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October 12-16

Assessing SWAT Model Capability in Predicting the Areas Contributing Flow in an Agricultural Watershed

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Outline

- Introduction
- Objectives
- Model evaluation
- Simulation of flow/no flow
- Conclusions


Yukon Territory
Whitehorse
Juneau
Watson Lake
Dawson
Great Bear Lake
Mackenzie
Echo Bay
Victoria Island
Cambridge Bay
Baffin Island
Nuuk (Godthåb)
Davis Strait
Northwest Territories
Yellowknife
Great Slave Lake
Hay River
Fort Smith
Rankin Inlet
Frobisher Bay
CANADA
Prince Rupert
British Columbia
Lake Athabasca
Labrador Sea
North Pacific Ocean
Prince George
Alberta
Reindeer Lake
Churchill
Hudson Bay
Edmonton
Saskatchewan
Manitoba
Nelson
Lake Winnipeg
Saskatchewan
Newfoundland
Goose Bay
Schefferville
Victoria
Vancouver
Calgary
Saskatoon
Chisasibi (Fort George)
Gander
Island of Newfoundland
Seattle
Lethbridge
Regina
Quebec
Moosonee
Chibougamau
Prince Edward Is.
Sydney
Saint Pierre and Miquelon (FRANCE)
Portland
Columbia
Winnipeg
Ontario
St. Lawrence River
New Brunswick
Charlottetown
Thunder Bay
Lake Superior
Québec
Fredericton
Sherbrooke
Halifax
Saint John
Nova Scotia
Sudbury
Montréal
Lake Huron
Ottawa
Mississippi
Lake Michigan
Minneapolis
Missouri
Toronto
Boston
Lake Ontario
Salt Lake City
Milwaukee
Hamilton
Detroit
Windsor
Lake Erie
New York
Chicago
Denver
UNITED
Philadelphia
Indianapolis
Washington, D.C.
North Atlantic Ocean
Los Angeles
Kansas City
St. Louis
San Diego
STATES
Phoenix
Albuquerque
Oklahoma City
Memphis
Mississippi
Atlanta
El Paso
Dallas
Ciudad Juárez
MEXICO
Province or territory capital
Scale 1:34,500,000
Lambert Conformal Conic Projection
standard parallels 52°N and 74°N
0 200 400 Kilometers
0 200 400 Nautical Miles

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Introduction

- Focus on prioritization and spatial location of best management practices (BMPs)
  - Identification of areas contributing runoff



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Objectives

- Assess the capability of the SWAT Model to predict areas contributing flow in an agricultural watershed


Yukon Territory
Victoria Island
Baffin Island
Great Bear Lake
Cambridge Bay
Nuuk (Godthåb)
Whitehorse
Echo Bay
Davis Strait
Juneau
Watson Lake
Mackenzie
Northwest Territories
Frobisher Bay
Yellowknife
Great Slave Lake
Rankin Inlet
Hay River
Fort Smith
CANADA
Labrador Sea
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Churchill
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Alberta
Newfoundland
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Nelson
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Manitoba
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Gander
Victoria
Vancouver
Saskatchewan
Lake Winnipeg
Island of Newfoundland
Calgary
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Lethbridge
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Moosonee
Chibougamau
Prince Edward Is.
Sydney
Saint Pierre and Miquelon (FRANCE)
Portland
Columbia
Winnipeg
Ontario
St. Lawrence River
New Brunswick
Charlottetown
Thunder Bay
Lake Superior
Québec
Fredericton
Sherbrooke
Saint John
Halifax
Nova Scotia
Sudbury
Montréal
Lake Huron
Ottawa
Lake Michigan
Mississippi
Minneapolis
Missouri
Toronto
Lake Ontario
Boston
Salt Lake City
Milwaukee
Hamilton
Detroit
Windsor
Lake Erie
New York
Chicago
Denver
UNITED
Philadelphia
Indianapolis
Washington, D.C.
North Atlantic Ocean
Los Angeles
Kansas City
St. Louis
San Diego
STATES
Phoenix
Albuquerque
Oklahoma City
Memphis
Atlanta
El Paso
Dallas
Ciudad Juárez
MEXICO
Province or territory capital
Scale 1:34,500,000
Lambert Conformal Conic Projection
standard parallels 52°N and 74°N
0 200 400 Kilometers
0 200 400 Nautical Miles
Gully Creek

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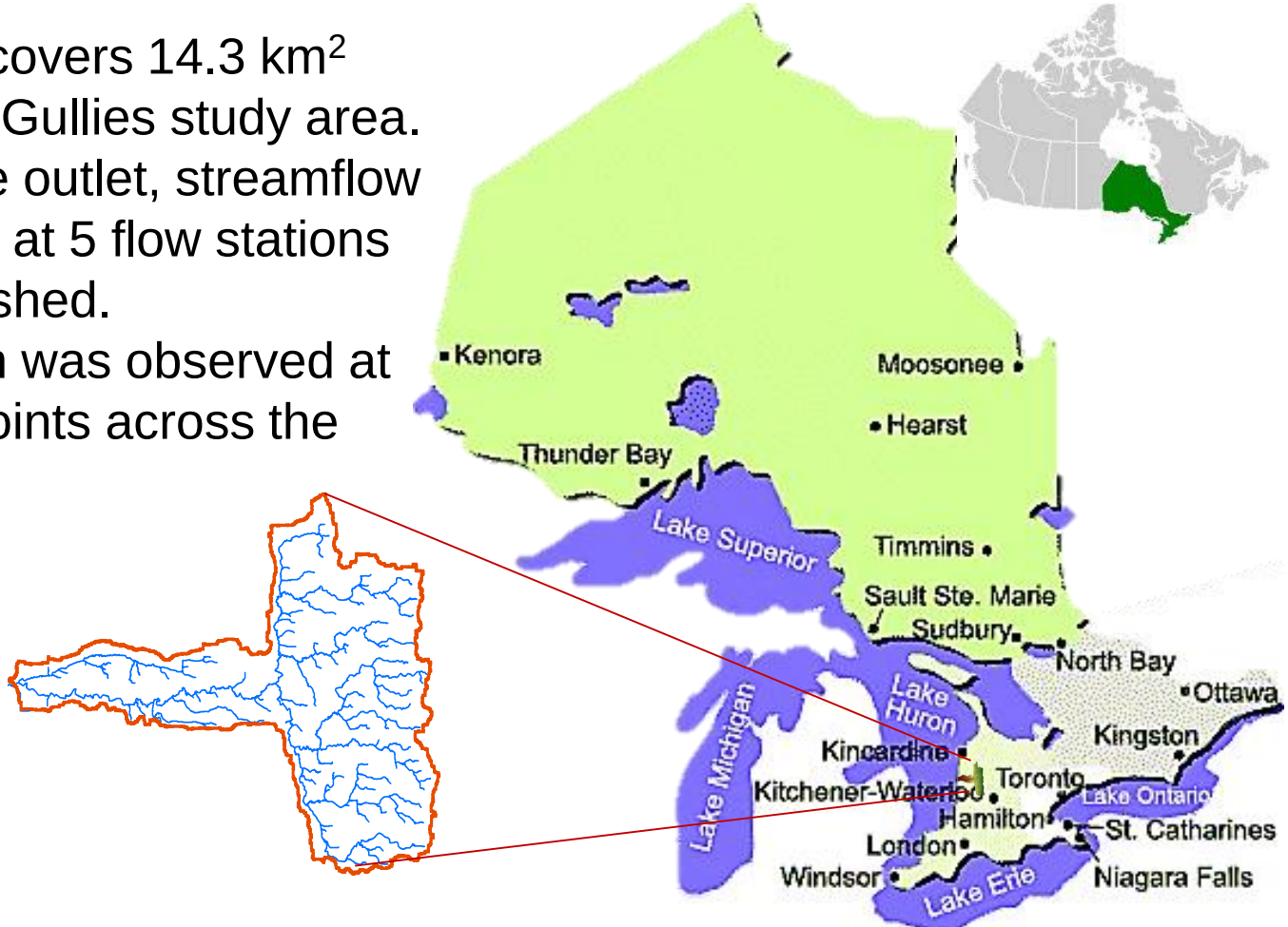
Gully Creek Watershed

