2024 International Watershed Modelling (SWAT) Conference

at NOS Conference Center in Lima, Peru

Sensitive Parameter Analysis of Forest Restoration with *Pinus Kesiya* on Small Watershed, Northern of Thailand

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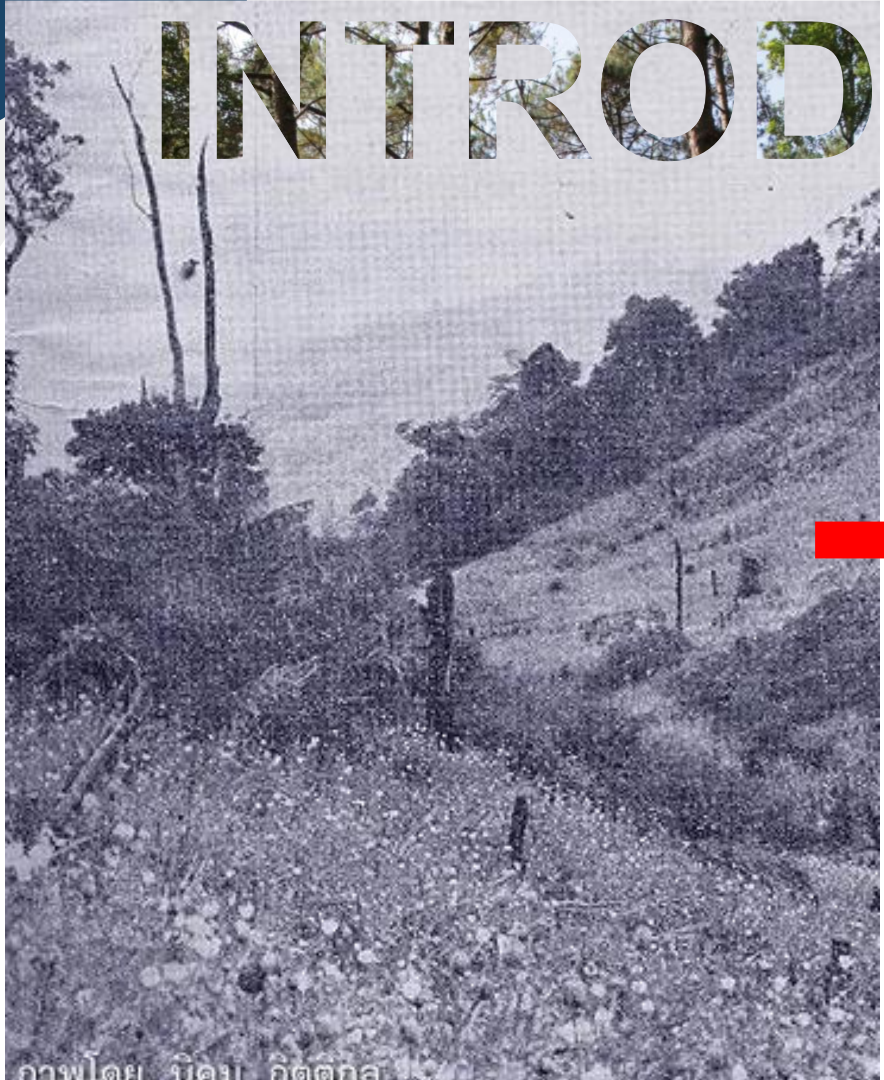
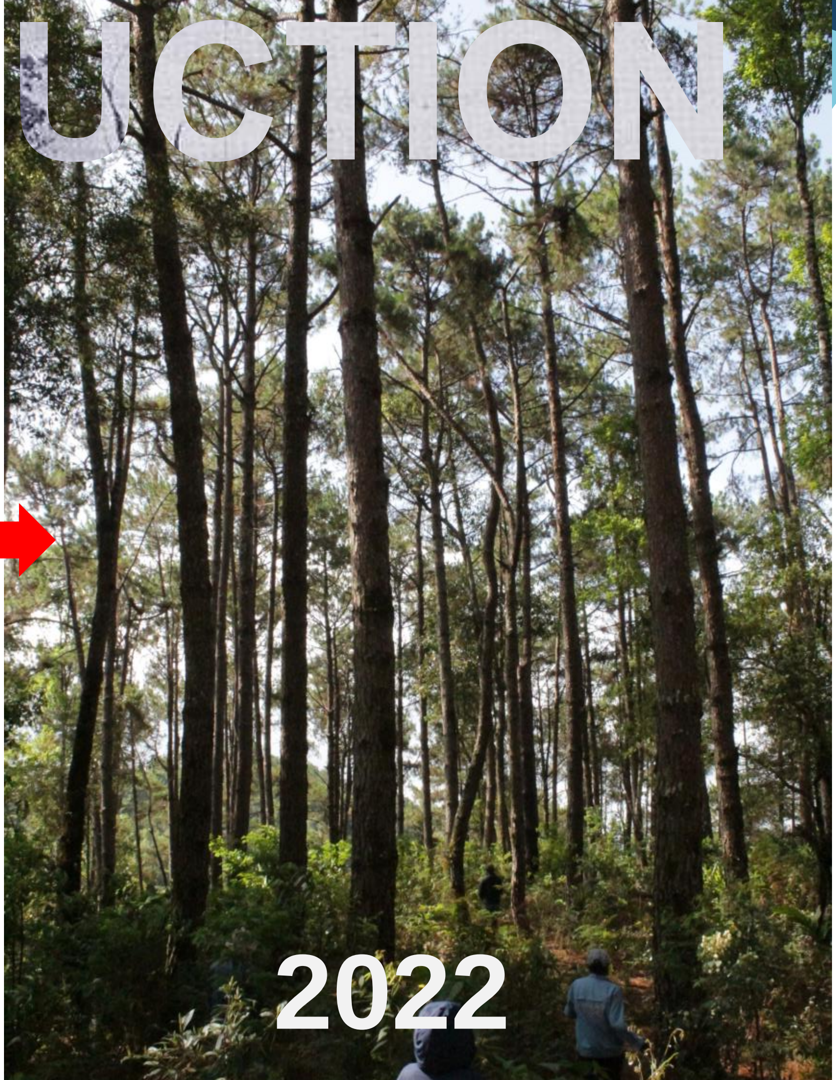
OUTLINE

