Identifying Sources of Suspended Sediment Using Radionuclides in an Agricultural Watershed in South Central Wisconsin

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BACKGROUND

- ✓ Sediment loss in agricultural runoff causes water quality impairment.
- ✓ Pollutants like phosphorus are transported in particulate bound forms.
- ✓ Identifying sources of in-stream sediments can help target management of non-point source pollution.

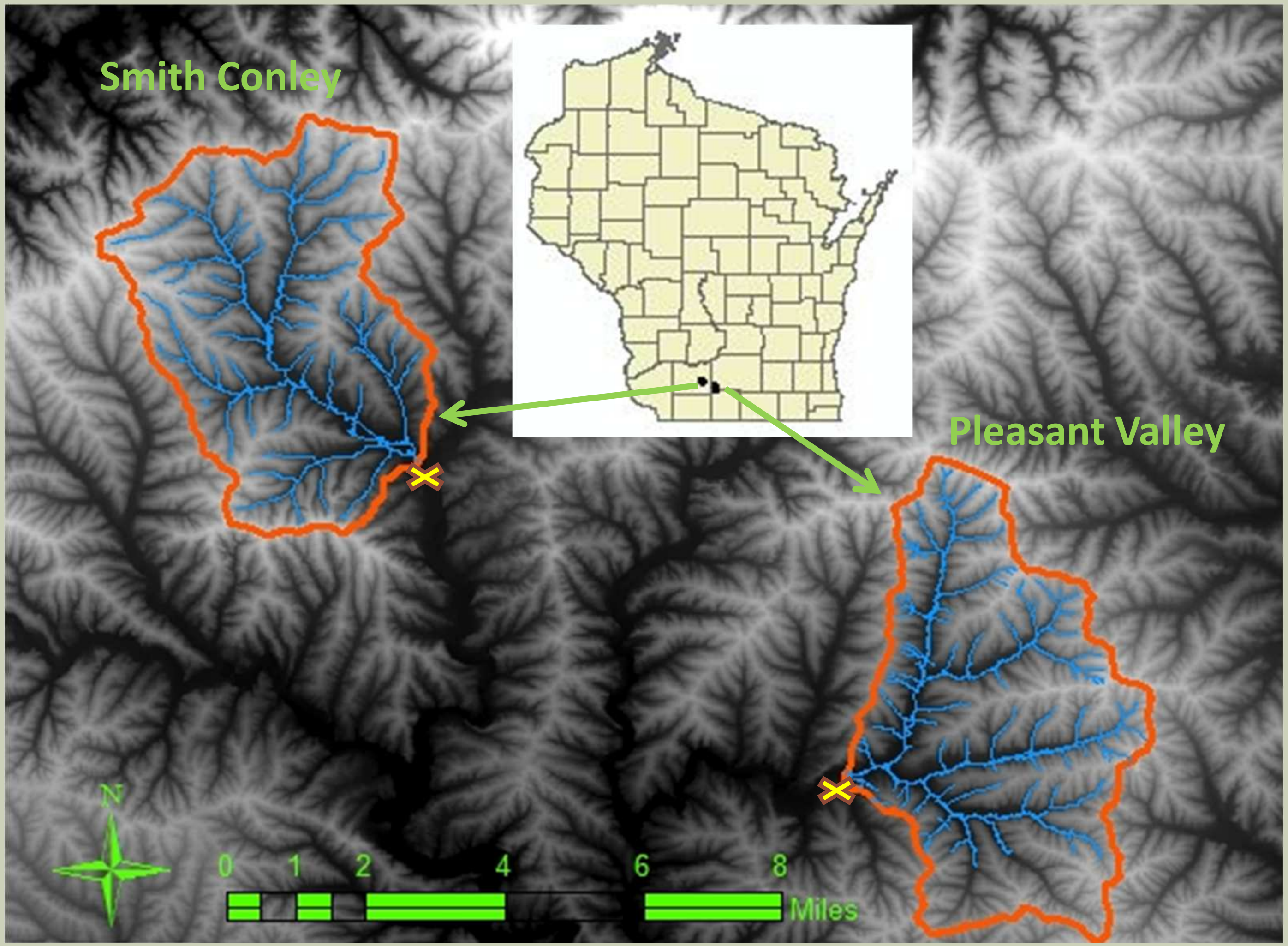
BACKGROUND

- ✓Sediment bound tracers are commonly used to identify different sources of in-stream sediments [e.g. Walling & Woodward (1992), Gellis & Landwehr (2006)].
- ✓Atmospheric fallout radionuclides have been used to study long term sediment transport processes.
- ✓Two most commonly used radionuclides are $^{210}Pb_{xs}$ ($t_{1/2}$ =22.3 yr) and ^{137}Cs ($t_{1/2}$=30.1 yr).

