Soil & Water Assessment Tool | SWAT

Weather Information Service Engine

Application the SWAT model for *Extreme Urban Flash Floods* in Seoul

18 July 2013

International SWAT Conference, Toulouse, France

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URL : *wise2020.org*

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Weather Information Service Engine

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Natural Hazards in Seoul: Floods

- Seoul is 605.41 km^2 with population of approximately 13 million
- 4 August 1998 Flood followed by floods in 2001, 2003, 2010, 2011 and 2012
- However, No Information or Warnings from Government

  4 August 1998 Flood: 384mm (8.2 midnight ~ 8.4. 1 pm)

  28 July 2011: 587 mm (7.26 ~ 7.28)

Rainfall distribution - 1998.8.2 midnight ~ 1998. 8.4. 1 pm, 384mm

'양쯔강 저기압' 지나며 '暴雨'

장대비 왜 오나

8월 들어 한반도에 「이상한 비」가 계속되고 있다. 장마가 끝났는데도 큰 비가 계속 내리고 있

크해 기단과 남쪽의 고온다습한 북태평양고기압이 만나 형성하는 장마전선의 영향으로 내리는 비다. 이 장마전선은 지난달 28일로 소멸됐다.

반면 최근의 큰 비는 기압골의 영

시간가량의 시차를 둔 채 단속적으로 비가 내렸다. 이처럼 이번 비가 한꺼번에 내리지 않고 시차를 두고 띄엄띄엄 내리는 것은 중국쪽에서 다가오는 저기압의 시차 때문이다.

• 장맛비와 다른 점
같은 '국지성 호우'지만 '기상이변'

• 왜 띄엄띄엄 내리나
비구름 時差두고 한반도에 상륙

• 지역편차 심한 이유
지리·북한산과 부딪혀 비 쏟아내

Gangnam & Mt.Woomyun (2011.7.28):
daily rainfall 171 mm (7.26), 301mm (7.27), 115 mm(7.28)

Weather Information Service Engine (WISE)

Weather Information Service Engine

Goal — **Better customized service**

Objective — **WISE**

- Funded by KMA
- 8 Years (2012 ~ 2019)
- $100 million

Strategy

Micro scale observation, modeling and analysis	Science Integration	Information delivery

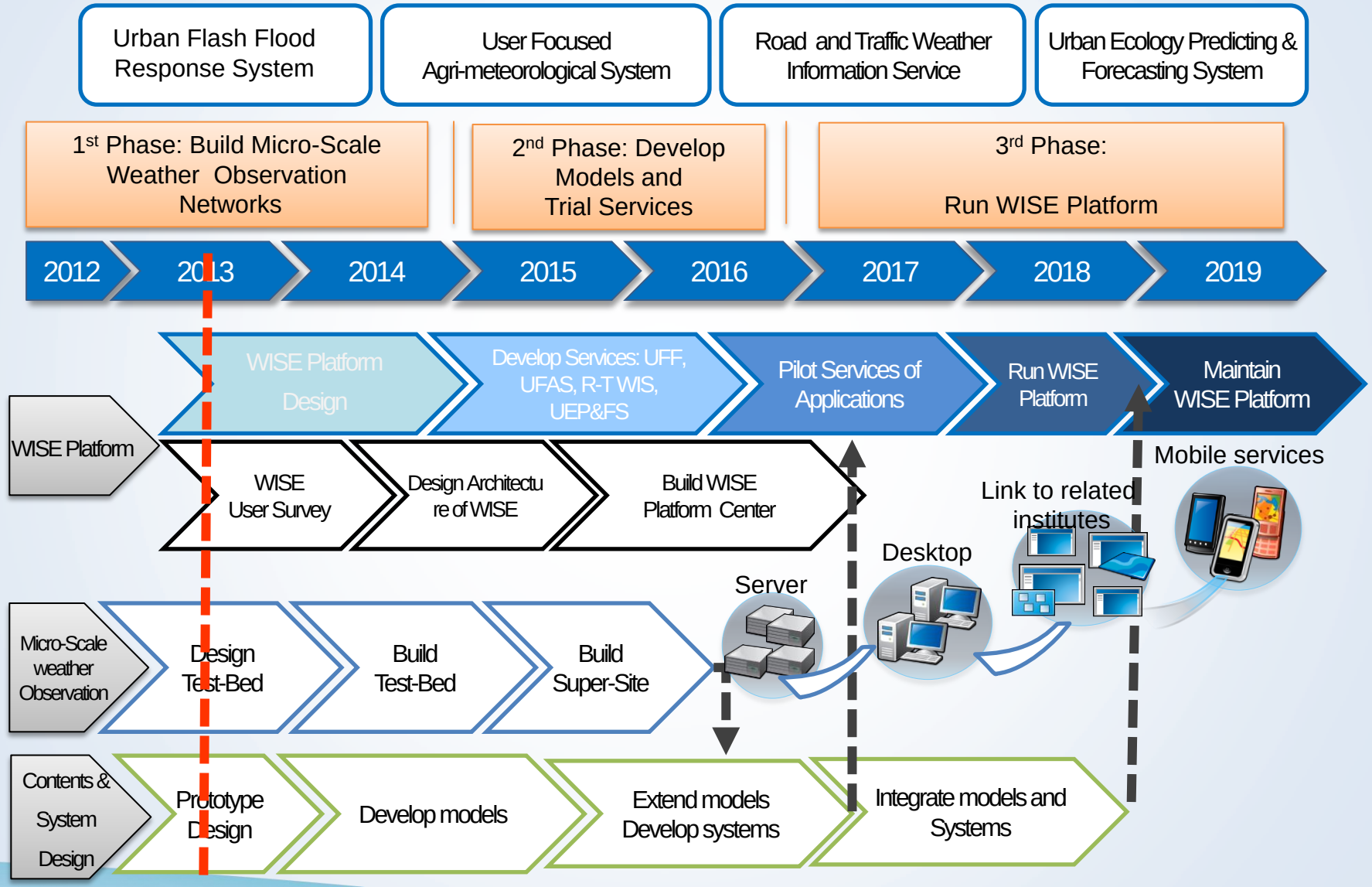
Subjects

Storm prediction system Boundary layer modeling Multi-scale modeling Joint Numerical Test-bed Observation	Urban applications Agriculture applications Urban eco-systems Business applications	WISE platform Information contents Graphic solution Technology transfer

Design Plan 2013 → Execute Step 1 2015 → Execute Step 2 2017 → Operation 2019

WISE & Applications

Weather Information Service Engine



Study Aims

Weather Information Service Engine

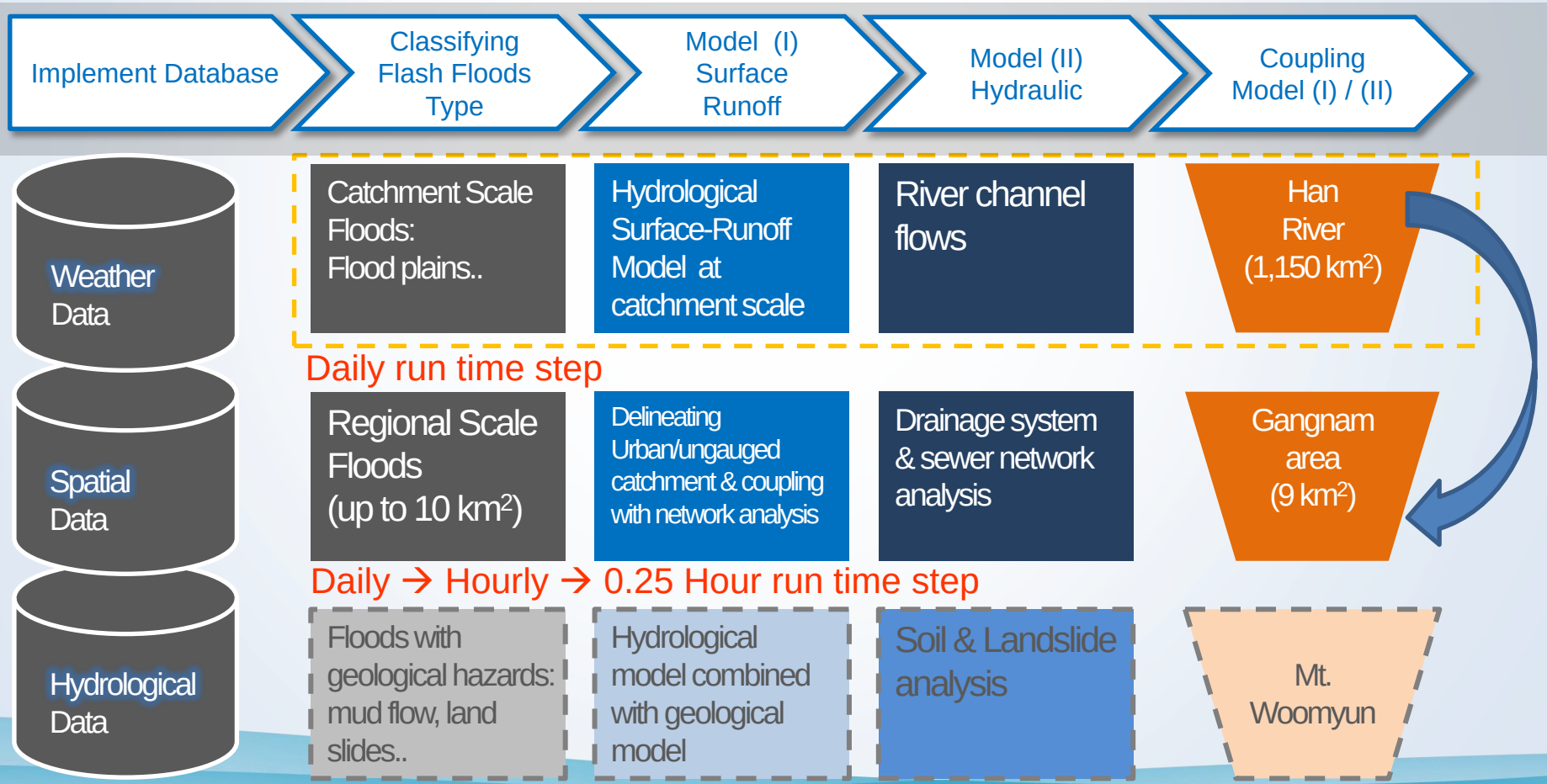
- Difficult to measure intensive rainfall, as it lasts short and exits over small areas and hard to estimate the inundation depth and other hydrological features on site of urban flash floods
- This study aims to provide a better understanding of urban flash flood with improving estimation of the amount of excess water and flood depth and to delineate flood vulnerable areas for Gangnam, one of the site of suffering from remarkable urban flash floods in Seoul.