- The Gully Creek watershed is located along the shoreline of Lake Huron.
- The watershed covers 14.3 km^2 within the North Gullies study area.
- In addition to the outlet, streamflow data is available at 5 flow stations within the watershed.
- Flow information was observed at 18 monitoring points across the watershed.



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SWAT Evaluation

- ✓ Model setup
- ✓ Calibration and validation

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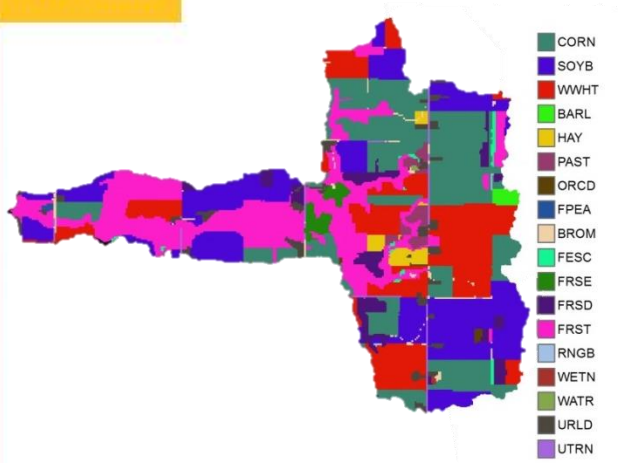
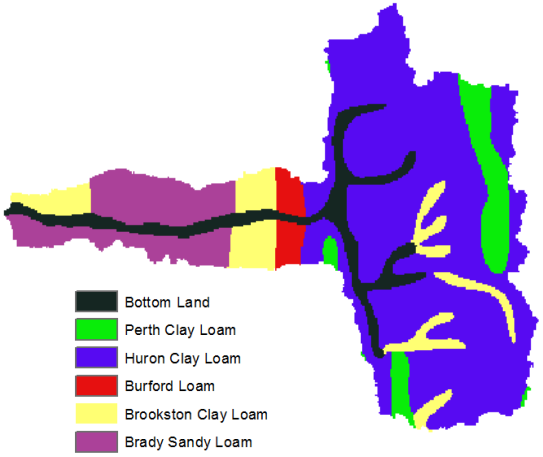
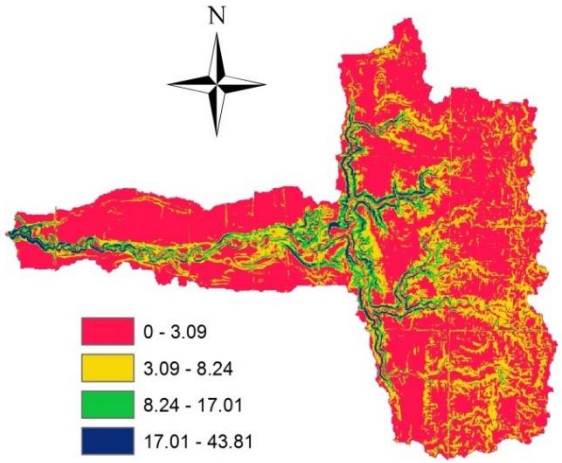
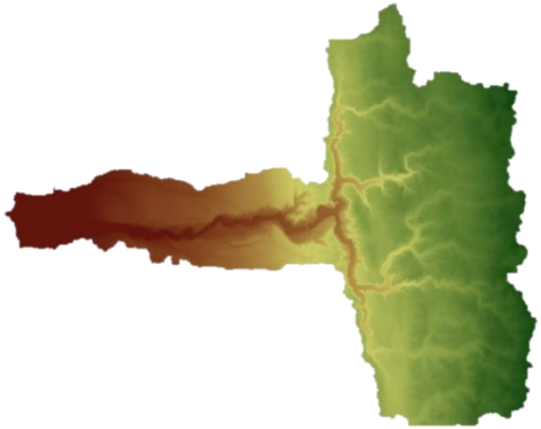
SWAT Setup

