COMPARISON OF WEPP AND SWAT FOR WATERSHED HYDROLOGY AND EROSION PREDICTION

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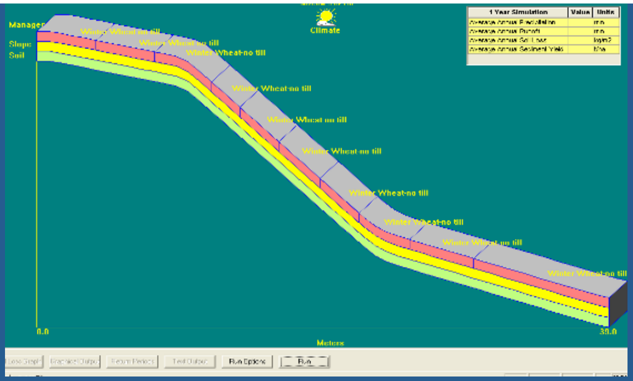
Introduction

- Hydrological modeling at hillslope and watershed scale:
  - placement of conservation practices
  - to determine BMP effectiveness
  - for understanding implications of land use change
- Comparison of WEPP and SWAT using modified versions, in the Town Brook watershed in New York state.

WEPP



- Process-based model
- Simulates both infiltration-excess and saturation-excess overland flow
- Improved subsurface lateral flow algorithms
- Direct input of key soil hydraulic properties (ρ_b, K_{sat}, θ_{fc}, θ_{wp})
- Simulated streamflow and sediment load consisted of cumulative hillslope output
- Baseflow determined using linear reservoir coefficient in post-processing
- No calibration to improve observed vs simulated results

