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SWATDRAIN

SWAT CONFERENCE 2015 PURDUE UNIVERSITY
October 12-16

Impact of Tile Drainage on Hydrology and Sediment Losses in an Agricultural Watershed using SWATDRAIN

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Outline

- Introduction
- Objectives
- SWATDRAIN
- Impact of tile drainage on watershed hydrology and sediment loads
- Conclusions

Why SWATDRAIN?

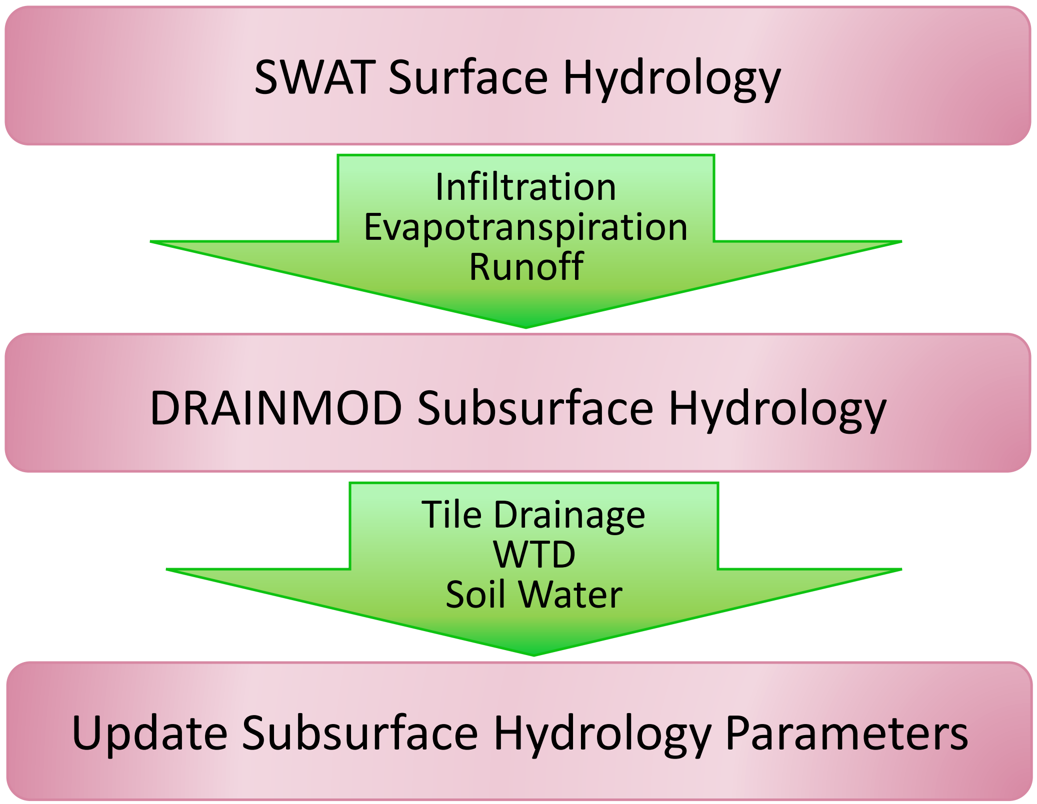
- SWAT
  - ✓ Surface flow
  - Subsurface flow
  - Water table depth
- Modified SWAT
  - Hooghoudt and Kirkham approaches
    - Volume drained and WTD relationship
- DRAINMOD
  - ✓ Subsurface flow
  - Water table management practices
  - Water table depth
- Inclusion of DRAINMOD into SWAT

