

TopoSWAT: a ArcPy Toolbox to Improve the Spatial Representation of Soil Properties and Hydrology Using Topographically Derived Initialization Processes

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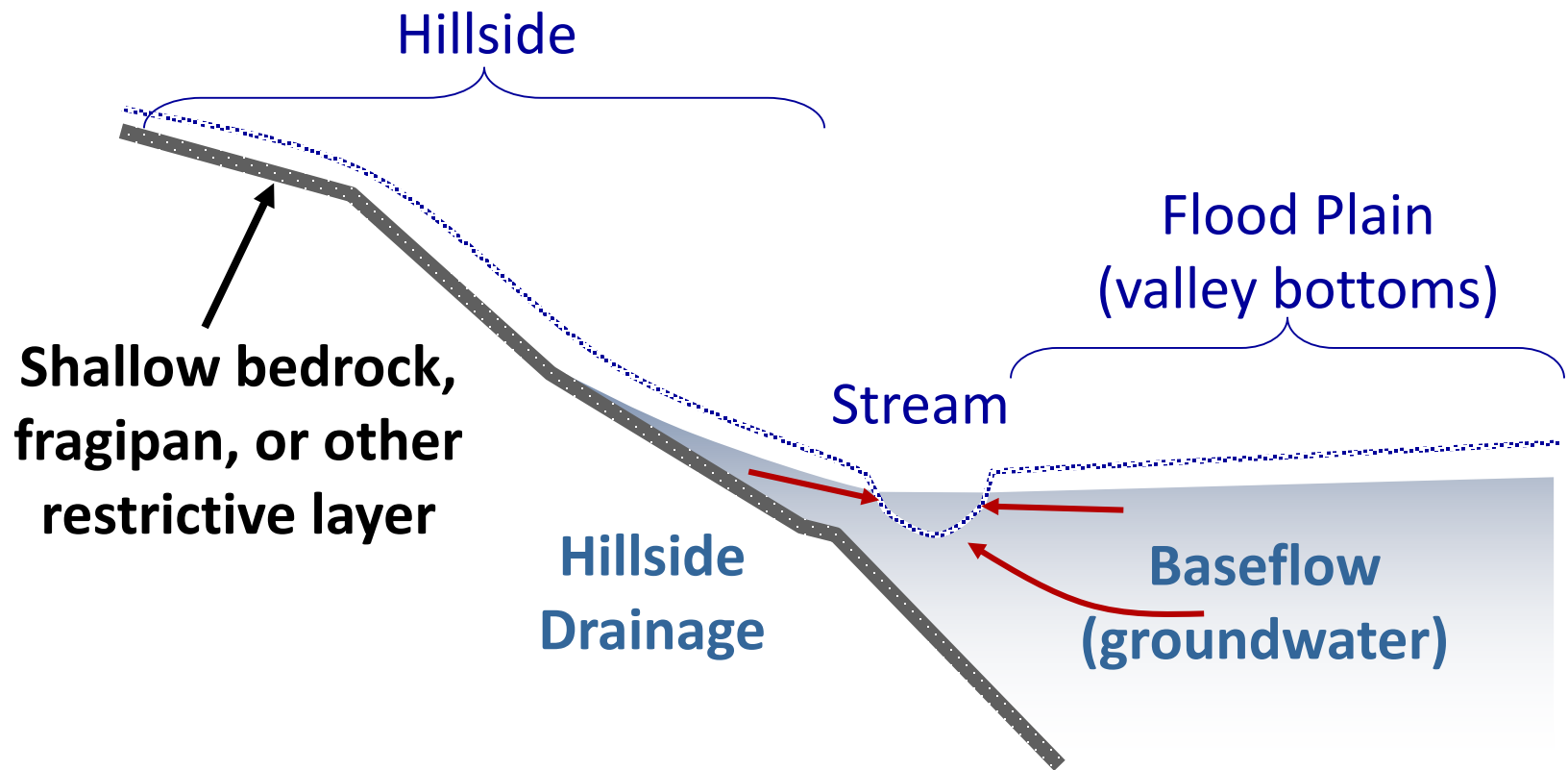
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Hydrologic Flowpaths

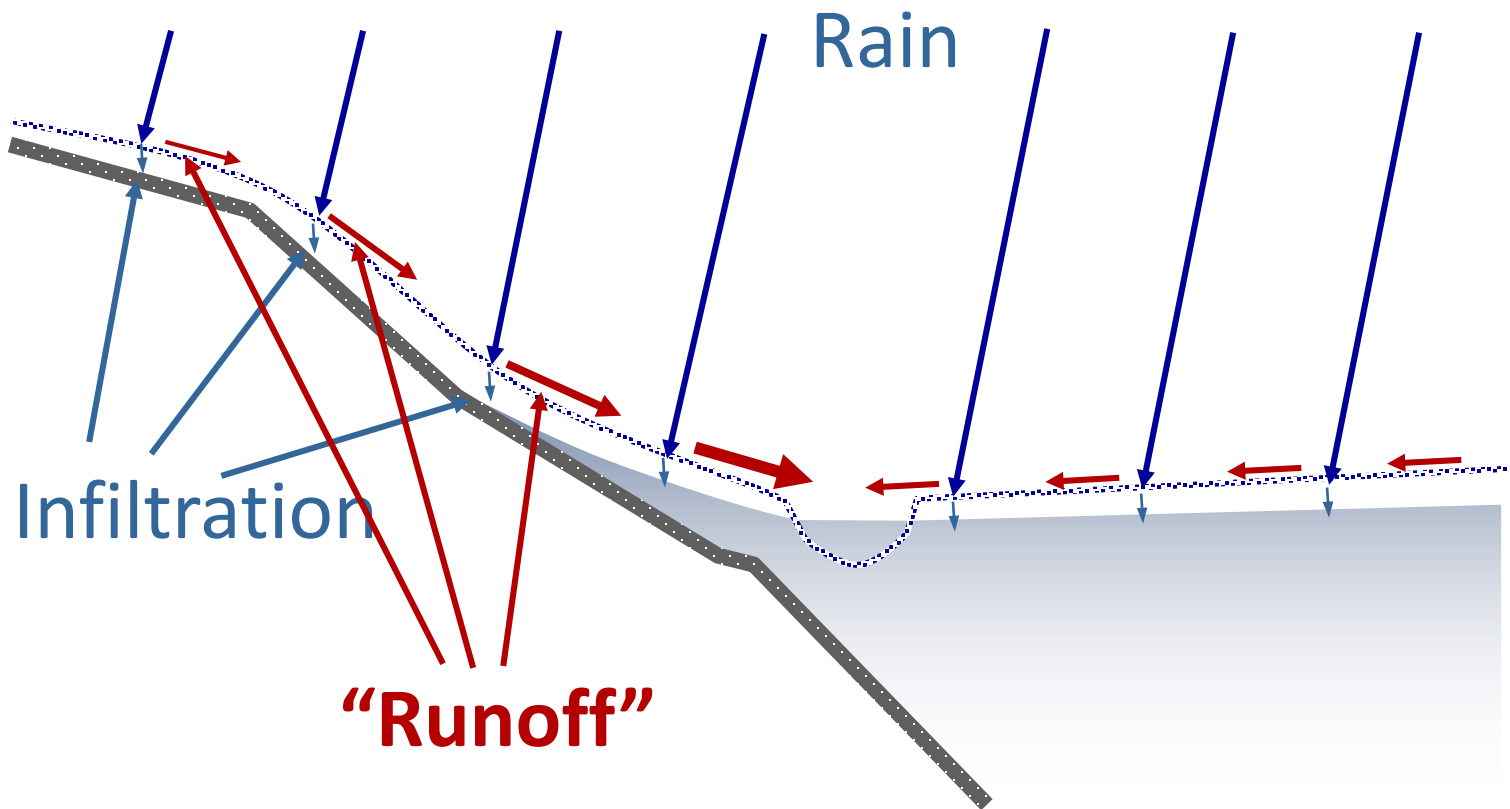
Outline

- Introduction to Topography, Soils, and TopoSWAT
- Variable Area Hydrology (VSA) Case
 - USDA WE-38, PA
- Hortonian Hydrology Case
 - Reisel, TX
- What does this imply for modeling field management?

