Effects of Topographic Feedback on Erosion and Deposition Prediction

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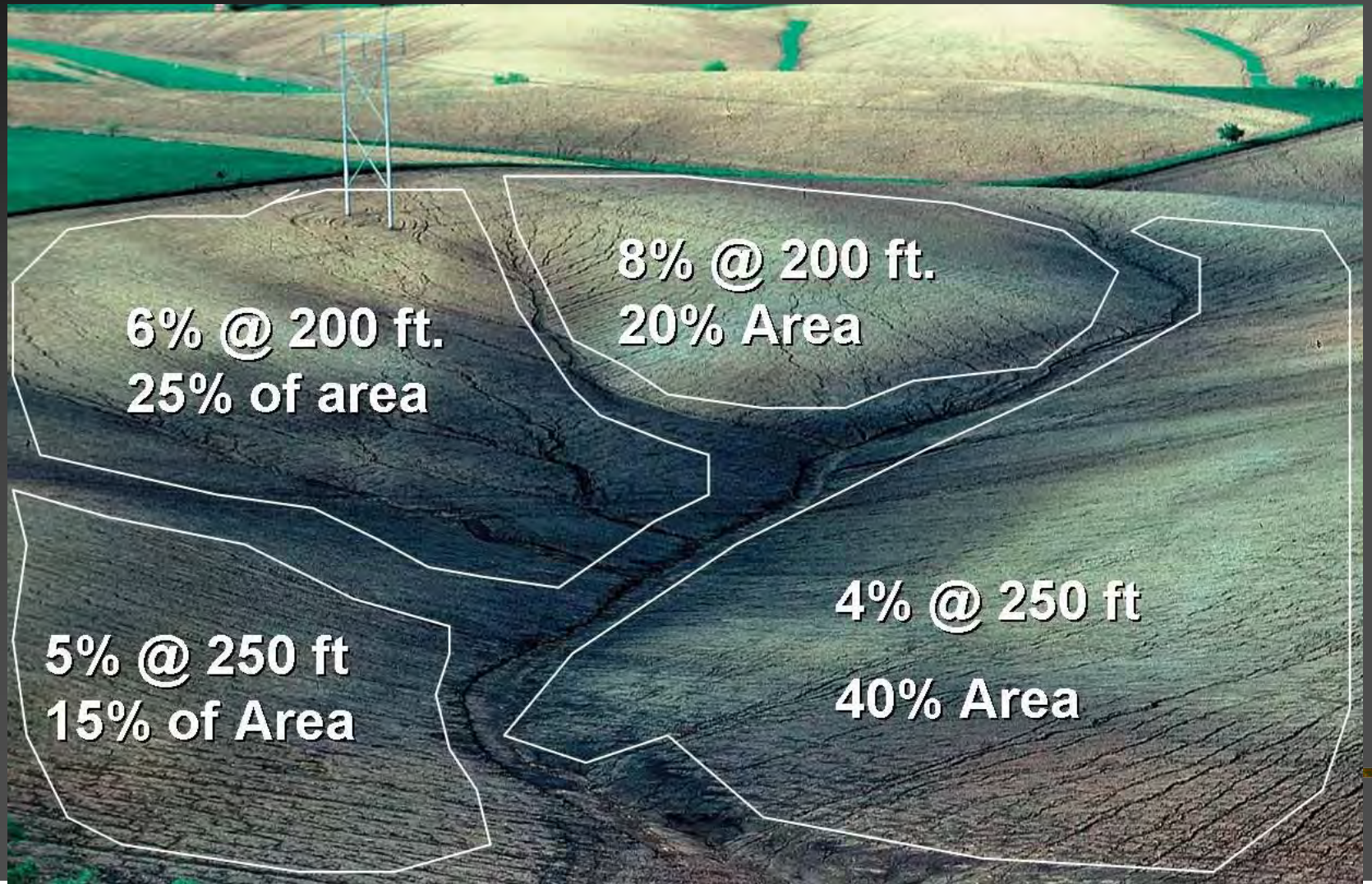
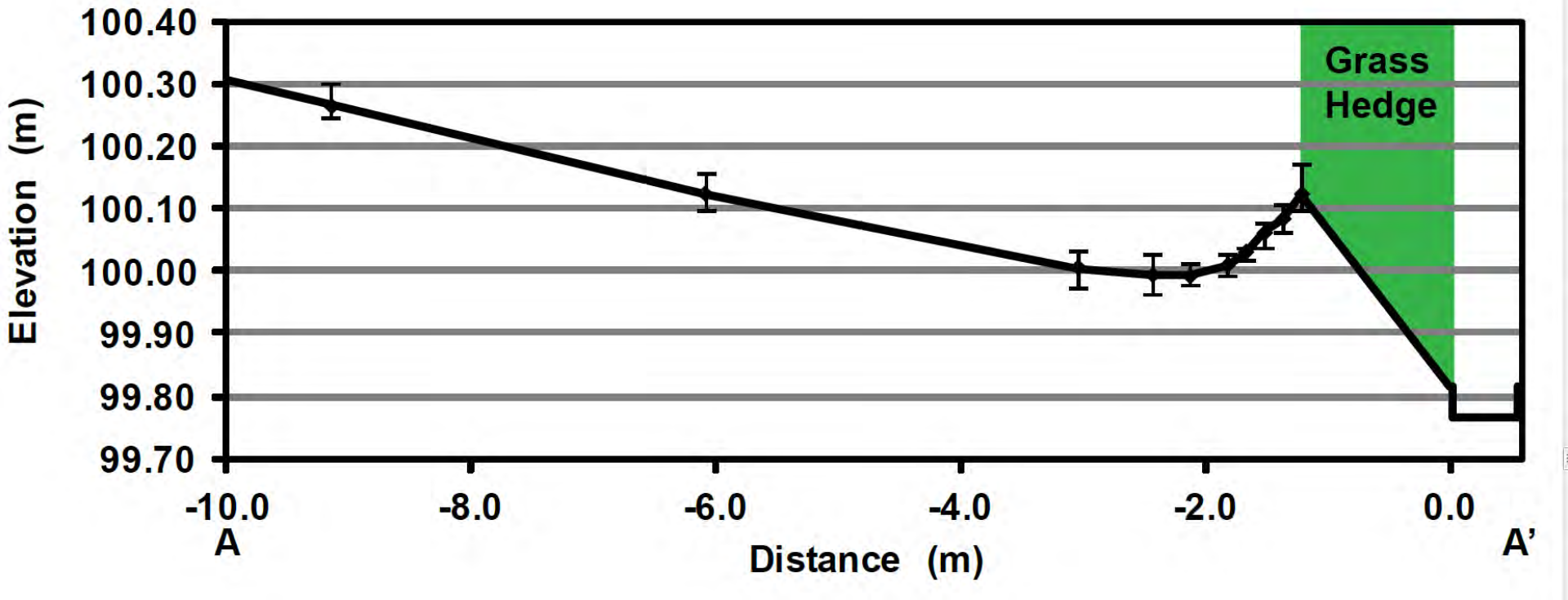
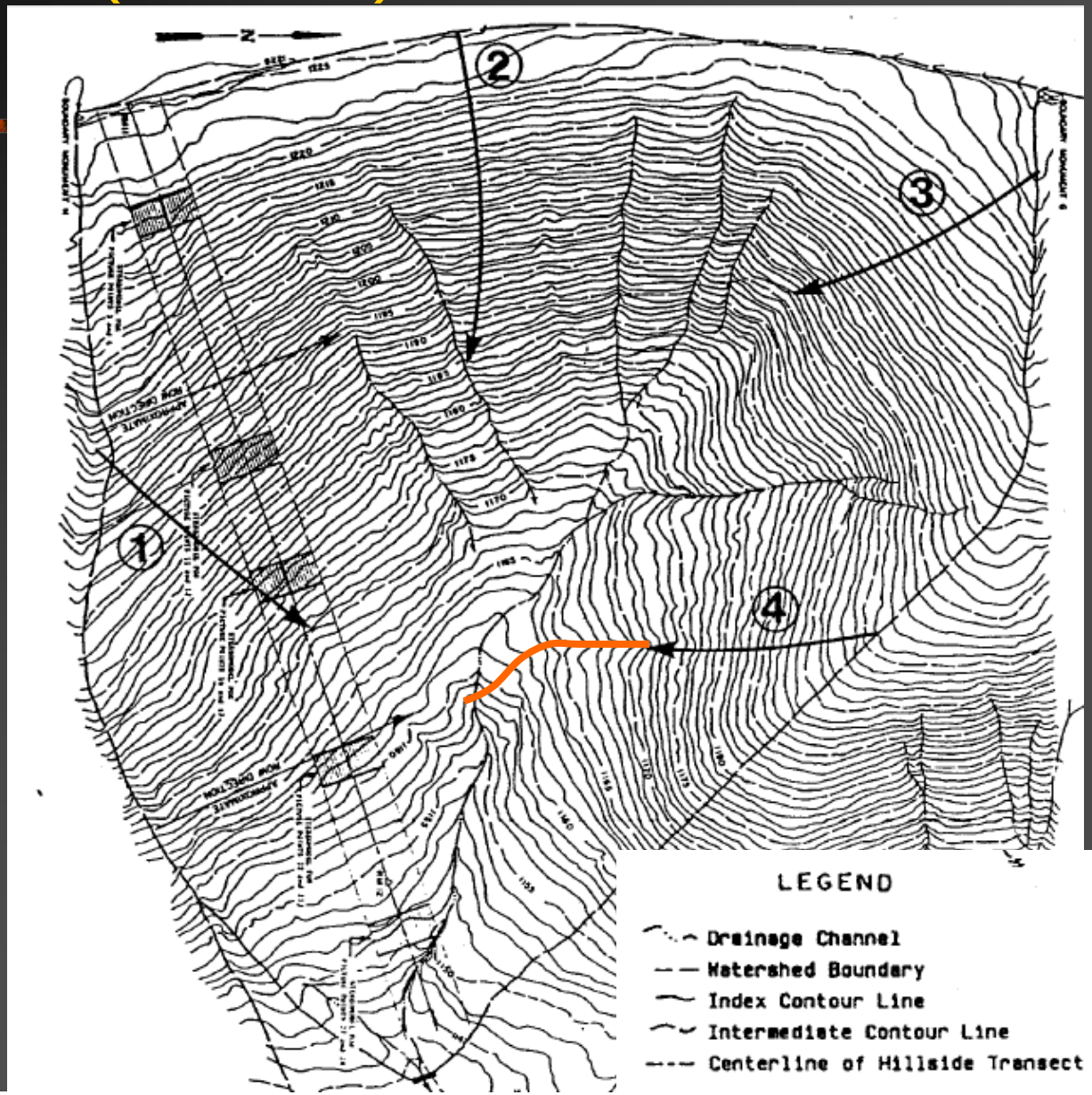
RUSLE2 computes sheet and rill erosion, not concentrated flow erosion



