The Best Water Partner

Analysis of the Impacts of Spatial Input Data Quality on the Determination of Runoff and Suspended Sediments in the Imha Watershed Using Swat Model

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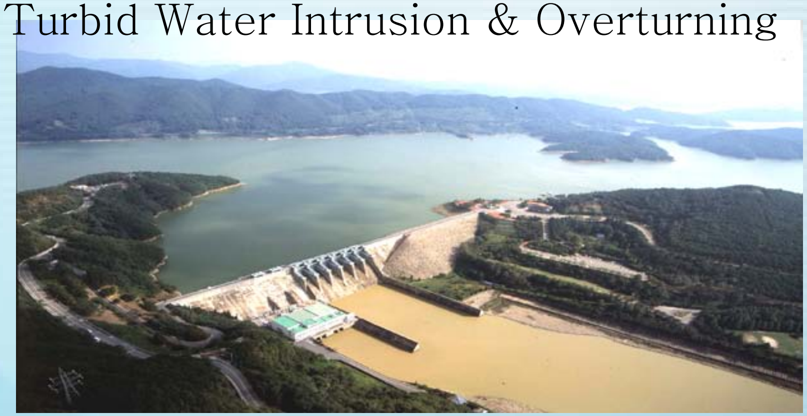
Background

- Frequent occurrence of turbid water due to extreme events
  - Typhoon Rusa(2002), Meami(2003)
  - Discharge release limitation due to high turbidity
- Optimized reservoir operation for high turbid water
  - Flood season: Release through selective withdrawal facility to prevent turbidity spread and overturning
  - Dry season: Joint dam operation to maintain the downstream turbidity less than 30 NTU
- Turbid water management
  - Watershed assessment
  - Identify high turbidity layer
  - Adequate Discharge release
    - When / how much
  - Impact on reservoir downstream

