2010 SWAT Korea

Evaluation of Mixed Forest Evapotranspiration and Soil Moisture using Measured and SWAT Simulated Results in a Hillslope Watershed

5 August 2010

JOH, Hyung-Kyung
Graduate Student

LEE, Ji-Wan / SHIN, Hyung-Jin / PARK, Geun-Ae
Graduate Student / Ph. D. Candidate / Ph.D.

KIM, Seong-Joon
Professor

Soil & Water Assessment Tool | SWAT

Dept. of Civil and Environmental System Eng.,
Konkuk University, Seoul, South Korea

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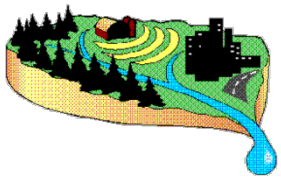
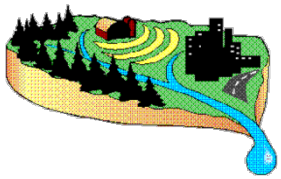
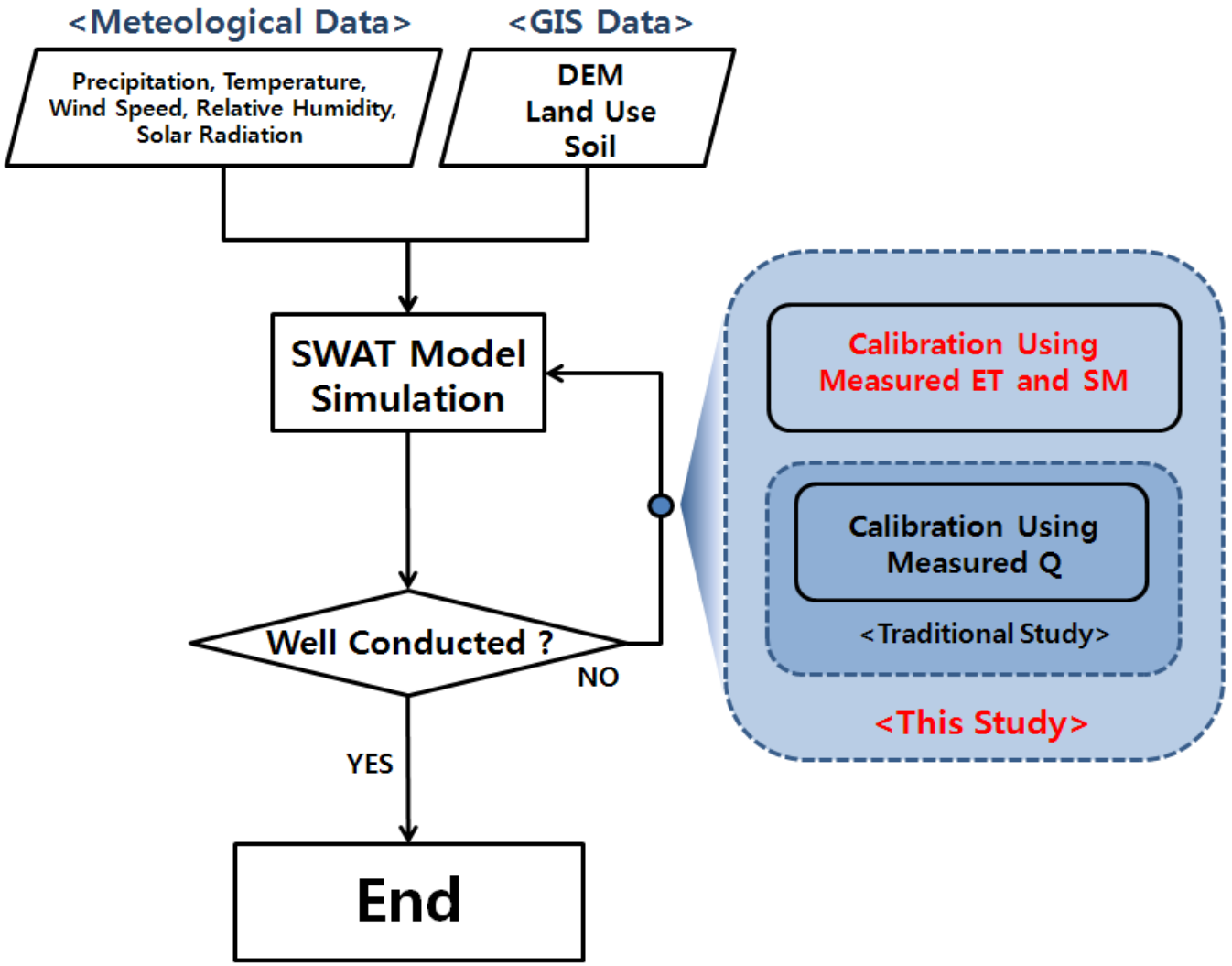