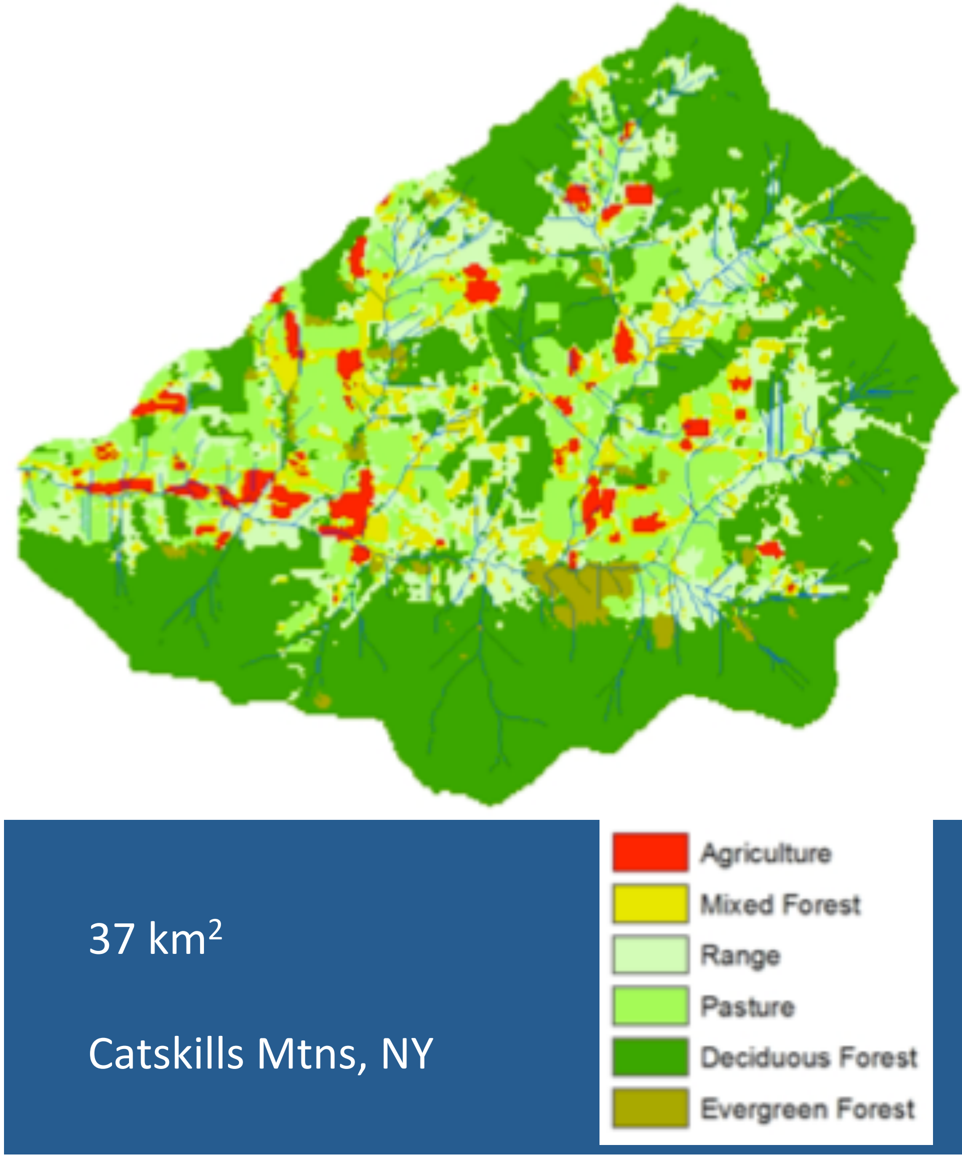
SWAT-VSA

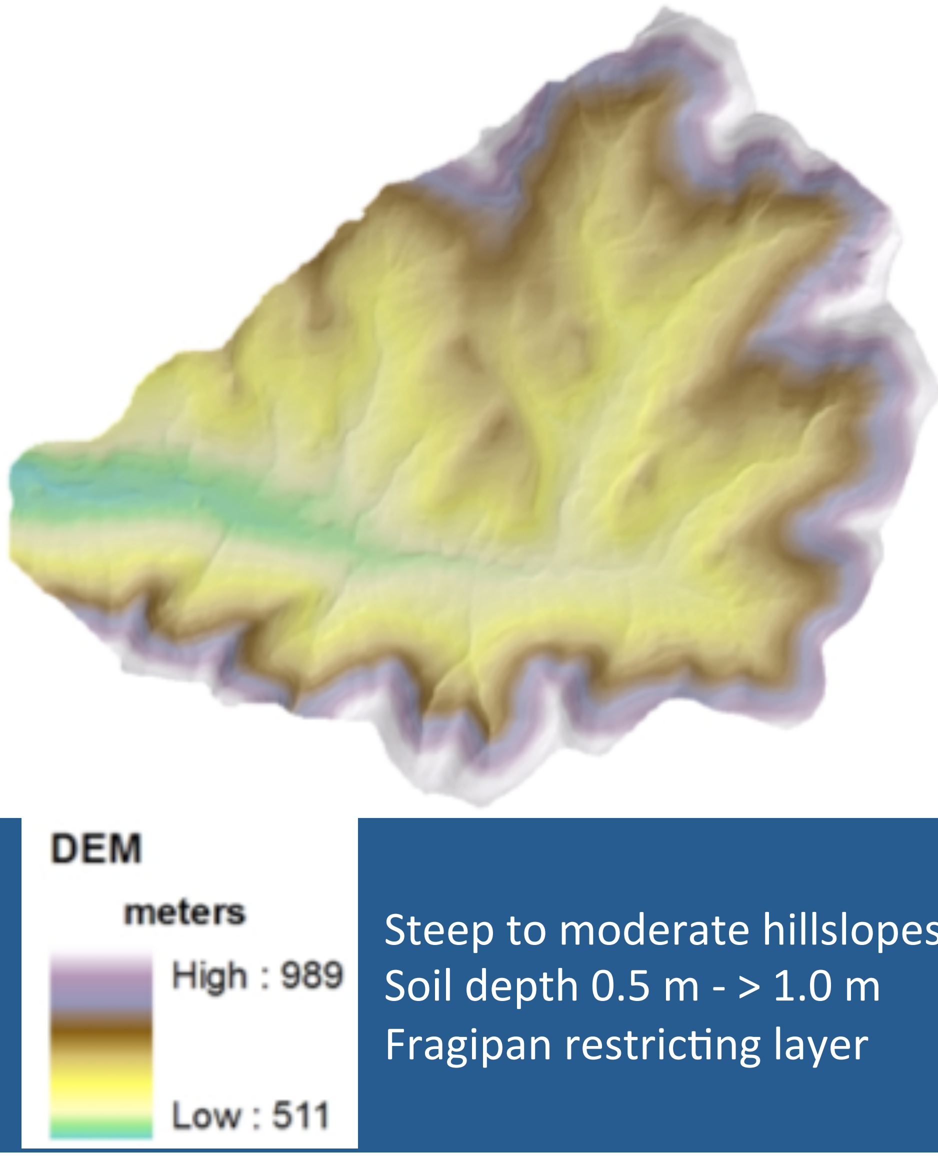
- Watershed scale model: CN and MUSLE
- Water balance methodology: soil water storage capacity (n * soil depth) distributed using topographic wetness index
- Baseflow index derived from time series of baseflow separated streamflow
- Calibration on CN to minimize root mean square error between observed and simulated
- Sediment export was calibrated to measured daily sediment yield at watershed outlet (1999-2001 WY)

WEPP vs SWAT-VSA

- WEPP can simulate hillslope scale hydrology, erosion and sediment yield
- SWAT uses Hydrologic Response Units (HRUs), which operate independently of landscape position; no flow between HRUs
- WEPP can be applied to small watersheds
- SWAT includes stream channel algorithms for application to larger watersheds

