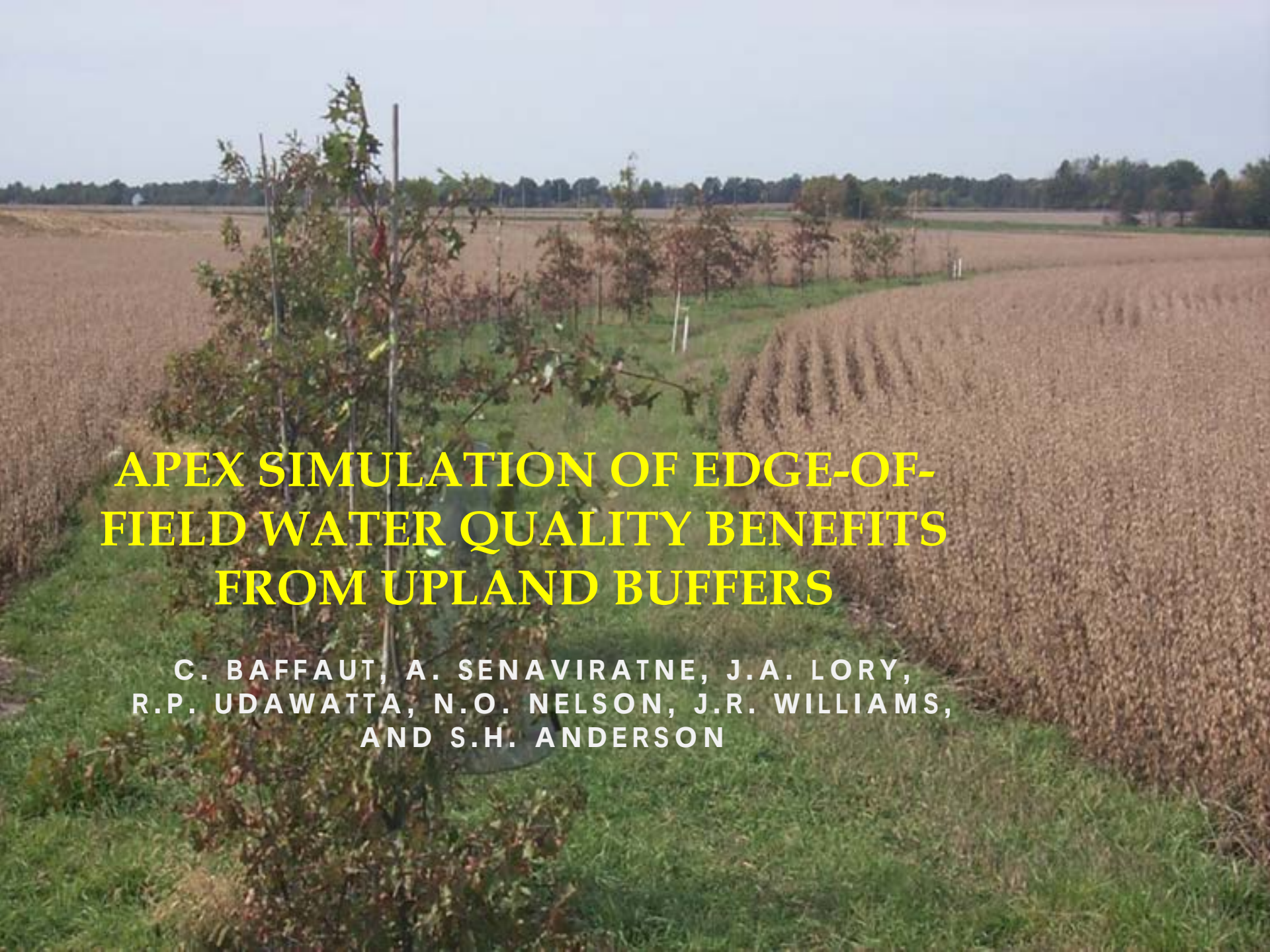
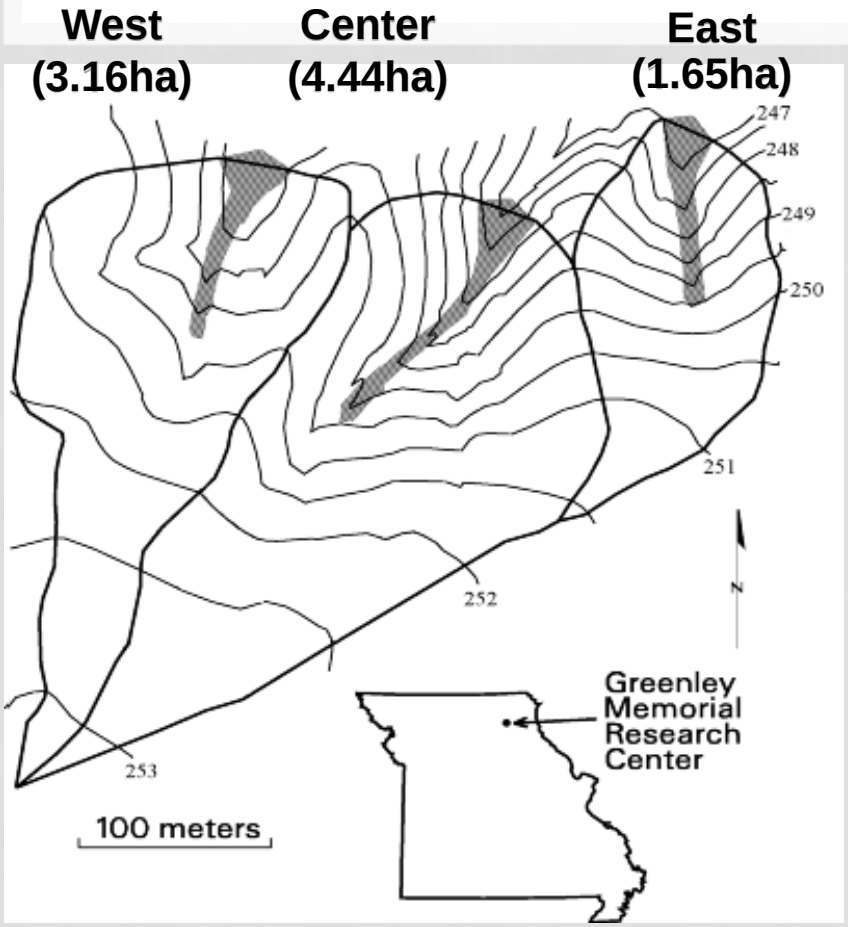


