Trading water:
quantifying inter-state trade of cereals in India

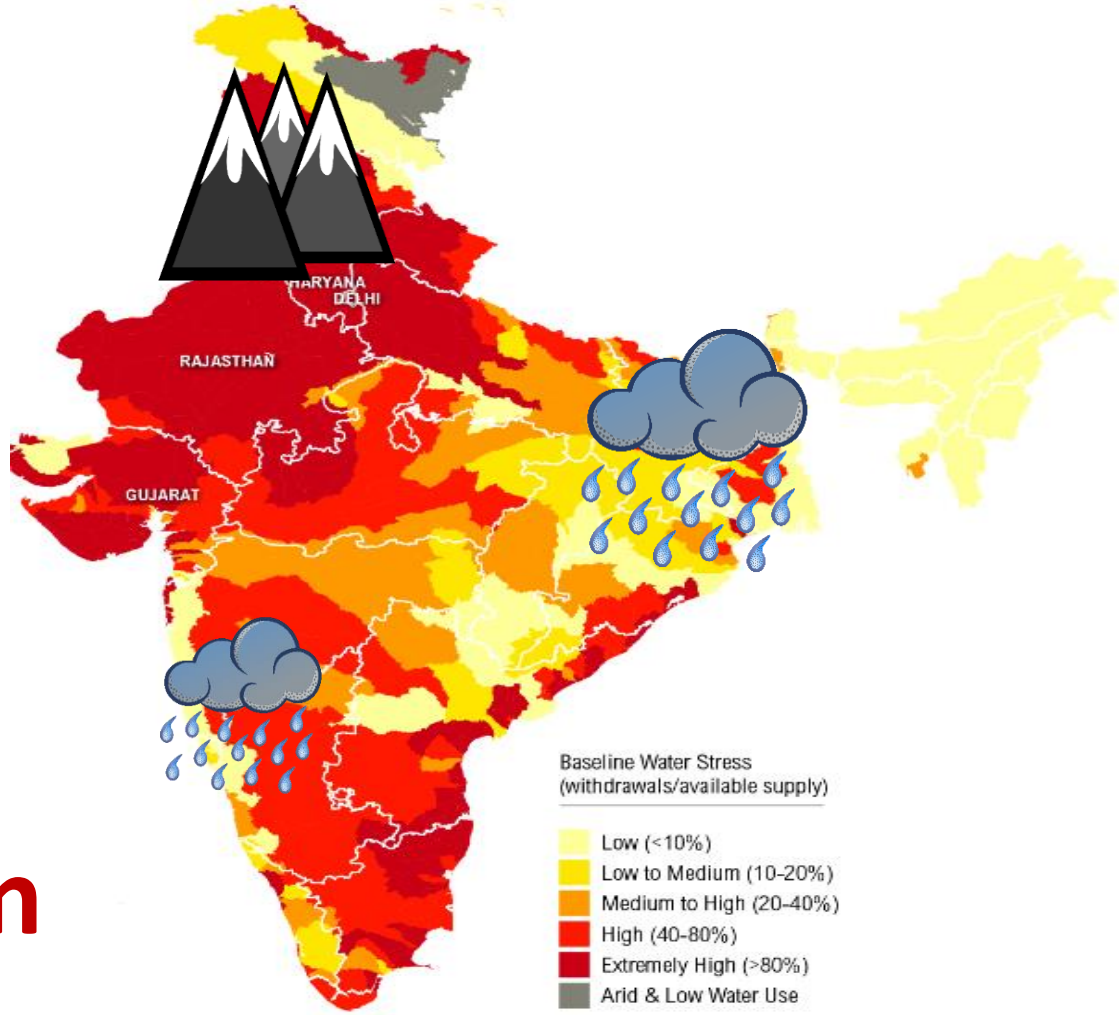
Francesca Harris

London School of Hygiene & Tropical Medicine

Francesca.Harris@lshtm.ac.uk

@franbharrs

Water resources in India



91% of water withdrawn for agriculture

WORLD RESOURCES INSTITUTE

SHEFS

Cereals in India

40% of all agricultural production is cereals
(DACNET, 2019)