Model Development Objectives

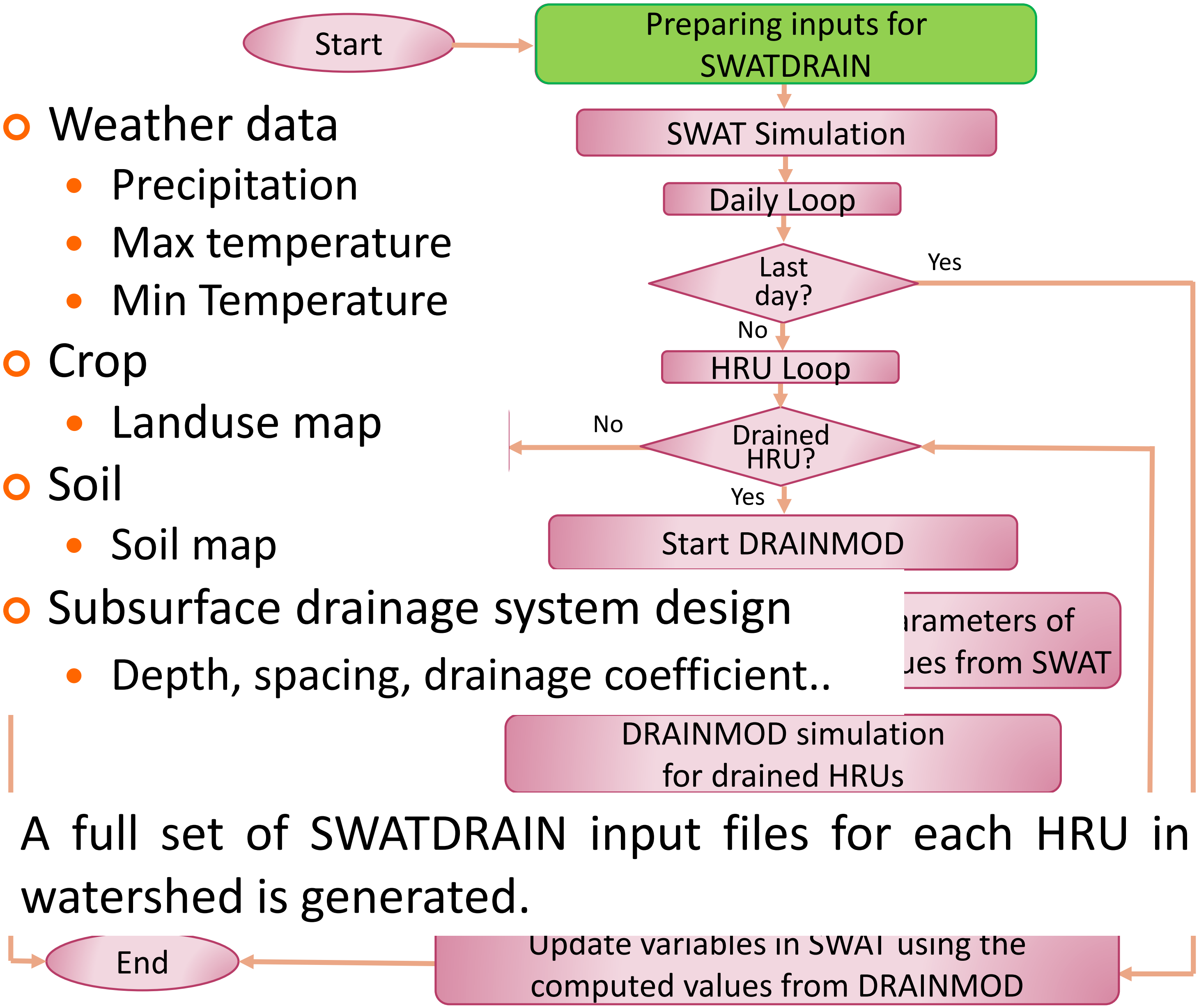
- Main goal:
  - ✓ Develop SWATDRAIN to simulate surface and subsurface hydrology of agricultural tile-drained watersheds
- Specific objectives:
  - ✓ SWATDRAIN – incorporate DRAINMOD into SWAT
  - ✓ Evaluate SWATDRAIN model on a fully tile-drained agricultural Watershed
  - ✓ Use the SWATDRAIN model to assess impacts of water management systems on watershed hydrology
  - Evaluate SWATDRAIN model for a partially tile-drained agricultural watershed and assess the impact of tile drainage on watershed hydrology and <u>sediment loading</u>

Overall Modeling Approach

DRAINMOD was fully incorporated into SWAT model



- Weather data
  - Precipitation
  - Max temperature
  - Min Temperature
- Crop
  - Landuse map
- Soil
  - Soil map
- Subsurface drainage system design
  - Depth, spacing, drainage coefficient..



A full set of SWATDRAIN input files for each HRU in the watershed is generated.

Different Approaches for Tile Drainage and WTD

Algorithm	Tile drainage	Water table depth
SWATDRAIN	ITDRN=2, DRAINMOD approach of tile drainage determination incorporated	IWTDN=2, DRAINMOD approach of WTD determination incorporated
SWAT (Original)	ITDRN=0, original tile drainage equation	IWTDN=0, the soil profile above the confining layer is allowed to fill with water up to field capacity
SWAT (Modified)	ITDRN=1, incorporates Kirkham and Hooghoudt tile drainage equations	IWTDN=1, drainage volume converted into WTD using a variable water table factor