APEX SIMULATION OF EDGE-OF-FIELD WATER QUALITY BENEFITS FROM UPLAND BUFFERS

C. BAFFAUT, A. SENAVIRATNE, J.A. LORY, R.P. UDAWATTA, N.O. NELSON, J.R. WILLIAMS, AND S.H. ANDERSON

GREENLEY WATERSHED STUDY

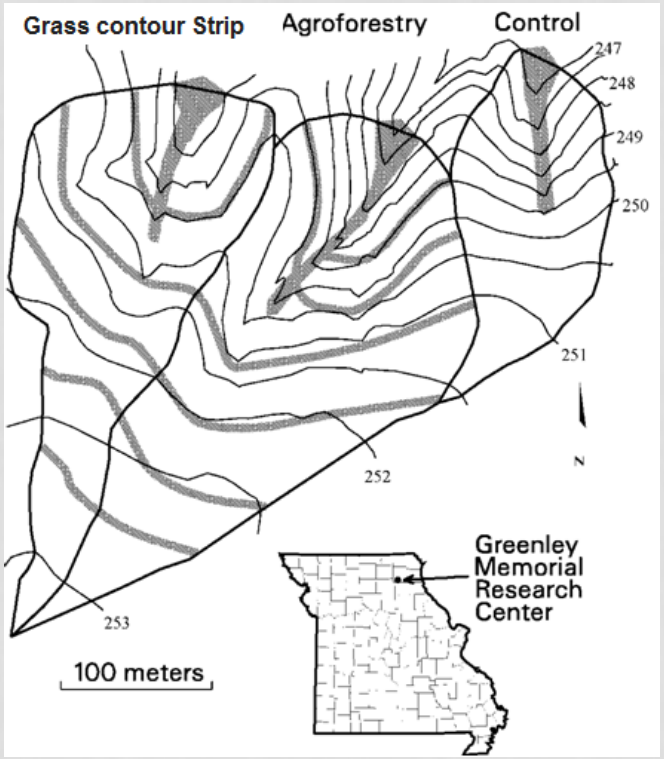


Soils with a restrictive layer at 4-37cm depth

- **Putnam silt loam at the summit (0 – 1% slope)**
- **Kilwinning silt loam on the side slopes (2 - 5%)**
- **Armstrong loam on the foot slopes (5 - 9%)**

Prior to 1991: Corn-soybean rotation with tillage
1991 – 2010 : No-till corn-soybean rotation

TREATMENT PERIOD: 1998 - 2008



- **Grass – legume strips (4.5m wide) redtop, brome grass, birds foot trefoil**
- **Agroforestry strips (4.5m wide): grass + pin oak, swampwhite oak, and bur oak**


1999

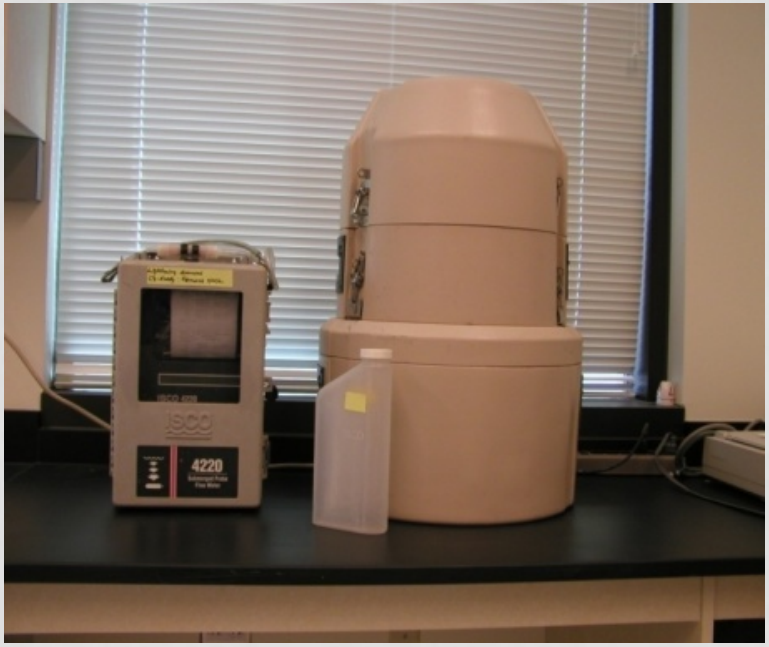

2002


2005


2007
AUG 1 2007

MONITORING

Each watershed is drained by a grass waterway, leading to a concrete approach structure and H-flume



Flow meter and water sampling device

EXPERIMENTAL RESULTS FROM PAIRED WATERSHED STUDY

	% Reduction in Tree & grass buffers	% Reduction in grass buffers
Runoff	15%	23%
Sediment	30%	28%
Total P	26%	22%

(Udawatta et al., 2011)

QUESTIONS AND OBJECTIVES

Questions

- Can we use APEX to simulate upland contour buffers?
- Is the simulated effectiveness of upland contour buffers meaningful?

