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Water resource sustainability: our shared responsibility

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Water Resource Sustainability: Our Shared Responsibility

Water Sustainapalooza Talk
University of Iowa
February 25, 2010

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Predictions across Scales

Top Down: Generalist

Bottom Up: Reductionist

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**Groundwater Contamination with Chlorinated Solvents (Source & Plume)**

Field studies indicate Source Mass Reduction reduces Source Strength (mass/time) in an approximately linear way.

**WHY?**

Falta, Basu and Rao, JCH 2005
Source Strength Reduction = (Source Mass Reduction)\(\Gamma\)

\(\Gamma = 0.5 \text{ to } 2.0\) ---- is a function of subsurface heterogeneity

Simple Model or Complex Model?

Basu et al., WRR 2008
Hypoxia in the Gulf of Mexico

How to develop simple models that predict responses across scales?
Annual Water Budget: Budyko Curve

Annual Streamflow can be predicted based only on Climatic Attributes

Potter et al, WRR (2005)
What about sub-annual time scales?
How fast does the catchment drain?

Rainfall

Streamflow

Complexity in Catchment Residence Time Distribution

McDonnell et al. 2006
Hypothesis:
Reduction in Complexity in Engineered Watersheds

Tiles bypass the complexity of the landscape?

Evidence Documented By:

- Multi-scale entropy analysis of 131 years of streamflow data in the Mississippi River indicates loss in complexity (Zhang et al. 2008)

- Simpler, exponential hydrograph recession curves in tile-drained watersheds compared to non-tile-drained (Schilling et al. 2008)
UNCALIBRATED TELM VS CALIBRATED SWAT

We can predict streamflow---Can we predict nitrogen load?

- Year 2003: P = 665 mm
- Year 2001; P = 510 mm
- Year 2002: P = 295 mm
- Year 2000: P = 500 mm

Uncalibrated TELM works as well as calibrated SWAT

- Simpler models than are currently used
- Add process complexity to the model when necessary

Why does Concentration vary less than Discharge?

50,000 – 200,000 sq km basins in the Mississippi River Basin
Why does Concentration vary less than Discharge?

Ellenbrook Catchment in Western Australia
Why does Concentration vary less than Discharge?

Catchments in the Baltic Sea Basin
Why do we see this pattern?

- Nutrient storage Legacy due to Anthropogenic Impacts
  buffers episodic inputs

- Transport Limited Systems --- Not Supply Limited

What Does it Mean?

Does biogeochemical stationarity (invariance) make water quality modeling simpler at least at the annual timescale?

What would be the implications for relative benefits of source reductions (eg, land-use change) vs. downstream mitigation (e.g., wetland construction) for hypoxia reduction?
Towards a Conceptual Model of “Tile-to-Tide” Hydrologic Responses

**Patterns**

**Processes**

**Predictions**

**Purpose**

Thank You
Conventional Biogeochemical Models

Calibration of spatially integrated input with spatially distributed parameters

Equifinality or Non-uniqueness

Water Quantity and Quality Data