Modeling Strategy

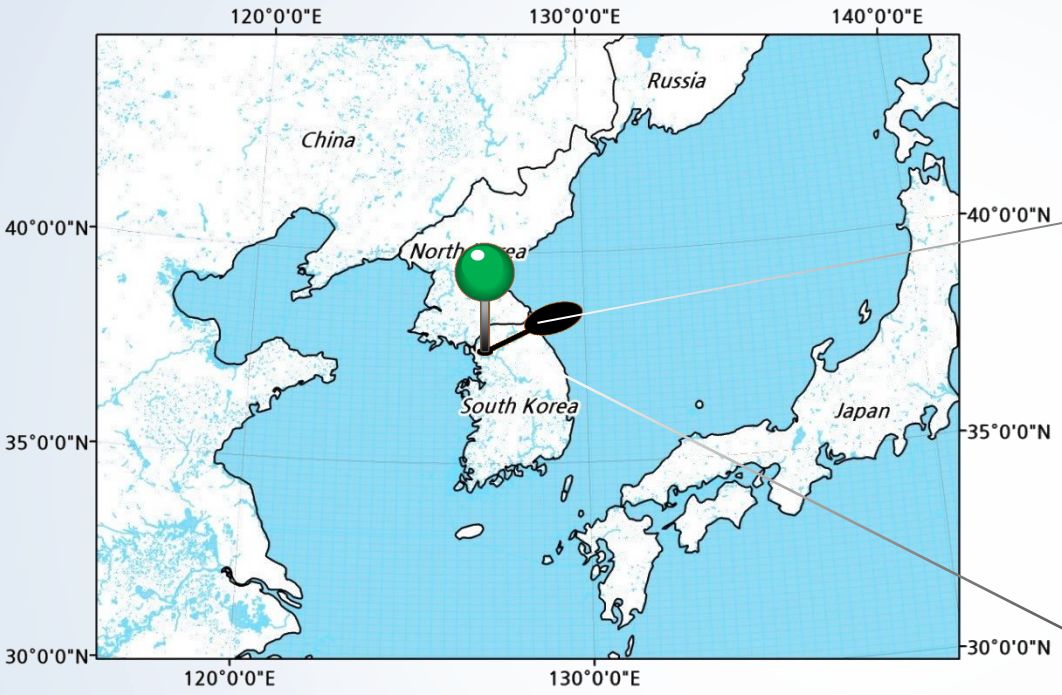
Weather Information Service Engine

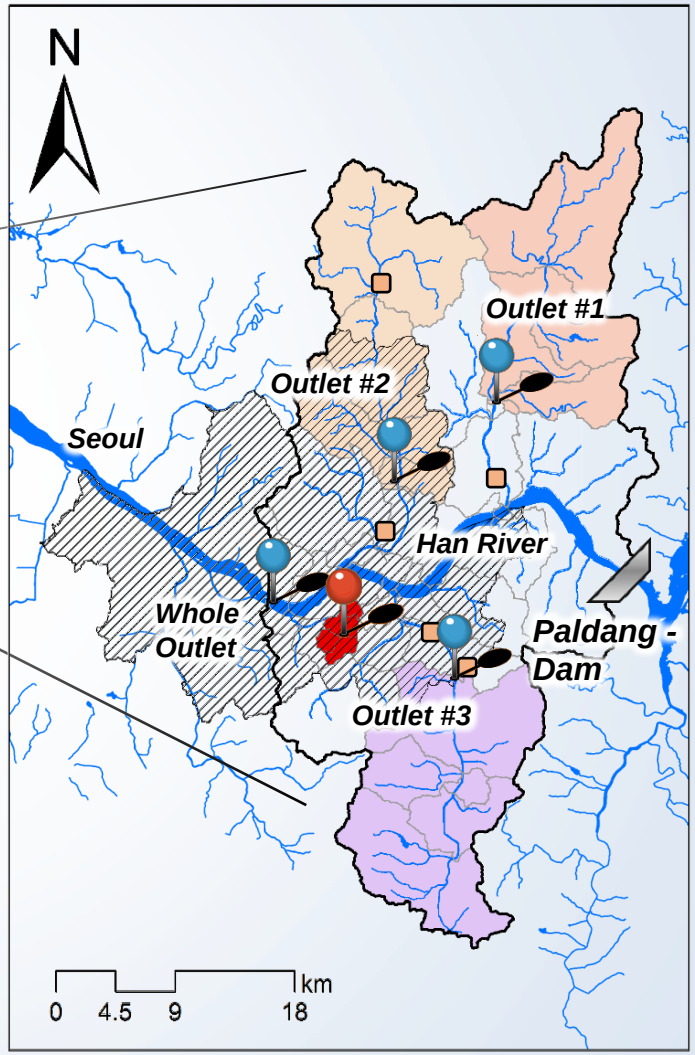
- A semi distributed model is built to evaluate sensitivity of intensive rainfall
- Multi-scale modelling is required to overcome limitations of ungauged catchment

Catchment to Regional scale (2012 ~ 2015)



Study Area





- Study Area Boundary
- Subbasin
- Ungauged Catchment
- Stream
- Water Level / Discharge Station
- Sewage Treatment Plant

Sites of Interest

Weather Information Service Engine

- Outlet #1

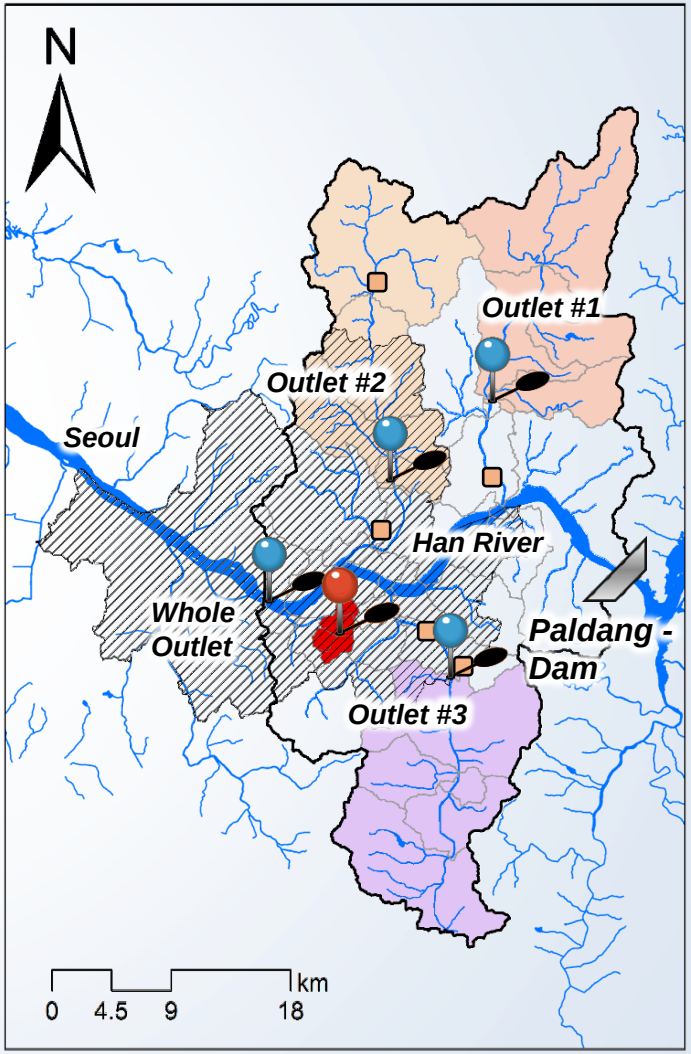
Area	:	199.1 km^2
Average Rainfall (Yearly)	:	1,573.2 mm
Average Discharge (Yearly)	:	3,037.3 m^3