Town Brook watershed

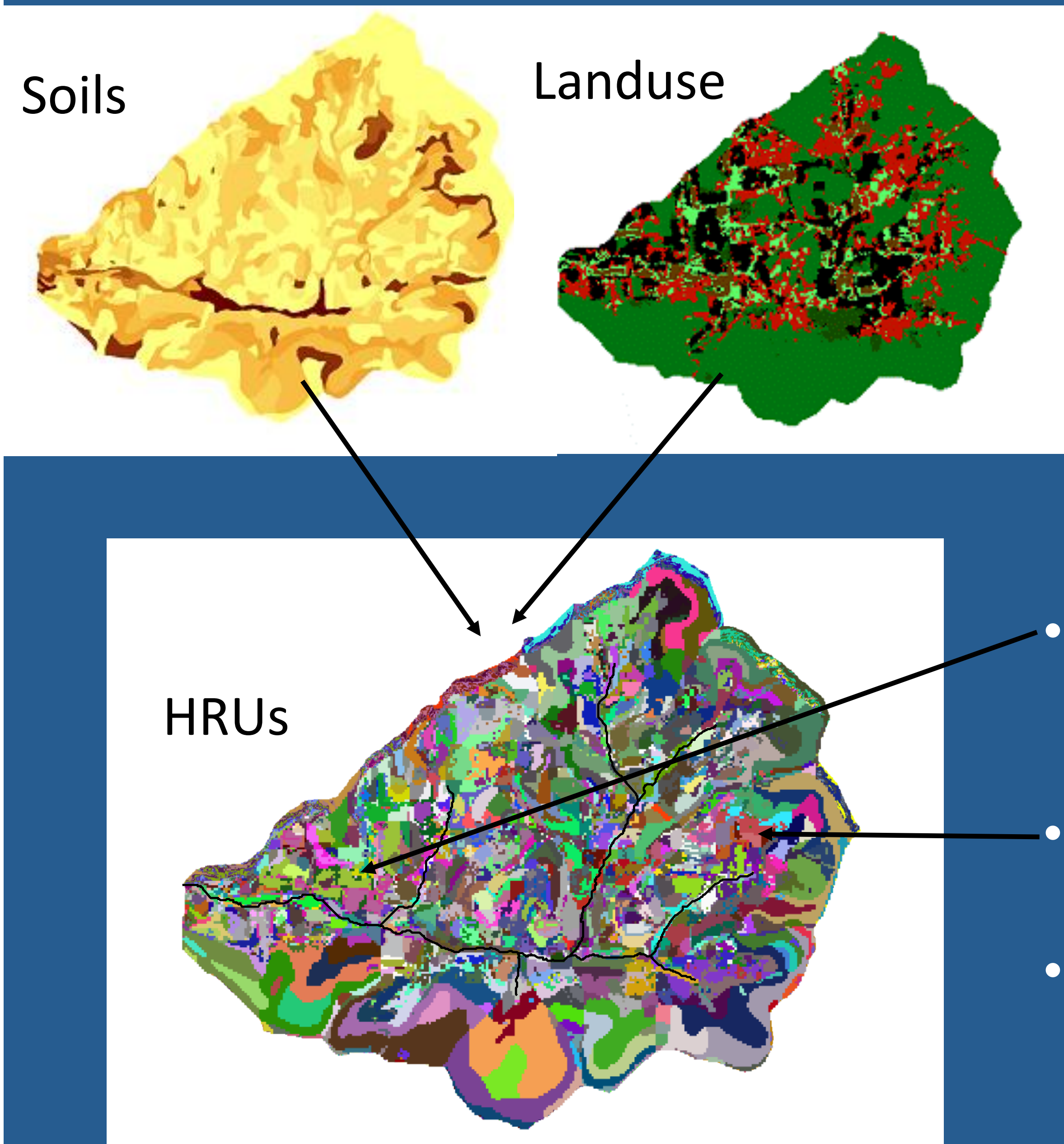




37 km^2

Catskills Mtns, NY

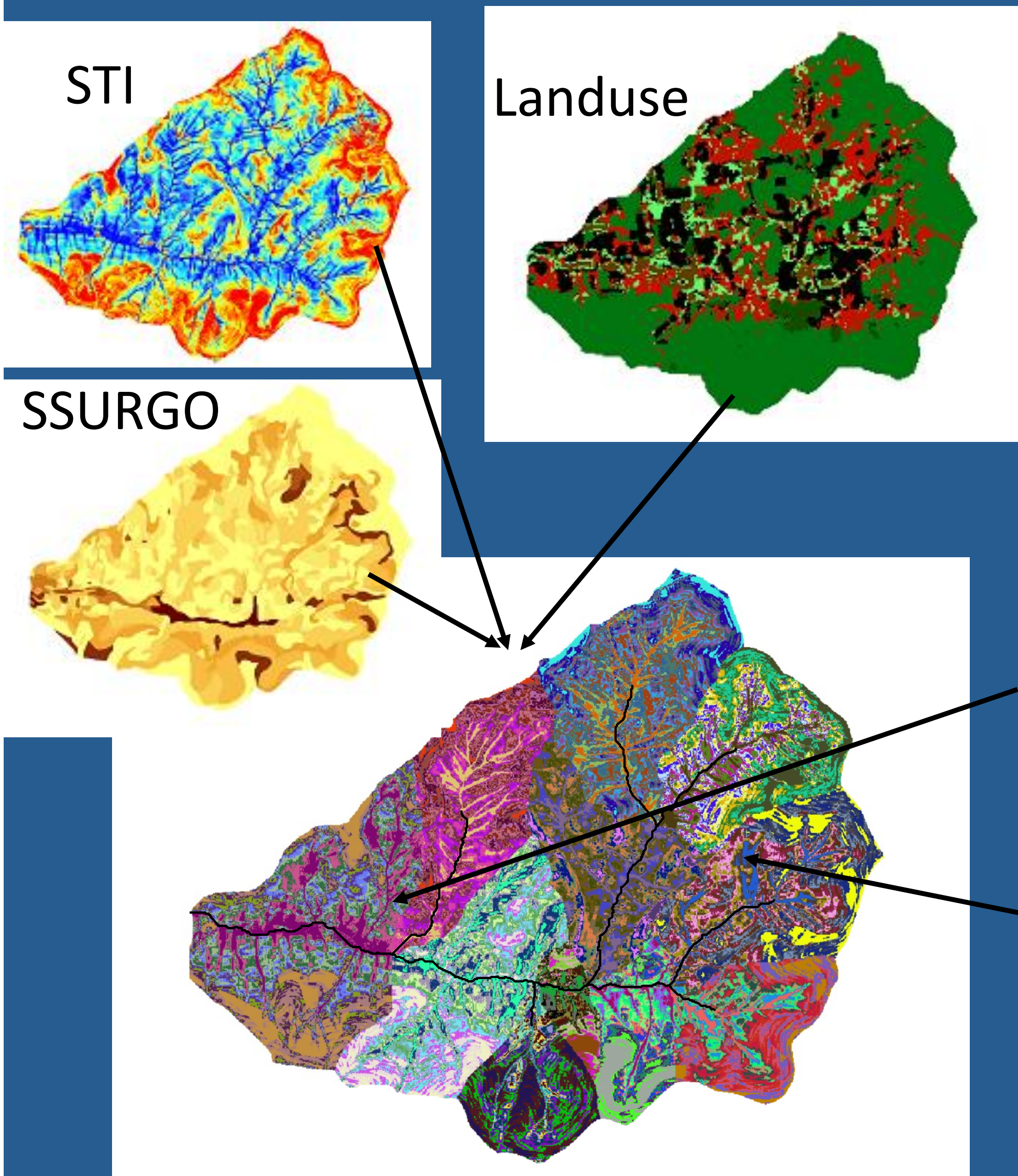
Steep to moderate hillslopes
Soil depth 0.5 m - > 1.0 m
Fragipan restricting layer



SWAT defines HRUs as the coincidence of soil type and landuse

- Hydrological/chemical properties are defined at the HRU

- So runoff/P loss is the same here (lowland pasture)
- As here (upland pasture)
- We know this is not the case