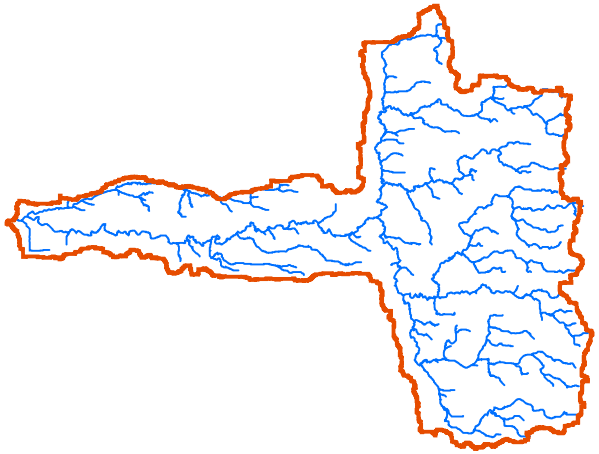


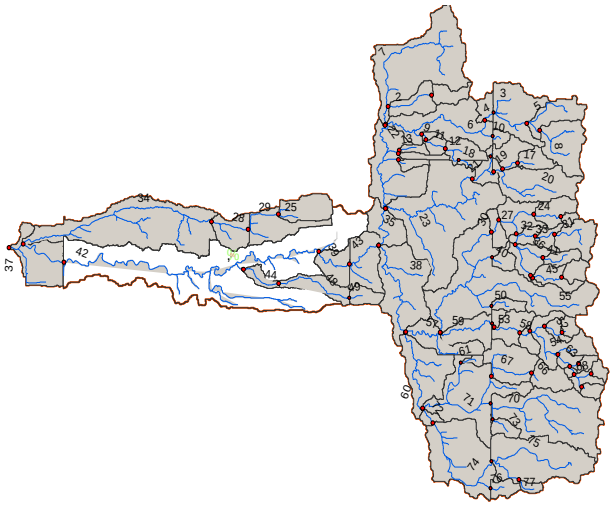




Number of HRUs: 518







Number of Subbasins: 77

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Calibration Parameters

Description	Calibrated Values
Surface runoff/infiltration approach	curve number
Soil evaporation compensation factor	0.90
Baseflow alpha factor	0.50
Initial soil water storage expressed as a fraction of field capacity water content	1.00
Snowfall temperature (°C)	0.95
Melt factor for sow on June 21 (mm H_2O/°C-day)	0.00
Melt factor for snow on December 21(mm H_2O/°C-day)	6.90
Snow pack temperature lag factor	1.40
Minimum snow water content that corresponds to 100% snow cover	0.20
Snowmelt base temperature (°C)	10.00
Plant uptake compensation factor	0.03
Surface runoff lag coefficient (d)	0.00
Soil available water content	0.10
Maximum canopy storage	5.00
Curve number coefficient	0.20
Manning's "n" value for overland flow	1.50
Manning's "n" value for main channel	0.15, 0.30 or 0.50
Channel hydraulic conductivity (mm/hr)	10.00
Groundwater "revap" coefficient	0.15

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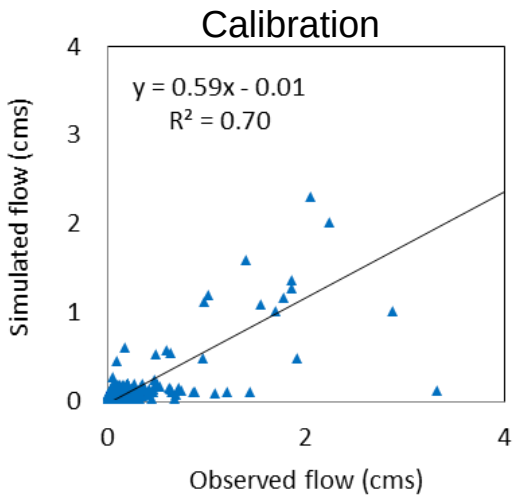
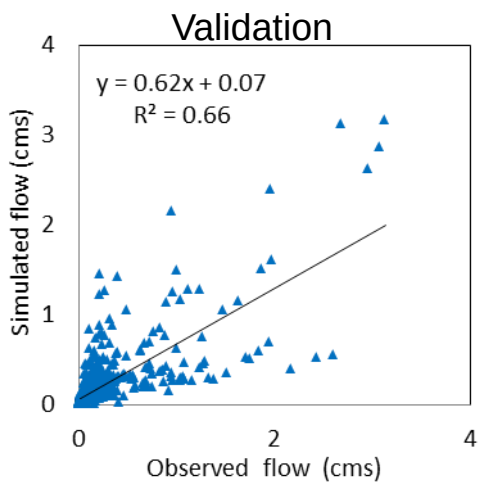
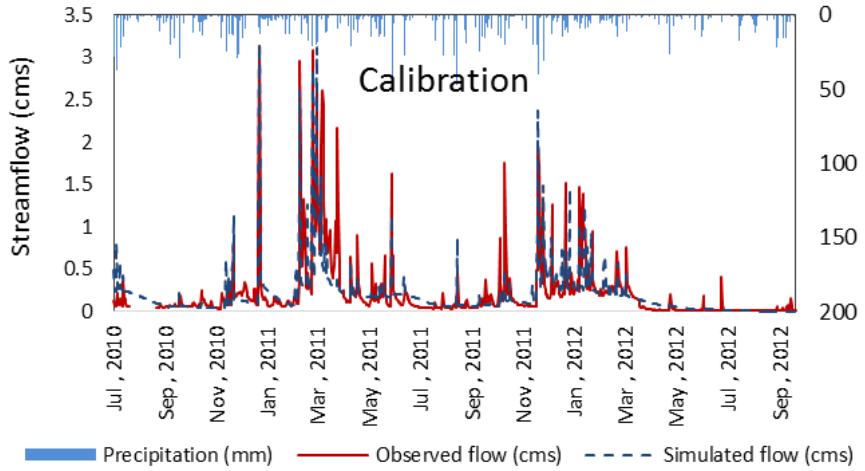
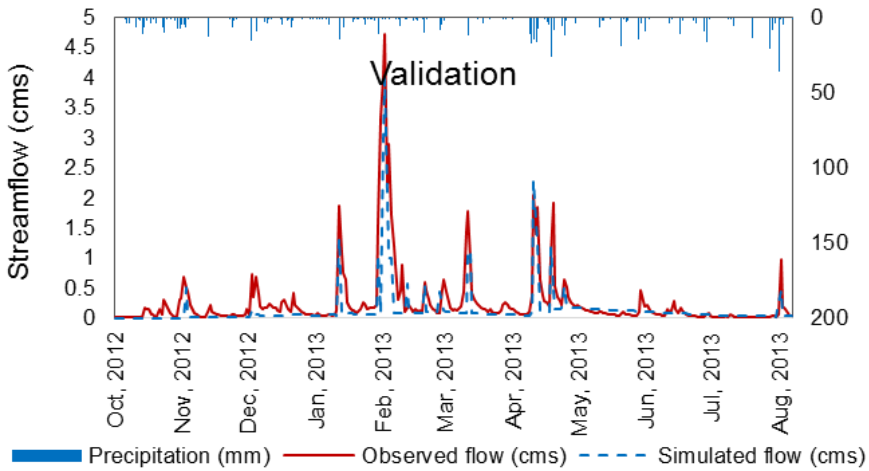
SWAT- Calibration and Validation (daily)