BACKGROUND

- ✓ Paired watershed study with treatment and control watershed.
- ✓ Does targeting a small proportion of the landscape that is responsible for a disproportionate amount of pollution work to improve water quality?

BACKGROUND



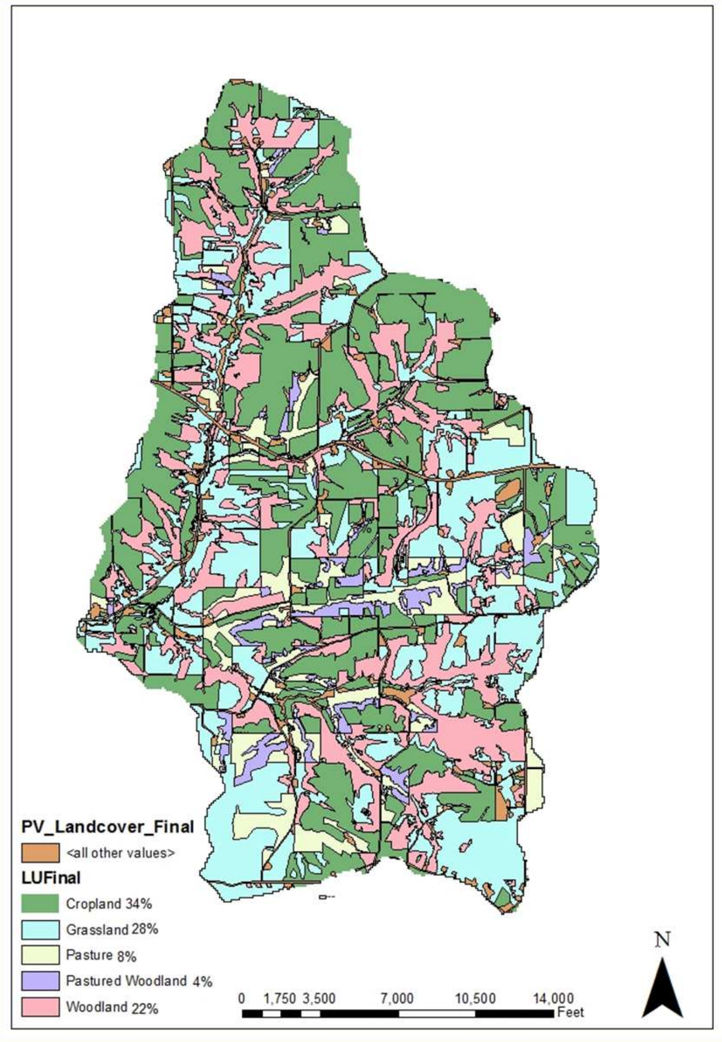
OBJECTIVE & HYPOTHESIS

- ✓ Objective: Source apportionment of in-stream sediments using atmospheric fallout radionuclides ^{137}Cs and $^{210}Pb_{xs}$.

- ✓ Hypothesis: As the ratio of cropland to undisturbed area increases within a watershed, upland soils will become the dominant contributor to suspended sediment compared to in-stream sources.

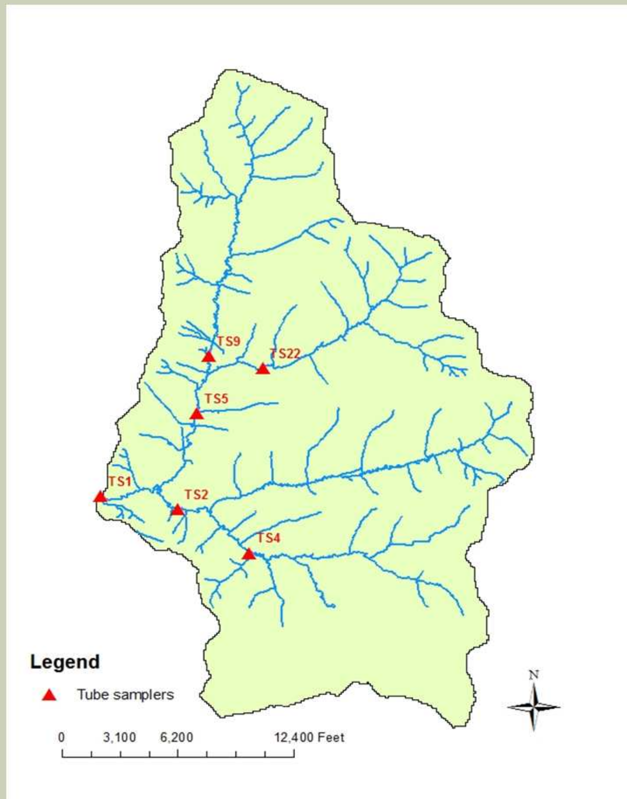
PROJECT SITE

- ✓ Dominant land uses are:
  - ✓ Cropland
  - ✓ Forest
  - ✓ Grassland
- ✓ Area is ~ 19 sq miles
- ✓ Average slope is 11%
- ✓ Silt loam soils