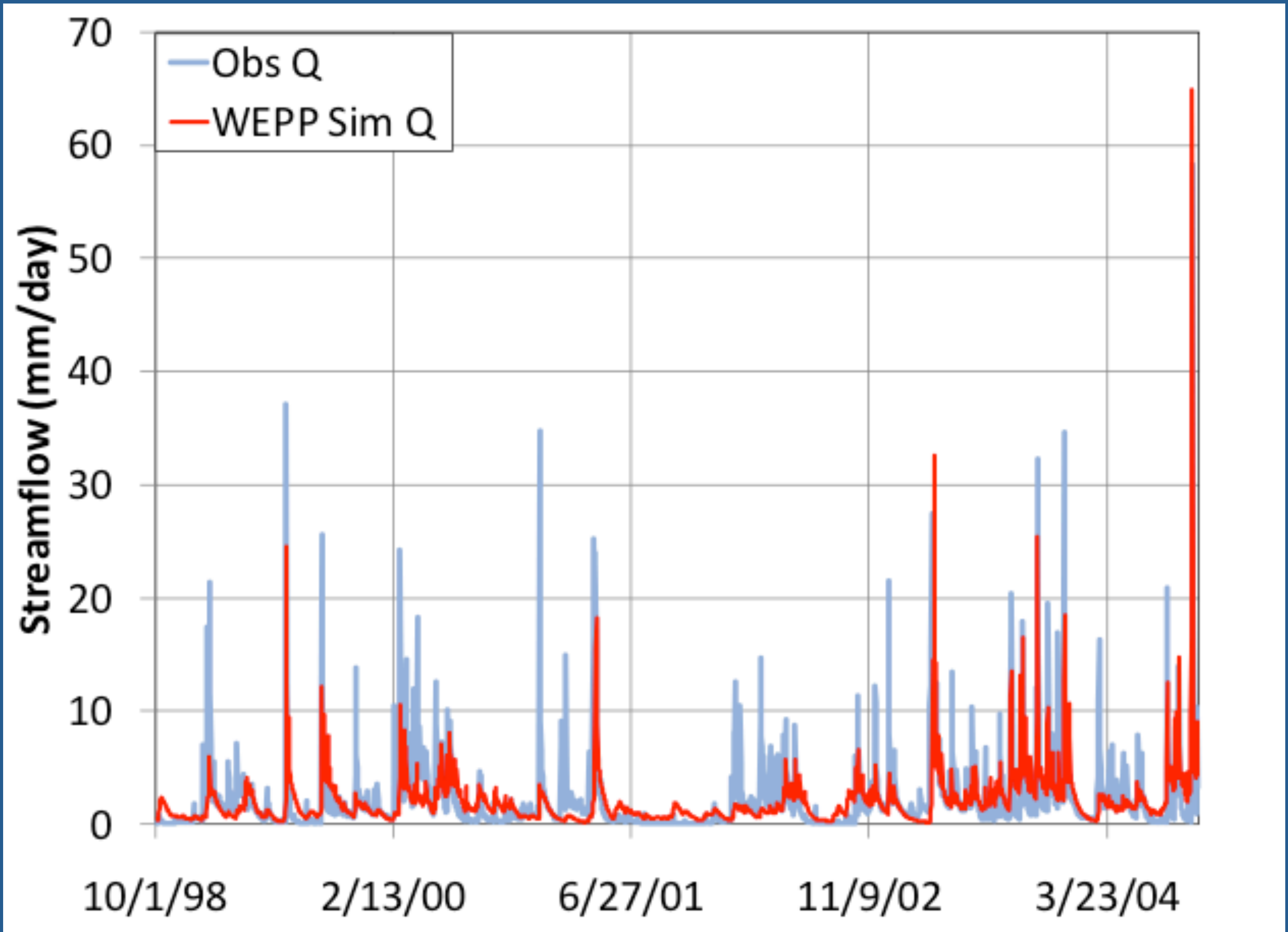


- SWAT-VSA defines HRUs as the coincidence of soil topographic index (and soil) and landuse
  - Weighted average of soil properties nested within an area weighted index class
- So runoff/P loss is now not the same here (lowland pasture)
- As here (upland pasture)

Results

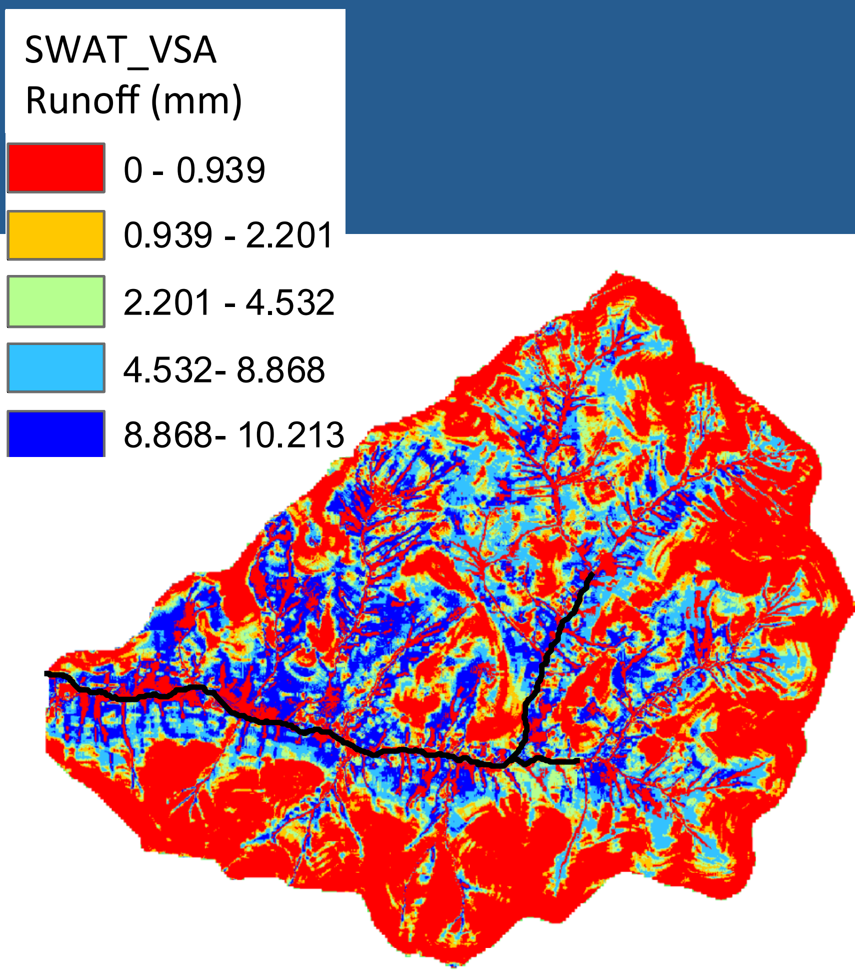
- Observed vs simulated streamflow (Oct 1, 1998 – Sept 30, 2004)
- Statistical comparison
- Composition of streamflow
- Major water balance components
- Sediment at the Town Brook watershed outlet
- Within hillslope water and net erosion