Purpose of this study

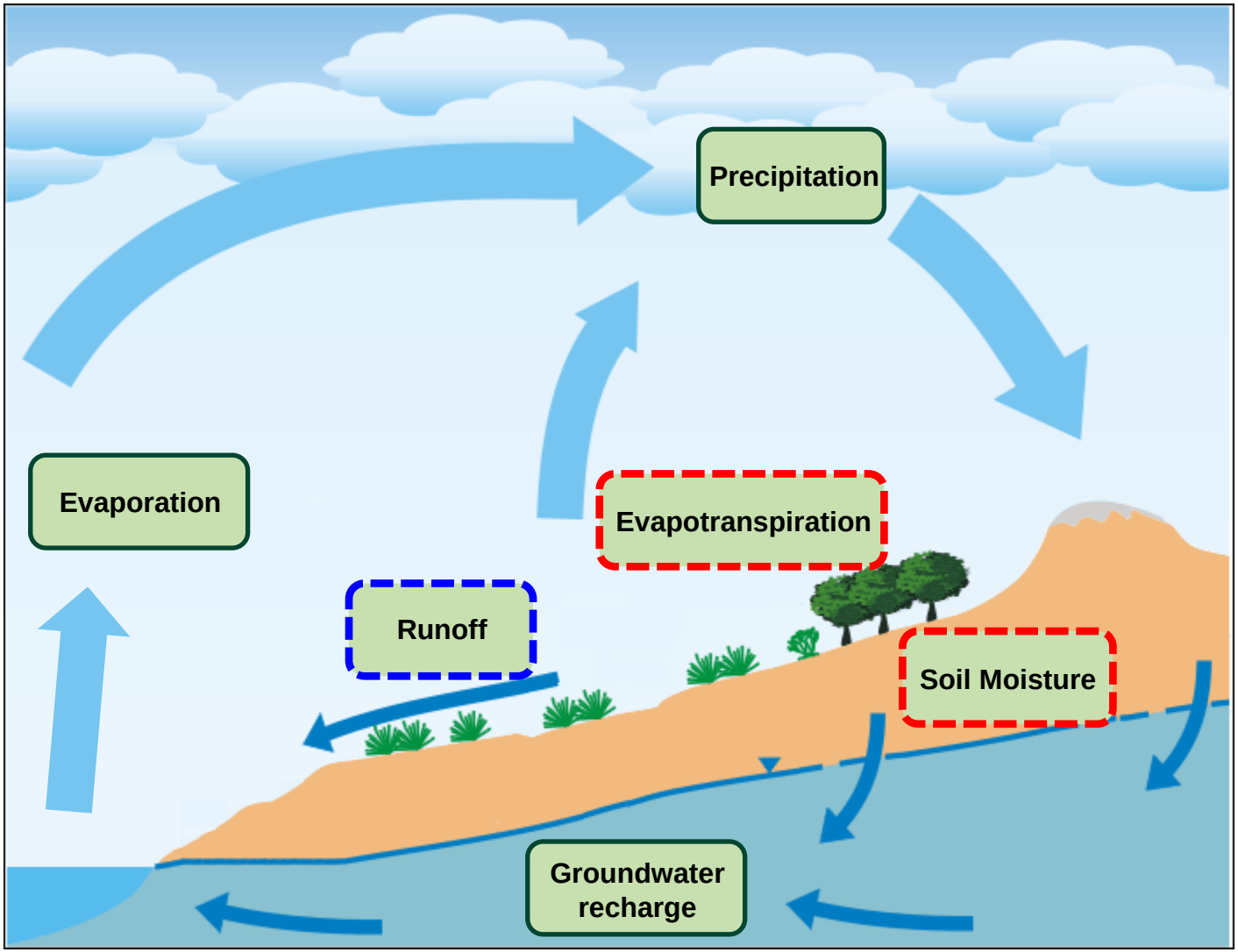


- ✓ In many SWAT modeling researches, the streamflow was the single most commonly used watershed response variable.
- ✓ However, considering numerous sources of uncertainty and the complexity of recently developed models, the approach often has errors to generate consistent parameter sets.
- ✓ One of possible methods to reduce calibration uncertainty is to utilize of additional observation data, and this utilization can explain the hydrological behaviors more accurately within the watershed.
- ✓ **Accordingly, this study is to evaluate the SWAT model by using measured streamflow (Q), evapotranspiration (ET) and soil moisture (SM). This evaluation is expected to improve the ability of model predictions.**

Study procedure

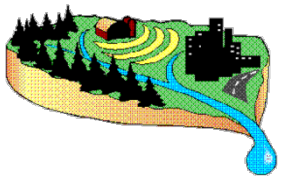


Hydrologic Cycle



http://www.bgr.bund.de/nn_335088/EN/Themen/Wasser/Bilder/Was__wasser__startseite__wasserkreis__g__en.html

Model theory



Water balance equation

- ✓ The hydrology cycle as simulated by SWAT is based on the water balance equation:

$$SW_t = SW_0 + \sum_{i=1}^{t}(R_{day} - Q_{surf} - E_a - w_{seep} - Q_{gw})$$

SW_t = *Final soil water content (mm)*

SW_0 = *Initial soil water content on day i (mm)*

R_{day} = *Amount of precipitation on day i (mm)*

Q_{surf} = *Amount of surface runoff on day i (mm)*

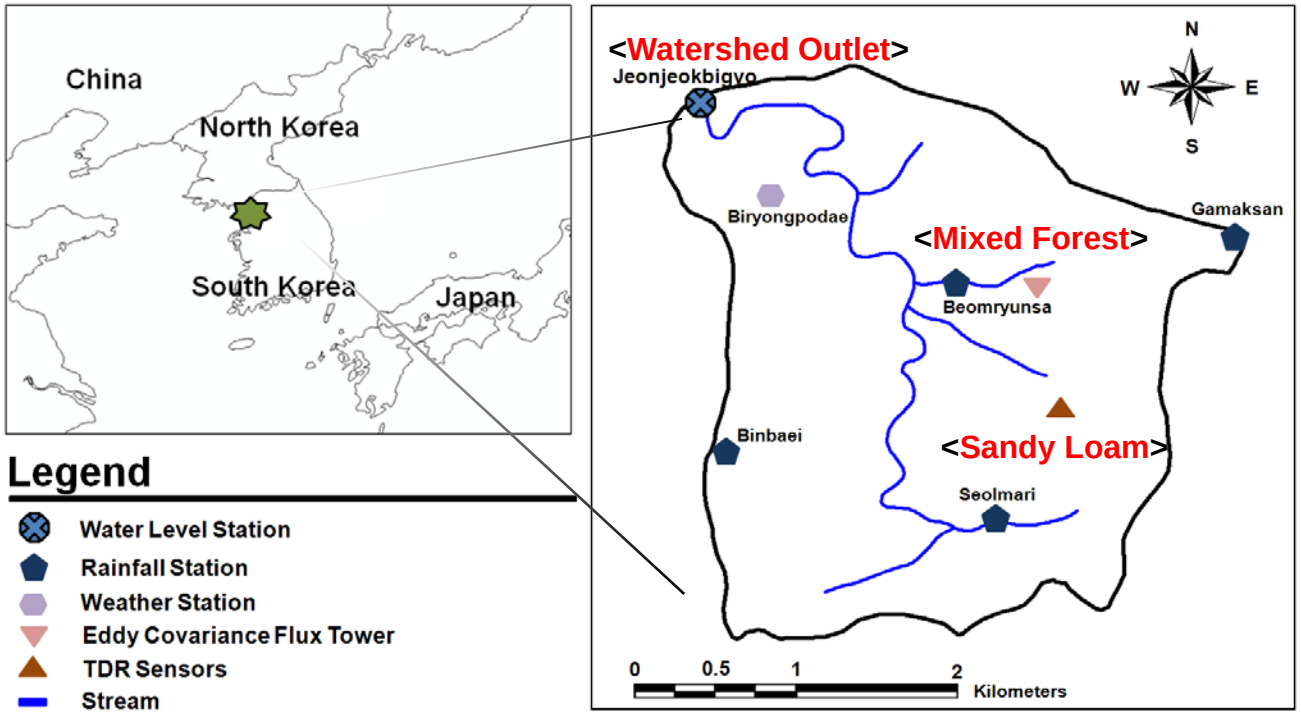
E_a = *Amount of evapotranspiration on day i (mm)*