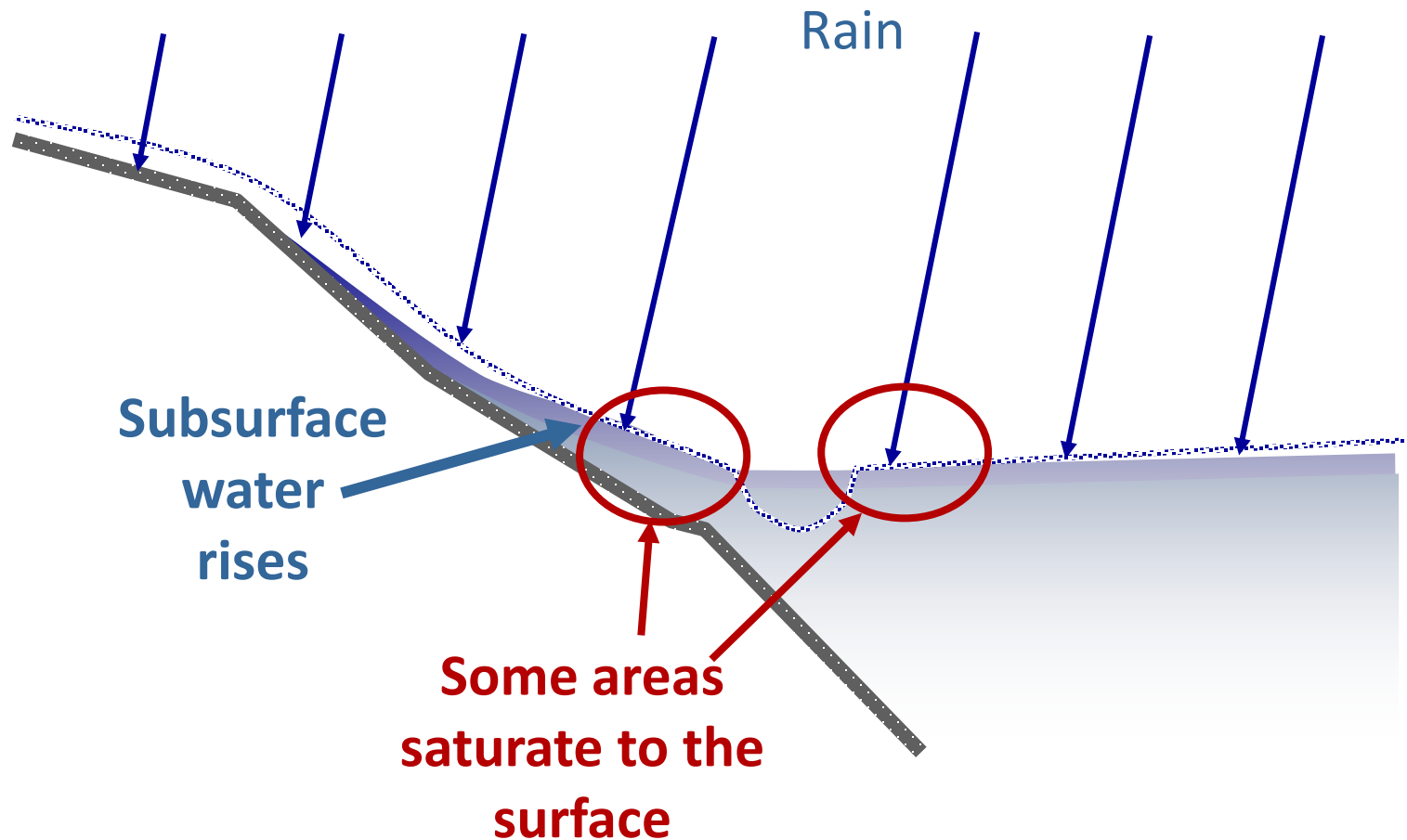
Hydrology...Two Paradigms



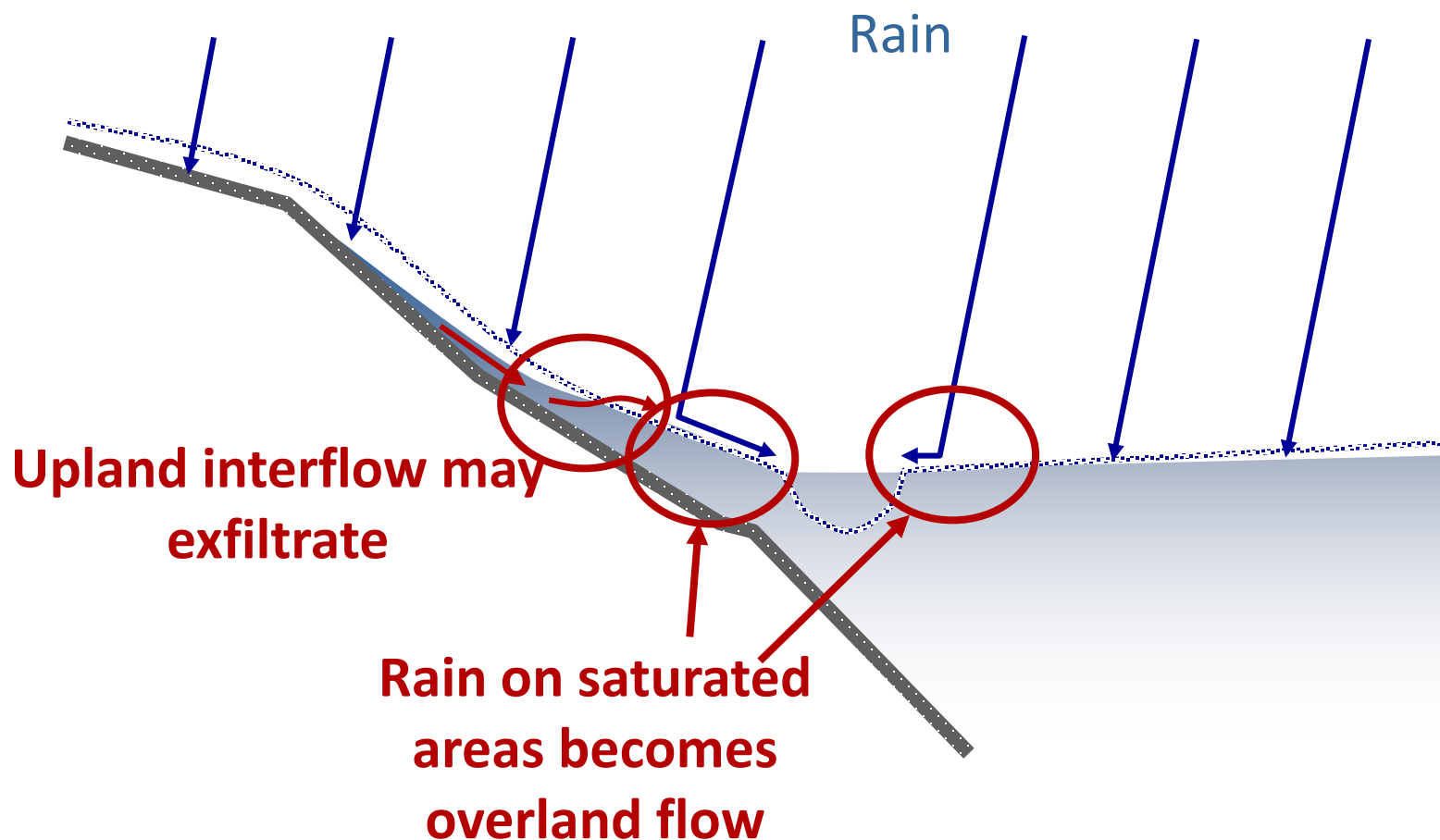
Infiltration Excess or Hortonian Runoff



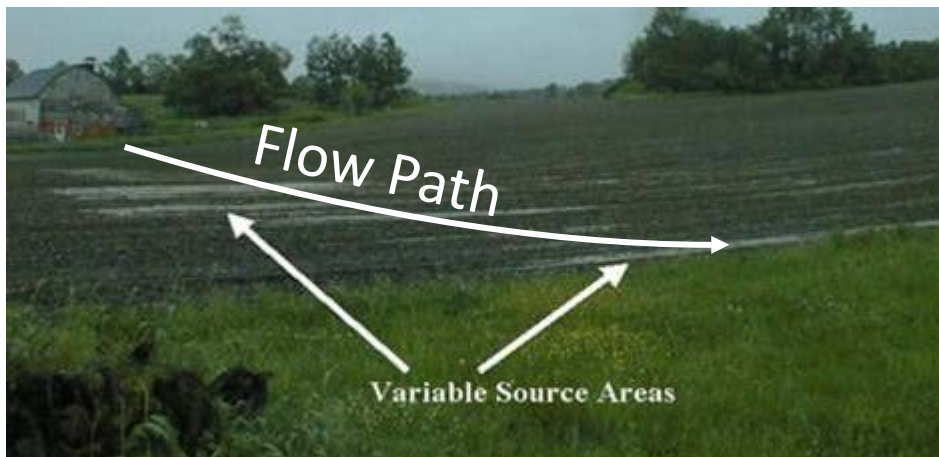
Saturation Excess Runoff



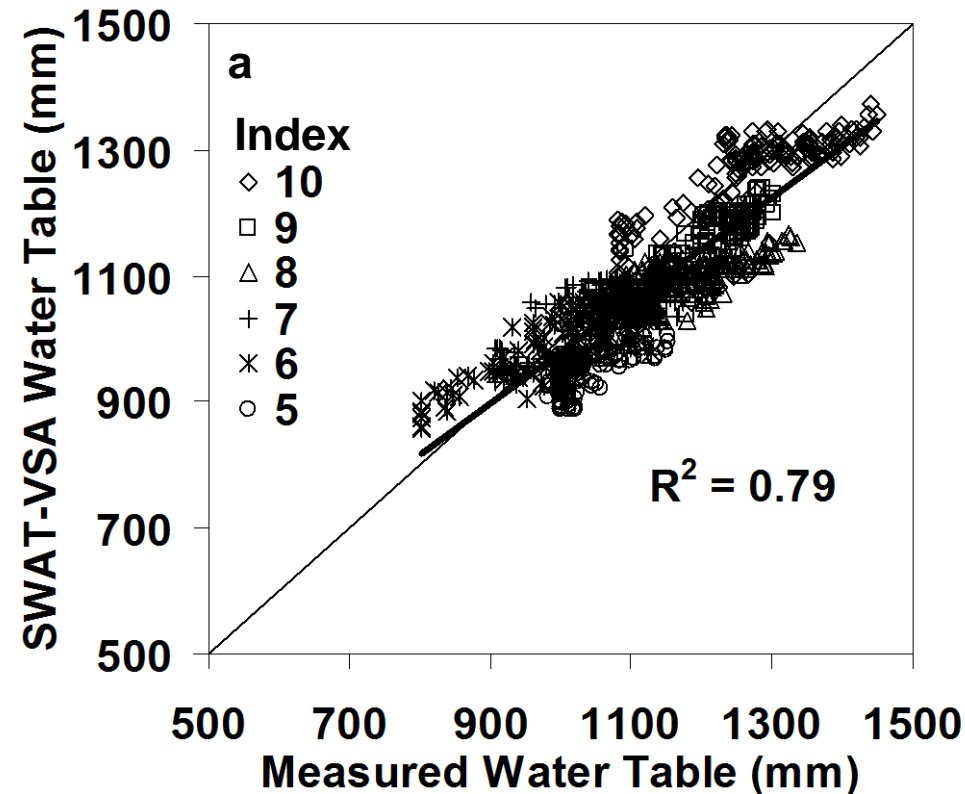
Saturation Excess Runoff



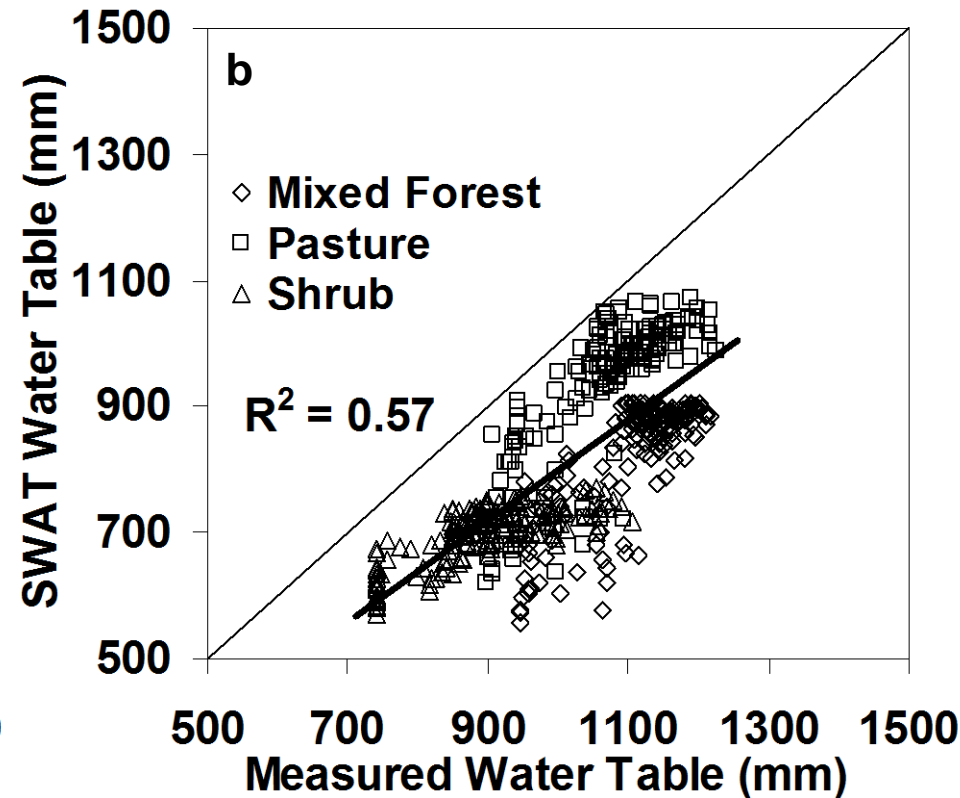
Variable Source Areas



SWAT-VSA



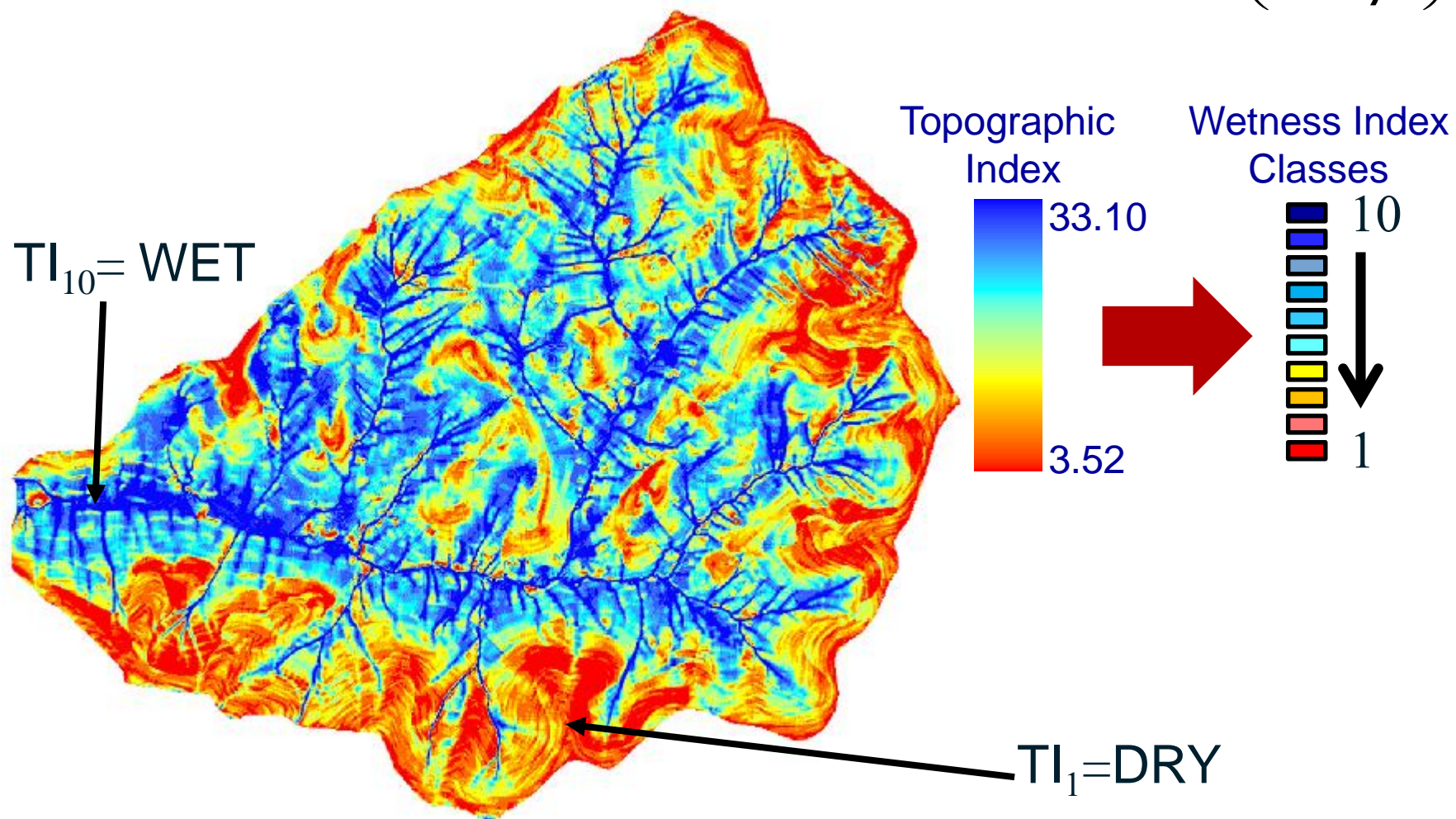
SWAT



Topographic Index

Wetness Index Classes

$$\lambda = \ln \left(\frac{a}{\tan \beta} \right)$$



TopoSWAT

- 01 BCubeHydro script
- 02 GoTo Watershed Delineator
- 03 BCubeLU script
- 04 TopoSoil script
- 05 GoTo HRU Analysis
- 06 GetCFSR script
- 07 GoTo Write Input Tables
- 08 VSADistribute script
- 09 GoTo Edit/Rewrite SWAT Input

Tracking Analyst Tools



Results



ArcToolbox



Wate



Long



Basin



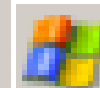
Land

0

4

8

10



Start



pj01



C:\Documents and

Layers

- ☐ MonitoringPoint
- ☒ Outlet
- ☒ Reach
- ☐ Export_Output
- ☐ FullHRU
- ☒ Watershed
- ☒ LongestPath
- ☒ Basin
- ☒ matternhru.tif
- ☐ LandSlope(LandSlope1)
- ☐ SwatSoilClass(LandSoils1)
- ☐ SwatLandUseClass(LandU:
- ☒ SourceDEM

TopoSoil

Please select the folder your SWAT project is in.

V:\Documents\SWAT\WE38_LiDAR10_TopoSWAT

Select the swat200*.mdb database.