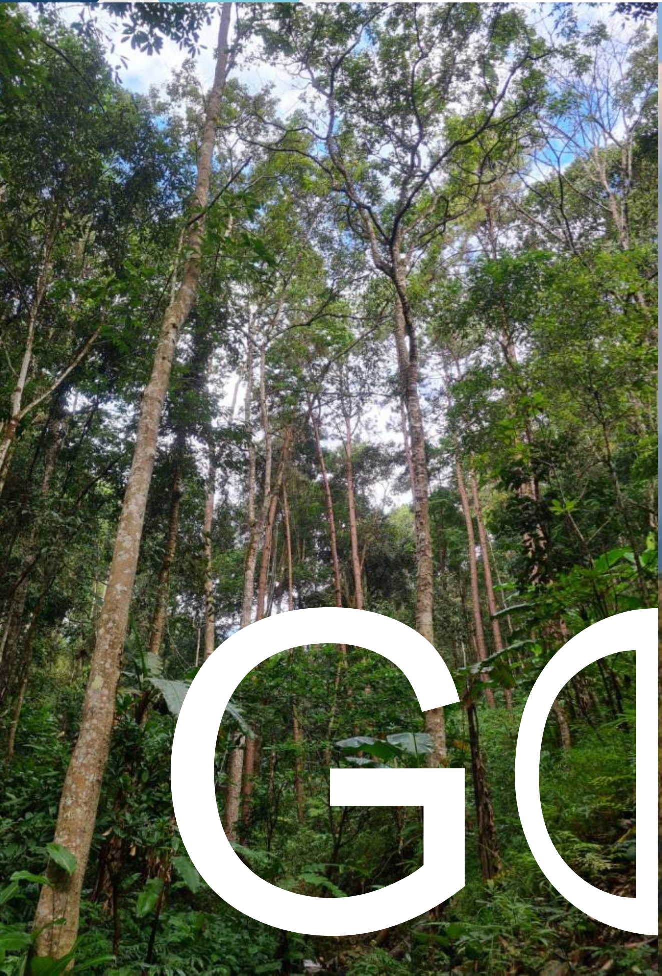
- Introduction
- Study site
- Model setup and simulation
- Sensitive parameter analysis
- Conclusion
- Next project

