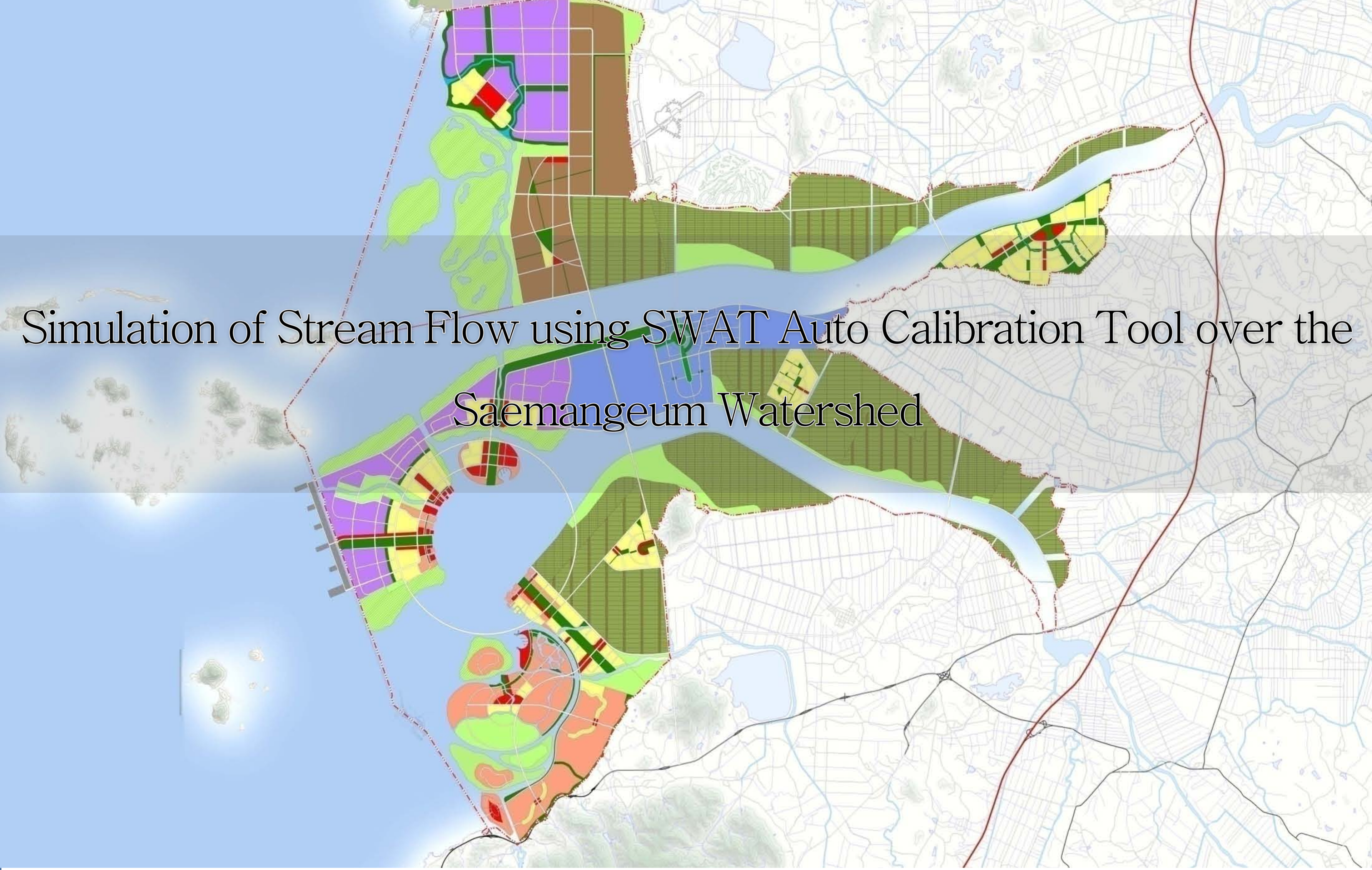

# Simulation of Stream Flow using SWAT Auto Calibration Tool over the Saemangeum Watershed

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# Contents

# Ⅰ. Introduction

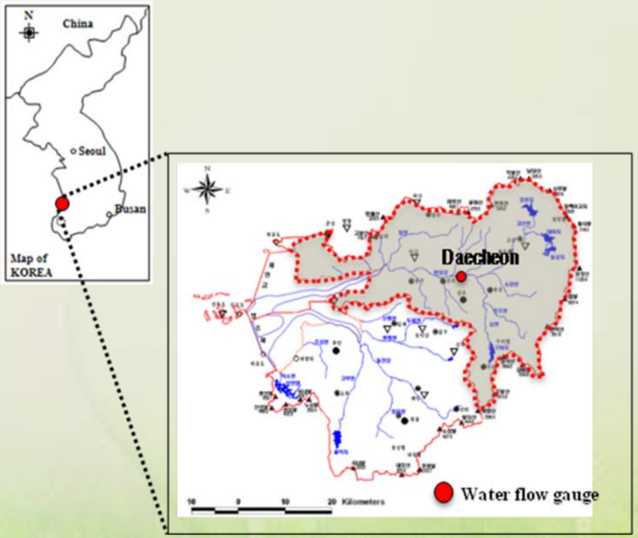
# Introduction

- ❖ For efficient water quality management of Samangeum lake, long-term prediction of stream flow is required.
- ❖ There are several methods of stream flow estimation such as stream flow monitoring, application of regression equation or hydrological model.
- ❖ Stream flow monitoring for the entire Samangeum watershed is not feasible due to cost and labor.
- ❖ Therefore, application of a hydrological model was attempted to estimate long-term stream flow.
- ❖ The Soil and Water Assessment Tool(SWAT) was chosen in this study to estimate stream flow of the watershed.
- ❖ Applicabality of SWAT on stream flow was validated by many researcher.
- ❖ However, hydrologic parameters calibration for basin scale such as Samangeum watershed is quite challenging task since huge variations of hydrologic properties of HRU's.
- ❖ So, autocalibration tool was embedded in SWAT version 2005 for easy calibration.
- ❖ The objective of this study is to evaluate the effectiveness of the SWAT's autocalibration tool at Saemangeum watershed.

# Ⅱ. Material and Methods

# Material and Methods

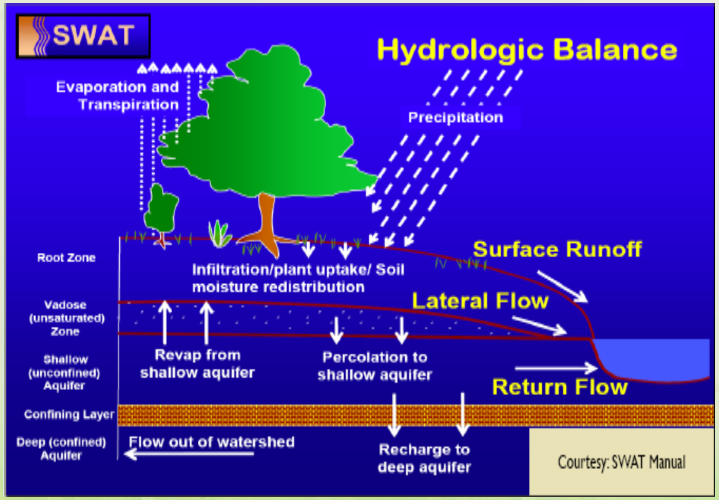
- What is the Saemangeum?
  - Saemangeum is an estuarine tidal flat on the coast of the Yellow Sea in South Korea.
  - The estuary was originally called "Mangeum" (萬金). This name was probably formed from combining the first character of "Mangyeong" and that of "Gimje."
  - Saemanguem was completed in April 27, 2010, officially becoming the longest estuarine ever built with the length of 33.9 km, breaking the record of Zuiderzee Works
- Description site
  - The Mangeong watershed was selected for this study. The watershed is a subwatershed of Saemangeum watershed. The Mangeong watershed(under Saemangeum watershed) area is 1,741 $km^2$ and located near Jeonju city, Jeonbuk, Korea.



# Material and Methods

- SWAT model description
  - SWAT (Soil and Water Assessment Tool) is a conceptual model developed to quantify the impact of land management practices in large, complex catchments (Arnold et al., 1993).
  - SWAT incorporates simulation of weather, crop growth, evapotranspiration, surface runoff, percolation, return flow, erosion, nutrient transport, pesticide fate and transport, irrigation, groundwater flow, channel transmission losses, pond and reservoir storage, channel routing, field drainage, plant water use and other supporting processes.
  - SWAT divides sub-catchments into hydrological response units (HRUs), which are unique combinations of soil and land cover.

