Evaluation of the Storm Event Model "DWSM" on a Watershed in Central New York, USA

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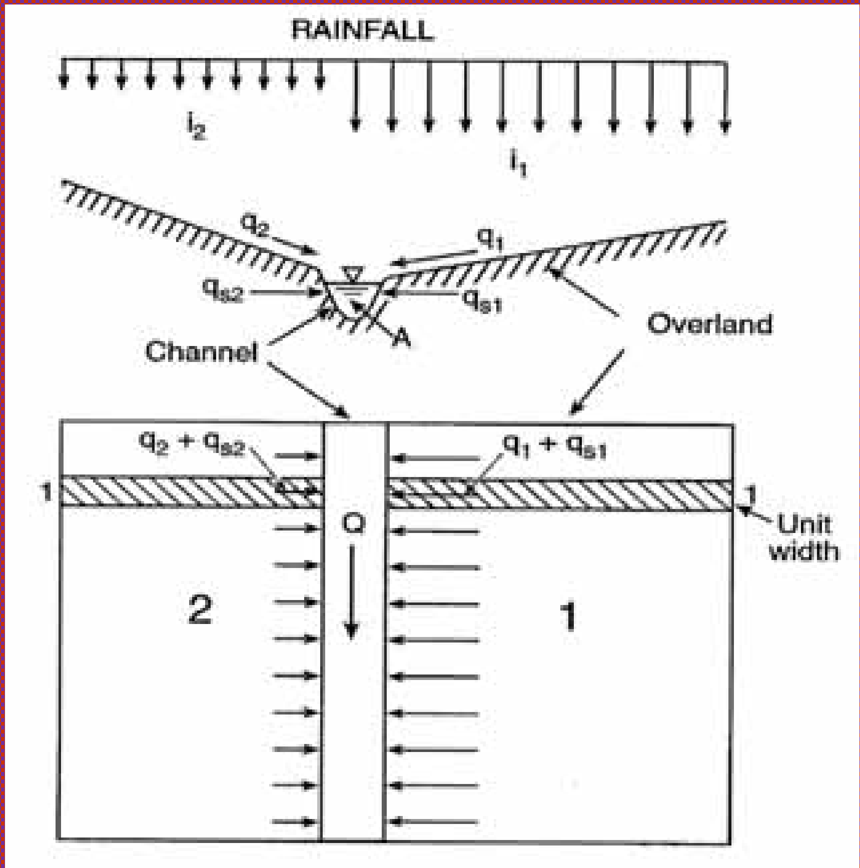
What is DWSM?

Dynamic Watershed Simulation Model: A physically based watershed model simulating hydrological and sediment transport processes within a watershed.

Fundamental structure of DWSM

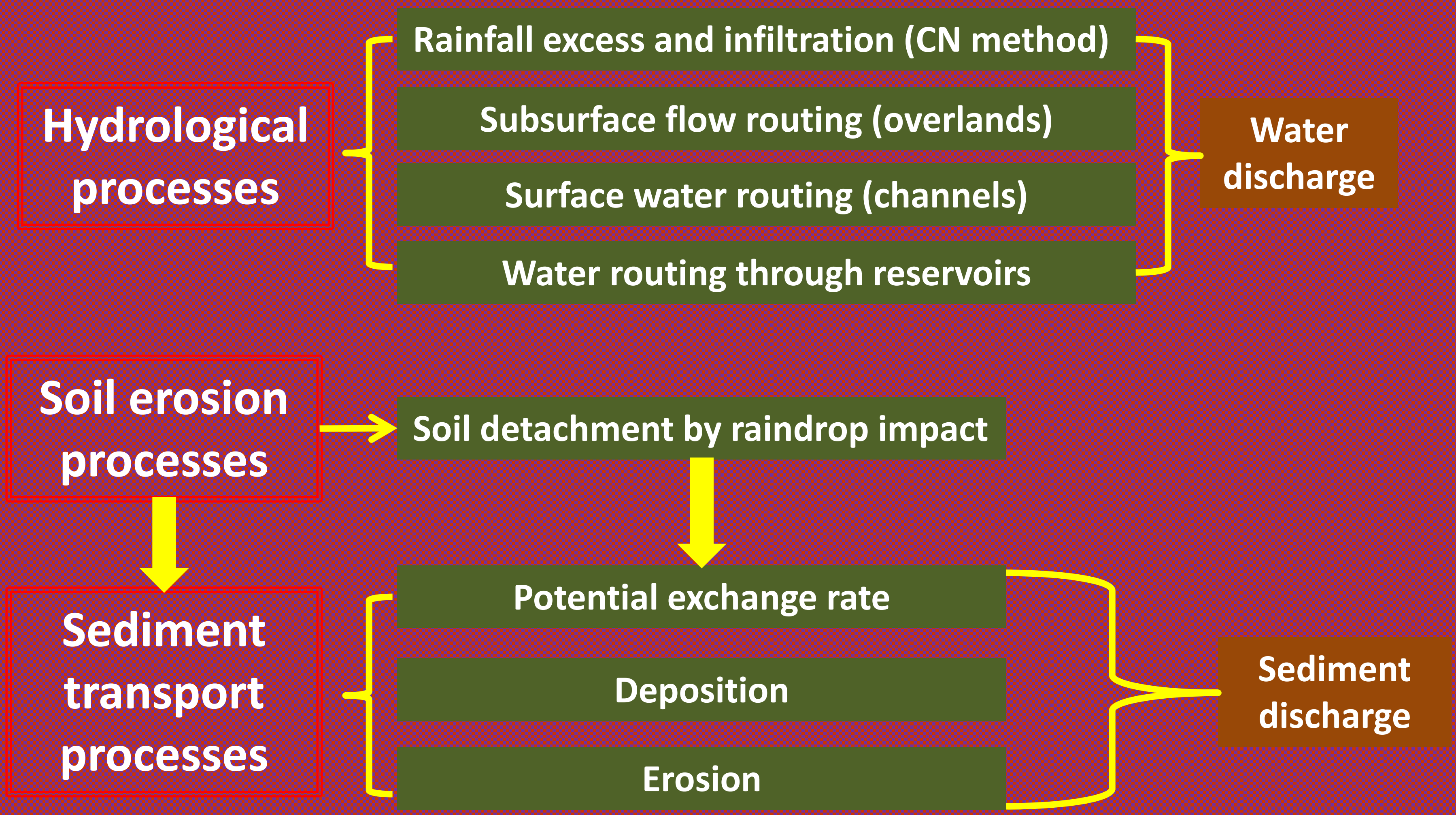
A watershed (1-D) = overland planes + channel segments + reservoir units

<u>Overland representation</u>: a rectangle whose width equals the adjacent channel length and length is the ratio of overland area to the with



From Borah et al., (2002)

DWSM model framework



Advantage and success of DWSM

- Flow routing schemes are based on shock fitting solutions of the kinematic wave equations and thus are more effective
- Relatively simple model structure: single value in each element