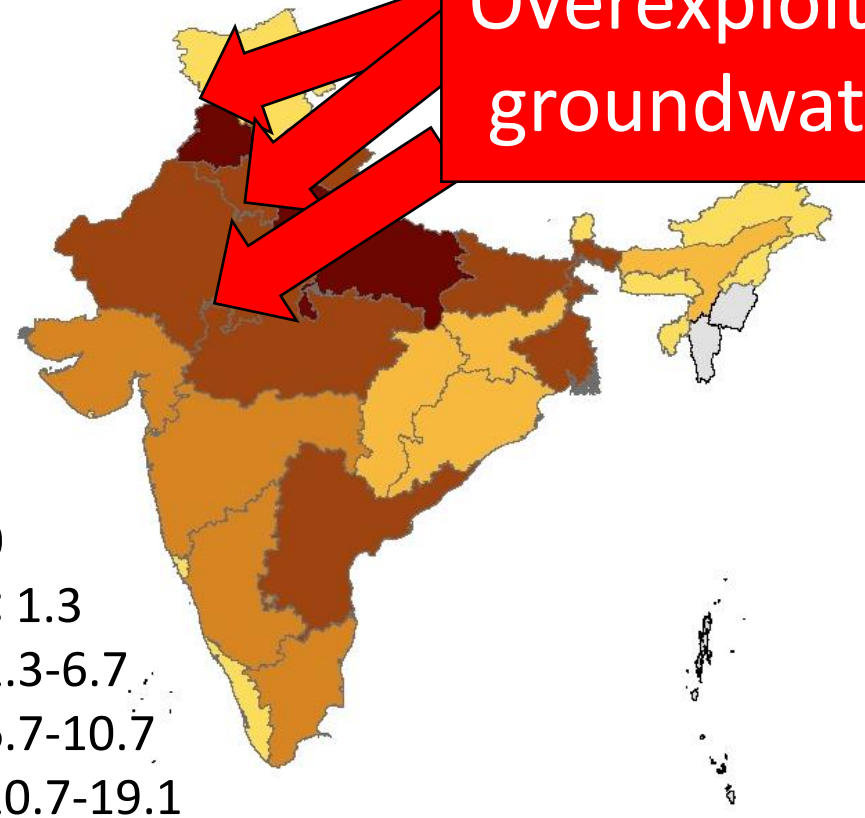
55% of all calories available are from cereals
(FAO, 2019)