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




Where, $SW_t$ : the final soil water content,

$SW_0$ : the initial soil water content,

$R_{day}$ : the amount of precipitation on day i,

$Q_{surf}$ : the amount of surface runoff on day i

$E_a$ : the amount of evapotranspiration on day i,

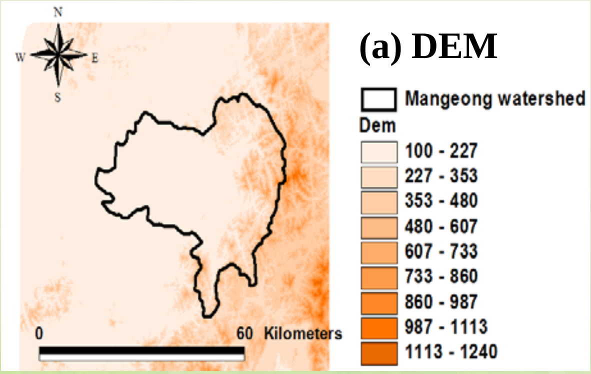
$w_{seep}$ : the amount of percolation and bypass flow exiting the soil profile bottom on day i,

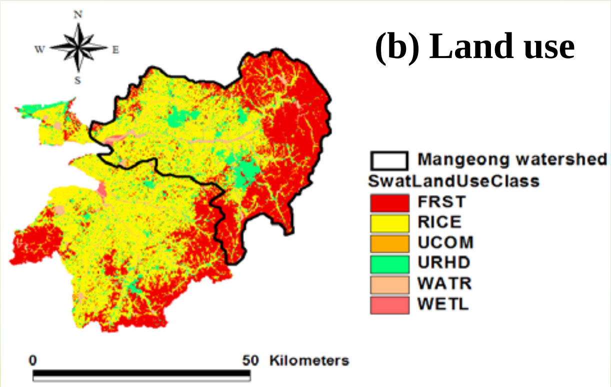
$Q_{gw}$ : the amount of return flow on day i.

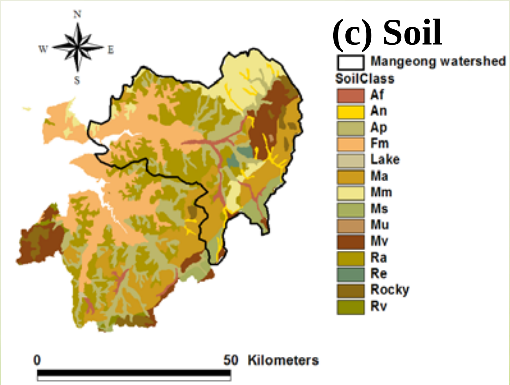
# Material and Methods

◆ Construction of input data for SWAT

- The SWAT model requires inputs on weather, topography, soils, land use and and stream channels, etc.
- Daily values of precipitation, maximum and minimum temperatures, solar radiation, wind speed, and relative humidity were collected from the weather service data of the KMA (Korea Meteorological Administration).
- Land use digital data (1:25,000) were used from the National Geographic Information Institute of MLTM(Ministry of Land, Transport and Maritime Affairs). Six land cover classes are found in this watershed.
- The detailed soil association map (1:25,000) from NIAST (National Institute of Agricultural Science and Technology)was used for the selection of soil attributes. Relational soil physical properties such as texture, bulk density, available water capacity, saturated conductivity, soil albedo, etc., were obtained from the Agricultural Soil Information System of NIAST.