WEPP: observed & simulated streamflow

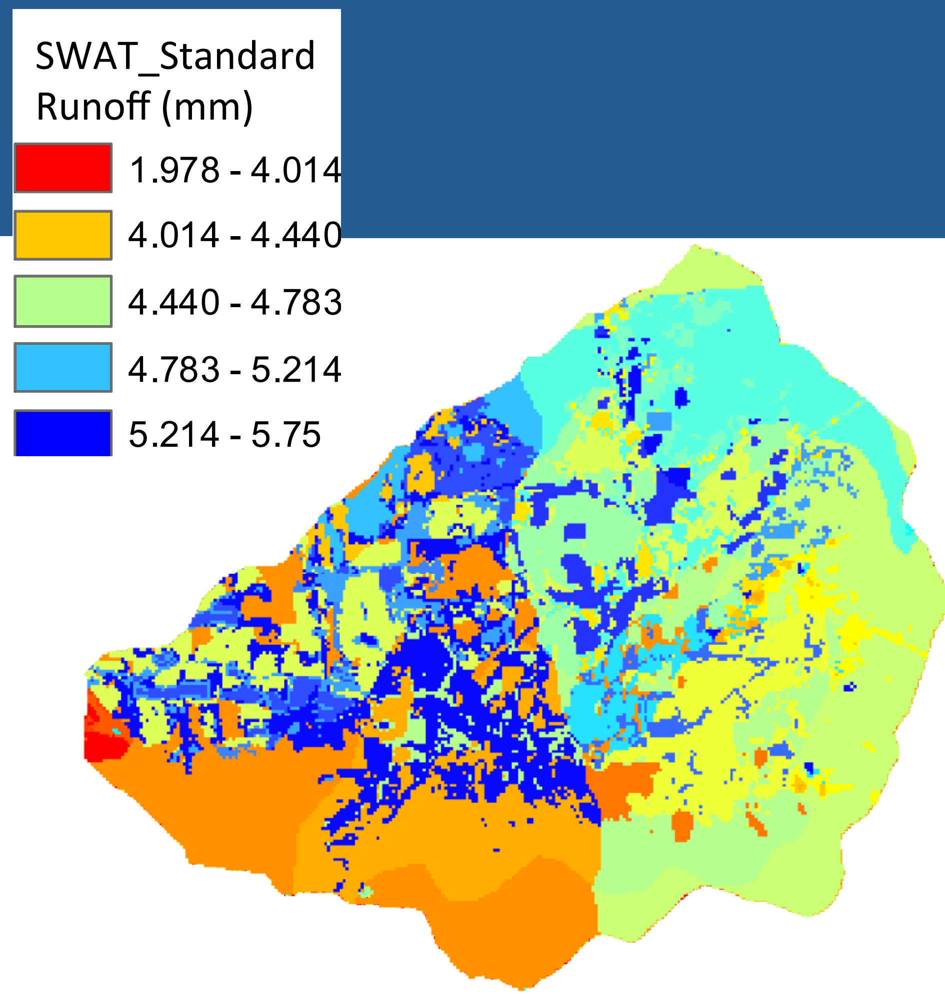


Runoff

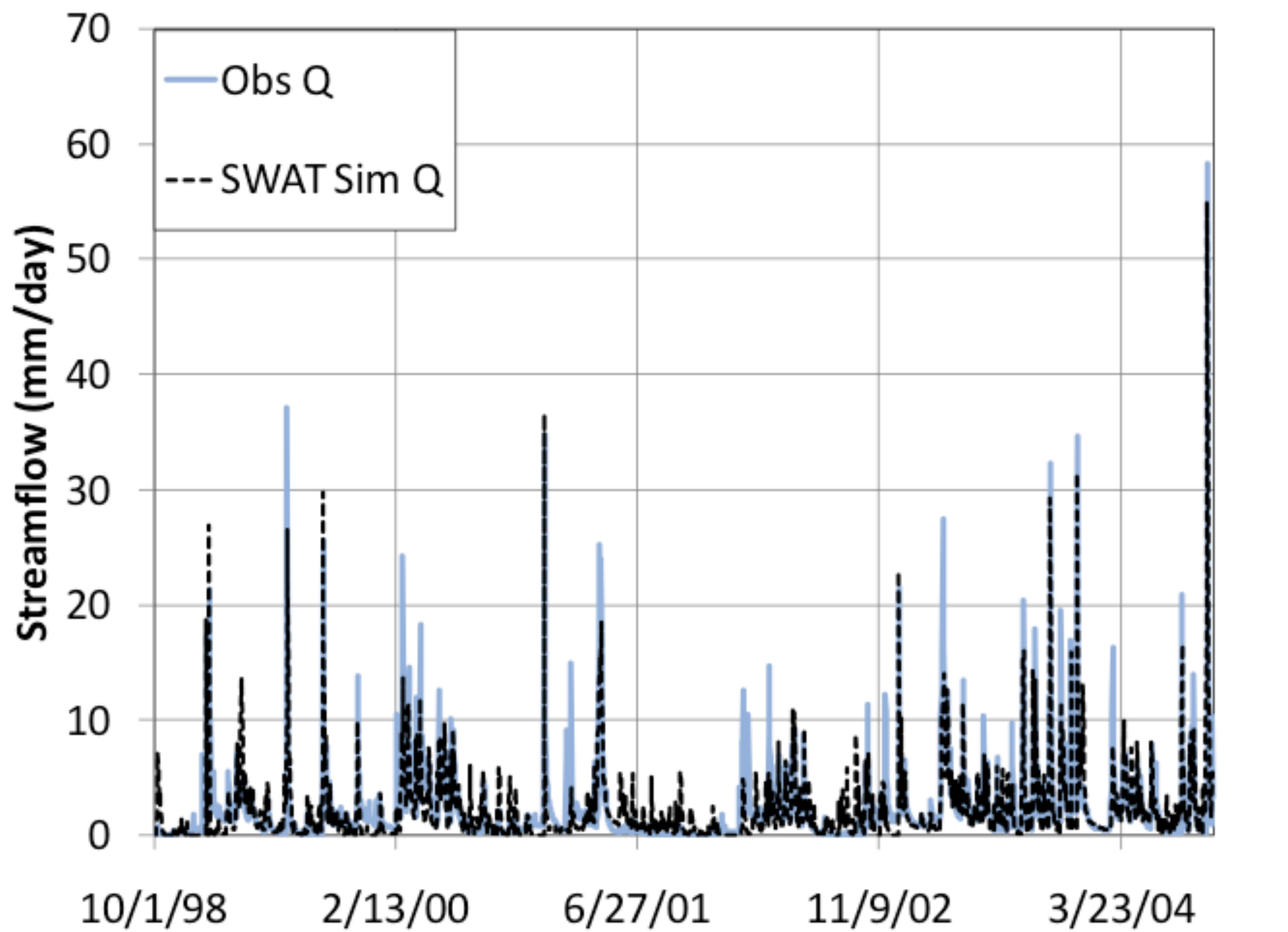
SWAT-VSA



SWAT-Standard



SWAT: observed & simulated streamflow

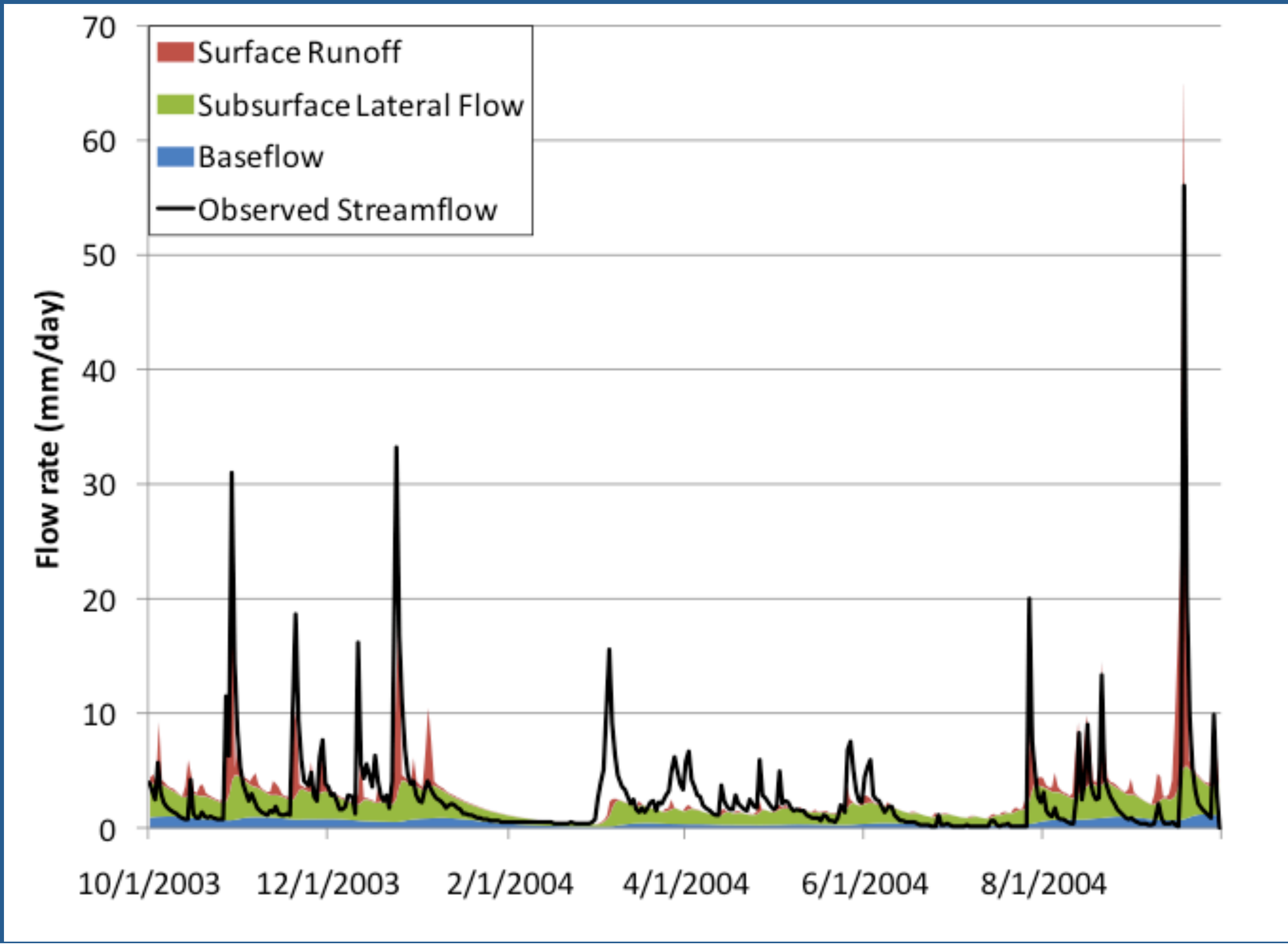


Agreement: observed vs simulated