W_{seep} = *Amount of water entering the vadose zone from the soil profile on day i (mm)*

Q_{gw} = *Amount of return flow on day i (mm)*

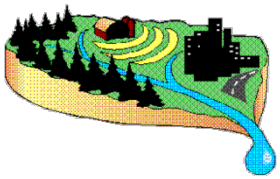
Study Area

Seolma-Cheon watershed



- ✓ Watershed area : 8.54 km^2
- ✓ Annual average precipitation : 1,210 mm
- ✓ Annual average temperature : 10.3 ℃
- ✓ Forest area : 96.2 % (8.22 km^2)
- ✓ Soil texture : Sandy loam, Loam

Gauge Stations



Streamflow gauge system

- ✓ In general, observation of Q is used in planning and designing water resources projects.
- ✓ Q is measured by Korean Institute of Construction and Technology using Parshall Flume systems at watershed outlet.

http://seolmacheon.kict.re.kr/main/codex/survey/page.jspx?id=discharge

Gauge Stations

Eddy covariance flux system

- ET is frequently a major component of water balance for many different types of ecosystems, and is a flux linking water, energy and carbon cycles.
- The accurate estimation of water loss by ET is very important for assessing water availability and requirements, making proper water resources plans, and calibrating and improving hydrologic models.
- Thus, the ET is observed by Korea Institute of Construction and Technology and Yonsei Univ. using Eddy covariance flux system, micrometeorologic observing system on the tower at mixed forest area since 2007.

http://hsc.re.kr/main/sub02_01_04.html

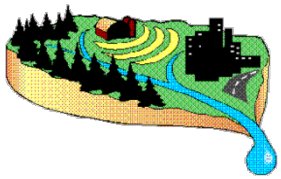
Gauge Stations

Soil moisture gauge system

- ✓ SM conditions controls many near surface processes including land-surface-atmosphere, land surface fluxes, vegetation phenology, and soil respiration.
- ✓ SM is also a very important water balance component for making water resources plans, and calibrating and improving hydrologic models.
- ✓ SM is measured by Korean Institute of Construction and Technology using Time Domain Reflectometry (TDR) sensors at sandy loam and mixed forest area since 2007.

http://hsc.re.kr/main/sub02_01_03.html

Input and Measured Data

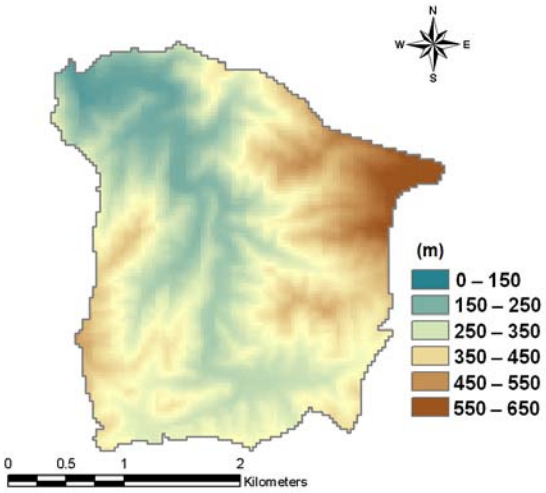


Data set for SWAT model

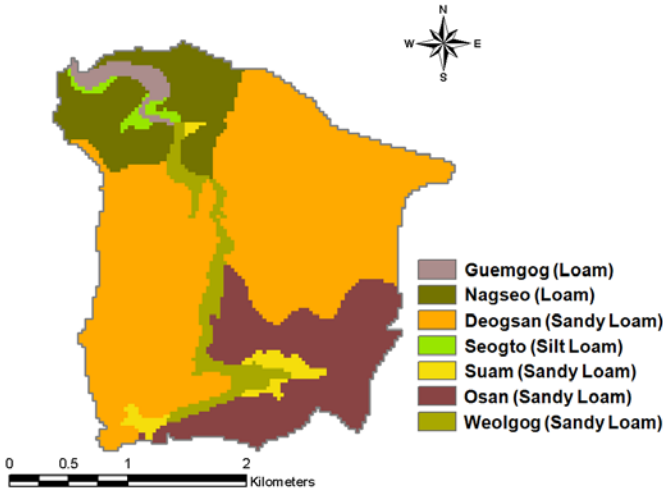
Data Type	Source	Scale / Periods	Data Description / Properties
Terrain	Korea National Geography Institute	30 m	Digital Elevation Model (DEM)
Soil	Korea Rural Development Administration	1/25,000	Soil classification and physical properties viz. texture, porosity, field capacity, wilting point, saturated conductivity, and soil depth
Land use	2004 Landsat TM Satellite Image	1/25,000	Landsat land use classification (8 classes)
Weather	Korea Institute of Construction Technology / WAter Management Information System	2003-2008	Daily precipitation, minimum and maximum temperature, mean wind speed and relative humidity data
Streamflow	Korea Institute of Construction Technology	2003-2008	Daily streamflow data at watershed outlet
Evapotranspiration	Korea Institute of Construction Technology / Yonsei Univ.	2007-2008	Daily evapotranspiration data at mixed forest area
Soil Moisture	Korea Institute of Construction Technology	2007-2008	Bihourly soil moisture data at mixed forest and sandy loam area