Landslide

Bank Washout

Turbid Water Intrusion & Overturning



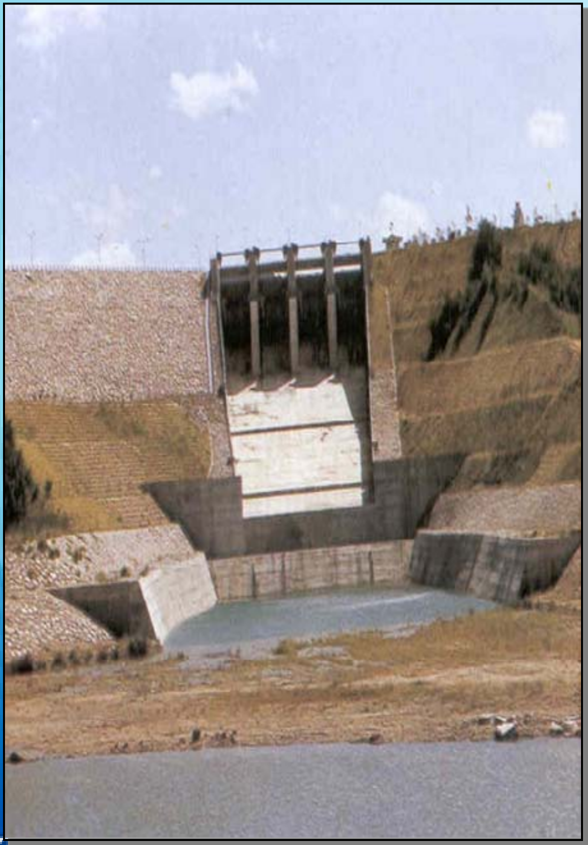
Impact on Downstream

Problems

Stop reservoir operation

Hinders water treatment plant operation

Negative Impact on Downstream



Introduction

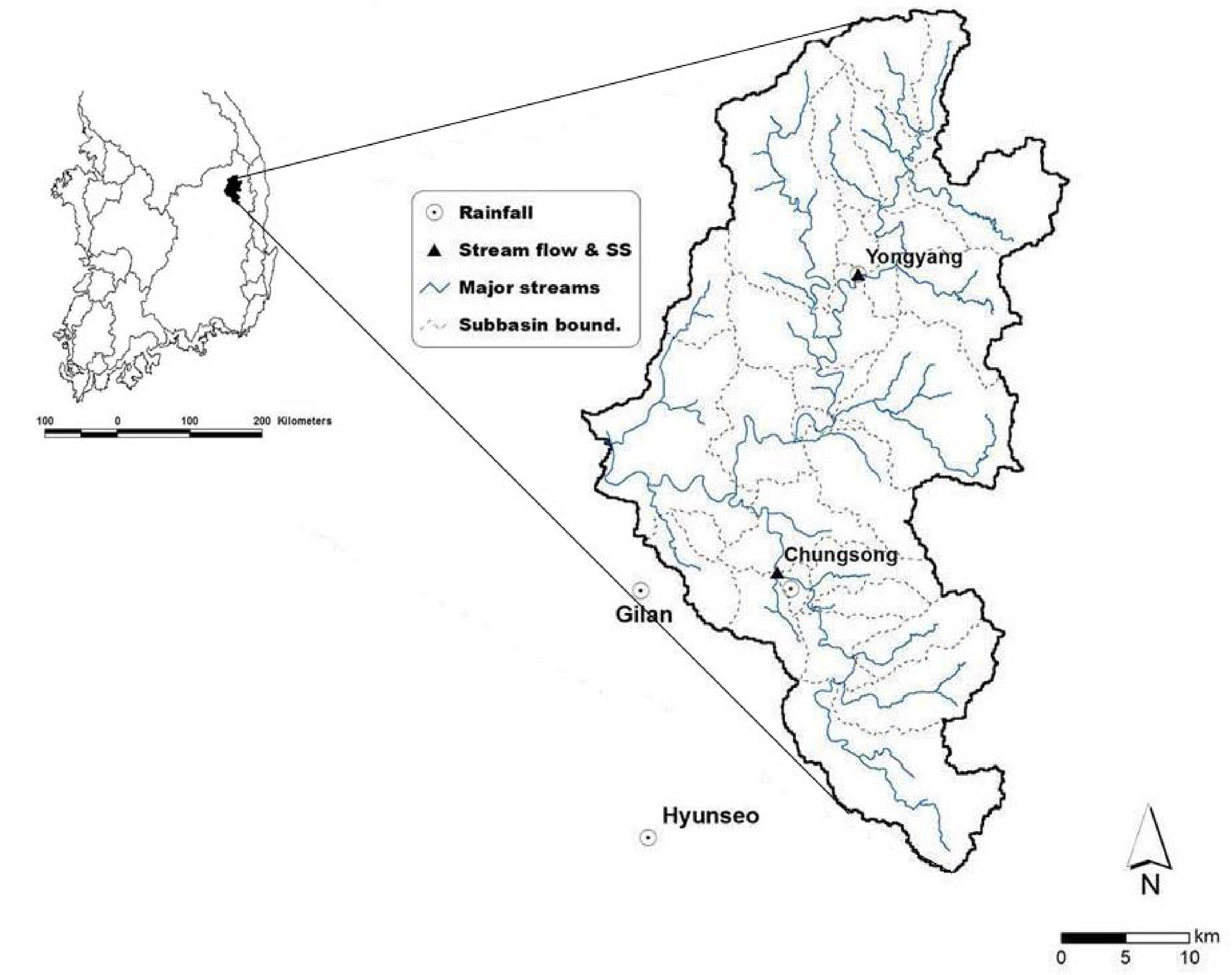
- Focused on watershed management for turbid water control
- Assessment on the impact of different spatial data quality and the efficiency of SWAT model for runoff and suspended sediment
- First, the impacts of five DEM grid sizes (i.e. 30m, 60m, 90m, 120m, and 150m) on model inputs (parameters) and outputs
- Combination of 30m and 120m DEMs with two different scales of land cover and soil type map