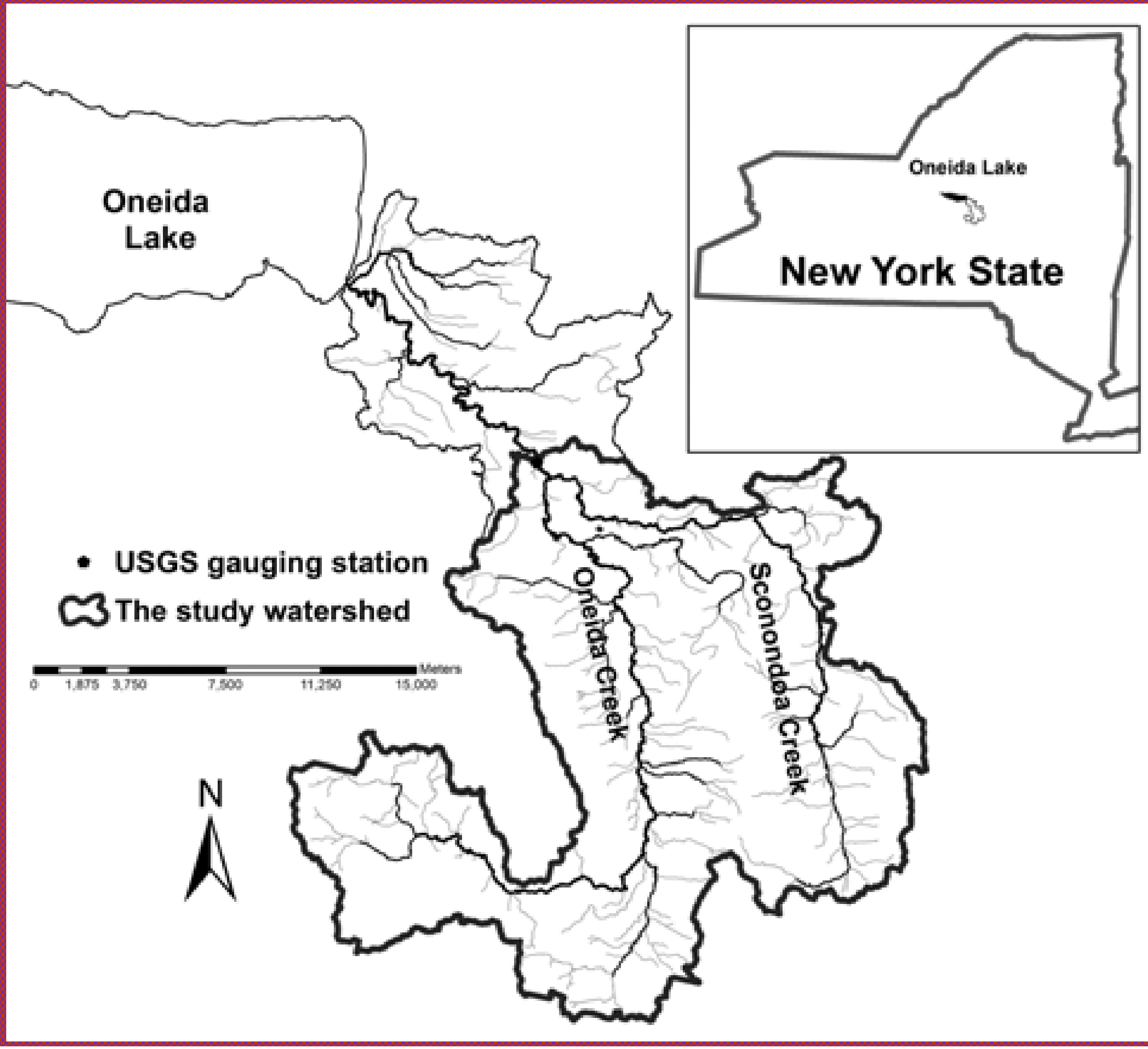
Successful applications of DWSM	Upper little Wabash River watershed, Illinois, USA (620 km^2)
	Dongsha River watershed, China (287 km^2)
	Court Creek watershed, Illinois, USA (251 km^2)
	Big Ditch watershed (100 km^2)
	USDA experimental watershed, W5, Mississippi (4.5 km^2)
	Beijing Olympic Forest Park sub-watershed, China (1.06 km^2)
	USDA experimental watershed, P4, Georgia (0.014 km^2)

Purpose of study

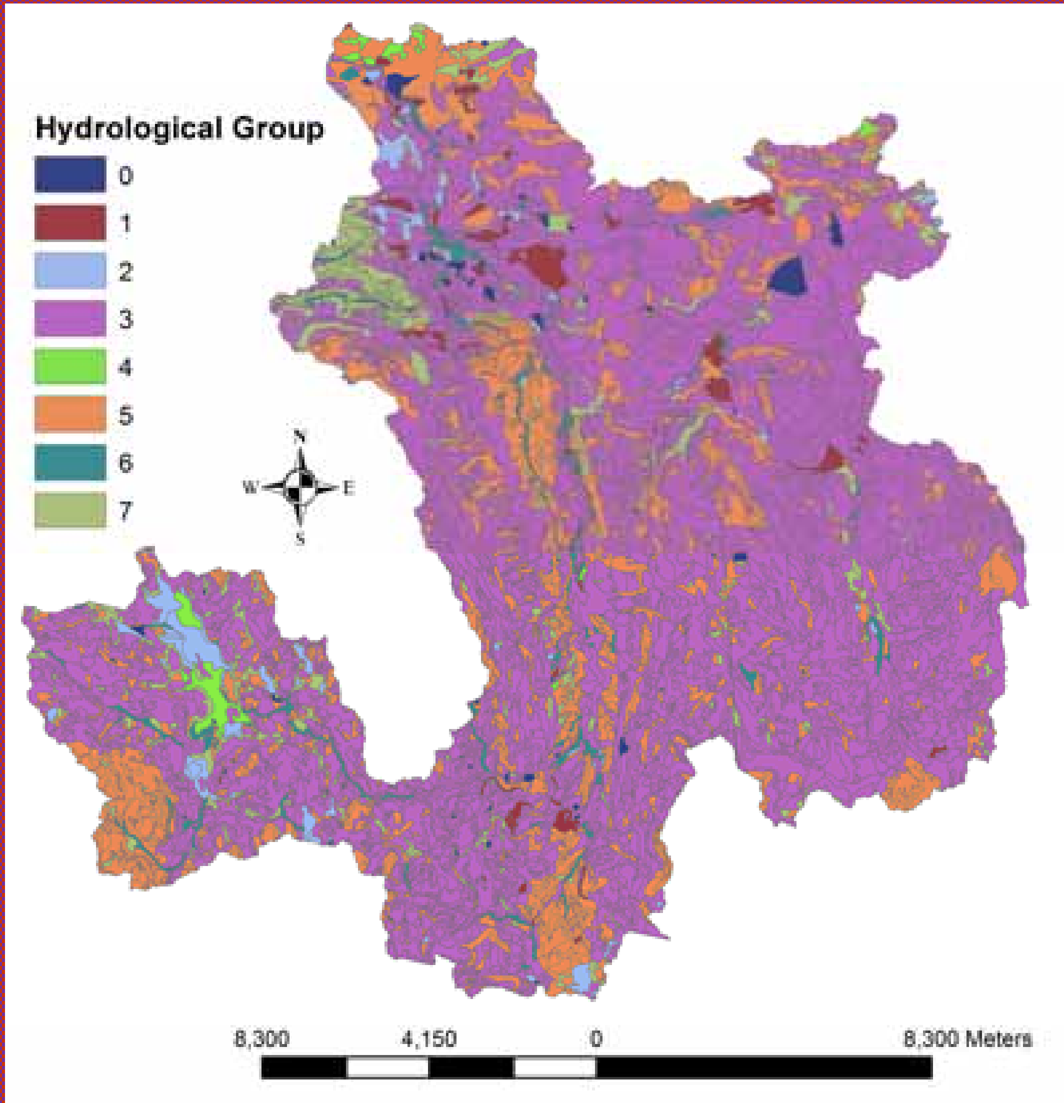
To test the ability of DWSM in predicting event-based water and discharges in a medium-sized watershed in New York, USA