- Outlet #2

Area	:	211.8 km^2
Average Rainfall (Yearly)	:	1,564.6 mm
Average Discharge (Yearly)	:	3,262.0 m^3

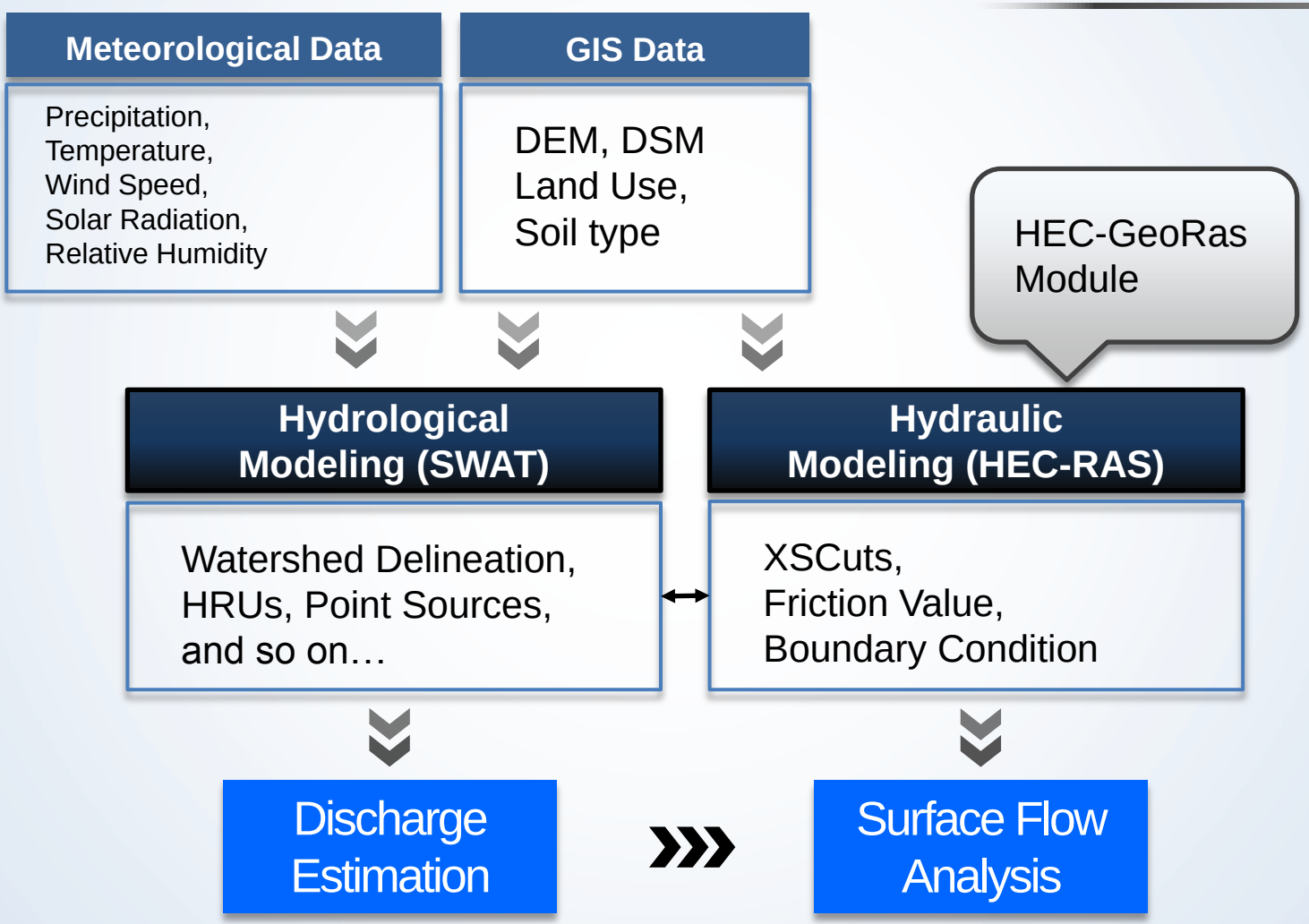
- Outlet #3

Area	:	201.6 km^2
Average Rainfall (Yearly)	:	1,490.2 mm
Average Discharge (Yearly)	:	5,909.7 m^3



Modeling Scheme

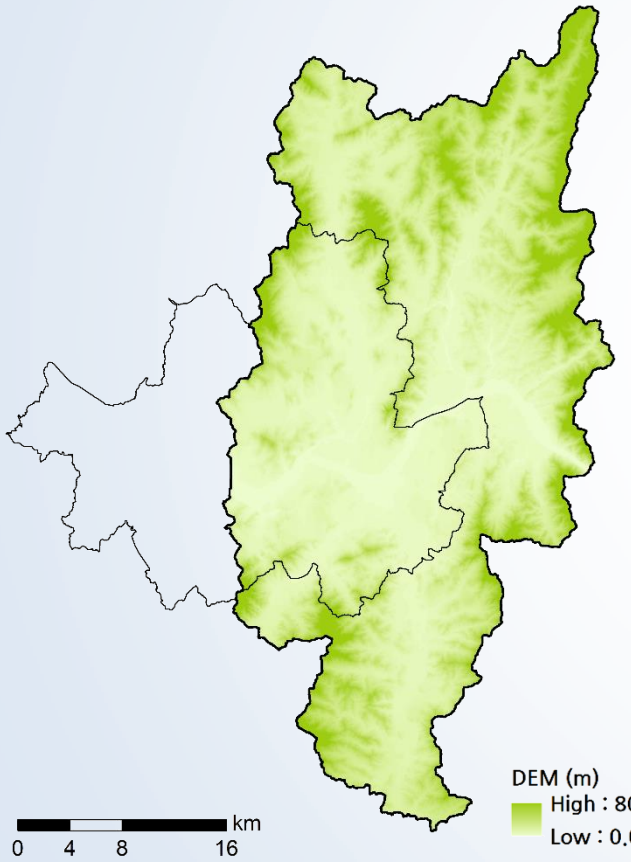
Weather Information Service Engine

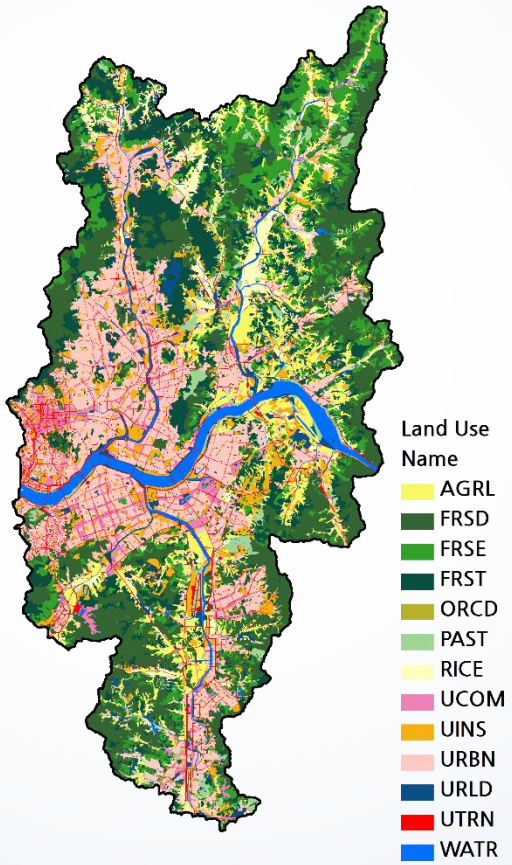


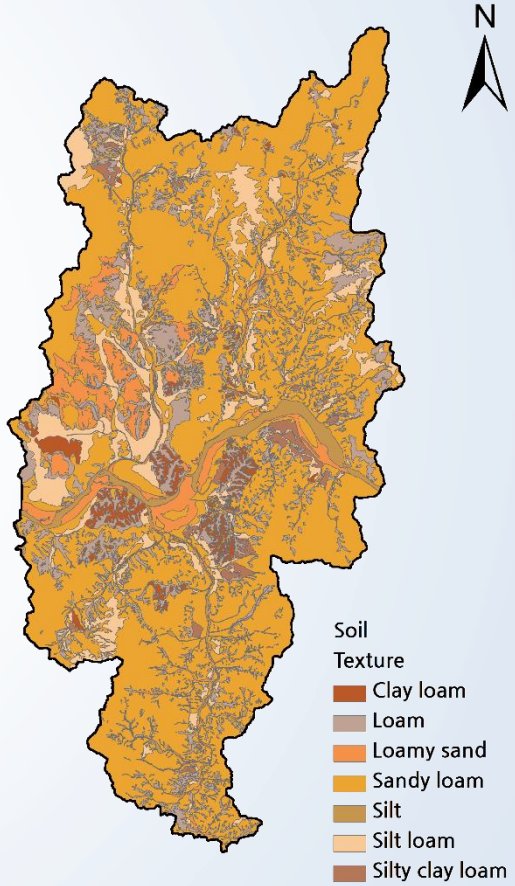
Spatial Input Data

Weather Information Service Engine

Spatial Resolution : 30 m







Performance Indicators

Weather Information Service Engine

- Coefficient of Determination

$$R^2 = \frac{b_i^2 \sum_{i=1}^{n} (x - \bar{x})^2}{\sum_{i=1}^{n} (y - \bar{y})^2}$$

