COMPARATIVE STUDY OF MODELING SEDIMENT AND NUTRIENT LOADS BY THE ALTERNATIVE MODELS SWAT AND SOURCE

Case study: Six Creek catchment, South Australia

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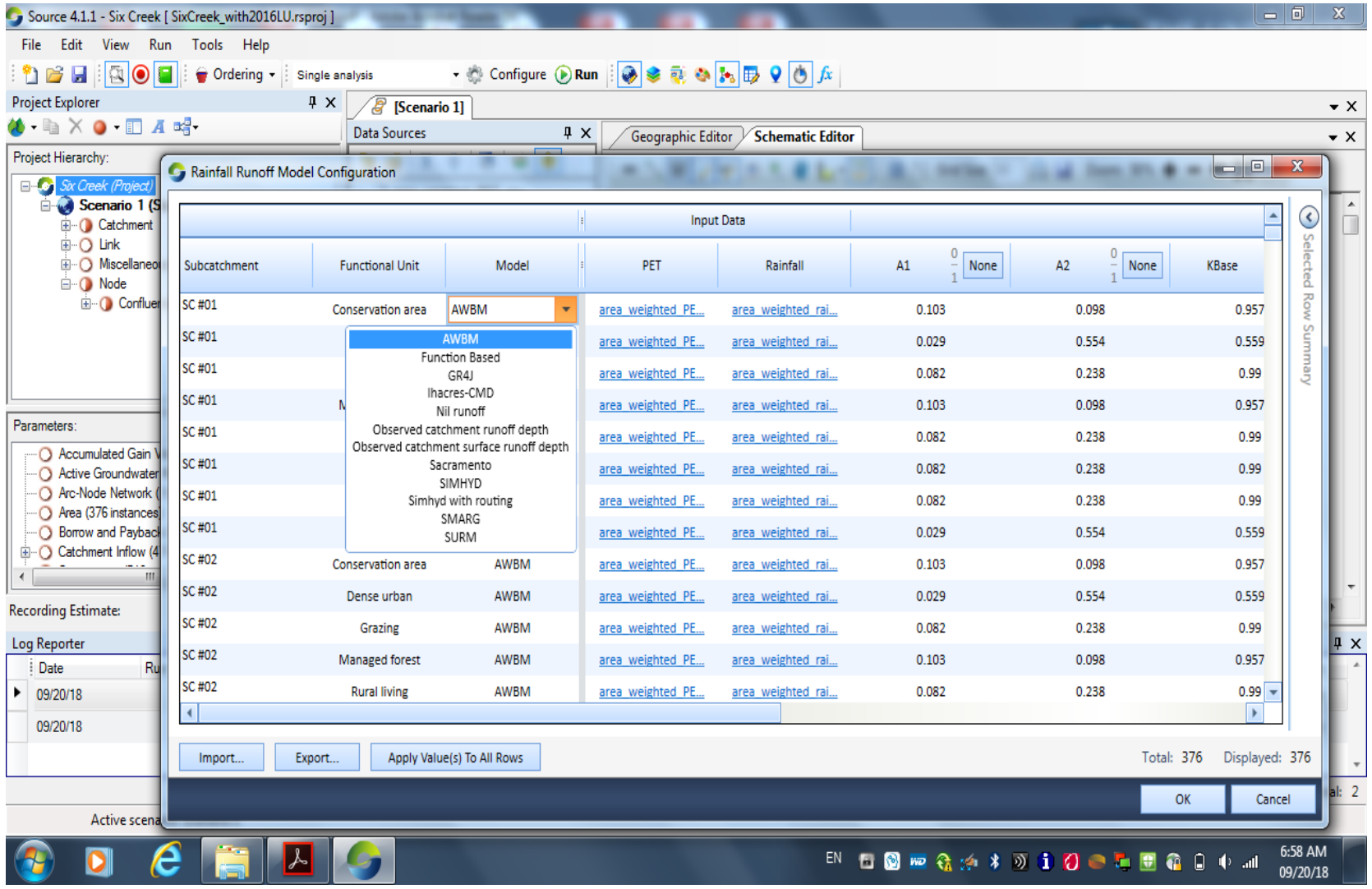
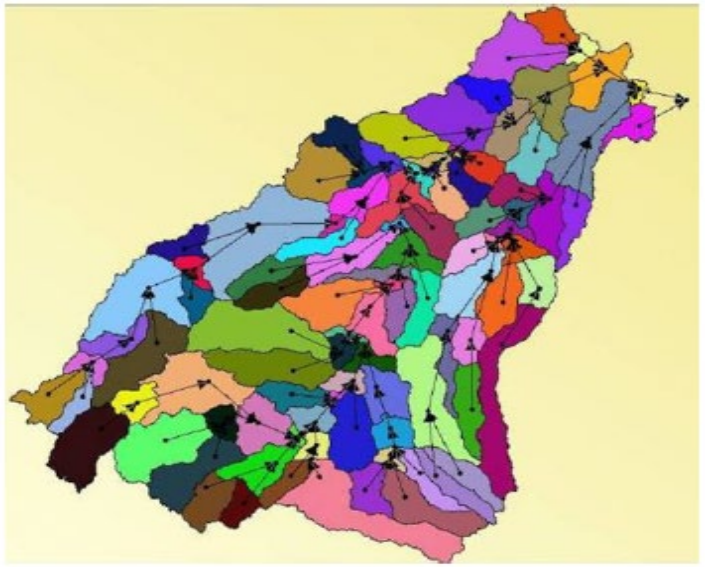
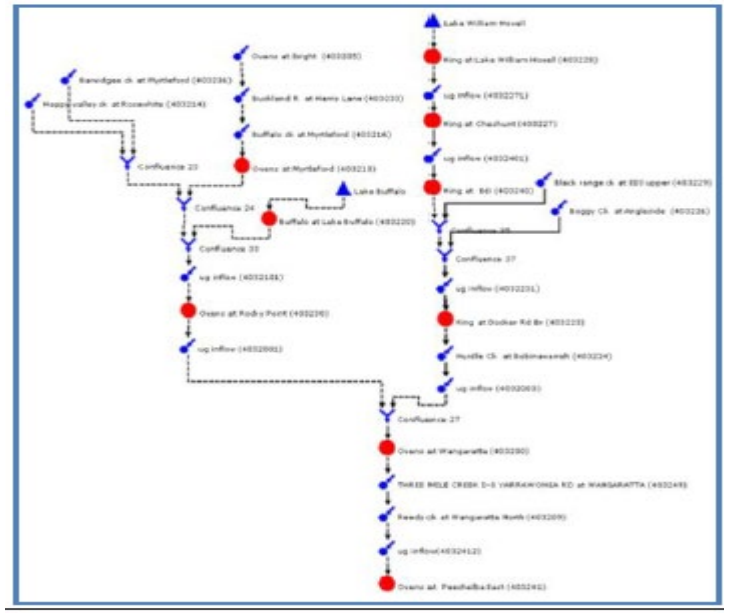
INTRODUCTION

SOURCE Integrated Modelling System



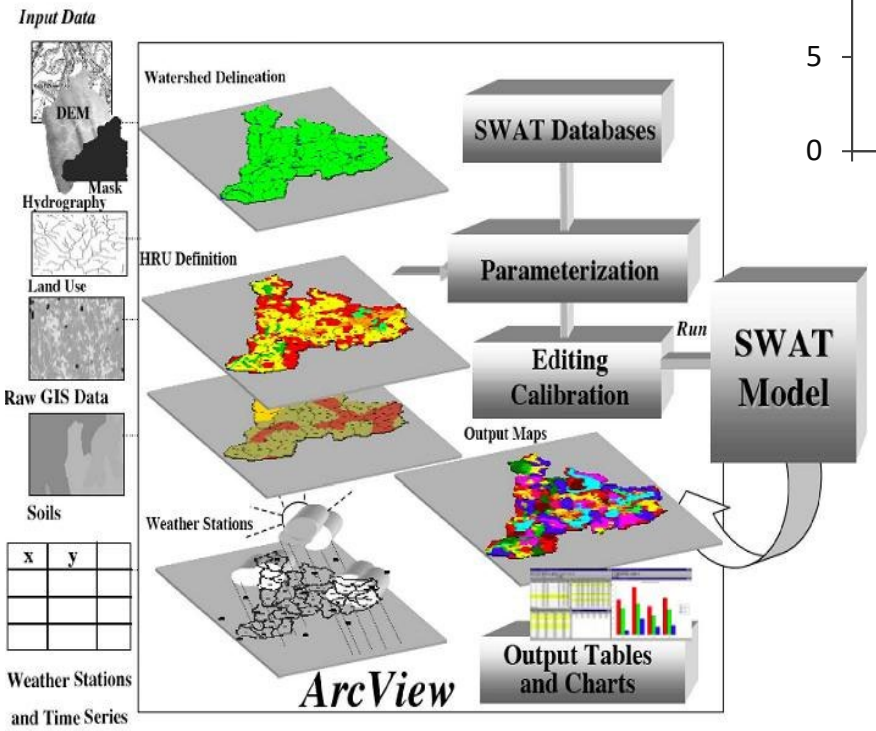


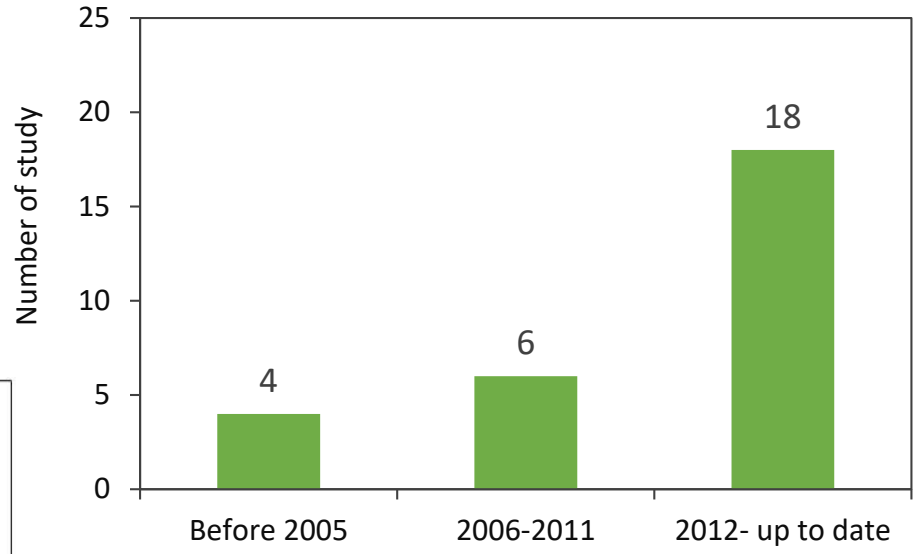


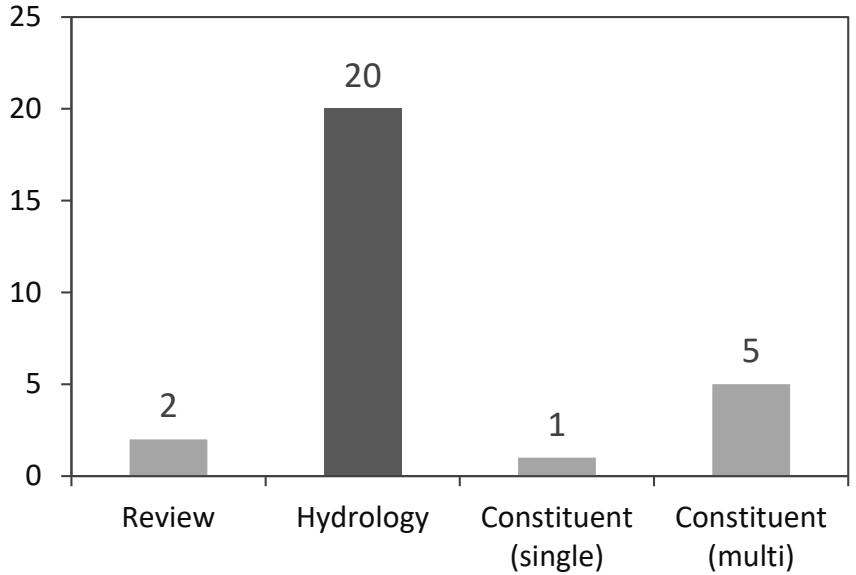
INTRODUCTION

Soil and Water Assessment Tool – SWAT

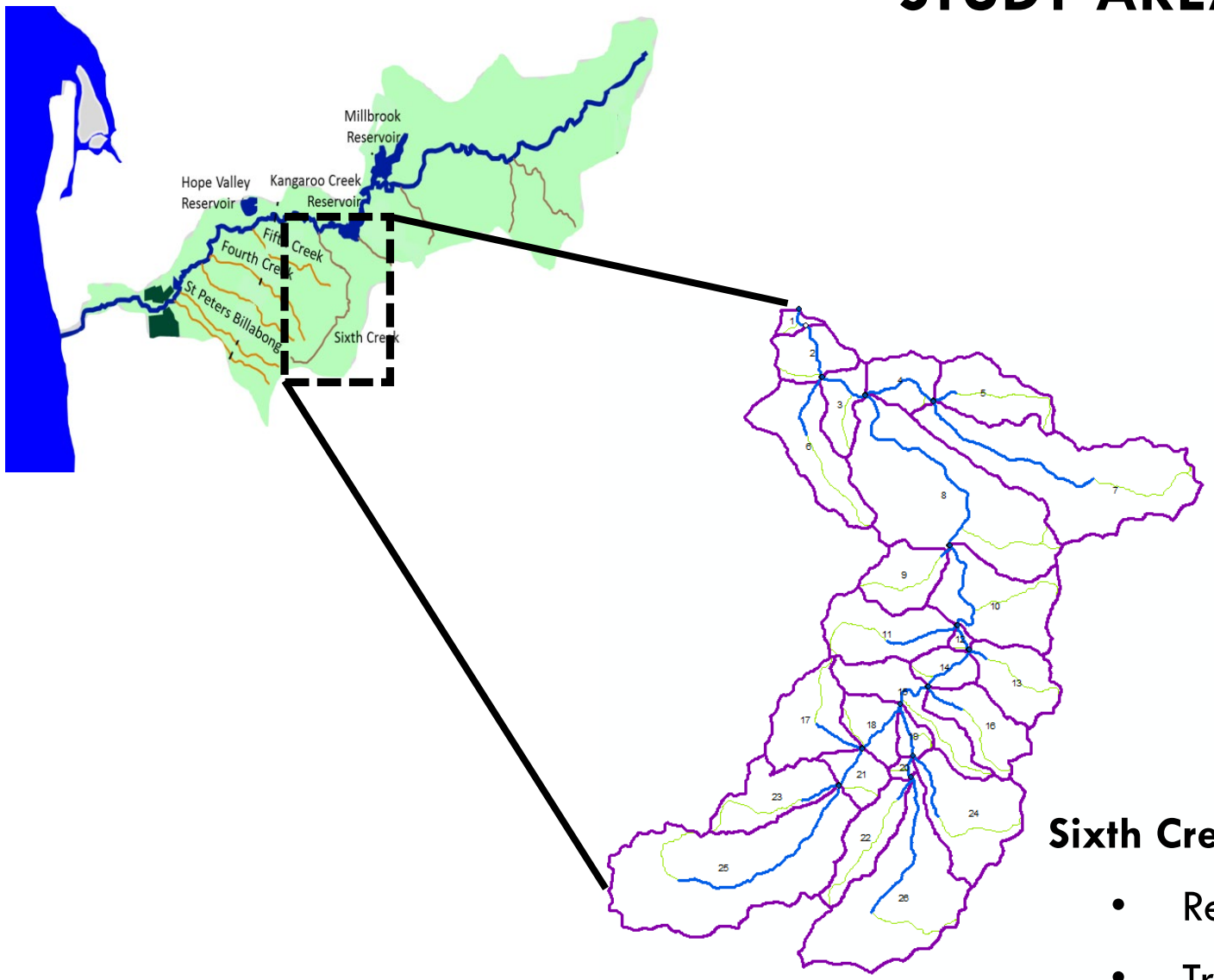
Approx. 40 studies published in Australia







STUDY AREA

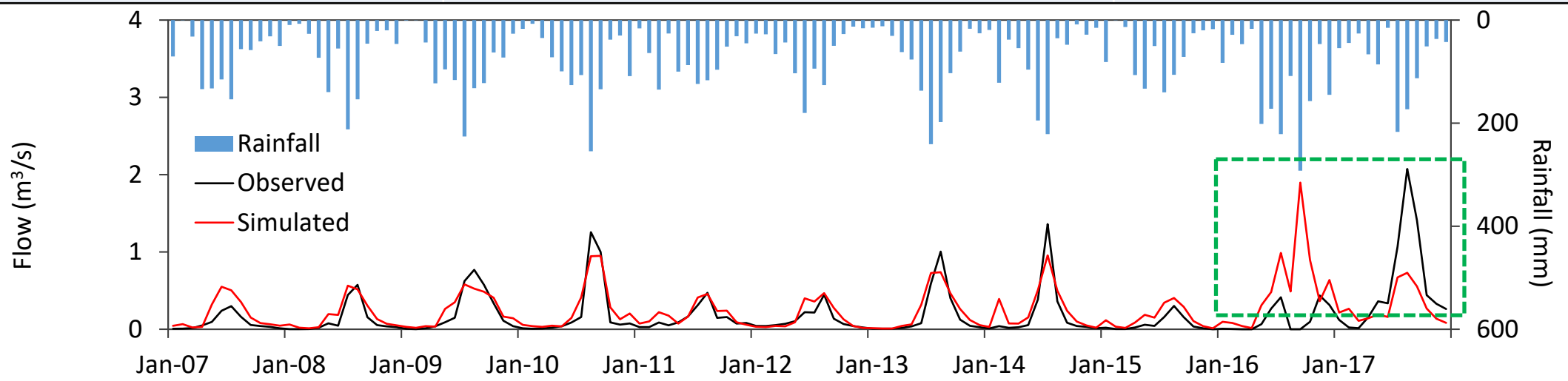


Sixth Creek:

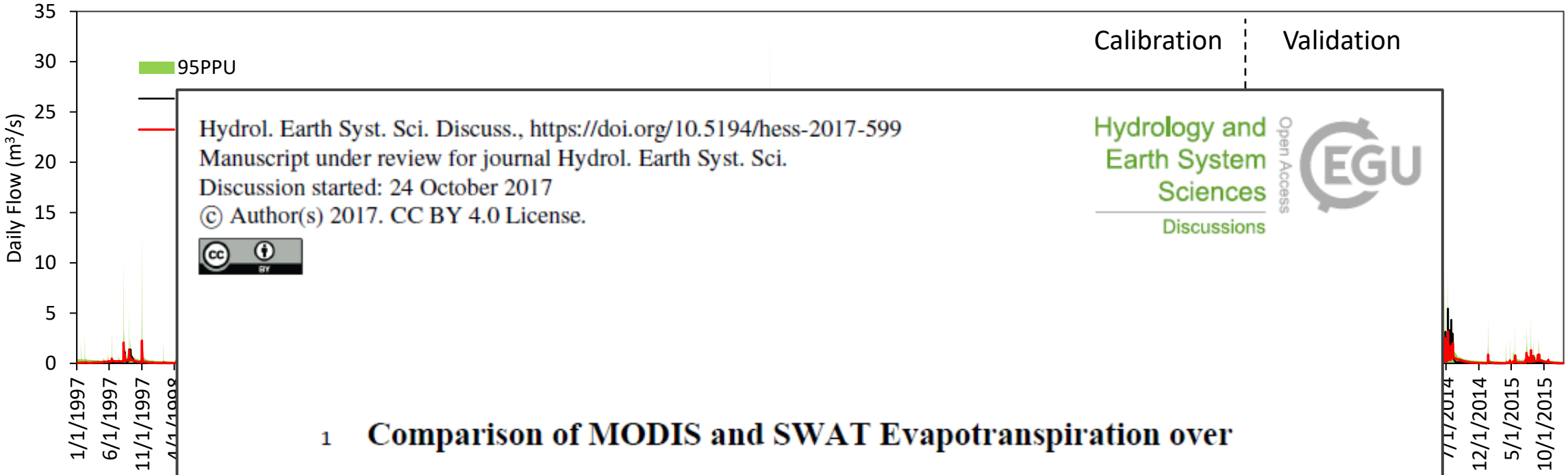
- Relatively small catchment area (42,35 km^2)
- Transition between Upper Torrens and Urban Torrens
- Diverse land-use and climate conditions
- Least disturbed stream condition

MODEL INPUTS

Model inputs	SWAT	SOURCE
DEM	• Contour interpolated 10m x 10 m	• Subbasin.ascii • Nodes.shp • Link.shp
Land-use (2016)	• Land-use raster 10m x 10m • Land-use.dbf	• Landuse.ascii
Soil	• Soil raster 10m x 10m • Soil.txt	• -
Climate data (SILO)	• Rain.txt • Tem.txt • Slr.txt • Rlh.txt	• Rain.csv • PET.csv



MODEL CALIBRATION: STREAMFLOW



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Discussion started: 24 October 2017

Hydrology and Earth System Sciences
Discussions
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1 **Comparison of MODIS and SWAT Evapotranspiration over**

2 **a Complex Terrain at Different Spatial Scales**

3 Olanrewaju O Abiodun[1], Huade Guan[1], Vincent E.A. Post[1], Okke Batelaan[1]

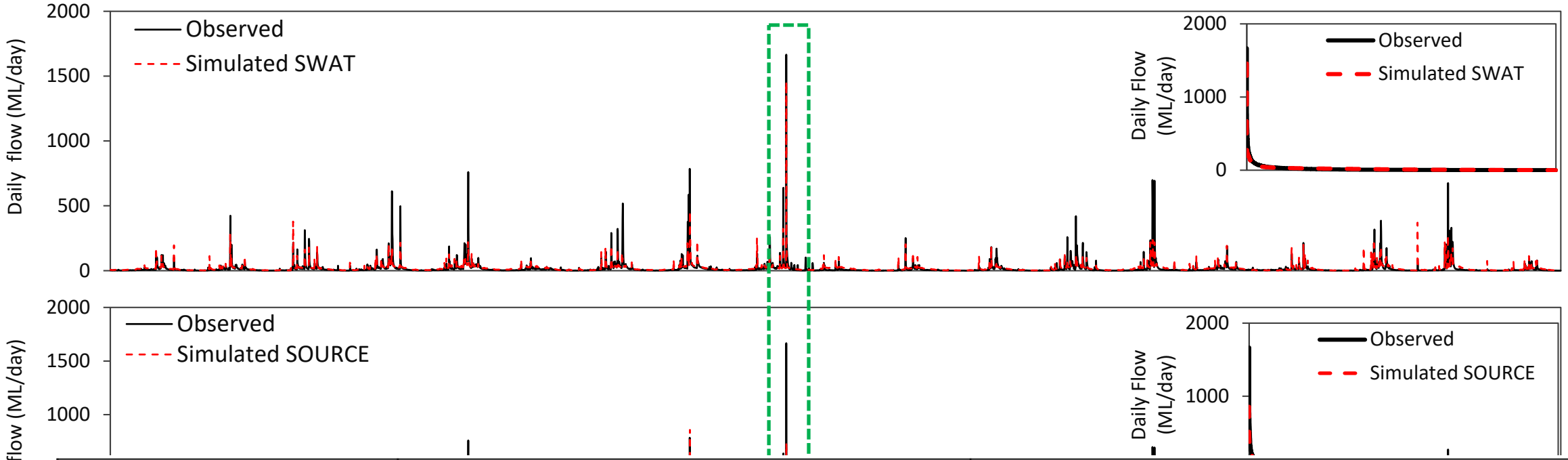
4

5 [1]National Centre for Groundwater Research and Training, College of Science and Engineering, Flinders

6 University, Australia

NSE	0.63	0.61
PBIAS	-11.7	-19.6

MODEL CALIBRATION: STREAMFLOW



	Calibration		Validation	
	SWAT	SOURCE	SWAT	SOURCE
Imported PET (from SILO)				
R^2	0.66	0.86	0.69	0.91
NSE	0.66	0.74	0.66	0.82
PBIAS	-2.1	-0.74	-15.7	15.5
Estimated PET (from SWAT)				
R^2	0.66	0.87	0.61	0.91
NSE	0.63	0.74	0.61	0.78
PBIAS	-11.7	16.7	-19.6	36.5

MODEL CALIBRATION: STREAMFLOW

Sensitive parameters for calibration and validation using SUFI2 model (SWAT) and SCE then Rosenbrock (SOURCE)

Parameters	Default	Fitted value	t-Stat	P-Value
SWAT				
CN2.mgt	[-0.3, 0.3]	-0.11	-16.82	0.00
CH_K2.rte	[0, 100]	66.30	9.89	0.00
CH_N2.rte	[0, 0.3]	0.14	6.94	0.00
ALPHA_BNK.rte	[0.1, 1]	0.96	-2.24	0.03
ESCO.hru	[0.7, 1]	0.84	-1.97	0.05
SOL_AWC(1, 2).sol	[-0.2, 0.2]	0.08	1.95	0.05
REVAPMN.gw	[0, 500]	357.50	-1.91	0.06
GW_DELAY.gw	[0, 500]	472.50	-1.62	0.11
RCHRG_DP.gw	[0, 0.4]	0.08	-1.56	0.12
SOL_K(1, 2).sol	[-0.2, 0.2]	-0.15	1.51	0.13
GW_REVAP.gw	[0.05, 0.2]	0.19	1.31	0.19
ALPHA_BF.gw	[0.1, 1]	0.80	-0.95	0.34

Parameter	Description	Default	Forest	Non-Forest
SOURCE				
x1	Capacity of the production soil store	[1, 1500]	596.62	213.41
x2	Water exchange coefficient	[-10.0, 5.0]	-3.74	-4.60
x3	Capacity of the routing store	[1, 500]	61.79	38.57
x4	Time parameter for unit hydrographs	[0.5, 4.0]	0.76	1.61

MODEL CALIBRATION: TSS, TN, AND TP LOADS

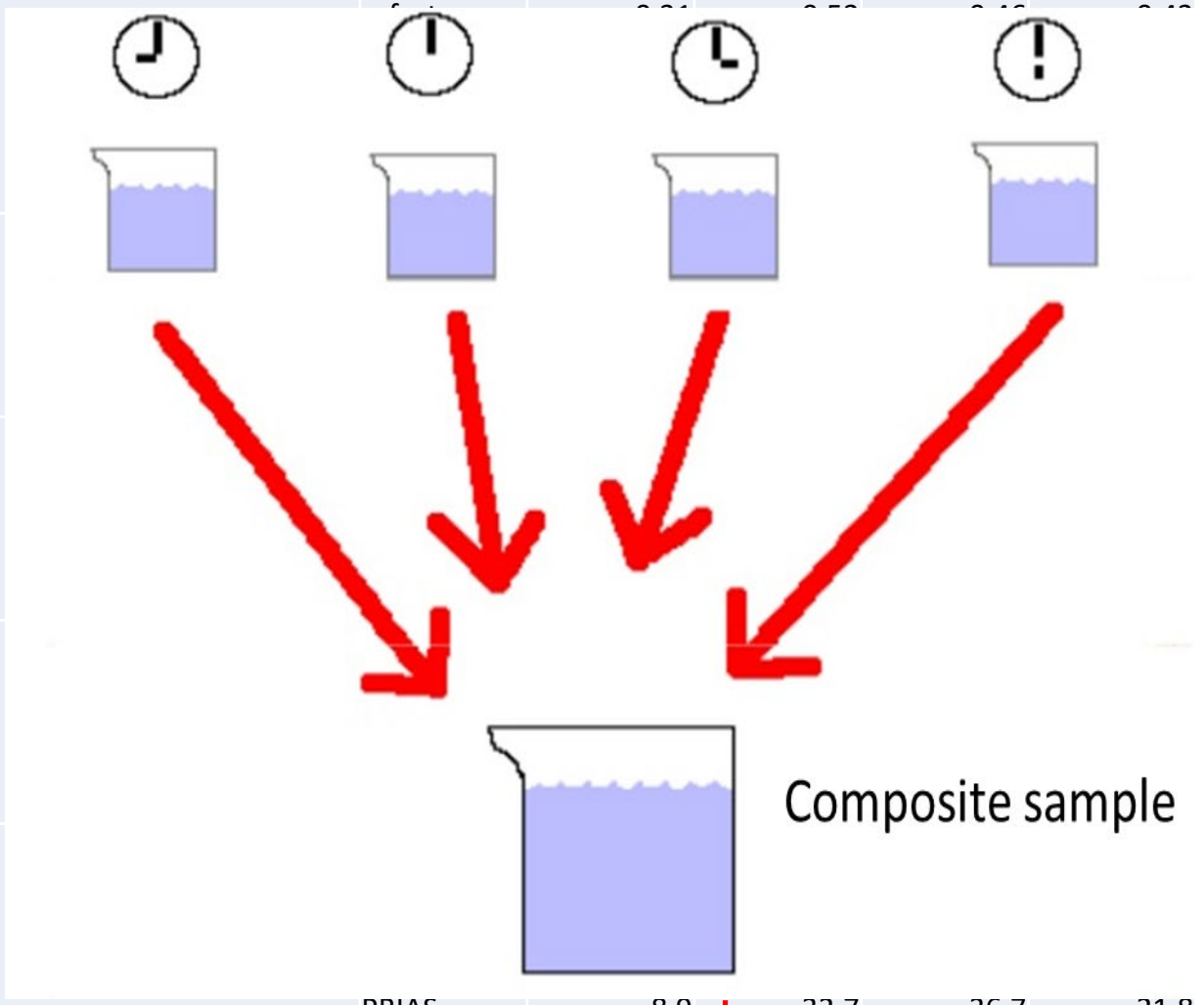
SWAT

Daily calibration	Flow	TSS	TN	TP
p-factor	0.62	0.1	0.7	0.1
r-factor	1.28	0.06	3.48	0.17
R^2	0.64	0.36	0.63	0.45
NSE	0.59	0.35	0.6	0.44
PBIAS	-18.9	47.6	2.2	35.4

Daily validation	Flow	TSS	TN	TP
p-factor	0.58	0.07	0.70	0.08
r-factor	1.26	0.10	2.65	0.11
R^2	0.61	0.18	0.50	0.33
NSE	0.61	0.17	0.47	0.31
PBIAS	-20.1	68.5	-39.5	57.5

Shrestha et al. (2016) Assessing SWAT models based on single and multi-site calibration for the simulation of flow and nutrient loads in the semi-arid Onkaparinga catchment in SA

Monthly calibration		Flow	TSS	TN	TP
	PBIAS	-8.9	-32.7	36.7	21.8



MODEL CALIBRATION: TSS, TN, AND TP LOADS

Daily calibration (2007-2011)

SWAT	Flow	TSS	TN	TP
R^2	0.64	0.36	0.63	0.45
NSE	0.59	0.35	0.6	0.44
PBIAS	-18.9	47.6	2.2	35.4

SOURCE	Flow	TSS	TN	TP
R^2	0.86	0.42	0.63	0.51
NSE	0.74	0.35	0.56	0.50
PBIAS	-0.74	2.5	-27.1	-38.8

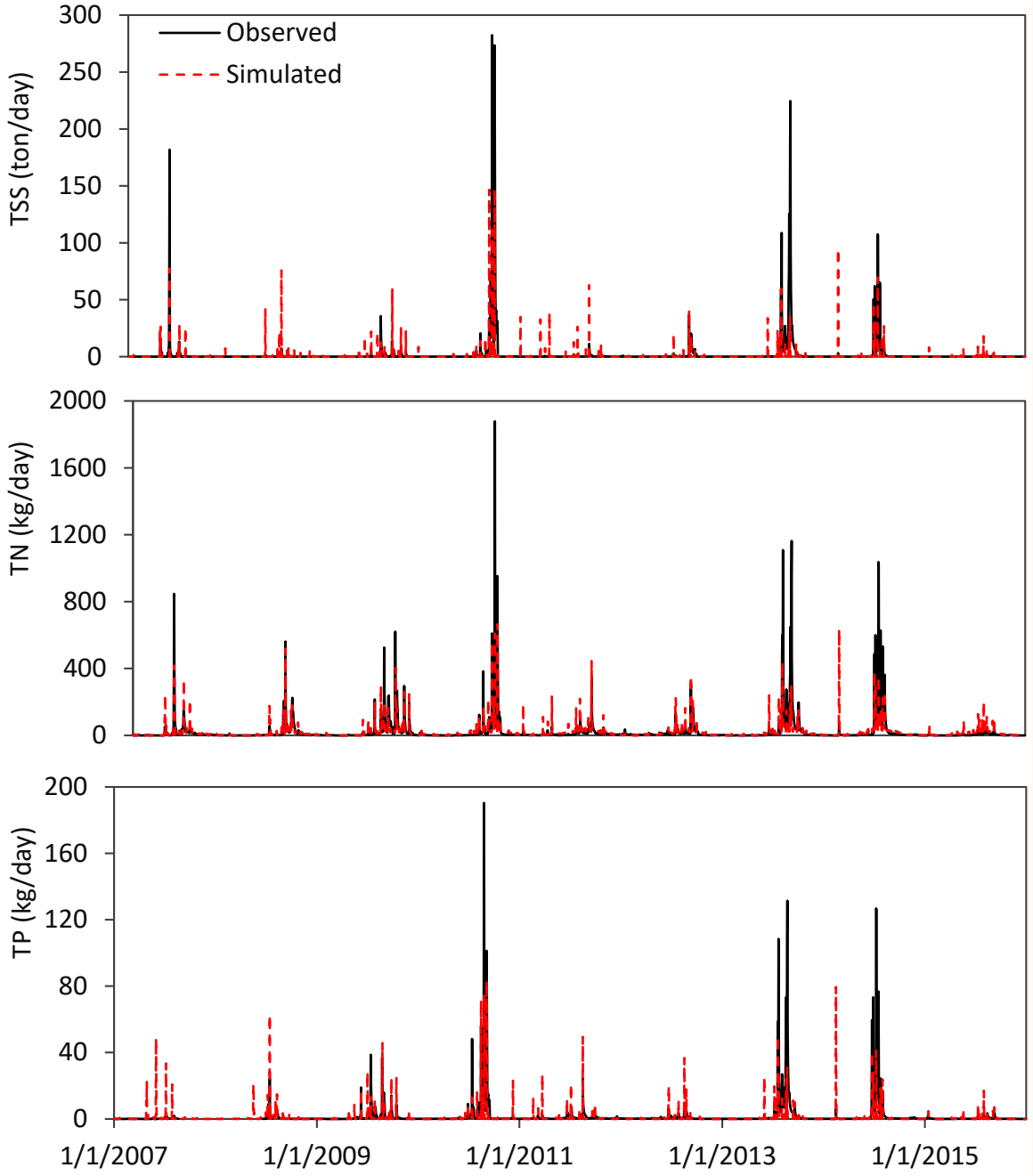
Daily validation (2012 – 2015)

SWAT	Flow	TSS	TN	TP
R^2	0.61	0.18	0.50	0.33
NSE	0.61	0.17	0.47	0.31
PBIAS	-20.1	68.5	-39.5	57.5

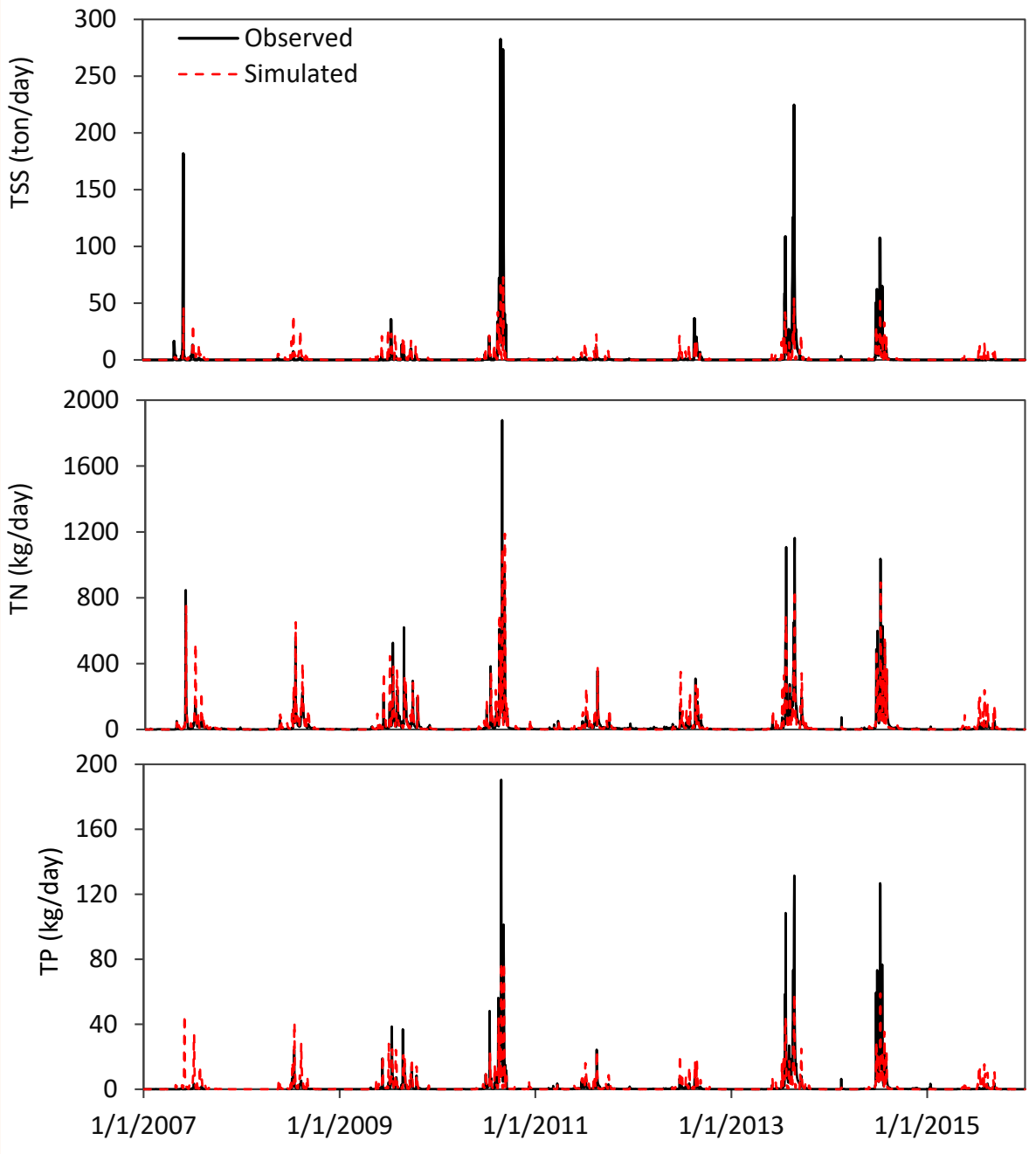
SOURCE	Flow	TSS	TN	TP
R^2	0.91	0.53	0.70	0.62
NSE	0.82	0.41	0.70	0.55
PBIAS	15.5	33.3	-6.6	19.3

MODEL CALIBRATION: TSS, TN, AND TP LOADS

SWAT outputs

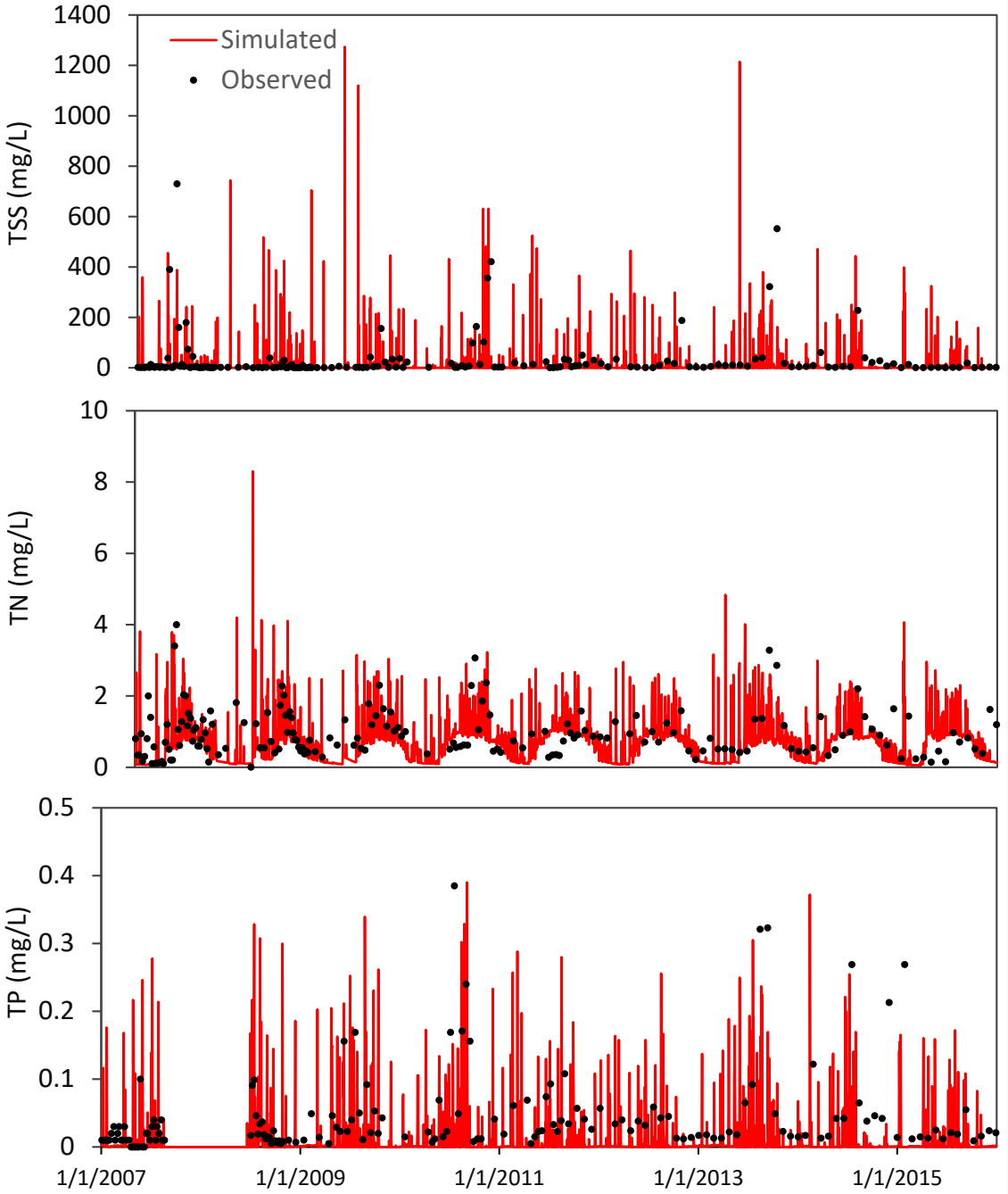


SOURCE outputs

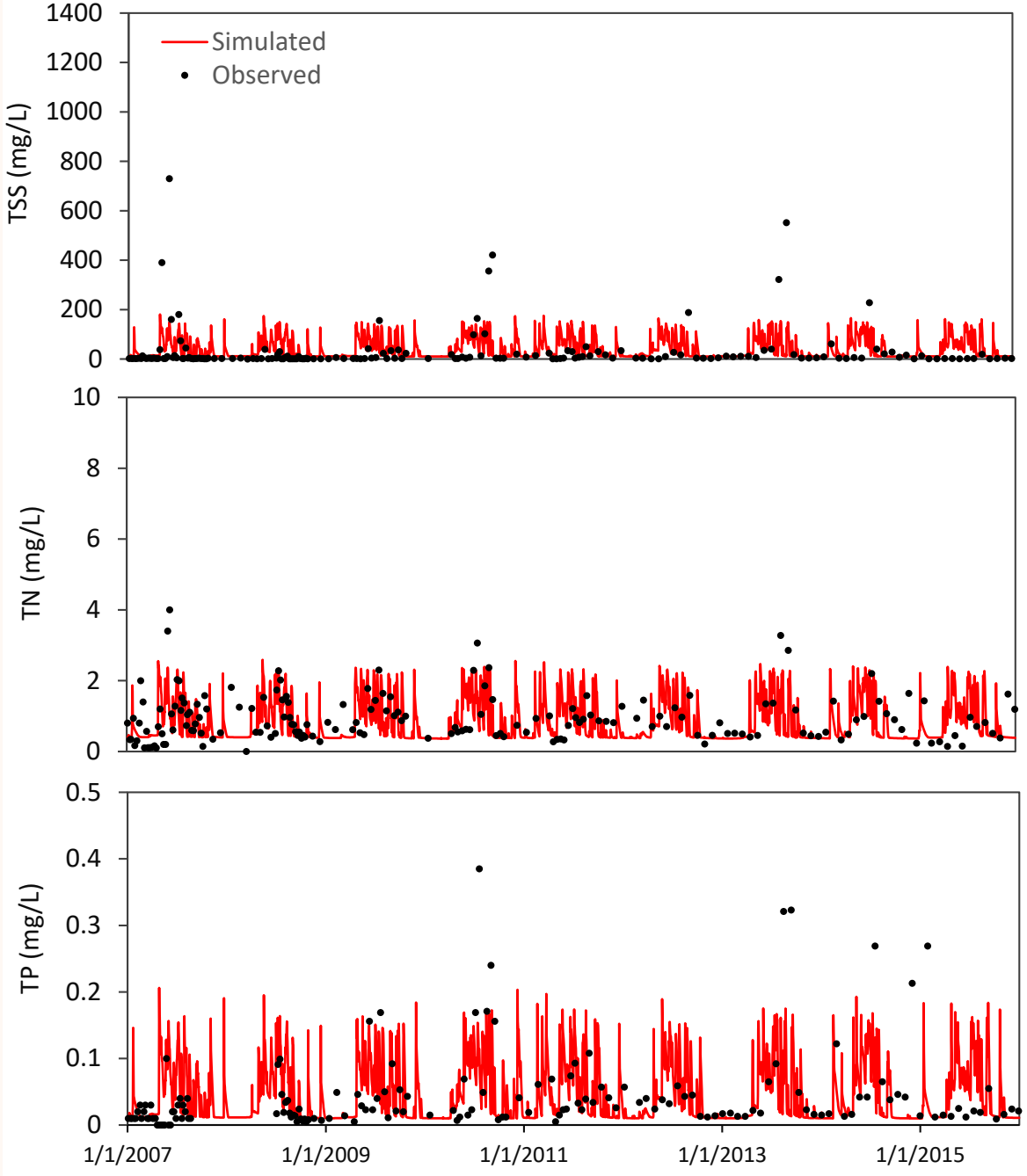


MODEL CALIBRATION: TSS, TN, AND TP CONCENTRATIONS

SWAT outputs



SOURCE outputs



MODEL CALIBRATION: TSS, TN, AND TP CONCENTRATIONS

Parameters for SOURCE constituent calibration using Event Mean Concentration/Dry Mean Concentration method*

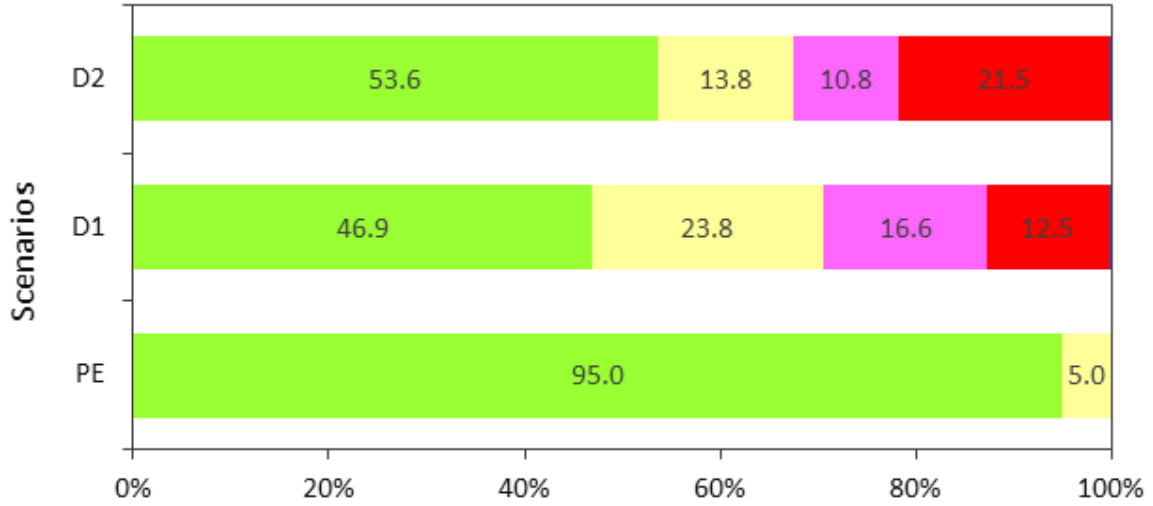
	TSS		TN		TP	
Land-use category	EMC	DMC	EMC	DMC	EMC	DMC
Dense urban	61-140	14-16	1.8-2.0	1.3-1.5	0.1-0.25	0.08-0.14
Forest	40-66	6-23	0.9-2.1	0.3-1.0	0.08-0.16	0.03-0.11
Grazing	140-184	12-20	2.1-3.0	0.8-1.1	0.24-0.6	0.09-0.23
Horticulture	140-308	20-21	3.0-5.3	1.1-3.4	0.6-0.93	0.03-0.34
Rural living	90-131	10-14	1.6-2.0	0.7-0.9	0.13-0.22	0.04-0.06
Utilities	40-140	12-16	1.3-2.0	1.3-1.3	0.12-0.25	0.07-0.14

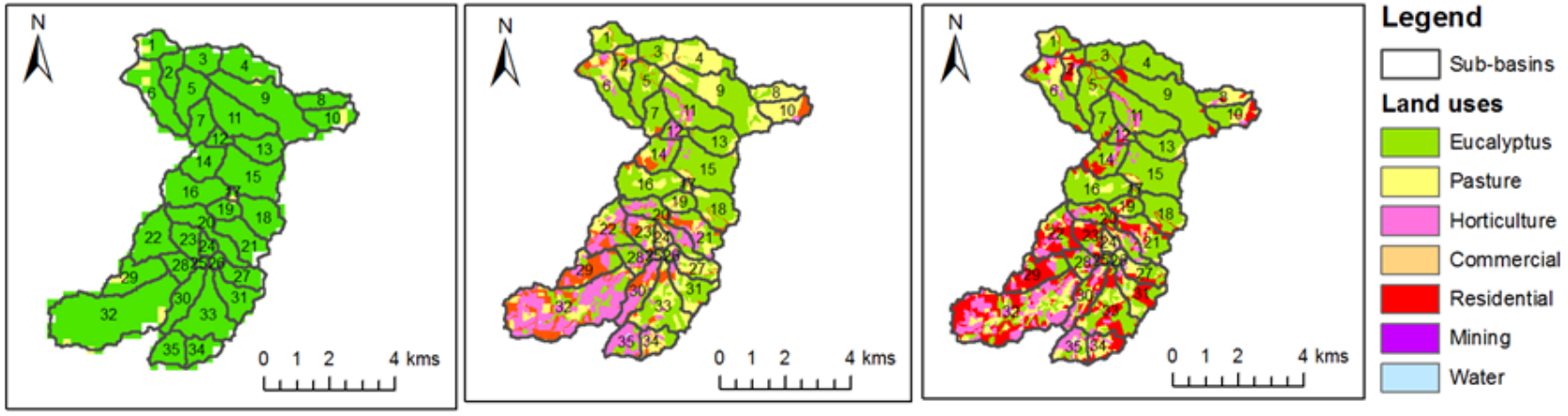
** Source: Fleming et al. (2010); Fetcher (2004)*

SCENARIO OF LAND USE CHANGE

Effects of land use intensification on hydrology at the catchment/sub-basin scale:

- PE- Pristine/Reference environment (Land use 2000, source: DLDC database Geoscience Australia)
- D1- Agricultural intensification (Land use 2007, source: SA Water)
- D2 – Urbanization and Forest restoration (Land use 2016, source: EPA)

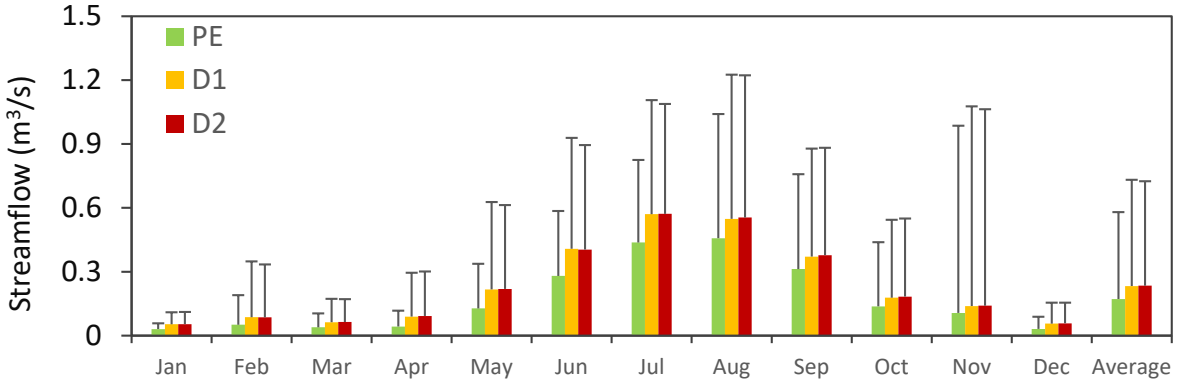


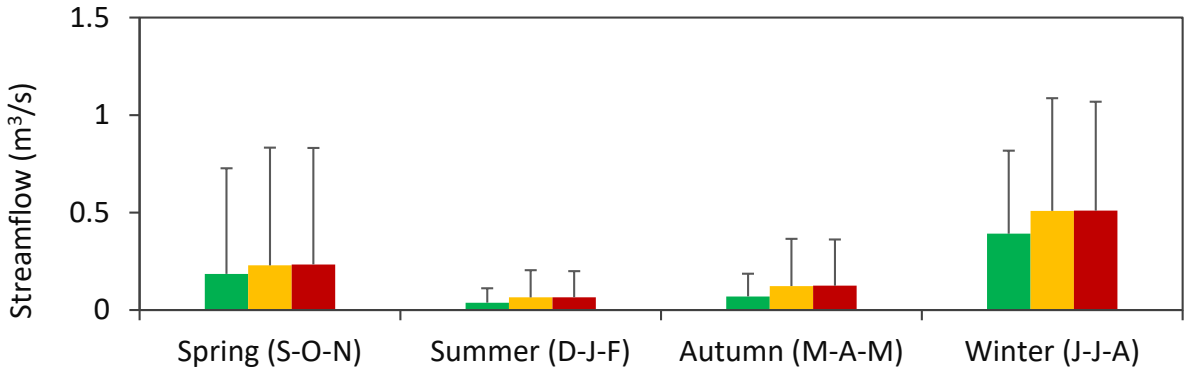


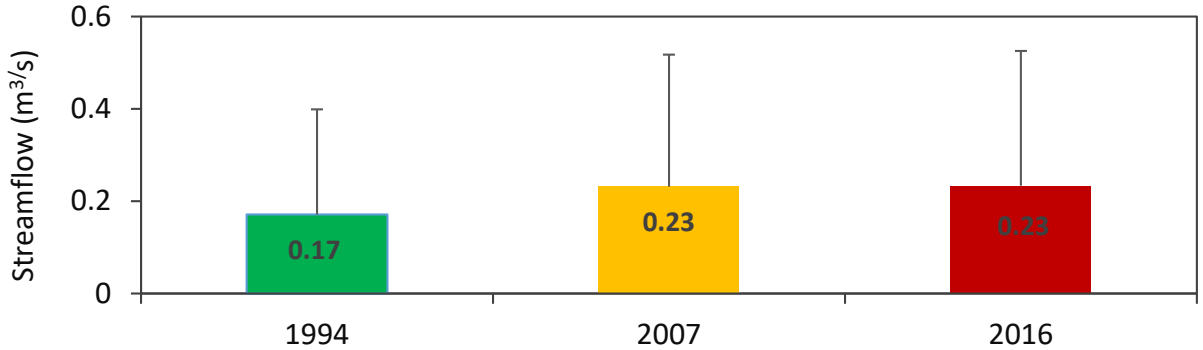
Effects of land use intensification on catchment hydrology:

- Temporal scale

SWAT

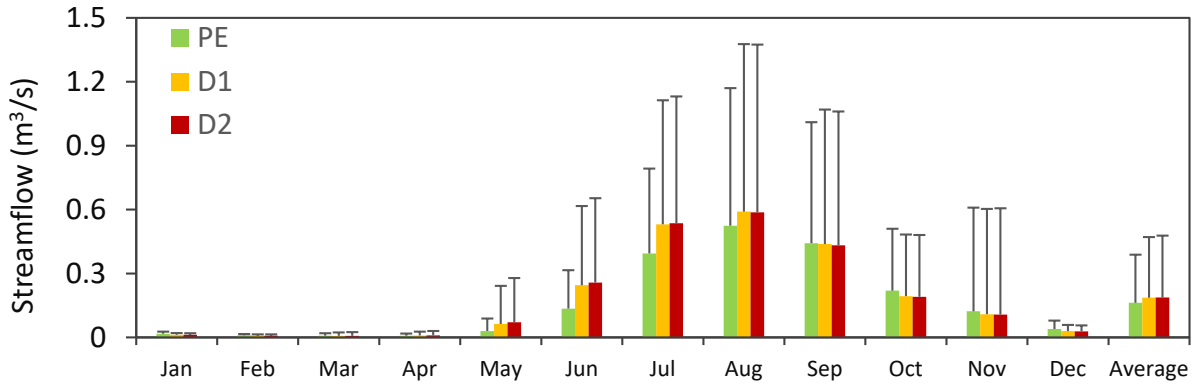




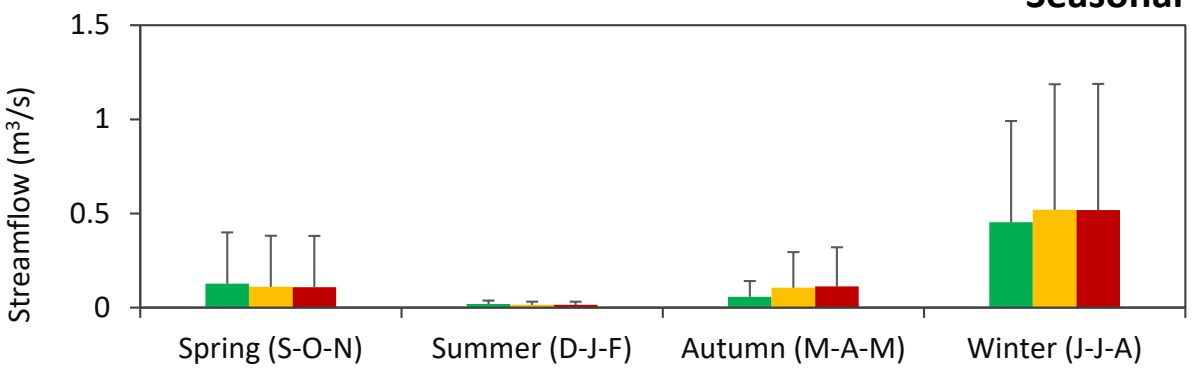


SOURCE

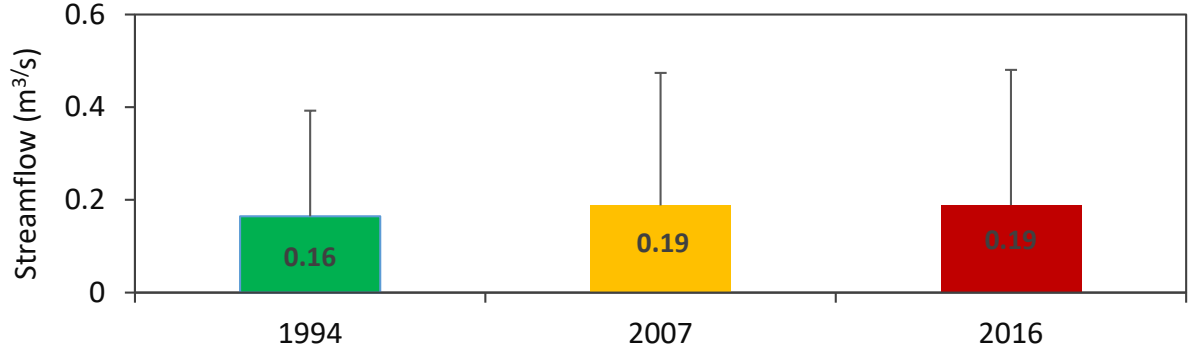
Monthly



Seasonal



Annual

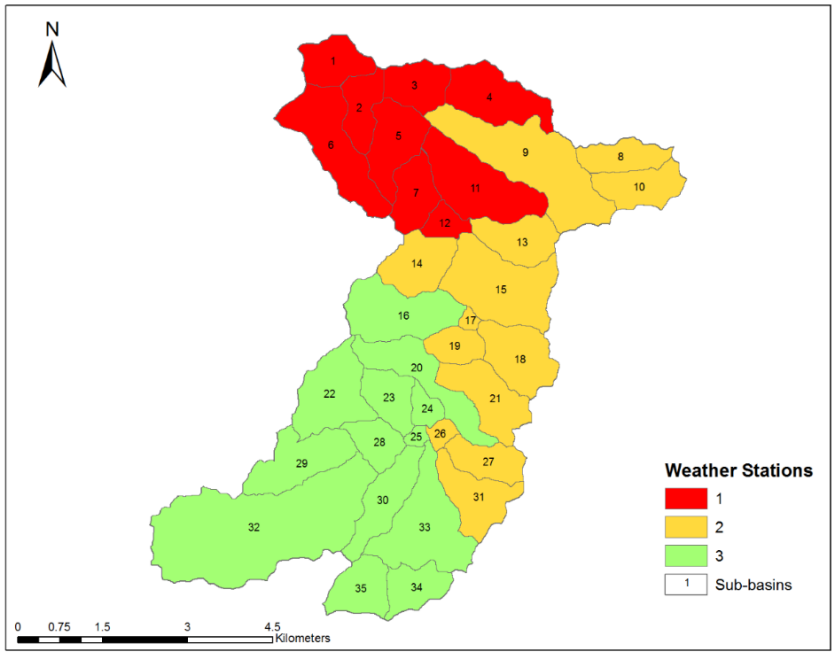


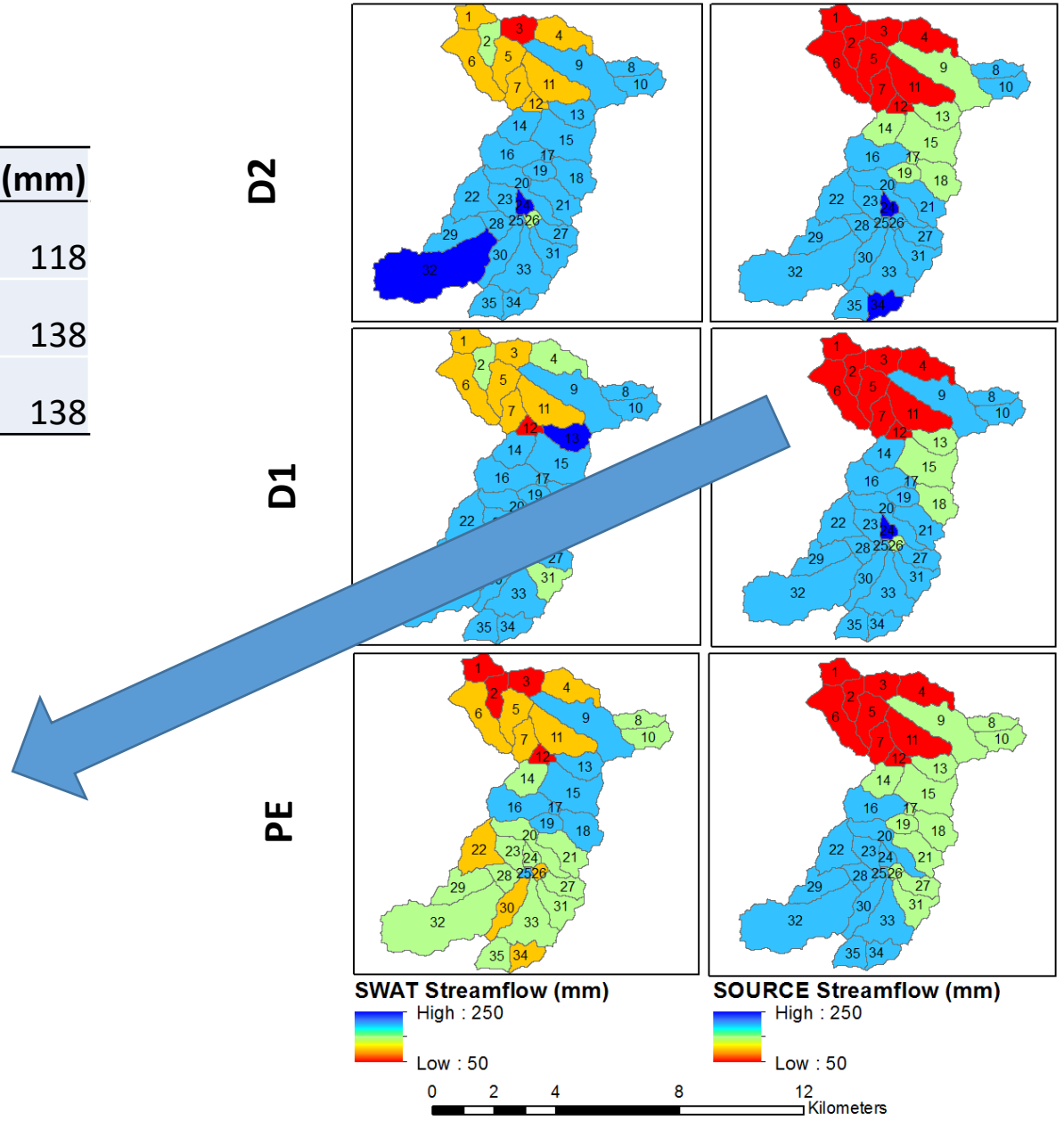
SCENARIO OF LAND USE CHANGE

Effects of land use intensification on catchment hydrology:

- Spatial scale

Scenarios	SWAT (mm)	SOURCE (mm)
PE (95% Forest)	118	118
D1 (Agricultural intensification)	155	138
D2 (Urbanization+ Re-forestation)	156	138





SCENARIO OF LAND USE CHANGE

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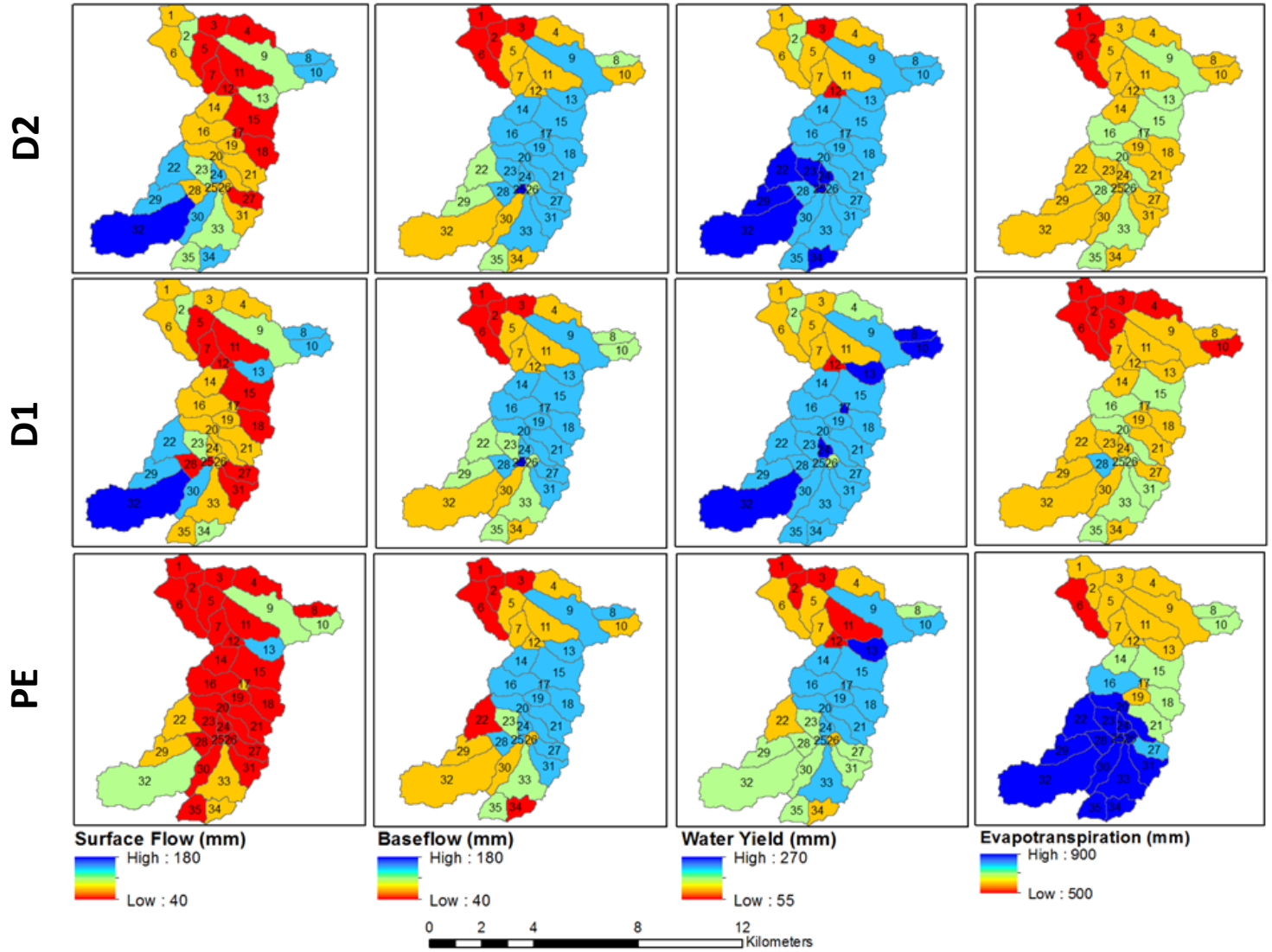
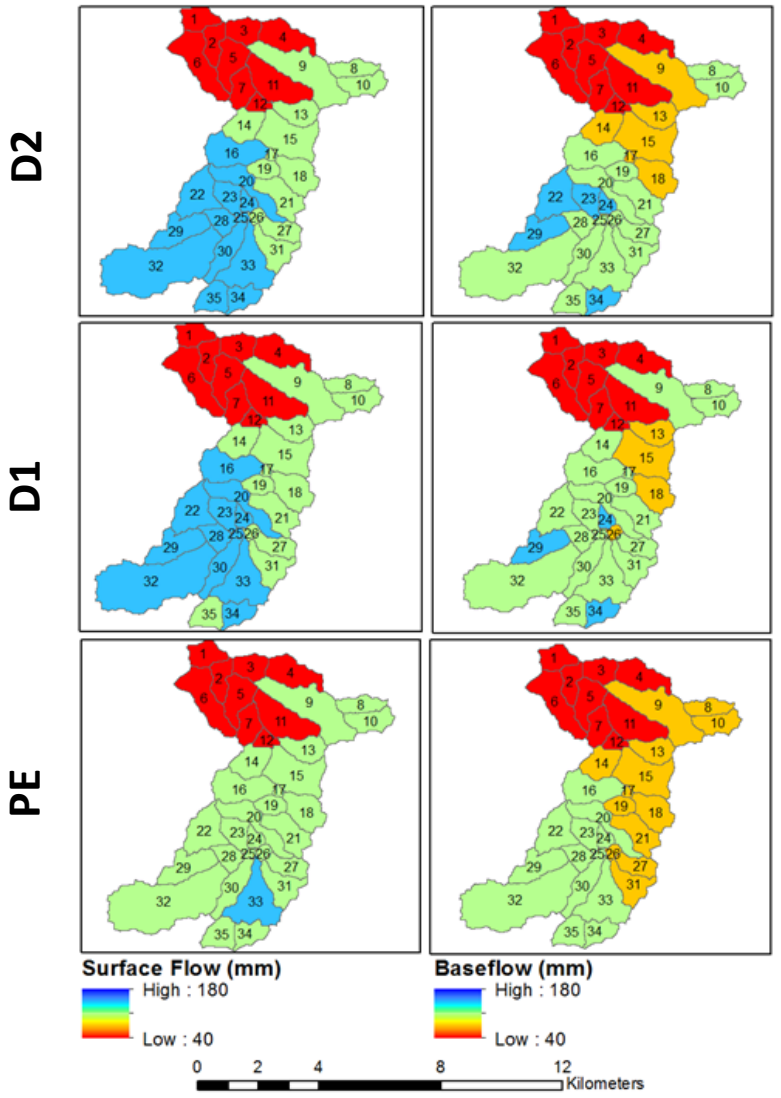


SWAT outputs



SOURCE outputs

CONCLUSION

- Both model provided relatively good results on daily calibration and validation of run-off and constituent loads
- SOURCE model performed better than SWAT model, except a case of extreme high event flow
- SWAT model estimated constituent concentrations with higher accuracy compared to SOURCE
- Results of scenarios of land-use change impact on streamflow is comparable between SWAT and SOURCE

- Future study:

  (1) address the impacts of land-use change on constituent loads using SWAT and SOURCE

  (2) apply the approach using two models to the large scale area

  (3) integrate SWAT/SOURCE models with lake models