GIS Input Data

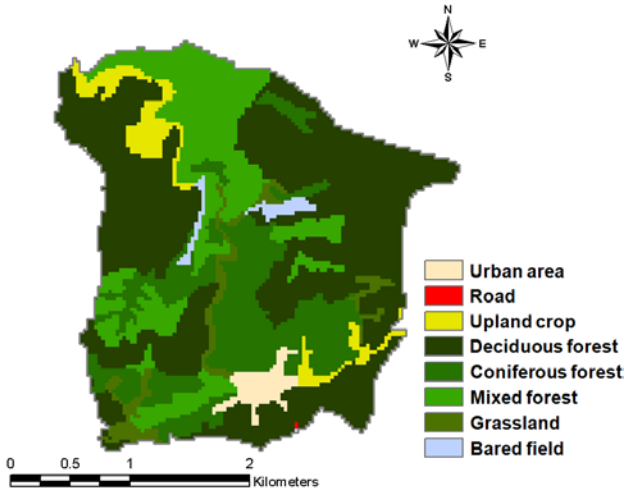
- **SWAT Input data**



(a) DEM



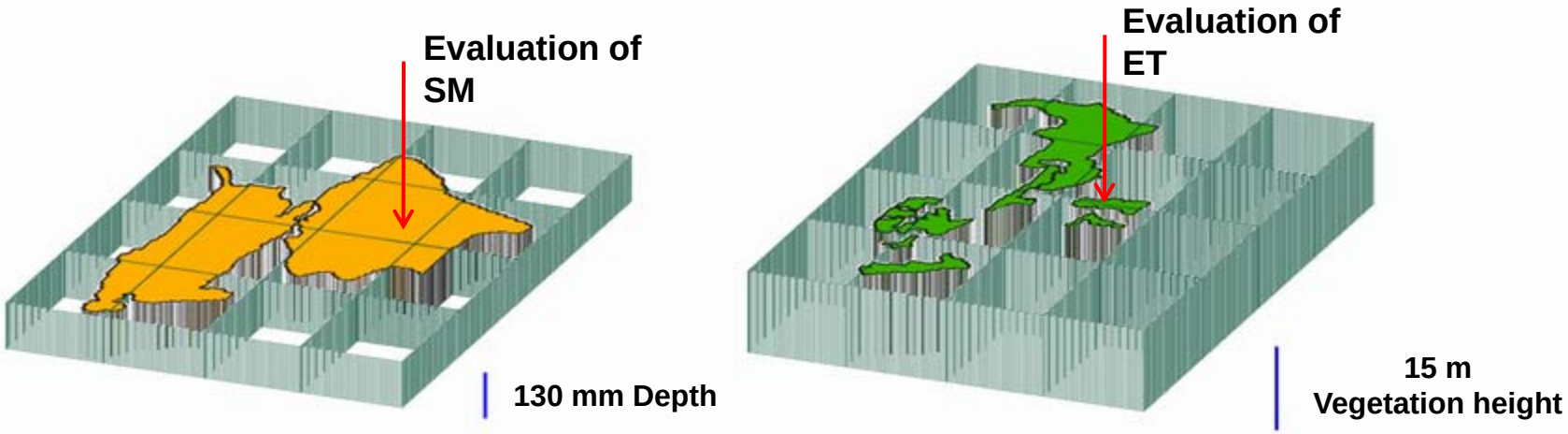
(b) Soil



(c) Landuse

GIS Input Data

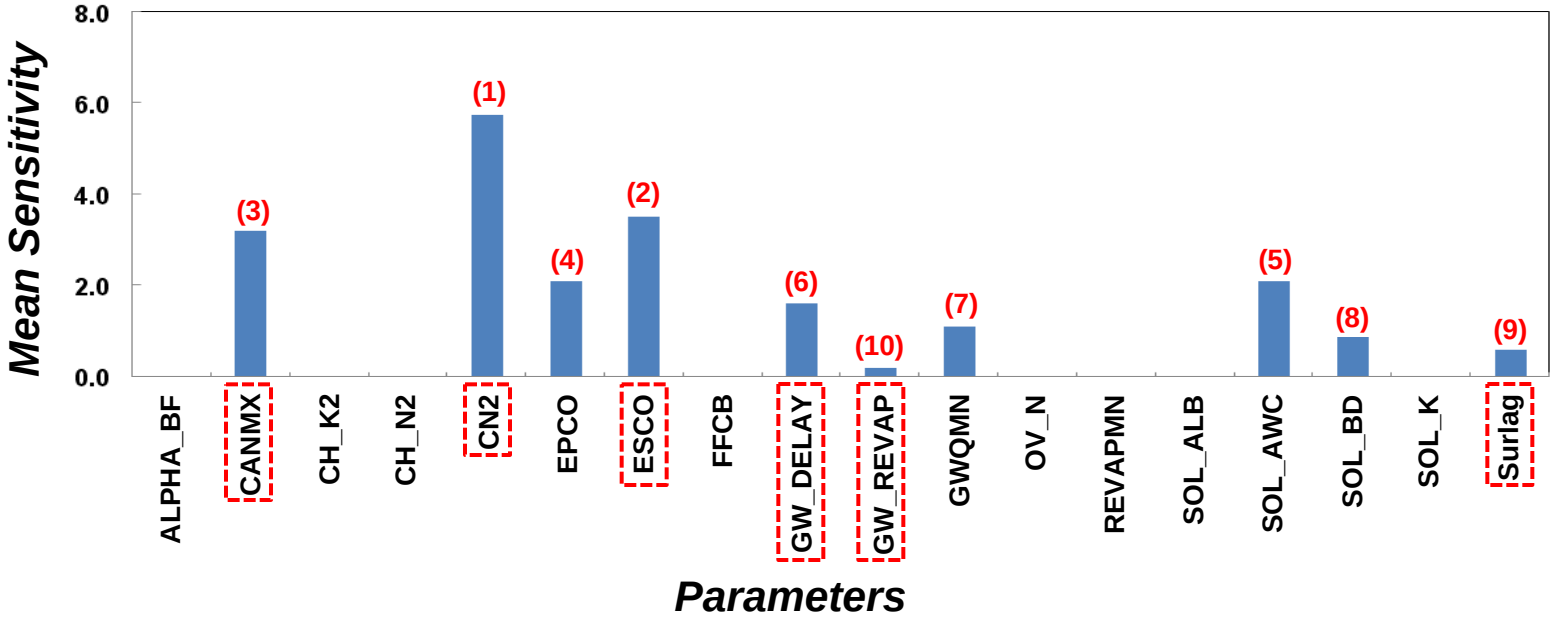
- **SWAT Input data**



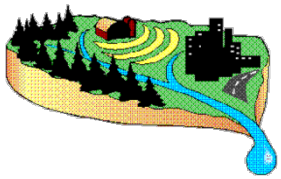
Sensitivity Analysis (SA)

Latin Hypercube (LH) – One-factor-At-a-Time (OAT)

- ✓ A parameter **SA** provides insights on which parameters contribute most to the output variance due to input variability. In this study, we performed an **LH-OAT** SA.
- ✓ The SA was performed for 18 parameters of hydrology that are related to Q, ET and SM.
- ✓ The parameters for the calibration were selected by the SA results.