INTRODUCTION





INTRODUCTION



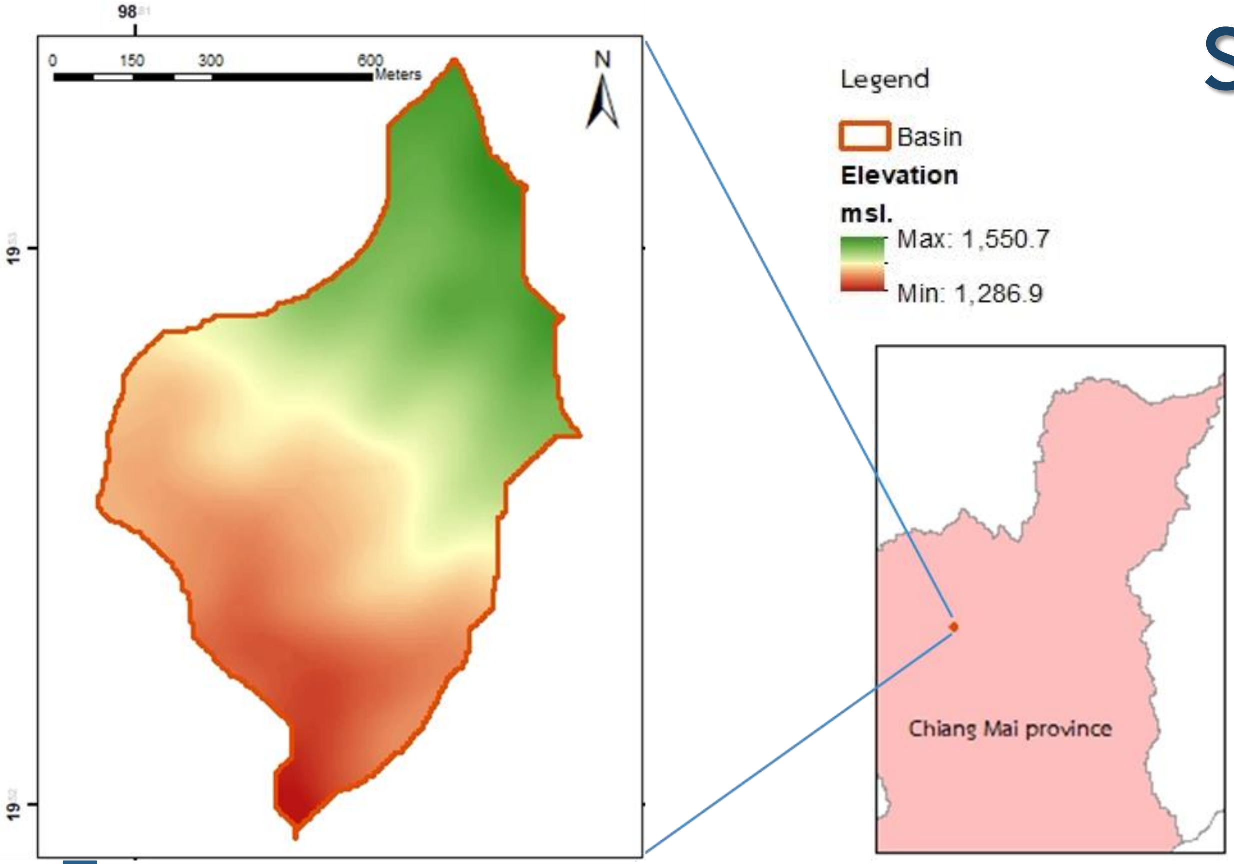
GOAL

22 main basin

Ping basin cover about 5 provinces:

- Chiang Mai
- Lamphun
- Tak
- Kamphaeng Phet
- Nakhon Sawan

STUDY SITE



98
0
150
300
600
Meters
N
19
19
Legend
Basin
Elevation
msl.
Max: 1,550.7
Min: 1,286.9
Chiang Mai province

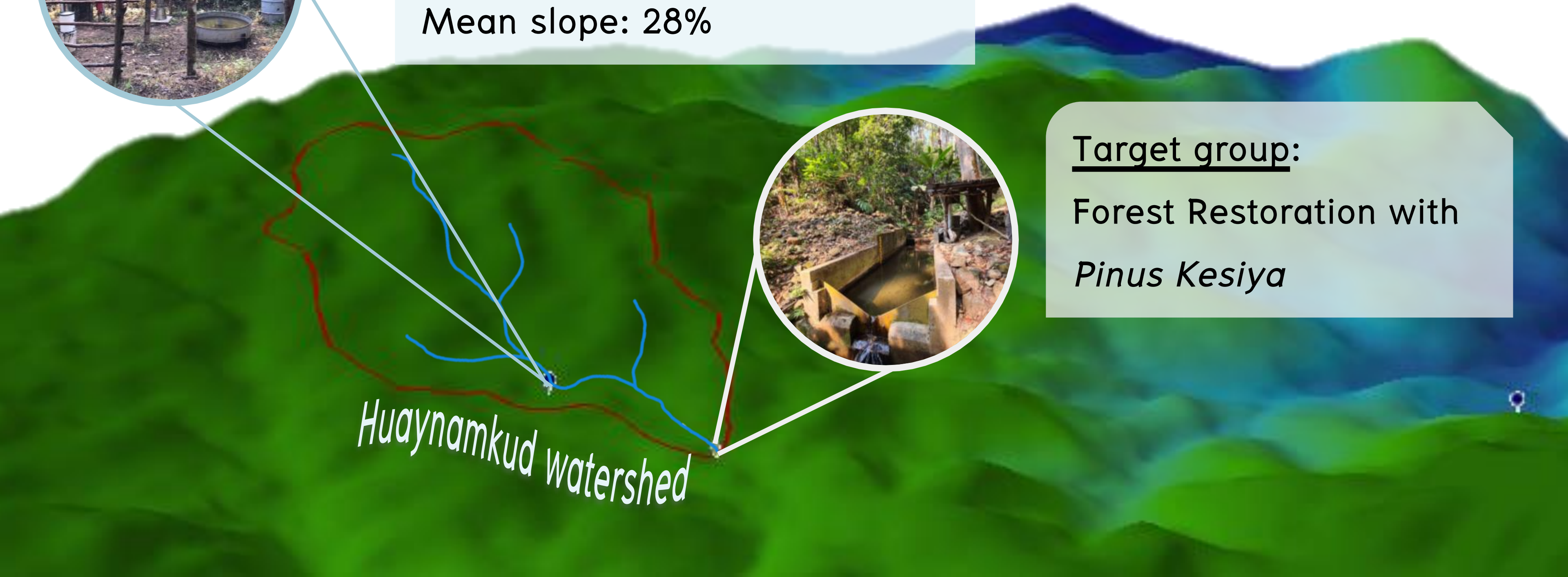
Thailand

STUDY SITE

Total area about 1 sq.km

Mean elevation: 1,430 msl.

