Quantifying and mapping China’s crop yield gains from sustainable and unsustainable irrigation water use 1981-2000

Danielle S. Grogan
University of New Hampshire - Main Campus, danielle.grogan@unh.edu

Fan Zhang
Xi’an Jiaotong University

Stanley Glidden
University of New Hampshire - Main Campus, stanley.glidden@unh.edu

Dominik Wisser
Universität Bonn

Alexander Prusevich
University of New Hampshire - Main Campus

See next page for additional authors

Follow this and additional works at: https://scholars.unh.edu/earthsci_facpub

Recommended Citation

This Conference Proceeding is brought to you for free and open access by the Earth Sciences at University of New Hampshire Scholars' Repository. It has been accepted for inclusion in Earth Sciences Scholarship by an authorized administrator of University of New Hampshire Scholars' Repository. For more information, please contact nicole.hentz@unh.edu.
Authors
Danielle S. Grogan, Fan Zhang, Stanley Glidden, Dominik Wisser, Alexander Prusevich, Changsheng Li, Richard B. Lammers, and Steve Frolking
Quantifying and mapping China’s crop yield gains from sustainable and unsustainable irrigation water use 1981-2000

Danielle S. Grogan1*, Fan Zhang1,2, Stanley Glidden1, Dominik Wisser3, Alex Pruevitich1, Changsheng Li1, Richard B. Lammers1, Steve Frolking1

1University of New Hampshire, Durham, NH; 2Xi’an Jiaotong University, Xi’an, China; 3Utrecht University, Utrecht, Netherlands

I. Research Questions

How much unsustainable water is used for irrigation in China? (c.2000)?

How will crop yields change when the unsustainable water runs out?

II. Background

• Chinese agriculture depends greatly on irrigation water. ~40% of China’s cropland is irrigated.
• It has been estimated that ~15% of China’s irrigation water comes from unsustainable sources.
• Regions that rely on unsustainable irrigation water could face water shortages in the future, and may already be experiencing water stress today.
• Identifying crops, regions, and total crop yields that will be impacted by the eventual loss of unsustainable water can help plan for future water management.

III. Methods

1) Use 2 models: WBM for irrigated and rainfed crop yields per area, WBM for sustainable water availability and crop water requirements. Input 30 years of climate variability.
2) Model two scenarios:
   a) Only use sustainable water for irrigation
   b) Allow unsustainable water for irrigation
3) Scale the MIRCA2000 dataset of irrigated and rainfed cropland areas to reduce irrigation water demand to sustainable water supply. Algorithm:
   I. MIRCA2000 irrigated areas
   II. MIRCA2000 rainfed areas
   III. Calculate total crop yield for MIRCA2000 areas (I, R) and for rescaled areas (I*, R*). Then difference is the crop yield reduction.

IV. Models

1. Water Balance Model

- A “bucket” model that keeps a water budget for each grid cell
- Cropland water budgets are kept at sub-grid cell resolution

2. Denitrification-Decomposition (DNDC)

- A biogeochemistry model of crop growth based on nutrient cycling
- Includes crop management parameters for fertilizer, manure, and multi-cropping rotations
- Estimates crop yields (kg/ha)
- Estimation is made on soil conditions, management, and climate.

V. Results

- The average loss for China in a dry year is 15% of total crop yields (~75 MMT C).
- The average loss for China in a wet year (not pictured) is 10% of total crop yields (~50 MMT C).
- There is a strong regional difference between crop yield losses southern China (~0 - 20%) and in the north and north-eastern regions (~40 - 100%).

Impact on food: a quick calculation

10% of irrigated yield = ~50 million metric ton C
1 metric ton Rice = ~1.3 x 10^9 Calories = one year of food for 2 people (assume 2000 Calories per year)
50 million metric tons x one year of food for 2 people = one year of food for 100 million people (7% China’s pop.)

Sustainable crop yield from areas equipped for irrigation is 10% (wet year) to 15% (dry year) lower than fully irrigated crop yield.