Objectives

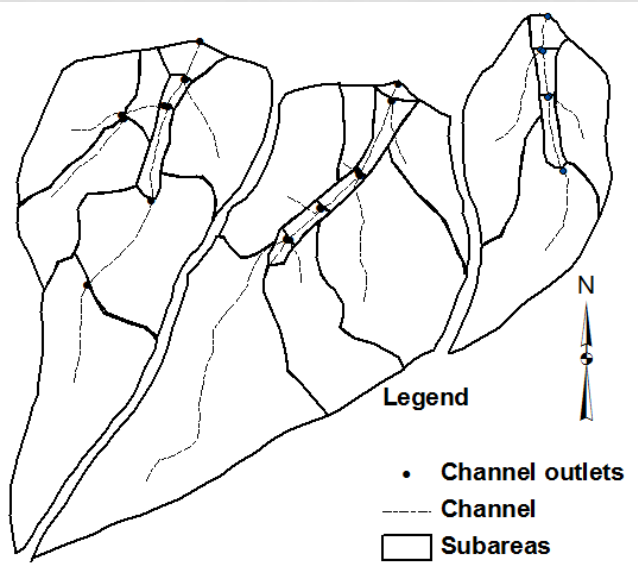
- Calibrate APEX when buffers are and are not present.
- Compare simulated buffer effectiveness to effectiveness obtained from monitoring data.

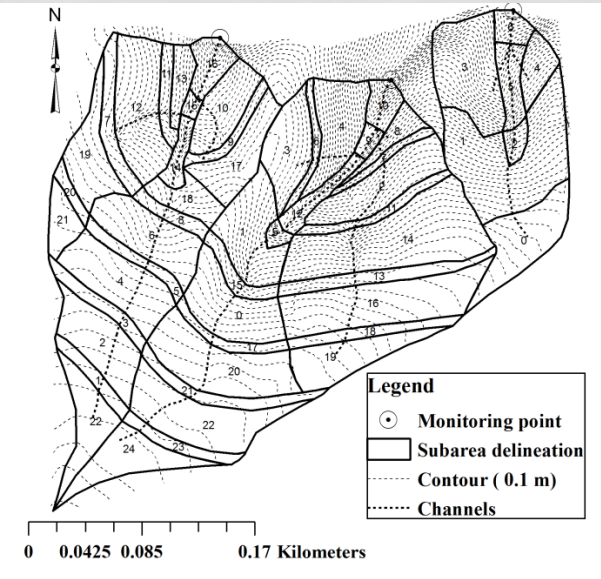
METHODS

- Calibrate APEX with no buffers (1993-1997)
  - Calibration on Center watershed
  - Validation on West and East watersheds
- Test that model for 1998-2008, during which buffers were present. New delineation is necessary.
- Recalibrate APEX using 1998-2008 data and test on 1993-1997 data.

WATERSHED DELINEATION

- No buffer: follow topography and soils
- Buffers: each buffer is a subarea.



