Water Security, Global Change and Land-Atmosphere Feedbacks

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• Water use in the Rafiji Basin, Tanzania.
• Upstream irrigation has dried wetlands, affected wildlife and reduced hydropower.
• Need to understand links between climate change, land use and water management.
Hydrological feedbacks in the Earth system

- Feedbacks strongest in transition zones between wet and dry climates.
- Need to know state of soil moisture in order to provide accurate forecasts.
- Changes to water management can affect regional climate.

Koster et al., 2004. Science 305:1138-1140
Key challenges

• How can we understand the effects of water management decisions in context of global change?

• We need models that can represent hydrological processes, water management and climate feedbacks.
Flow routing and inundation in JULES

Joint UK-Land Environment Simulator (JULES) takes temperature, wind speed, humidity, LW & SW radiation and precipitation from RCM;

- Evaporation
- Radiation
- Rainfall
- Snow

Diagnose state of soil moisture by using a Pareto distribution of soil moisture stores;

Convert to surface and subsurface flow.

Inundated wetland area calculated using sub-grid elevation data

Dadson et al., 2010, J. Geophys. Res., 115: D23114
Irrigation alters South Asian monsoon

- Indus-Ganges largest continuous area of irrigation in the world
- Irrigation -> evaporation -> cooler land-surface
- Better representation of monsoon depressions with irrigation in the model

Saeed et al., 2009, GRL, 36: L20711
Land-atmosphere feedbacks in W. Africa

- Niger Inland Delta, Mali;
- Inundation drives water vapour flux and temperature anomaly;
- Seasonal flooding provides up to 50% of water vapour to atmosphere.

Dadson et al., 2010, J. Geophys. Res., 115: D23114
Development of a “wetland breeze”;
50% more daytime storms during floods
Better land-surface modelling will improve weather forecasts in West Africa.

Dadson et al., 2010, J. Geophys. Res., 115: D23114
• Proposed new 90 MW dam at Fomi will:
  – reduce fish populations by up to 36%
  – disrupt complex relation between flooding and ecology (3-4 million staging waterbirds)
  – but increase rice production in newly-irrigated areas by 320,000 t (to meet 90% of domestic demand)

• How can policymakers balance need for mitigation of & adaptation to climate change with food security, wetland biodiversity, and other ecosystem services?