Tillage erosion



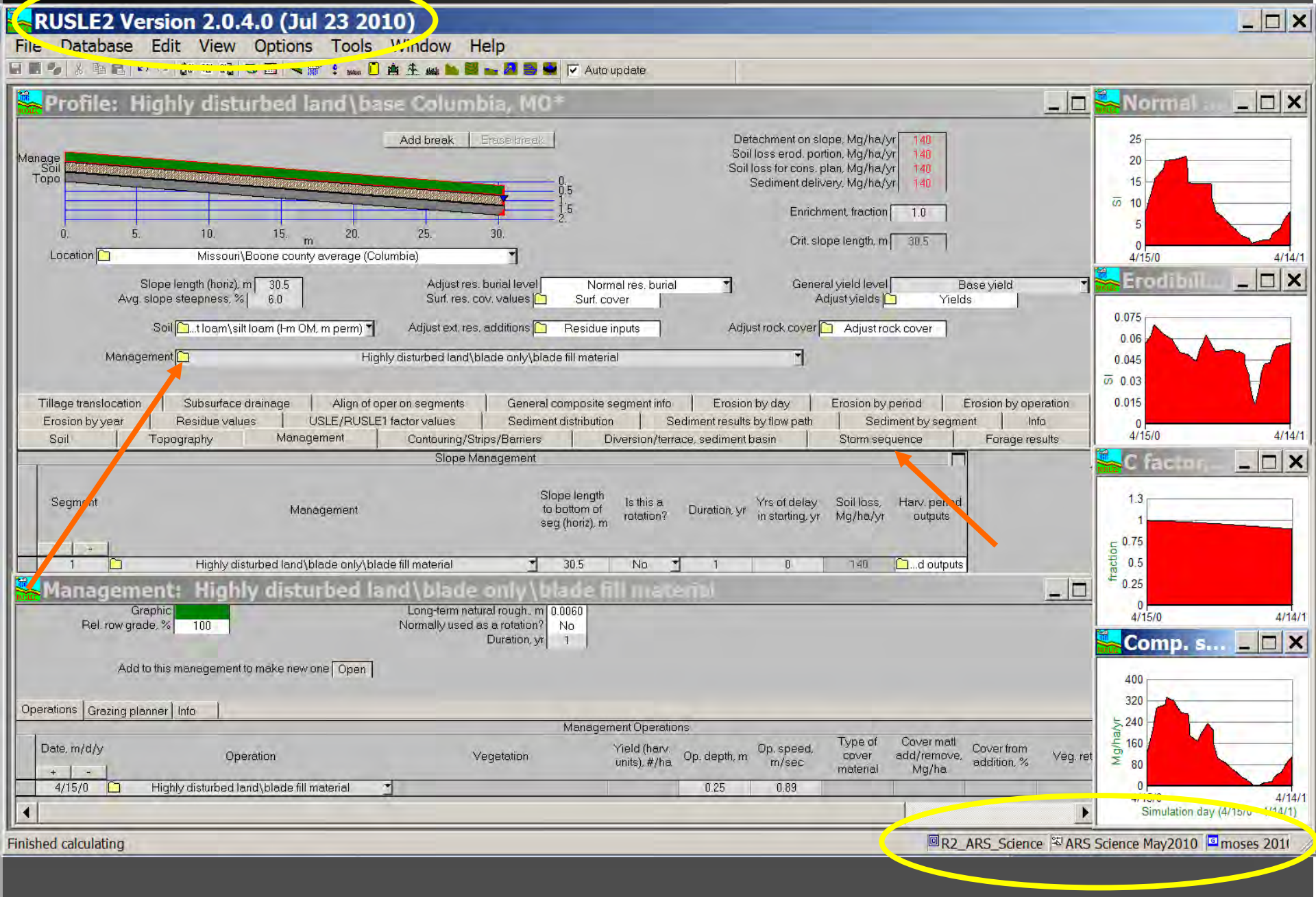
Ephemeral gully channels end RUSLE2 hillslopes (AH 703)



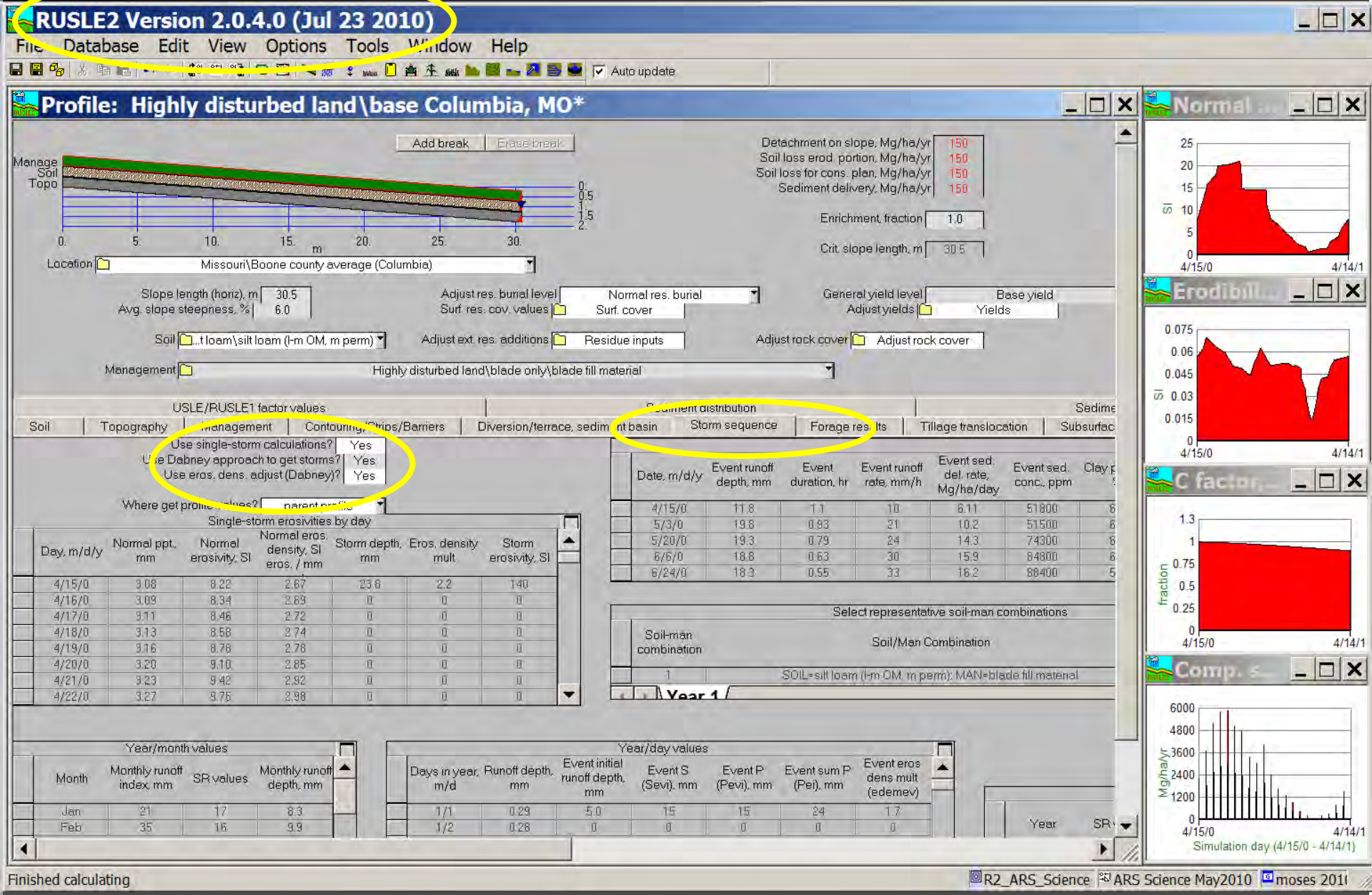
To make use of LiDAR topotraphic sources a 2-D version of RUSLE2