C:\Swat\ArcSWAT\Databases\SWAT2012.mdb

☒ Do you want to write your usersoil to the swat200*.mdb? (optional)

☒ Add TI Classes? (optional)

☐ Add Elevation Classes? (optional)

Elevation Increment in meters.

100

☐ Add Aspect D8 Classes? (optional)

OK Cancel Environments... << Hide Help

Layers

- ☐ MonitoringPoint
- ☒ Outlet
- ☒ Reach
- ☐ Export_Output
- ☐ FullHRU
- ☒ Watershed
- ☒ LongestPath
- ☒ Basin
- ☒ matternhru.tif
- Mattern_HRU.txt.SW_
 - 51.835
 - 51.83500001 - 57.149
 - 57.14900001 - 59.643
 - 59.64300001 - 63.519
 - 63.51900001 - 66.071
 - 66.07100001 - 68.538
 - 68.53800001 - 68.622
 - 68.62200001 - 70.622
 - 70.62200001 - 71.04
 - 71.04000001 - 71.064
 - 71.06400001 - 72.989
 - 72.98900001 - 73.006
 - 73.00600001 - 79.435
 - 79.43500001 - 82.121
- ☐ LandSlope(LandSlope1)
- ☐ SwatSoilClass(LandSoils1)
- ☐ SwatLandUseClass(LandU
- ☒ SourceDEM

VSADistribute

Project Directory

V:\Documents\SWAT\WE38_LiDAR10_TopoSWAT

☒ Distribute CN?

☒ Distribute Soil Depths?

Soils Factor

0.3

☒ Distribute Clay Content?

Clay Factor?

0.3

☒ Distribute Sand Content?

Sand Factor

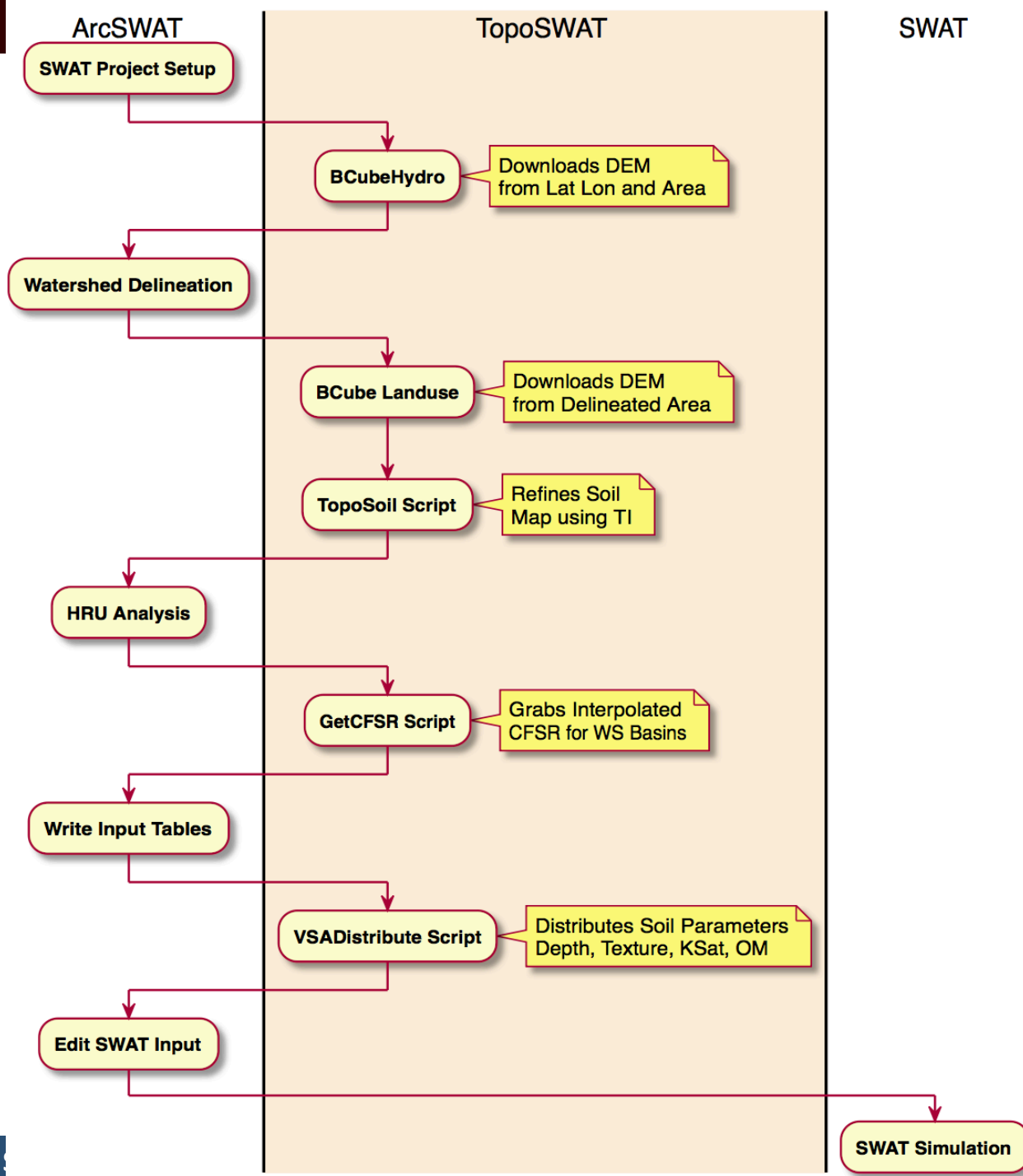
-0.3

OK

Cancel

Environments...

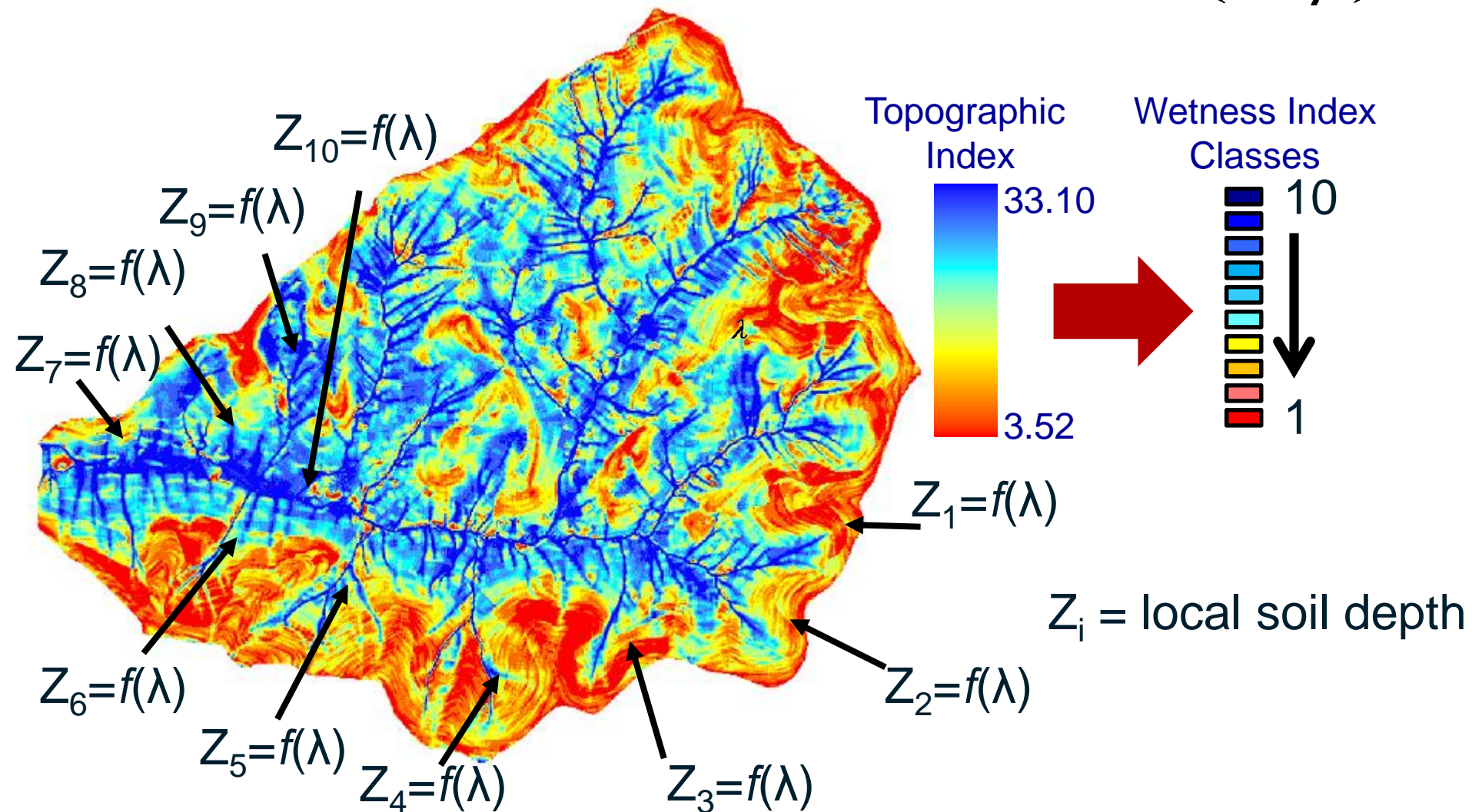
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Topographic Index