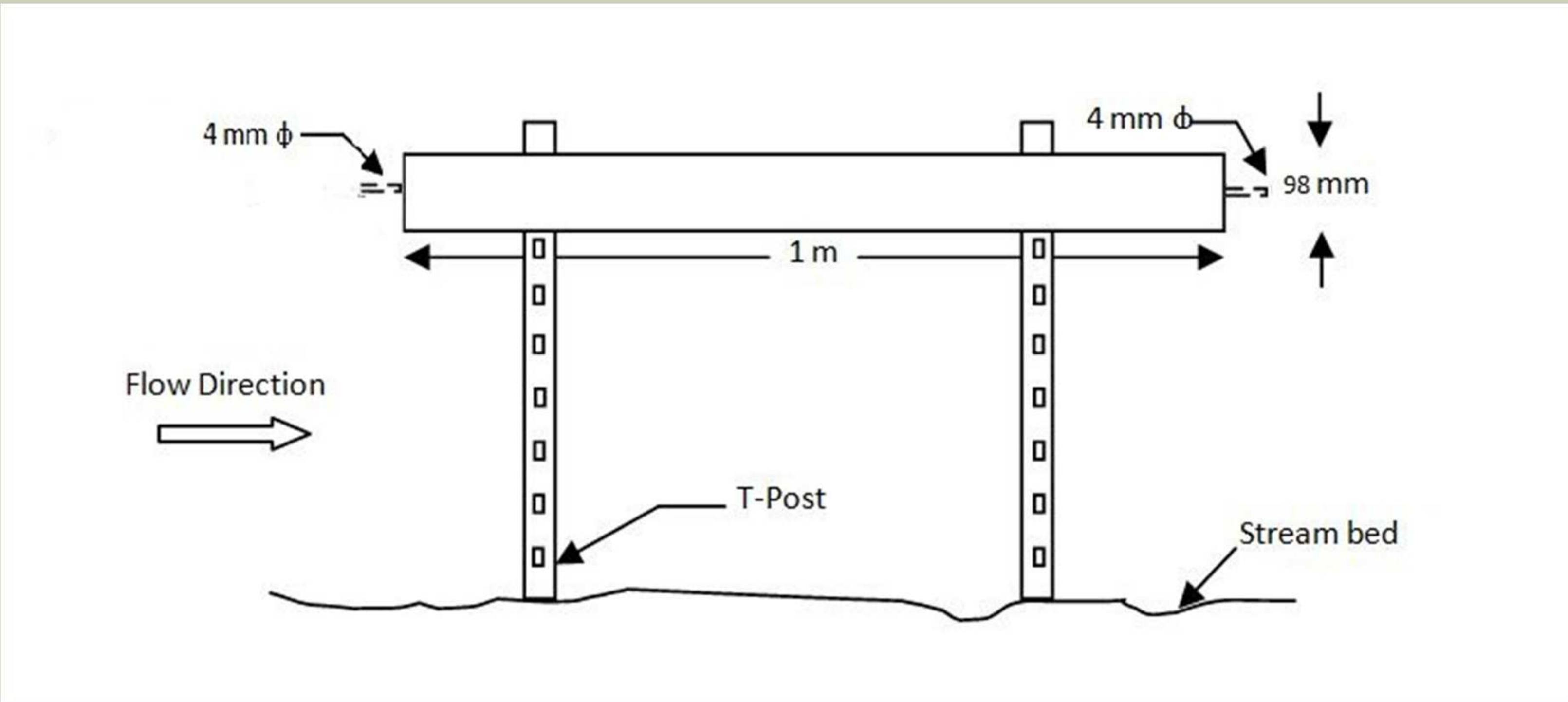


METHODOLOGY

- Suspended sediment samples were collected monthly for 4 months using Phillips et al. (2000) tube samplers.