Imha & Andong Watershed

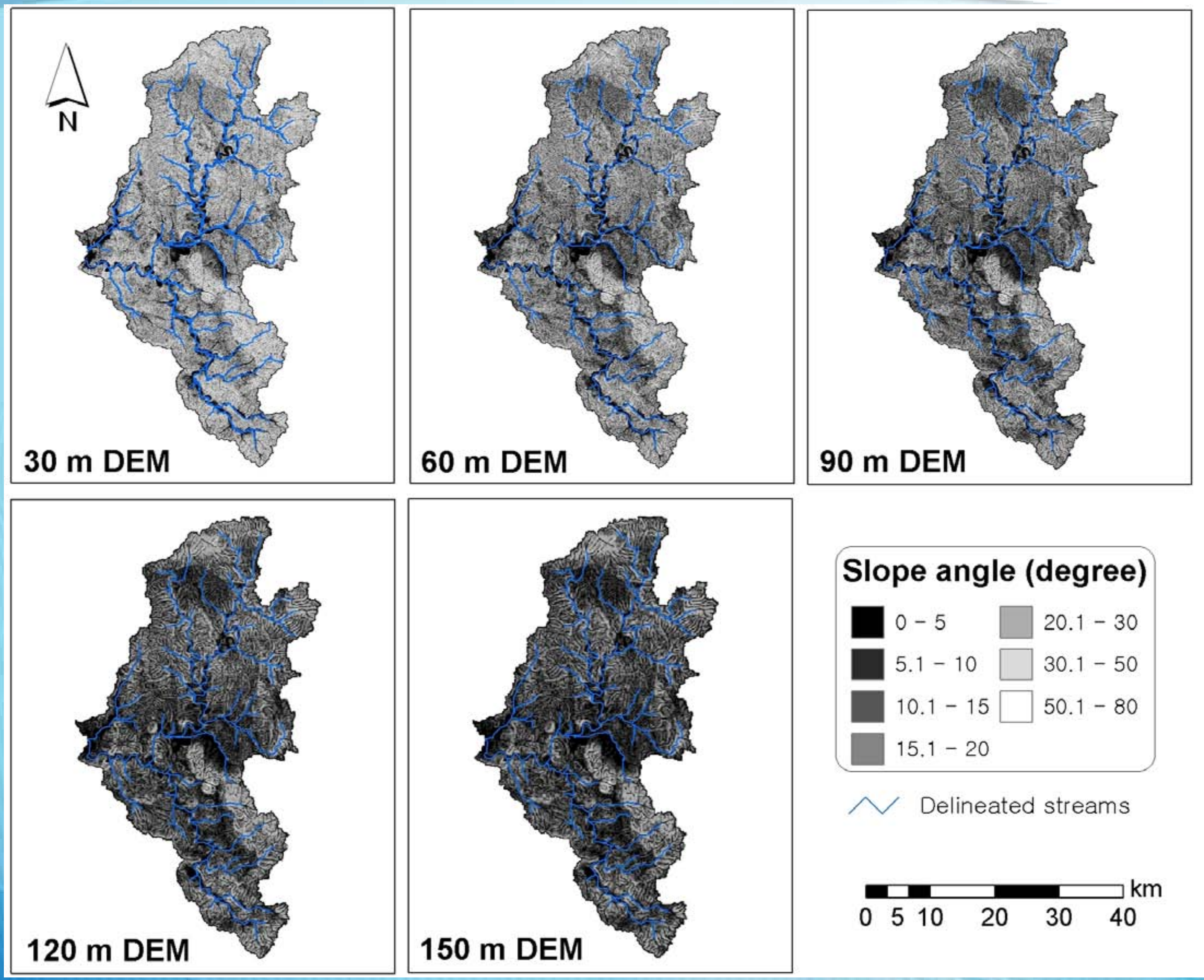
Table 1. comparision of two catchments

Properties	Imha	Andong
Area (km^2)	1,361	1,584
Major Landcover	Forest (79.8%) Agriculture (15.0%)	Forest (82.2%) Agriculture (11.9%)
Major Soil type	Ms (Lithosols, Micaceous and Hard Siliceous Materials,silty loam or sandy loam)	Ma (Lithosols, Siliceous Crystalline Materials, silty loam or sandy loam)
Avg. Ann. Precipitation (mm, 2000-04)	1,158	1,348
Total channel length (km)	5,741	5,381
Storage volume (m^3)	424M	1000M
Elevation (m, EL)	54~1,215	105~1,550