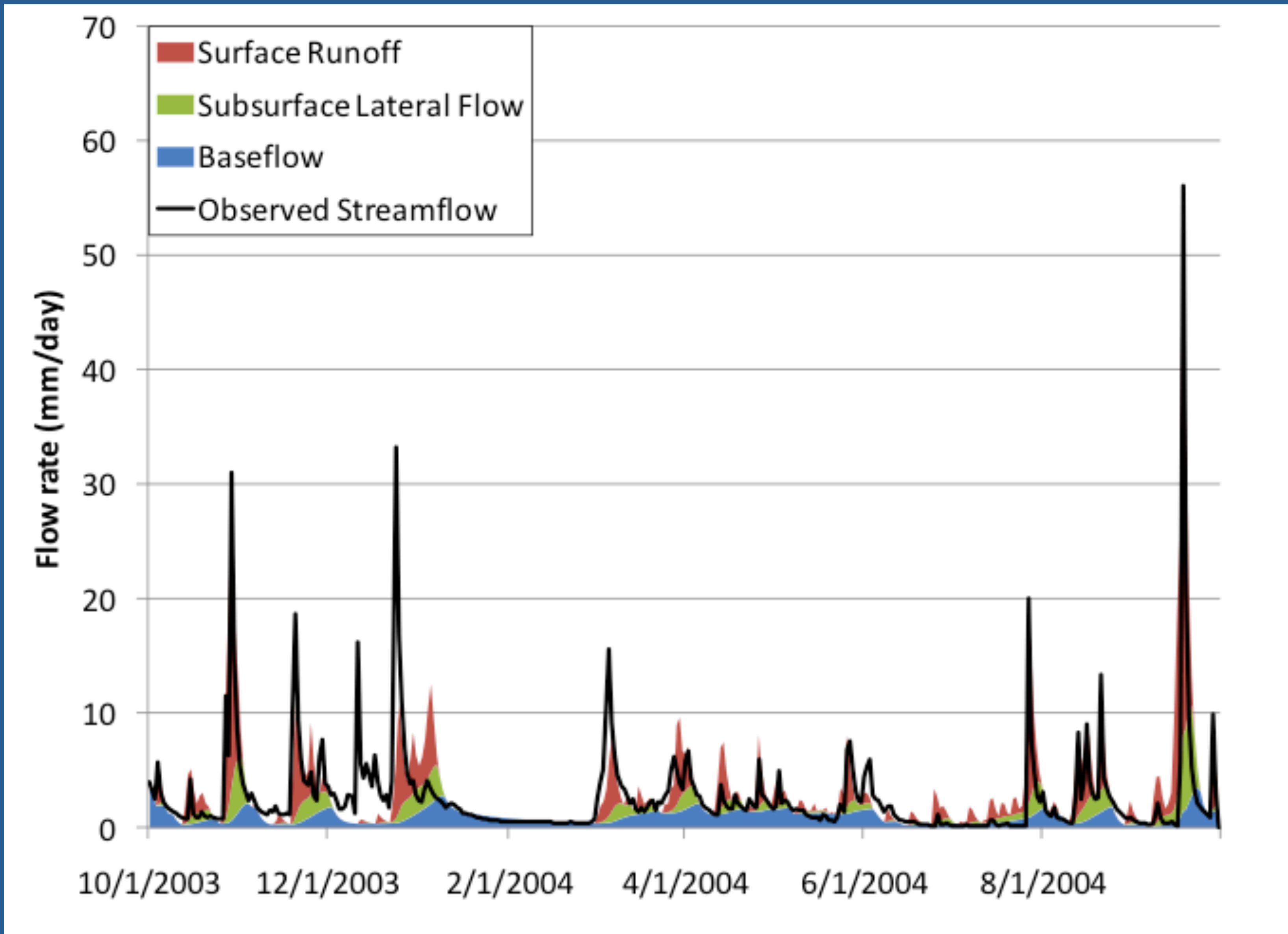
	SWAT-VSA			WEPP		
Time Period	NS Eff	SE (mm)	R^2	NS Eff	SE (mm)	R^2
All Years	0.58	2.05	0.64	0.40	2.09	0.41
1999	0.43	2.34	0.59	0.45	1.44	0.46
2000	0.55	1.64	0.59	0.36	1.08	0.38
2001	0.69	1.69	0.70	0.15	1.73	0.17
2002	0.28	1.43	0.36	0.20	0.71	0.21
