

Modeling Water Quantity and Nutrients in Devils Lake Watershed Using SWAT

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Devils Lake Watershed

- Area

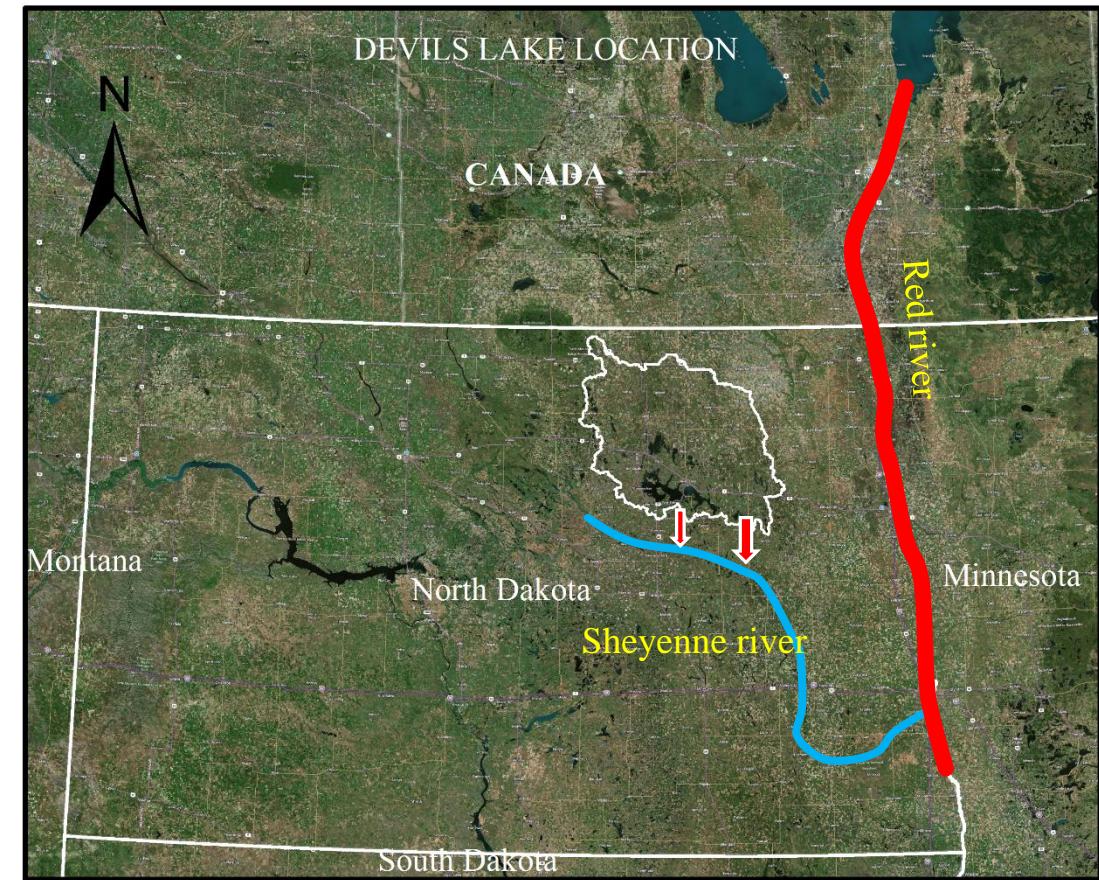
10187 Km²

- Land use

Mostly cropland and pasture

- Why is it important

- It is a terminal lake
- The lake level has raised around 11 meter after 1950



Natural spill to Sheyenne river: 445 meter

Devils Lake Precipitation



Devils Lake Elevation



2007

2010





Method

Watershed Delineation

Revised using USGS Data

HRU Definition

Flow Calibration-validation

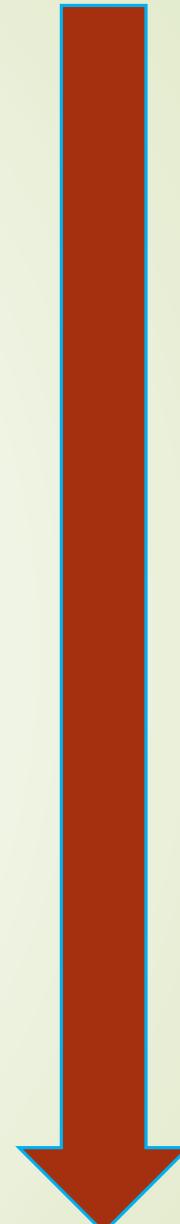
Lake Elevation Simulation

Sediment Calibration-validation

Lake Sediment Simulation

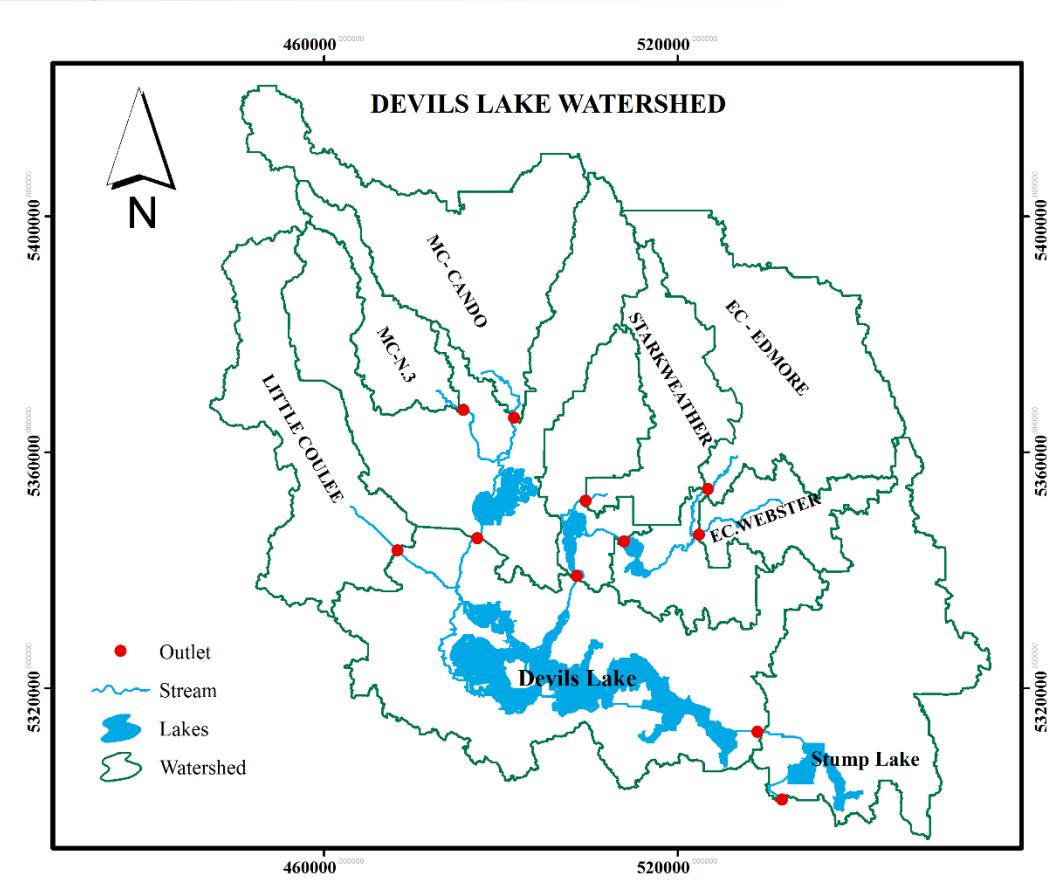
Total Phosphorus and Nitrogen Calibration-validation