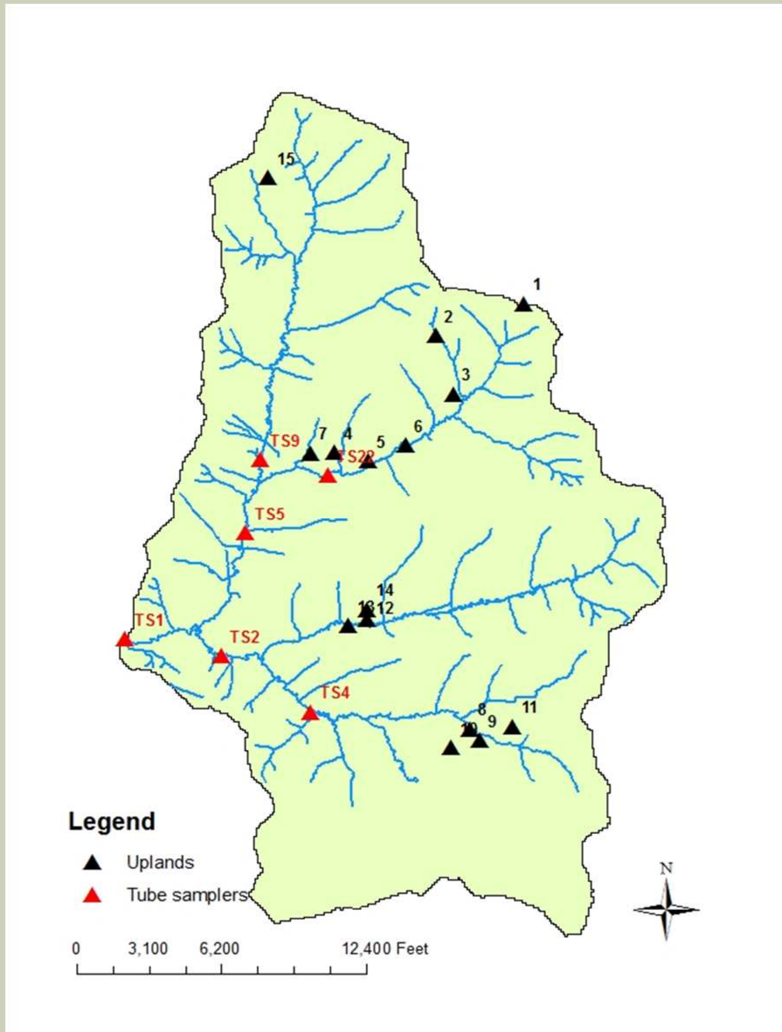
METHODOLOGY



METHODOLOGY

METHODOLOGY

- ✓ Two sources considered:
  - ✓ Uplands
  - ✓ Stream bed/bank
- ✓ All source material samples collected from top 2.5 cm.