Mean slope: 28%

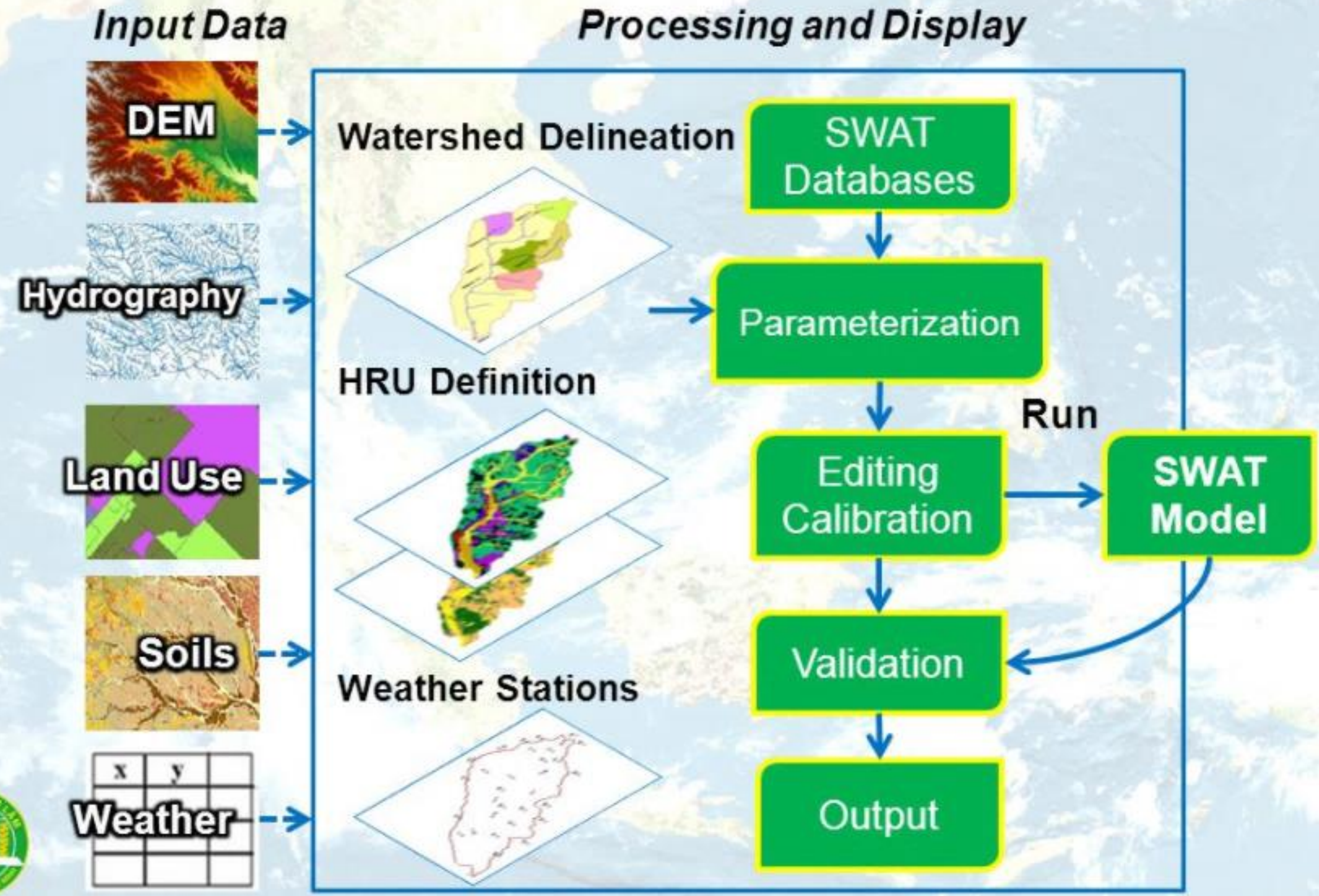


Target group:

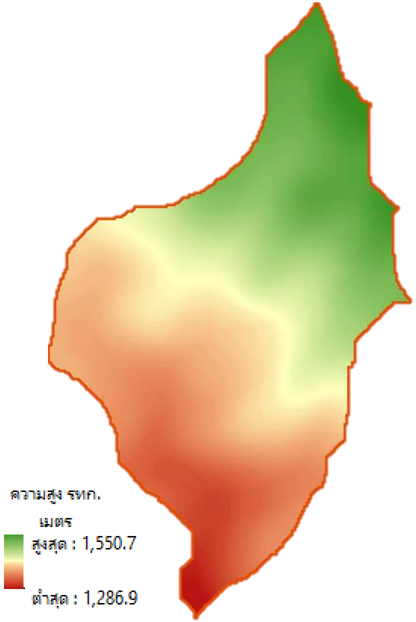
Forest Restoration with *Pinus Kesiya*

Model setup and Simulation

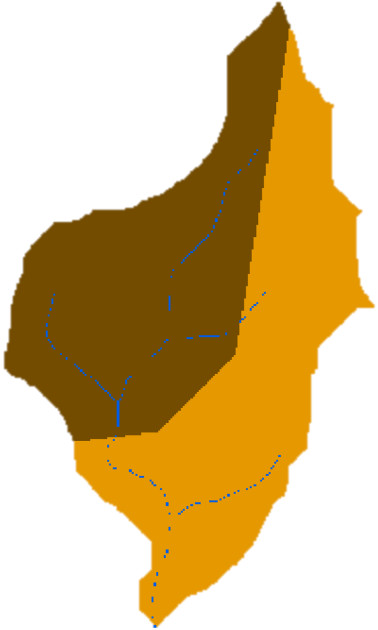
SWAT model


Input Data
Processing and Display
DEM
Hydrography
Land Use
Soils
x
y
Weather
Watershed Delineation
HRU Definition
Weather Stations
SWAT Databases
Parameterization
Editing Calibration
Run
SWAT Model
Validation
Output