Lake Nutrient Simulation

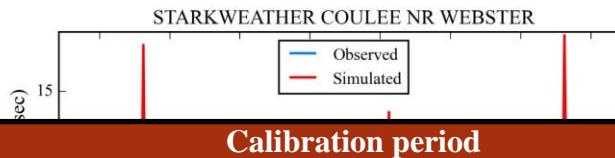
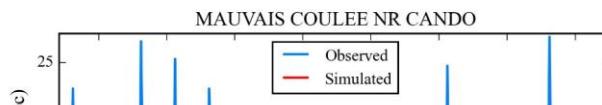
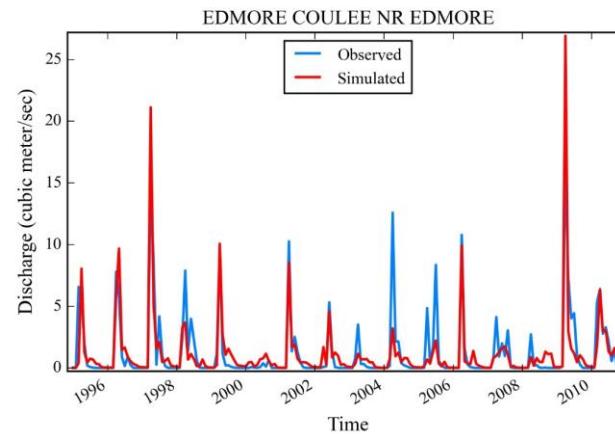
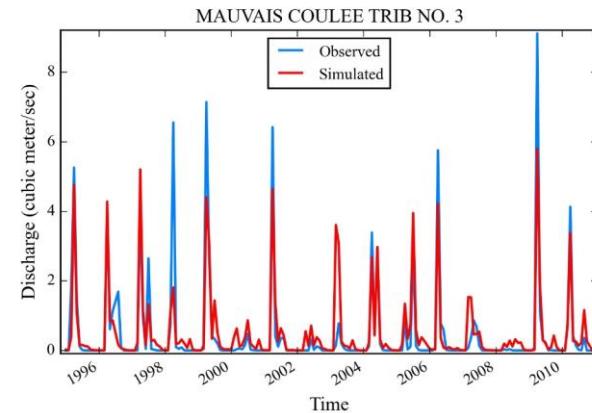


Flow

- Calibration 1993-2003
- Validation 2004-2010
- Using USGS data

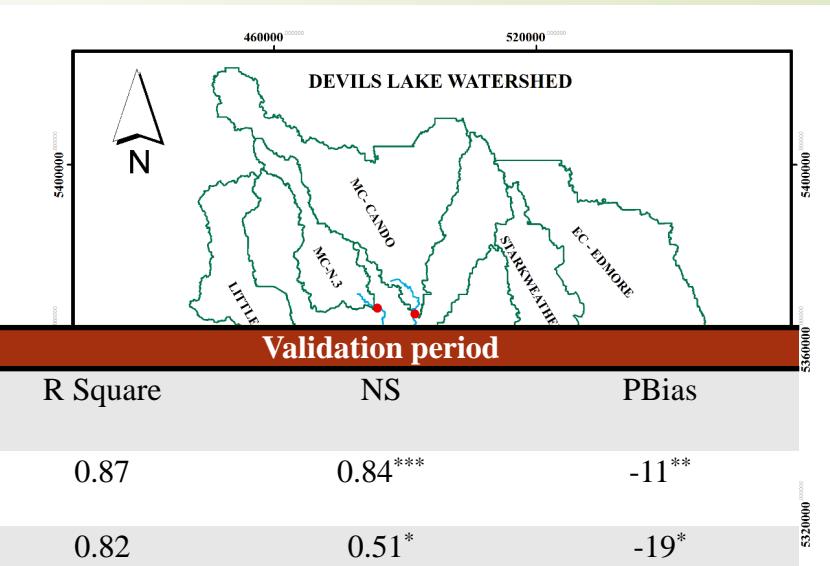
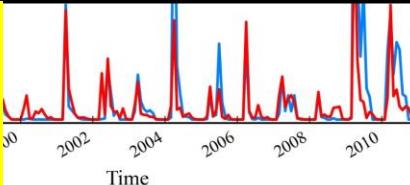


	<u>Parameter</u>	<u>Fitted Value</u>
1	R_CN2.mgt	-0.16
2	R_SOL_AWC(..).sol	-0.12
3	R_SOL_K(..).sol	-0.10
4	R_SOL_ALB(..).sol	-0.48
5	V_ALPHA_BF.gw	0.08
6	V_GW_DELAY.gw	141.80
7	V_REVAPMN.gw	12.45
8	V_GW_REVAP.gw	0.12
9	V SHALLST.gw	312.50
10	V_RCHRG_DP.gw	0.55
11	V_EPCO.hru	0.99
12	V_ESCO.hru	0.73
13	V_OV_N.hru	0.01
14	V_CH_N2.rte	0.27
15	V_CH_K2.rte	128.03
16	V_SURLAG.hru	4.51
17	V_SFTMP.bsn	1.13
18	V_SMTMP.bsn	5.00
19	V_SMFMX.bsn	7.39
20	V_SMFMN.bsn	5.53
21	V_TIMP.bsn	0.91