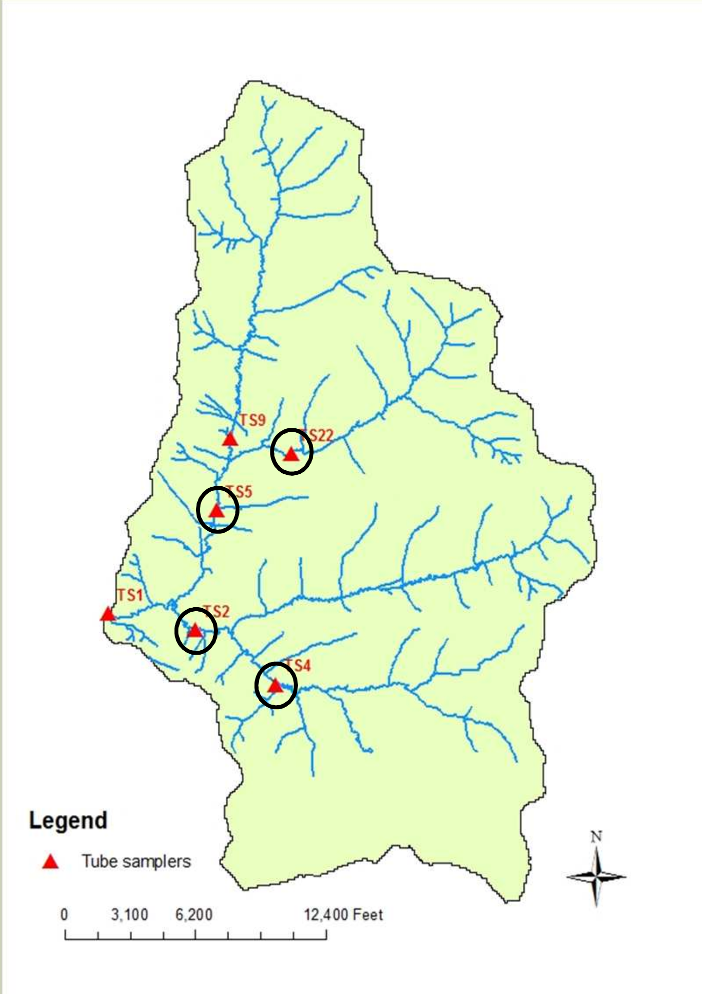


RESULTS & DISCUSSION

- ✓ Both tracers were able to discriminate between uplands and stream bed/banks according to Mann Whitney test at $p=0.1$
- ✓ Multivariate mixing model based on Collins et al. (1998) was used to calculate relative contributions from different sources to in-stream sediments.

RESULTS & DISCUSSION

- ✓ Four sub-watersheds were considered for this study.
- ✓ The outlets for the sub-watersheds were considered to be the sites where the tube samplers were installed.
- ✓ Sites 2, 4, 5, 22

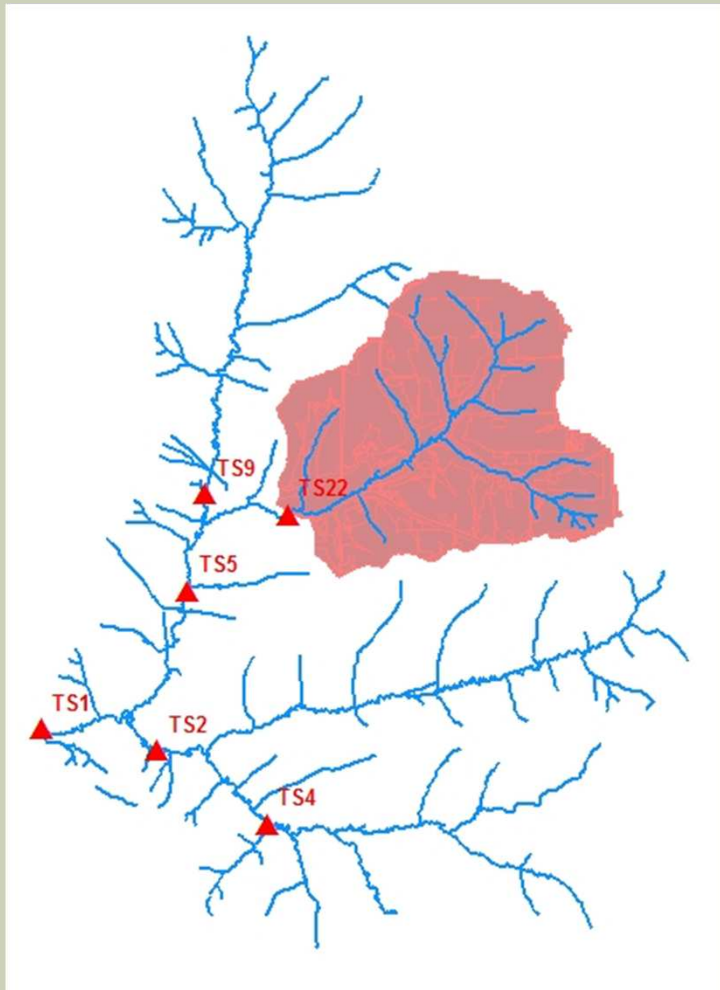


RESULTS & DISCUSSION

✓ Site 22

Mean particle size (Z) and organic carbon (O) correction factors used in Collins et al. model		
Correction Factor	Uplands	Stream Bed/Bank
Z	1.2	1.5
O	1.2	1.7