Link between producers and consumers

CEREAL PRODUCTION
Million tonnes/year

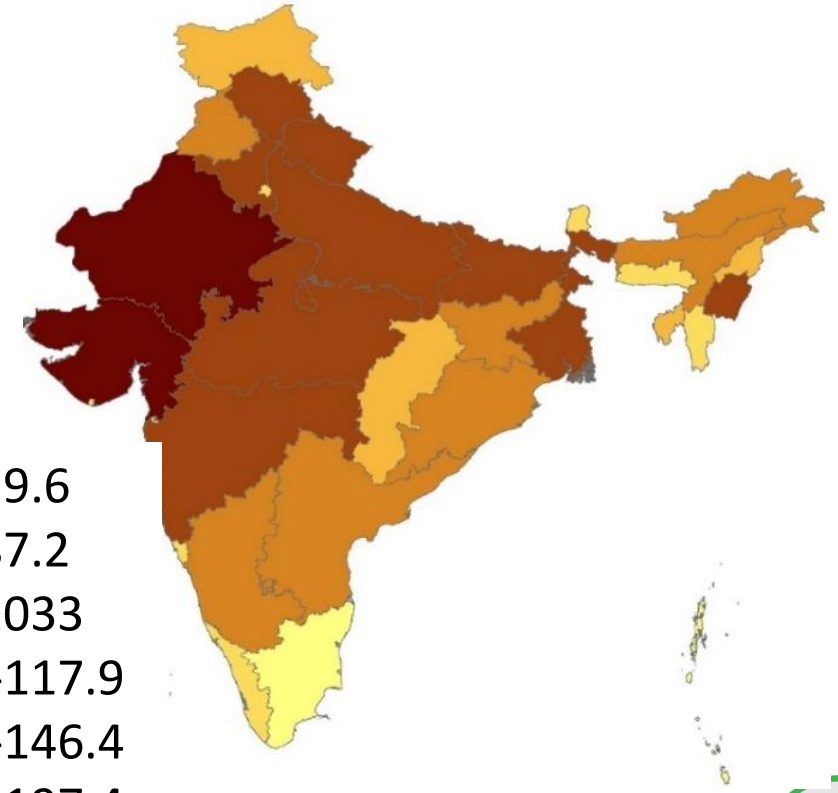
Overexploited groundwater

?



0
< 1.3
1.3-6.7
6.7-10.7
10.7-19.1
>19.1

CEREAL CONSUMPTION
Kg/cap/year



34.8-59.6
59.6-87.2
87.2-1033
103.3-117.9
119.9-146.4
146.4-197.4

SHEFS

Methods

- **Cereal supply and demand balances** for each state (Govt. production data, National Sample Survey) – centered on the years 2011-12 – **NOTE - NO PDS!!**
- **Assign water footprints** to cereal production; developed through the Cool Farm Tool Water (Kayatz et al., 2019)
- **Approximate direction of trade flows using a linear program model** (based on distance, state GDP and other measures)
- **Calculate the flows of water** between states based on cereal trade