- RUSLE2 runoff event sequences
- Slope length calculated from runoff ratios
- GIS tools to identify raster flow network and channel locations
- Linkage with a concentrated flow (ephemeral gully) erosion model

http://www.ars.usda.gov/Research/docs.htm?docid=20222



http://www.ars.usda.gov/Research/docs.htm?docid=20222



HYDROLOGICAL PROCESSES
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Enhancing RUSLE to include runoff-driven phenomena

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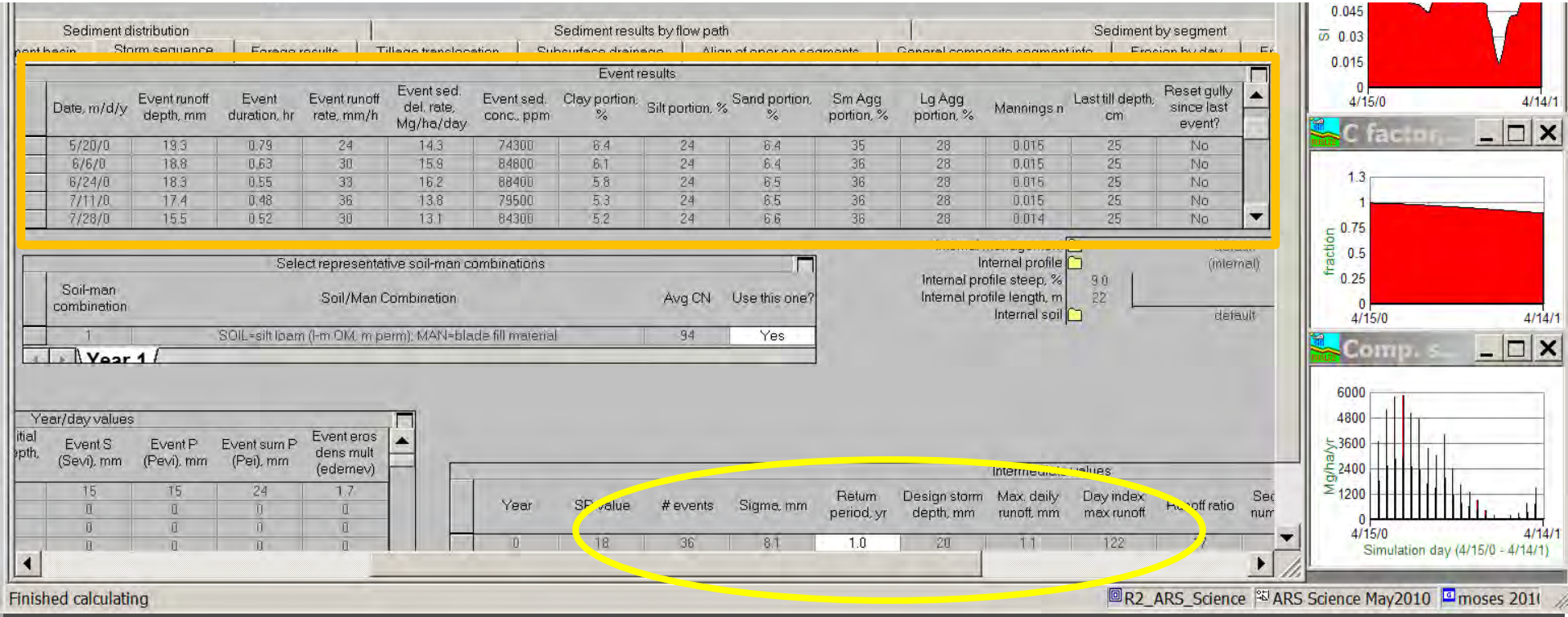


Shell GIS program combines cells into profiles that end at channels

- RUSLE2 Simulation Units
  - One Simulation Unit ("Profile") for each Channel Cell
  - Defined based on drainage patterns (flow directions)
  - Input Layers: Flow Directions and Channel Cells

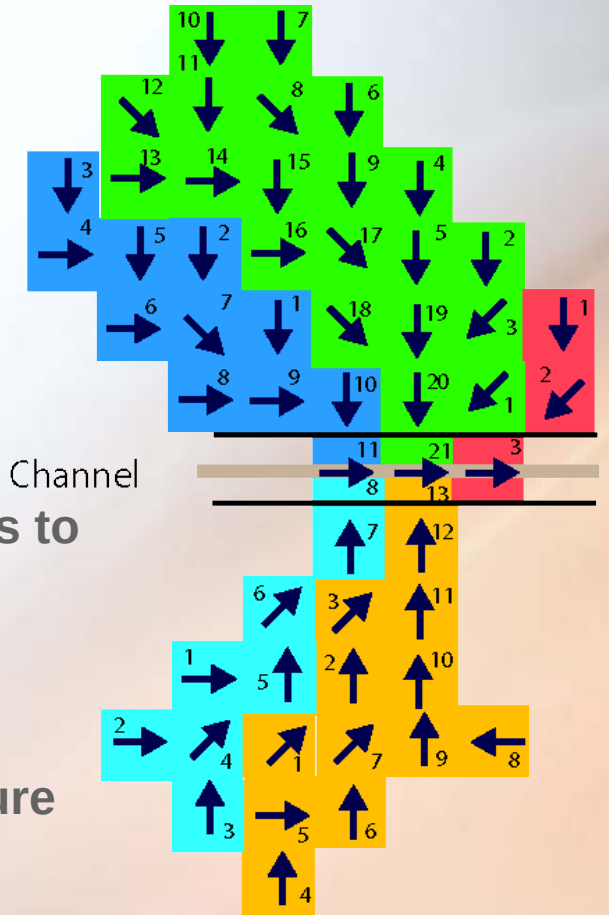
Shell program:

sequences cells

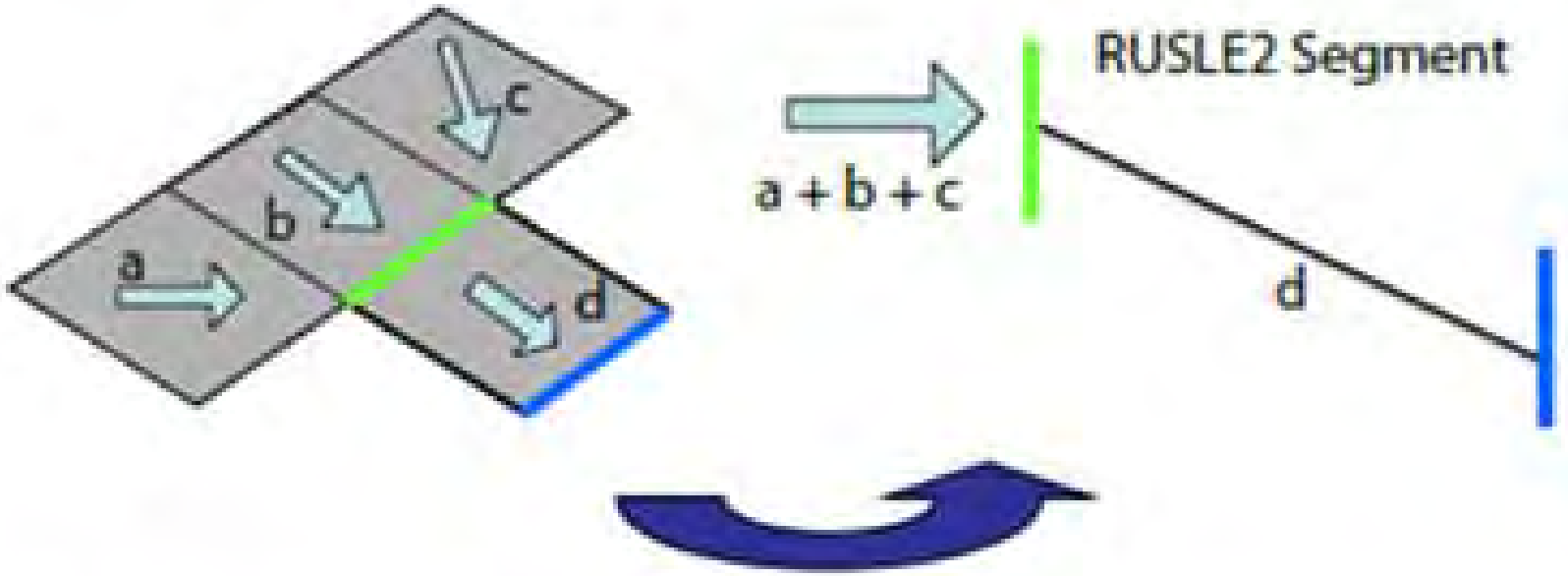
calls RUSLE2 DLL

Cell sequencing algorithm:

- **Start from channel cell**
- **Find cells draining into current cell**
- **If a contributing cell was found, move analysis to that cell and repeat search**
- **ID No-Inflow cells; assign number**
- **Inspect cells in downslope direction**
- **Save cell connectivity in auxiliary data structure**

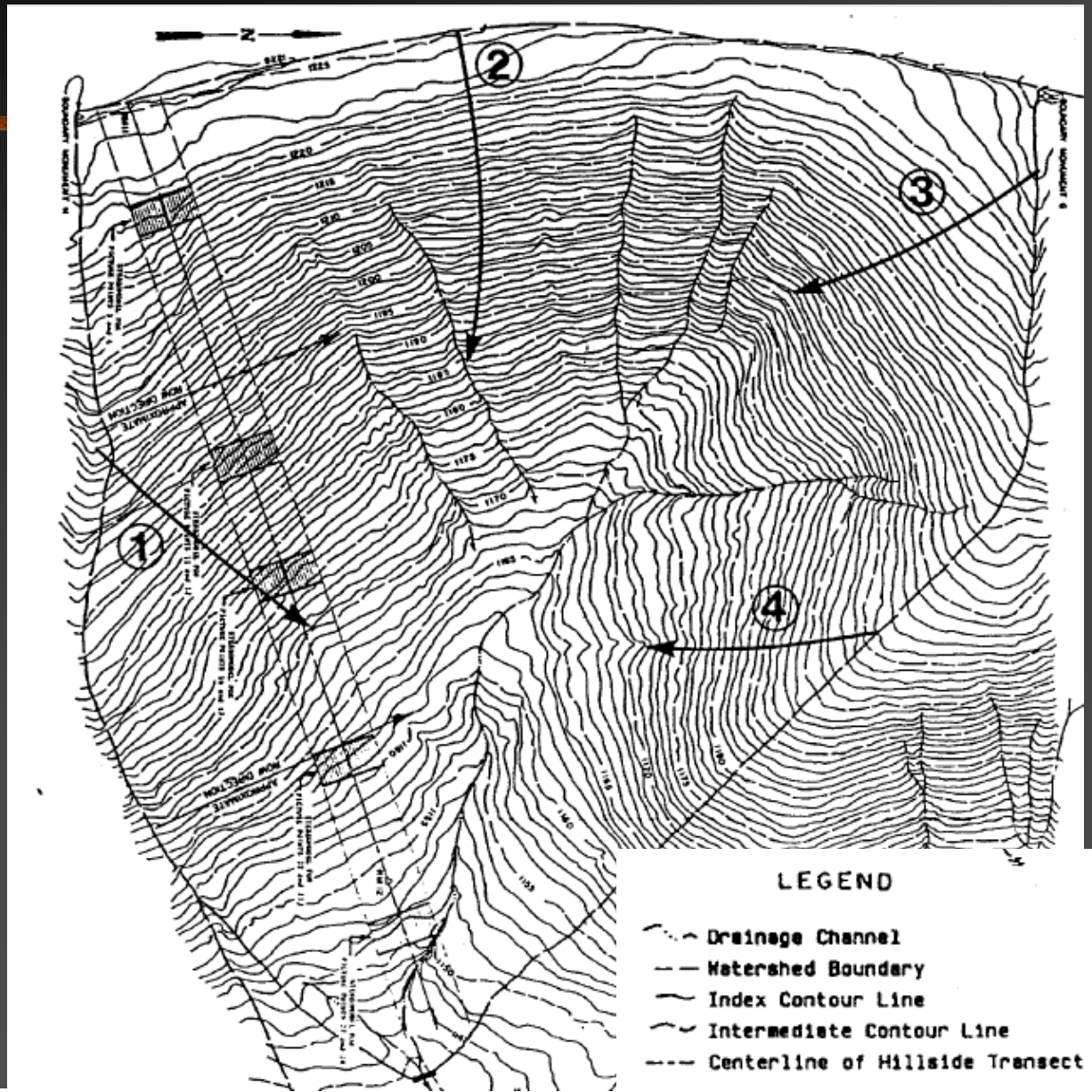


Slope length calculated as ratio of runoff leaving to runoff generated within cell



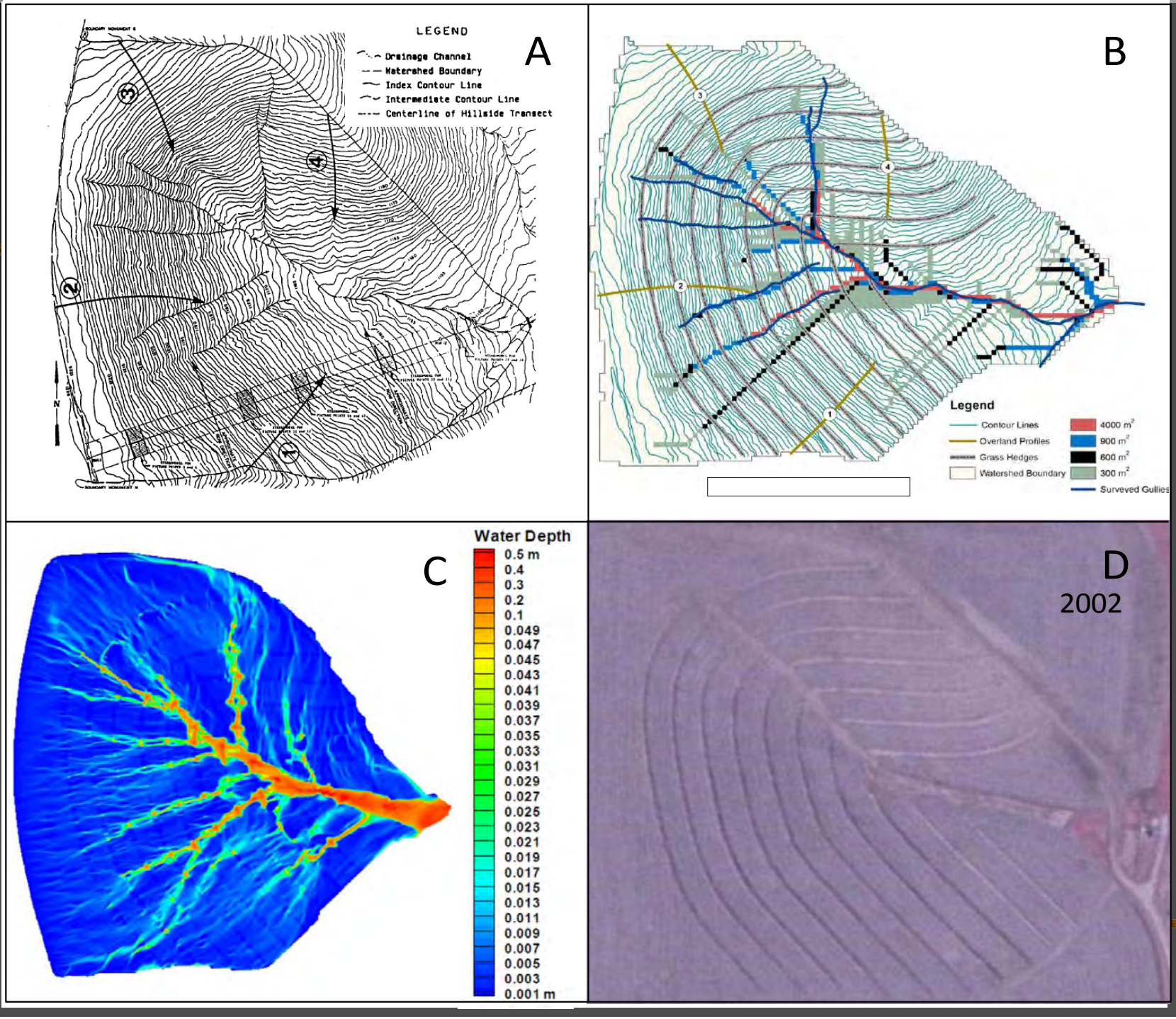
Rusle2 tracks runoff and erosion from cell to cell. Sediment loads and characteristics leaving each cell are stored and used in the sediment transport computations of the subsequent cell.