Site description



5 different scaled DEM



DEM with General Watershed Parameters

Grid size (m)	AREA (Km^2)	SLOPE (m/m)	SLOPEL (m)	CHSLOPE (m/m)	CHWID (m)	CHLEN (Km)
D30	1,335.83	0.40	0.05	0.008	32.65	15.58
D60	1,328.00	0.31	1.36	0.009	32.17	15.03
D90	1,312.18	0.27	5.29	0.010	32.02	15.28
D120	1,336.05	0.21	15.05	0.014	31.63	14.56
D150	1,327.61	0.18	18.33	0.013	28.24	9.21

- DEM scale Increases (low DEM Resolution)
  - Slope decrease
  - Slope Length increase
  - Channel slope increase
  - Channel width decrease
  - Channel length decrease

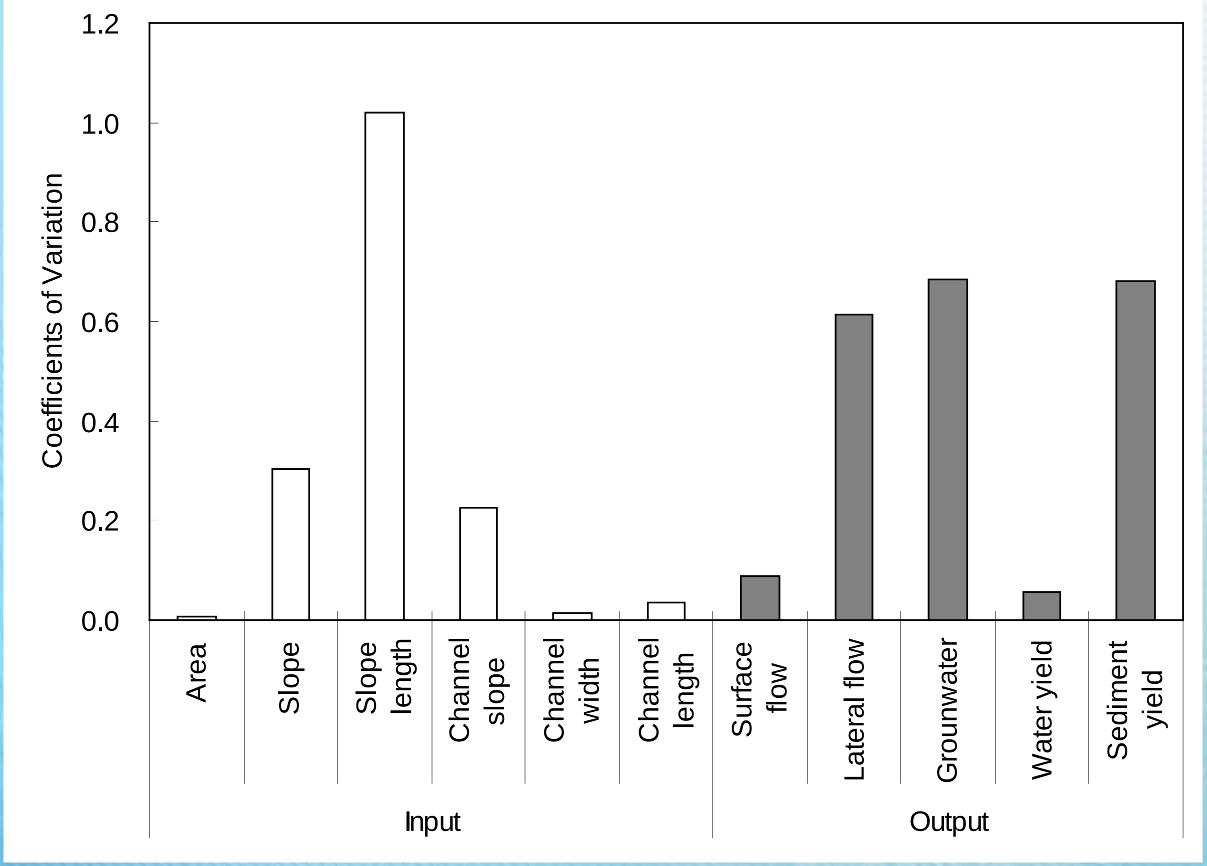
DEM with Water and Sediment

Grid size (m)	SURQ (mm)	LATQ (mm)	GWQ (mm)	WYQ (mm)	SYL (ton/ha)
D30	122.32	524.03	71.85	718.20	1.88
D60	125.11	489.86	96.03	711.00	4.31
D90	132.54	387.29	169.68	689.51	8.93
D120	146.28	135.65	359.05	640.98	15.75
D150	149.52	91.67	391.88	633.07	15.48

- When DEM scale Increases (Coarser DEM Resolution)
  - Surface runoff increase
  - Lateral flow decrease
  - Ground water increase
  - Net water yield increase
  - Sediment yields increase