SHEFS

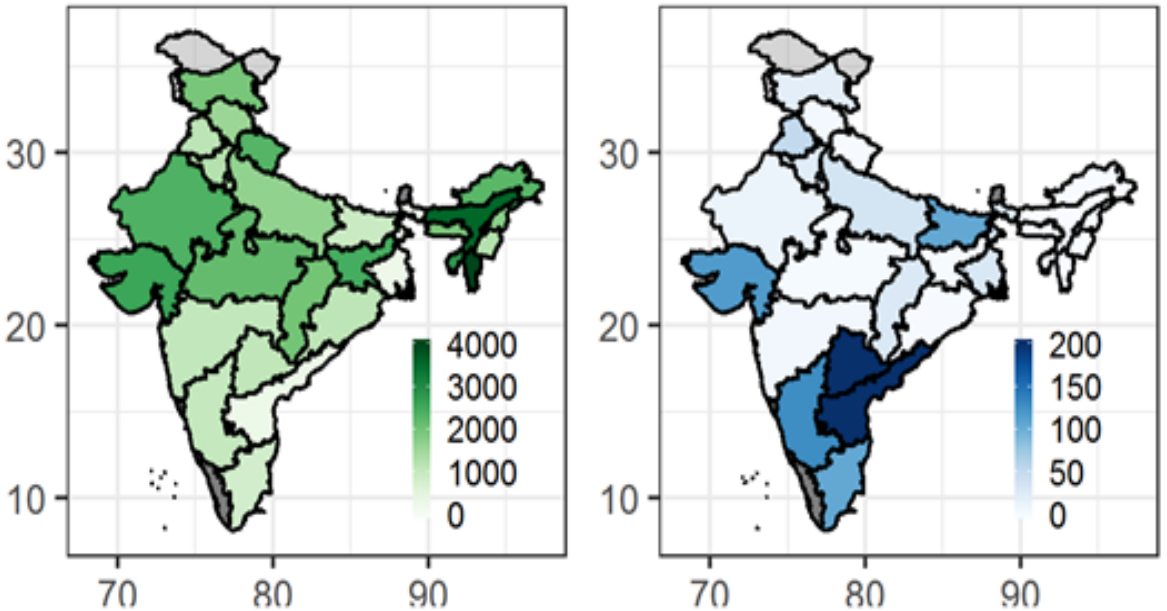
Green and blue water footprints

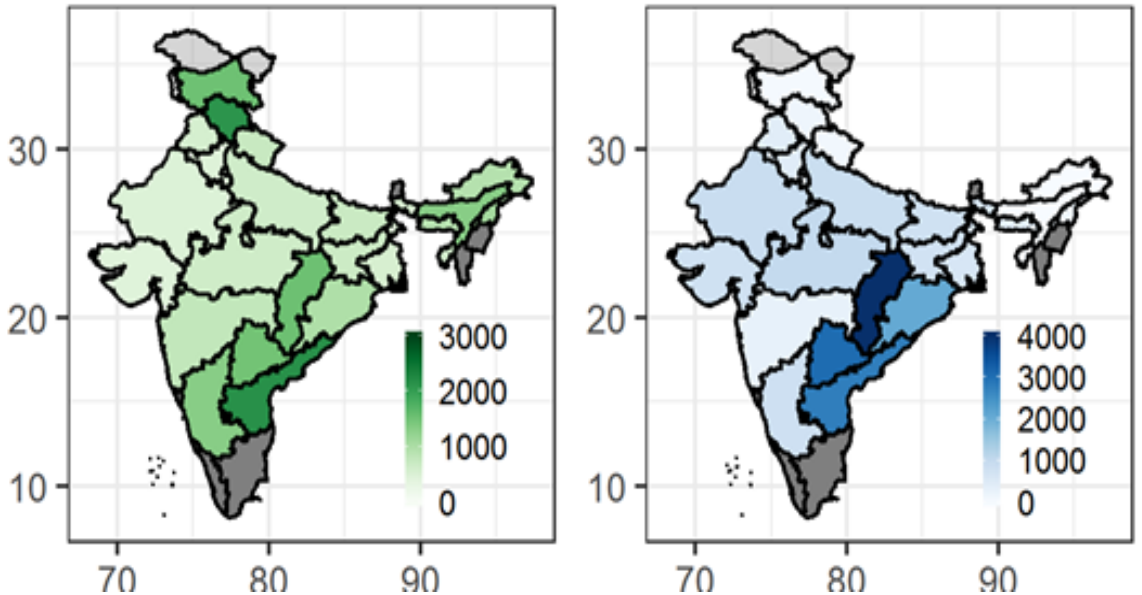
Volume of surface or groundwater evaporated or incorporated into product