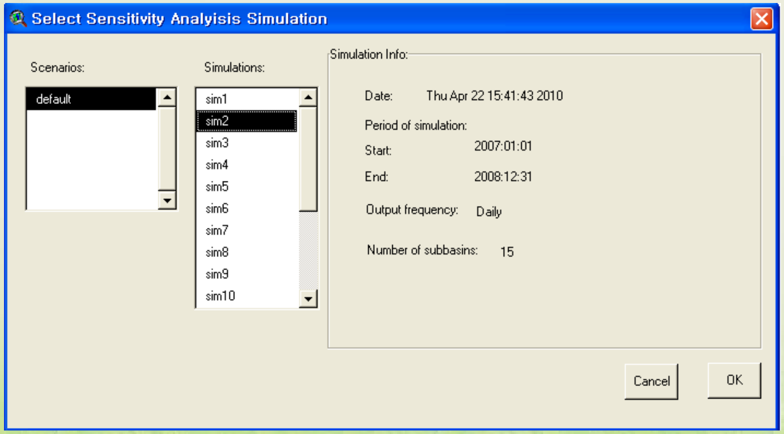



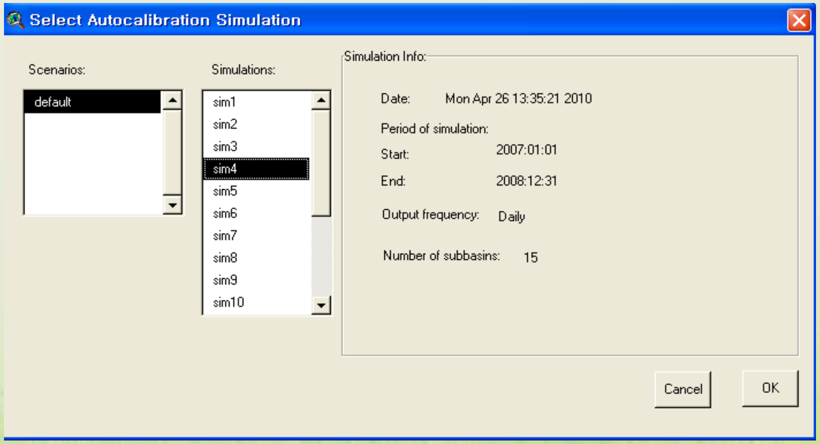



# Material and Methods

◆ Auto-calibration in SWAT 2005

- SWAT is a complex model with many parameters that can complicate manual model calibration.
- A parameter sensitivity analysis tool is embedded in SWAT to determine the relative ranking of which parameters most affect the output variance due to input variability.
- The SWAT model, version 2005 (SWAT2005) has an embedded autocalibration procedure that is used to obtain an optimal fit of process parameters.
- This procedure is based on a multi-objective calibration and incorporates the Shuffled Complex Evolution Method algorithms.



# Material and Methods

- Model evaluation methods

- The performance of SWAT was evaluated using statistical analyses to determine the quality and reliability of the predictions when compared to observed values.

- The goodness-of-fit measures used were the coefficient of determination (R2; Eq. (1)) and the Nashe Sutcliffe efficiency (NSE) value (Eq. (2)) (Nash and Sutcliffe, 1970).

- For this study, the criteria of NSE > 0.5 and $R^2$ > 0.6 were chosen to assess how well the model performed (Green et al., 2006) with results greater than 0.5 and 0.6 for NSE and $R^2$, respectively, meaning that the model performed satisfactorily and results below those numbers intending that the model did not perform well.

$$R^2 = \frac{\left(\sum_{i=1}^{n}(O_i-\overline{O})(P_i-\overline{P})\right)^2}{\sum_{i=1}^{n}(O_i-\overline{O})^2\sum_{i=1}^{n}(P_i-\overline{P})^2} \qquad (1)$$

$$NSE = \frac{\sum_{i=1}^{n}(O_i-\overline{O})^2-\sum_{i=1}^{n}(P_i-O_i)^2}{\sum(O_i-\overline{O})^2} \qquad (2)$$

# III Results and discussion

# Results and discussion

- Sensitivity analysis

- Parameter sensitivity analysis was conducted using SWAT's sensitivity analysis tool.
- The most sensitive parameters were: channel effective hydraulic conductivity(CH_K2), SCS Curve Number II value (CN2), surface runoff lag time(SURLAG), base flow alpha factor (Alpha_Bf), soil evaporation compensation factor(ESCO), and available water capacity (Sol_Awc), respectively. After sensitivity analysis, some important parameters were selected for optimization.
- Calibration of selected parameters was conducted using SWAT autocalibration tool over the Saemangeum Watershed.

