IIASA’s EPIC modeling of crop production systems – wheat

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Topics:

- EPIC - a tool for assessment environmental impacts of cropland management
- Deploying of IIASA’s global modeling system for sub-continental assessment

- High input management system – irrigated
- High input system - rainfed
- Low input system - rainfed
- Subsistence system

Wheat yield (HI rainfed)

Enough data?

BAU scenario
Management change scenario
EPIC: a biophysical model of cropland management

- Soil erosion impacts for 135 U.S. land resource regions (Putnam et al. 1988)
- Components from CREAMS (Knisel 1980), SWRRB (Williams et al. 1985), GLEAMS (Leonard et al. 1987) and many processes important in land use management (Sharpley et Williams 1990, Williams et al. 2000)
- Environmental Policy Integrated Climate (Williams et al. 1996)
- Carbon cycling routine was performed by Izaurralde et al. (2006) based on CENTURY (Parton et al. 1994)
- Documentation of EPIC's historical development and applications was given by Gassman et al. (2004)
- GEPI by Liu et al. (2007) operational on a global scale (Liu 2009)

**MAJOR COMPONENTS:**
- crop growth and competition,
- weather simulation,
- hydrology,
- wind/water soil erosion,
- nutrient cycling,
- soil organic carbon
- pesticide fate,
- soil temperature/moisture,
- tillage effects,
- plant environment control
- grazing

**INPUTS:**
- Weather
- Soil
- Topography
- Land use & crop management

**OUTPUTS:**
- Annual / Monthly / Daily
- Crop biomass / yields
- N, P and C cycle
- Crop stress
- Water / wind erosion
- Water cycle / hydrology
- Etc.
IIASA’s EPIC modeling system for EU – setup and validation
Data sources

- European Soil Database (ESDB)
  [http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB/index.htm]
- ESDB OC Top v. 1.2
  [http://eusoils.jrc.ec.europa.eu/ESDB_Archive/octop/octop_data.html]
- HYPRES
  [http://www.macaulay.ac.uk/hypres/hypres_update.html]
- GTOPO30
- SRTM90
  [http://www2.jpl.nasa.gov/srtm]
- AGISCO
- CORINE & PELCOM
- NEW CRONOS, EUROSTAT
  [http://www.esds.ac.uk/international/support/user_guides/eurostat/cronos.asp]
- MARS/MOCA crop calendar
- CGMS daily meteorological data 1997-2007
  [http://mars.jrc.ec.europa.eu/mars/Projects/CGMS]
- European river catchments
- CC-TAME crop fertilization DB
Geo-explicit wheat management calendar (50 km)

Potential Heat Units

$$PHU = \sum_{d=1}^{m} (T_{av} - T_{b}), \text{ when } T_{av} > T_{b}$$

Planting dates → Tillage P,K-fertilizer app.

Fraction of PHU at harvest → Optimization

Optimization

N-fertilizer application

CLIMATE & FERTILIZATION DBs

Operation Schedule

EPIC Crop

Operation Schedule

Planting density

$$OPV5 = -0.00003P_e^2 + 0.012P_e + 31.198$$

Plant available precipitation (P_e, mm)
Wheat yield validation

EUROSTAT – average WWHT yield per NUTS2 (t/ha)

EPIC – average WWHT yield per NUTS2 (t/ha)
IIASA’s EPIC modeling system – sample application of crop management impact assessment (CARBON-EXTREME)
Conversion from conventional to reduced tillage – impacts on the total SOC

Conventional tillage management
Mouldboard plough
Tillage depth: 150 mm
Mixing efficiency: 99 %
Crop residue left on surface: 1 %

Reduced tillage management
Disk and chisel plough
Tillage depth: 150 mm
Mixing efficiency: 85 %
Crop residue left on surface: 15 %
Conventional to reduced tillage – impact on SOC pools

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<thead>
<tr>
<th></th>
<th>PREC (mm)</th>
<th>T (°C)</th>
<th>PREC x T</th>
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<tbody>
<tr>
<td>Total SOC in ploughing layer (t/ha)</td>
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<td><img src="image" alt="b" /></td>
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<td>SOC in passive humus (kg/ha)</td>
<td><img src="image" alt="d" /></td>
<td><img src="image" alt="e" /></td>
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<td>SOC in slow humus (kg/ha)</td>
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# Conventional to reduced tillage – impact on SOC pools

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<th>PREC (mm)</th>
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<td>SOC in structural</td>
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<td>litter (kg/ha)</td>
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<td>SOC in metabolic</td>
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<td>litter (kg/ha)</td>
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<tr>
<td>SOC in structural</td>
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<td>litter / biomass (kg/ha)</td>
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### Diagrams

#### j.

#### k.

#### l.

#### m.

#### n.

#### o.

#### p.
Soil loss by water erosion under wheat production system

Average yearly soil loss by water erosion (MUSLE, 1997-2007)
Soil loss by water erosion under wheat production system
Probability of extreme erosion events

Probability of erosion more than 40 t/ha/year
- < 1%
- 1 - 20%
- 20 - 50%
- > 50%

Probability of erosion more than 20 t/ha/year
- < 1%
- 1 - 20%
- 20 - 50%
- > 50%
Thank you!