Example: Treynor WS 11 (AH 703)



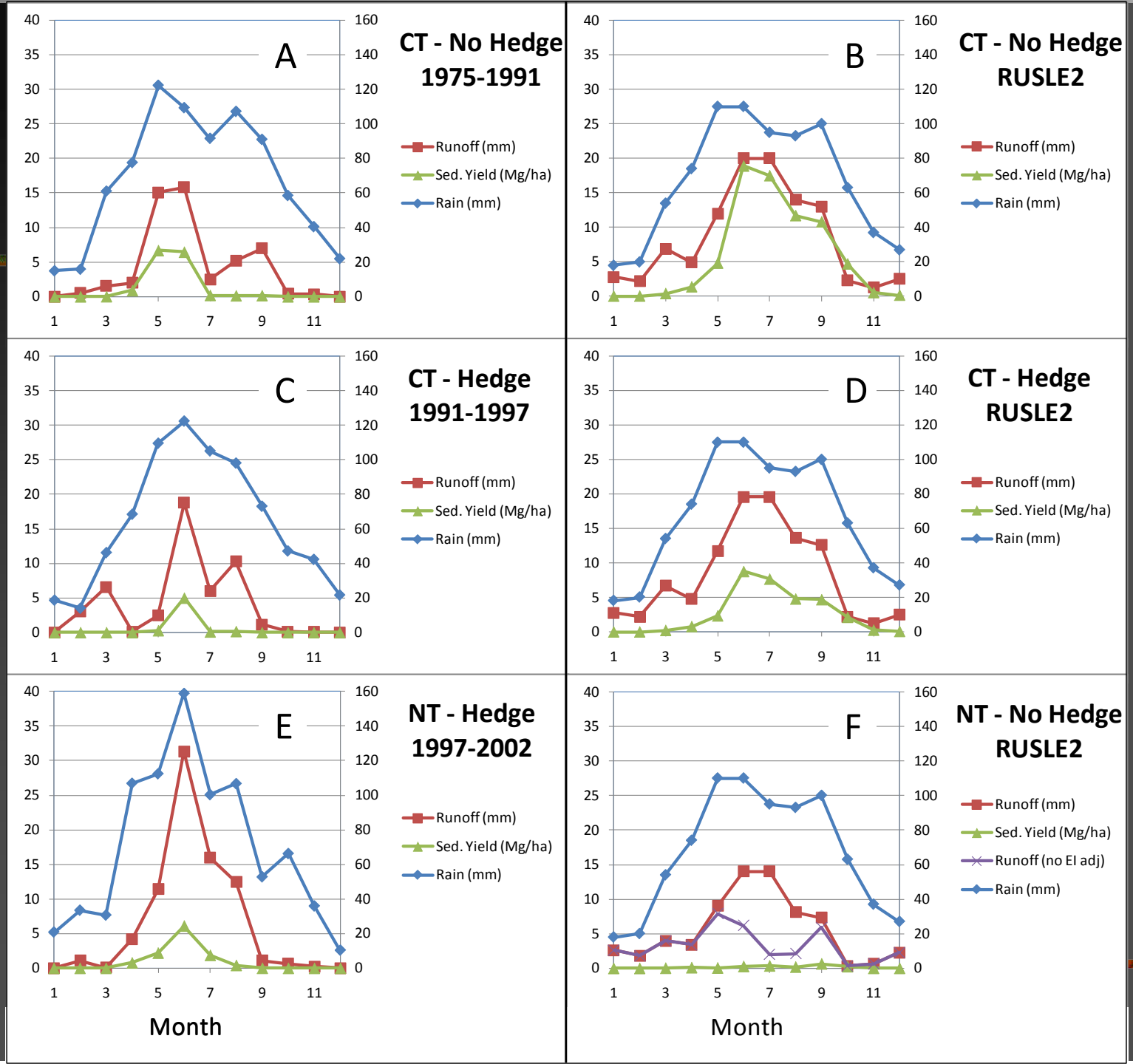
HISTORY

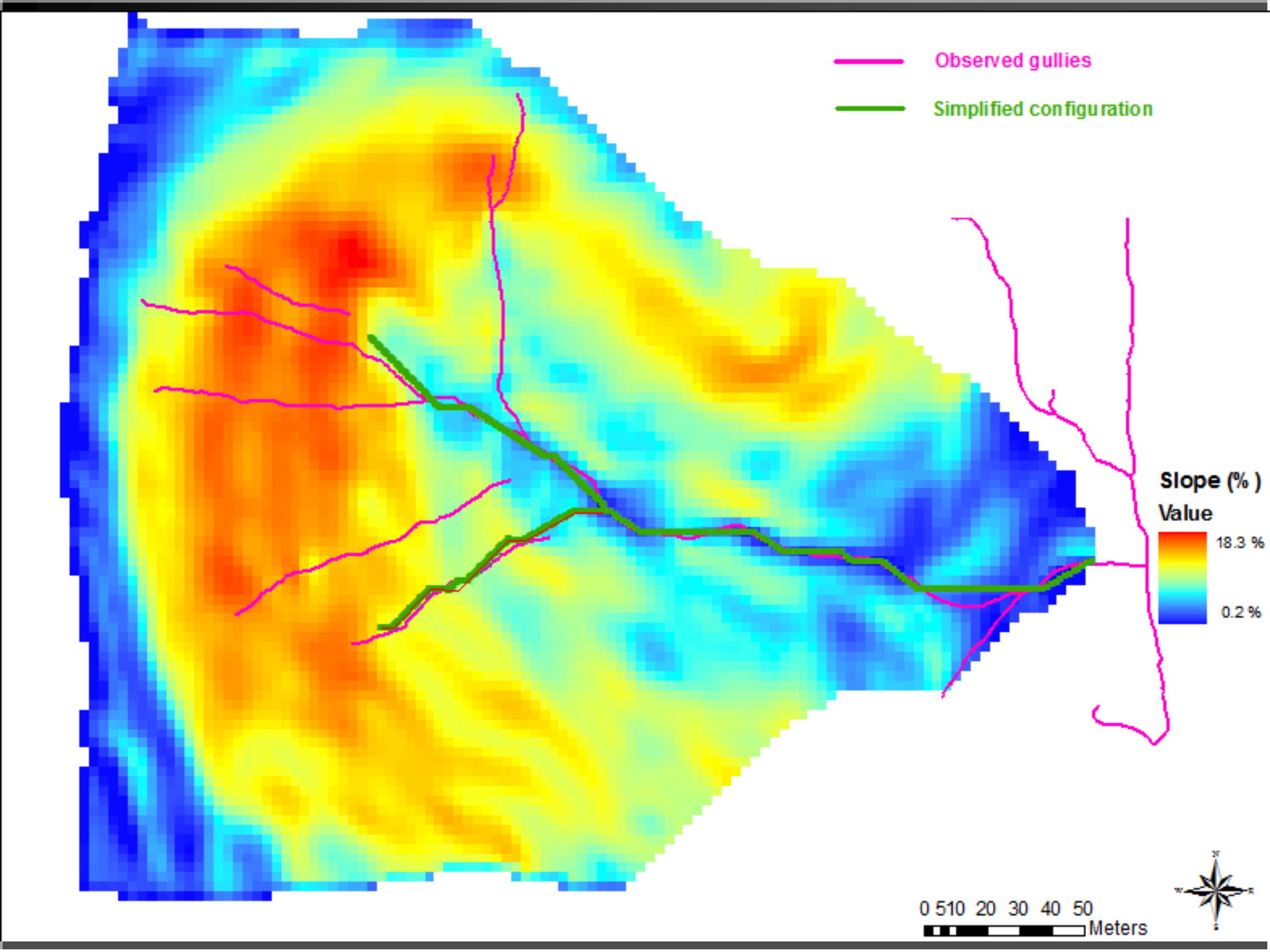
- CT 1975-1997
- Hedges established starting 1992
- NT 1997-2002