- Root Mean Square Error

$$RMSE = \left[\frac{\sum_{i=1}^{N} (O_i - P_i)^2}{N} \right]^{0.5}$$

- Nash-Sutcliffe Model Efficiency

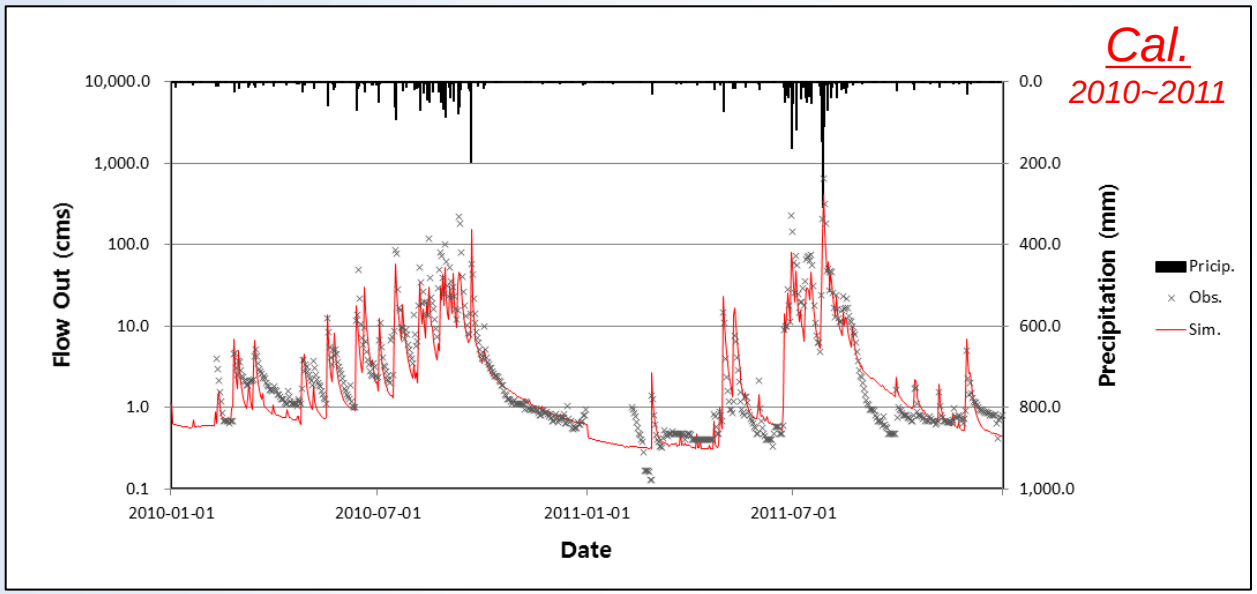
$$NS = 1 - \frac{\sum_{i=1}^{N} (O_i - P_i)^2}{\sum_{i=1}^{N} (O_i - \overline{O})^2}$$

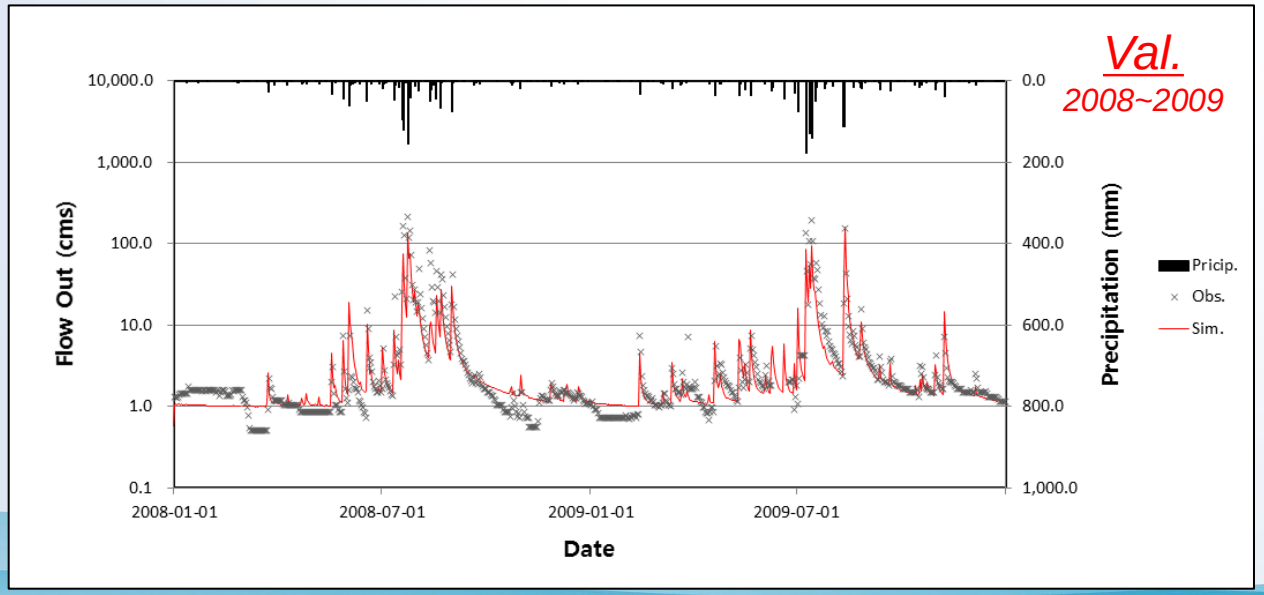
Where,

b	:	Estimated Regression Coefficient
x	:	Variable
y	:	Variable
O	:	Observed Value
P	:	Predicted Value
N	:	Number of Data

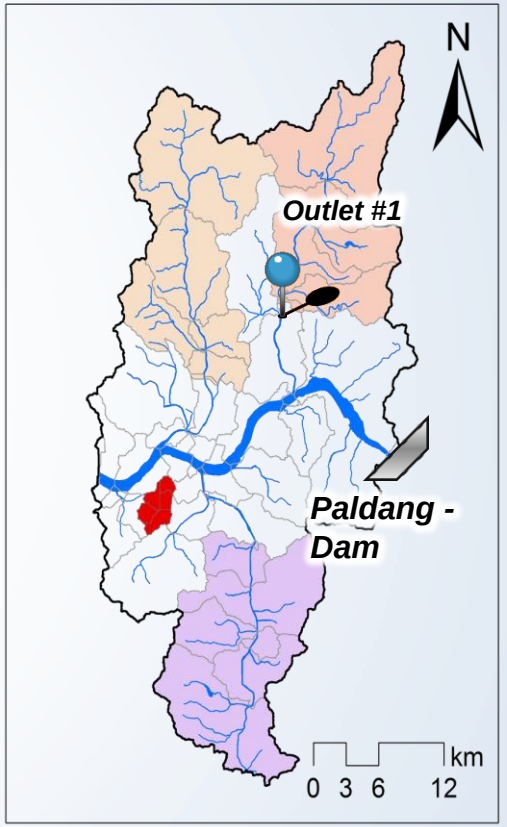
Evaluation Results (I)