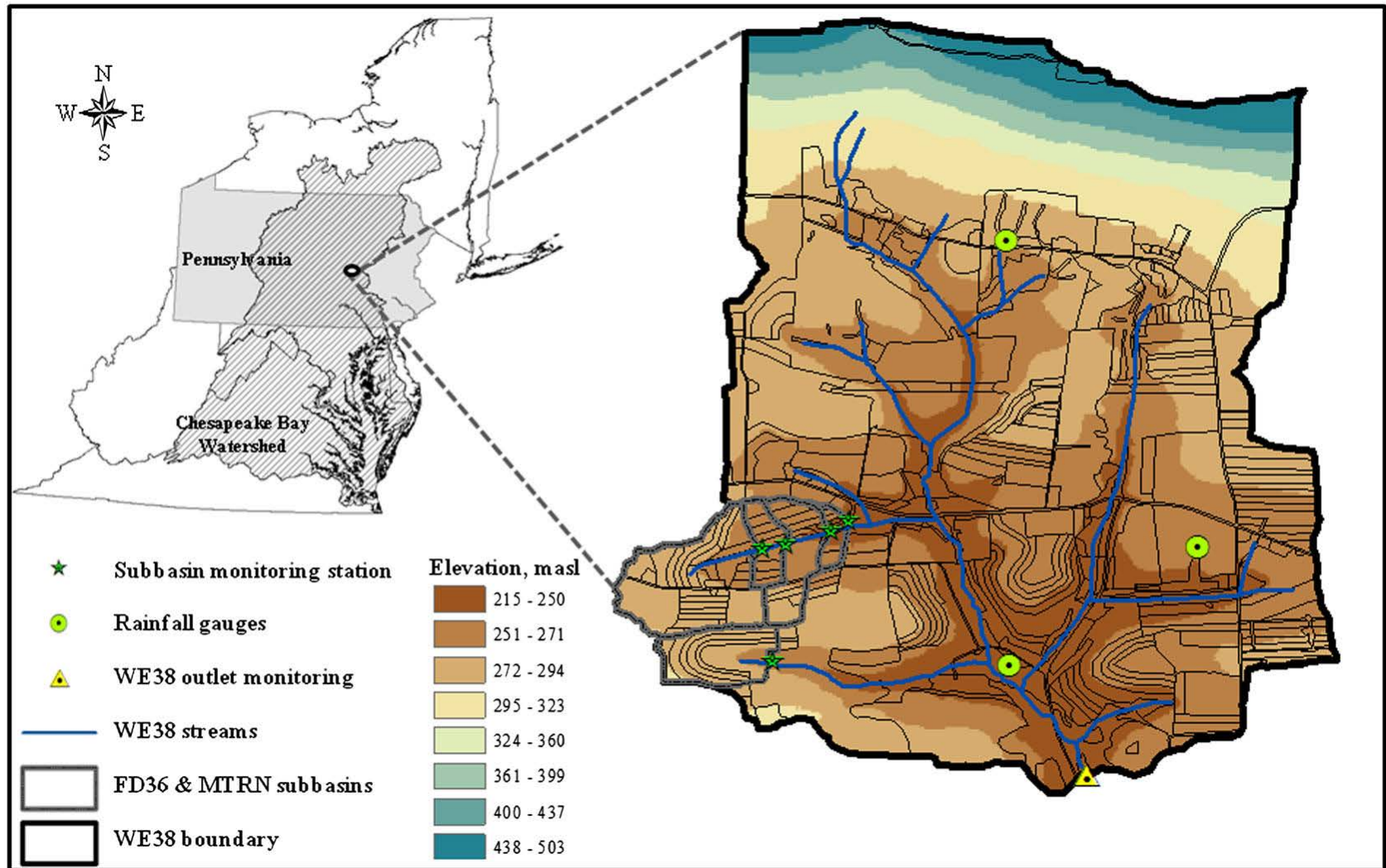
Wetness Index Classes

$$\lambda = \ln \left(\frac{a}{\tan \beta} \right)$$

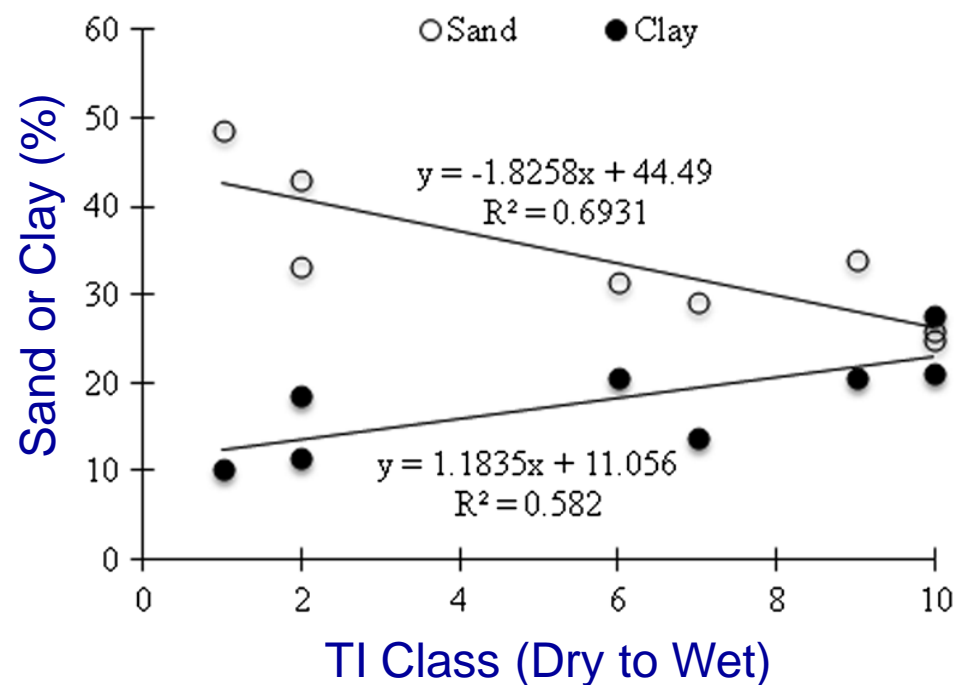
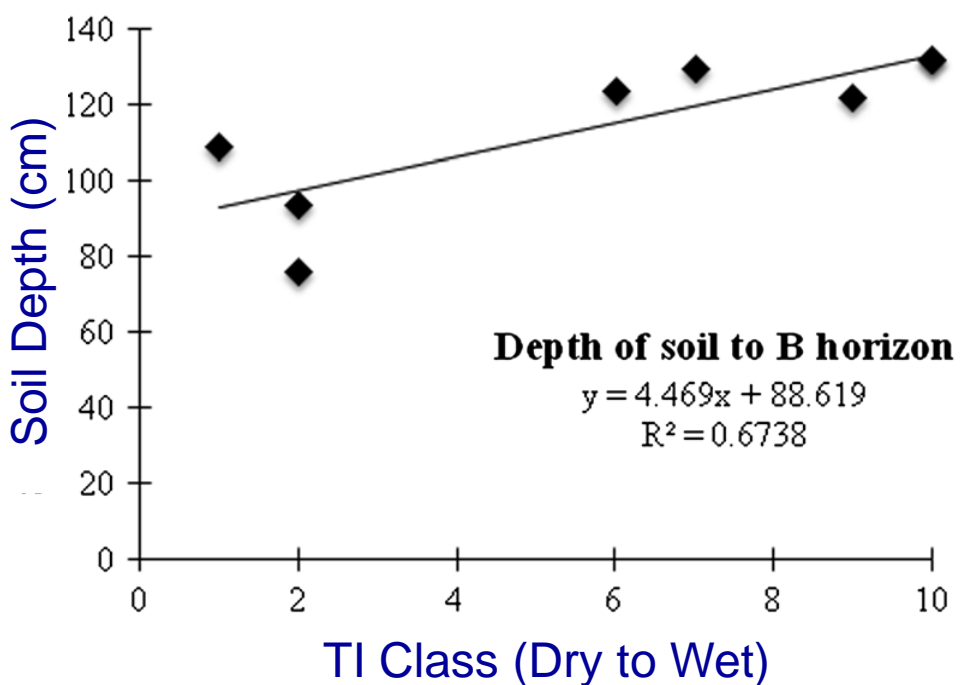