The study area

- Area = 311 km^2
- Annual Precipitation = 1270 mm

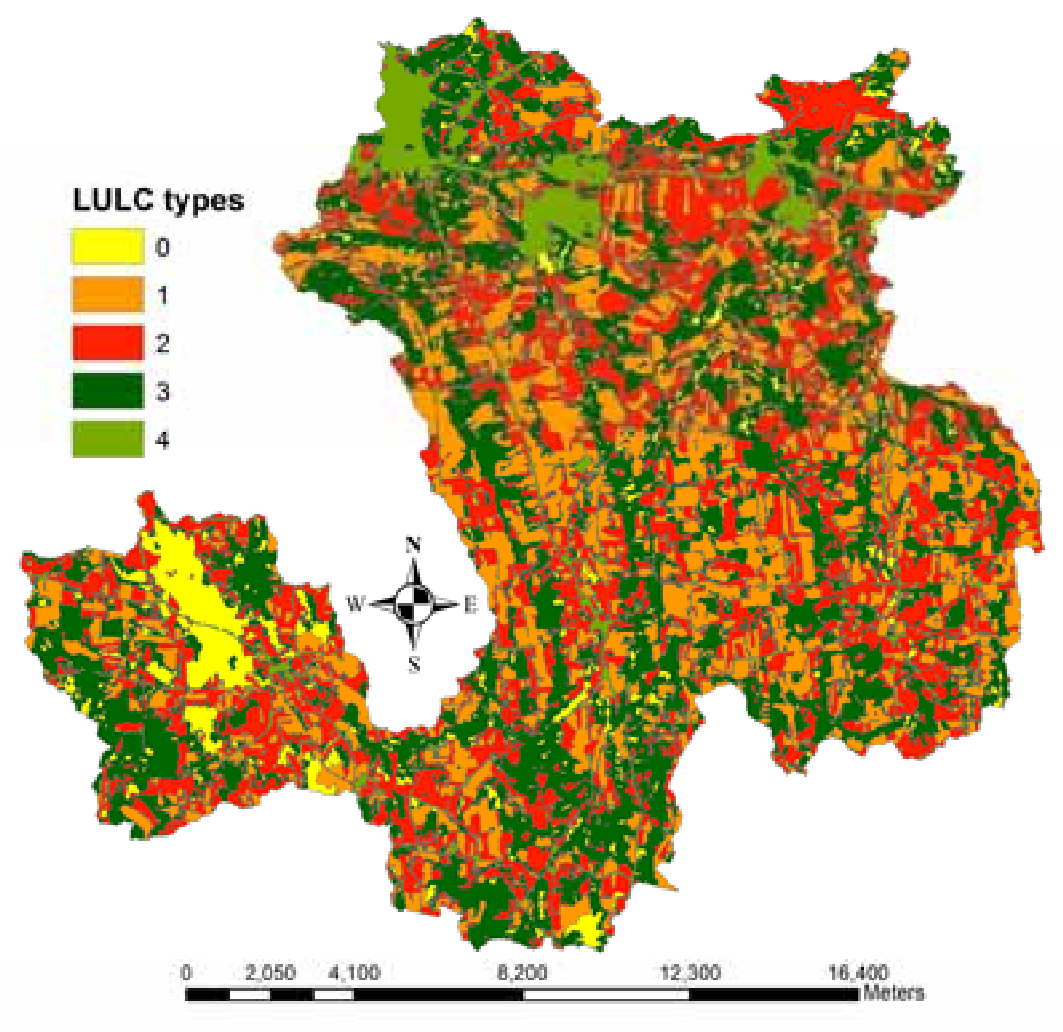


Soil pattern



Class	Hydro. group
0	Null
1	A
2	A/D
3	B
4	B/D
5	C
6	C/D
7	D

Land Use and Land Cover (LULC) pattern



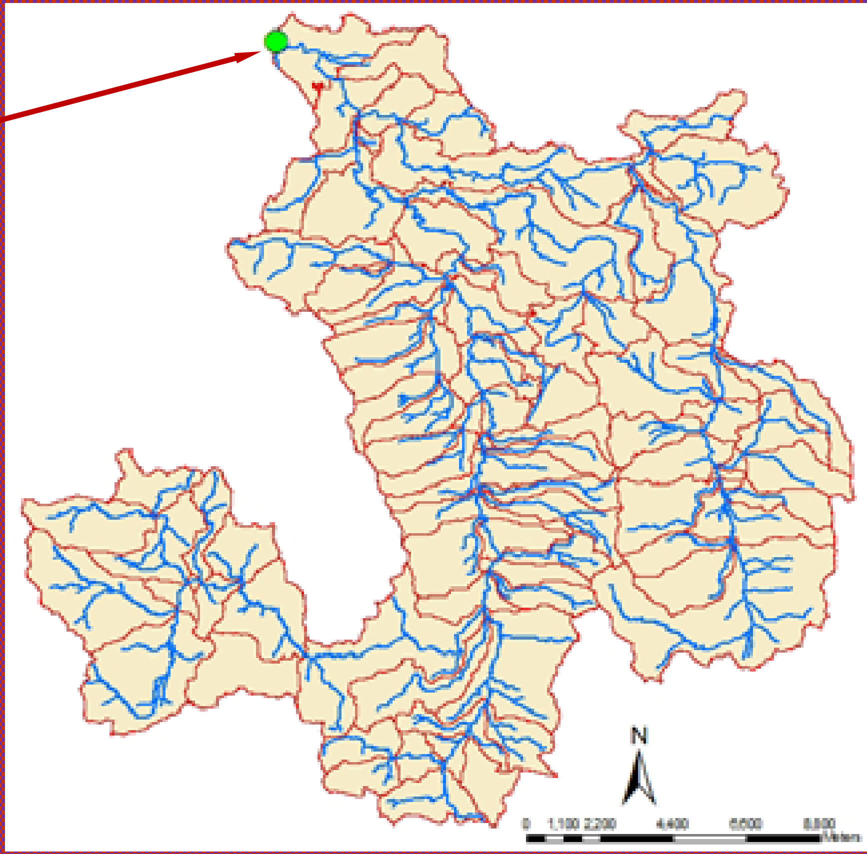
Class	LULC type
0	Open water
1	Crop
2	Pasture
3	Forest and shrub
4	Urban

