Irrigation system transitions simulated by LPJmL

Jonas Jägermeyr

email: jonas.jaegermeyr@columbia.edu | twitter: @JonasJaegermeyr
Stretching food abundance at the cost of the environment

Neolithic Revolution
10,000 – 5,000 yr BP

Industrial Revolution
1700-2000 yr AD

Food / Environmental consequences
Environmental limits to expanding food production

Adapted from: Siebert et al. (2015), Müller Schmied et al. (2016)
Current global Environmental Flow violations

(1980-2009 mean)

40% of today’s irrigation water use at the expense of EFRs

Jägermeyr et al. (2017), Nature Comm.
Food production dependence on environmental flows

>20% of irrigated production at the expense of environmental flows

(1980-2009 mean)

Kcal production [%]

Jägermeyr et al. (2017), Nature Comm.
Mechanistic representation of irrigation systems

Surface irrigation

Sprinkler irrigation

Drip irrigation
Global average irrigation efficiency at 33%

50% of consumptive water use is lost (600 km\(^3\))

<table>
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<tr>
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<th>Surface</th>
<th>Sprinkler</th>
<th>Drip</th>
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<td>Rohwer et al. 2007</td>
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<td>Sauer et al. 2010</td>
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Hydro-climatic opportunities in current rainfed and irrigated systems

- Transpiration:
  - Rain and irrigation water: 100%
- Evaporation:
  - Rain and irrigation water: 33% (46% in irrigated systems, 30% in rainfed systems)
  - Seepage and lateral runoff: 16% (7% in irrigated systems, 1% in rainfed systems)

- Surface runoff:
  - Irrigated: 27%
  - Rainfed: 26%

Only 40% of water used productively

Jägermeyr et al. 2016, ERL
Irrigation system transitions and water saving potentials

“Ambitious” irrigation transition:
- Drip systems where feasible
- Sprinkler is default
- Surface irrigation for paddy rice

40% of irrigation losses are savable

Jägermeyr et al. 2016, *ERL*
Rain-fed management options

1. Soil moisture conservation
2. Water harvesting
Integrated farm water management can halve the global food gap

"Ambitious" implementation in rainfed and irrigated systems

Global +40% kcal gain

No land or water use expansion

Jägermeyr et al. 2016, ERL
Reconciling irrigated food production with environmental flow

Respect EFRs

-20% irrigated production
-5% total production

Respect EFRs + integrated water management

+10% total production

Jägermeyr et al. (2017), Nature Comm.
1. **What needs to be incorporated into irrigation modeling and projections (and consider the timescale: long term projections or short term forecasts)?**

   *System efficiencies, water availability, environmental flows*

2. **To what ends are the needs you identify useful? (i.e., for the irrigation research community, for direct policy application, for decision-support?)**

   *Water allocation planning, establishing efficiency targets, viability assessments*

3. **What needs would require longer-term efforts or are more challenging/irreducible?**

   *Multi-model assessments of water saving potentials require models with detailed irrigation water partitioning*

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**Thank you!**

Email: jonas.jaegermeyr@columbia.edu

Twitter: @JonasJaegermeyr