Weather Information Service Engine





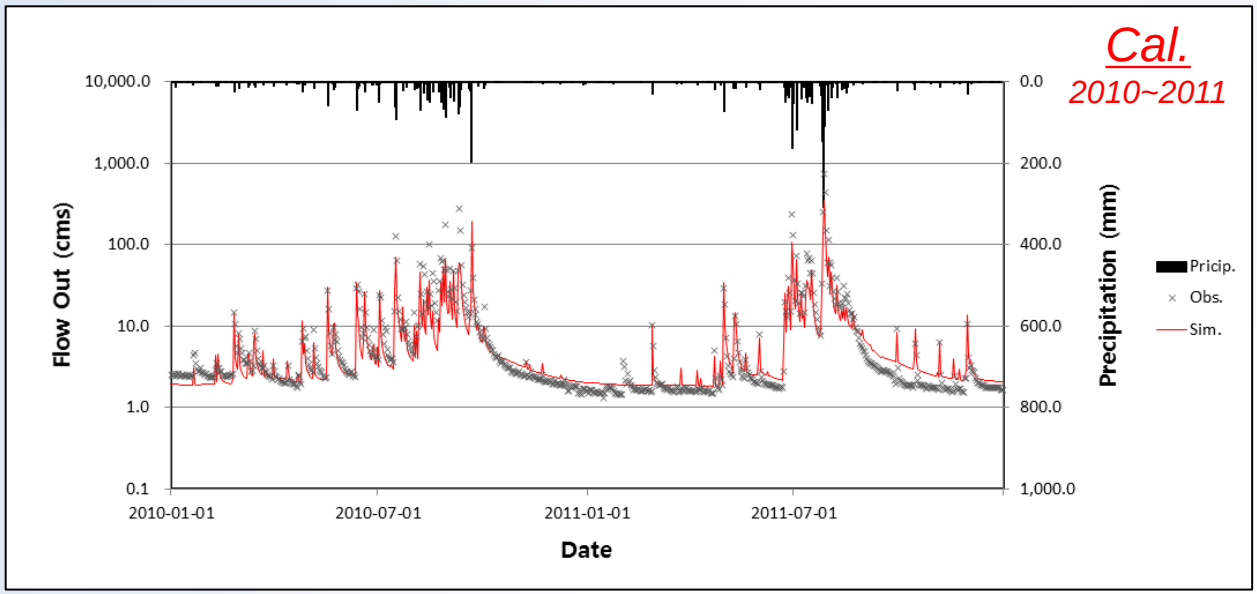
Daily

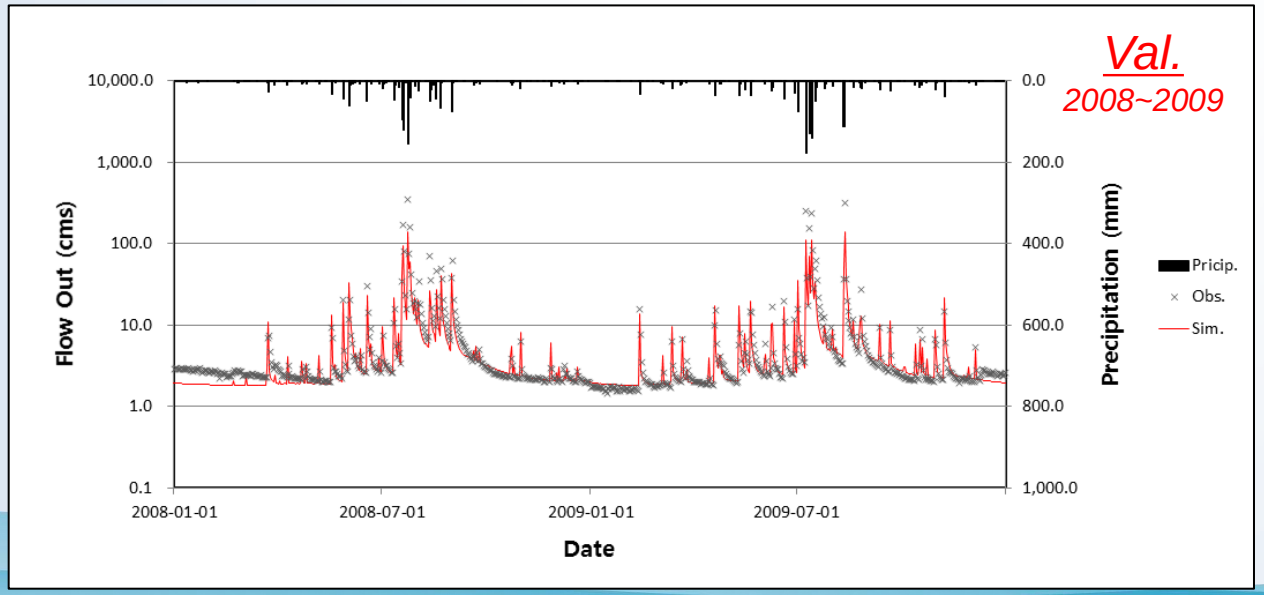


	Cal.	Val.
R^2	0.67	0.55
NS	0.50	0.24
RMSE	26.4	29.5

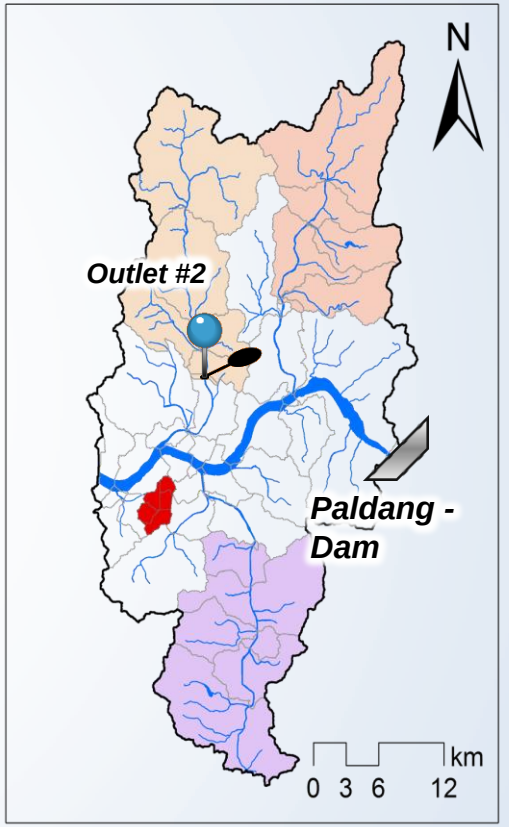
Evaluation Results (II)