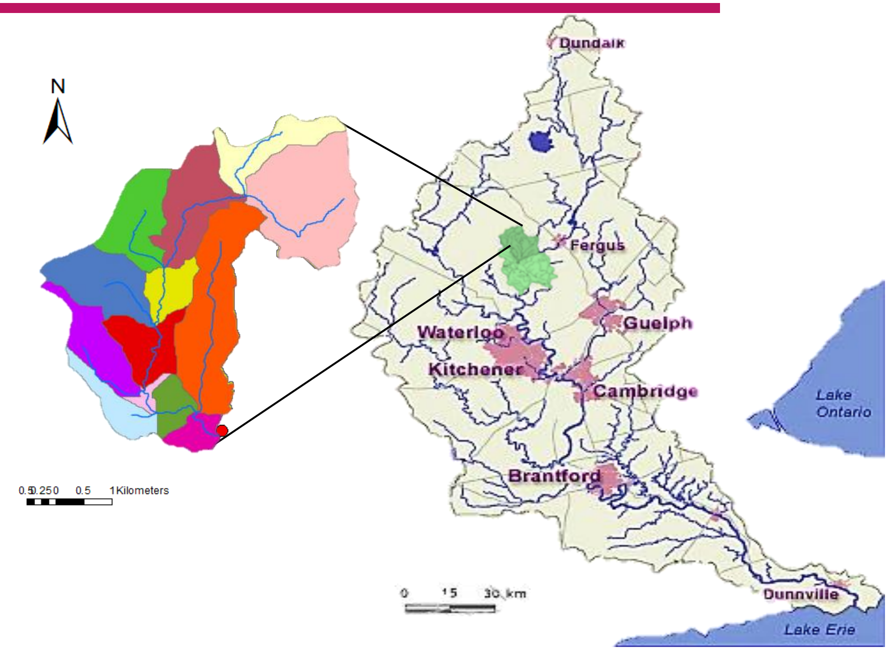
Model Evaluation

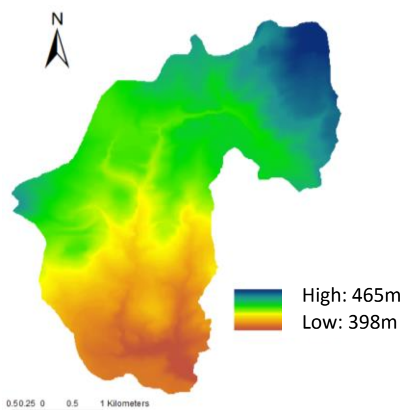
Canagagigue Creek West Watershed
(Partially Tile-Drained)

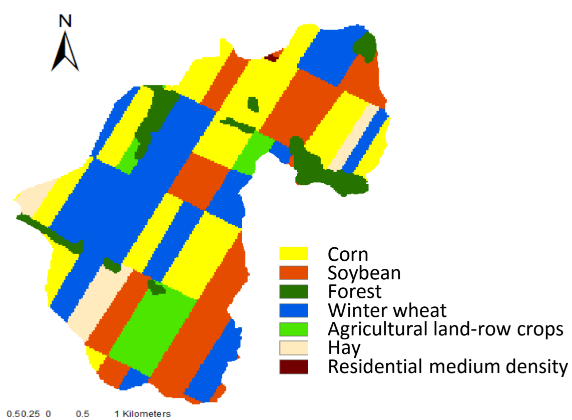

Previous Study - Green Belt
Canagagigue Creek
Northwest Territories
CANADA
UNITED STATES
Echo Bay
Watson Lake
Yellowknife
Great Slave Lake
Hay River
Fort Smith
Rankin Inlet
Lake Athabasca
Reindeer Lake
Churchill
Hudson Bay
Davis Strait
Frobisher Bay
Labrador Sea
Newfoundland
Goose Bay
Schefferville
Alberta
Edmonton
Calgary
Lethbridge
Saskatchewan
Saskatoon
Regina
Manitoba
Lake Winnipeg
Nelson
Winnipeg
Ontario
Moosonee
Chisasibi (Fort George)
Quebec
Chibougamau
St. Lawrence River
Gander
Saint John's
Island of Newfoundland
Saint Pierre and Miquelon (FRANCE)
Prince Edward Is.
Sydney
Charlottetown
New Brunswick
Fredericton
Halifax
Saint John
Nova Scotia
Thunder Bay
Lake Superior
Sudbury
Lake Huron
Montréal
Sherbrooke
Québec
Ottawa
Lake Michigan
Minneapolis
Mississippi
Missouri
Salt Lake City
Milwaukee
Toronto
Hamilton
Lake Ontario
Boston
Detroit
Windsor
Lake Erie
New York
Chicago
Philadelphia
Denver
Indianapolis
Washington, D.C.
Kansas City
St. Louis
North Atlantic Ocean
Albuquerque
Oklahoma City
Memphis
Atlanta
El Paso
Ciudad Juárez
Dallas
Province or territory capital
Scale 1:34,500,000
Lambert Conformal Conic Projection standard parallels 52°N and 74°N
0 200 400 Kilometers

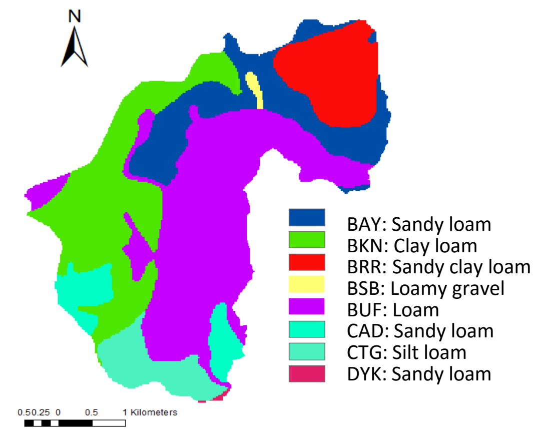
Canagagigue Creek Watershed

- Canagagigue Creek
- Area: 18 km^2
- Topography: flat-to-undulating
- Land use: agriculture
- Soil: loam or clay loam
- Tile drainage systems (Laterals: 20 m apart and 1 m deep)