Volume of rainwater evaporated or incorporated into product

SHEFS

Results – water footprints of cereals in India





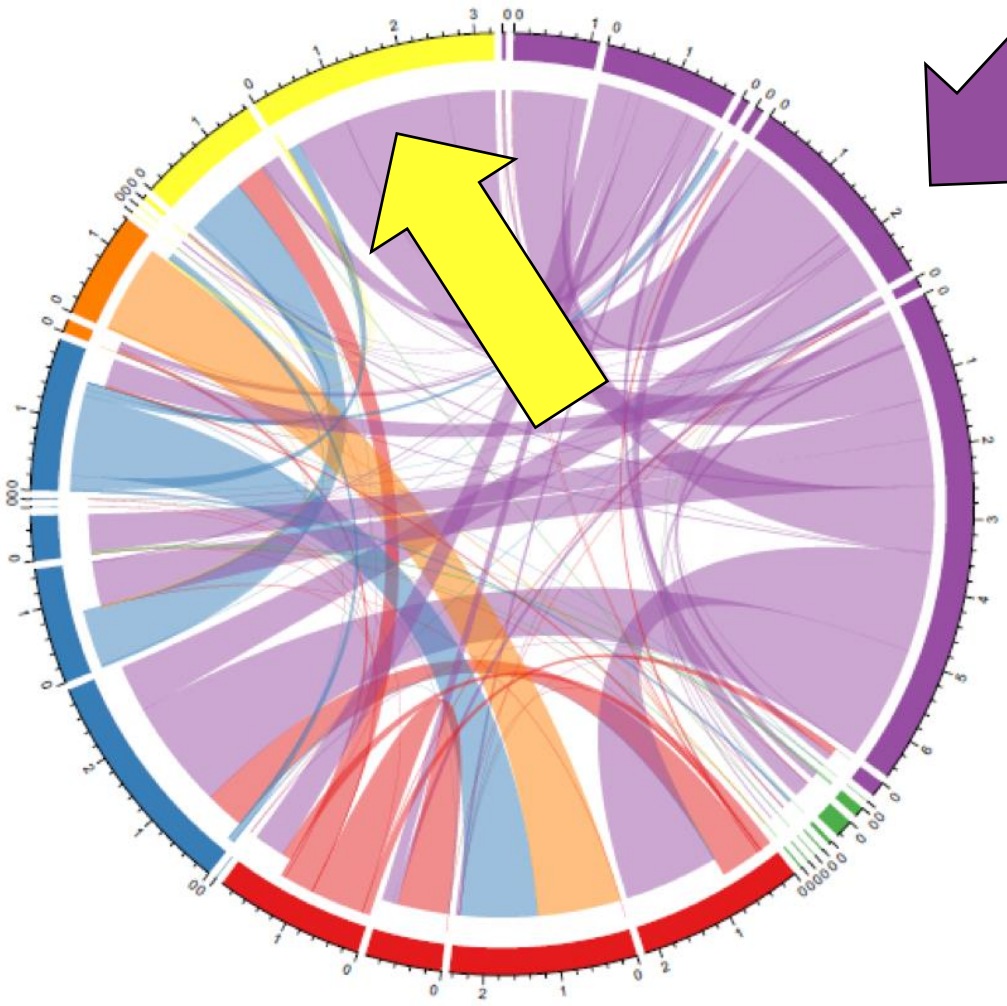
(Kayatz et al., 2019)