Sub-watersheds	Number of Observation	Calibration period			Validation period		
		R Square	NS	PBias	R Square	NS	PBias
M.C-N.3	192	0.67	0.67**	-6.8***	0.87	0.84***	-11**
M.C-CANDO	192	0.69	0.67**	-7.3***	0.82	0.51*	-19*
E.C-EDMORE	192	0.77	0.74**	-7.6***	0.63	0.55*	17*
STARK WEAHTHER	192	0.6	0.51*	1.9***	0.76	0.78***	18*
E.C.WEBSTER	192	0.86	0.85***	3.7***	0.77	0.62**	39
LITTLE COULEE	154	0.76	0.63**	-90	0.7	0.21	-113

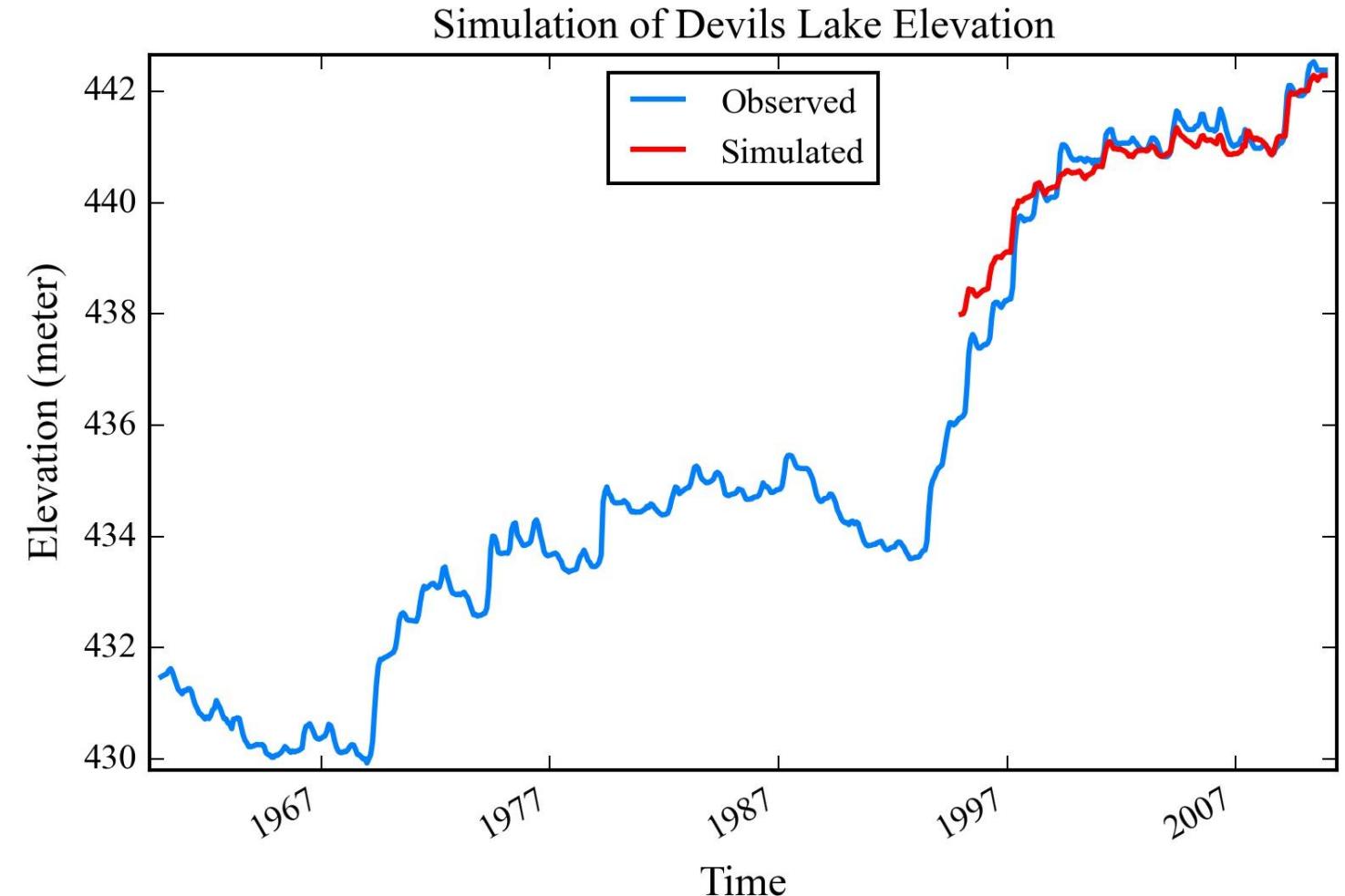
*** Very good simulation
** Good simulation
* Satisfactory simulation