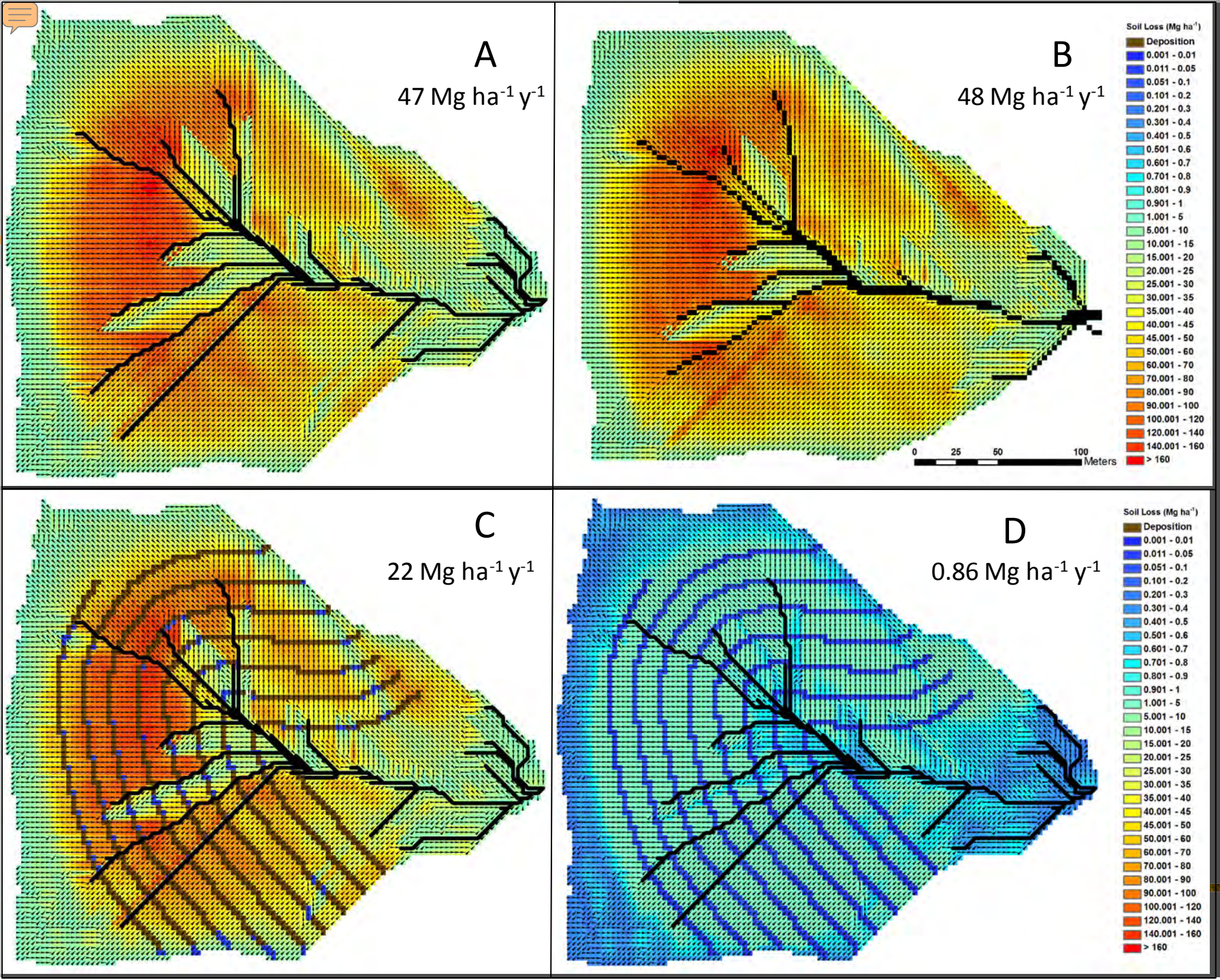

A
LEGEND
Drainage Channel
Watershed Boundary
Index Contour Line
Intermediate Contour Line
Centerline of Hillside Transect
B
Legend
Contour Lines
Overland Profiles
Grass Hedges
Watershed Boundary
4000 m²
900 m²
600 m²
300 m²
Surveyed Gullies
C
Water Depth
0.5 m
0.4
0.3
0.2
0.1
0.049
0.047
0.045
0.043
0.041
0.039
0.037
0.035
0.033
0.031
0.029
0.027
0.025
0.023
0.021
0.019
0.017
0.015
0.013
0.011
0.009
0.007
0.005
0.003
0.001 m
D
2002