Calibrated parameters



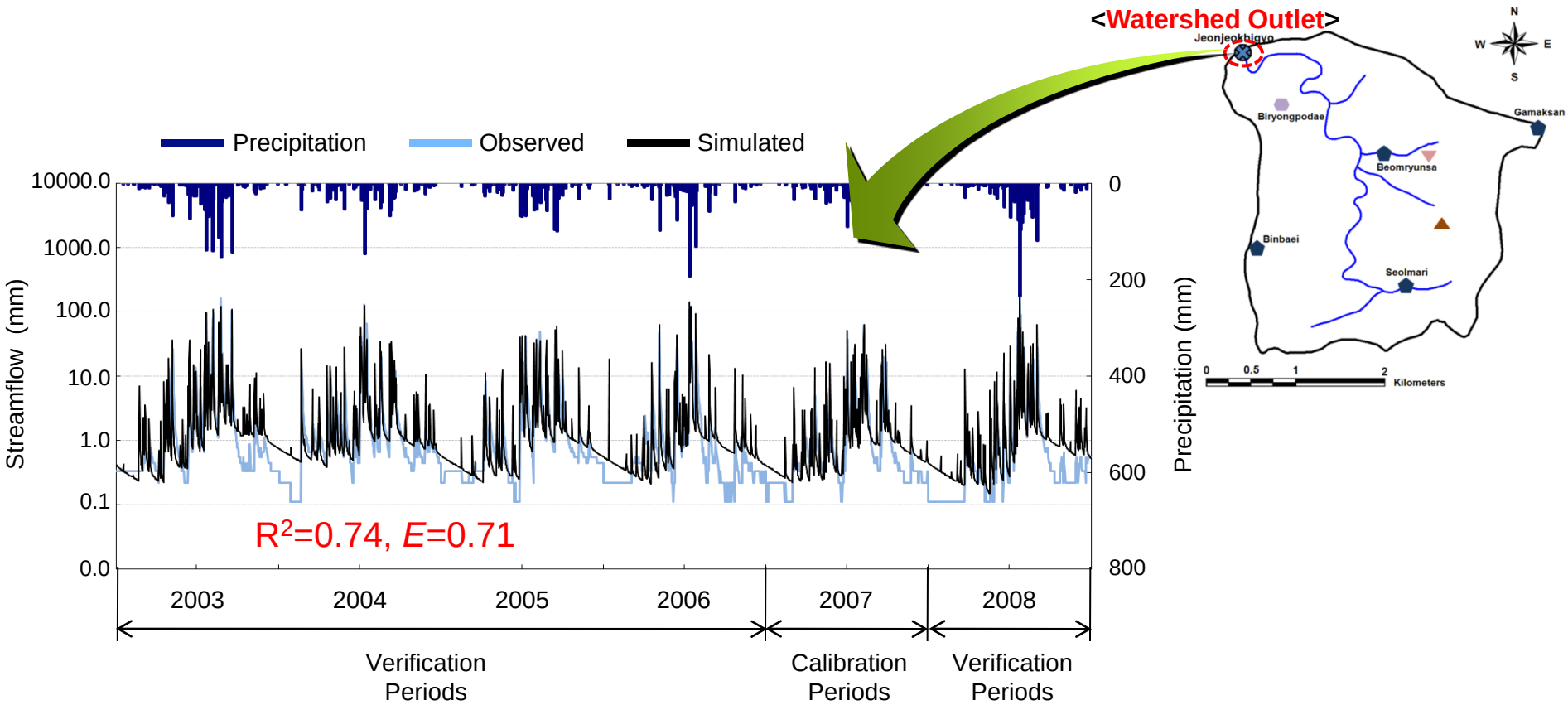
Calibrated parameters for SWAT model

	Parameters	Description	Range	Adjusted Values	Abraham et al. (2007)	Feyereisen et al. (2007)
Q	CN2	SCS curve No. for moisture condition	35 ~ 98	70	-25 %	50
	GWQMN	Threshold depth of water in the shallow aquifer required for return flow to occur	-1000 ~ 1000	0	10	0
	GW_DELAY	Groundwater delay	0 ~ 500	100	20	1
	GW_REVAP	Groundwater “revap” coefficient	0.02 ~ 0.2	0.2	0.15	0.02
	Surlag	Surface runoff lag coefficient	1 ~ 24	24	-	-
ET	CANMX	Maximum canopy storage	0 ~ 100	5	-	-
	EPCO	Plant uptake compensation factor	0 ~ 1	1	-	-
	ESCO	Soil evaporation compensation factor	0 ~ 1	0.01	0.1	0.74
SM	CANMX	Maximum canopy storage	0 ~ 100	5	-	-
	ESCO	Soil evaporation compensation factor	0 ~ 1	0.01	0.1	0.74
	SOL_AWC	Available water capacity of the soil layer	0 ~ 1	0.15	-	-
	SOL_BD	Moist bulk density	0.9 ~ 2.5	1.6	-	-