Devils Lake Elevation

RMSE=0.46 Meter

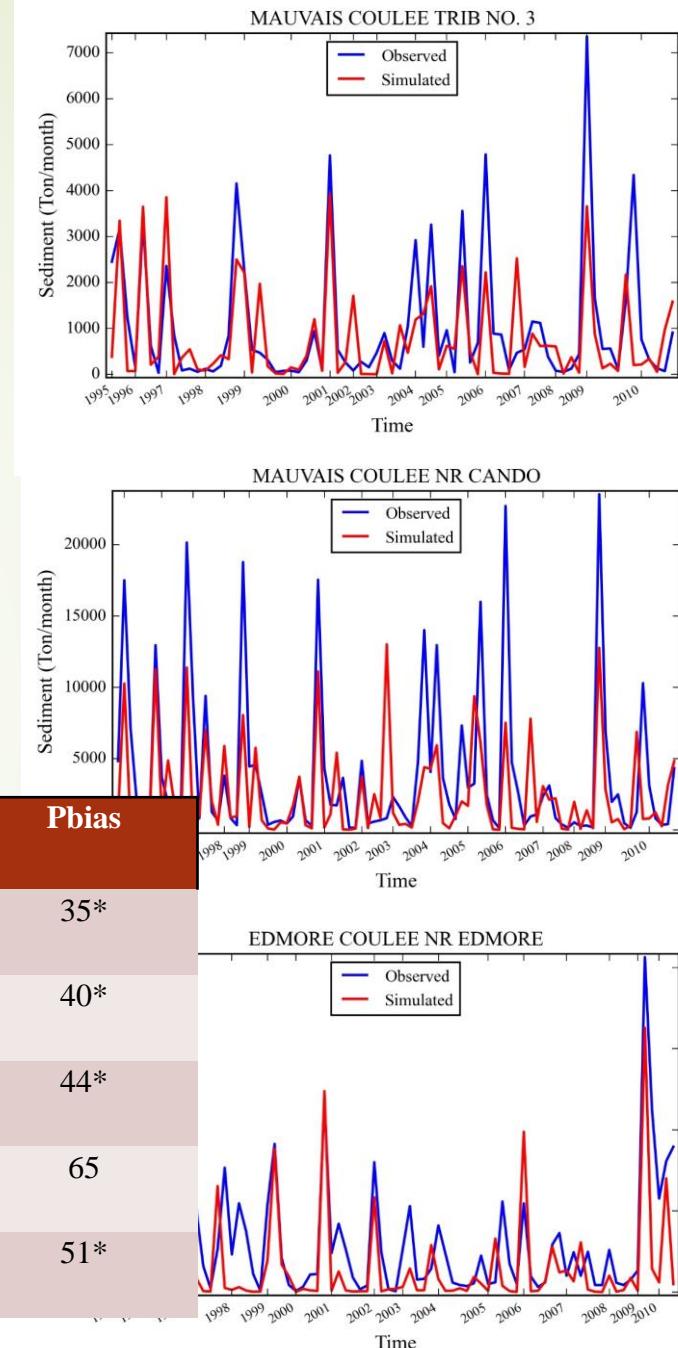
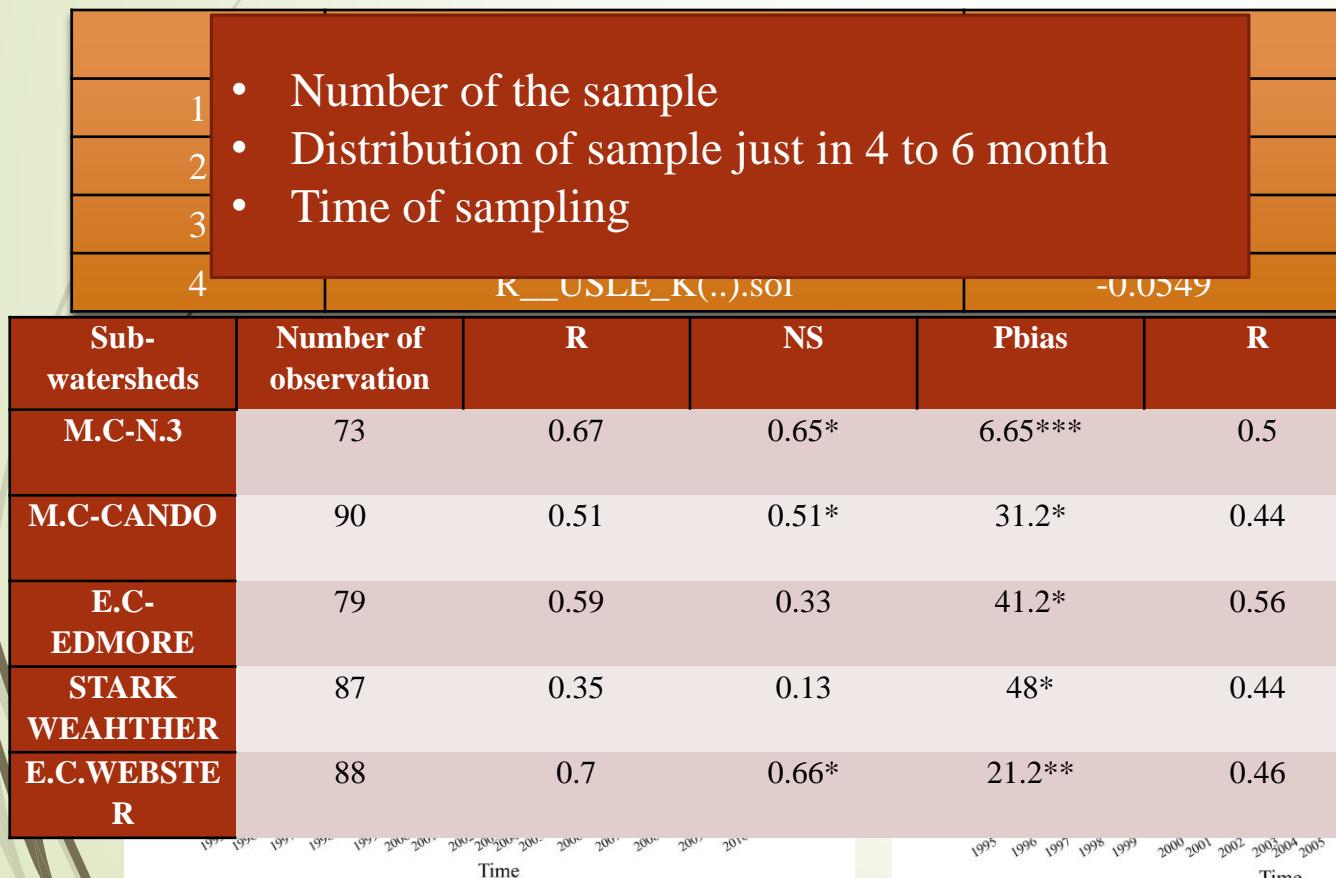
R square=0.96