Input spatial data



DEM

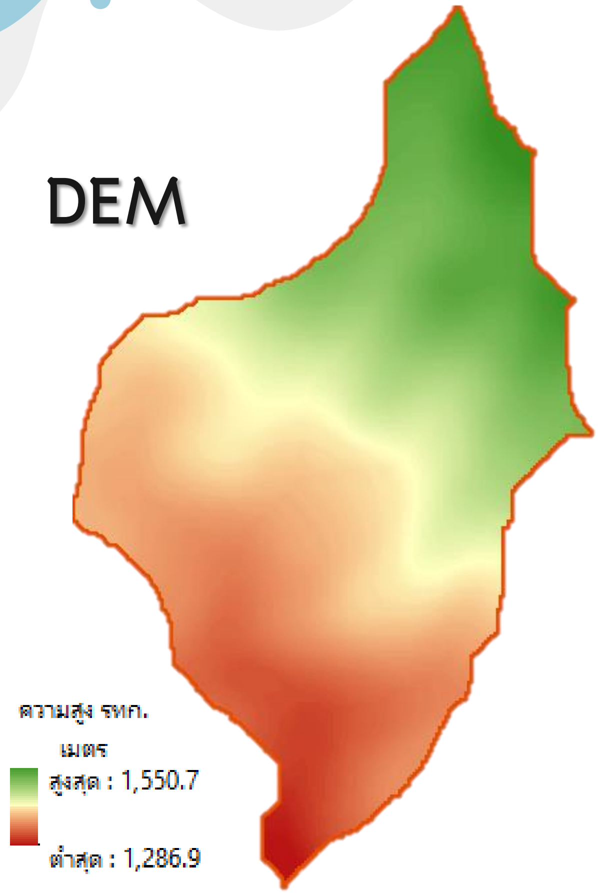


Soil Group

Land Use

Input spatial data

DEM



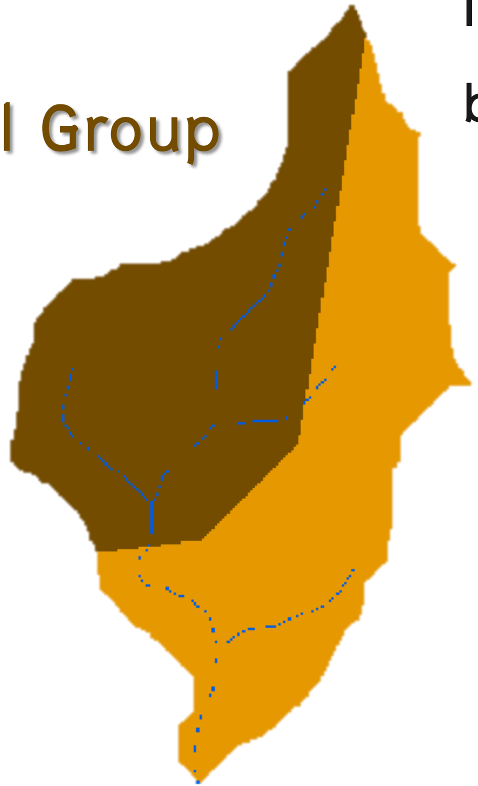
DEM was generated from 2 sets data using ArcGIS program:

- Contour data interval 20 m from Royal Thai Survey Department.
- The elevation ground check using GPS (high accuracy)

Resolution: 5x5 meter

Input spatial data

Soil Group



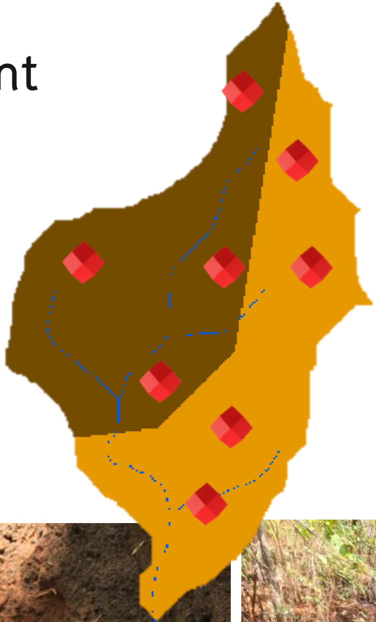
In Thailand, we divided into 62 soil group by Land Development Department.

We design to collect some soil hydrological characteristics that parent material from:

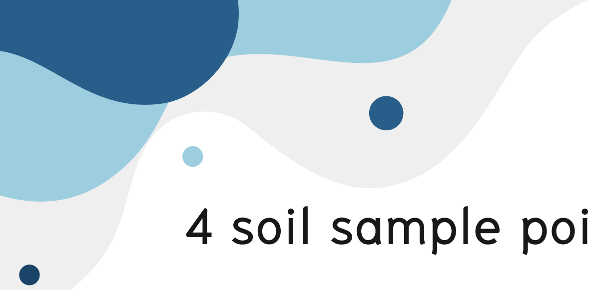
- sedimentary and metamorphic of the Tanaosri series in the Solurian&Delonian
- Igneous rocks, granite and nodirite formed in the Triassic period.

Input spatial data

4 soil sample point

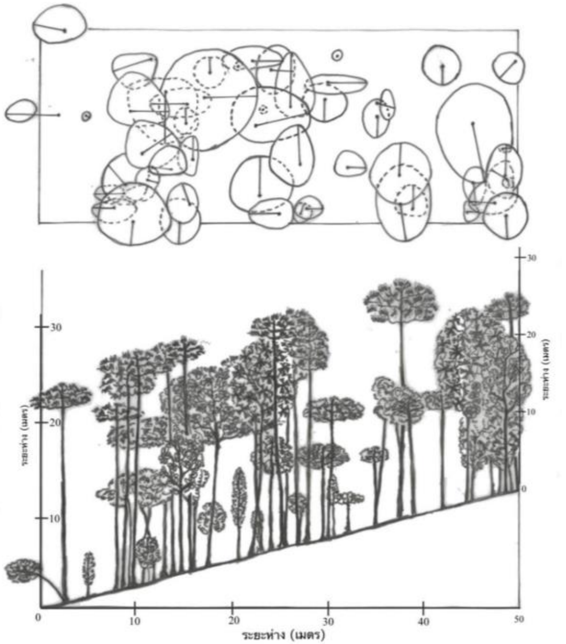


- Soil texture
- OM
- Soil nutrient
- Soil bulk density
- Soil water holding capacity