Class	Percentage
1 + 2	68%
3	23%
4	7%

Event-based continuous sampling

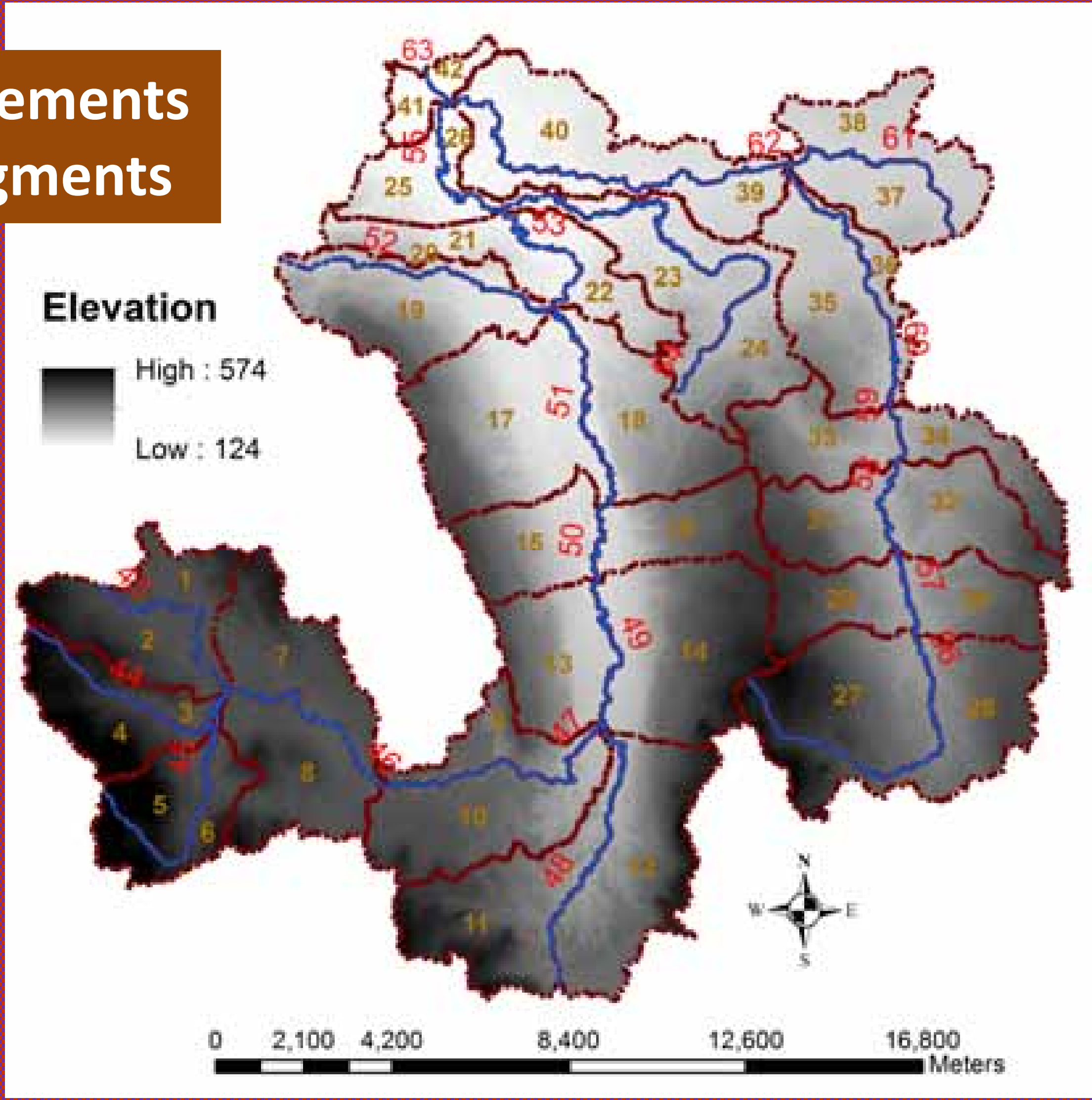
An ISCO automatic pumping sampler

Sampling site



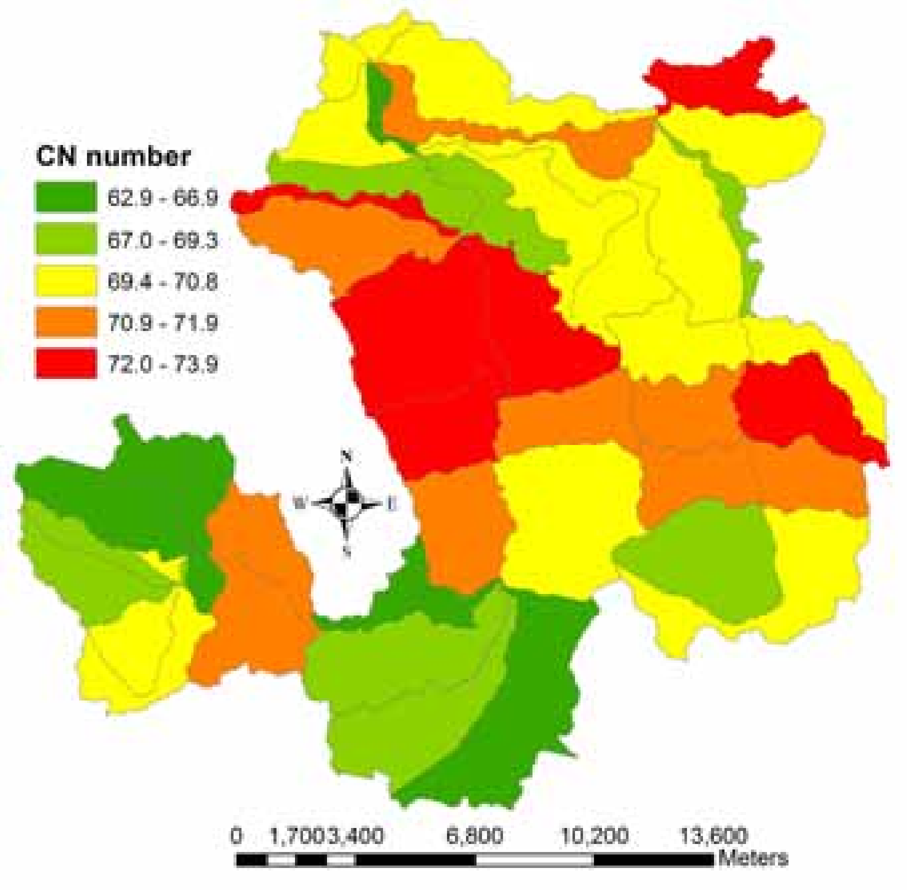
Model structure

42 overland elements
21 channel segments



Input data preparation

Area-averaged CN values for all overlands



CN determination (McCuen 1982)