Calibration and Verification

Discharge

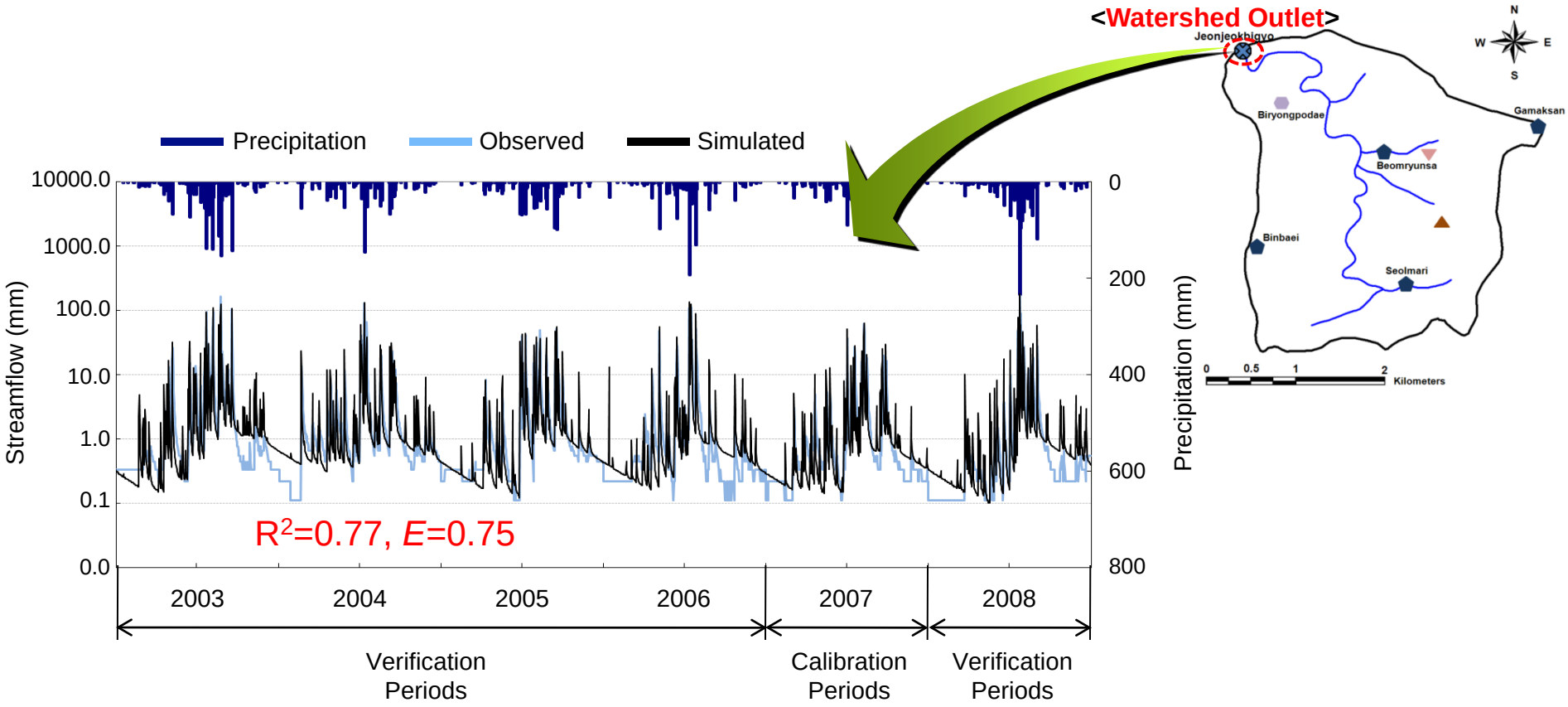
- ✓ Calibration period : 2007 / Verification period : 2003-2006, 2008
- ✓ Using daily streamflow records



Calibration and Verification

Discharge

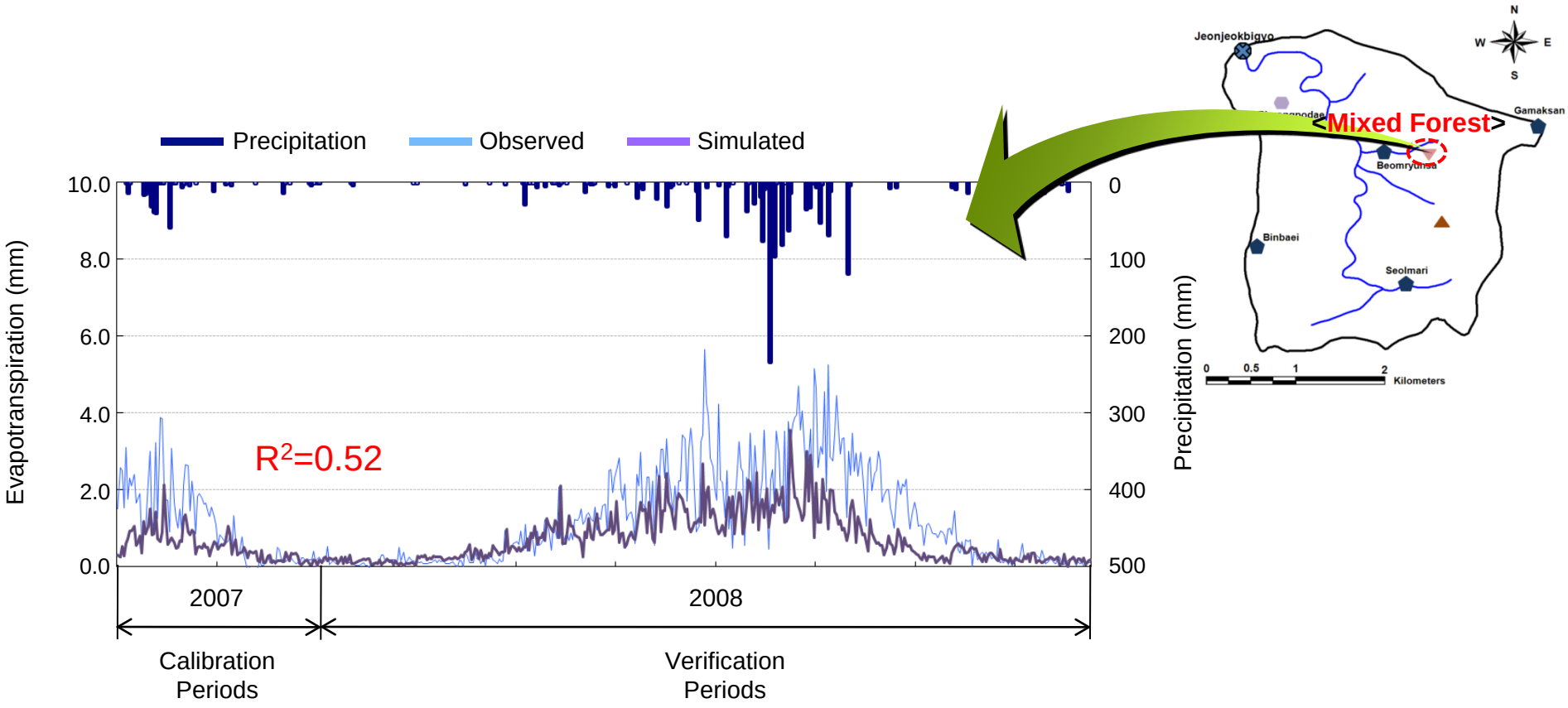
- ✓ Calibration period : 2007 / Verification period : 2003-2006, 2008
- ✓ Using daily streamflow, evapotranspiration and soil moisture records