Weather Information Service Engine





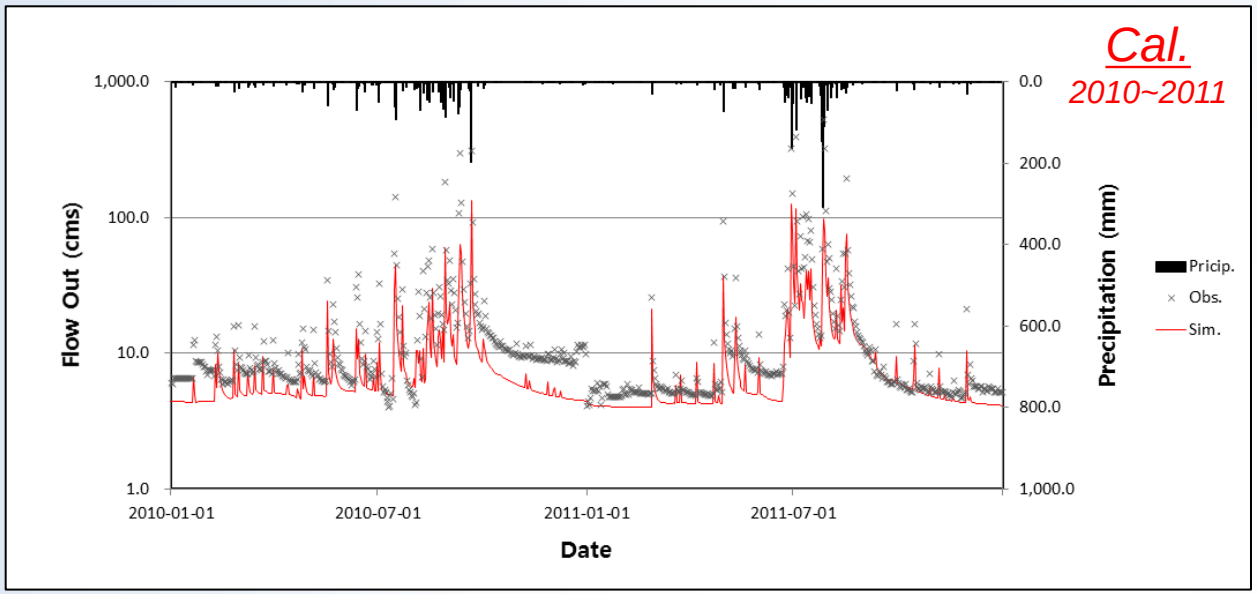
Daily

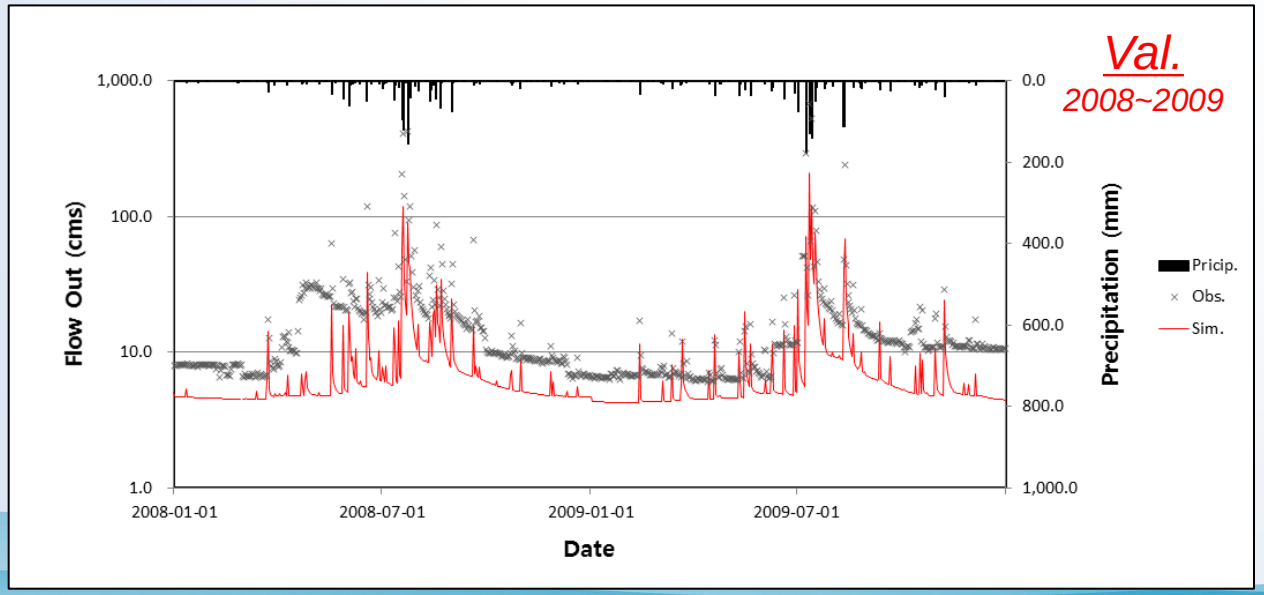


	Cal.	Val.
R^2	0.84	0.75
NS	0.65	0.41
RMSE	23.2	30.3

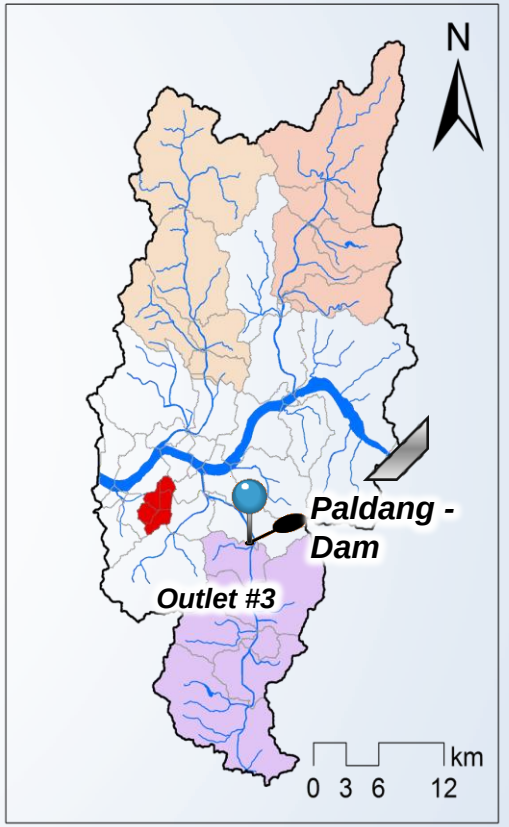
Evaluation Results (III)

Weather Information Service Engine





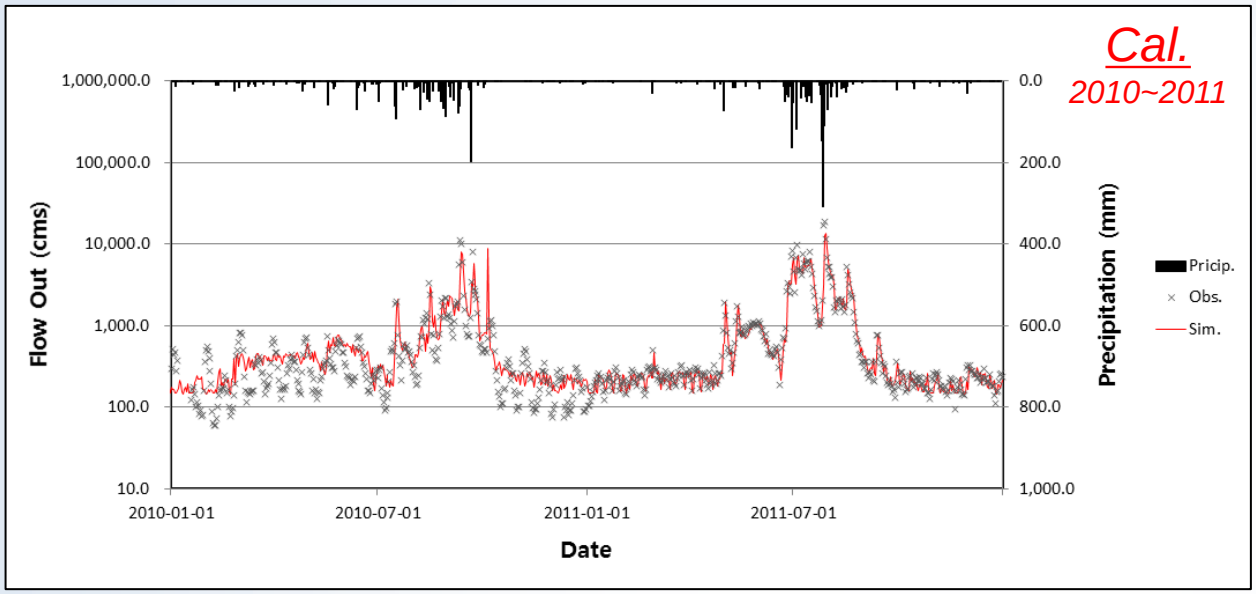
Daily

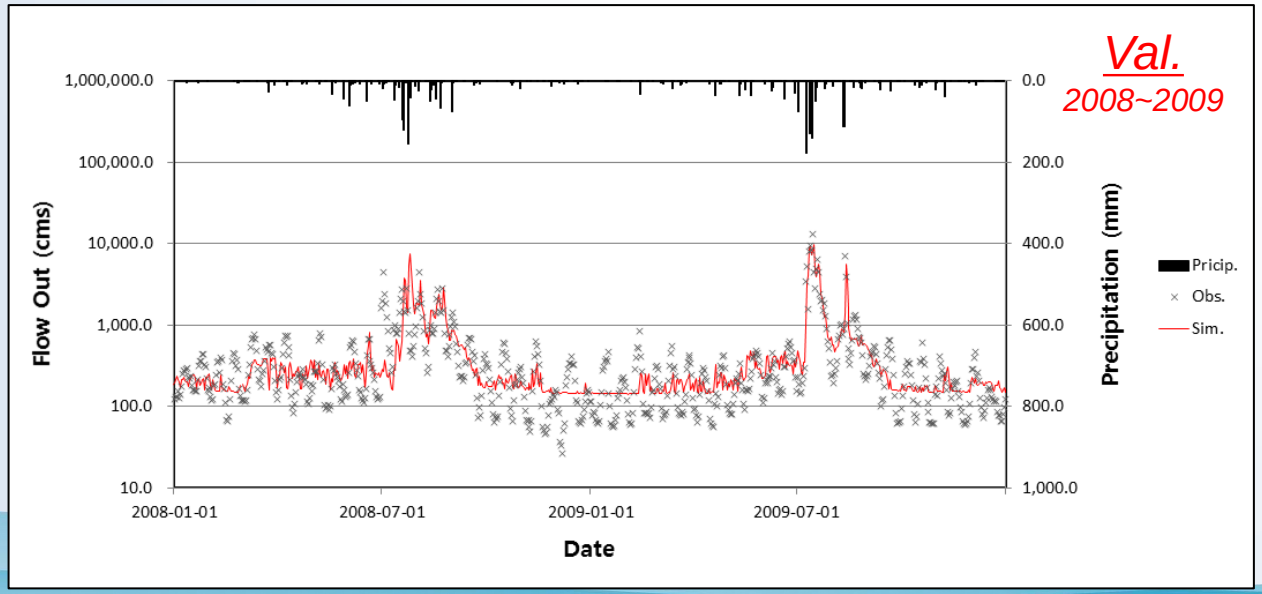


	Cal.	Val.
R^2	0.48	0.54
NS	0.36	0.42
RMSE	27.4	21.1

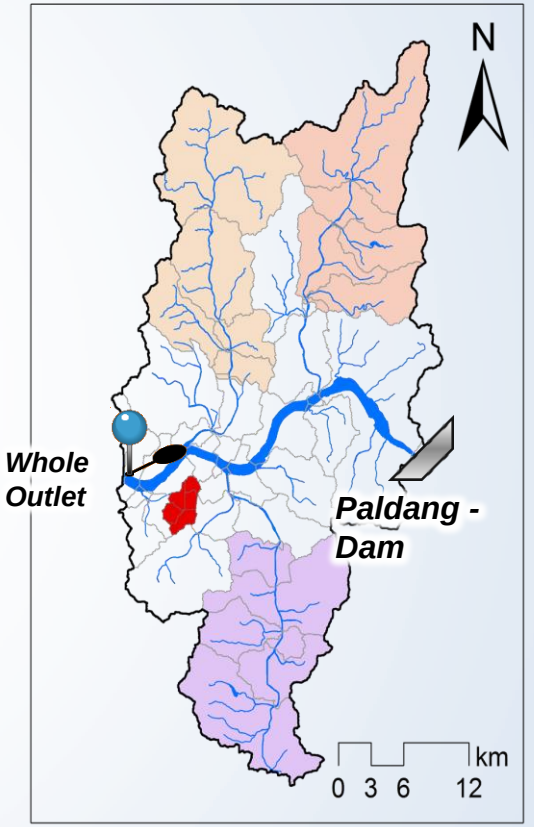
Evaluation Results (Whole)