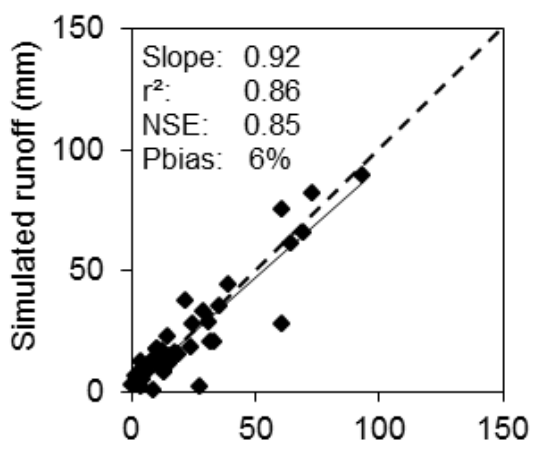


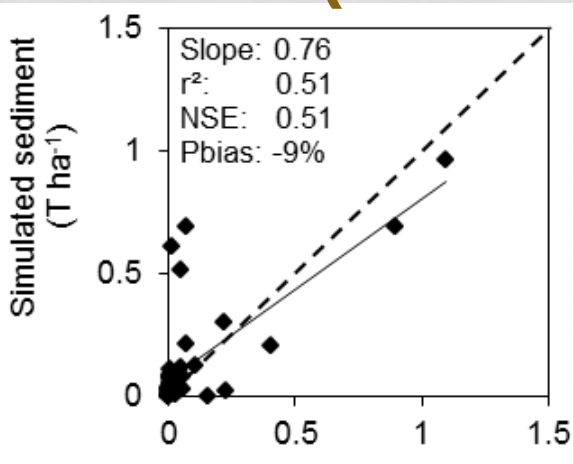
RUNOFF AND WATER QUALITY DATA

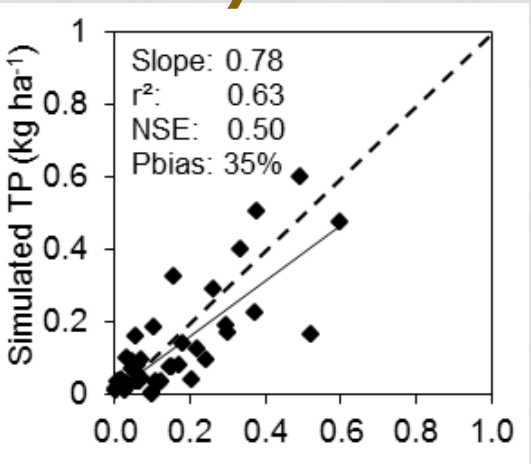
		Center No-buffer	West No-buffer	East Control No-buffer	Center Upland Tree Buffers	West Upland Grass Buffers	East Control No-buffer
		1993-1997			1998-2008		
Runoff (mm)	Number of events	47	47	47	42	42	42
	Median	13.7	18.9	15.7	16.5	20.5	21.3
	Range	0.6 - 93.2	0.6 - 141	0.9 - 149	2.0 - 75	0.6 - 109	0.8 - 110
Sediment (kg ha^{-1})	Number of events	43	41	43	30	28	29
	Median	10.0	14.0	9.0	3.0	3.0	5.0
	Range	0.3 - 1090	0.2 - 1090	0.4 - 1171	0.3 - 49	0.3 - 37	0.1 - 38
TP (kg ha^{-1})	Number of events	43	41	43	20	20	20
	Median	0.099	0.106	0.069	0.074	0.08	0.08
	Range	0.003 - 0.60	0.002-0.83	0.003-0.67	0.008-0.44	0.005-0.63	0.004-0.67

NO BUFFERS MODEL RESULTS

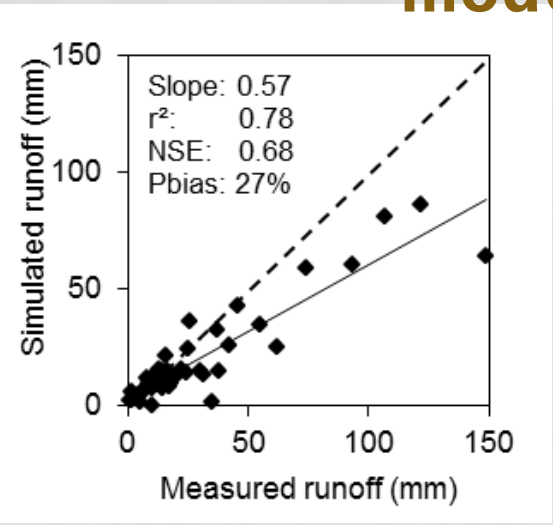
model calibration (Center watershed)