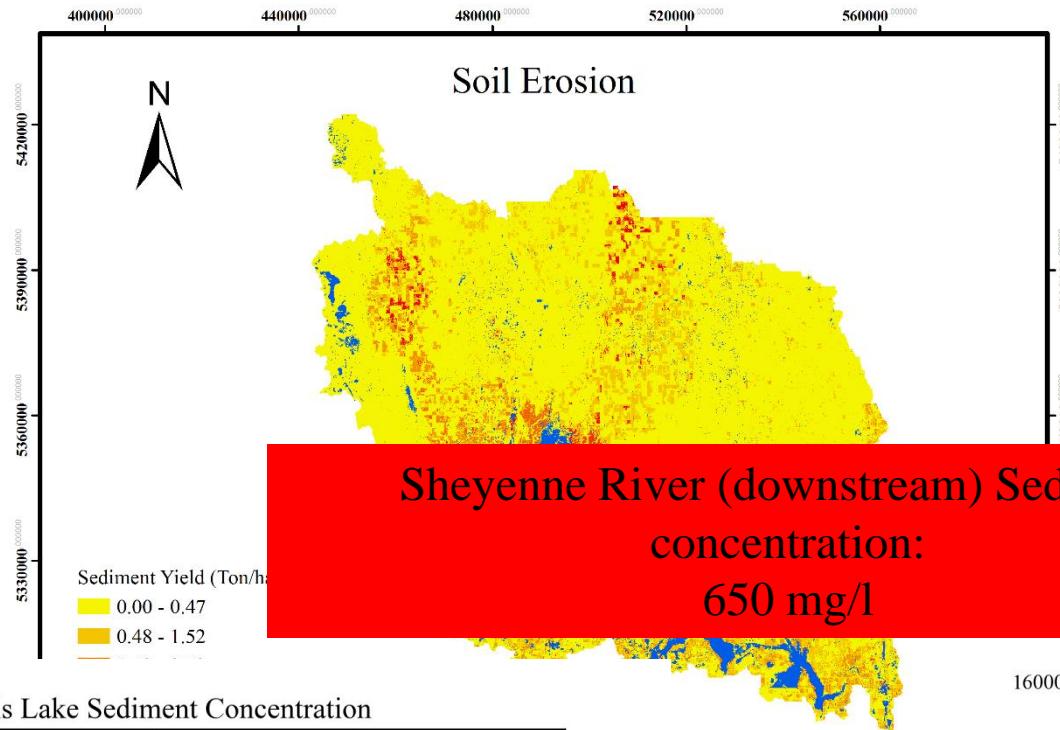


Sediment

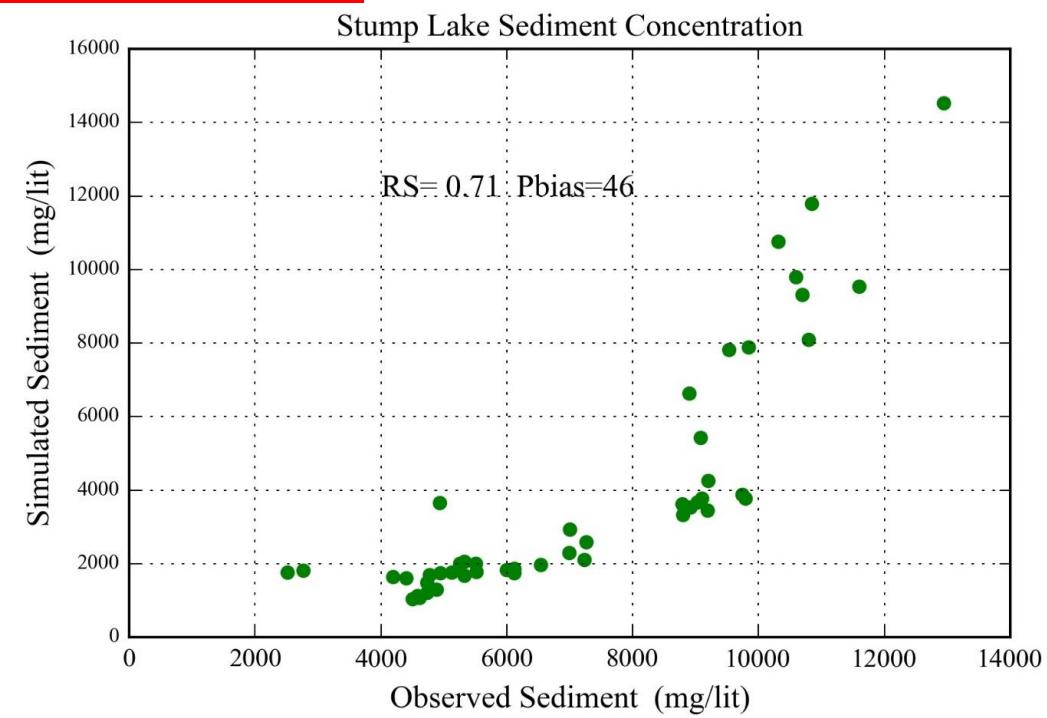
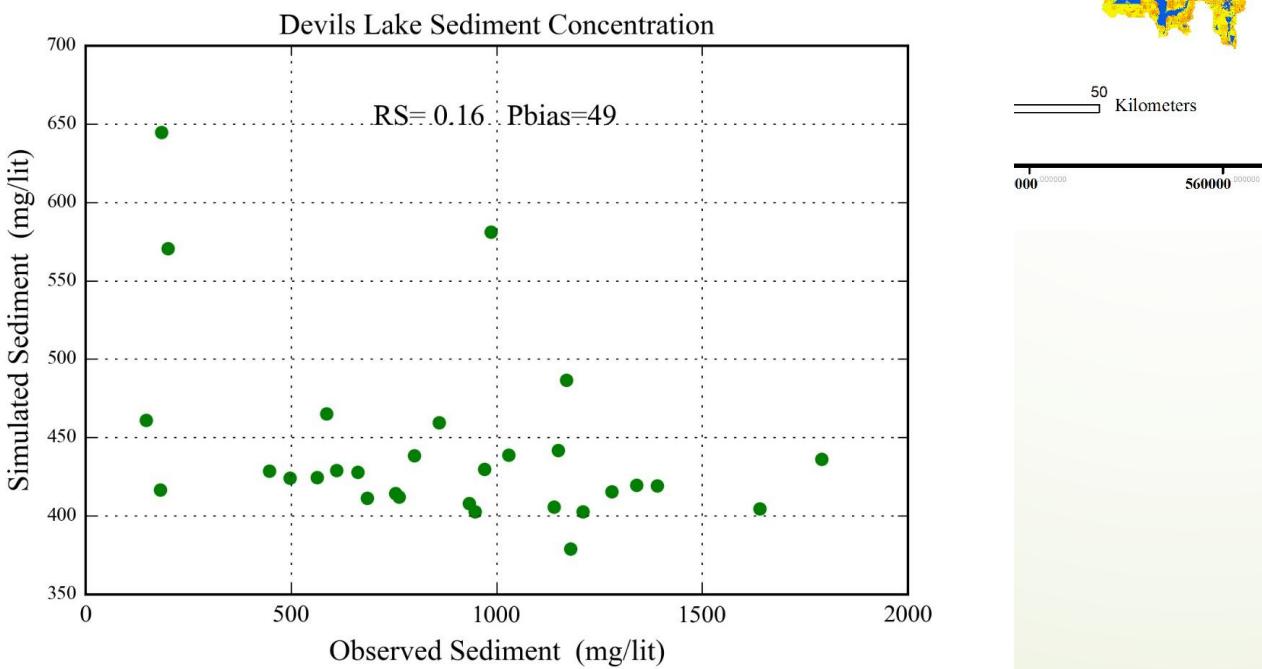
Average sediment concentration is vary between 500-750 (mg/liter) in Devils Lake tributaries.