Variable Source Area Hydrology

USDA WE38, PA



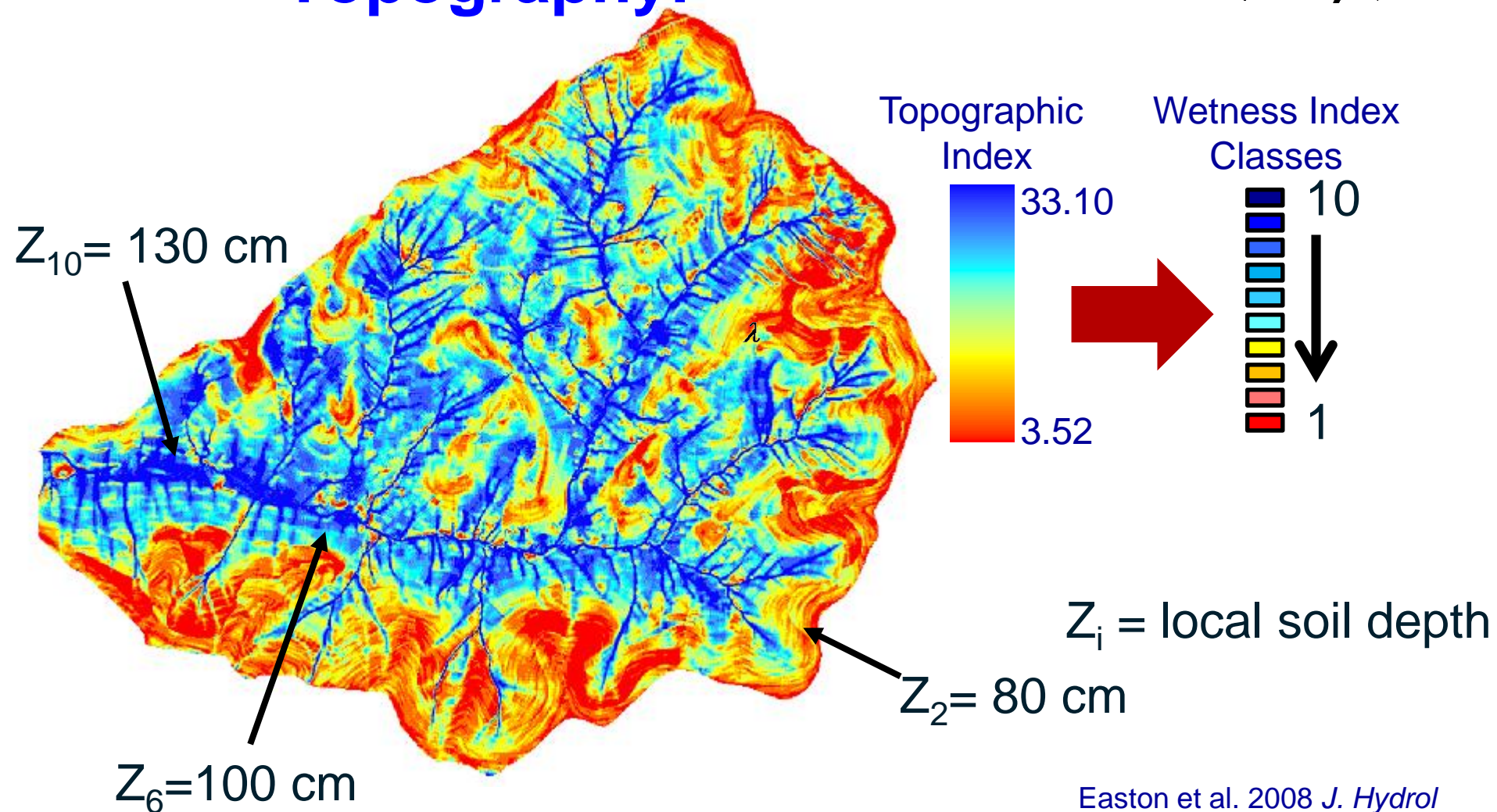
Topography to explain soil depth and fractions



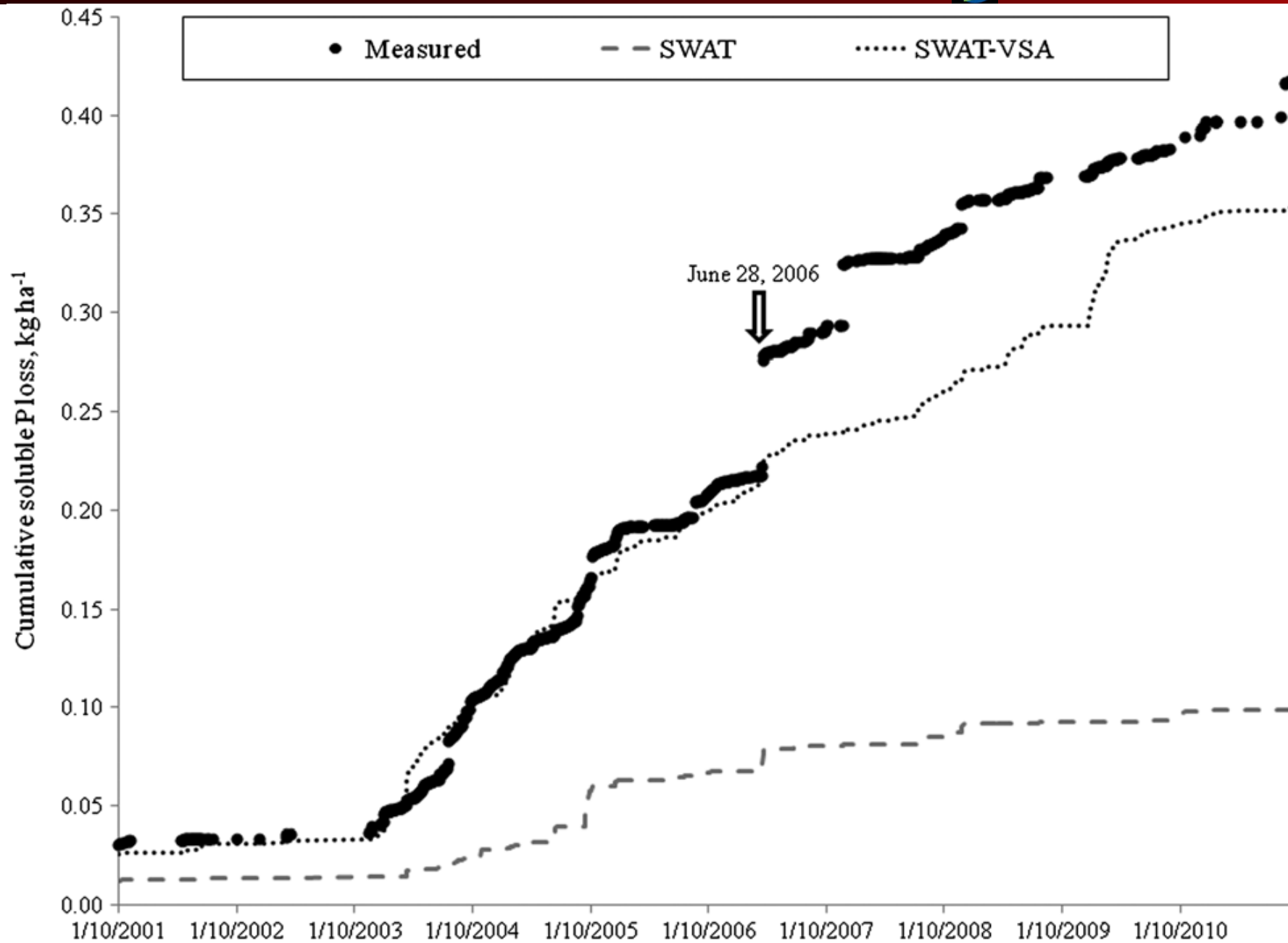
Using measured pedon data from ARS long term watershed

Soil genesis as explained by Topography!