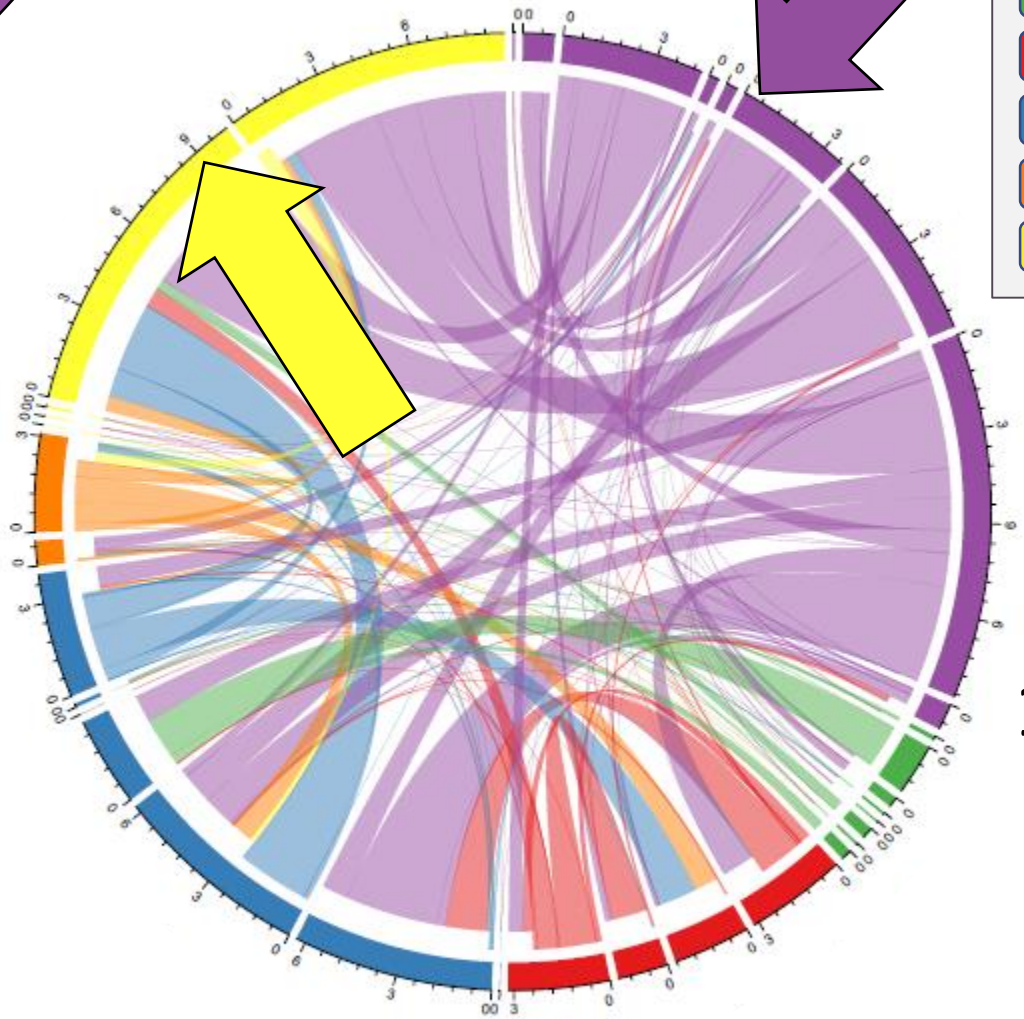
SHEFS

Interstate trade of cereals and associated water

47 Km^3/year

68 Km^3/year





Regions
- North
- Northeast
- East