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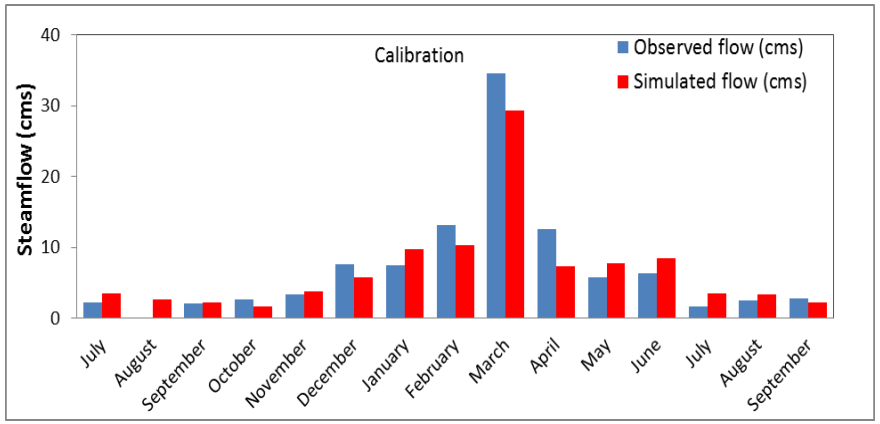
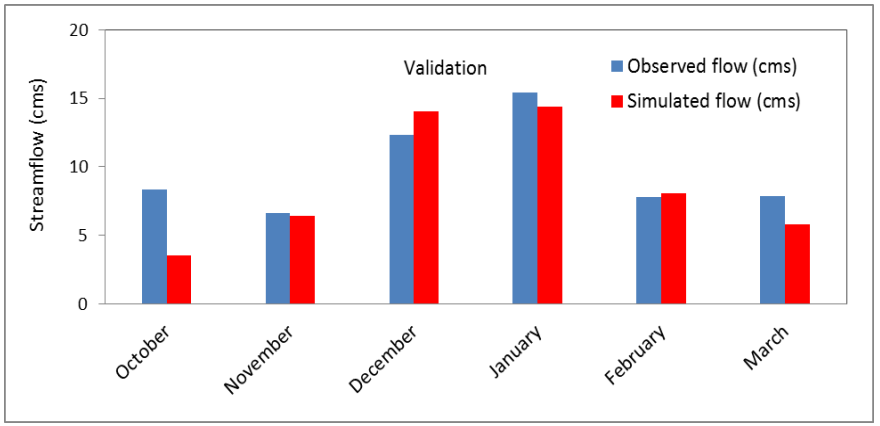
SWAT- Calibration and Validation (monthly)





Statistical Index	Monthly		Daily	
	Calibration	Validation	Calibration	Validation
R^2	0.93	0.81	0.70	0.66
NSE	0.90	0.62	0.70	0.57
PBIAS	3.01	7.96	3.01	7.96

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SWAT Evaluation

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- ✓ Simulation of results at 5 additional flow stations across the watershed

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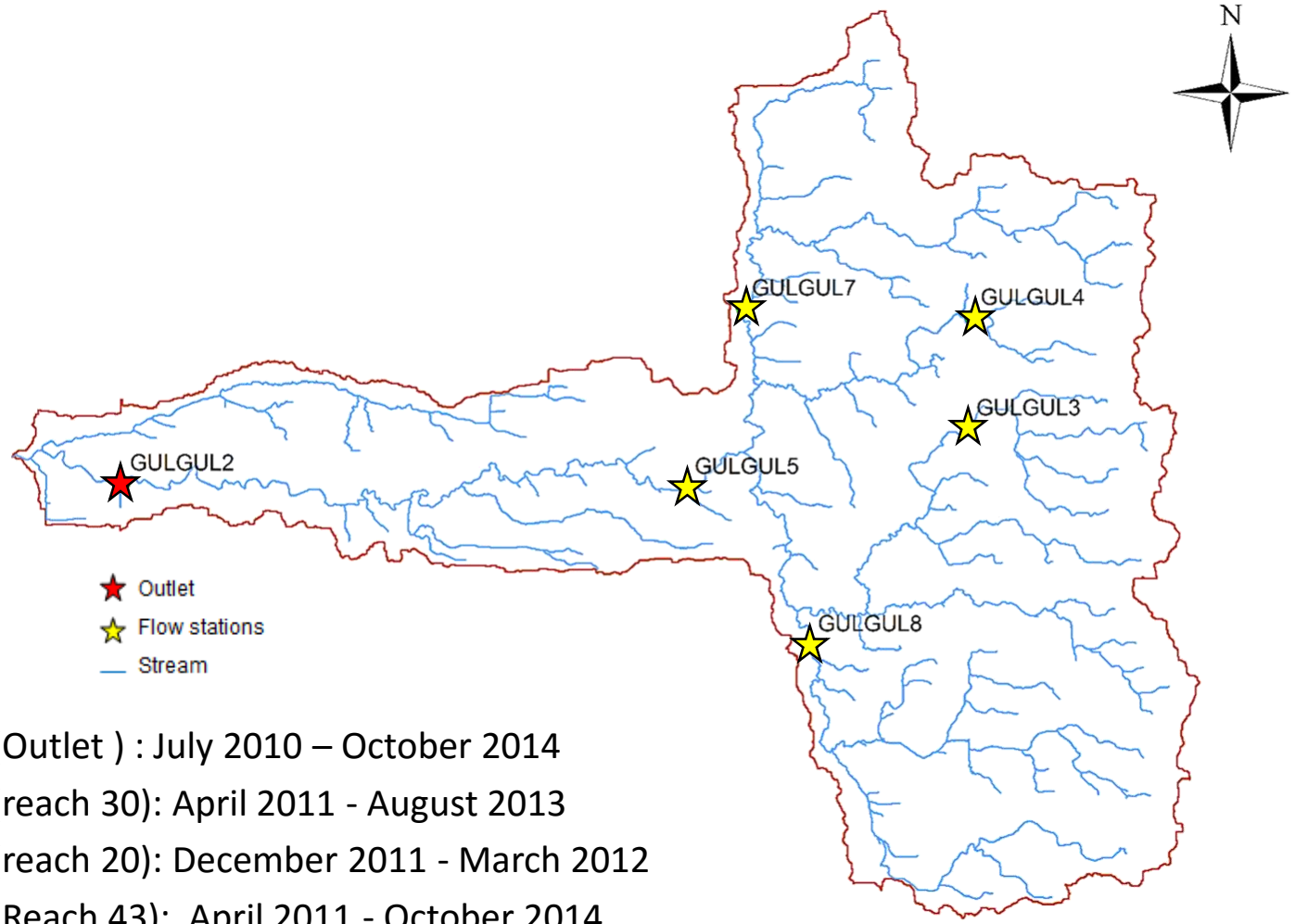
Data Availability