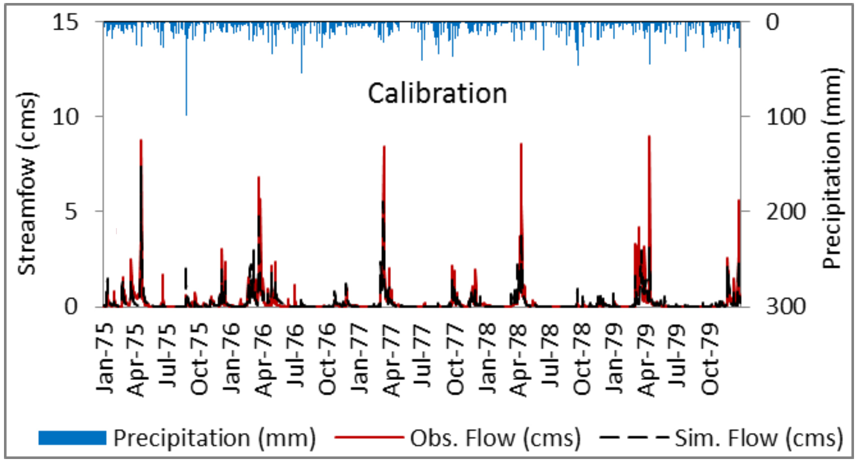


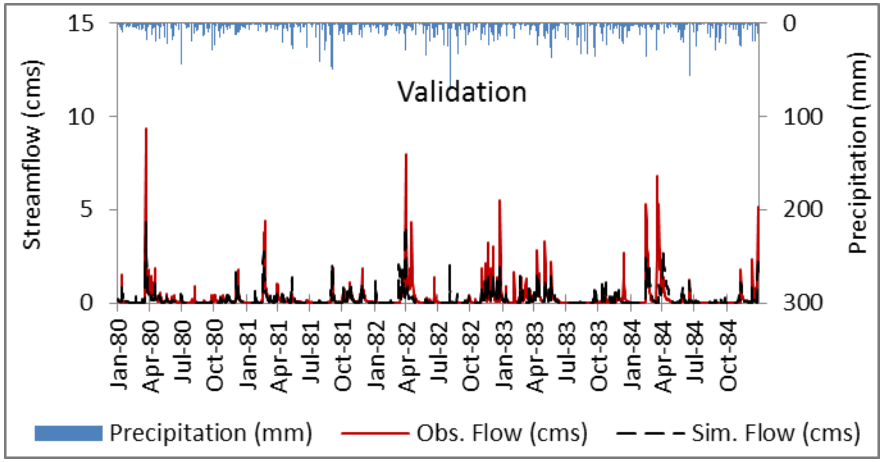






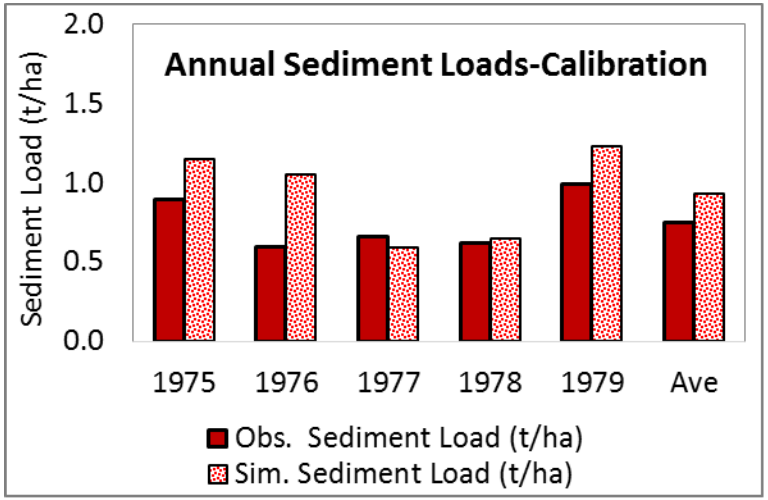
Streamflow

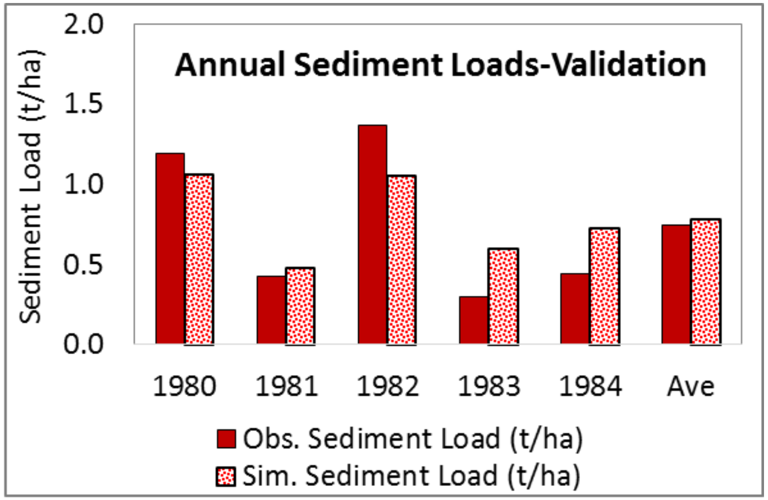


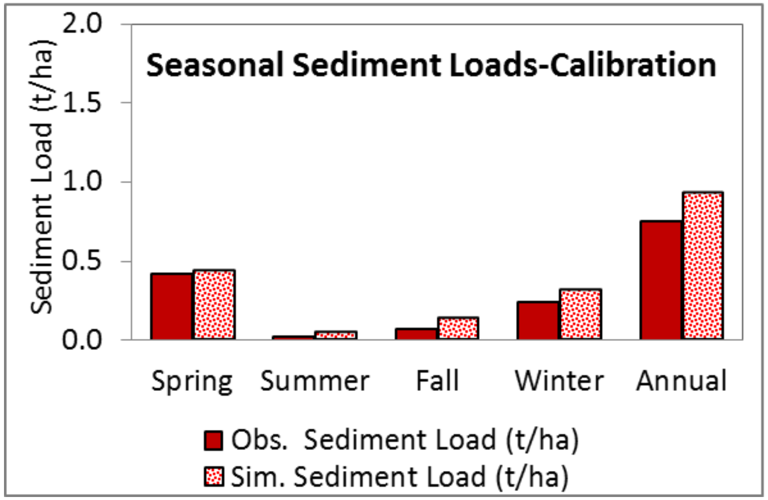