- South
- Western
- Central

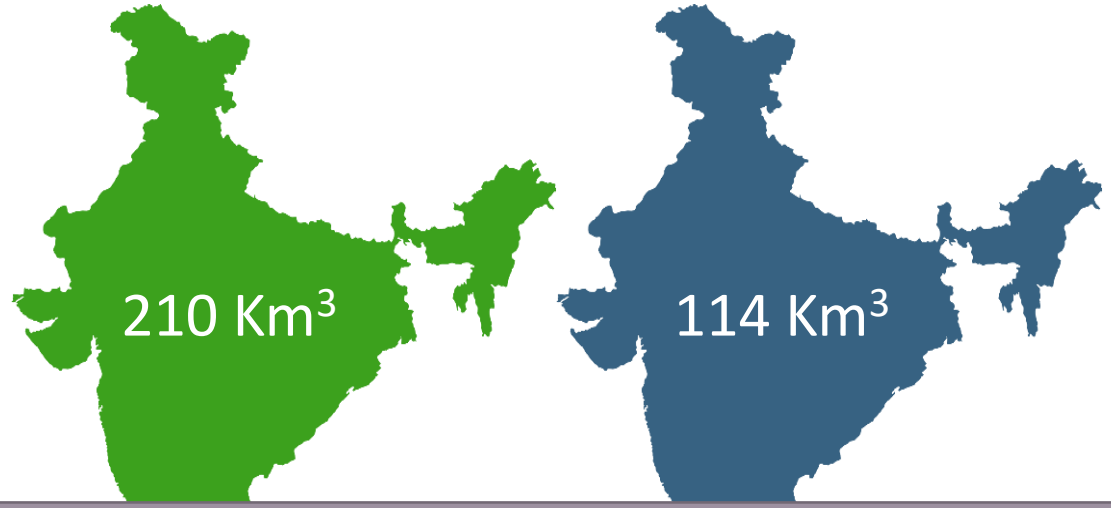
1 Km^3/year

SHEFS

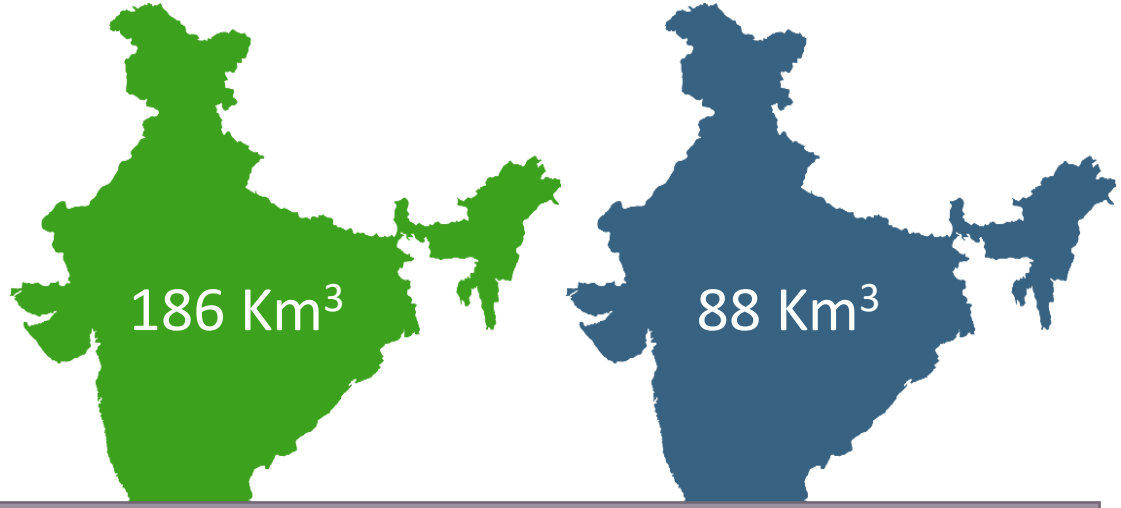
Water savings through trade (2011-12)