2003	0.59	1.95	0.60	0.22	2.29	0.29
2004	0.62	2.83	0.70	0.59	2.74	0.63

NS Eff = Nash-Sutcliffe Efficiency; SE = standard error

WEPP: composition of streamflow



SWAT: composition of streamflow



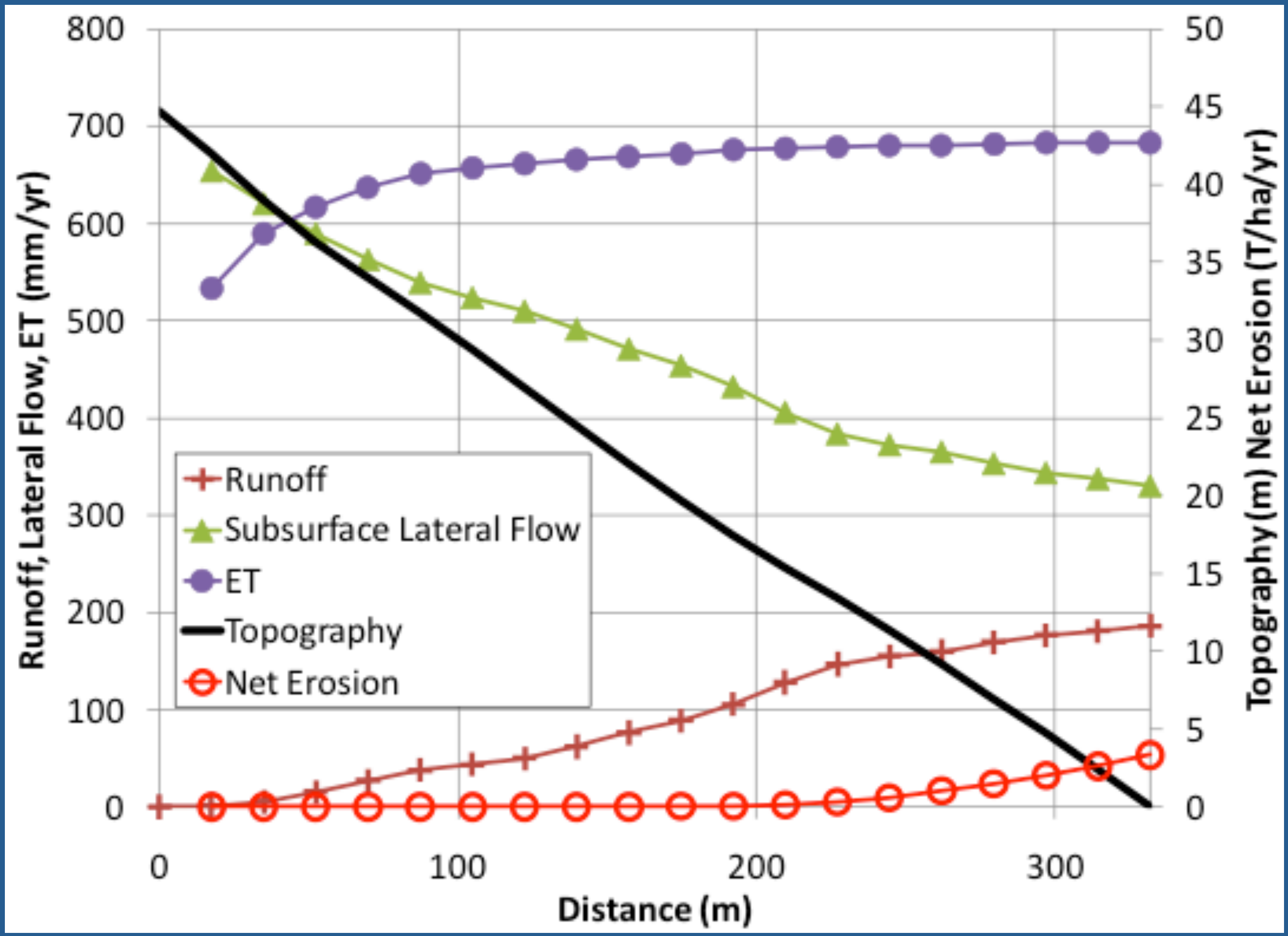
Average annual distribution of water balance components simulated