$$\lambda = \ln \left(\frac{a}{\tan \beta} \right)$$

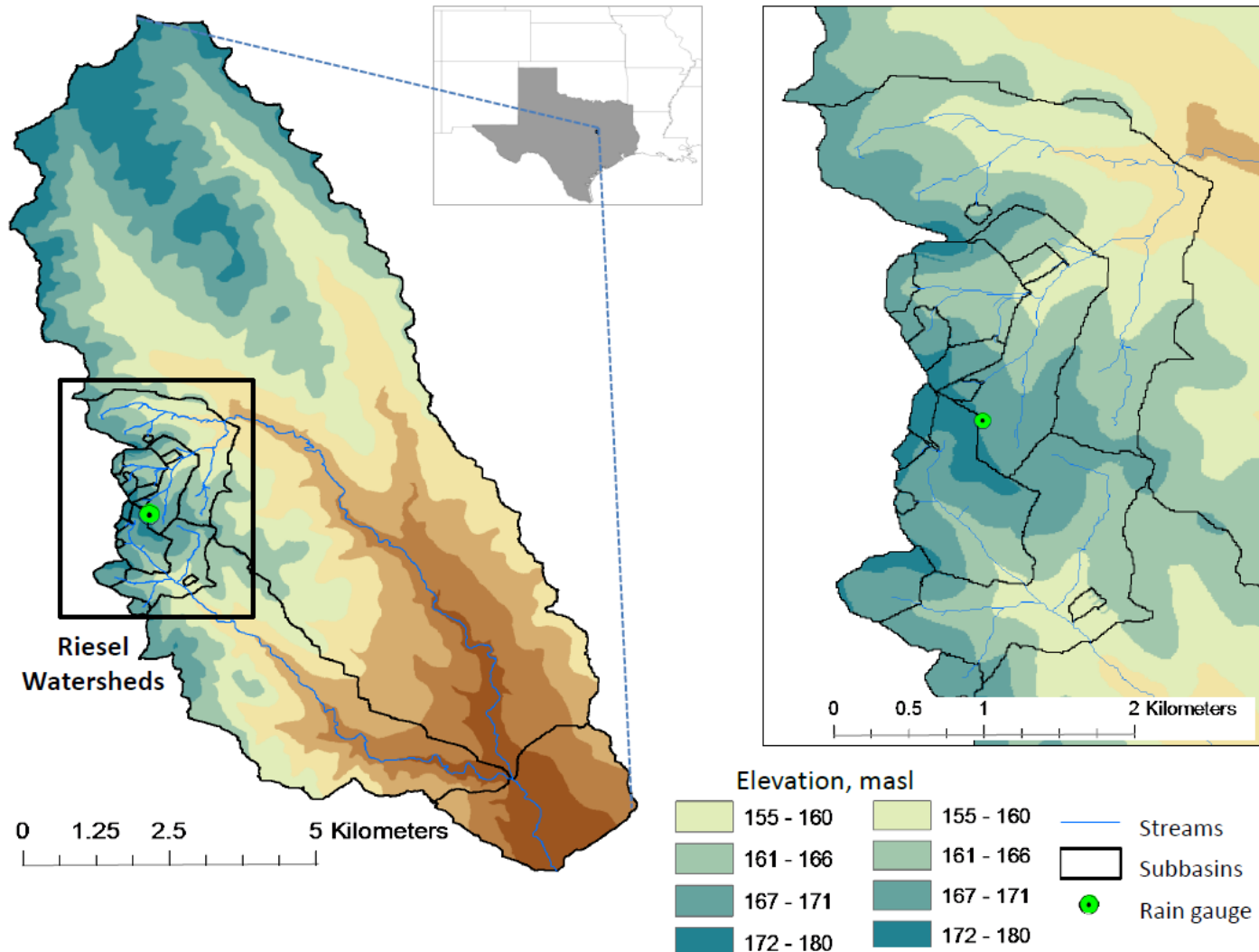


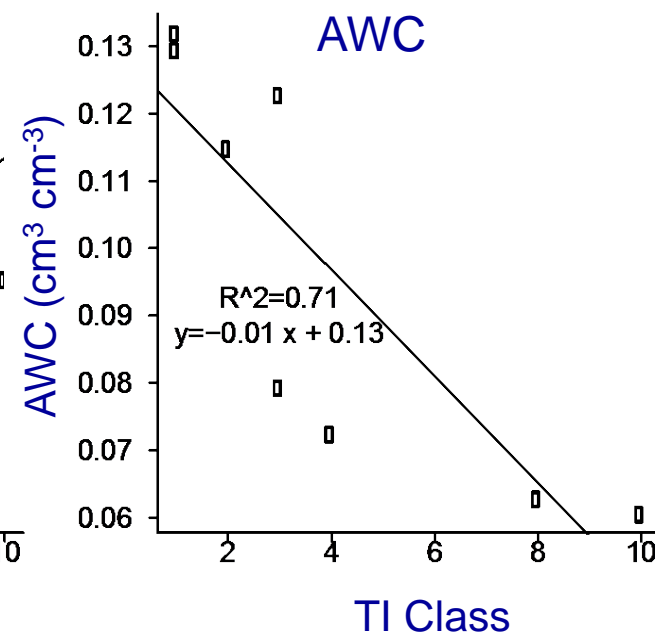
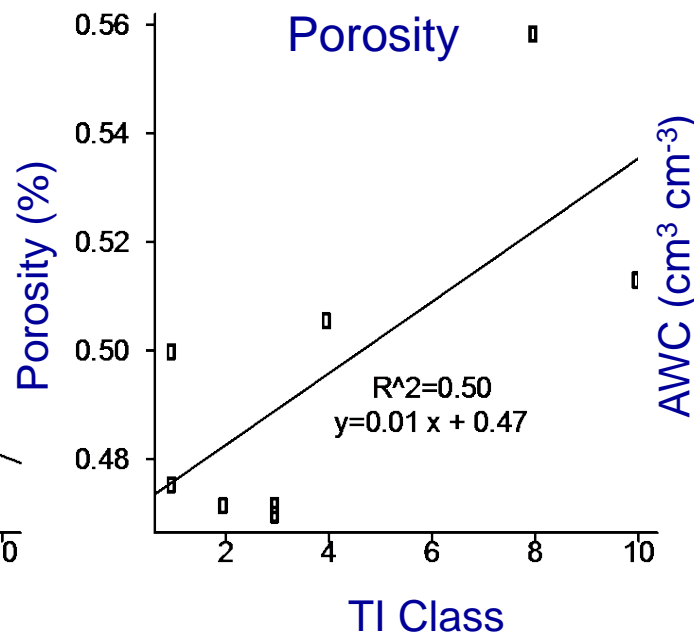
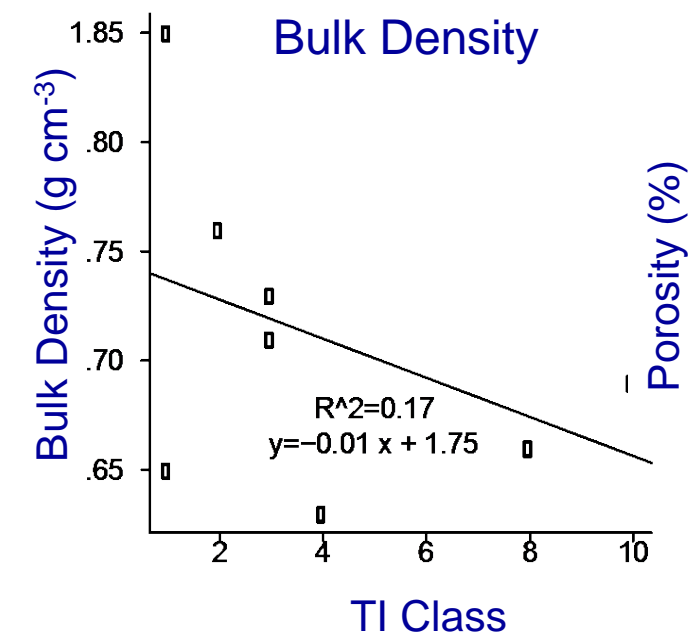
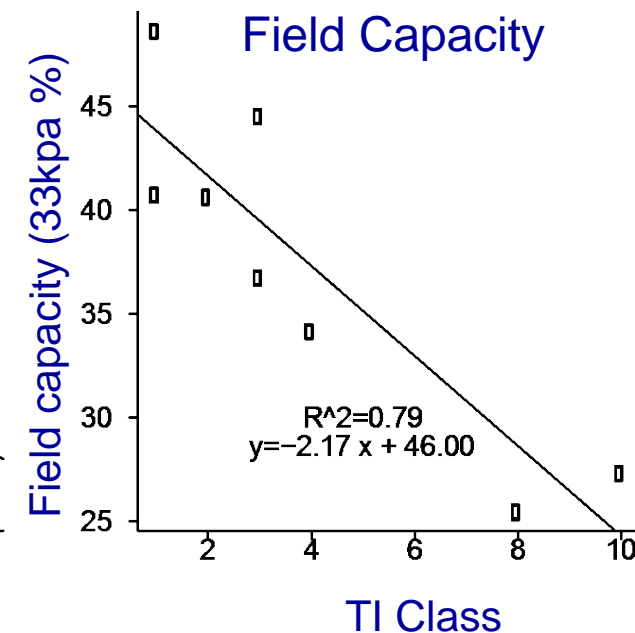
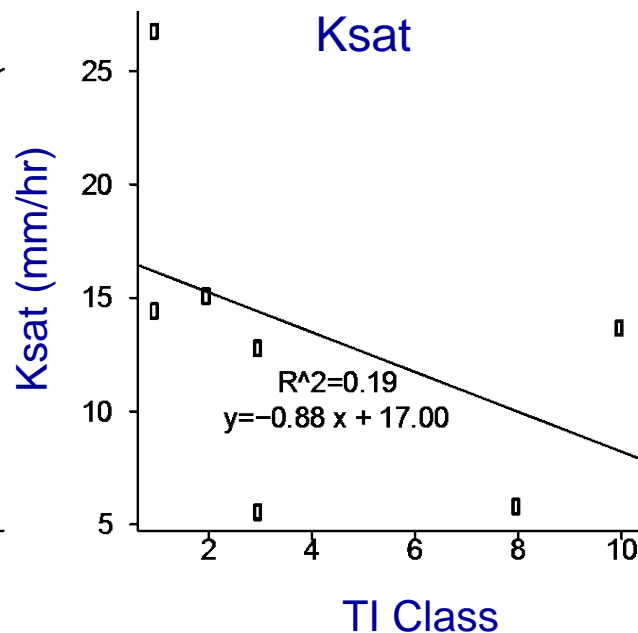
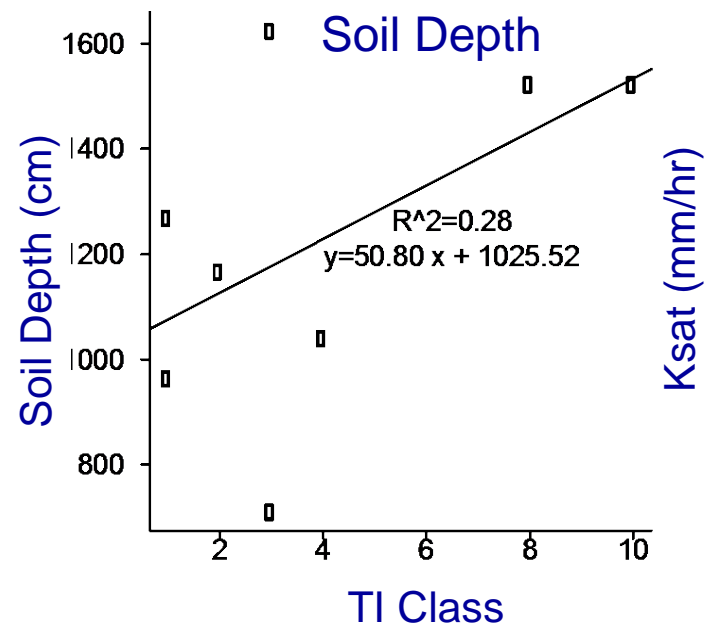
Easton et al. 2008 *J. Hydrol*
Collick et al. 2014. *Hydrol Proc*
Fuka et al. 2015. *Hydrol Proc*