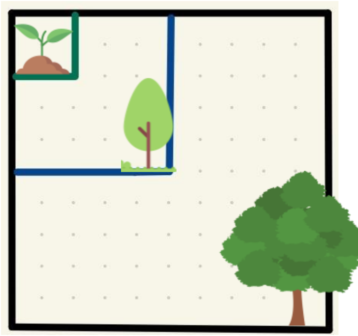
Input spatial data

Land Use

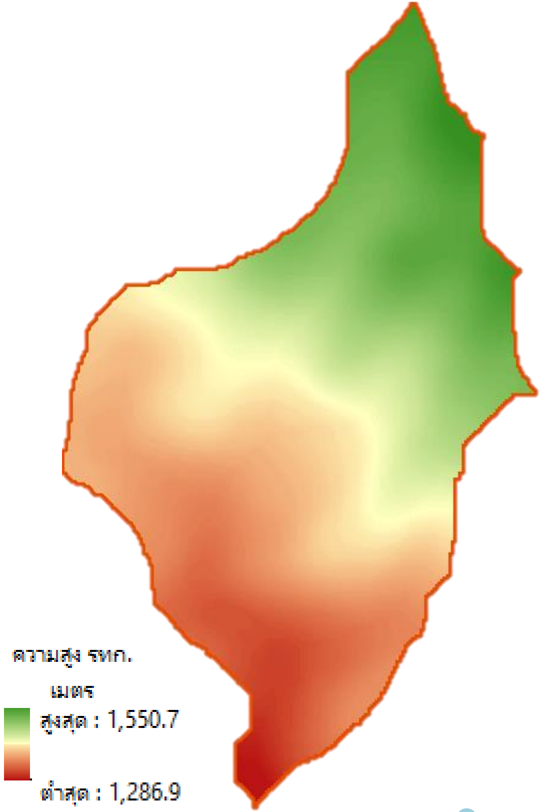


Input spatial data

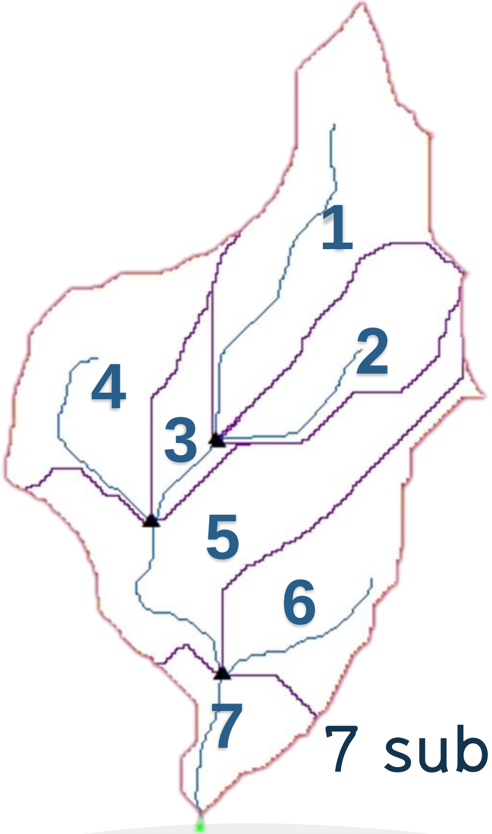
3 sample plot



Watershed delineation

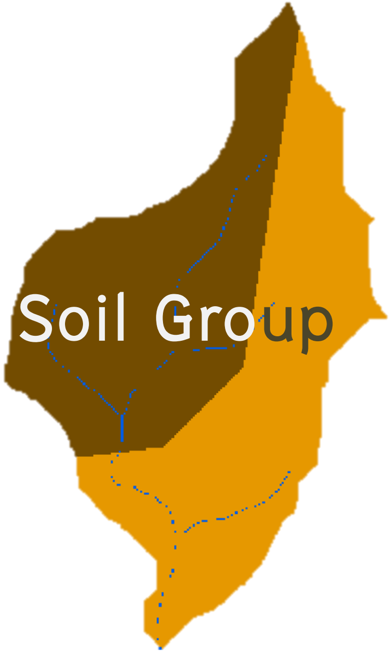


DAT = 2 ha



7 sub basin

HRU analysis



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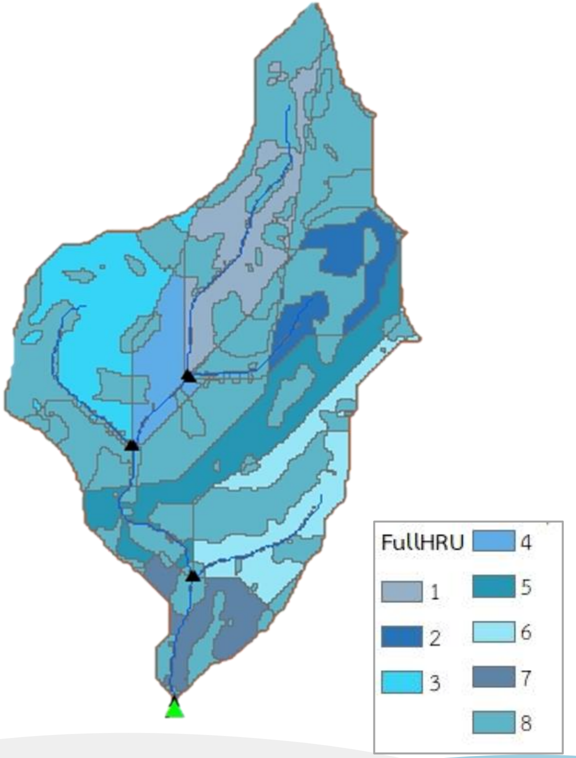
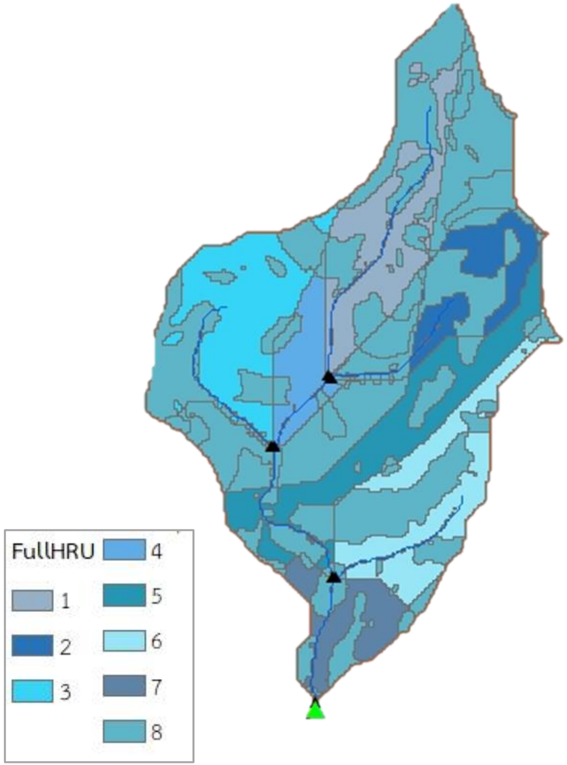
Slope