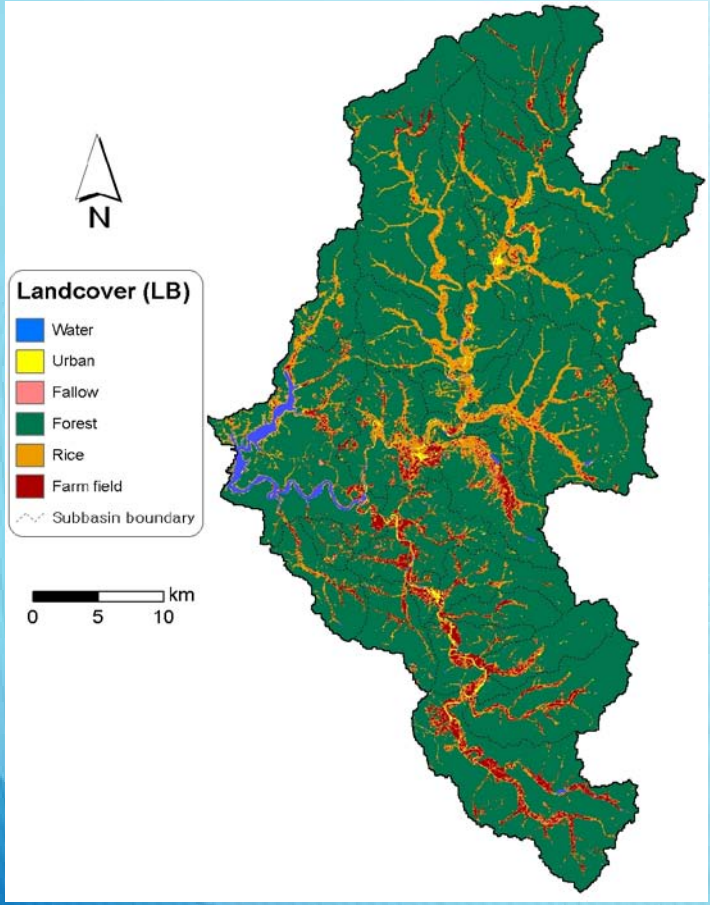
CV with DEM resolution

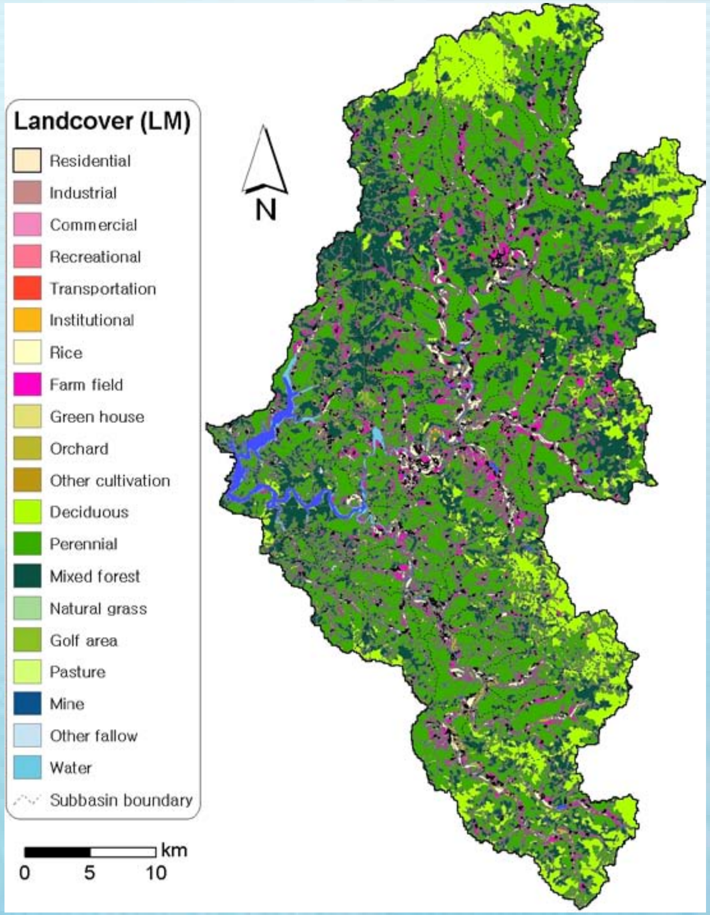
- Slope length, Lateral flow, subsurface flow, and sediment yield are more sensitive to DEM resolution



Land Cover maps

- 1:50,000 and 1:25,000