Hortonian Dominated Systems

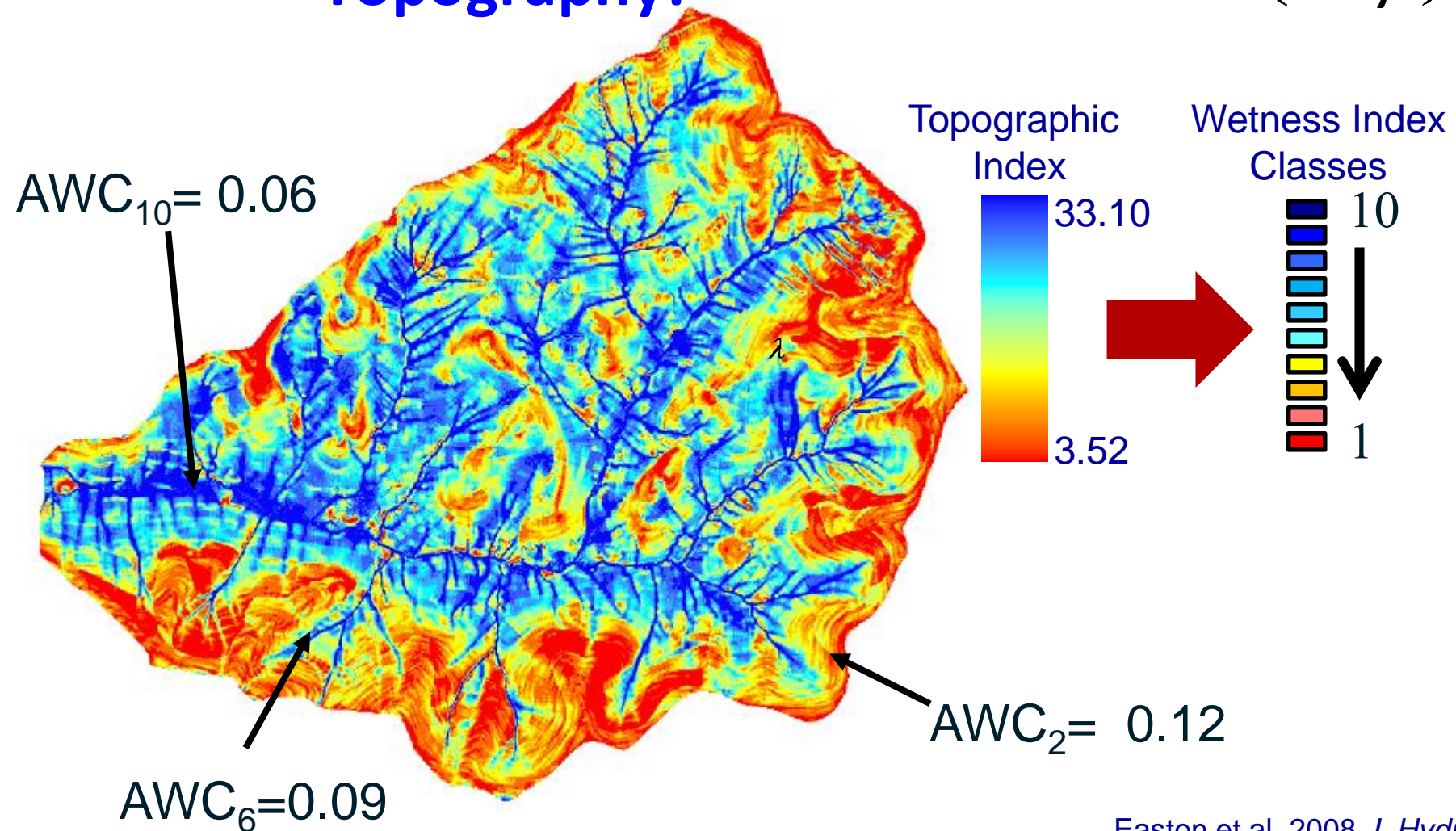
Riesel, TX





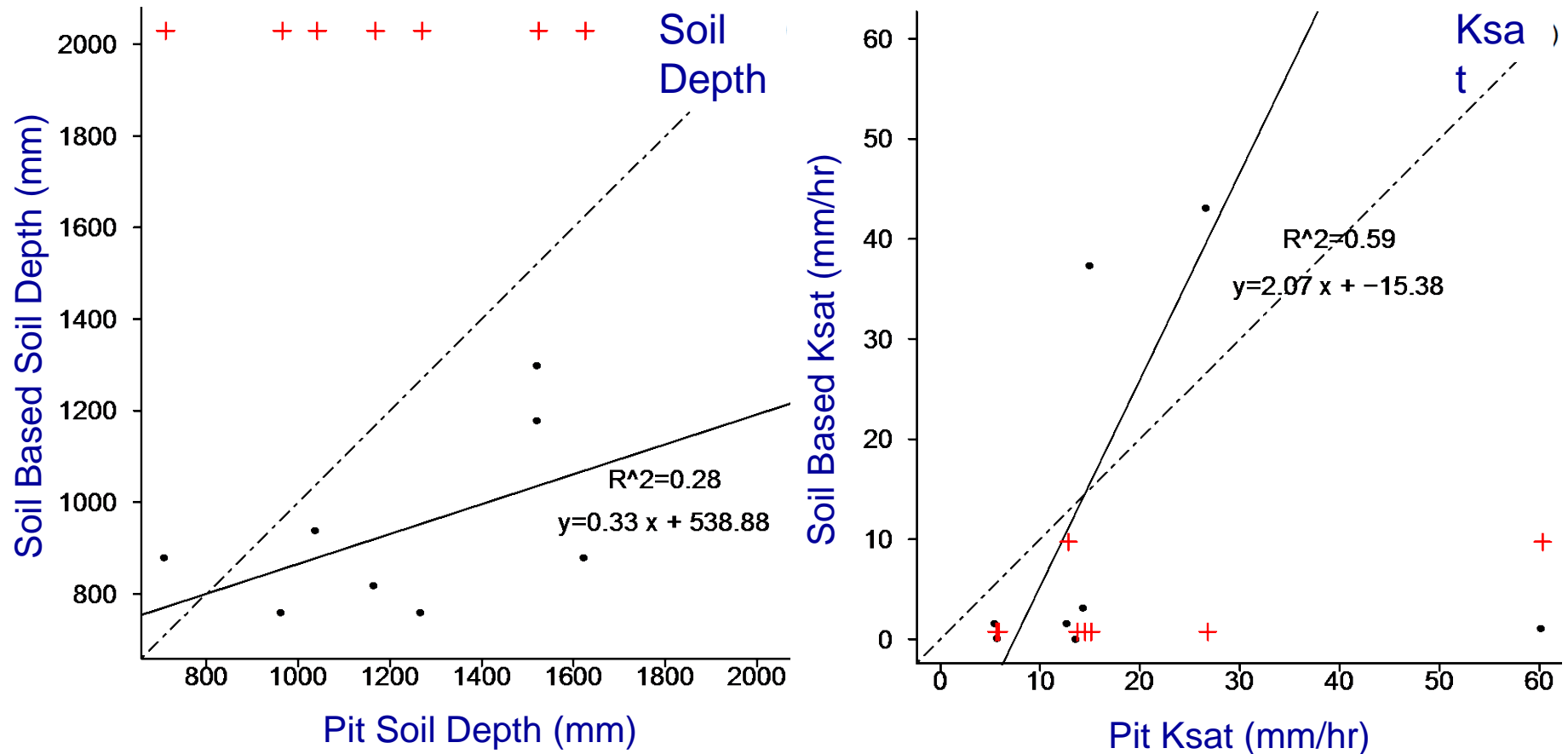
Soil moisture as explained by Topography!

$$\lambda = \ln \left(\frac{a}{\tan \beta} \right)$$



Easton et al. 2008 *J. Hydrol*
Collick et al. 2014. *Hydrol Proc*
Fuka et al. 2015. *Hydrol Proc*

How does SSURGO perform?



TI adjusted FAO Soils (●) vs base SSURGO Soils (+)

Discussion

- TI initialization exhibited strong correlations with field level measurements
 - Resulted in improved predictions of field level contaminant transport, particularly for phosphorus
- SSURGO initialization captured soil properties and the hydrologic response poorly
 - Sometimes under predicting and sometimes over predicting, in part due to the overestimated soil depth and AWC
- These results indicate that adjusting model parameters based on topography can result in more accurate soil characterization and improve model performance at the field scale