Classifies into 3 class:

0–15, 15–30 and 30+ %



Weather data input



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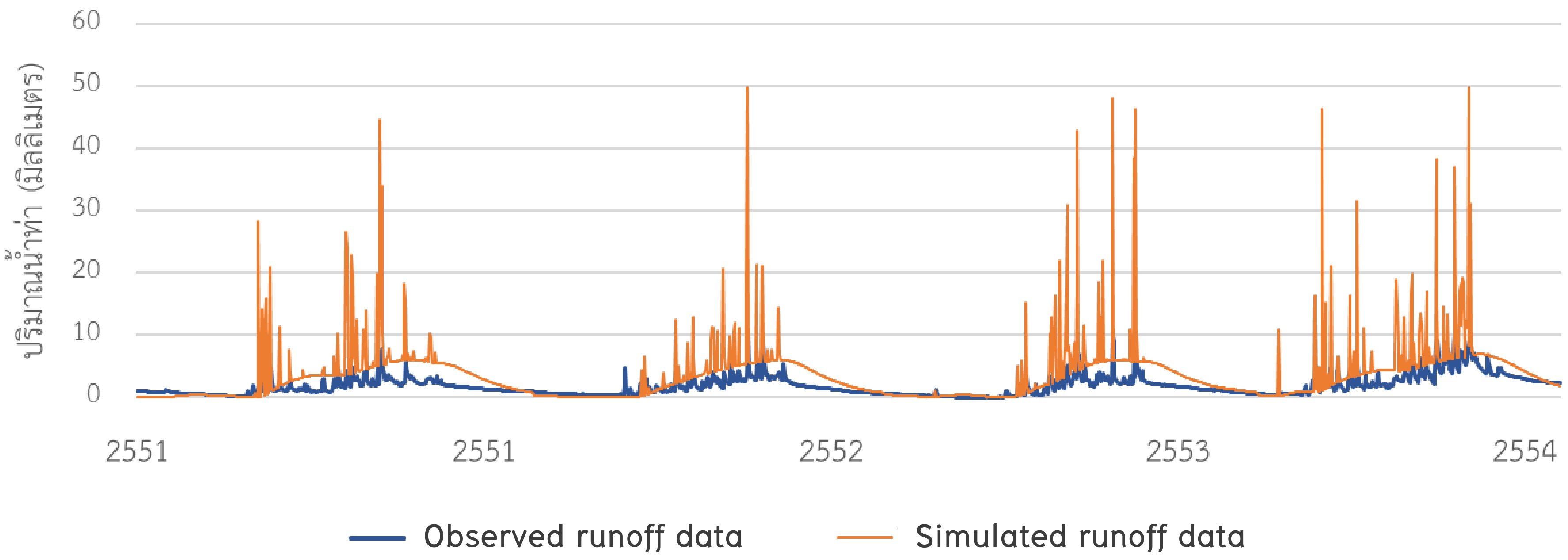
Daily weather variables for the period 1999 to 2022 (24 years) includes:

- Rainfall (mm)
- Min–Max air temperature (°c)
- Mean air humidity (%)

*For wind speed and solar radiation data use a default data of the SWAT model

After run SWAT model **Before** calibration



$R^2 = 0.46$

Model Calibration and Validation

Using Sequential Uncertainties Fitting Ver–2 (SUFI–2) algorithm

- For the calibration, we used monthly streamflow data for the period 2008 to 2011
- For the validation, we used monthly streamflow data for the period 2017 to 2020

daily stream discharge of Huaynamkud water level station were obtained from a weir 120-V-Notch.

Model Calibration and Validation

- The model performance was evaluated using the coefficient of determination (R^2) and the Nash–Sutcliffe efficiency (NSE)

$$R^2 = \left[\frac{\sum_{i=1}^{n}(o_i - \bar{o})(P_i - \bar{P})}{\sqrt{\sum_{i=1}^{n}(o_i - \bar{o})^2}\sqrt{\sum_{i=1}^{n}(P_i - \bar{P})^2}}\right]^2$$

$$\text{NSE} = \frac{\sum_{i=1}^{n}(o_i - P_i)^2}{\sum_{i=1}^{n}(o_i - \bar{o})^2}$$

Where Oi is the measured data on day i, Pi is the simulated output on day i, $\bar{o}$ is the average of the measured value during the simulated period, $\bar{P}$ is the average of the simulated value during the simulated period.