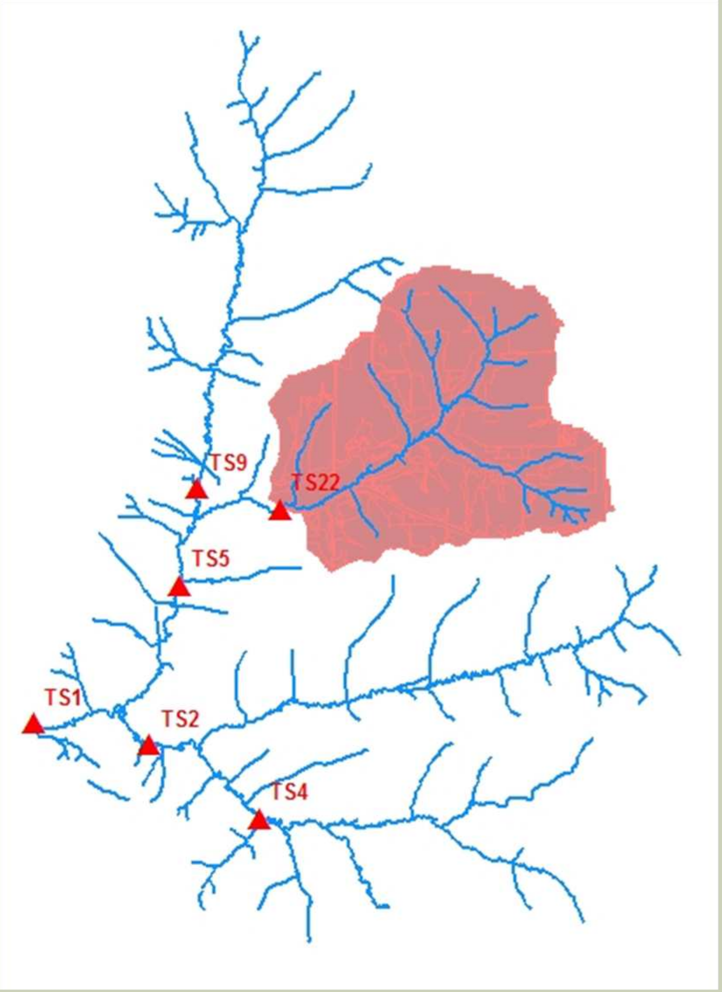
Relative % contribution of uplands and stream bed/bank to in-stream suspended sediment	
Uplands	Stream Bed/Bank
100	0



RESULTS & DISCUSSION

✓ Site 22

Land use percentage for site 22 sub-watershed	
Land Use	**Percentage**
Cropland	45
Pasture	3
Pasture Woodland	1
Woodlands	14
Grassland	37

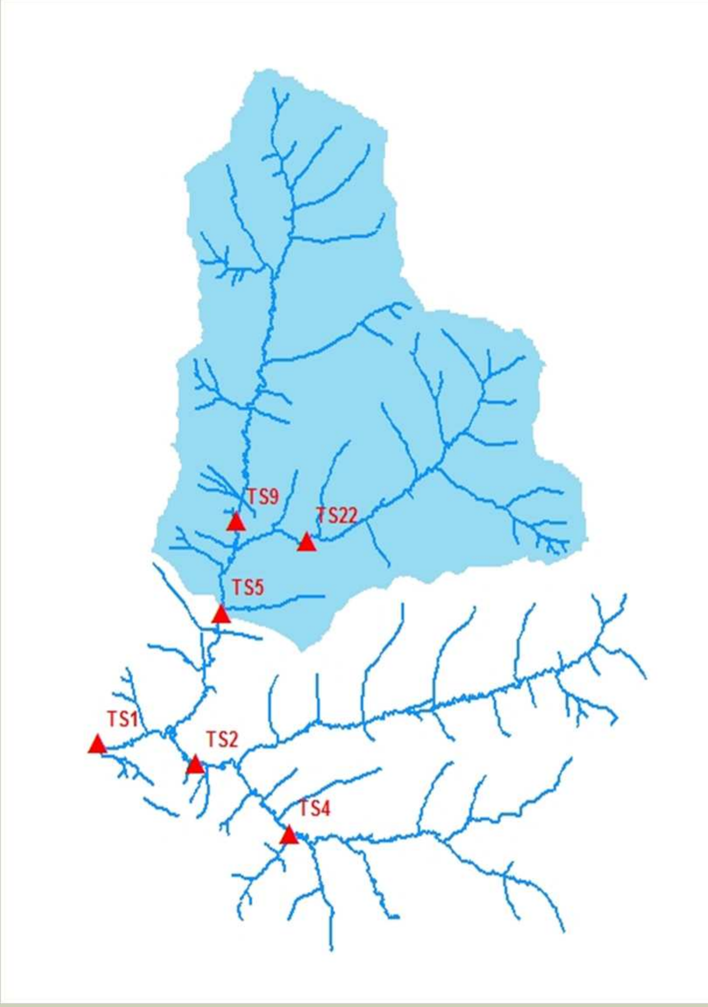


RESULTS & DISCUSSION

✓ Site 5

Relative % contribution of uplands and stream bed/bank to in-stream suspended sediment	
Uplands	**Stream Bed/Bank**
65	35

Land use percentage for site 5 sub-watershed	
Land Use	**Percentage**
Cropland	35
Pasture	3
Pasture Woodland	1
Woodlands	18
Grassland	43