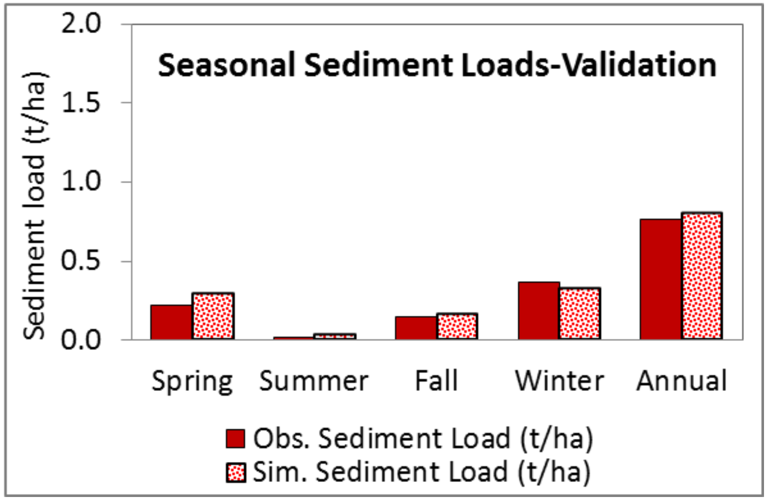
Index	Daily		Monthly	
	Calibration	Validation	Calibration	Validation
R^2	0.74	0.62	0.93	0.75
PBIAS	1.60	17.90	1.60	17.90
NSE	0.72	0.63	0.92	0.73