- 1:50,000 Landcover map – total 8 classes of landuse

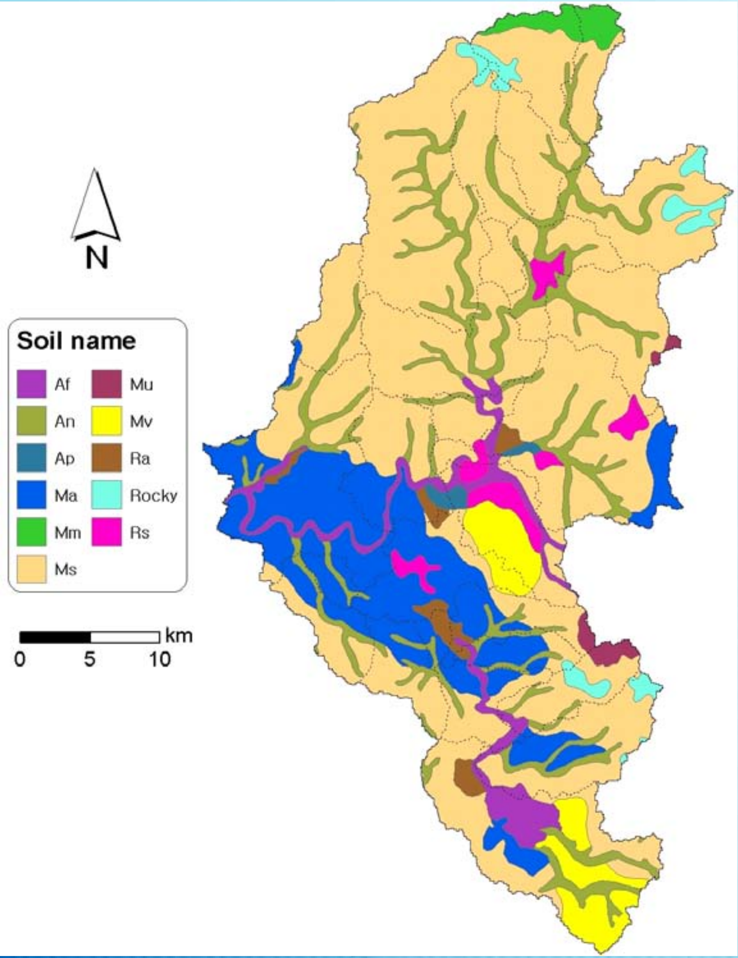
Class	Area (%)	Class	Area (%)	Class	Area (%)	Class	Area (%)
Urban	0.88	Wetland	10.1	Forest	0.88	Farm field	10.1
Follow	0.02	Pasture	0.03	Rice	0.02	Water	0.03

