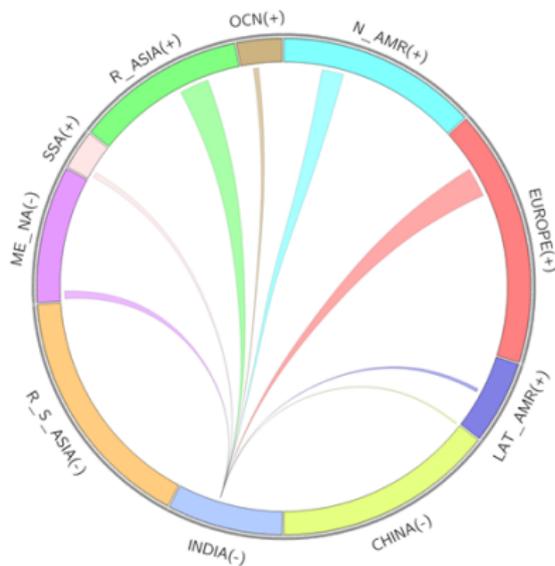


Index of irrigation water availability in 2000

Increasing water scarcity alters the  
geography of food trade

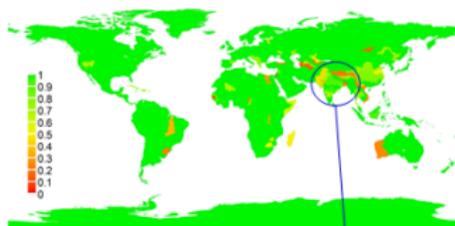


Index of irrigation water availability in 2030



Regions facing the most severe water scarcity are most likely to increase net food import from the others.

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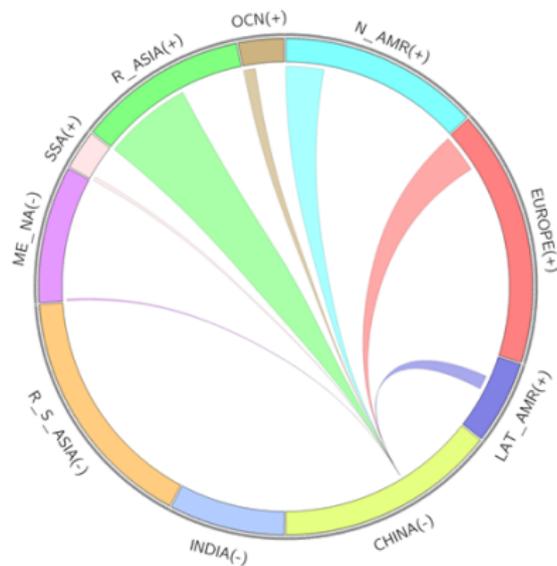


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## Result 4: Welfare change

- Future water scarcity will cost the world \$US 3.7 billion (2001 price).
- Asian countries expect to suffer a significant welfare loss, while American and Oceania countries will see the opposite.
- Two major sources of welfare loss are - less water endowment and worsened terms of trade.

## Conclusion

- Regional production impacts of irrigation shortages are quite heterogeneous, varying with the size of the shortfall, the irrigation intensity of crop production, as well as the crop mix.
- Water scarcity can significantly alter the geography of international trade.
- The economic implications of water scarcity include the direct impact on yields and crop areas, as well as its macro-economic outcomes affected by prices and international trade. Future water scarcity will cost the world \$US3.7 billion (2001 price).



## Features of the model

- What we built...
  - A multi-region (19), multi-sector, general equilibrium model;
  - Water supply is exogenous at basin level, but competed by different crops;
  - Distinguished irrigated and rainfed crop production based on land use ([Monfreda et al. 2008](#)) and water use ([Portmann et al. 2010](#)) data;
  - I and R sectors pay the same cost share for non-water-land inputs, such that yield boost is completely explained by water.
- What do we contribute to the existing water-related global models such as GTAP-BIO-W ([Taheripour et al. 2013](#)), IMPACT ([Rosegrant et al. 2012](#)) and GTAP-W ([Calzadilla et al. 2011](#)):
  - Water is an explicit input;
  - More heterogeneous land productivity represented by the interaction of Agro-ecological Zone (AEZ) and river-basin;
  - Capability to trace bilateral trade.