- GULGUL2 (Outlet) : July 2010 – October 2014
- GULGUL3 (reach 30): April 2011 - August 2013
- GULGUL4 (reach 20): December 2011 - March 2012
- GULGUL5 (Reach 43): April 2011 - October 2014
- GULGUL7 (Reach 60): Sep 2012- April 2014
- GULGUL8 (Reach 22): Sep 2012- December 2013

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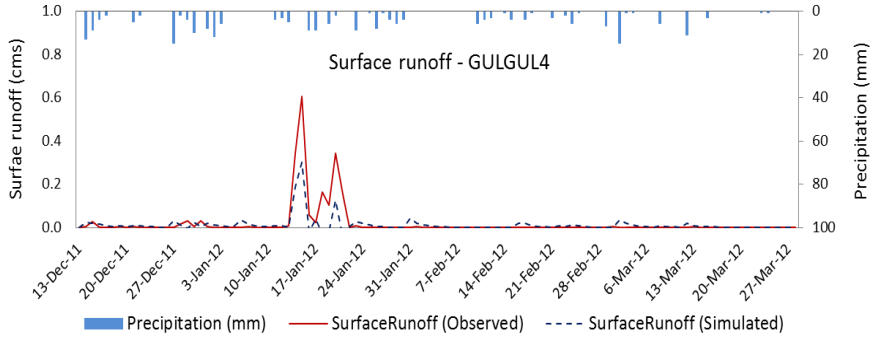
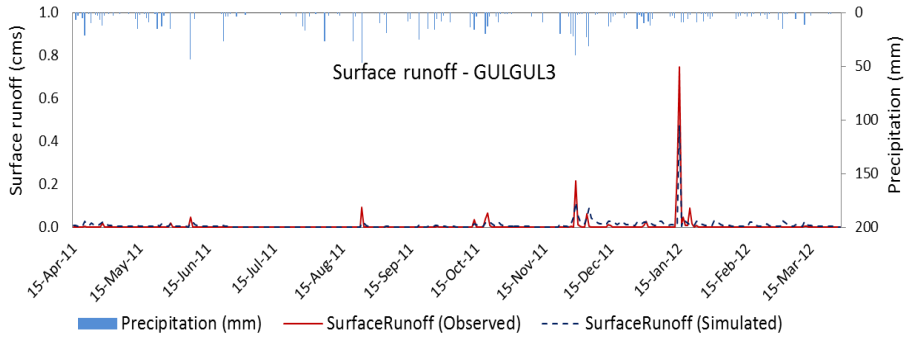
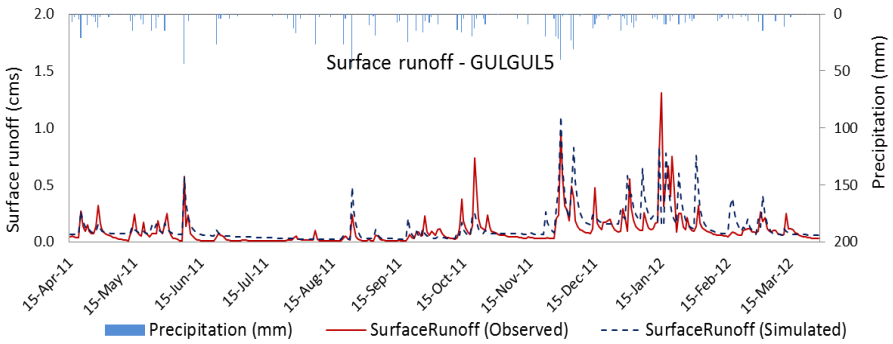
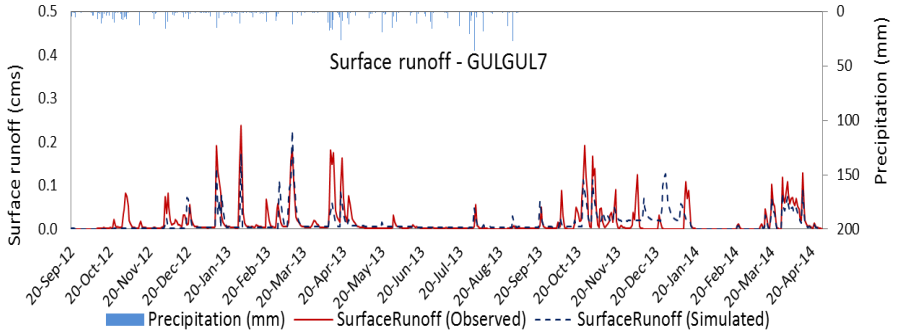
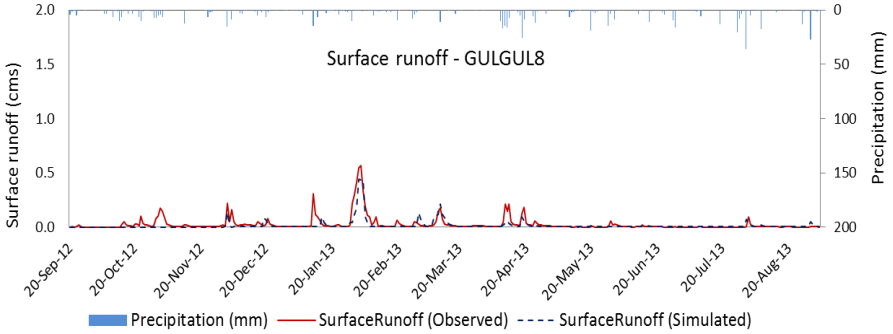
Rainy Days – Surface Runoff