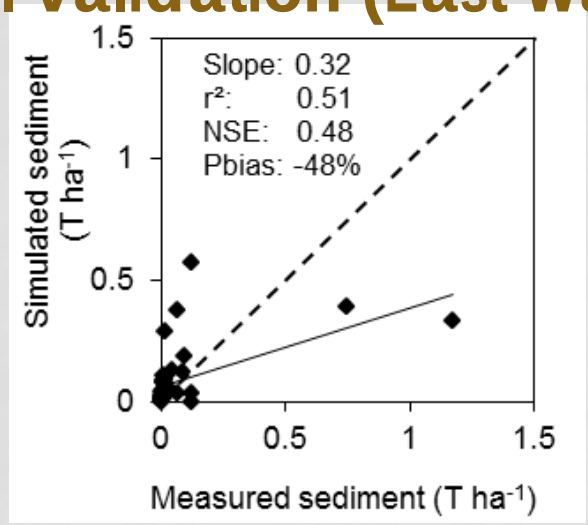


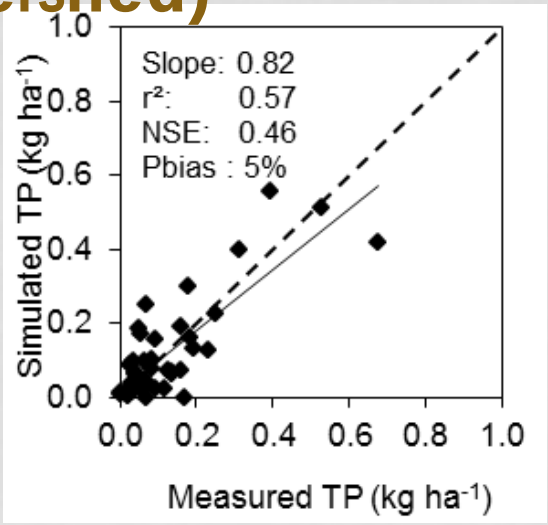




model validation (East watershed)