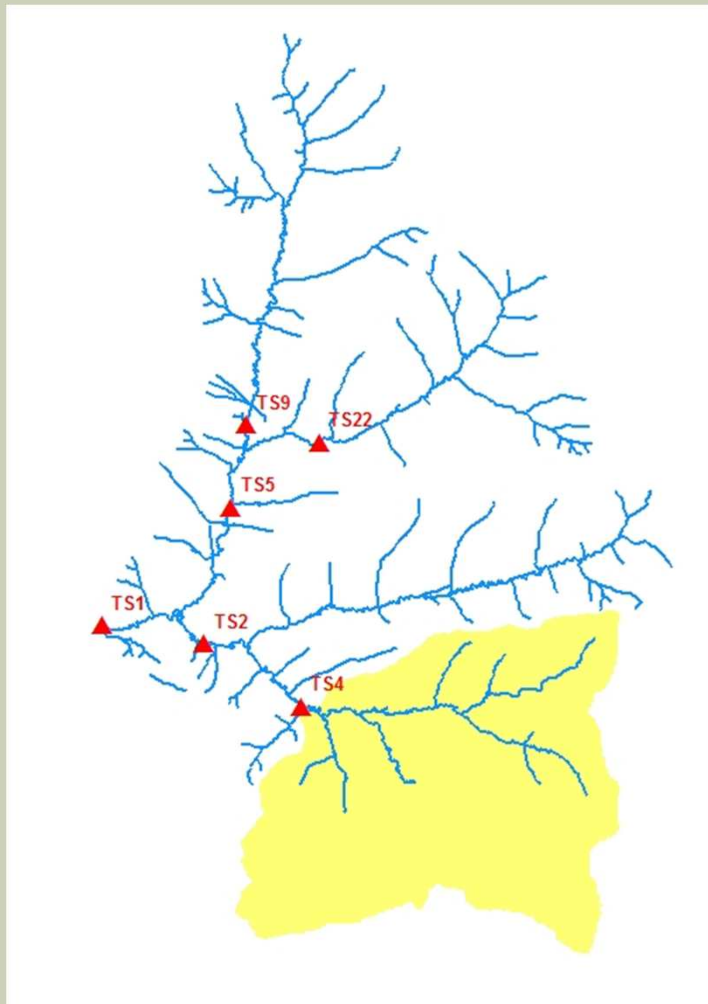


RESULTS & DISCUSSION

✓ Site 4

Relative % contribution of uplands and stream bed/bank to in-stream suspended sediment	
Uplands	Stream Bed/Bank
22	78

Land use percentage for site 4 sub-watershed	
Land Use	Percentage
Cropland	22
Pasture	12
Pasture Woodland	4
Woodland	25
Grassland	37