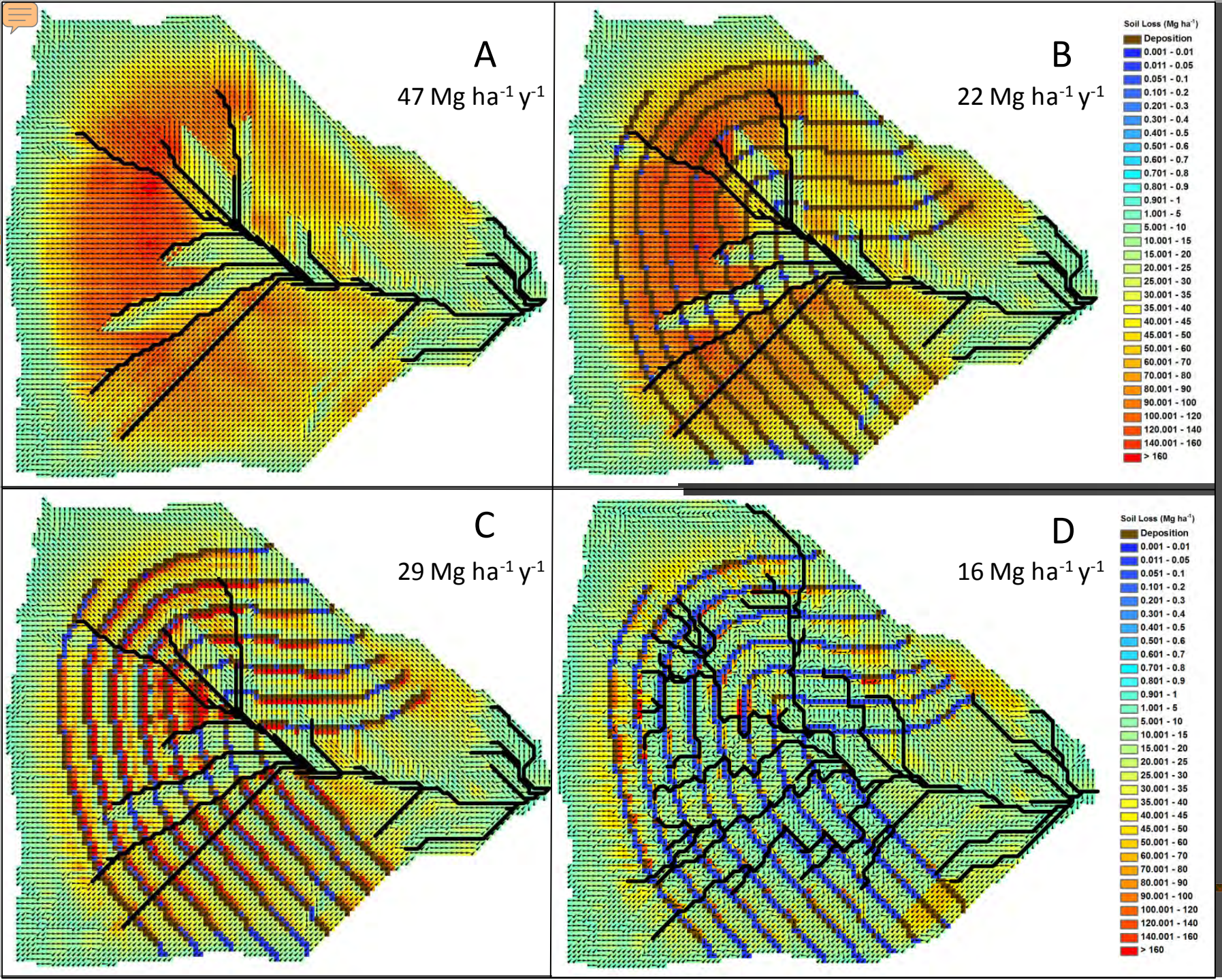
Scenarios to be Presented

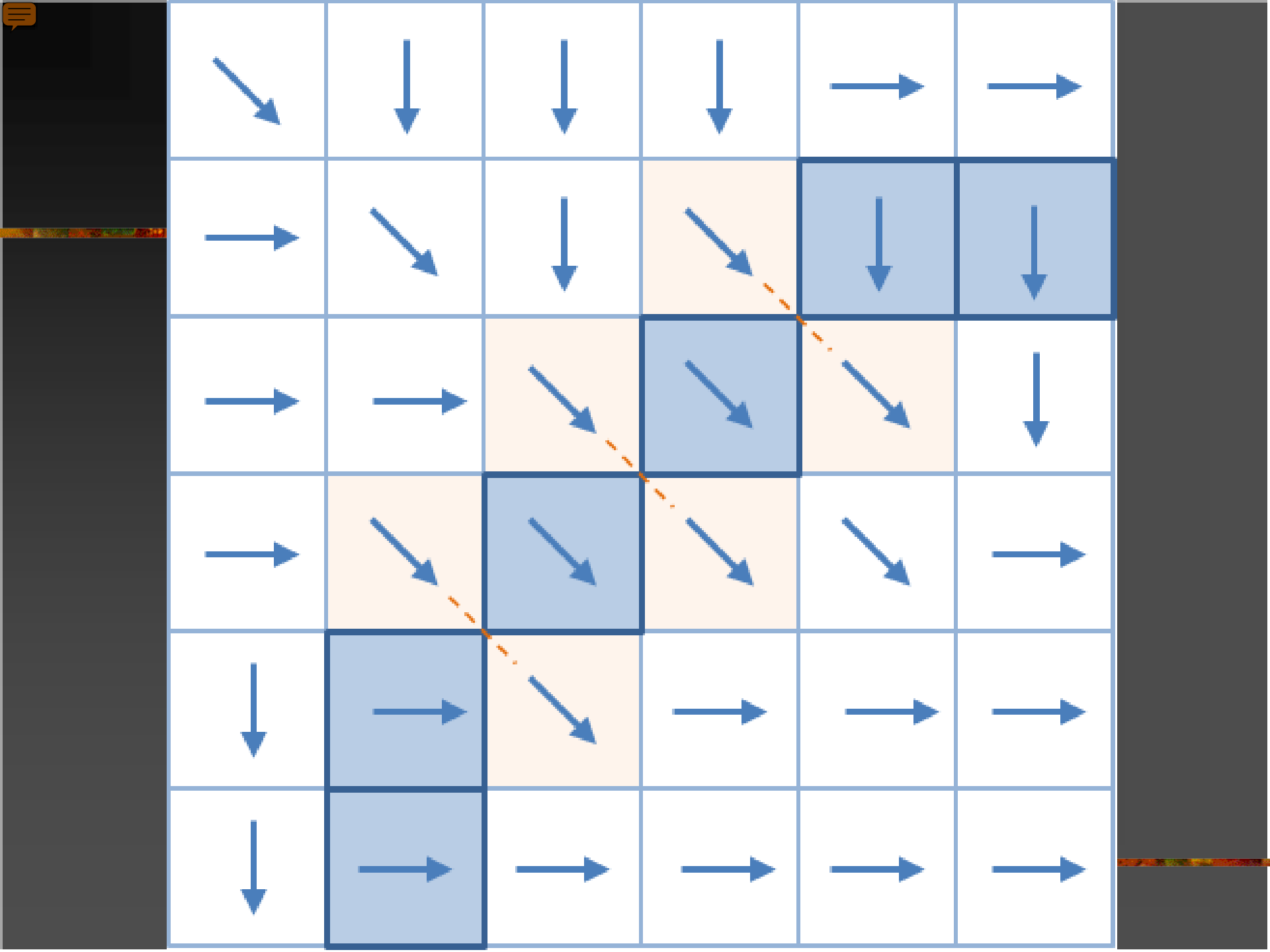
- Profile 2 vs measured runoff and sediment yield
- Distributed erosion predictions
  - with initial channels and topography
  - with initial channels but steepness reflecting 50 years of tillage and water erosion
  - with channels and steepness reflecting 50 years of tillage and water erosion

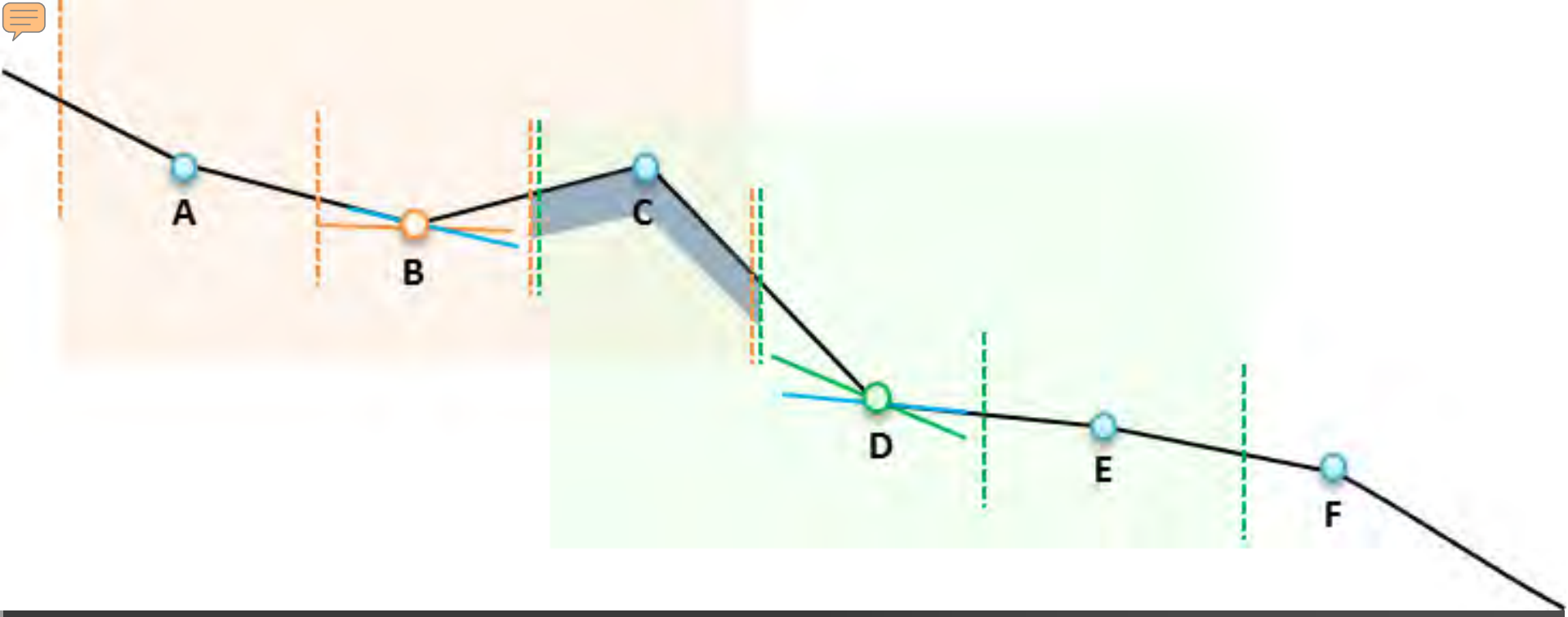

A
CT - No Hedge
1975-1991
B
CT - No Hedge
RUSLE2
C
CT - Hedge
1991-1997
D
CT - Hedge
RUSLE2
E
NT - Hedge
1997-2002
F
NT - No Hedge
RUSLE2
Runoff (mm)
Sed. Yield (Mg/ha)
Runoff (no EI adj)
Rain (mm)
Month
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
120
140
160
1
3
5
7
9
11

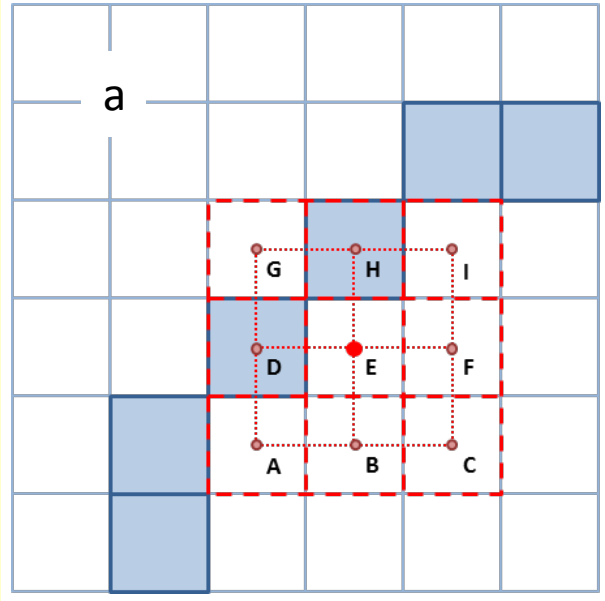

Observed gullies
Simplified configuration
Slope (%)
Value
18.3 %
0.2 %
0 510 20 30 40 50
Meters