The total water use of cereal consumption in India….

… if states were self sufficient



…. with interstate trade

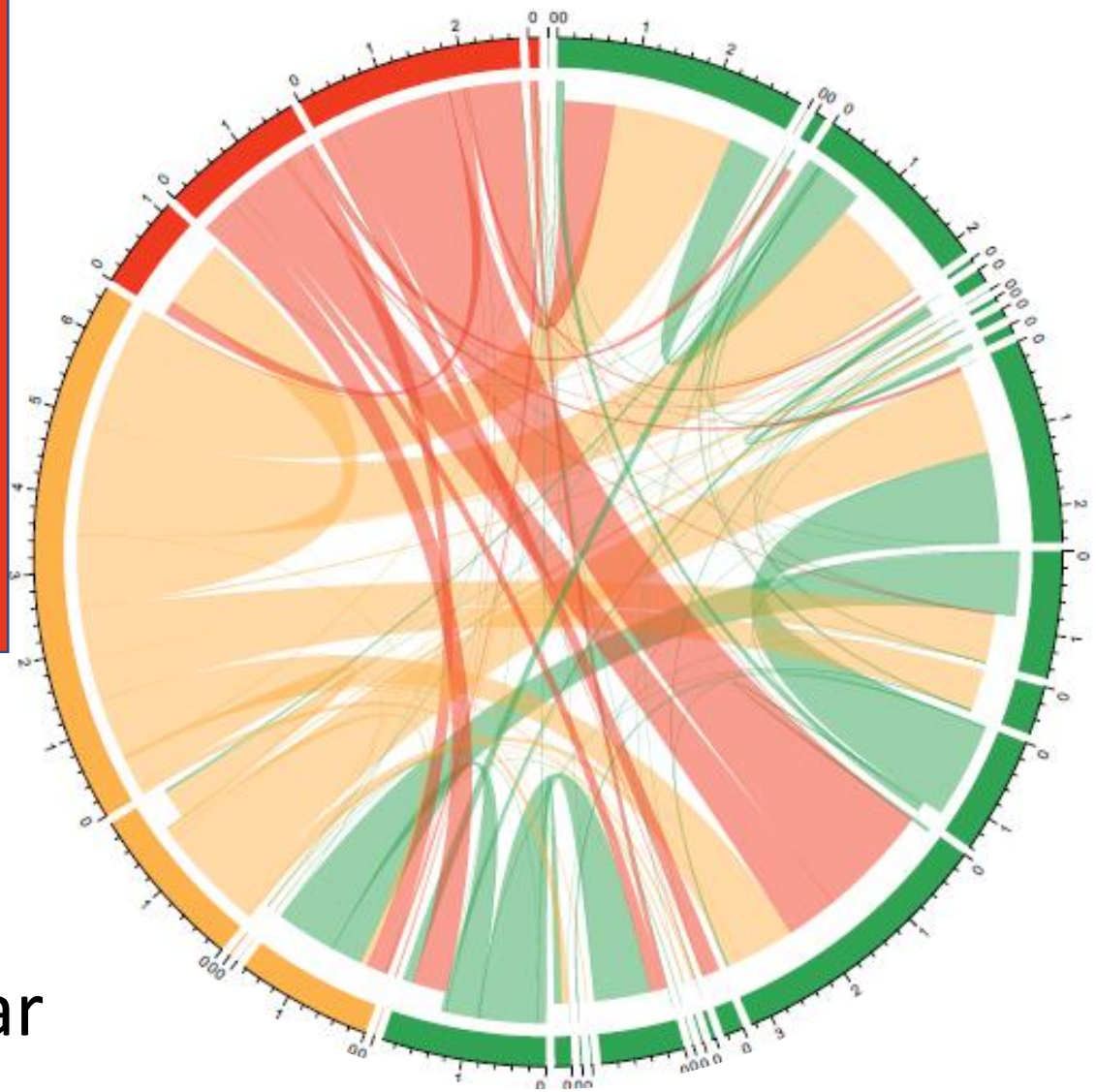


Trade "saves" 12% of green water and 25% blue water resources in India

SHEFS

Groundwater status and trade

33% of cereal exports from over-exploited states ->Received by 18 states



Stage of groundwater depletion

- Safe
- Semi-critical to critical
- Over exploited

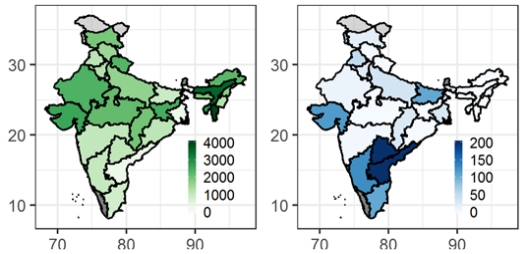
Blue water

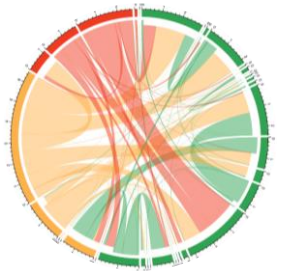
Volume of surface or groundwater evaporated or incorporated into product

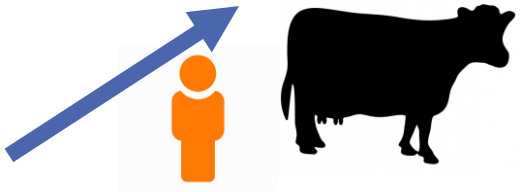
1 Km^3/year

Policy implications

- Trade can help reduce water use by **balancing resources**, and allowing production to increase in **more productive states**
- However, it ↑ **interdependencies** in the food systems – therefore it is currently putting more people at **risk of groundwater shortages**.
- ↑ **population and changing consumer demands** (e.g. increasing dairy (Alae-Carew et al., 2019) means solutions are needed
- For example, switching to more **"water efficient" and nutrient rich cereals** such as maize, sorghum and millet







References and Acknowledgements

- Alae-Carew, C., Bird, F.A., Choudhury, S., Harris, F., Aleksandrowicz, L., Milner, J., Joy, E.J., Agrawal, S., Dangour, A.D. and Green, R., 2019. Future diets in India: A systematic review of food consumption projection studies. *Global Food Security*, *23*, pp.182-190.
- DACNET, 2019, Land Use Statistics Information System: http://aps.dac.gov.in/APY/Index.htm
- Kayatz, B., Harris, F., Hillier, J., Adhya, T., Dalin, C., Nayak, D., Green, R.F., Smith, P. and Dangour, A.D., 2019. "More crop per drop": Exploring India's cereal water use since 2005. *Science of the Total Environment*, *673*, pp.207-217.

This study forms part of the Sustainable and Healthy Food Systems (SHEFS) programme supported by the Wellcome Trust's Our Planet, Our Health programme [grant numbers: 205200/Z/16/Z]. The Wellcome Trust had no role in the design, analysis or writing of this work.

Many thanks to LSHTM and SHEFS colleagues:

Rosemary Green, Edward Joy, Alan Dangour, Pauline Scheelbeek, Soledad Cuevas, Benjamin Kayatz, Bhavani Shankar, Carole Dalin, Ruth Quinn, Cami Moss, Carmelia Alae-Carew

SHEFS