Land Use Description	Curve Number by Hydrologic Soil Group			
	A	B	C	D
Residential (High Density)	77	85	90	92
Residential (Med. Density)	57	72	81	86
Residential (Low Density)	48	66	78	83
Commercial	89	92	94	95
Industrial	81	88	91	93
Disturbed/ Transitional	76	85	89	91
Agricultural	67	77	83	87
Open Land	39	61	74	80
Meadow	30	58	71	78
Woods (Thick Cover)	30	55	70	77
Woods (Thin Cover)	43	65	76	82
Impervious	98	98	98	98
Water	100	100	100	100

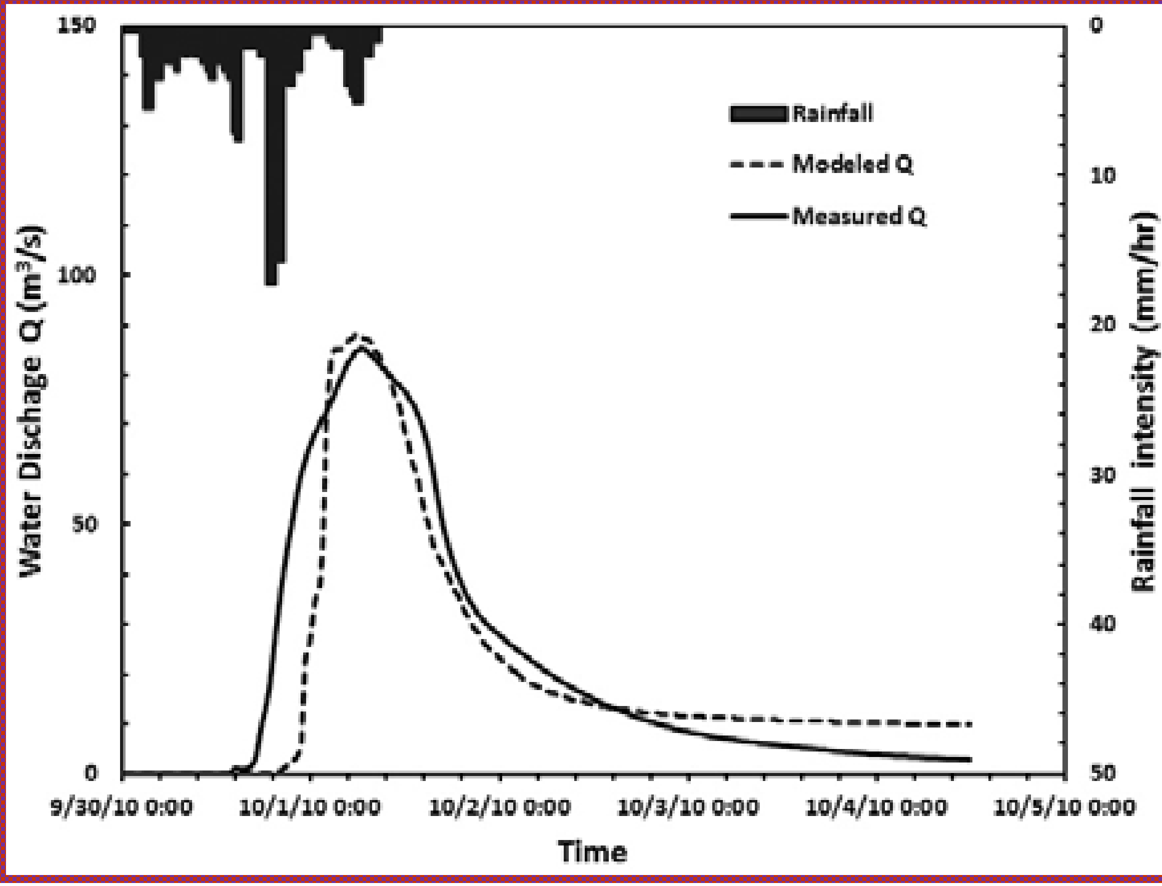
Example: Input parameters for overlands

	OVA	SLEN	SLOP	CNN	FRIC	IRS	COND	CONT	FDCI	GDXI
1	1097.3	2428.3	0.0381	72.9	0.200	1	0.007	0.22	16.00	100.0
2	1770.1	3916.9	0.0558	70.5	0.200	1	0.006	0.21	16.00	100.0
3	628.3	1226.4	0.0715	68.8	0.200	1	0.006	0.21	16.00	100.0
4	1544.2	3014.1	0.0915	68.3	0.200	1	0.006	0.20	16.00	100.0
5	1077.1	1642.3	0.1032	70.5	0.200	1	0.006	0.21	16.00	100.0
6	1149.7	1753.0	0.0940	71.5	0.200	1	0.006	0.21	16.00	100.0
7	2240.8	4601.0	0.0510	70.8	0.200	1	0.006	0.21	16.00	100.0
8	2311.7	4746.5	0.0643	71.0	0.200	1	0.006	0.21	16.00	100.0
9	1135.0	1922.4	0.1293	67.0	0.200	1	0.006	0.20	16.00	100.0
10	2768.6	4689.2	0.0958	65.3	0.200	1	0.006	0.20	16.00	100.0
11	2970.3	3862.0	0.1283	66.8	0.200	1	0.006	0.20	16.00	100.0
12	3280.1	4264.7	0.1341	67.0	0.200	1	0.006	0.20	16.00	100.0
13	2039.6	4518.3	0.0986	71.0	0.200	1	0.006	0.21	16.00	100.0
14	3769.3	8350.0	0.0960	68.7	0.200	1	0.006	0.21	16.00	100.0
15	1763.7	7607.6	0.0940	70.5	0.200	1	0.006	0.21	16.00	100.0
16	1701.1	7337.5	0.0860	69.4	0.200	1	0.006	0.21	16.00	100.0
17	3983.5	7291.0	0.0817	72.1	0.200	1	0.006	0.22	16.00	100.0
18	2433.2	4453.5	0.1091	70.5	0.200	1	0.006	0.21	16.00	100.0
19	2430.5	4089.9	0.1199	70.4	0.200	1	0.006	0.21	16.00	100.0
20	524.5	882.5	0.1070	73.3	0.200	1	0.007	0.22	16.00	100.0