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Statistical Analysis

Statistical Index	Monthly				
	GULGUL 3	GULGUL 4	GULGUL 5	GULGUL 7	GULGUL 8
R^2	0.75	0.76	0.82	0.81	0.79
NSE	0.66	0.67	0.80	0.78	0.77
PBIAS	11.3	9.8	5.7	7.96	7.96

Statistical Index	Daily				
	GULGUL 3	GULGUL 4	GULGUL 5	GULGUL 7	GULGUL 8
R^2	0.65	0.66	0.75	0.75	0.78
NSE	0.60	0.63	0.71	0.68	0.69
PBIAS	13.5	14.7	8.4	11.0	10.3

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Flow/No flow observation points

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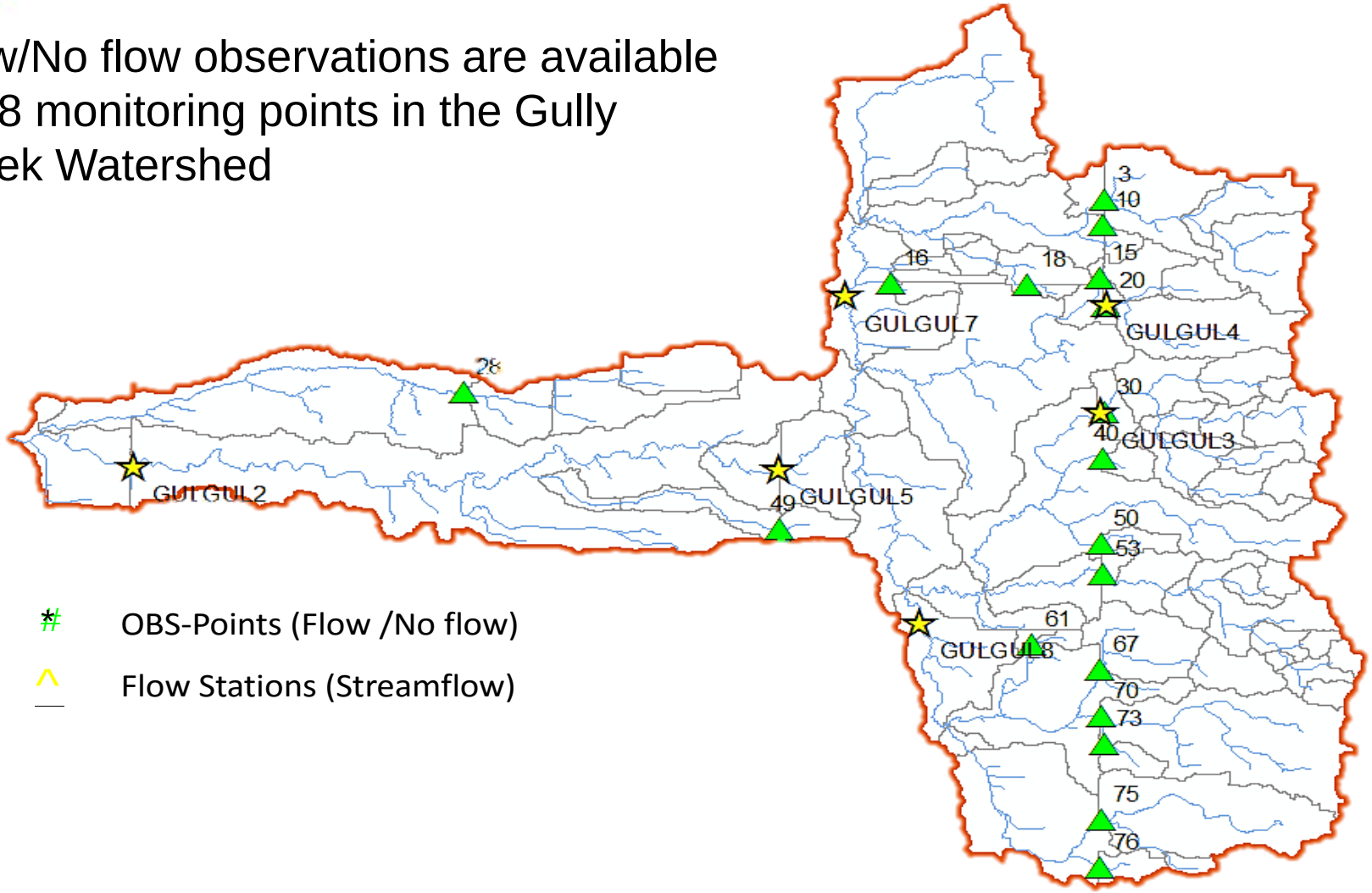
Data Availability

Flow/No flow observations are available at 18 monitoring points in the Gully Creek Watershed



\# OBS-Points (Flow /No flow)

^ Flow Stations (Streamflow)

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Observed – Flow/No Flow Data

Flow/no flow observations at the18 Monitoring Points

Total number of observations: 162
Total number of Flow observations: 66
Total number of No flow observations: 96

ID	2008-01-07	2009-02-12	2011-01-01	2013-01-29	2013-04-08	2013-04-10	2013-04-12	2014-04-30	2014-05-13
3	No flow	Flow	No flow	No flow	Sitting water	Flow	No flow	Saturated	Flow
10	No flow	No flow	No flow	No flow	No flow	No flow	Flow	No flow	No flow
15	No flow	No flow	No flow	No flow	No flow	No flow	Flow	Saturated	Saturated
16	No flow	No flow	No flow	No flow	No flow	No flow	Flow	No flow	No flow
18	No flow	No flow	No flow	No flow	No flow	No flow	Flow	No flow	No flow
20	Flow	Flow	No flow	Flow	Flow	Flow	Flow	Flow	Flow
28	No flow	No flow	No flow	No flow	No flow	No flow	Flow	Flow	Flow
30	Flow	Flow	Flow	No flow	Saturated	Flow	Flow	Flow	Flow
40	No flow	Sitting water	No flow	No flow	Sitting water	Flow	Flow	Flow	Flow
49	No flow	Sitting water	No flow	No flow	Sitting water	Flow	Flow	Saturated	Saturated
50	No flow	No flow	No flow	No flow	No flow	No flow	Flow	Sitting water	Flow
53	Flow	Flow	No flow	No flow	Flow	Flow	Flow	Flow	Flow
61	No flow	No flow	Flow	No flow	No flow	No flow	Flow	No flow	No flow
67	Saturated	Flow	Flow	No flow	No flow	No flow	Flow	No flow	Saturated
70	Flow	Flow	No flow	Flow	Flow	Flow	Flow	Flow	Flow
73	No flow	No flow	No flow	No flow	Flow	No flow	Flow	Saturated	Saturated
75	No flow	Flow	No flow	Flow	Flow	Flow	Flow	Flow	Flow
76	No flow	No flow	No flow	No flow	Flow	No flow	Flow	Flow	Flow