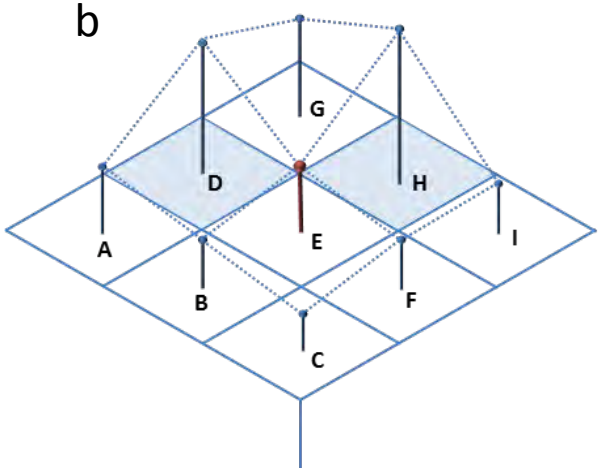

A
47 Mg ha-1 y-1
B
48 Mg ha-1 y-1
C
22 Mg ha-1 y-1
D
0.86 Mg ha-1 y-1
Soil Loss (Mg ha-1)
Deposition
0.001 - 0.01
0.011 - 0.05
0.051 - 0.1
0.101 - 0.2
0.201 - 0.3
0.301 - 0.4
0.401 - 0.5
0.501 - 0.6
0.601 - 0.7
0.701 - 0.8
0.801 - 0.9
0.901 - 1
1.001 - 5
5.001 - 10
10.001 - 15
15.001 - 20
20.001 - 25
25.001 - 30
30.001 - 35
35.001 - 40
40.001 - 45
45.001 - 50
50.001 - 60
60.001 - 70
70.001 - 80
80.001 - 90
90.001 - 100
100.001 - 120
120.001 - 140
140.001 - 160
> 160
0 25 50 100
Meters

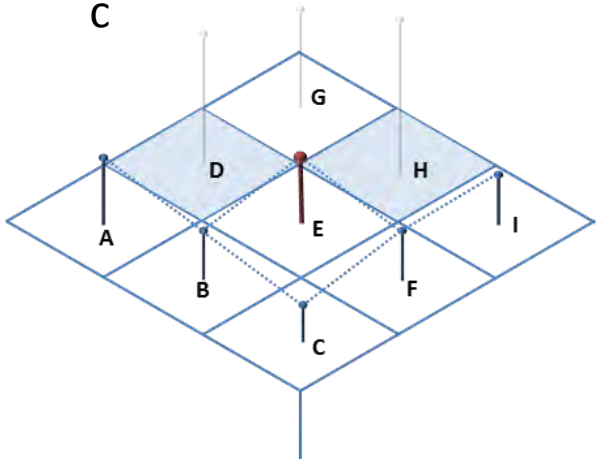

A
47 Mg ha-1 y-1
B
22 Mg ha-1 y-1
C
29 Mg ha-1 y-1
D
16 Mg ha-1 y-1
Soil Loss (Mg ha-1)
Deposition
0.001 - 0.01
0.011 - 0.05
0.051 - 0.1
0.101 - 0.2
0.201 - 0.3
0.301 - 0.4
0.401 - 0.5
0.501 - 0.6
0.601 - 0.7
0.701 - 0.8
0.801 - 0.9
0.901 - 1
1.001 - 5
5.001 - 10
10.001 - 15
15.001 - 20
20.001 - 25
25.001 - 30
30.001 - 35
35.001 - 40
40.001 - 45
45.001 - 50
50.001 - 60
60.001 - 70
70.001 - 80
80.001 - 90
90.001 - 100
100.001 - 120
120.001 - 140
140.001 - 160
> 160




A
B
C
D
E
F


a
G
H
I
D
E
F
A
B
C

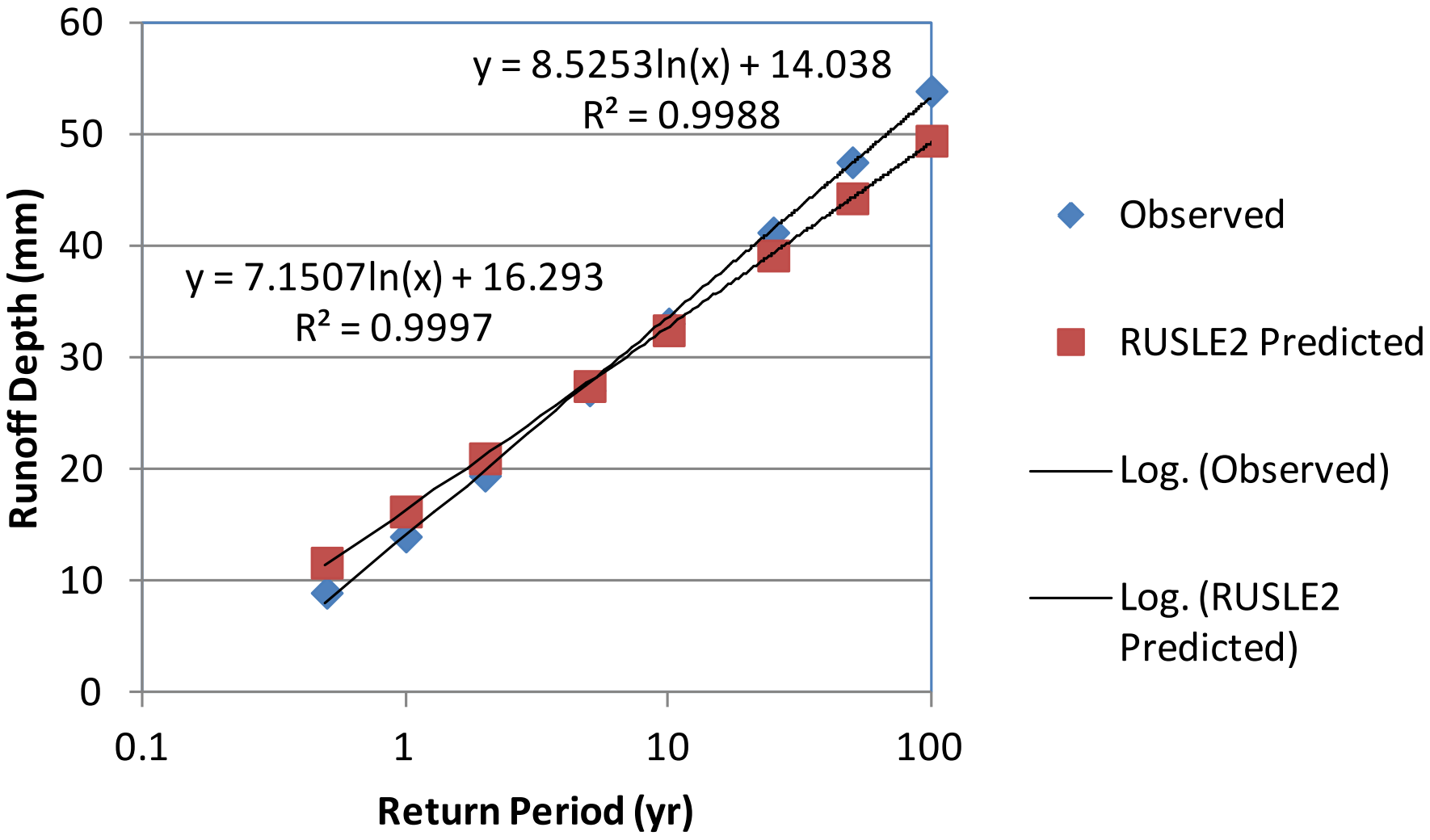

b
G
D
H
A
E
I
B
F
C


c
G
D
H
A
E
I
B
F
C

Summary

- RUSLE2 is a hybrid field-scale conservation planning tool
- RUSLE2 is being optimized to create distributed erosion estimates based on LiDAR data
- Representative runoff event sequence outputs are suitable for linkage with an ephemeral gully model
- Improved GIS tools are needed before feedback will create realistic topographic patterns

Questions?


y = 8.5253ln(x) + 14.038
R² = 0.9988
y = 7.1507ln(x) + 16.293
R² = 0.9997
Runoff Depth (mm)
60
50
40
30
20
10
0
0.1
1
10
100
Return Period (yr)
Observed
RUSLE2 Predicted
Log. (Observed)
Log. (RUSLE2 Predicted)