21	1397.9	3454.5	0.0926	68.5	0.200	1	0.006	0.21	16.00	100.0
22	1264.4	3124.6	0.0590	65.7	0.200	1	0.006	0.20	16.00	100.0
23	1812.1	1437.8	0.0663	68.2	0.200	1	0.006	0.20	16.00	100.0
24	2339.6	1856.3	0.0813	67.0	0.200	1	0.006	0.20	16.00	100.0
25	1160.9	2952.6	0.0601	71.4	0.200	1	0.006	0.21	16.00	100.0
26	335.3	852.8	0.0405	60.4	0.200	1	0.005	0.18	16.00	100.0
27	2709.2	3305.3	0.0795	67.4	0.200	1	0.006	0.20	16.00	100.0
28	2944.8	3592.8	0.0829	68.5	0.200	1	0.006	0.21	16.00	100.0
29	1456.6	5203.4	0.0800	69.8	0.200	1	0.006	0.21	16.00	100.0
30	1417.5	5064.0	0.0685	69.5	0.200	1	0.006	0.21	16.00	100.0
31	1498.1	5649.9	0.0878	67.9	0.200	1	0.006	0.20	16.00	100.0
32	2013.2	7592.4	0.0733	70.0	0.200	1	0.006	0.21	16.00	100.0
33	1681.0	10008.2	0.0992	67.2	0.200	1	0.006	0.20	16.00	100.0
34	1219.8	7262.5	0.0799	68.1	0.200	1	0.006	0.20	16.00	100.0
35	2513.2	4278.2	0.0684	66.6	0.200	1	0.006	0.20	16.00	100.0
36	602.8	1026.1	0.0559	66.0	0.200	1	0.006	0.20	16.00	100.0
37	1336.2	2685.1	0.0273	68.2	0.200	1	0.006	0.20	16.00	100.0
38	1755.5	3527.7	0.0165	69.7	0.200	1	0.006	0.21	16.00	100.0
39	1652.9	1794.4	0.0393	67.0	0.200	1	0.006	0.20	16.00	100.0
40	2440.1	2648.9	0.0263	66.4	0.200	1	0.006	0.20	16.00	100.0
41	280	3485.3	0.0104	72.5	0.200	1	0.007	0.22	16.00	100.0
42	451	5623.1	0.0247	64.5	0.200	1	0.006	0.19	16.00	100.0

Definition of parameters

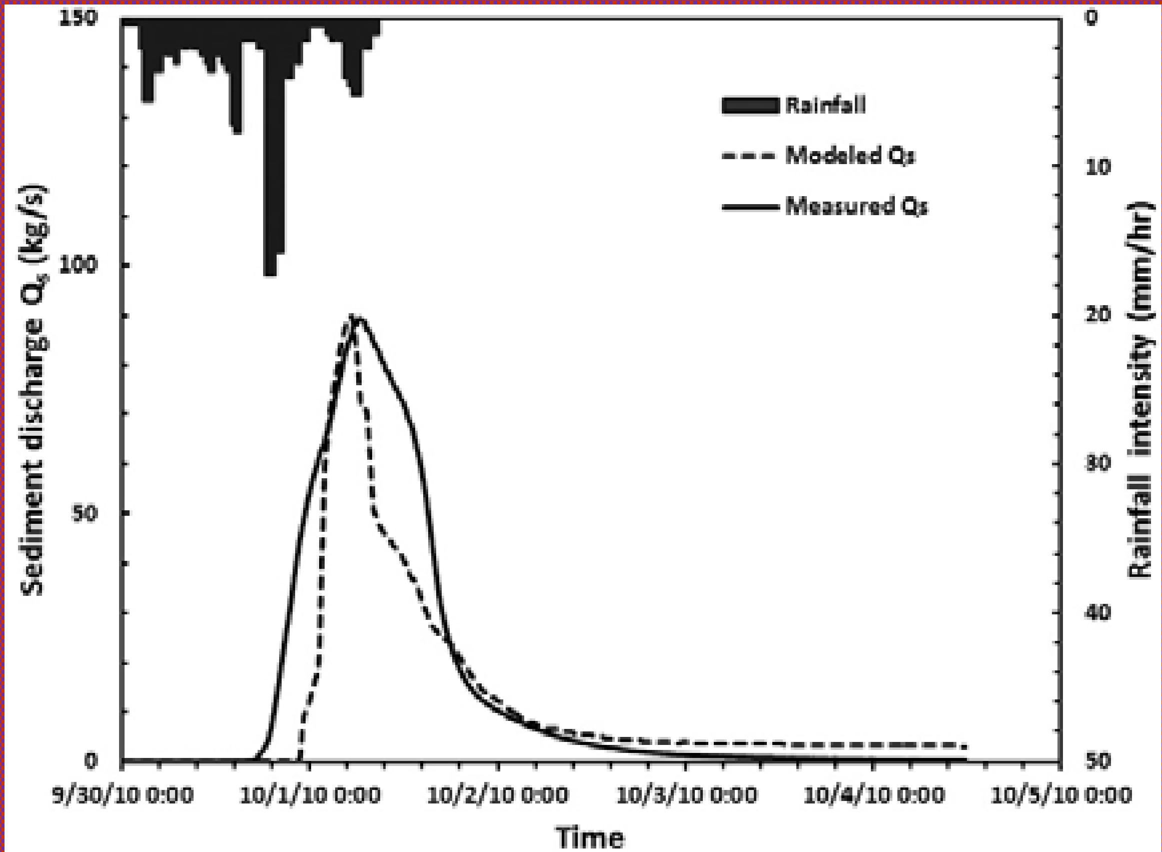
- OVA –overland area
- SLEN – overland slope length
- SLOP – overland slope
- CNN – curve number for overlands
- FRIC – Manning's n
- IRS – rain gauge number
- COND – effective lateral saturated hydraulic conductivity
- CONT – initial uniform moisture content in the soil
- FDCI – flow detachment coefficient
- GDXI – space increment for sediment routing

