Online Hydrologic Modeling of Agricultural Erosion: Future Climate Scenarios

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Motivation

• Recent studies have shown a significant decline in erosion (Kok et al., 2009; Brooks et al., 2010)
  – Due to reduced tillage management practices
• 1000+ water bodies in Idaho violate the CWA
  – Most dominant is sediment
  – Similar for the PNW
Motivation

• Little evidence of significant declining pollutant loading in many watershed studies (Mulla et al., 2008)
  – Failure to implement BMPs in the most critical areas of the watershed.
Motivation

- Better tools are needed to identify these critical areas and improve them with appropriate BMPs. (Mulla et al., 2008)
  - Simple
  - Minimal data requirements
  - Minimal calibration
REACCH Solutions

• 2005 Tillage practices in the PNW (Kok et al., 2009)
  – Conventional till – 40%
  – Mulch till – 50%
  – No till – 10%
The Big Picture

• Will current BMPs be as effective in the future?
  – Changing climate zones
  – Will rainfall intensity increase?
    • More runoff and erosion

• How can we mitigate these impacts?
Current Needs

• Targeted erosion control practices
• Simple modeling tools
  – Efficient and effective management practice
  – Minimize
    • Erosion
    • Runoff
    • Pollutants
WEPP Model

- **W**atershed **E**rosion **P**rediction **P**roject
- Developed by the USDA
- Process-based hydrology and erosion model
  - Not empirical
- Extensive input
- Time consuming
- Data readily available
  - Soil (USDA SURRGO)
HCT: Hydrologic Characterization Tool

• Based on the WEPP Model
• Uses common default parameters
• Few inputs
  – Climate
  – Soil
  – Management practice
  – Slope
HCT Limitations

• Static data
  – New regions, climates, soils and management must be added manually

• Represents a single slope
  – Characteristic land type
Objectives

• Create tools to generate soil and climate files
  – Climate tool (Stephen)
  – Soil tool (USDA STATSGO 2006)

• Improve HCT scope
  – Incorporate future climate scenarios
  – Generate widespread soil files

• Apply HCT throughout the REACCH region
  – 2 AEZs
  – Future climate scenarios
  – Predict runoff & erosion rates
Soil File Generation

- Uses USDA STATSGO Soil Survey data (2006)
  - Access Database files
    - SQL
- Soil File Tool (Python)
  - Gathers Data
  - Sorts
  - Output
Soil File Generation

• **ArcMap interface**
  – Select soil unit

• **Console interface**
  – Input: unit key into the soil tool
  – Output: CT, MT, and NT soil files
Climate File Generation

- Stephen Fricke (John Abatzoglou)
- RCP 4.5 (CNRM-CM5 Model)
- Generate WEPP file with Cligen 5.3
- Climate tool (PERL)
  - Adds wind speed & solar radiation
Intermediate Crop (Dry)

- Shallow: Naff (43 cm)
- Intermediate: Thatuna (94 cm)
- Deep: Palouse (152 cm)

Annual Crop (Wet)

- Shallow: Nez Perce (51 cm)
- Intermediate: Southwick (97 cm)
- Deep: Palouse (152 cm)
Erosion Comparison: Intermediate Crop (Dry)

Tillage Practices: Conventional Till – CT; Mulch Till – MT; No Till – NT
**Erosion Comparison: Annual Crop (Wet)**

**Tillage Practices:** Conventional Till – **CT**; Mulch Till – **MT**; No Till – **NT**
Rain Runoff: Annual Crop Zone

Tillage Practices: Conventional Till – CT; Mulch Till – MT; No Till – NT
Erosion Events by Year: Annual Crop Wet

2006 – 2036
Annual Events: 40
Annual Erosion (t ha\(^{-1}\)): 6.8

2036 – 2066
Annual Events: 30
Annual Erosion (t ha\(^{-1}\)): 6.9

2066 – 2096
Annual Events: 23
Annual Erosion (t ha\(^{-1}\)): 13.5
Summary

• Developed WEPP soil and climate file generation tools (Python, Perl)
• Mulch Till is an effective practice
  – ~85% reduction in soil erosion
• Future climate simulations suggest
  – Fewer erosion events
  – Increasing magnitude
Future Application

• HCT
  – Dynamic map-based data selection
    • Soil
    • Server side climate generation

• Soil Creation
  – ArcMap tool

• Investigate the assumption of static rainfall intensity characteristics in future climate scenarios
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References: