Hydrologic Modeling of White Rock Creek Watershed with SWAT-SWMM

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Introduction

Soil and Water Assessment Tool (SWAT)

- SWAT has been developed to evaluate impacts of various Land use and land management conditions on water yield, sediment and non-point source loadings.
- Components : hydrology, weather, erosion, plant growth, nutrients, pesticides, land management, stream routing.

- SWAT is not able to treat urban drainage system.

Introduction

Storm Water Management Model (SWMM)

- SWMM is capable of both single-event and continuous simulation for runoff and water quality processes within an urban catchment.
- Routing process through a system of pipes, channels, storage/treatment devices, pumps, and regulators can be simulated.

- SWMM has a difficulty in accounting for land cover types other than urban.

Introduction

Integrated SWAT-SWMM model

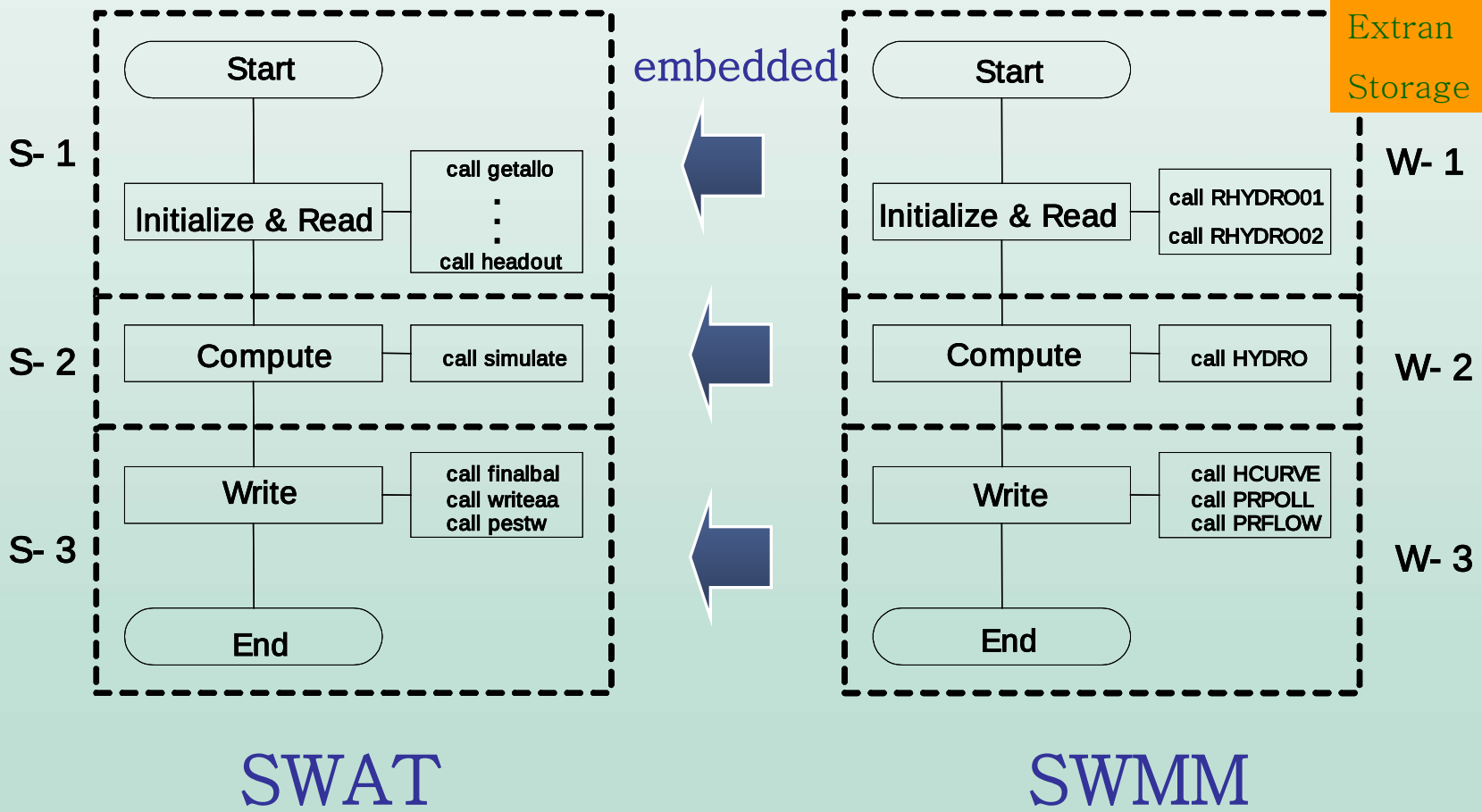
- Comprehensive hydrological model is required to better represent characteristics of both urban and rural areas.
- SWAT-SWMM has been developed in order to overcome the aforementioned shortcomings of SWAT and SWMM.

- Main aims of the presentation
  - To explain how to integrate SWAT and SWMM
  - To illustrate some simulated results for the White Rock Creek watershed in USA

Model Development

Integration of SWAT and Runoff Block of SWMM

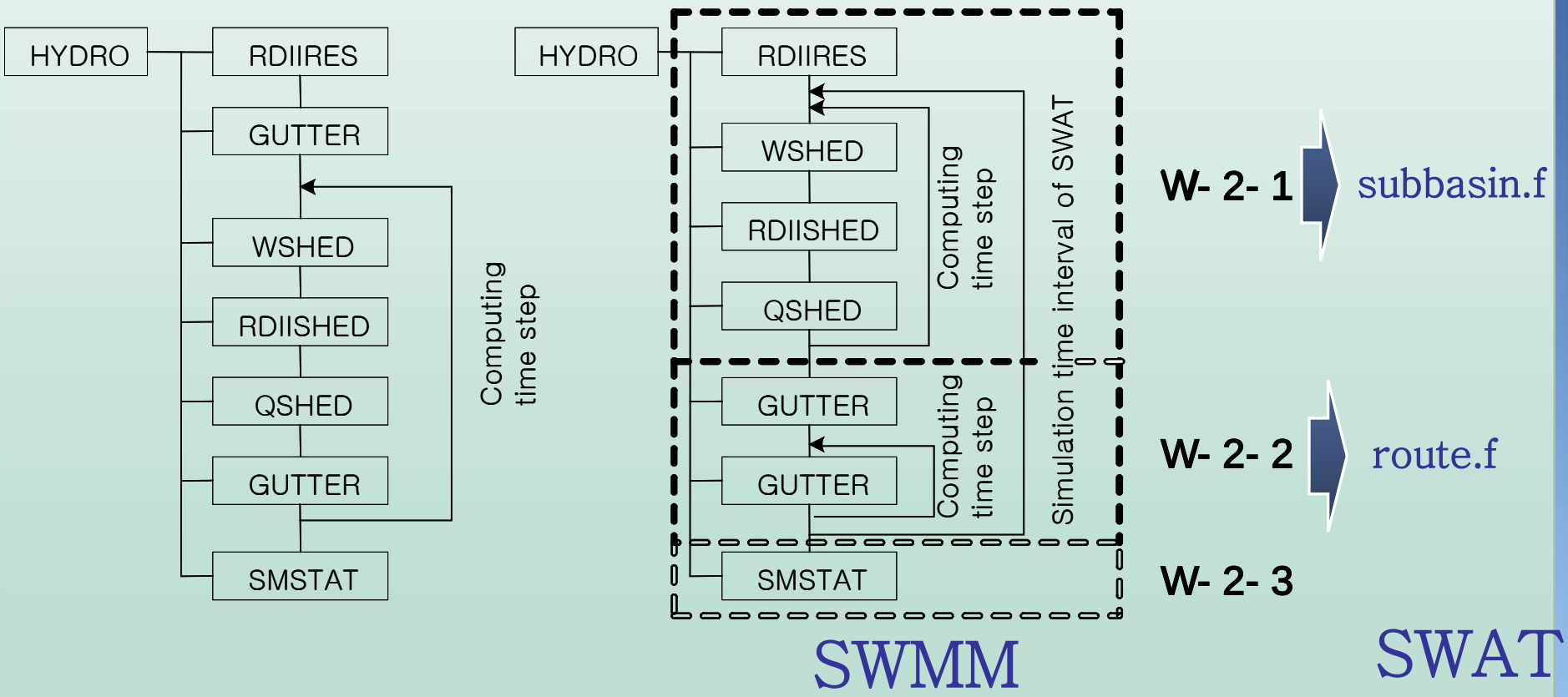
Runoff
Transport
Extran
Storage Treatm



Model Development

Integration of SWAT and Runoff Block of SWMM

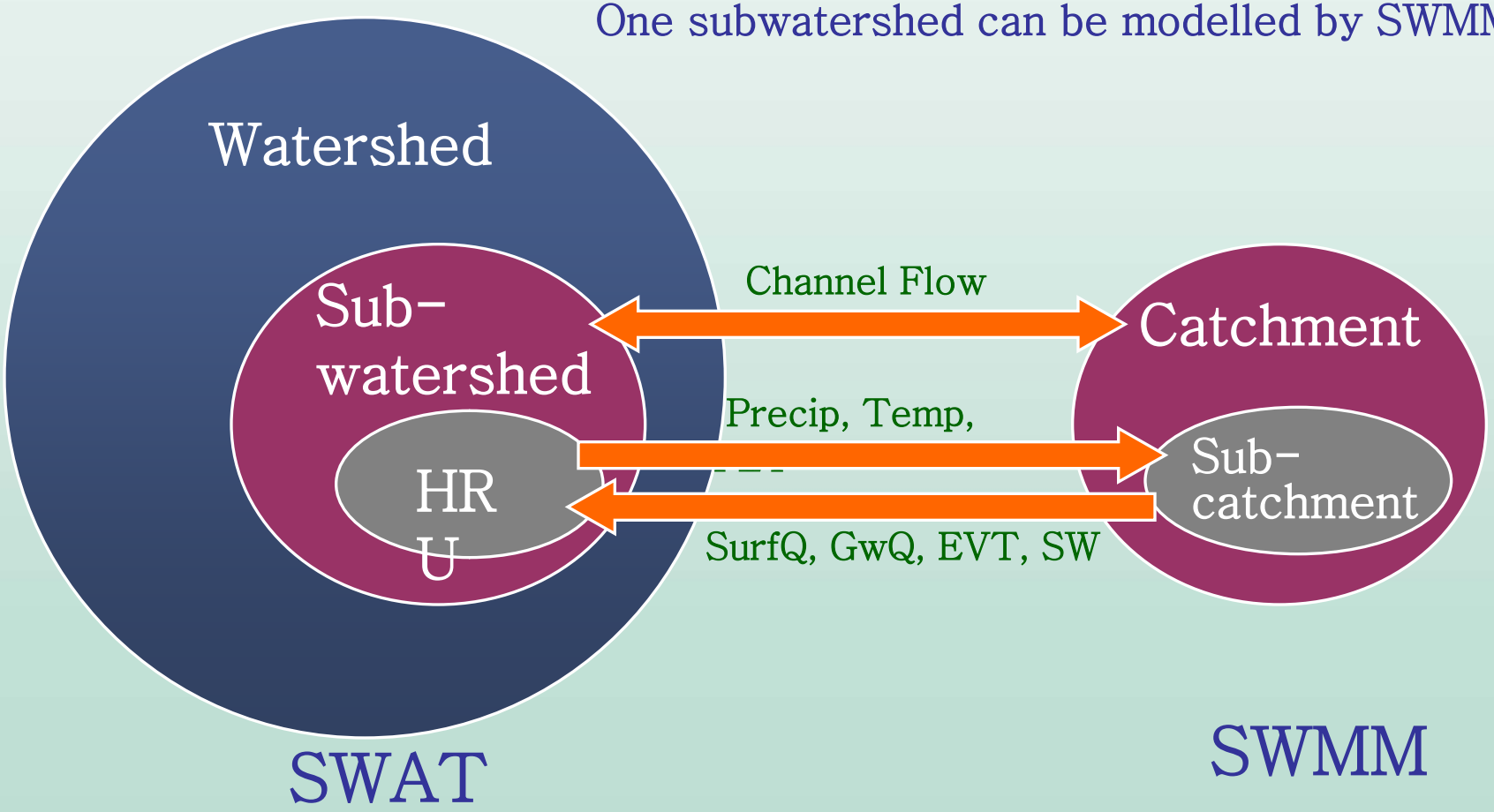
Separate "hydro" into land phase routing part and channel/pipe routing part



Model Development

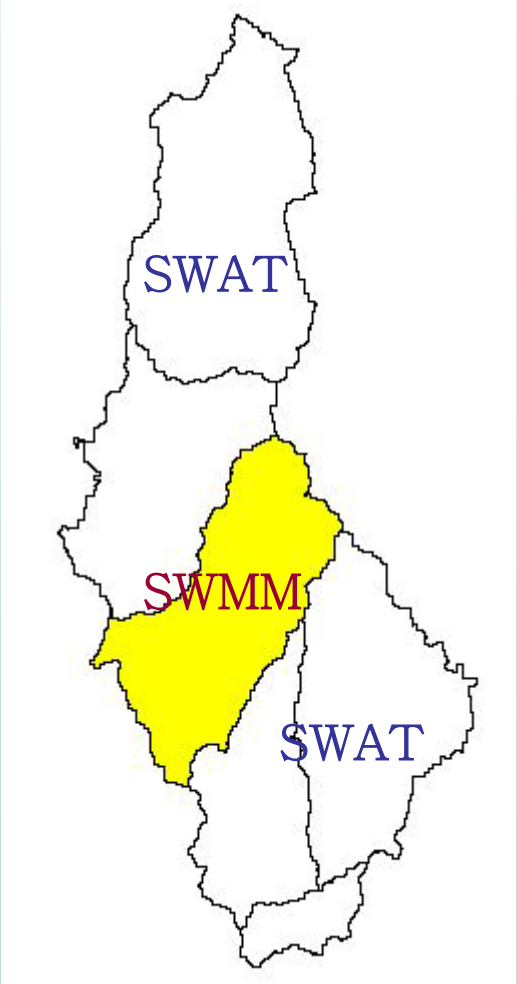
Linking Subwatershed of SWAT and Catchment of SWMM

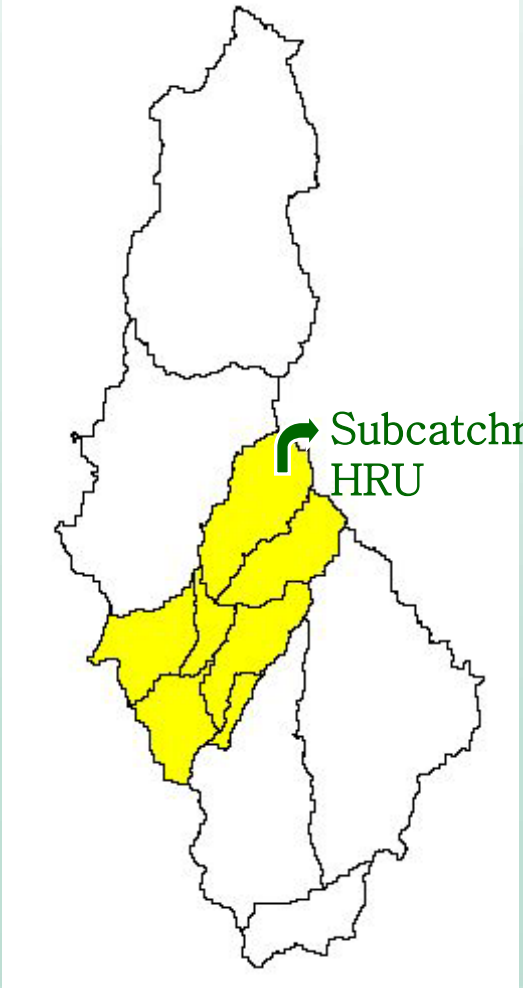
One subwatershed can be modelled by SWMM



Model Development

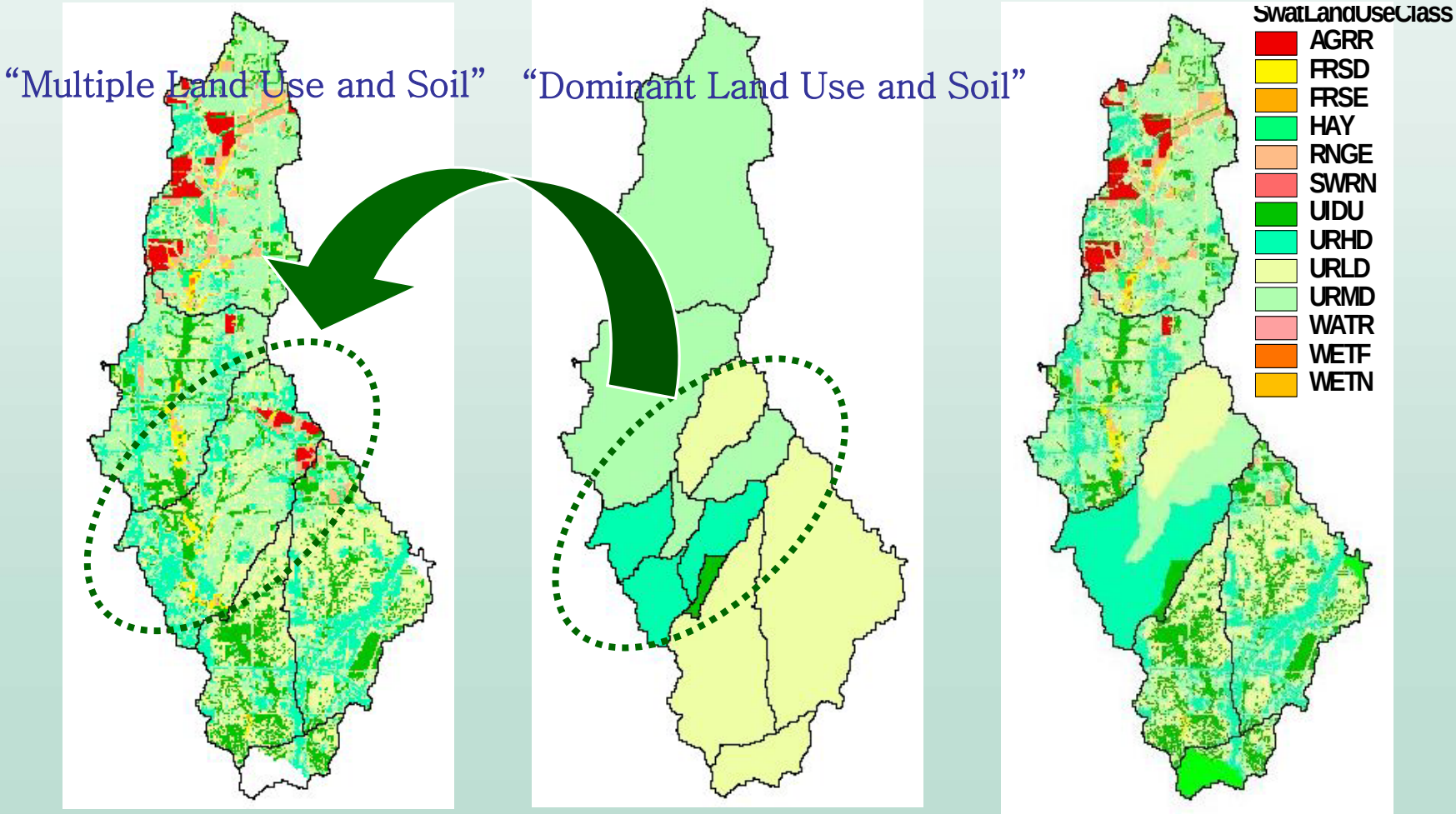
Linking HRU of SWAT and Subcatchment of SWMM





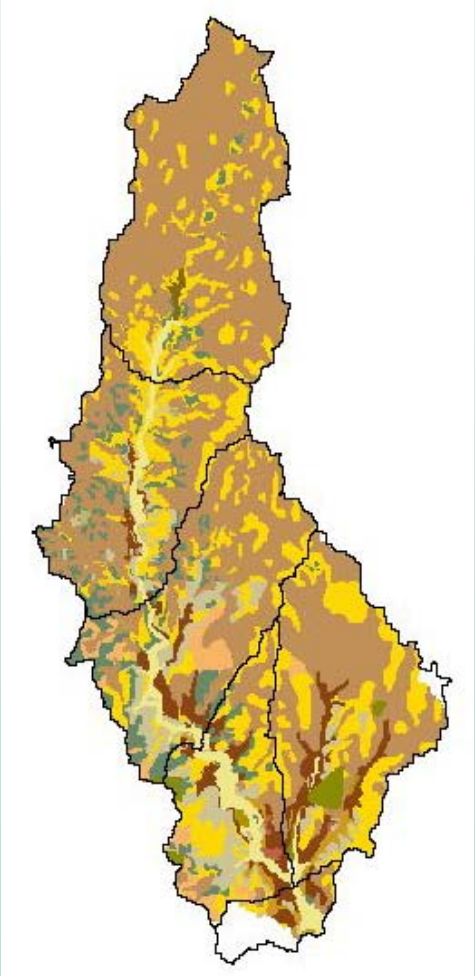
Model Development

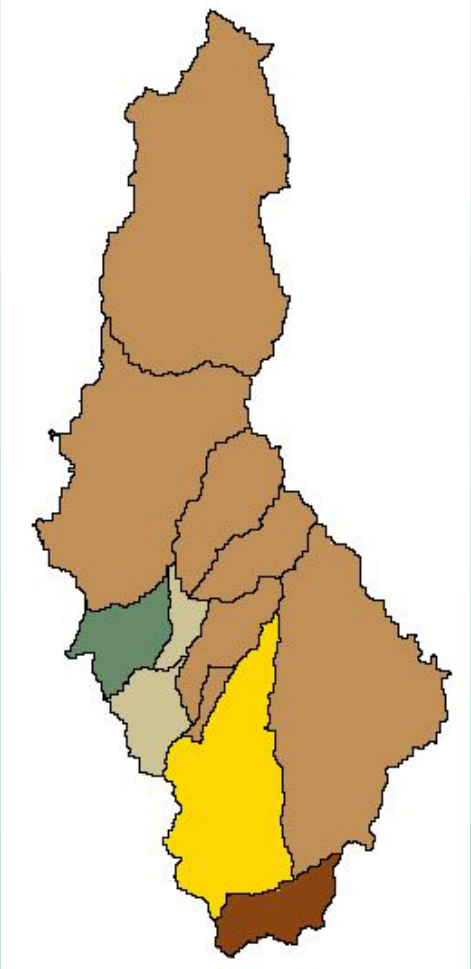
Linking HRU of SWAT to Subcatchment of SWMM

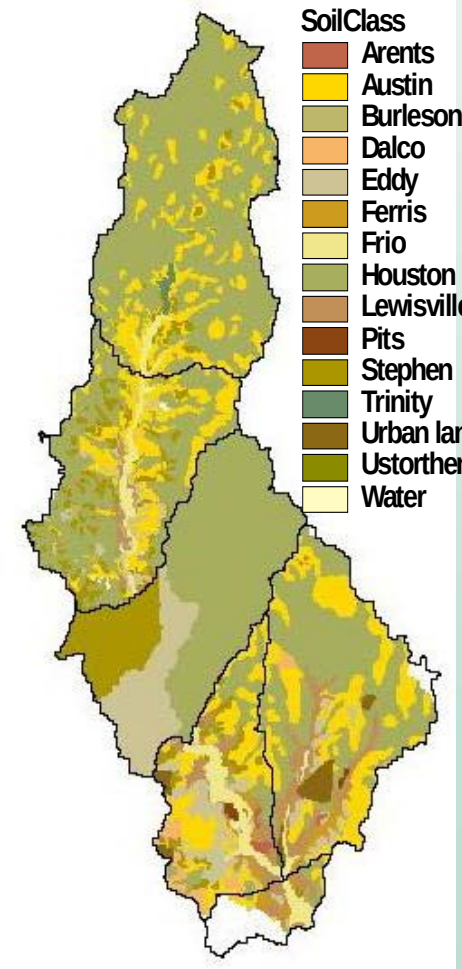


Model Development

Linking HRU of SWAT to Subcatchment of SWMM

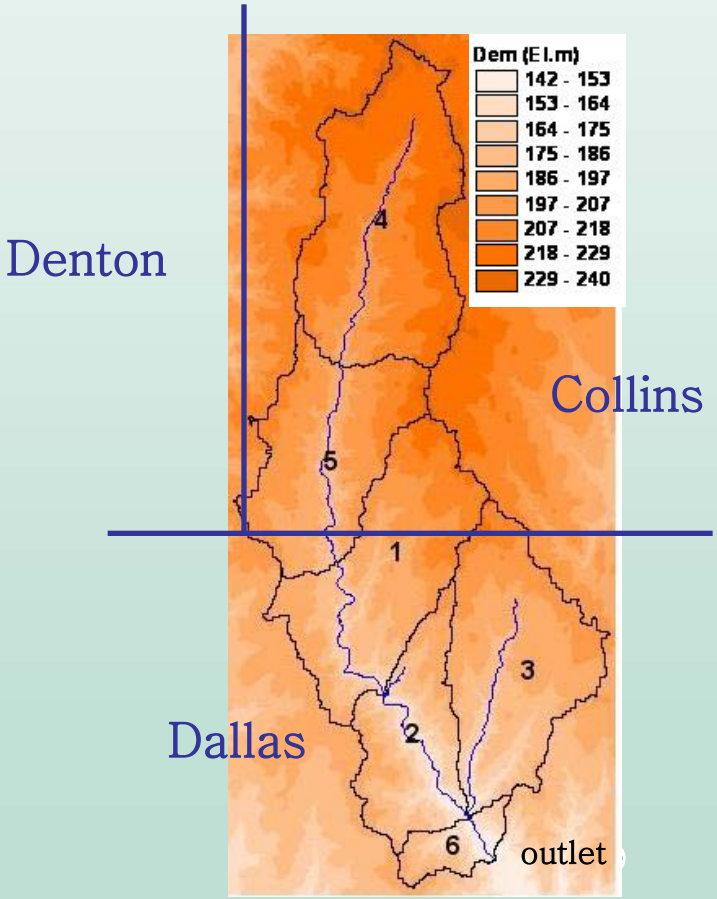






Model Application

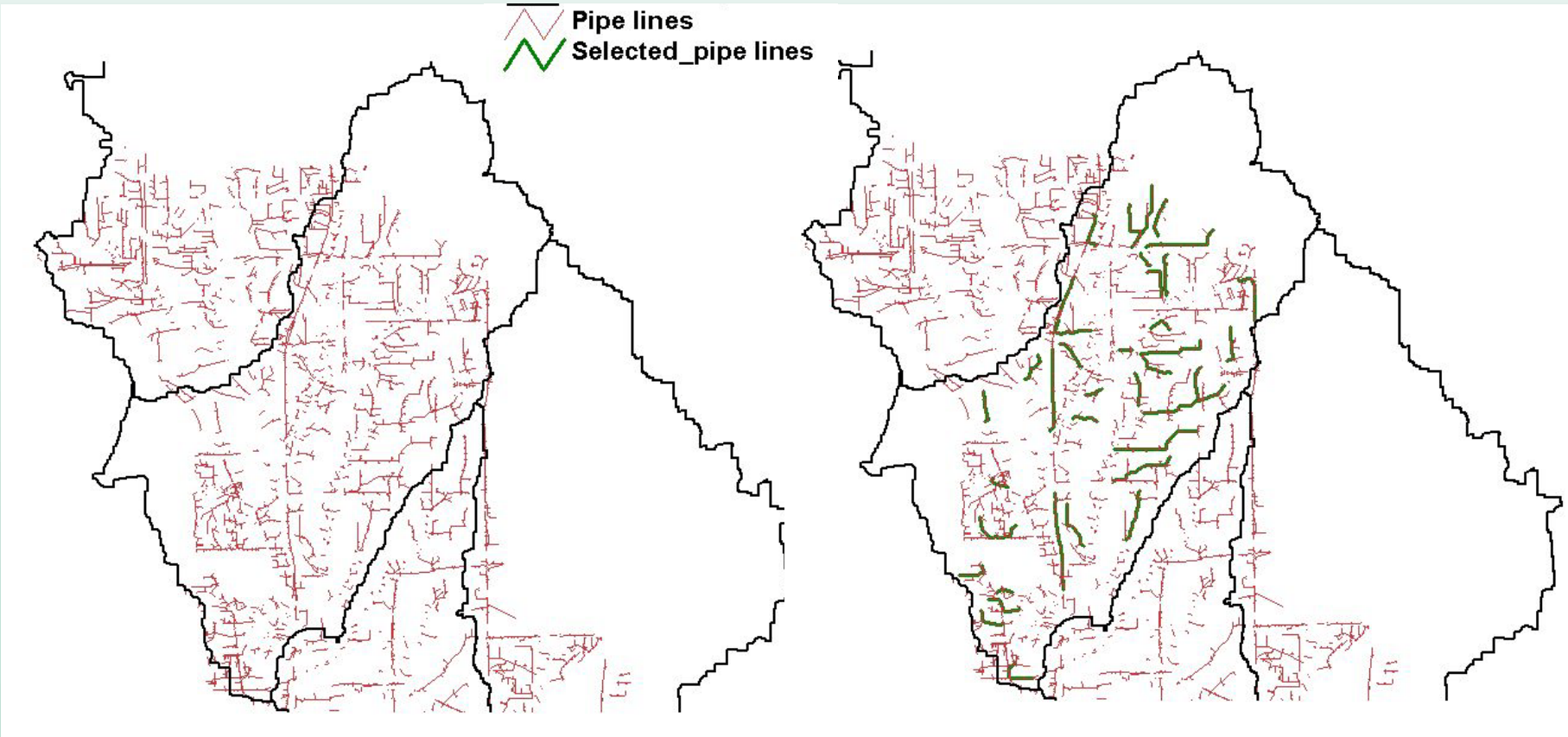
Study Area : White Rock Creek Watershed



- Area : 172 km^2
- Altitude : El. 140-240 m
- DEM : 30m x 30m
- 6 subwatersheds
- Subwatershed No.1

  = SWMM catchment

Model Input： Pipe lines in Dallas



Model Application

Mode

****
* C H A N N E L
****

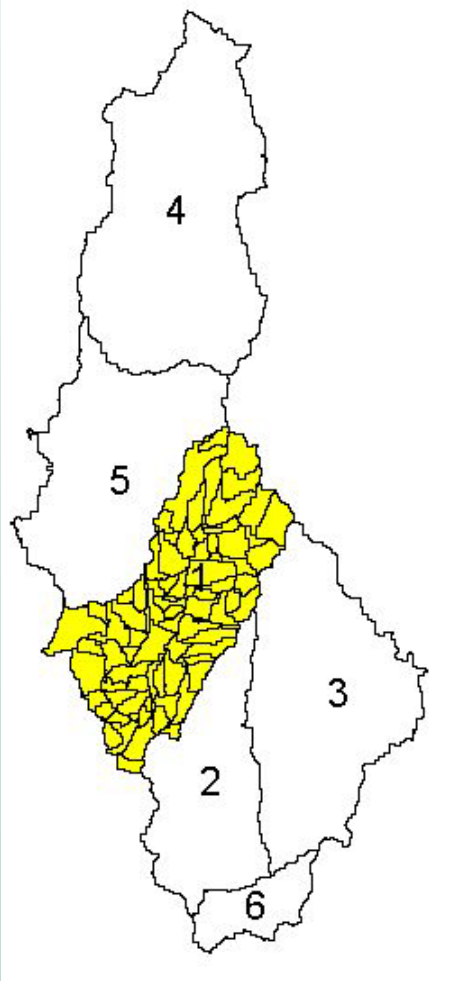
Input Sequen Number	NAMEG: Channel ID #	Drains to NGTO:
1	1	10 Tr
2	2	3 Tr
3	3	5 Tr
4	4	6 Tr
5	5	6 Tr
6	6	11 Tr
7	7	11 Tr
8	8	15 Tr
9	9	14 Tr
10	10	14 Tr
11	11	15 Tr
12	12	16 Tr
13	13	16 Tr
14	14	23 Tr
15	15	23 Tr
16	16	18 Tr
17	17	18 Tr
18	18	22 Tr
19	19	22 Tr
20	20	25 Tr
21	21	25 Tr
22	22	25 Tr
23	23	29 Tr
24	24	29 Tr

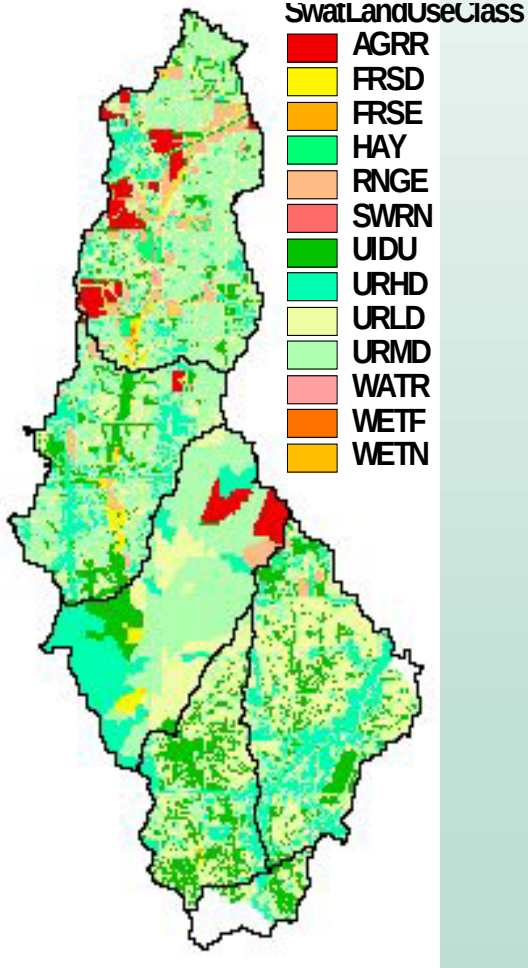
****
* S U B C A T C H M E N T D A T A *
****

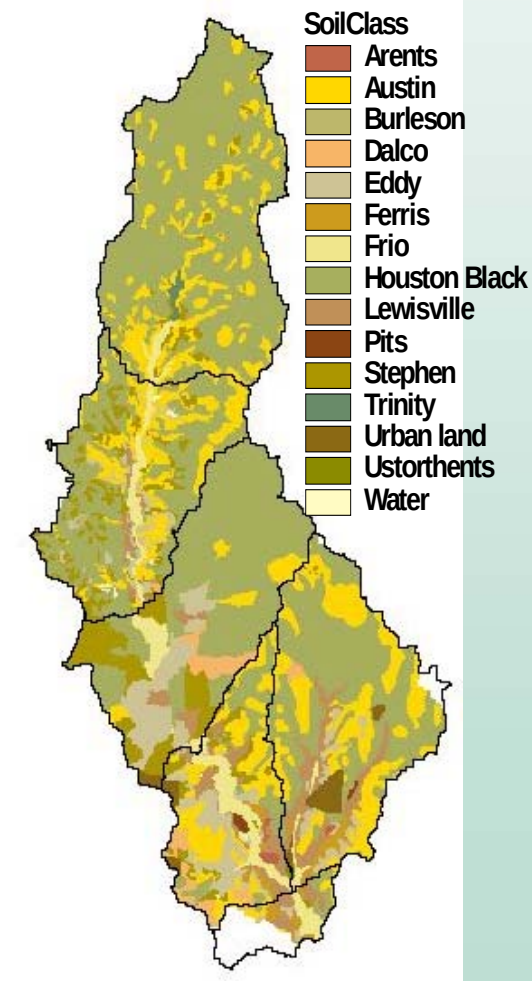
SUBCATCH-MENT NO.	CHANNEL OR INLET	WIDTH (M)	AREA (HA)	PERCENT IMPERV.	SLOPE (M/M)	RESISTANCE FACTOR IMPERV.	RESISTANCE FACTOR PERV.	DEPRES. STORAGE(MM) IMPERV.	DEPRES. STORAGE(MM) PERV.
1	1	10	235.94	34.18	0.00	0.0200	0.014	0.041	0.540	2.500
2	2	3	630.19	108.55	23.00	0.0200	0.014	0.041	0.530	2.500
3	3	5	379.47	77.96	44.00	0.0200	0.014	0.041	0.590	2.500
4	4	6	246.41	66.50	23.00	0.0200	0.014	0.041	0.580	2.500
5	5	6	461.54	99.81	0.00	0.0200	0.014	0.041	0.520	2.500
6	6	11	85.48	5.20	63.00	0.0200	0.014	0.041	0.500	2.500
7	7	11	193.05	25.70	23.00	0.0200	0.014	0.041	0.560	2.500
8	8	15	267.24	55.42	23.00	0.0100	0.014	0.041	0.740	2.500
9	9	9	269.65	29.78	44.00	0.0200	0.014	0.041	0.580	2.500
10	10	14	458.22	186.19	23.00	0.0200	0.014	0.041	0.570	2.500
11	11	15	242.47	17.71	7.00	0.0200	0.014	0.041	0.580	2.500
12	12	16	375.22	79.26	23.00	0.0100	0.014	0.041	0.670	2.500
13	13	16	537.86	111.15	0.00	0.0200	0.014	0.041	0.610	2.500
14	14	23	212.82	13.50	44.00	0.0400	0.014	0.041	0.400	2.500
15	15	23	361.26	43.84	7.00	0.0300	0.014	0.041	0.460	2.500
16	16	18	211.10	20.37	23.00	0.0200	0.014	0.041	0.570	2.500
17	17	17	420.62	69.41	0.00	0.0100	0.014	0.041	0.650	2.500
18	18	22	457.88	79.26	23.00	0.0200	0.014	0.041	0.510	2.500
19	19	22	171.68	32.94	44.00	0.0200	0.014	0.041	0.550	2.500
20	20	25	190.46	18.14	23.00	0.0100	0.014	0.041	0.680	2.500
21	21	25	256.32	23.78	7.00	0.0100	0.014	0.041	0.750	2.500
22	22	25	162.46	8.85	7.00	0.0400	0.014	0.041	0.400	2.500
23	23	29	442.46	81.05	7.00	0.0400	0.014	0.041	0.400	2.500
24	24	24	194.02	45.82	23.00	0.0100	0.014	0.041	0.660	2.500
25	25	30	425.82	97.83	23.00	0.0300	0.014	0.041	0.420	2.500
26	26	30	163.06	9.78	7.00	0.0400	0.014	0.041	0.370	2.500
27	27	26	223.65	32.88	23.00	0.0300	0.014	0.041	0.480	2.500
28	28	26	178.68	19.63	23.00	0.0200	0.014	0.041	0.530	2.500
29	29	32	240.96	20.93	7.00	0.0500	0.014	0.041	0.350	2.500

Model Application

Model Input : Preprocessed landuse and soil maps

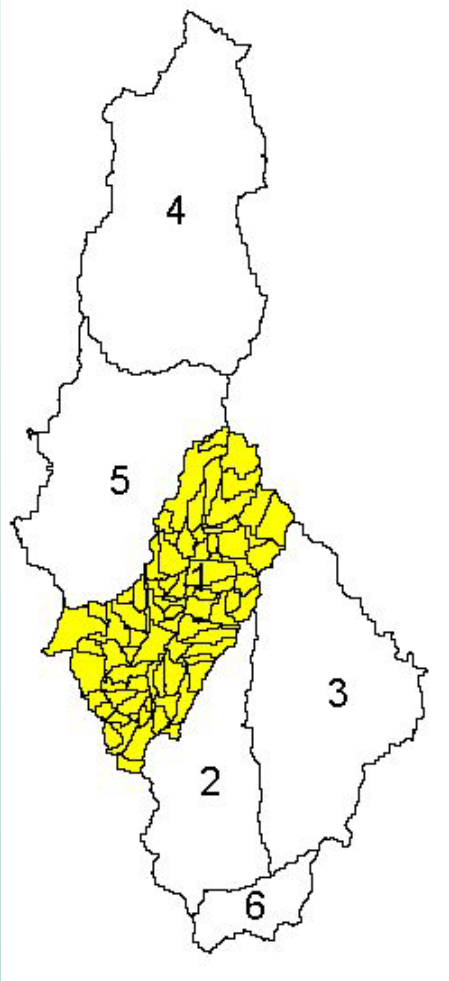






Model Application

Model calibration process



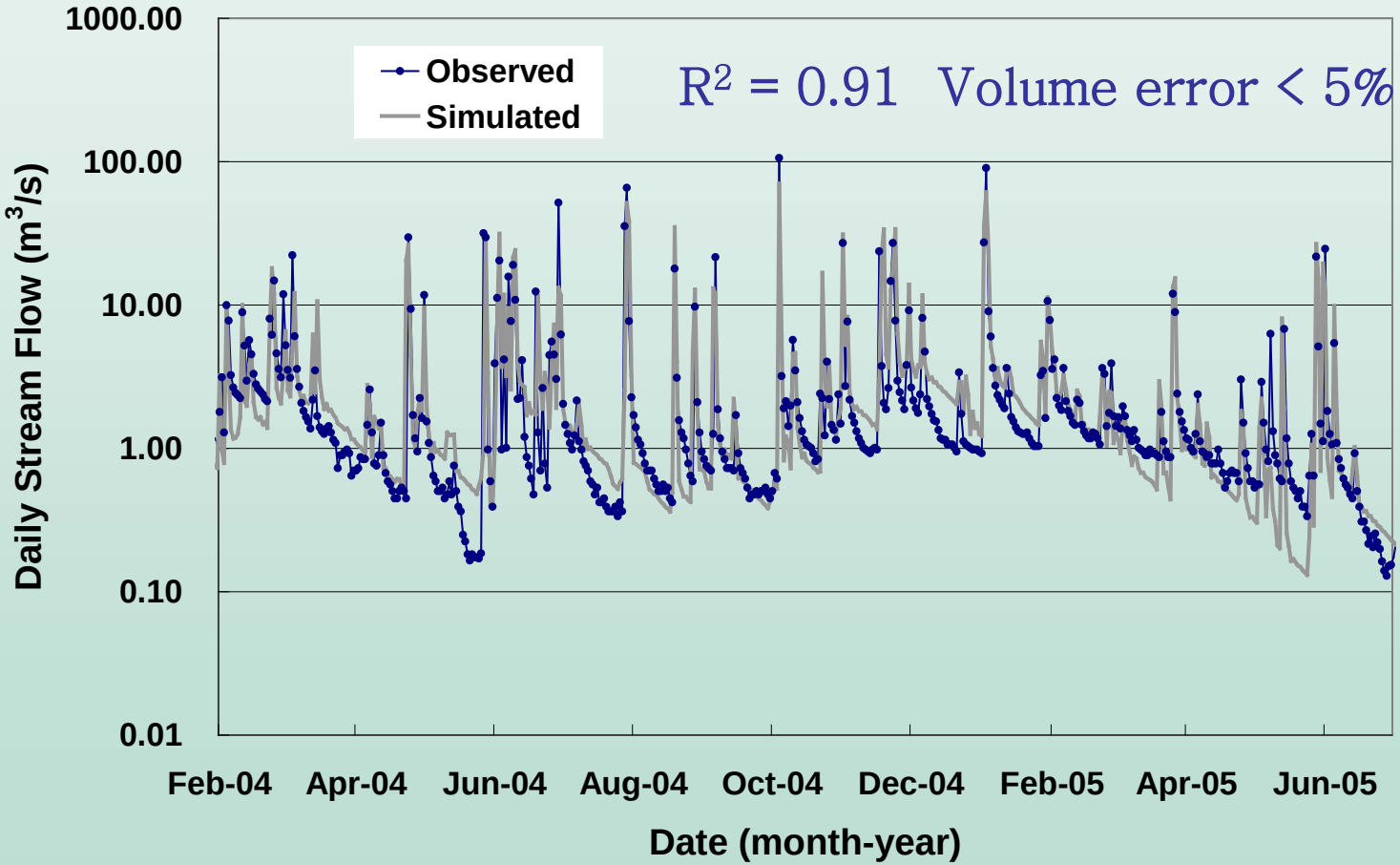
- SWAT calibration was performed for entire watershed
- SWMM calibration was performed for sub-watershed No1.

- Major adjusted parameters

CN2	↓	fo	↓
EPCO	↓	fc	↓
Ksat	↑	n	↓
Gw_delay	↑	A1	↑
FIMP	↓	A2	↑

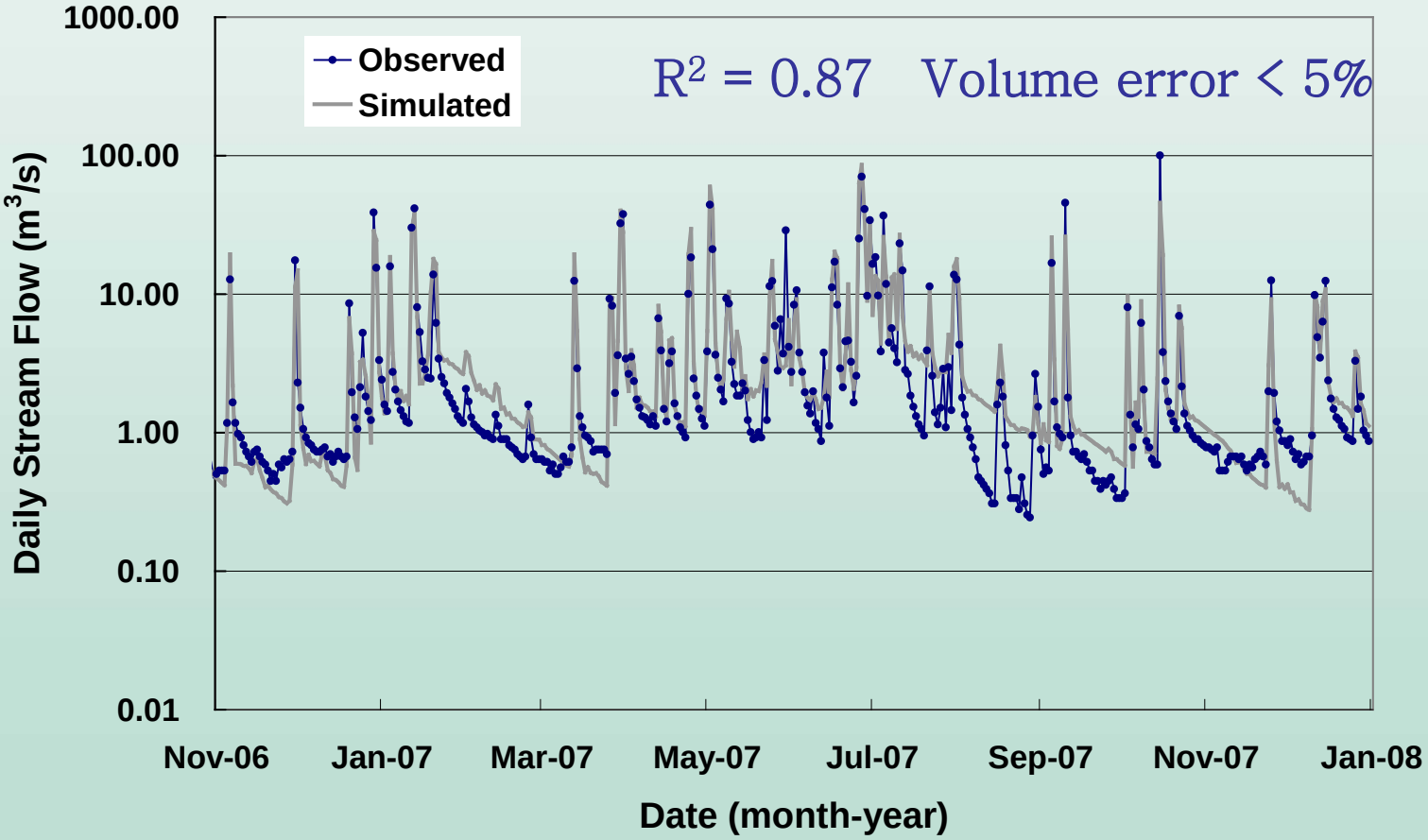
Model Application

Model calibration : Period of 2004-2005 years



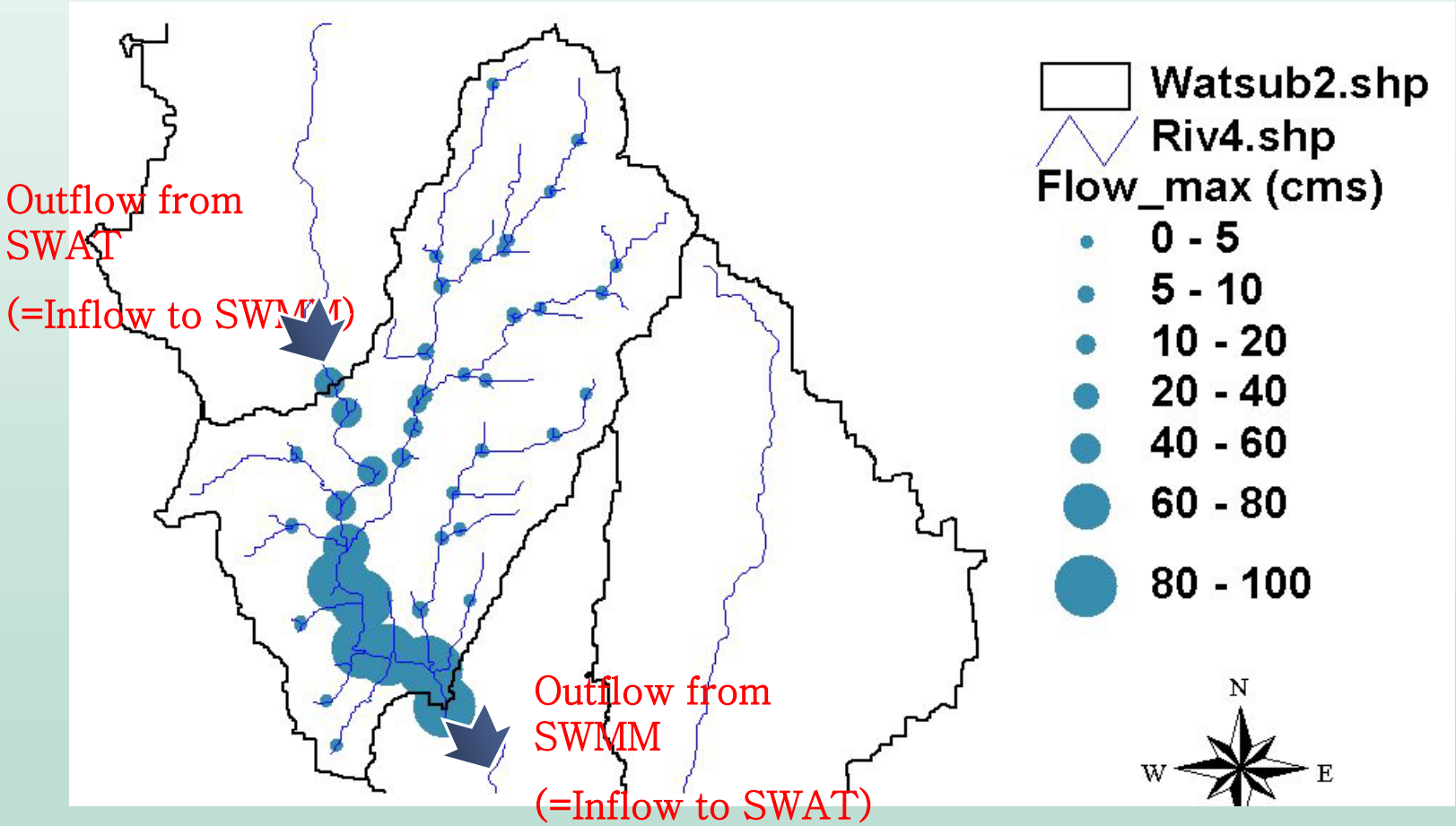
Model Application

Model validation : Period of 2006-2007 years



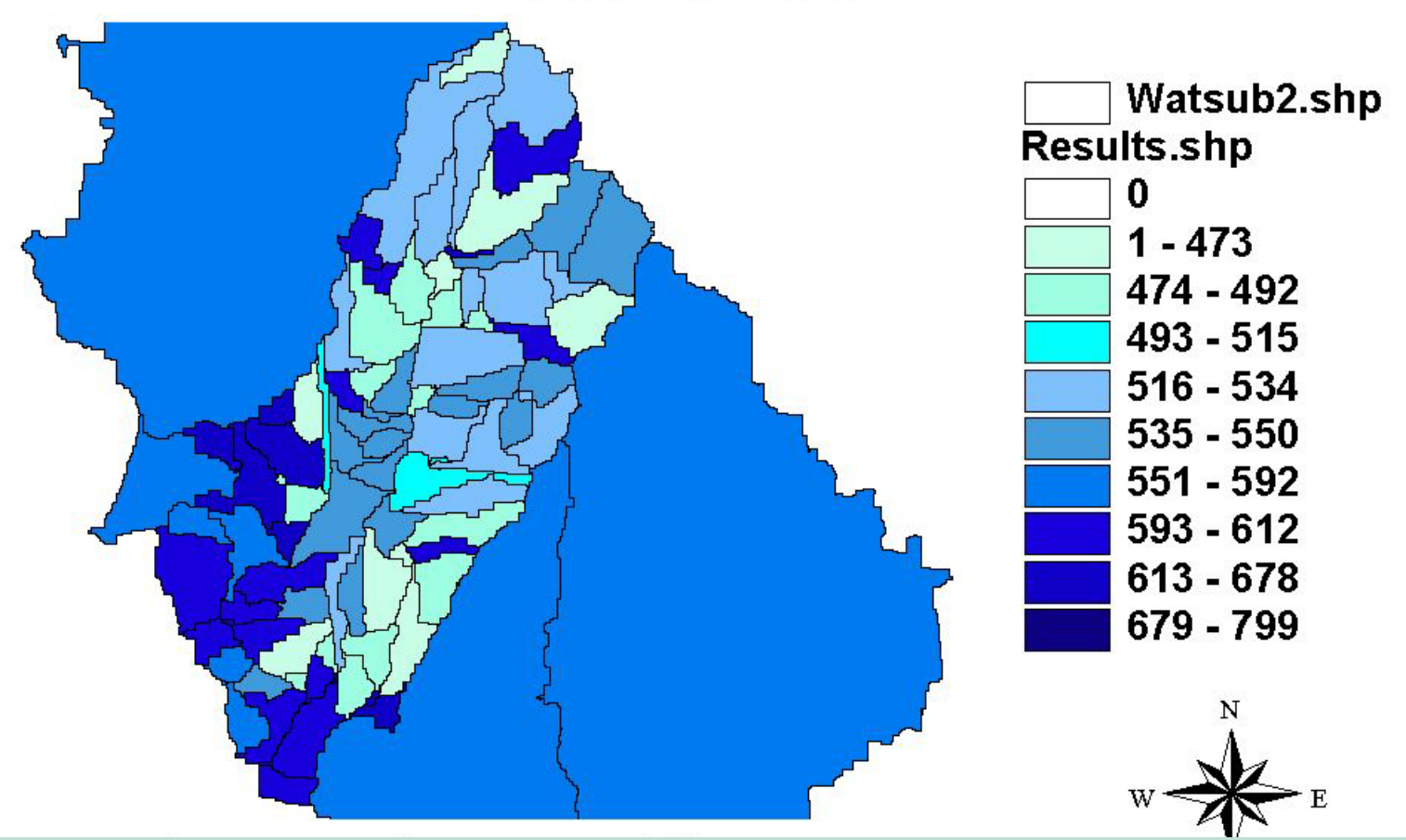
Model Application

Simulated results : maximum flowrate in channel / pipe lines



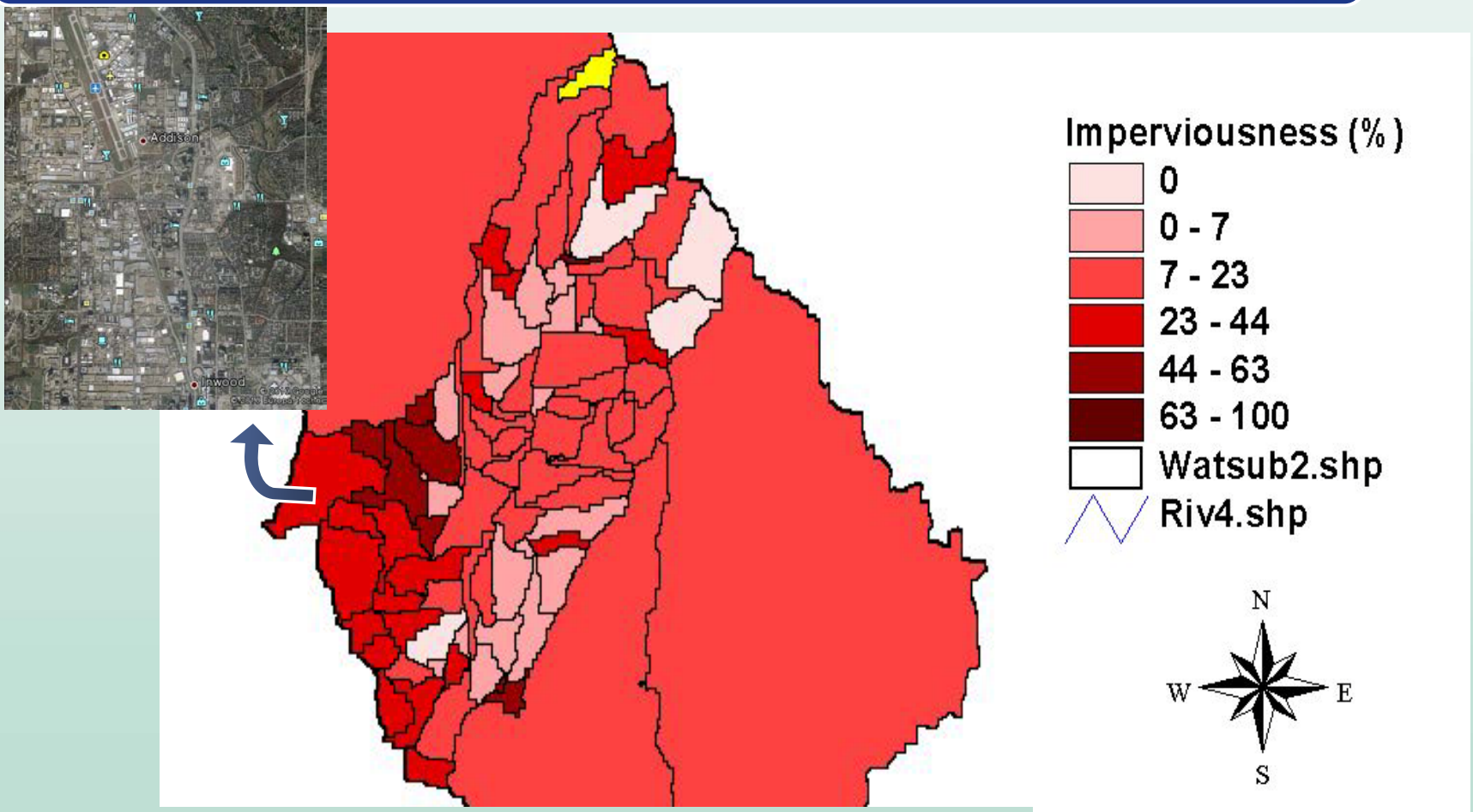
Model Application

Simulated results : spatial annual water yield



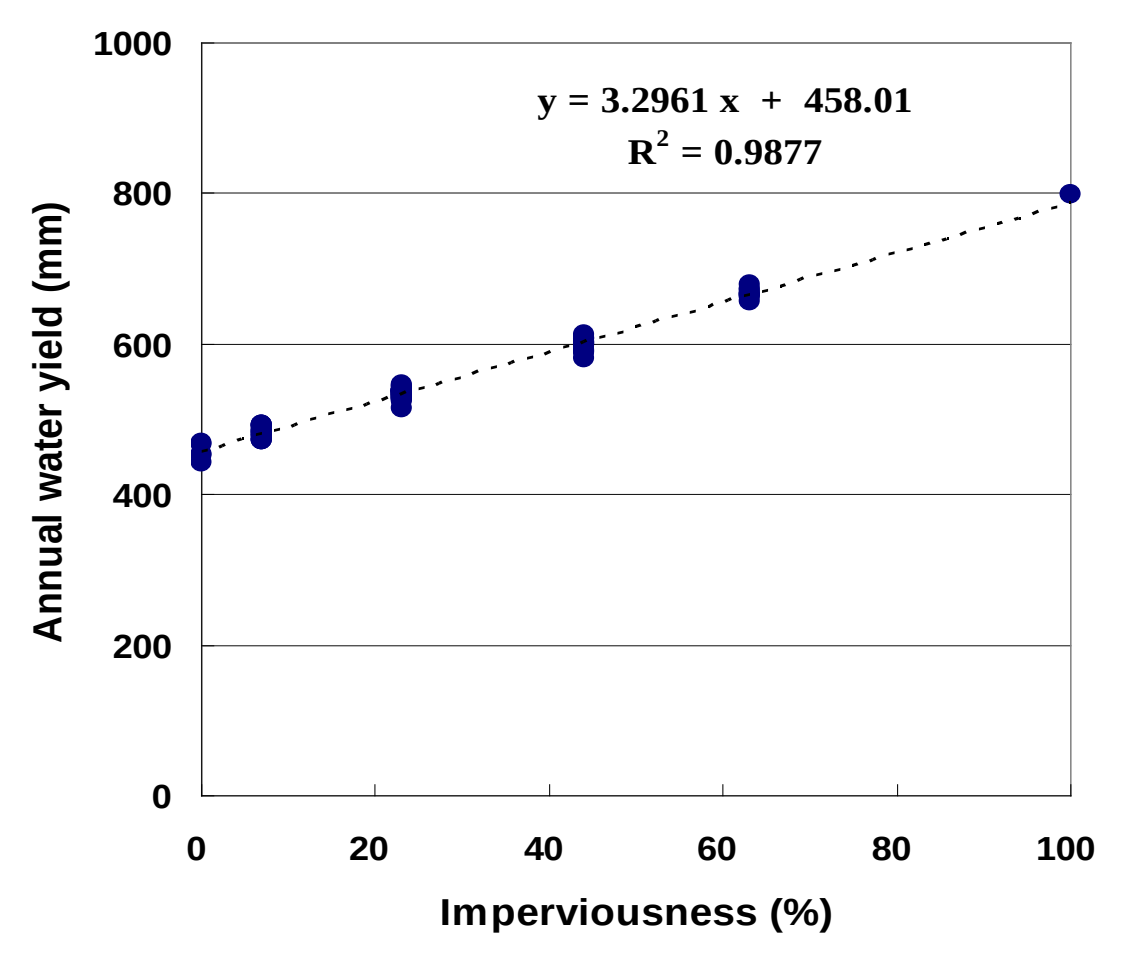
Model Application

Simulated results : spatial imperviousness



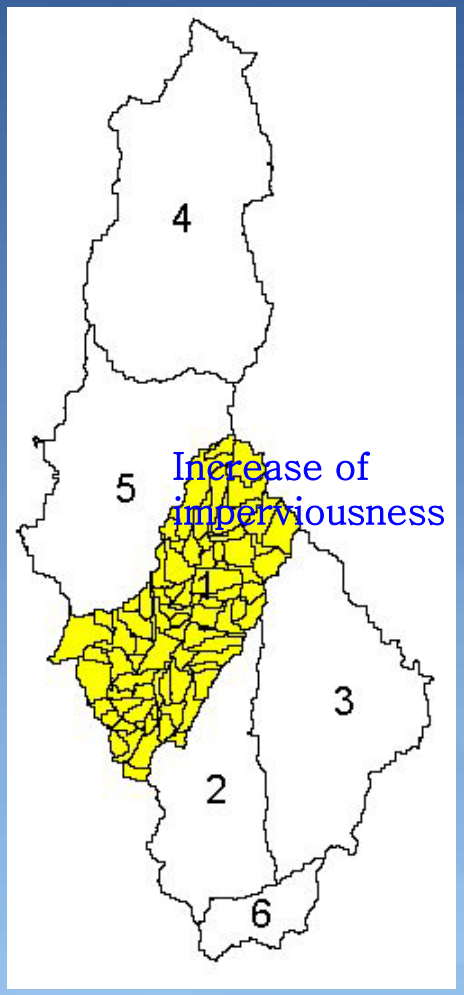
Model Application

Simulated results : imperviousness vs water yield



Model Application

Simulated results : effects of imperviousness



- Variations of downstream flows at outlet
- Variations of hydrological components for the entire watershed

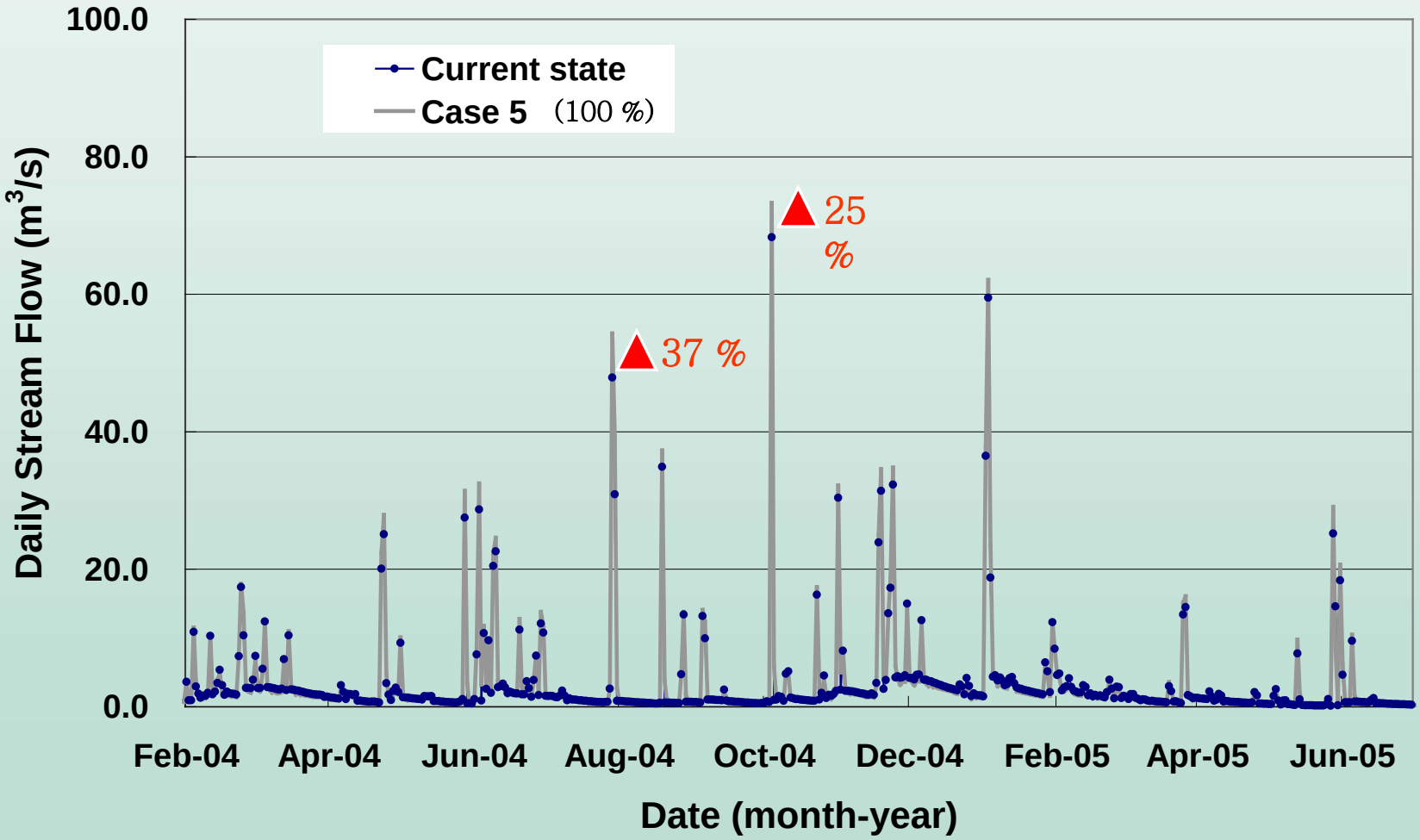
- 6 Cases of simulations were performed.

