Use of GRACE Satellites to Assess Impacts of Agriculture on Water Storage

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Basic Issues

• How can we monitor changes in water storage globally?
• What is controlling changes in water storage?
• How can we manage water resources more sustainably?
Methods:

• Satellites (GRACE satellites, total water storage)
• Global and regional models
• Ground-based monitoring
• Water use, land use change

Stippled areas: Trend ≥ 3 standard deviations of interannual variability

Scanlon et al., 2022
Long-term Changes in Water Storage in NW India

- Net increase in water storage of 350 km$^3$ (1900 – 2010)
- Decline of ~ 100 km$^3$ (2000 – 2010)
- Surface water irrigation recharging groundwater

MacAllister et al., NG, 2022
GRACE Total Water Storage Changes in NW Saudi Arabia

Rodell et al., 2018
Irrigation Expansion in Saudi Arabia to Support Agriculture

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Rodell et al., 2018

Scanlon et al., ERL, 2021
Human Intervention
Irrigation

Scanlon et al., ERL, 2021
Move Agriculture from Semi-arid to more Humid Regions

The Next California
Phase 1: Investigating Potential in the mid-Mississippi Delta River region
Julia Kurnik, WWF Director, Innovation Startups - Markets

Major virtual groundwater exporters include the USA (31% of global total), India (15%), Pakistan (13%).

Hoekstra and Mekonnen, PNAS, 2012
Summary

• Satellite data allow us to track water storage variability and irrigated agriculture globally over past two decades
• GRACE data show declines in water storage in semiarid regions globally related to irrigation and climate
• Long-term trends in NW India and Pakistan: rises in storage related to canal irrigation followed by declines linked to groundwater pumpage
• US: Groundwater pumpage impacts on storage in humid region much less than in arid region because capturing surface water in humid region
• Virtual water transfer in food trade
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