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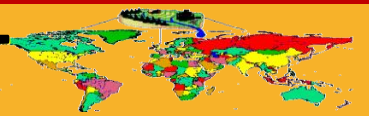
Simulation of Flow/No Flow by SWAT



- ✓ Watershed was delineated to 77 subbasins
- ✓ Watershed was delineated to 218 subbasins

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Simulation of Flow/No Flow by SWAT

- ✓ Watershed delineated into 77 subbasins

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Observed vs Simulated Flow Events

	Total Observations	Flow Observations	No Flow Observations
Observed	162	66	96
Simulated by SWAT	99	64	25
	61%	97%	26%
Not Simulated by SWAT	63	2	71
	39%	3%	74%

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Simulated Flow/ No Flow (77 subbasins)

Dates	Point 3	
	Observation	Simulated
2008-01-07	No flow	Flow
2009-02-12	Flow	Flow
2011-01-01	No Flow	No Flow
2013-01-29	No Flow	No Flow
2013-04-08	Sitting water	Flow
2013-04-10	Flow	Flow
2013-04-12	No flow	No Flow
2014-04-30	Saturated	Flow
2014-05-13	Flow	Flow
		6/9

Point 10	
Observation	Simulated
No flow	Flow
No flow	No Flow
No flow	Flow
No flow	No Flow
No flow	No Flow
No flow	Flow
Flow	Flow
No flow	Flow
No flow	Flow
	4/9

Point 15	
Observation	Simulated
No flow	Flow
No flow	No Flow
No flow	Flow
No flow	Flow
No flow	No Flow
No flow	No Flow
Flow	Flow
Saturated	Flow
Saturated	Flow
	4/9

Dates	Point 16	
	Observation	Simulated
2008-01-07	No flow	No Flow
2009-02-12	No flow	No Flow
2011-01-01	No flow	Flow
2013-01-29	No flow	Flow
2013-04-08	No flow	Flow
2013-04-10	No flow	Flow
2013-04-12	Flow	Flow
2014-04-30	No Flow	Flow
2014-05-13	No Flow	Flow
		3/9

Point 18	
Observation	Simulated
No flow	Flow
No flow	No Flow
No flow	Flow
No flow	Flow
No flow	Flow
No flow	Flow
Flow	Flow
No Flow	Flow
No Flow	Flow
	2/9

Point 20	
Observation	Simulated
Flow	Flow
Flow	Flow
No flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	8/9

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Simulated Flow/ No Flow (77 subbasins)

Dates	Point 28	
	Observation	Simulated
2008-01-07	No Flow	No Flow
2009-02-12	No Flow	No Flow
2011-01-01	No Flow	Flow
2013-01-29	No Flow	Flow
2013-04-08	No Flow	Flow
2013-04-10	No Flow	Flow
2013-04-12	Flow	Flow
2014-04-30	Flow	Flow
2014-05-13	Flow	Flow
		5/9

Point 30	
Observation	Simulated
Flow	Flow
Flow	Flow
Flow	Flow
NoFlow	Flow
Saturated	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	7/9

Point 40	
Observation	Simulated
No Flow	Flow
Sitting Water	Flow
No Flow	Flow
No Flow	Flow
Sitting Water	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	4/9

Dates	Point 49	
	Observation	Simulated
2008-01-07	No Flow	No Flow
2009-02-12	Sitting Water	Flow
2011-01-01	No Flow	Flow
2013-01-29	No Flow	Flow
2013-04-08	Sitting Water	Flow
2013-04-10	Flow	Flow
2013-04-12	Flow	Flow
2014-04-30	Saturated	Flow
2014-05-13	Saturated	Flow
		3/9

Point 50	
Observation	Simulated
No Flow	Flow
No Flow	No Flow
No Flow	No Flow
No Flow	Flow
No Flow	Flow
No Flow	Flow
Flow	Flow
Sitting Water	Flow
Flow	Flow
	4/9

Point 53	
Observation	Simulated
Flow	Flow
Flow	Flow
No Flow	Flow
No Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	7/9

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Simulated Flow/ No Flow (77 subbasins)

Dates	Point 61	
	Observation	Simulated
2008-01-07	No Flow	Flow
2009-02-12	No Flow	No Flow
2011-01-01	Flow	Flow
2013-01-29	No Flow	Flow
2013-04-08	No Flow	Flow
2013-04-10	No Flow	Flow
2013-04-12	Flow	Flow
2014-04-30	No Flow	Flow
2014-05-13	No Flow	Flow
		3/9

Point 67	
Observation	Simulated
Saturated	Flow
Flow	Flow
Flow	Flow
No Flow	No Flow
No Flow	No Flow
No Flow	Flow
Flow	Flow
No Flow	Flow
Saturated	Flow
	5/9

Point 70	
Observation	Simulated
Flow	Flow
Flow	Flow
No Flow	No Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	9/9

Dates	Point 73	
	Observation	Simulated
2008-01-07	No Flow	No Flow
2009-02-12	No Flow	Flow
2011-01-01	No Flow	No Flow
2013-01-29	No Flow	No Flow
2013-04-08	Flow	Flow
2013-04-10	No Flow	Flow
2013-04-12	Flow	Flow
2014-04-30	Saturated	Flow
2014-05-13	Saturated	Flow
		5/9

Point 75	
Observation	Simulated
No Flow	Flow
Flow	Flow
No Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	7/9

Point 76	
Observation	Simulated
No Flow	No Flow
No Flow	Flow
No Flow	Flow
No Flow	Flow
Flow	Flow
No Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	4/9