Weather Information Service Engine





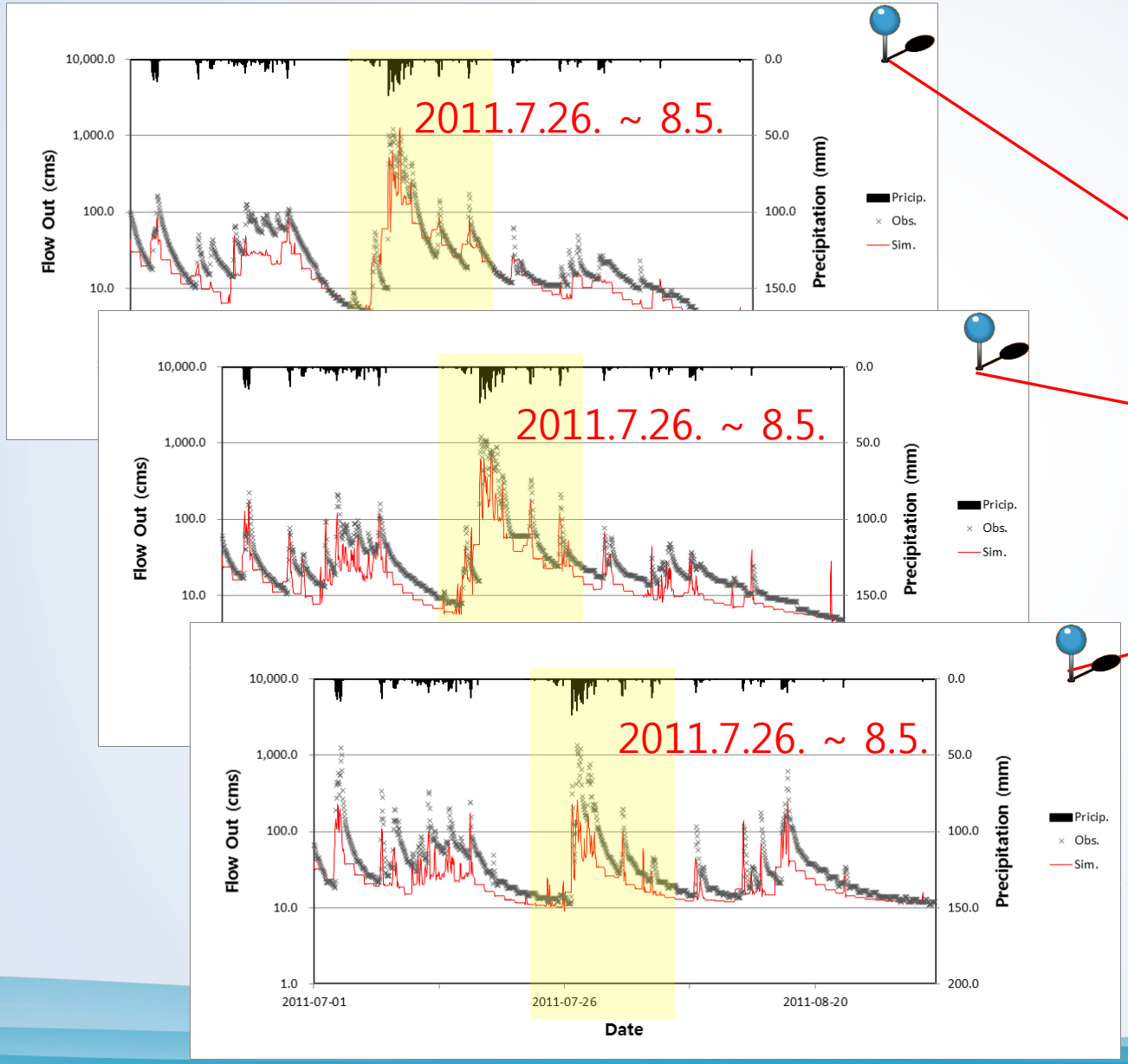
Daily



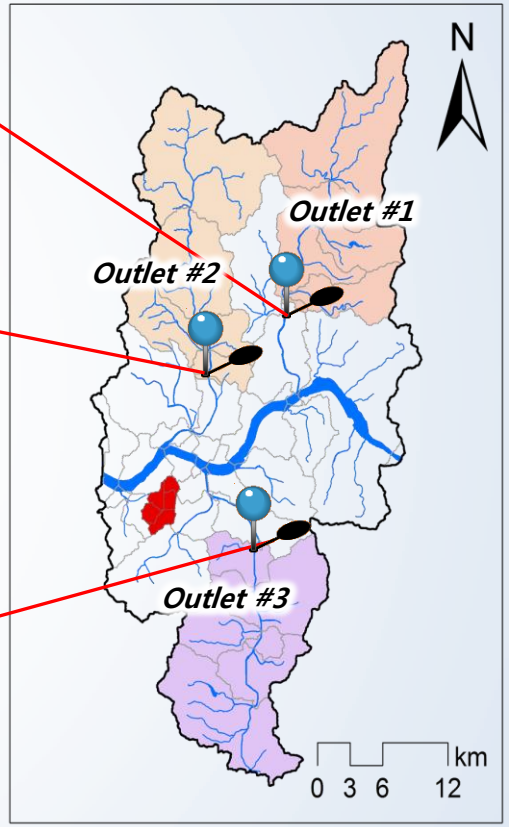
	Cal.	Val.
R^2	0.75	0.85
NS	0.54	0.85
RMSE	34.7	571.3