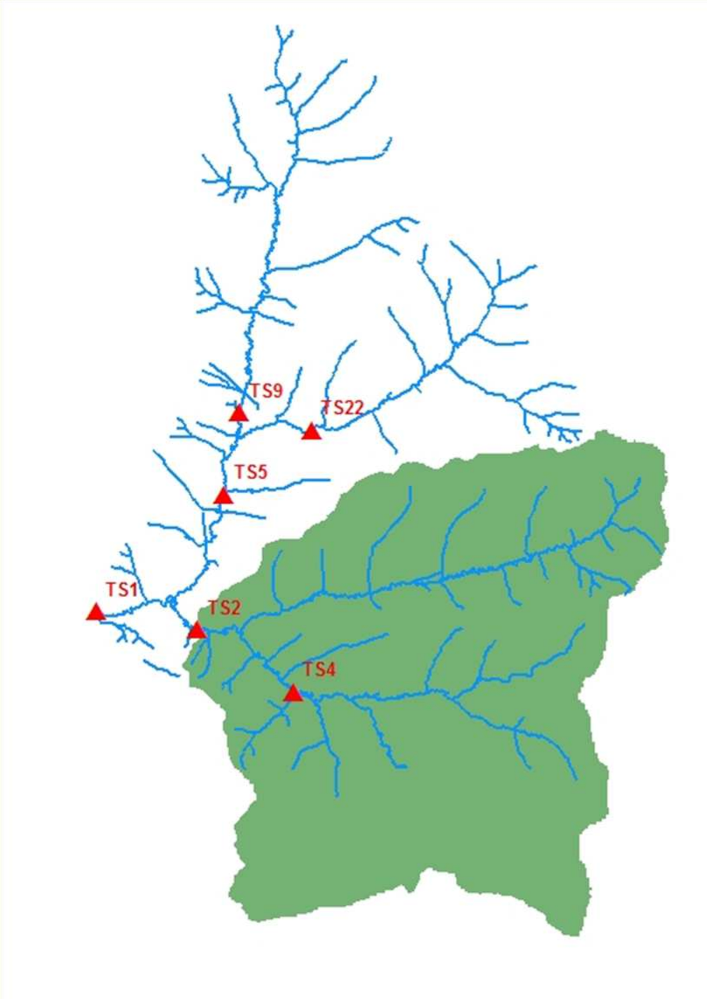


RESULTS & DISCUSSION

✓ Site 2

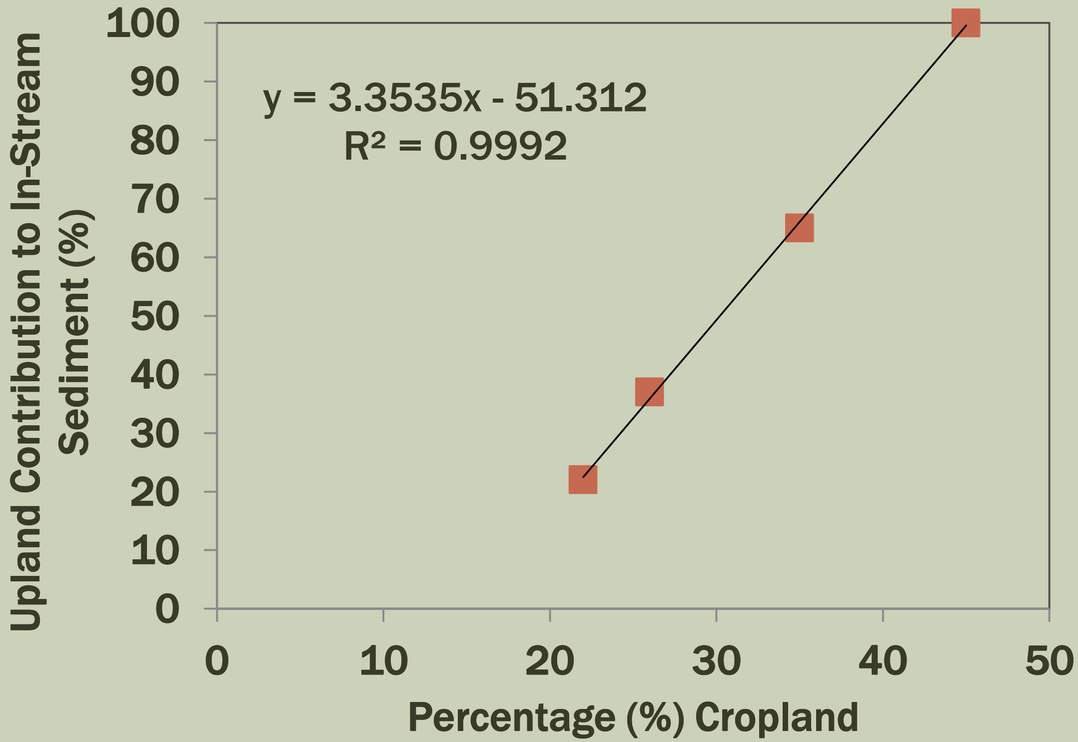
Relative % contribution of uplands and stream bed/bank to in-stream suspended sediment	
Uplands	Stream Bed/Bank
37	63

Land use percentage for site 2 sub-watershed	
Land Use	Percentage
Cropland	26
Pasture	13
Pasture Woodland	6
Woodland	21
Grassland	33



RESULTS & DISCUSSION

- ✓ Relationship between upland contributions to in-stream sediment and cropland percentage.



CONCLUSIONS

- ✓ Land use plays an important role in contributing to in-stream sediments.
- ✓ Uplands were the major contributor to in-stream sediments in watersheds with cropland as a major land use.
- ✓ Stream beds/banks were the major contributor to in-stream sediments in watersheds with undisturbed areas (e.g. grassland and woodland) as major land uses.

FUTURE WORK

- ✓ Collect more upland and bed/bank samples to enhance spatial coverage throughout the watershed.
- ✓ Conduct source apportionment on complete watershed and by season.
- ✓ Conduct source apportionment based on different upland categories.

QUESTIONS?

✓ We would like to acknowledge USDA-NIFA for funding this project. We thank the Dane County, Wisconsin, Department of Land and Water Resources staff, Faith Fitzpatrick at the USGS Wisconsin Water Science Center and Laura Ward Good at the University of Wisconsin - Madison for their help with sample collection and the many other research activities that are part of this study.