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SWAT CONFERENCE 2015
PURDUE UNIVERSITY
October 12-16

Simulation of Flow/No Flow by SWAT

- ✓ Watershed delineated into 218 subbasins

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School of Engineering,
University of Guelph,
Guelph, ON, Canada

	Total Events	Flow events	No flow events
Observed	162	66	96
Simulated by SWAT	107	56	51
	66%	85%	53%
Not Simulated SWAT	55	10	45
	34%	15%	47%

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Simulated Flow/ No Flow (218 subbasins)

Dates	Point 3	
	Observation	Simulated
2008-01-07	No flow	No Flow
2009-02-12	Flow	Flow
2011-01-01	No Flow	Flow
2013-01-29	No Flow	Flow
2013-04-08	Sitting water	Flow
2013-04-10	Flow	Flow
2013-04-12	No flow	No Flow
2014-04-30	Saturated	Flow
2014-05-13	Flow	Flow
		5/9

Point 10	
Observation	Simulated
No flow	No Flow
No flow	No Flow
No flow	No Flow
No flow	No Flow
No flow	Flow
No flow	Flow
Flow	Flow
No flow	Flow
No flow	Flow
	5/9

Point 15	
Observation	Simulated
No flow	No Flow
No flow	No Flow
No flow	No Flow
No flow	No Flow
No flow	Flow
No flow	Flow
Flow	Flow
Saturated	Flow
Saturated	No Flow
	6/9

Dates	Point 16	
	Observation	Simulated
2008-01-07	No flow	No Flow
2009-02-12	No flow	No Flow
2011-01-01	No flow	Flow
2013-01-29	No flow	No Flow
2013-04-08	No flow	Flow
2013-04-10	No flow	Flow
2013-04-12	Flow	Flow
2014-04-30	No Flow	Flow
2014-05-13	No Flow	Flow
		4/9

Point 18	
Observation	Simulated
No flow	Flow
No flow	No Flow
No flow	Flow
No flow	No Flow
No flow	Flow
No flow	Flow
Flow	Flow
No Flow	Flow
No Flow	Flow
	3/9

Point 20	
Observation	Simulated
Flow	Flow
Flow	Flow
No flow	No Flow
Flow	No Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	8/9

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Simulated Flow/ No Flow (218 subbasins)

Dates	Point 28	
	Observation	Simulated
2008-01-07	No Flow	No Flow
2009-02-12	No Flow	No Flow
2011-01-01	No Flow	No Flow
2013-01-29	No Flow	No Flow
2013-04-08	No Flow	Flow
2013-04-10	No Flow	Flow
2013-04-12	Flow	Flow
2014-04-30	Flow	Flow
2014-05-13	Flow	Flow
		7/9

Point 30	
Observation	Simulated
Flow	Flow
Flow	Flow
Flow	Flow
No Flow	No Flow
Saturated	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	8/9

Point 40	
Observation	Simulated
No Flow	No Flow
Sitting Water	No Flow
No Flow	No Flow
No Flow	No Flow
Sitting Water	No Flow
Flow	Flow
Flow	No Flow
Flow	Flow
Flow	Flow
	8/9

Dates	Point 49	
	Observation	Simulated
2008-01-07	No Flow	No Flow
2009-02-12	Sitting Water	No Flow
2011-01-01	No Flow	No Flow
2013-01-29	No Flow	No Flow
2013-04-08	Sitting Water	Flow
2013-04-10	Flow	Flow
2013-04-12	Flow	No Flow
2014-04-30	Saturated	Flow
2014-05-13	Saturated	Flow
		5/9

Point 50	
Observation	Simulated
No Flow	Flow
No Flow	Flow
No Flow	Flow
No Flow	Flow
No Flow	Flow
No Flow	Flow
Flow	Flow
Sitting Water	Flow
Flow	Flow
	2/9

Point 53	
Observation	Simulated
Flow	Flow
Flow	Flow
No Flow	No Flow
No Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	8/9

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Simulated Flow/ No Flow (218 subbasins)

Dates	Point 61	
	Observation	Simulated
2008-01-07	No Flow	No Flow
2009-02-12	No Flow	No Flow
2011-01-01	Flow	No Flow
2013-01-29	No Flow	No Flow
2013-04-08	No Flow	Flow
2013-04-10	No Flow	Flow
2013-04-12	Flow	No Flow
2014-04-30	No Flow	Flow
2014-05-13	No Flow	Flow
		3/9

Point 67	
Observation	Simulated
Saturated	No Flow
Flow	No Flow
Flow	No Flow
No Flow	No Flow
No Flow	No Flow
No Flow	No Flow
Flow	No Flow
No Flow	No Flow
Saturated	No Flow
	6/9

Point 70	
Observation	Simulated
Flow	Flow
Flow	Flow
No Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	8/9

Dates	Point 73	
	Observation	Simulated
2008-01-07	No Flow	No Flow
2009-02-12	No Flow	No Flow
2011-01-01	No Flow	No Flow
2013-01-29	No Flow	No Flow
2013-04-08	Flow	Flow
2013-04-10	No Flow	Flow
2013-04-12	Flow	Flow
2014-04-30	Saturated	No Flow
2014-05-13	Saturated	No Flow
		8/9

Point 75	
Observation	Simulated
No Flow	No Flow
Flow	Flow
No Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
Flow	Flow
	8/9

Point 76	
Observation	Simulated
No Flow	No Flow
No Flow	No Flow
No Flow	Flow
No Flow	No Flow
Flow	No Flow
No Flow	Flow
Flow	No Flow
Flow	Flow
Flow	Flow
	5/9

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77 Subbasins vs 218 Subbasins

	Total Events		Flow Events		No Flow Events	
Number of Subbasins	77	218	77	218	77	218
Observed	162		66		96	
Simulated correctly	99 61%	107 66%	64 97%	56 85%	25 26%	51 53%
Not Simulated correctly	63 39%	55 34%	2 3%	10 15%	71 74%	45 47%

These results do not show any consistent improvement of flow/ No flow simulations by dividing the watershed into more sub-basins.

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Conclusions

- SWAT model adequately simulated the streamflow at the outlet of the watershed.
- The model has the capability to simulate surface runoff at spatial locations across the watershed.
- Increasing the number of subbasins does not result in any significant improvement in the capability of the model to simulate no/no flow at various locations in the watershed.

Thanks

Questions?

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