Streamflow simulations were considered reasonable if R^2>0.5 and NSE>0.5.

Sensitive analysis

Selected input parameter of SWAT model

No.	Input parameter	Category	Description of parameter	Min-Max range
1	CN2	MGT	SCS runoff curve number	0.5-1.5
2	ALPHA_BF	GW	baseflow recession factor (1/days)	0.0-1.0
3	REVAPMN	GW	Threshold depth of water in the shallow aquifer for percolation to the deep aquifer (mm)	0.0-500.0
4	GWQMN	GW	Threshold depth of water in the shallow aquifer required for return flow to occur (mm)	0.0-5000.0
5	SOL_AWC	SOL	Available water capacity of soil layer (mm H2O/mm soil)	0.5-1.5
6	SOL_Z	SOL	Depth from soil surface to bottom of layer (mm)	0.0-800.0
7	SOL_K	SOL	Saturated hydraulic conductivity (mm/hr)	0.5-1.5
8	GW_REVAP	GW	Groundwater “revap” coefficient	0.02-0.2
9	GW_DELAY	GW	Groundwater delay (days)	0.0-500.0
10	Surlag	BSN	Surface runoff lag coefficient	0.05-24.0
11	CANMX	HRU	Maximum canopy index	0.0-100.0
12	ESCO	BSN	Soil evaporation compensation factor	0.01-1.0

Summary of sensitivity analysis

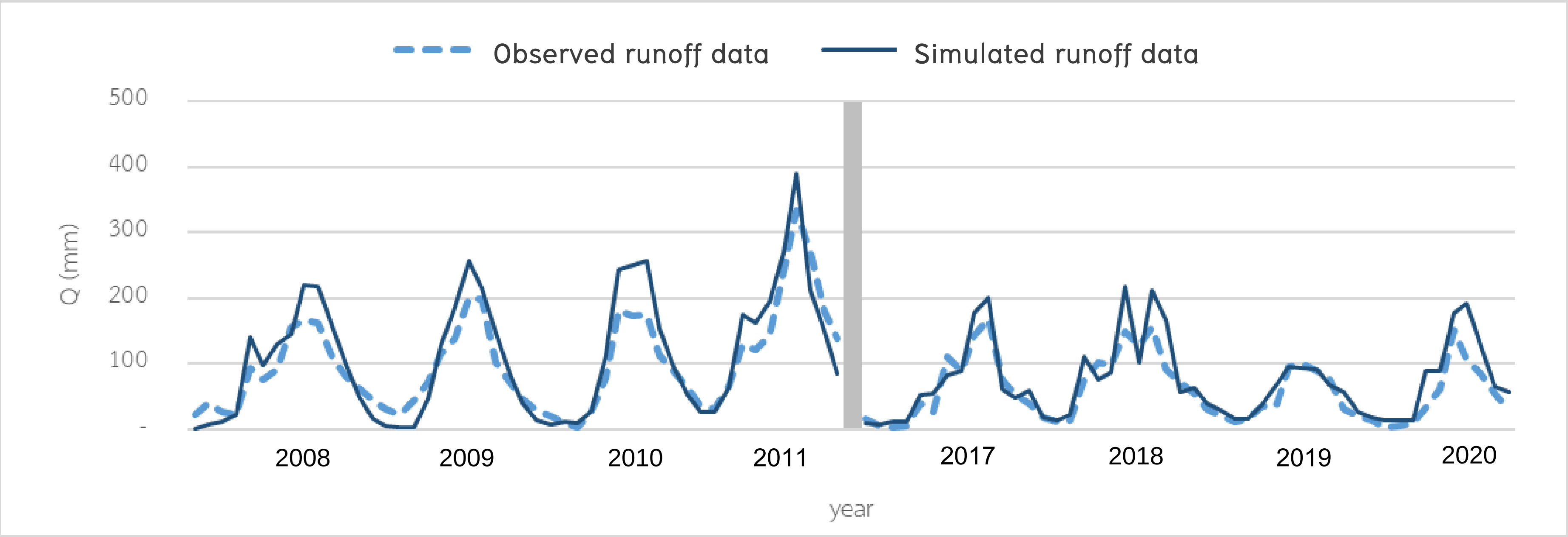
SWAT input parameter	Category	Local sensitivity		
		t-stat	P-value	Ranking
SOL_AWC	.sol	-21.7642	0.0000	1
ESCO	.hru	-16.9401	0.0000	2
REVAPMN	.gw	-5.2341	0.0000	3
GW_REVAP	.gw	-1.9396	0.0275	4
GW_DELAY	.gw	-1.6161	0.0306	5
GWQMN	.gw	-1.4712	0.0415	6

Model calibration

$R^2 = 0.87$ NSE = 0.76

Model validation

$R^2 = 0.72$ NSE = 0.70



CONCLUSTION

- The SWAT model can be applied to a good level of small watersheds in Thailand to consider each hydrological factor.

- For Huaynamkud watershed, SOL_AWC.sol, ESCO.hru, REVAPMN.gw, GW_REVAP.gw, GW_DELAY.gw, and GWQMN.gw were evaluated to be most sensitive input parameter.

- These parameter are also recommended to utilize for the similar physical pattern of other tropical watershed

Next project

- Soil sediment (on-site) calibration
- Analyze the influence of climate change on streamflow amount and flow characteristics in the future. We assume that if small watersheds have changed, the large ones will also be affected.
- Land use changes for decision-making on the protected area management of the organization.

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Thank you for attention

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