Water Balance Component	Percent of annual Precipitation (%)	
	SWAT-VSA	WEPP
Precipitation	100%	100%
Evapotranspiration	37%	39%
Baseflow	14%	12%
Runoff	21%	13%
Lateral Flow	28%	35%

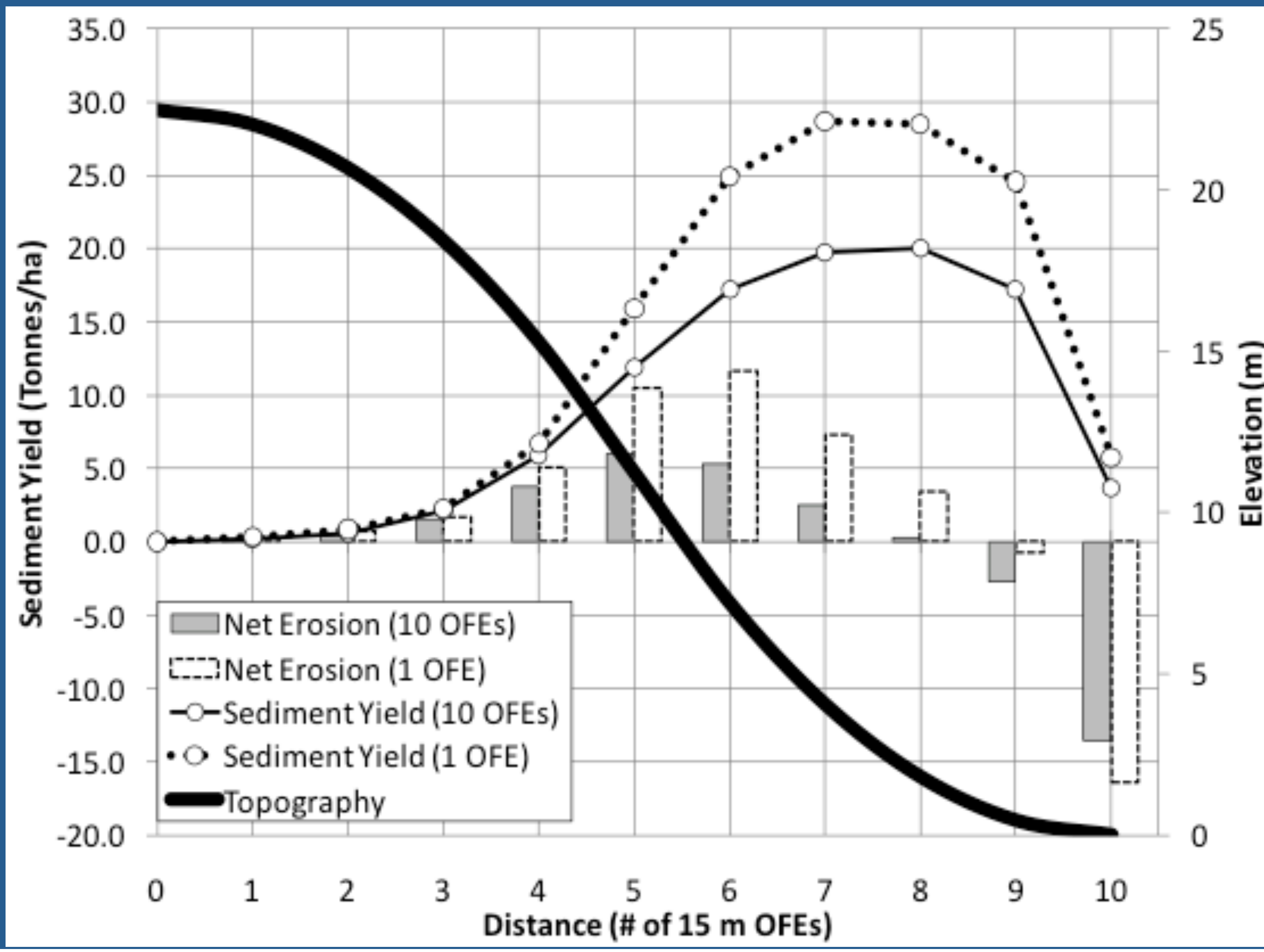
Observed vs simulated sediment at Town Brook watershed outlet

Description	Sediment Yield (T/yr)	Sediment Yield (T/ha/yr)
Obs. at watershed outlet	1,931	0.5
SWAT at watershed outlet	15,717	4.3
WEPP from hillslopes	546	0.1

WEPP: predictions within hillslope



Net-erosion & sediment yield



Conclusions

- Agreement between observed & simulated streamflow comparable
- SWAT (calibrated) simulated a (flashy) hydrograph that agreed better with observations than WEPP (non-calibrated)
- Simulated hydrographs by WEPP can be improved with better representation of transpiration changes in deciduous forests

Conclusions

- Sediment yield was over-predicted by SWAT
- Sediment yield predictions from hillslopes suggest that the majority of sediment delivered at the outlet of the stream may be derived from streambanks
- This study shows WEPP can be applied to large watersheds
- SWAT is more appropriate for large scale applications
- WEPP has ability to provide detail water and mass balance evaluation at the hillslope scale