Results of the 9/30/2010 event: hydrograph



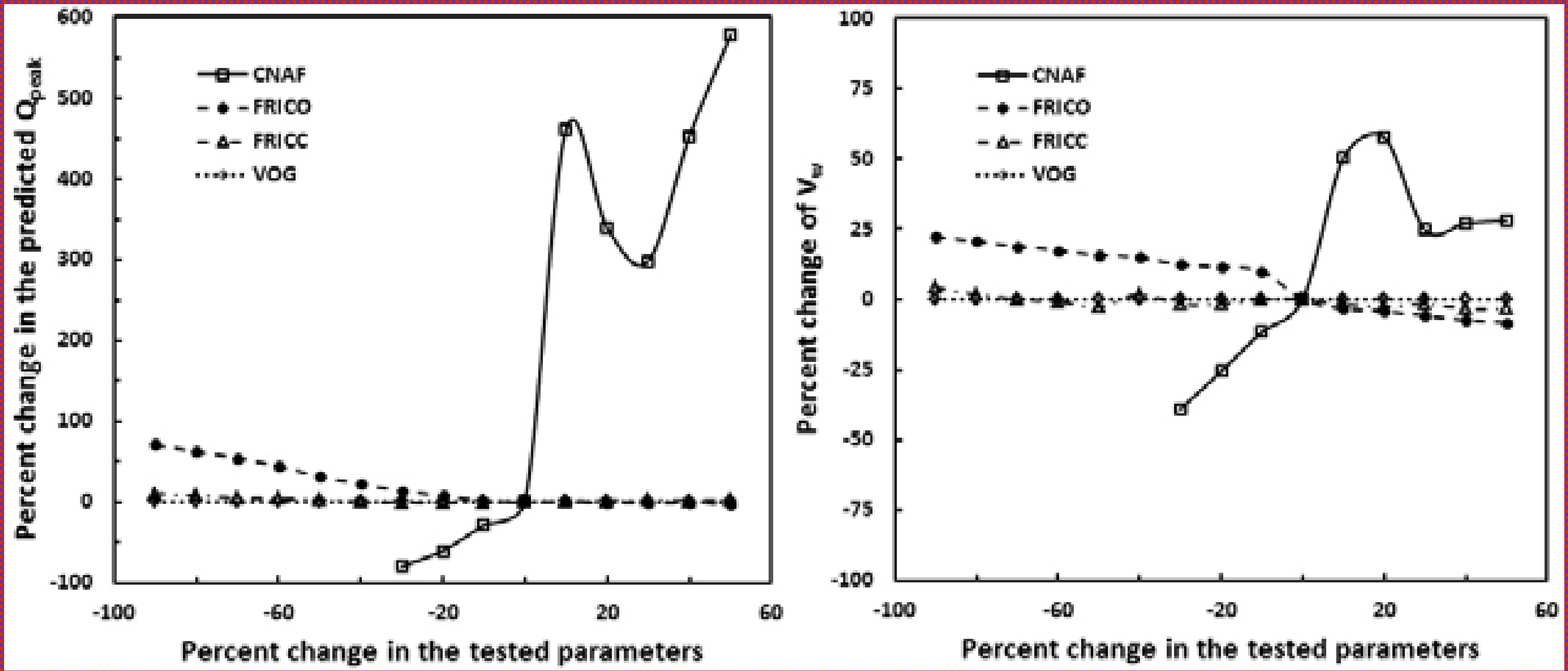
	Measured	Modeled	Error
Q_{peak} (m^3/s)	85.35	88.15	3.3%
V_{water} (m^3)	8.38×10^6	7.49×10^6	10.7%

Results of the 9/30/2010 event: sedigraph



	Measured	Modeled	Error
Q_{speak} (kg/s)	89.29	89.76	0.6%
SSY_e (ton)	5748	4465	-22.3%

Sensitivity analysis: water discharges

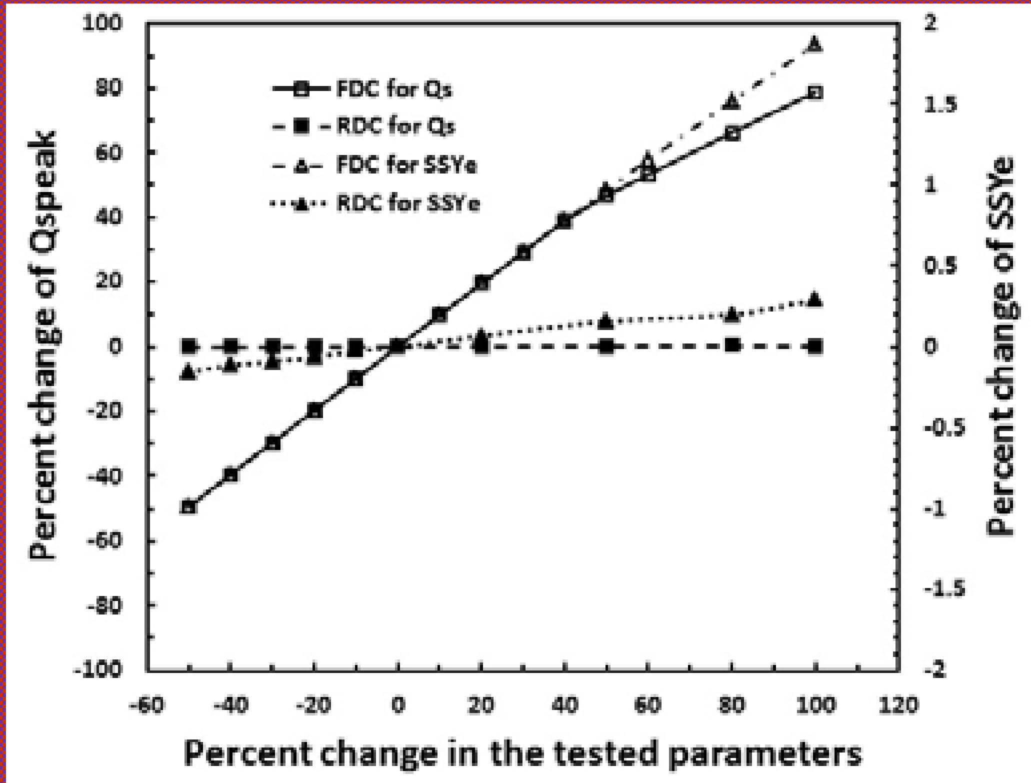


Peak discharge Q_{peak}

Event total water volume V

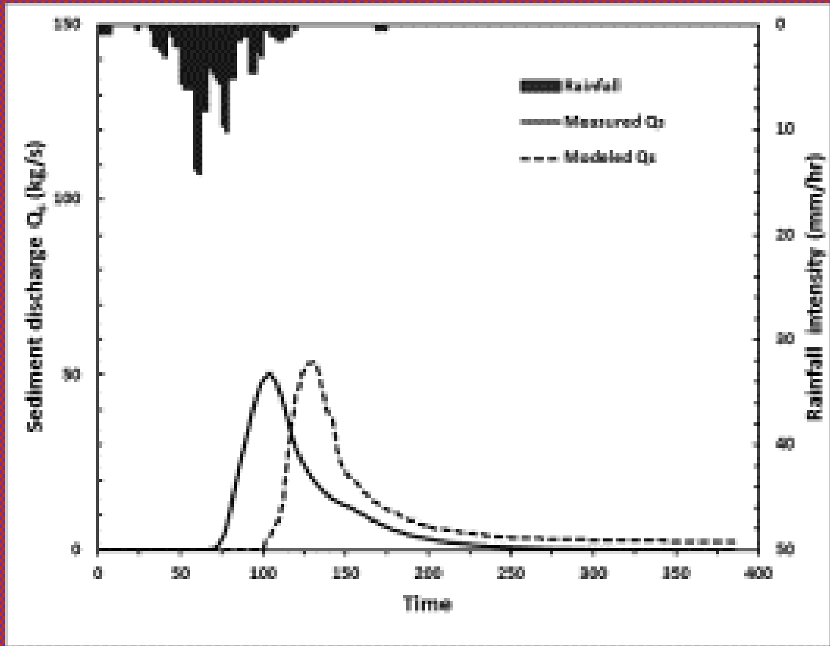
Curve number adjustment coefficient (CNAF) is the most sensitive parameter