Calibration and Verification

Evapotranspiration

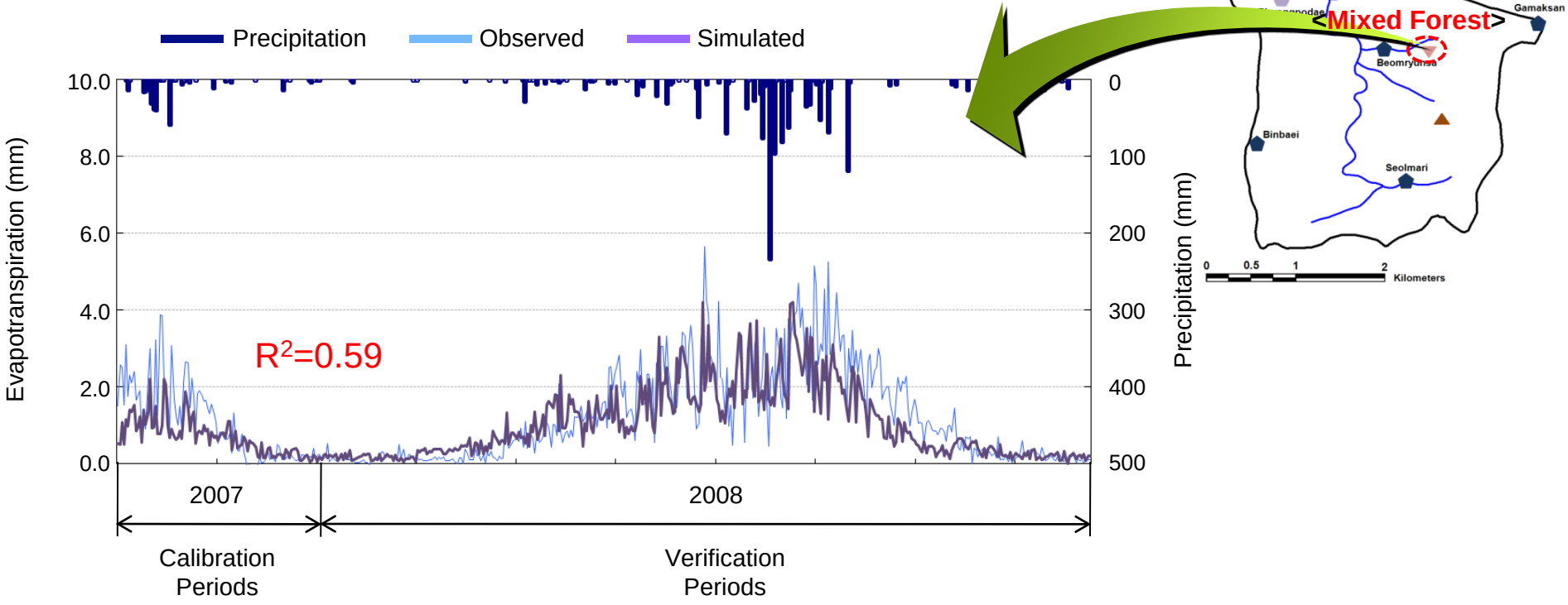
- ✓ Calibration period : 2007 / Verification period : 2008
- ✓ Using daily streamflow records



Calibration and Verification

Evapotranspiration

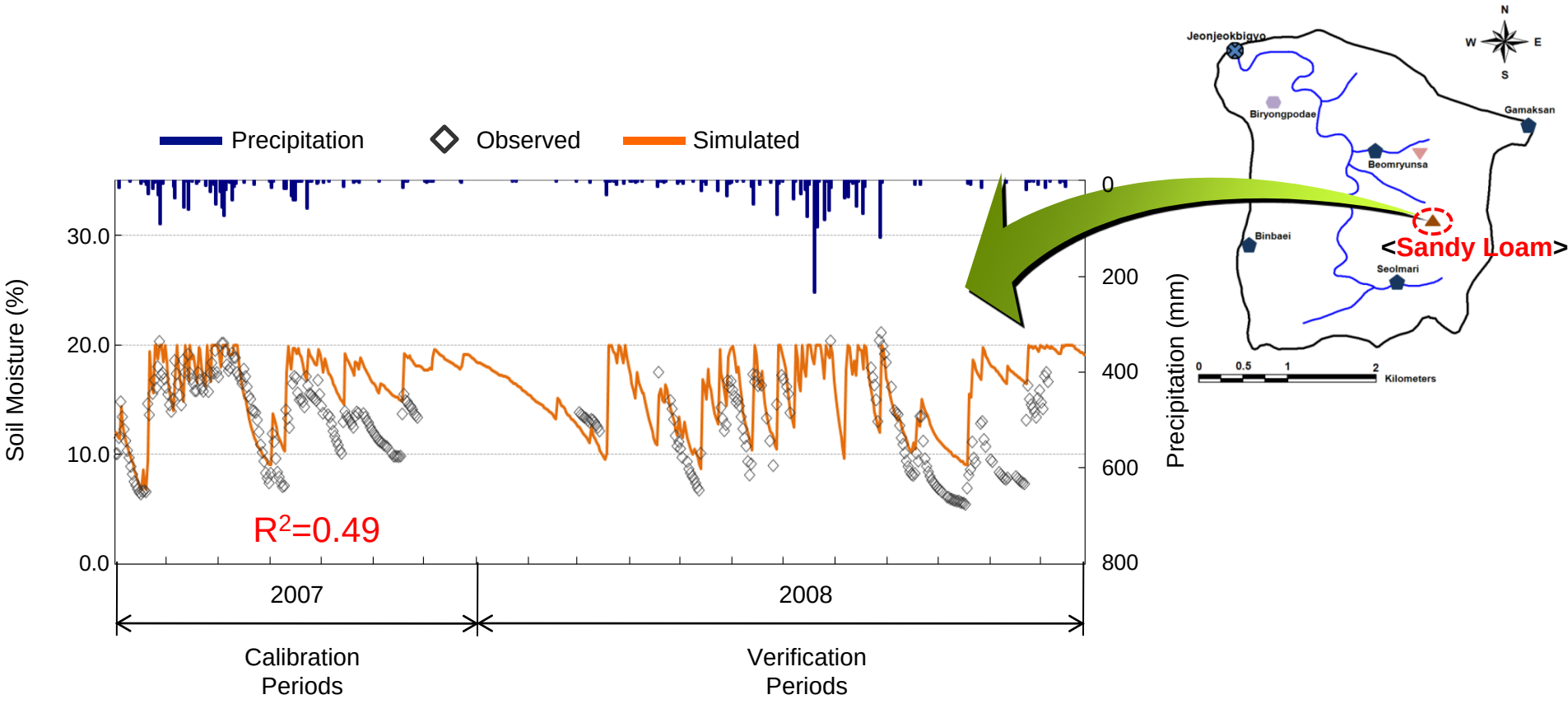
- ✓ Calibration period : 2007 / Verification period : 2008
- ✓ Using daily streamflow, evapotranspiration and soil moisture records