Hourly Simulation

Weather Information Service Engine



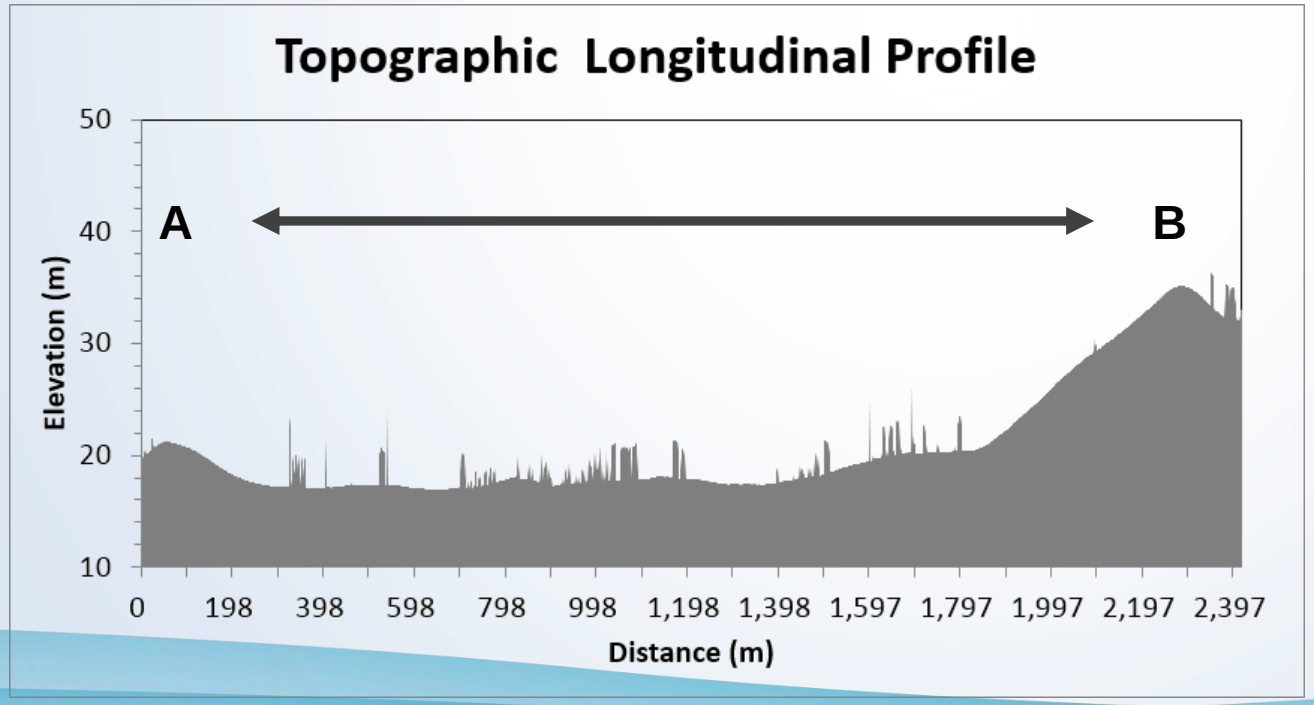
Hourly

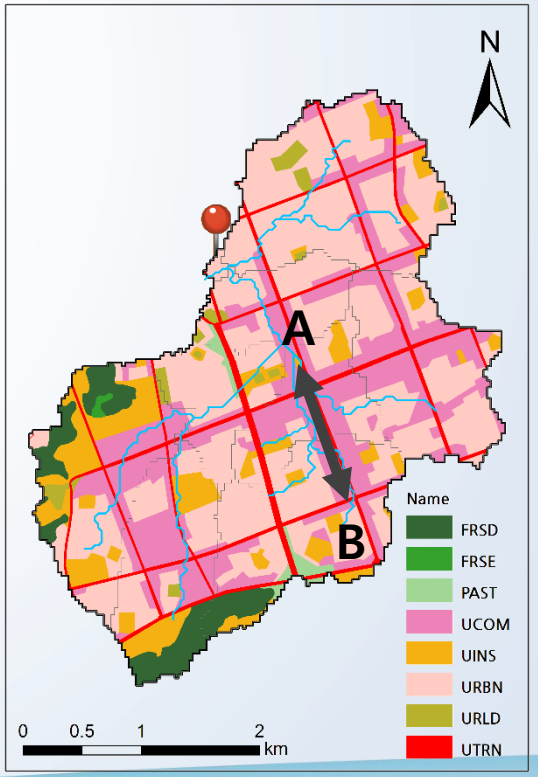


	#1	#2	#3
R^2	0.42	0.62	0.57
NS	0.36	0.41	0.12
RMSE	177.9	198.6	189.5

Small Ungauged Urban Catchment: Gangnam

- Heavy Urbanization Since Late 1960s
- Remained as Steep Slop Small Ungauged Urban Catchment
- Ineffectively Designed Urban Drainage / Sewer Systems
- Intensive Road Networks Accelerate Excess Water to Get Lower Lying Areas





Surface Flow Analysis

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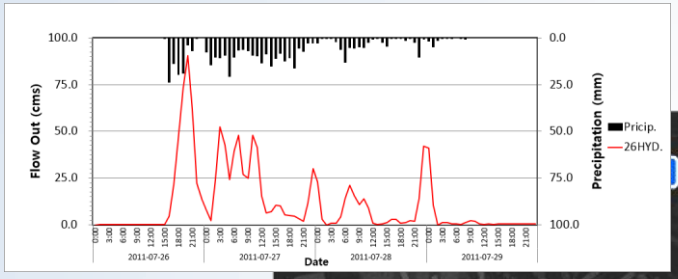
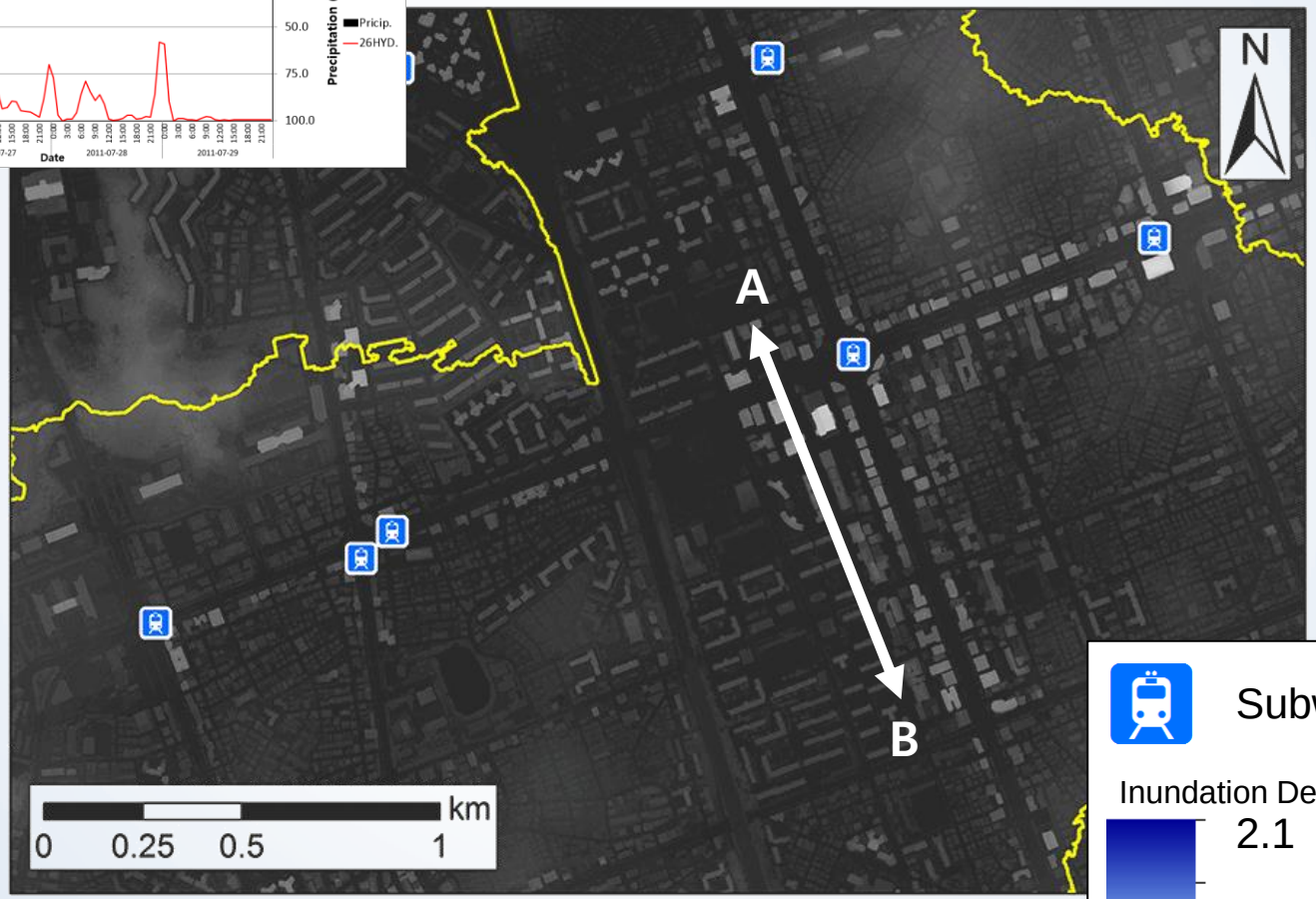
Flood Risk Map





Subway Station

Inundation Depth (m)

2.1

0.1

Summary & Conclusions

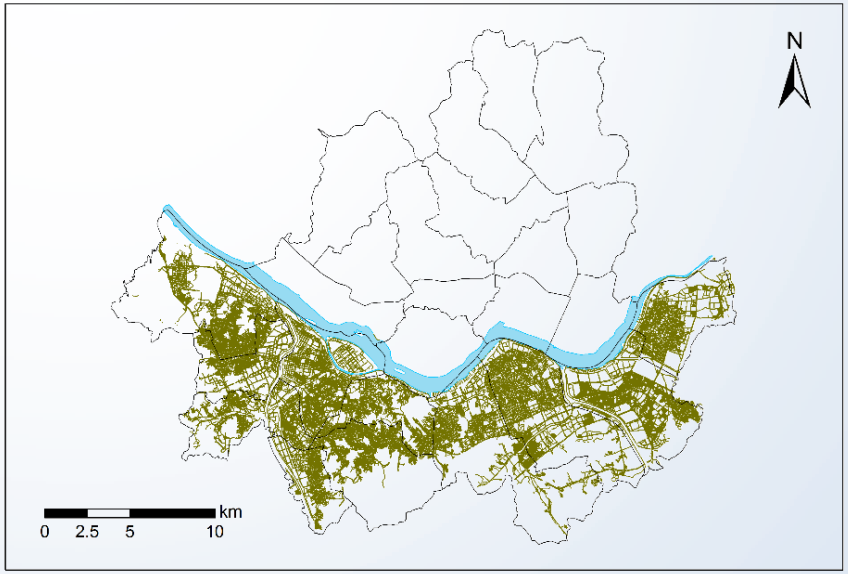
Weather Information Service Engine

- This preliminary study is an on-going work as a part of the WISE (Weather Information Service Engine) project and purposes to forecast and prevent weather disaster, especially is focused on urban flash flood.
- The practice target of urban flash flood was occurred on July 26th 2011.
- This urban flash flood and flooding inundation at rainy season were simulated with coupling hydrologic (SWAT) and hydraulic (HEC-RAS) models.
- Undoubtedly, the simulated flooding inundation results were over / under estimated because of the lack of sewer network system analysis.

Forward

Weather Information Service Engine

- Parameter Optimization for Urban Ungauged Catchment
- Uncertainty Analysis
- Sensitivity Analysis
- Sewer Network Analysis
- Predict Lag Time Delayed Under Various Range of Intensive Rainfalls (What If)



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Thank You for Listening

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Weather Information Service Engine

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KMA Korea Meteorological Administration