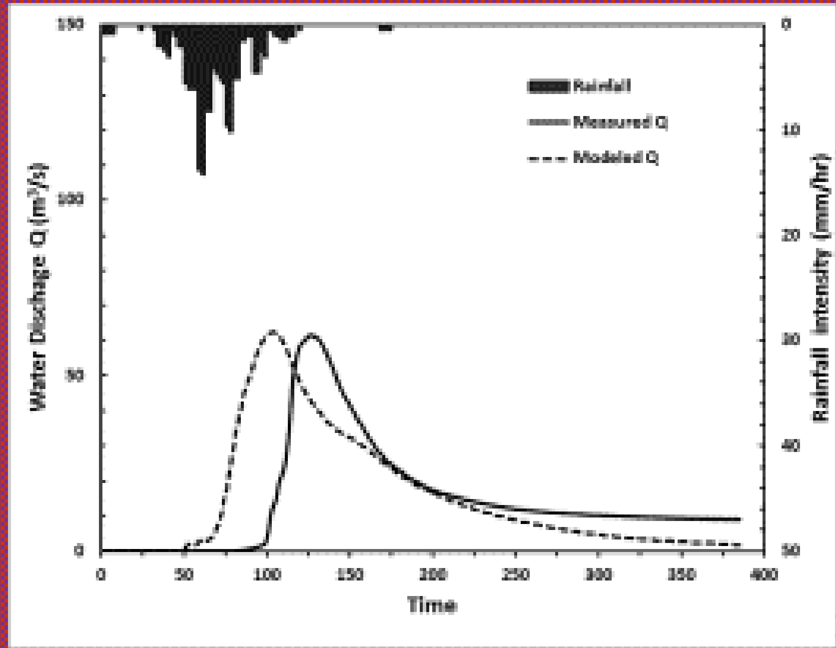
Sensitivity analysis: sediment discharge



flow detachment coefficient (FDC) is most sensitive parameter

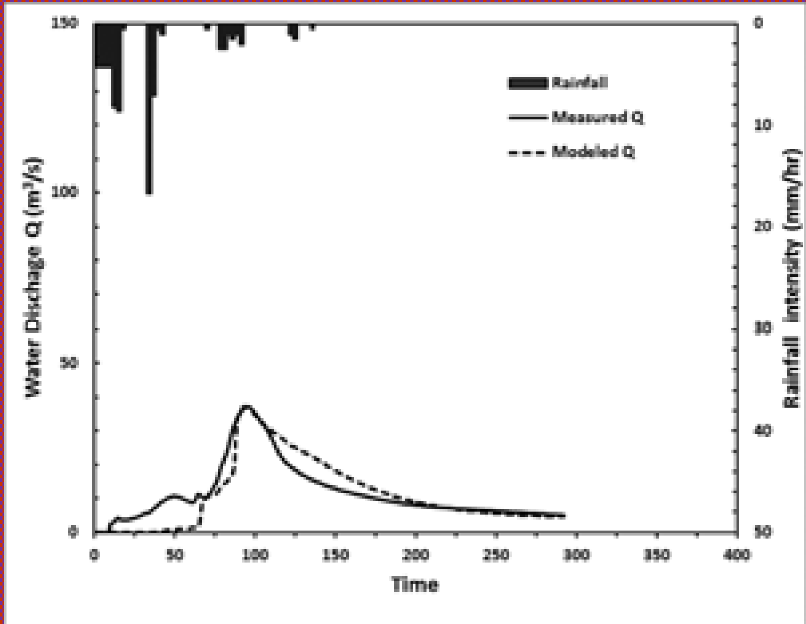
Results of the 8/22/2010 event

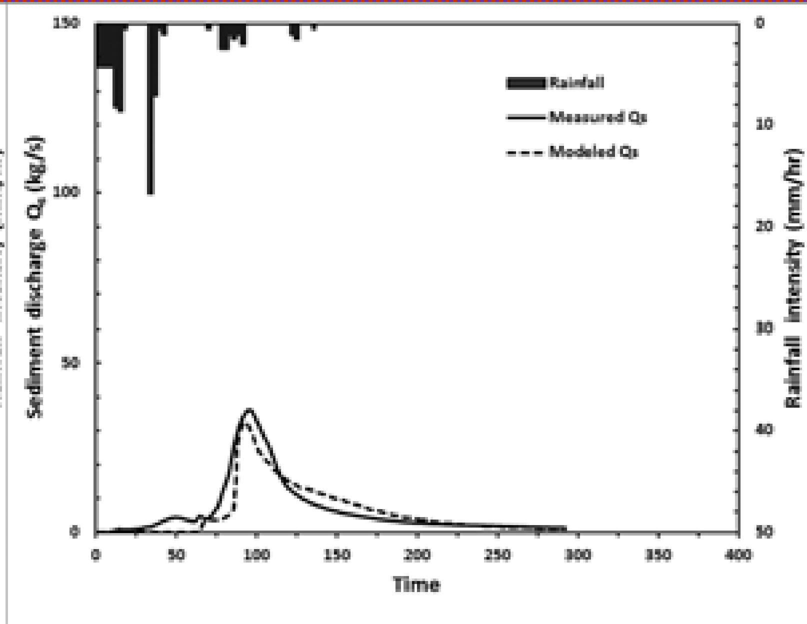




	Measured	Modeled	Error
Q_{peak} (m^3/s)	62.40	61.55	-1.4%
V_{water} (m^3)	5.33 x 10^6	5.06 × 10^6	-5.0%
Q_{speak} (kg/s)	50.29	53.73	6.8%
SSY_e (ton)	2306	2553	10.7%

Results of the 6/28/2010 event





	Measured	Modeled	Error
Q_{peak} (m³/s)	37.10	37.32	0.6%
V_{water} (m³)	3.04×10^6	2.91×10^6	-4.5%
Q_{speak} (kg/s)	36.12	32.42	10.2%
SSY_e (ton)	1723	1561	-9.4%

Comparison of sensitive parameters

EVENTS	CNAF	FDC
9/30/2010	0.84	0.36
8/22/2010	0.85	0.36
6/28/2010	1.24	0.36

Conclusions

DWSM is a reliable watershed model to predict water and sediment discharges in Oneida Creek watershed