Annual and Average Seasonal Sediment Loads

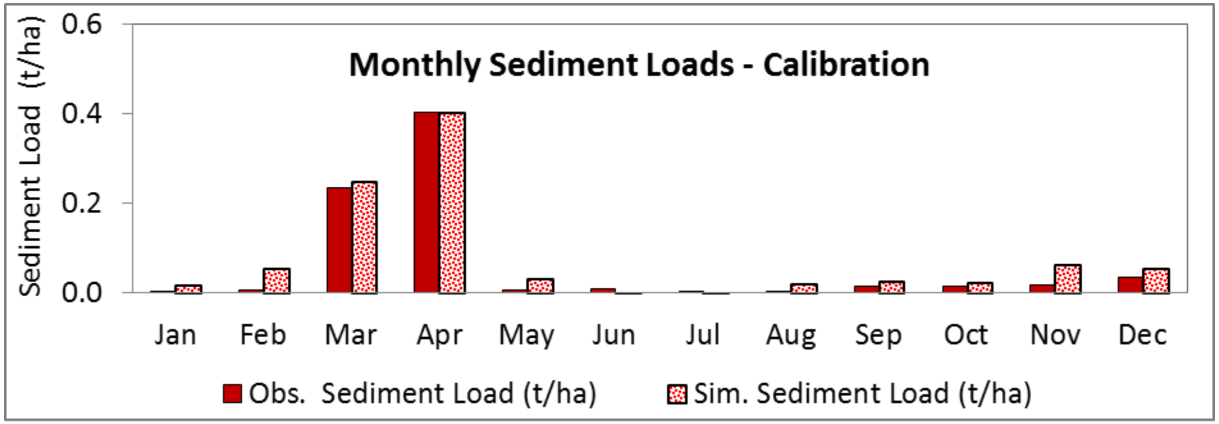


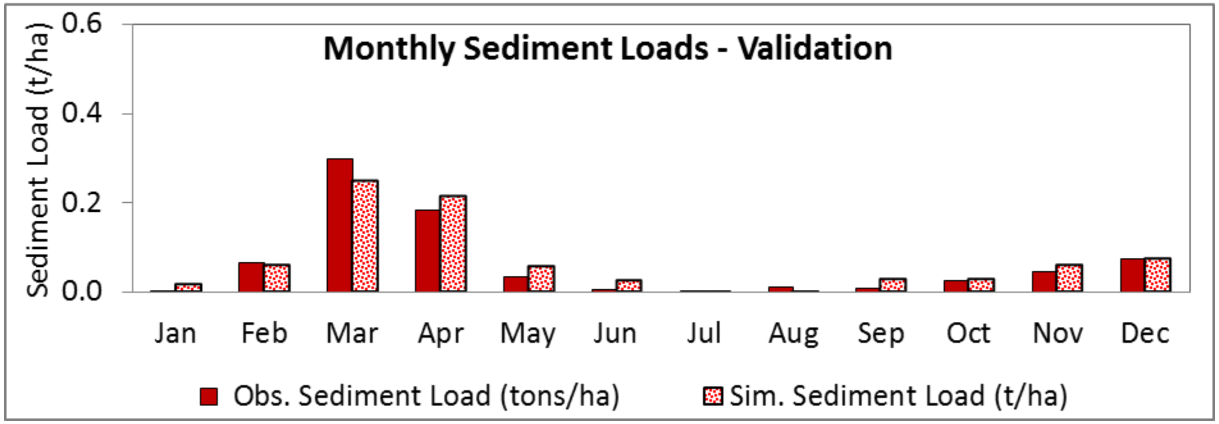






Average Monthly Sediment Loads





Index	Monthly	
	Calibration	Validation
R^2	0.84	0.78
PBIAS	-13.75	2.74
NSE	0.80	0.68

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Impact of Tile Drainage on
Water Balance and sediment Loads

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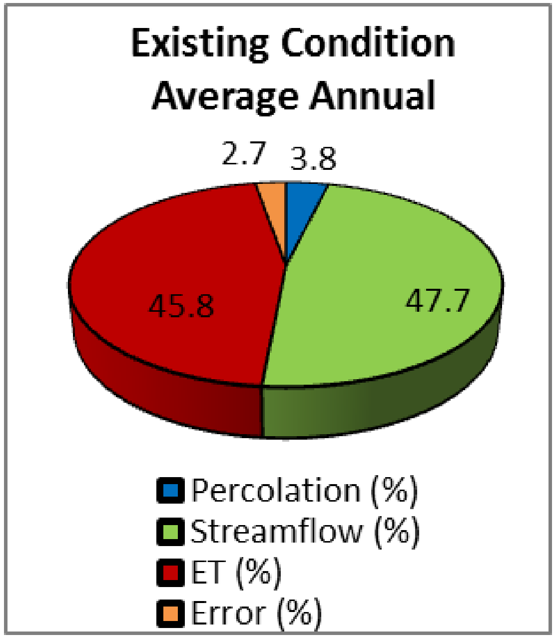
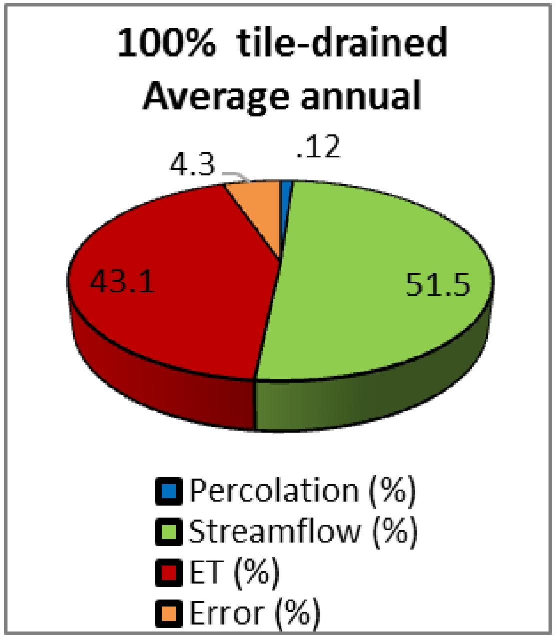
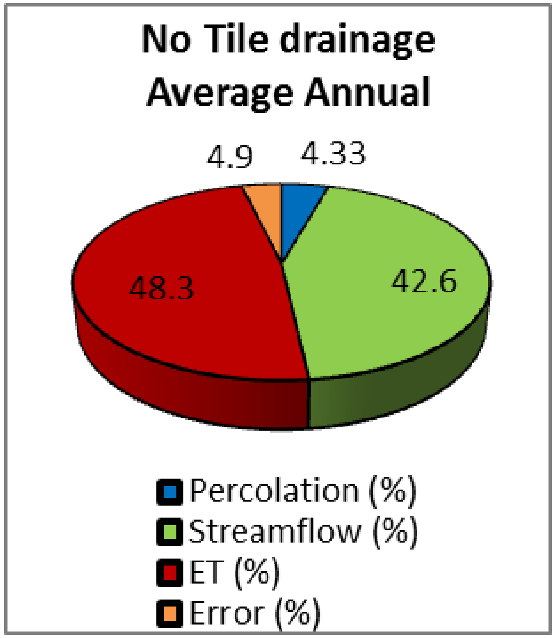
Different Tile Drainage Scenarios

