Watershed Conservation Management Planning Using the Integrated Field & Channel Technology of AnnAGNPS & CONCEPTS

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BMP’s can be studied from field scale to their impact on a watershed scale.
Erosion can occur anywhere in a watershed.

- Erosion in fields
- Erosion in small field channels
- Erosion in stream systems
Tillage-Induced Ephemeral Gully Erosion -“TIEGEM”

As a result of a non-erosive layer at the bottom of the tillage depth
Branching of Ephemeral Gullies
Disturbed Stream Systems
AnnAGNPS

A partnering effort between the USDA:

Agricultural Research Service

and

Natural Resource Conservation Service

National Sedimentation Laboratory

United States Department of Agriculture

NRCS
CONCEPTS – CONservational Channel Evolution and Pollutant Transport System

CONCEPTS simulates long-term response of channels to loadings of water and sediments, and to instream structures.

**Input:**
- Channel geometry
- Composition of bed and bank materials
- Erosion resistance and shear strength of bed and bank materials
- Rates of flow and sediments entering the channel

**Output:**
- Changes in channel geometry
- Time series of hydraulic variables and sediment yield
TYPES OF EROSION

- Interrill and rill (sheet-rill)
- Wind
- Ephemeral gully
- Permanent, incised (classical) gully
- Stream channel
- Mass movement
- Geologic
Watershed Erosion → Model Components

- Sheet & Rill
- Ephemeral Gully
- Classical Gully
- Channel Erosion

- RUSLE
- EGEM → REGEM → TIEGEM
- Runoff/Sediment Relat.
- CONCEPTS when significant changes of channel morphology are possible
Watershed Sedimentation Processes

ARS Models

CONCEPTS

RUSLE

Hillslope

Surface Erosion

Gully Erosion

Mass Erosion

Hillslope Storage

Bank Erosion

Channel

Channel Transport

Channel Storage

Net Watershed Sediment Yield

Production

Storage and Transport

Yield

AnnAGNPS
Sediment and nutrients transported to the edge of the field.
AnnAGNPS Cell Landscape

Erosion Types

Overland flow

Interrill

Rill

Ephemeral Gully (Concentrated flow)
Track loadings by source throughout the transport process

Water, Sediment, & Chemical Sources

Cell A
Cell B
Cell C
Cell D
Cell E
Cell F

reach 1
reach 2
reach 3
reach 4

feedlot
point source
gully
Impoundment
watershed outlet

Water, Sediment, & Chemical Sources
AGNPS WATERSHED DESCRIPTION

FOCUS ON STREAM REACHES by CONCEPTS

SUBWATERSHEDS

CONNECTED BY THE CHANNEL NETWORK
AnnAGNPS

- Incorporates simple reach routing processes.
- There is no memory between runoff events.
CONCEPTS is better suited:

- When a significant portion of sediment originates from channel sources.
- When hydrodynamic channel morphological process simulations are needed.
Integration of REMM Within Models

Riparian Buffer System

Stream

Field

Erosion and Deposition
Case Study – James Creek, MS

- Listed as impaired due to excessive sedimentation
- Channel impacted by:
  - Channelization (~1905)
  - Dredging and snagging (1968)
  - Construction of several low-water crossings (1960s – 1990s)
  - Construction of Tennessee-Tombigbee waterway (1980s)
James Creek – Description

- 1430 mm rainfall
- Drainage area 111 sq km (43 sq mi)
- Soils: dominated by silty clays and silt loams
- Most of the watershed in cultivated croplands, pasture or fallow conditions
  - Main crops: corn, soybeans, cotton, wheat, and sorghum
- Implemented BMPs: reduced tillage, strip cropping, terraces
James Creek – Channel Characteristics

- Lower 6.6 km has ‘natural’ sinuous alignment
- Bank erosion is prevalent
- Boundary materials are predominantly silts and clays
GIS Land Use Layer

- Planting Soybeans into Harvested Wheat Fields
- Gully Migration into Furrows
- Soybeans in a Reduced Tillage Field
Synthesis of 1967 Cross-Sections

DISTANCE ABOVE MOUTH OF JAMES CREEK, IN KILOMETERS

THALWEG ELEVATION, IN METERS

- 1967
- 2002
- Floodplain
- Low-water crossing

Sinuous reach
Channelized reach
YEARLY RAINFALL FROM ABERDEEN, MISSISSIPPI – 1967-2001

1967-2001 AVERAGE (1411 mm)

LONG-TERM AVERAGE (1317 mm)
ANNAGNPS SIMULATED YEARLY RUNOFF AT DARRACOTT ROAD

YEAR
RAINFALL or RUNOFF (mm)
RAINFALL
RUNOFF
AnnAGNPS Simulated Runoff and Sediment Yield by Field

Sediment Load Portion from Upland Sources @ Outlet = 2.2 T/ha/y (1 t/ac/y)
Comparison of Cross Sections

[Diagram showing comparison of elevation changes over horizontal distance from 1967 Initial Condition, 2002 Measured, and 2002 Simulated data.]
Sediment Load

YEAR


SEDIMENT LOAD, IN TONES

10000000
1000000
100000
10000
1000
100
10

All channels
Fields
Total
## Sediment Load at the Watershed Outlet (1967 – 2002)

<table>
<thead>
<tr>
<th>Reach</th>
<th>Channel (T)</th>
<th>Sheet and Rill (T)</th>
<th>Total (T)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above rkm 7.92</td>
<td>7220000</td>
<td>910000</td>
<td>8130000</td>
</tr>
<tr>
<td>Below rkm 7.92</td>
<td>677000</td>
<td>53340</td>
<td>730000</td>
</tr>
<tr>
<td><strong>Total Load (T)</strong></td>
<td><strong>7900000</strong></td>
<td><strong>964000</strong></td>
<td><strong>8860000</strong></td>
</tr>
<tr>
<td><strong>Average Load (T/y)</strong></td>
<td><strong>226000</strong></td>
<td><strong>27500</strong></td>
<td><strong>253000</strong></td>
</tr>
<tr>
<td><strong>Average Yield (T/y/km²)</strong></td>
<td><strong>2015</strong></td>
<td><strong>246</strong></td>
<td><strong>2260</strong></td>
</tr>
<tr>
<td><strong>Contribution (%)</strong></td>
<td><strong>89</strong></td>
<td><strong>11</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>
Summary

- AnnAGNPS is a watershed conservation planning tool (CEAP).

- CONCEPTS provides needed capabilities to characterize channel erosion contributions.

- Used together these technologies allow watershed management planning to target the appropriate issues.
Thank you