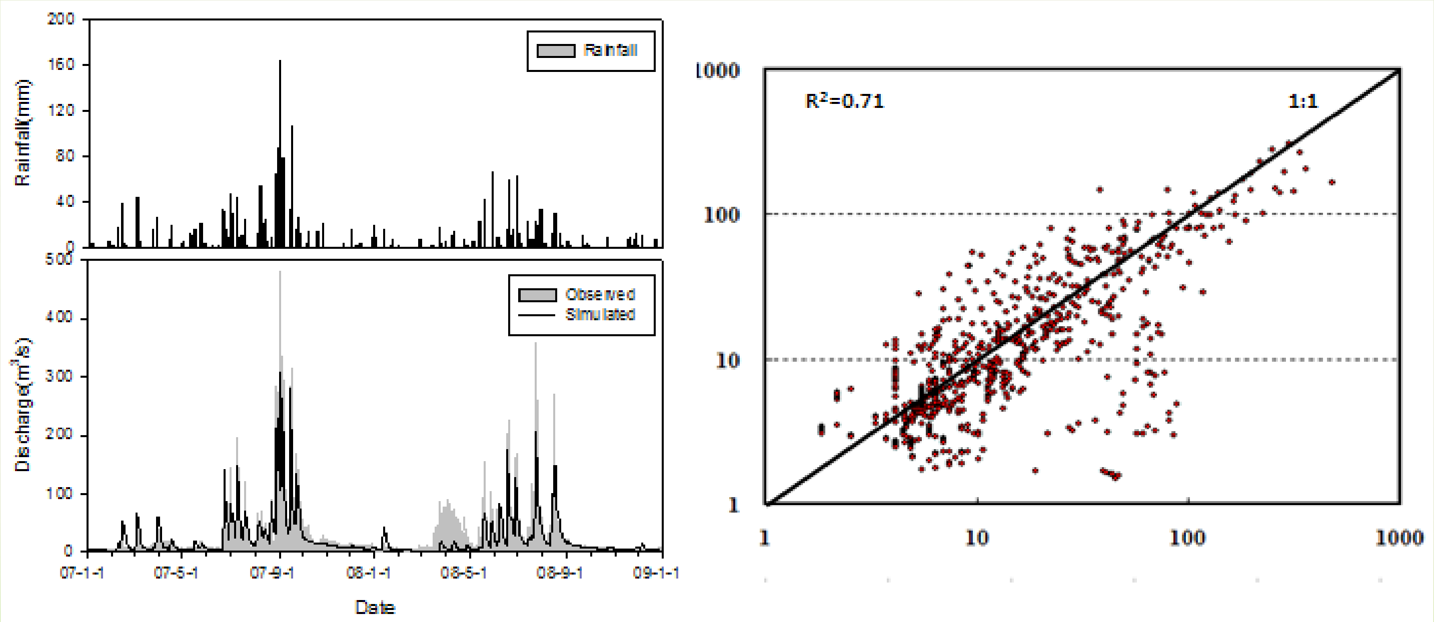
Parameters for calibration in SWAT model

| Parameter | Description | Optimized value |
|---|---|---|
| ESCO | Soil evaporation compensation factor | 0.97 |
| CH_K2 | Effective hydraulic conductivit y in main channel alluvium | 148.5 |
| GW_DALAY | Groundwater delay time | 47.33 |
| SURLAG | Surface runoff lag coefficient | 0.00003 |
| CN2 | Curve number | 58.72 |
| GW_REVAP | Groundwater revap coefficient | 0.17 |
| ALPHA_BF | Baseflow alpha factor | 0.96 |
| SOL_AWC | Avaliable soil water capacity | 0.21 |

# Results and discussion

◆ Hydrologic autocalibration results

- The SWAT model was calibrated using autocalibration tool against 2 hydrologic years(2007-2008) of daily measured runoff at the water flow gauge. Below figures compare the observed and simulated stream flows using SWAT's autocalibration tool during study period.
- The statistics of $R^2$ and NSE were 0.71 and 0.69, respectively. The simulation results showed good agreement with the observed data. It means that auto-calibration tool of SWAT was reliable for the optimization of parameters reflecting Saemangeum Watershed conditions.



# Ⅳ. Conclusions

# Results and discussion

- The ability of the SWAT autocalibration tool to simulate runoff from Saemangeum watershed was assessed in this study. The goodness-of-fit measures demonstrated that SWAT simulations using autocalibration tool explained the daily runoff in the observed data well($R^2$>0.5, NSE>0.4).
- Overall, we identified application of SWAT's autocalibration tool as reliable evidenced by statistical measures.

**Thank you very much indeed**

**for your kind atttention.**

**Have a nice weekend!**