- Existing condition (65% of the watershed under tile drainage);
- Entire watershed is tile-drained; and
- No tile drains installed in the watershed

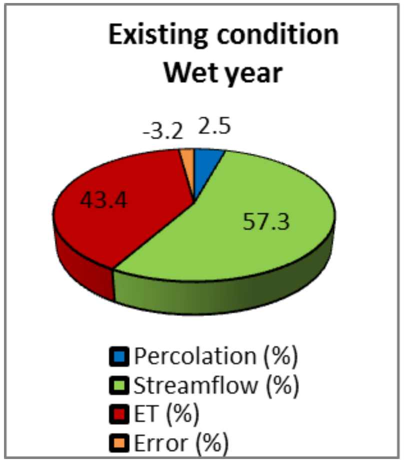
Water Balance – Average Annual Precipitation

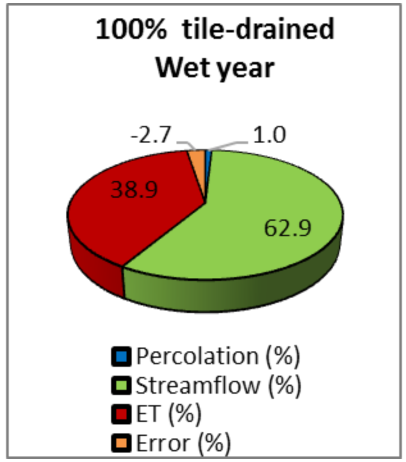


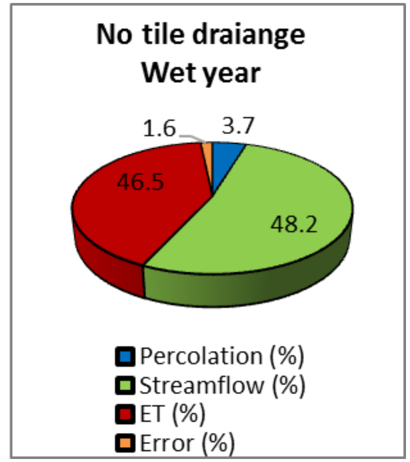




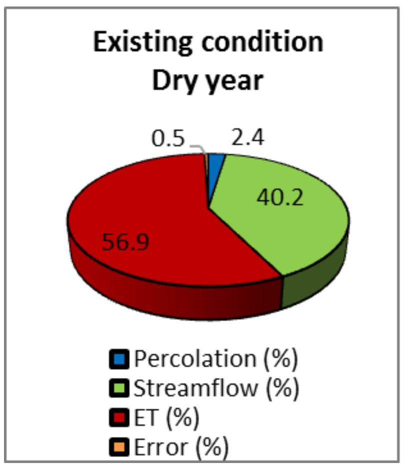
Water Balance – Dry Year and Wet Year

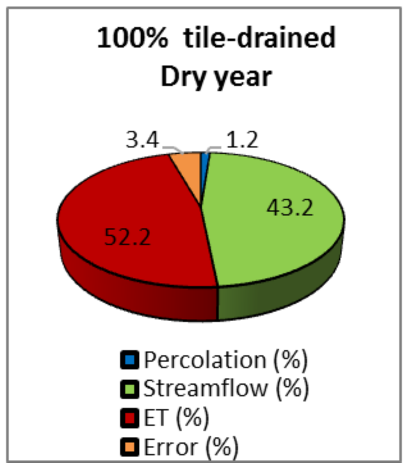


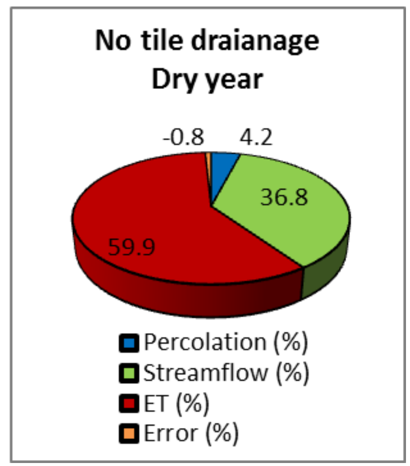




In the wet year, precipitation was 92.3 mm(~10%) higher than average.

