Developing Drought Assessment Tool for India under Intensive Groundwater Irrigation: a SWAT-based Approach

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SWAT Modeling Activities at IFPRI

- SWAT-Banifing (Mali)
- SWAT-Nigeria
- SWAT-SA (India)
- SWAT-SSA
Why SWAT?

- Methods for drought analysis
  - drought indices (SPI, PDSI and CMI etc.)
  - process-based model
- Advantages of the SWAT model
  - hydrology
  - crop production
  - water and land management practices (irrigation)
Study Area

Legend
- Subbasins
- Country

Pakistan
Nepal
Bhutan
India
Bangladesh
Sri Lanka
Myanmar
China
Challenges in SWAT-India Model Development
Challenges in SWAT-India Model Development

Data source: the Global Reservoir and Dam (GRanD) Database (Lehner et al, 2011)
Model Validation

- Total Water Storage (TWS) variation data from Gravity Recovery And Climate Experiment (GRACE)
  - *vertically integrated water mass anomalies (surface water, groundwater and soil moisture etc.)*

- Methodology for comparing GRACE- and SWAT-based TWS variation data

- GRACE data for this study
  - *10-day TWS variation data from July, 2002 through June, 2011*
Mode Fit to GRACE Data

No simulation for groundwater irrigation activities
Mode Fit to GRACE Data

No simulation for groundwater irrigation activities
Irrigated Crops

(a) Wheat
(b) Rice
(c) Cotton
(d) Sugarcane
(e) Maize

Data source: IFPRI SPAM (You et al., 2009)
Groundwater Irrigation in India

Data source: Global groundwater use inventory (Siebert et al., 2010)
Other Key Steps/Parameters/Assumptions

- Modified subroutine (Kang et al., 2006; Xie and Cui, 2011) for water balance simulation of rice paddy (percolation and seepage loss = 3 mm H$_2$O/day)

- Irrigation efficiency = 0.7

- Consolidation of shallow and deep aquifer (deep aquifer percolation coefficient = 0)

- Unconstrained abstraction from unconsolidated aquifers in northern India
Mode Fit to GRACE Data

With simulation for groundwater irrigation activities
Mode Fit to GRACE Data

With simulation for groundwater irrigation activities
Conclusions and Discussions

- The developed SWAT application is promising to serve as a predictive modeling tool to address groundwater management issues in future drought analysis.

- Uncertainties
  - lack of full accounting of groundwater balance
  - parameter sensitivity
Thank you!