– Increase rate of impervious area

Current State, Case 1: 20 % , Case 2: 40 %

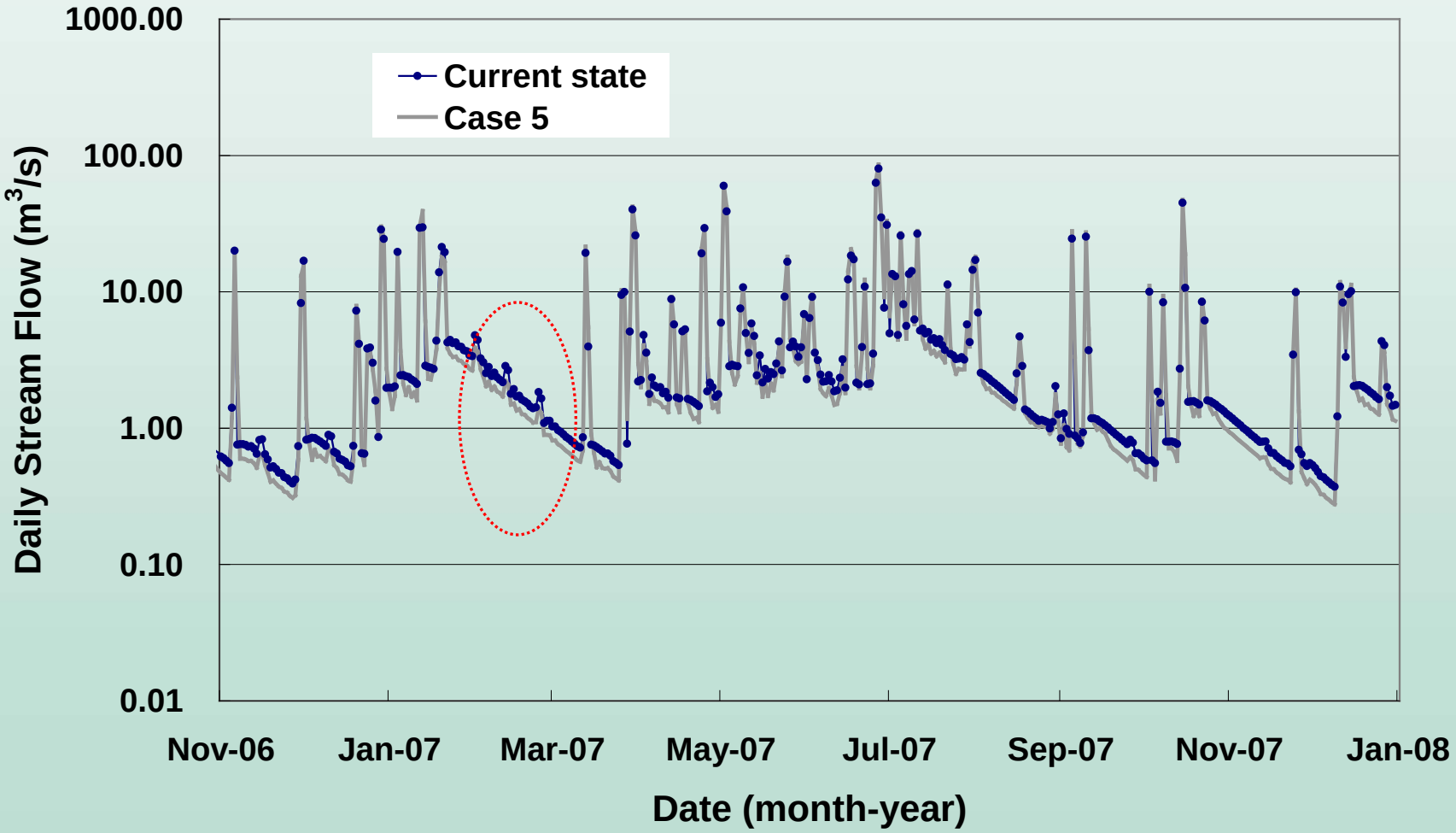
Case 3: 60 % , Case 4: 80 % , Case 5: 100 %

Simulated results : effects of imperviousness



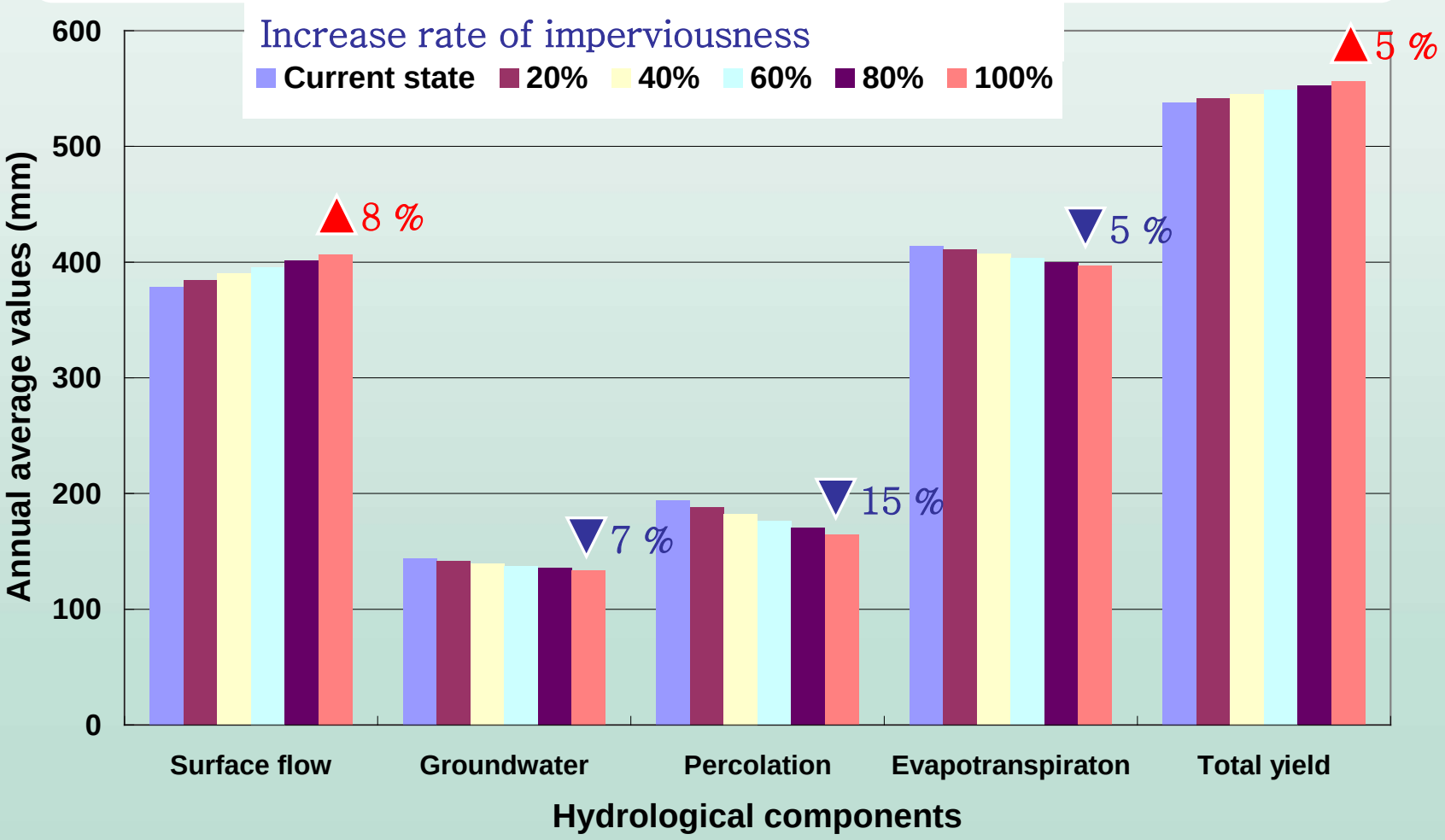
Model Application

Simulated results : effects of imperviousness



Model Application

Simulated results : effects of imperviousness



Conclusion

- Performance of integrated SWAT-SMMM model was verified.
- SWAT-SWMM can be effectively used for assessing hydrologic components for urban as well as rural areas.

- Future Works
  - To link water quality components of SWAT and SWMM to each other
  - To make SWAT processes be calculated at subdaily time scale
  - To test applicability of SWAT-SWMM for other watersheds

Thank you for listening !