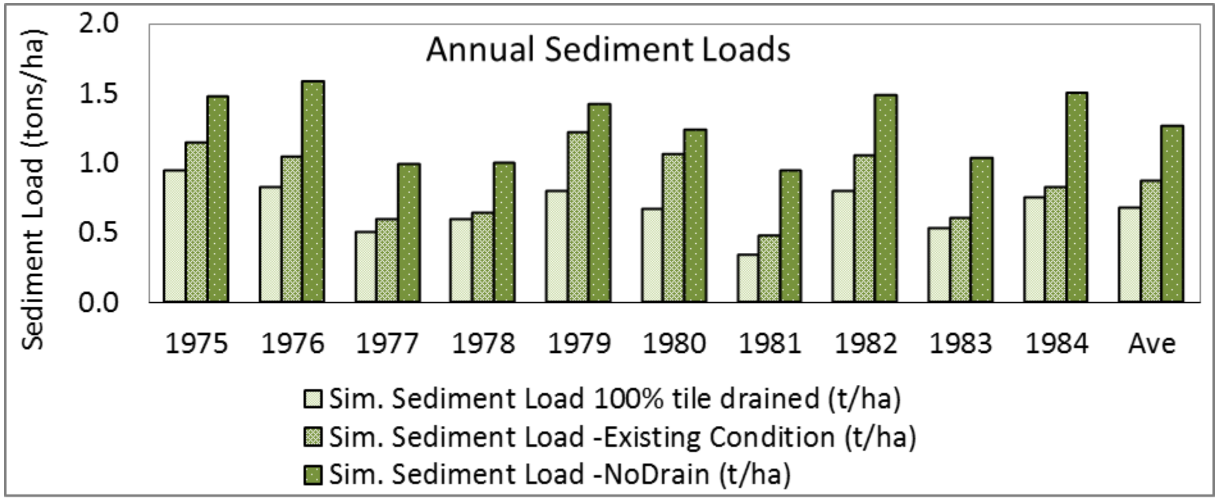


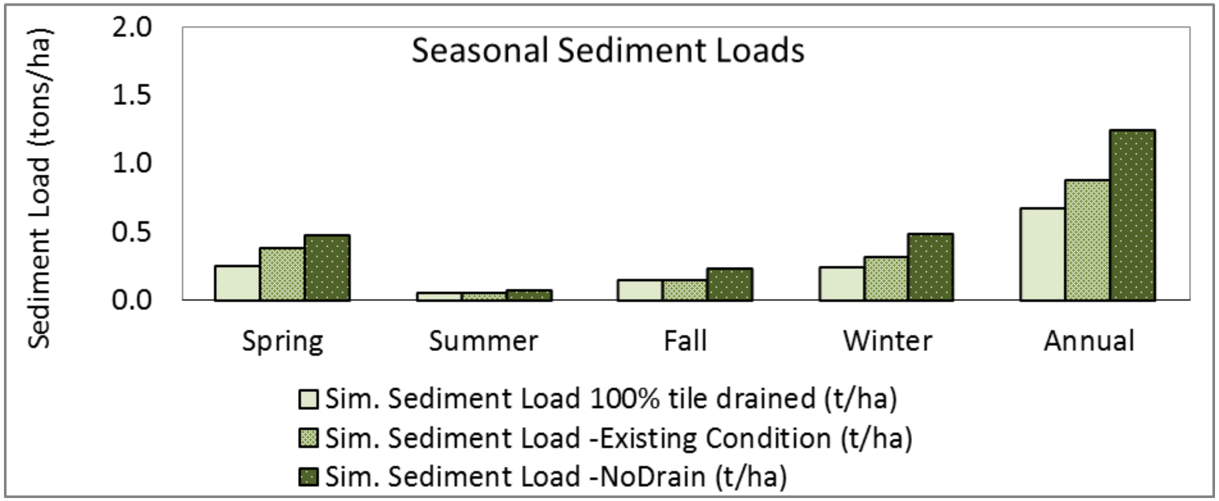




In the dry year, precipitation was 144.0 mm (~15%) lower than the average.

Annual and Seasonal Sediment Loads





Conclusions

- A new model, called SWATDRAIN, has been developed by fully incorporating DRAINMOD into SWAT in order to improve its capability to predict subsurface hydrology of agricultural tile drained watersheds. The model works well for both fully drained and partially drained watersheds.
- The model appears to predict well the impact of tile drainage on hydrology and sediment loads in tile-drained watersheds.

Thank You!