- Number of the sample
- Distribution of sample just in 4 to 6 month
- Time of sampling





Mean Erosion: 0.8 Ton/ha/year

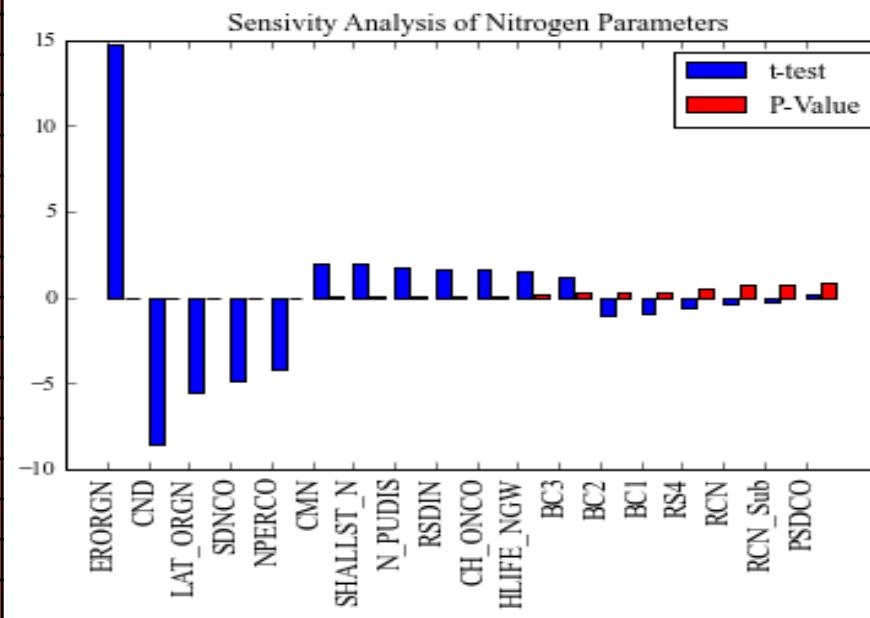
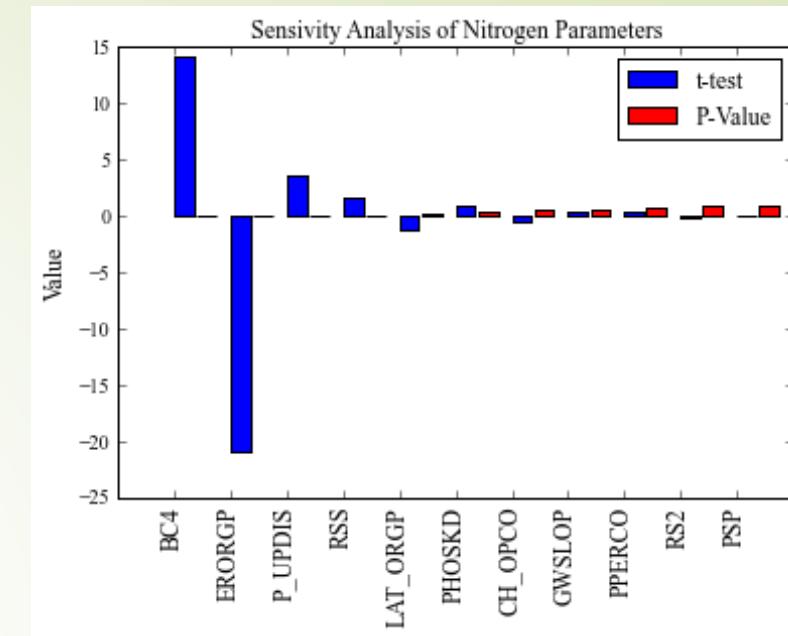


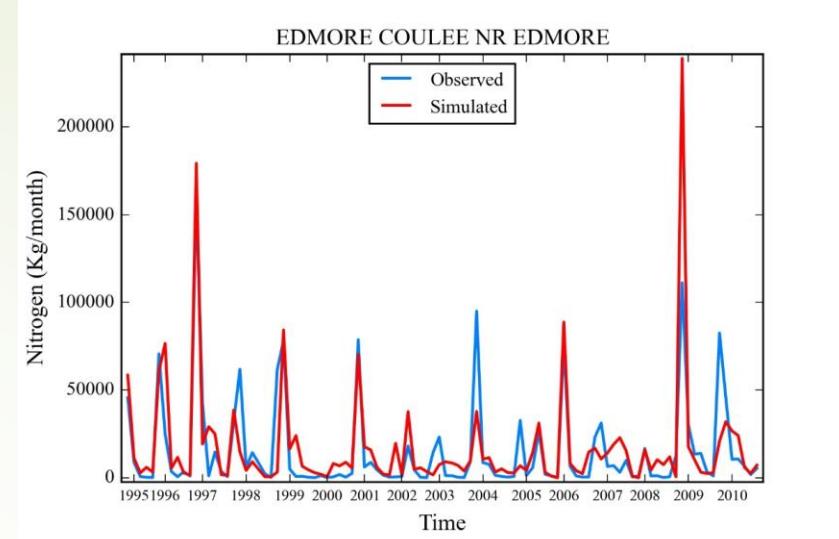
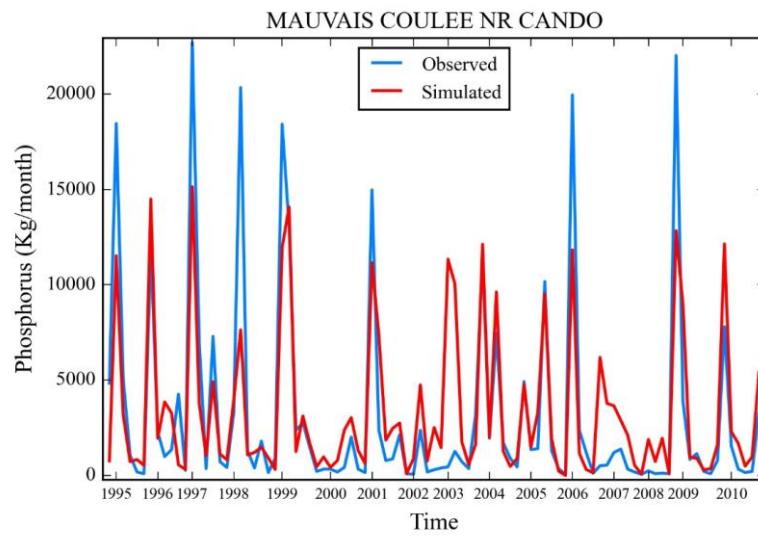
Phosphorus and Nitrogen

- Average Phosphorus concentration in Devils Lake tributaries is 0.4 mg/lit.
- Average Total Nitrogen in Devils Lake tributaries is 1.9 mg/lit.

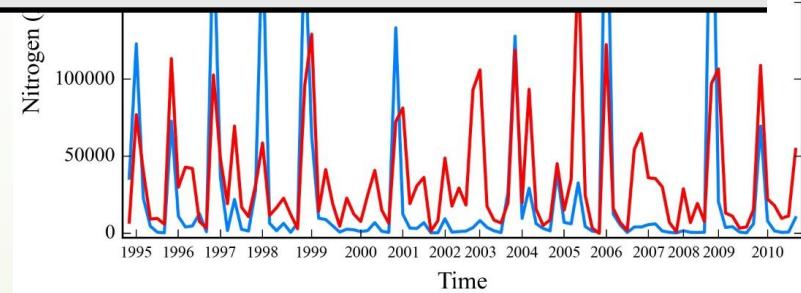
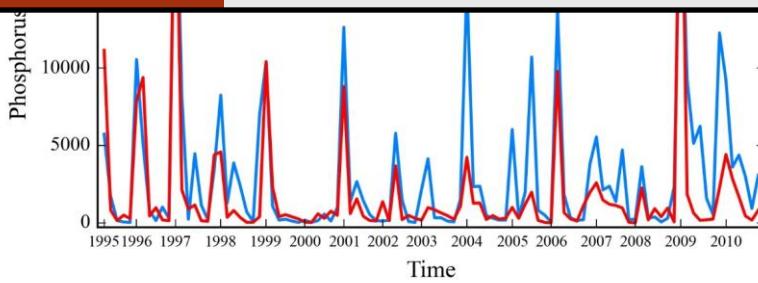
	<u>Parameter</u>	<u>Fitted Value</u>
1	V_BC4.swq	0.53
2	V_RS5.swq	0.08
3	V_RS2.swq	0.01
4	V_LAT_ORGP.gw	11.30
5	V_GWSOLP.gw	277.50
6	V_CH_OPSCO.rte	8.65
7	V_ERORGPN.hru	1.14
8	V_PSP.bsn	0.57
9	V_PHOSKD.bsn	115.75
10	V_PPERCO.bsn	11.13
11	V_P_UPDIS.bsn	72.65

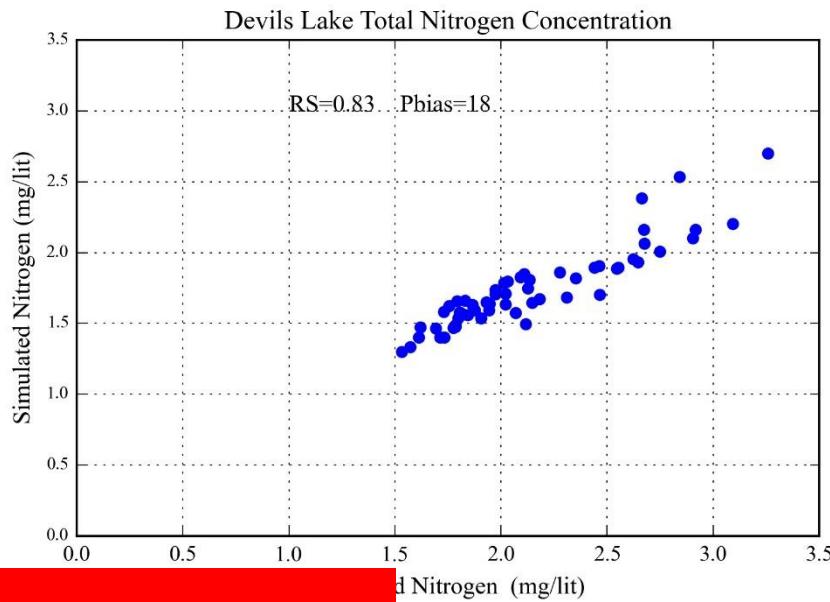
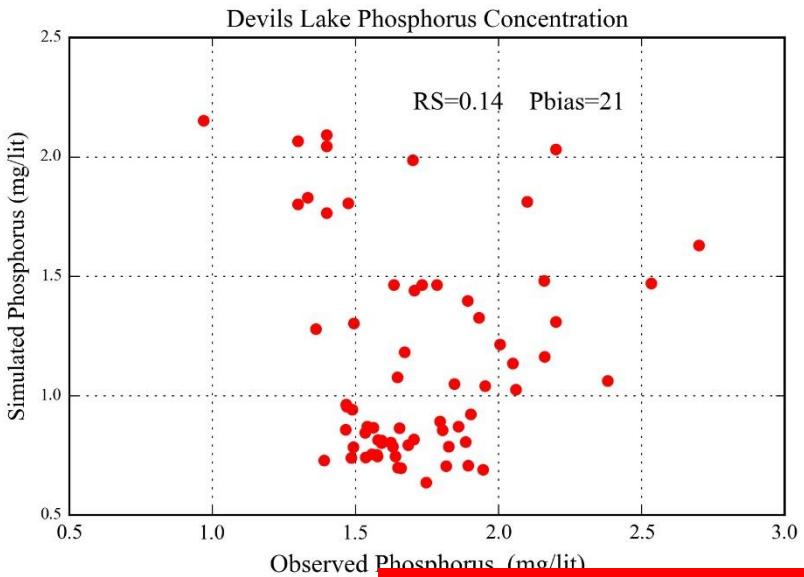
	<u>Parameter</u>	<u>Fitted-Value</u>
1	V_RCN_SUB_BSN.bsn	1.52
2	V_RSDCO.bsn	0.06
3	V_NPERCO.bsn	0.15
4	V_N_UPDIS.bsn	72.05
5	V_SDNCO.bsn	0.14
6	V_CDN.bsn	2.73
7	V_CMN.bsn	0.003
8	V_RCN.bsn	5.33
9	V_BC3.swq	0.25
10	V_BC2.swq	0.85
11	V_BC1.swq	0.64
12	V_RS4.swq	0.05
13	V_LAT_ORGN.gw	8.30
14	V_HLIFE_NGW.gw	119.50
15	V_SHALLST_N.gw	315.50
16	V_CH_ONCO.rte	14.35
17	V_RSDIN.hru	2065
18	V_ERORGPN.hru	1.00