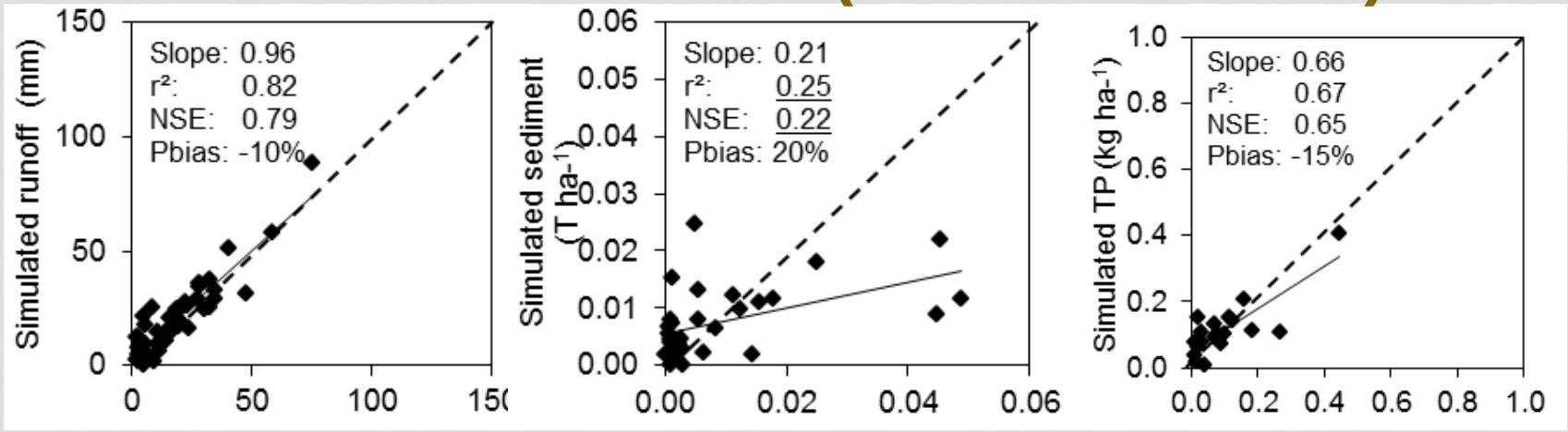




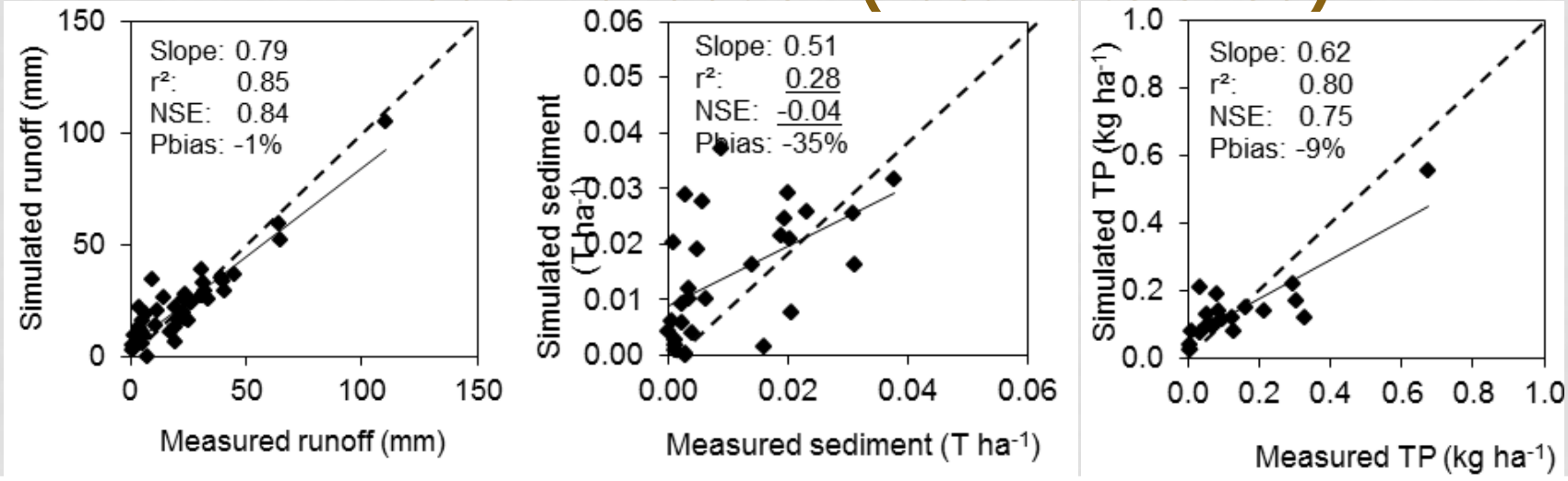


BUFFER MODEL RESULTS

model calibration (Center watershed)



model validation (East watershed)



PERFORMANCE ACROSS MANAGEMENTS

	NSE Value for the Center watershed	
No Buffer Model	**Calibration on the no-buffer period**	**Validation on buffer period**
Runoff	0.85	0.6
Sediment	0.51	-19
TP	0.50	-0.01
Upland Buffer Model	**Calibration on buffer period**	**Validation on the no-buffer period**
Runoff	0.79	0.82
Sediment	0.22	0.01
TP	0.65	0.55

BUFFER EFFECTIVENESS

	Agroforestry buffers	
Paired watershed approach based on 2004-2008 monitored events	Runoff	TP
Udawatta et al. (2011) using monitoring data	-15%	-26%
Values simulated with the buffer APEX model	-17%	-28%
Based on March-Nov 2004-2008 APEX simulated daily values		
Paired watershed approach	-22%	-29%
Direct simulation of no buffer conditions with the buffer model	-25%	-28%

DISTRIBUTIONS OF P46 AND P69 WHEN NSC > 0.2 FOR SEDIMENT.

P46	No buffer		With buffers	
0.6	**378**	**66%**	0	0%
0.75	160	28%	11	6%
0.9	32	6%	**160**	**94%**
	570		171	

P69	No buffer		With buffers	
0.1	0	0%	**139**	**81%**
0.2	122	21%	32	19%
0.35	160	28%		
0.6	**288**	**51%**		
	570		171	

Greater P 46 value with buffers means higher effectiveness of residues

Smaller P 69 value with buffers means lower rate of residue mineralization.

CONCLUSIONS

- APEX can simulate meaningful runoff and P losses from a field with and without upland contour buffers.
- P46 (the effectiveness of residue at reducing erosion) and P69(coefficient adjusting the mineralization rate) need to be adjusted to reflect changing biological processes caused by the conservation practice.
- Some of what we see may be the cumulative long-term effect of no-till rather than the effect of upland contour buffers.
- Improved understanding of these processes will result in process-based equations to calculate the value of these parameters.
- Until then, calibration and uncertainty analysis are necessary to obtain meaningful estimates of practice effectiveness.