Calibration and Verification

Soil moisture

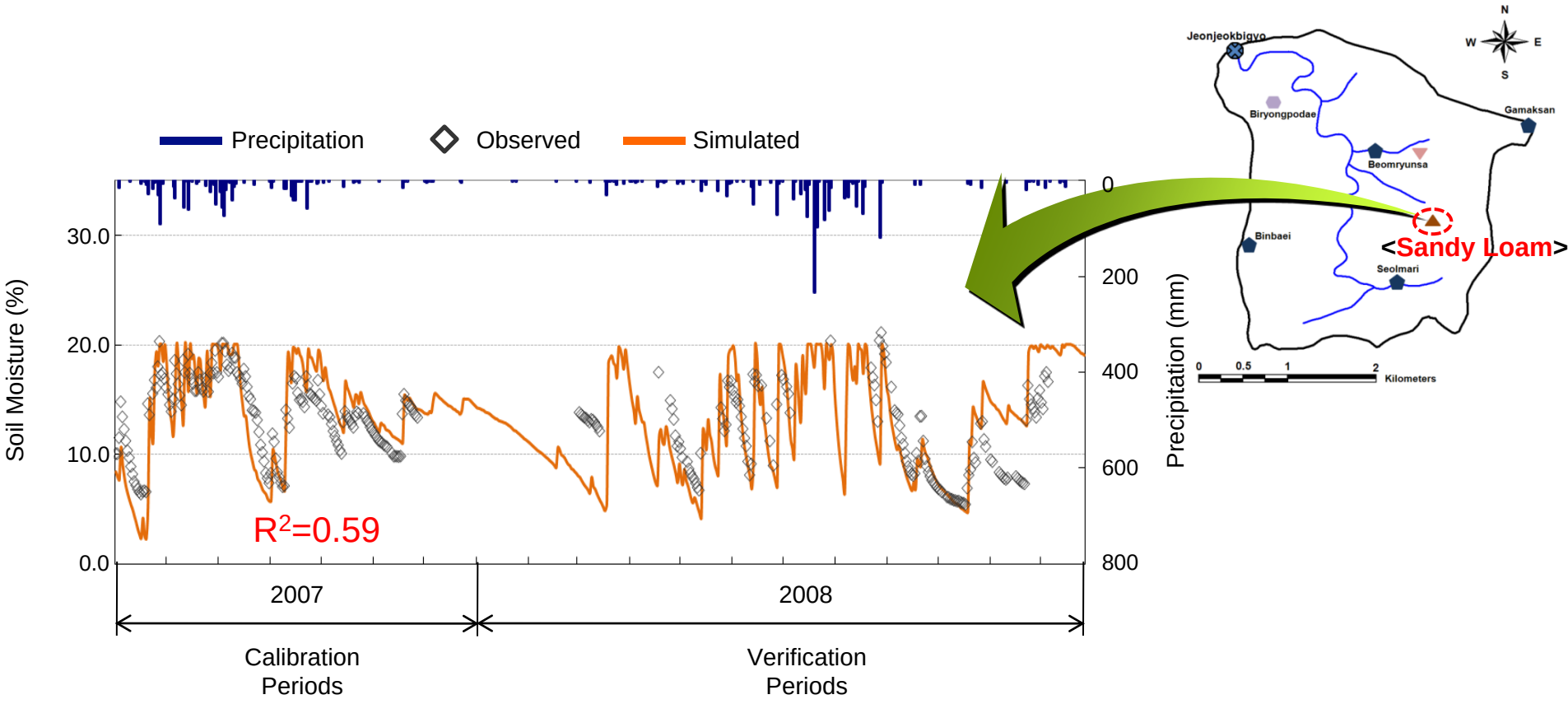
- ✓ Calibration period : 2007 / Verification period : 2008
- ✓ Using daily streamflow records



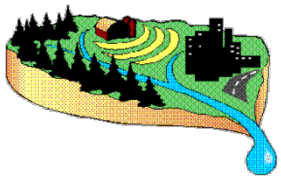
Calibration and Verification

Soil moisture

- ✓ Calibration period : 2007 / Verification period : 2008
- ✓ Using daily streamflow, evapotranspiration and soil moisture records



Summary and Conclusion



- ✓ This study was tried to identify uncertainty of SWAT model parameters by evaluating the model using measured ET and SM data.
- ✓ After all, the model results were improved when the calibration was conducted using measured data.
- ✓ **The capability of the behavior of the simulation model and uncertainty analysis methodology could be more effectively tested if the calibration and verification could be applied to a 'data rich' watershed.**

This research was supported by a grant (code # 2-2-3) from Sustainable Water Resources Research Center of 21st Century Frontier Research Program and by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2009-0080745).

“ Thank You ”

For further information, please contact:

JOH, Hyung-Kyung
Graduate student, Dept. of Civil & Environmental System Engineering, Konkuk University
jawbreak@konkuk.ac.kr

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Dept. of Civil and Environmental System Eng.,
Konkuk University, Seoul, South Korea