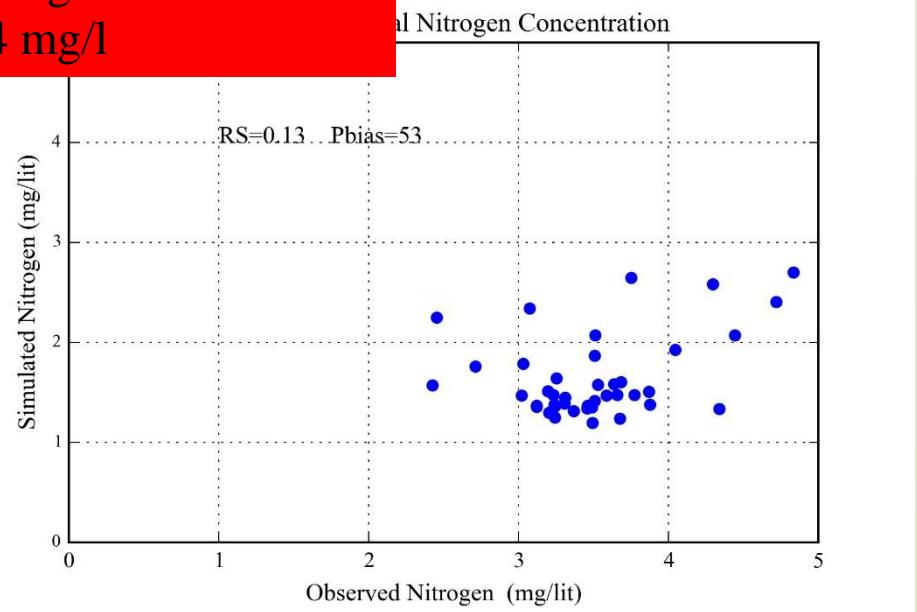
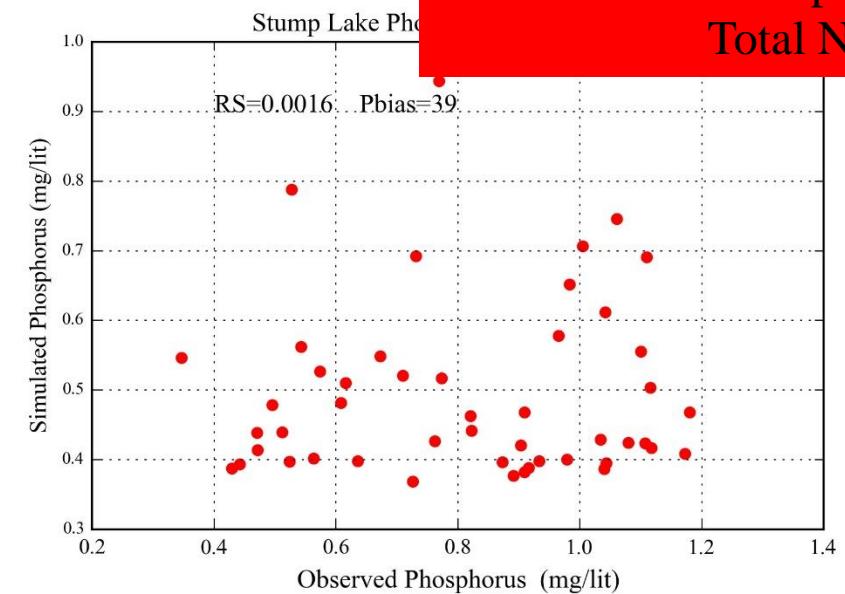


Phosphorus	Number of observation	R	NS	Pbias	R	NS	Pbias
MC-CANDO	95	0.62	0.63*	-0.17***	0.71	0.73**	-13***
EC-EDMORE	103	0.61	0.65*	28**	0.62	0.47	0.5***
Nitrogen							
MC-CANDO	96	0.4	0.32	-42*	0.36	32	-47*
EC-EDMORE	102	0.713	0.74**	-17***	0.55	0.12	-10***





Sheyenne river :
Phosphorus : 0.25 mg/l
Total Nitrogen: 1.4 mg/l



Conclusion

- ❑ The SWAT Model successfully simulated the Devils Lake elevation.
- ❑ The soil erosion in Devils Lake watershed may not be a big concern, but still the sediment concentration in Stump Lake is too high.
- ❑ The concentration of phosphorus and nitrogen both in Lakes and tributaries is much higher than Sheyenne River which can cause ecological problem for downstream.

Further research

Using GSM data to predict lake elevation and nutrient at the Devils Lake watershed by 2030.

Evaluation feasible scenarios to prevent flood and improve water quality (Like change in land use).

Acknowledgment

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