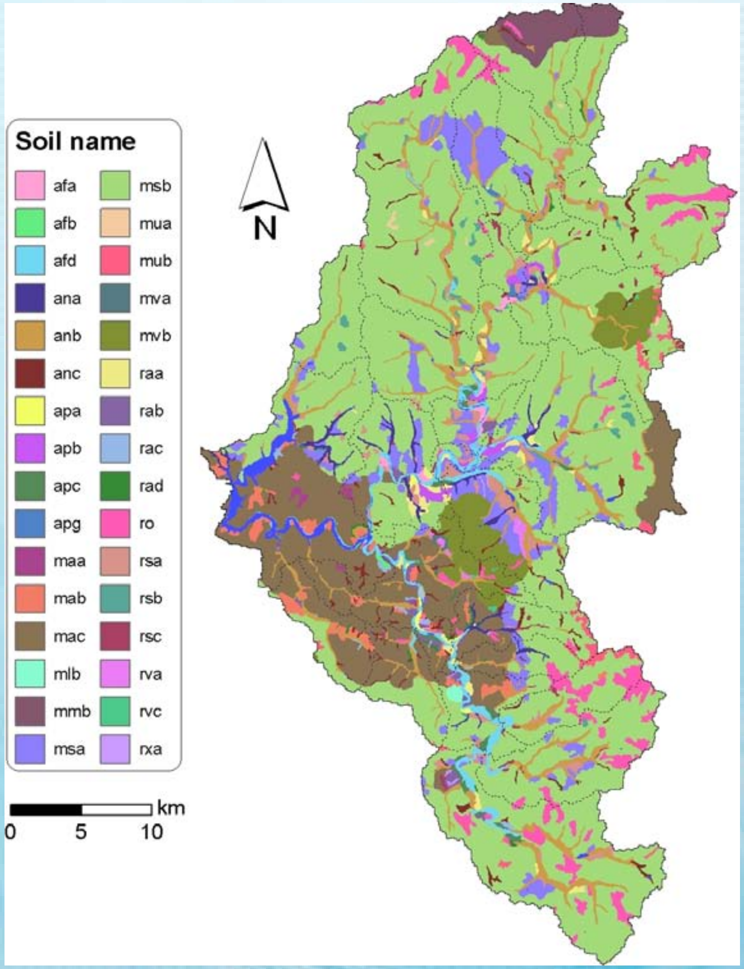
- 1:25,000 Landcover map – 18 classes of land use

Class	Area (%)	Class	Area (%)	Class	Area (%)
Residence	0.88	Paddy	3.34	Deciduous forest	14.87
Industry	0.02	Farm field	10.1	Evergreen forest	44.76
Commercial	0.05	Vinyl house	0.03	Mixed forest	20.17
Recreation	0.00	Orchard	1.43	Pasture	0.40
Transportation	0.34	Other crops	0.07	Wetland	0.45
Institutional	0.08	Fallow	0.61	Water	2.4

Soil Maps

- 1:250,000 and 1:50,000





Soil types and description

- 11 soil types for 1:250,000 soil map,
- while 32 soil types for and 1:50,000

Soil types	Descriptions
Af	alluvial soils and river wash, flood plains
An	complex of soils, narrow valleys
Ap	low-humic gley and alluvial soils, alluvial plains
Ma	litho sols, siliceous cristalline materials
Mm	litho sols, micaceous and hard siliceous materials
Ms	litho sols, sedimentary materials
Mu	brown forest soils and lithosols, undifferentiated materials
Mv	litho sols, siliceomafic materials
Ra	red-yellow podzolic soils siliceous crystalline materials
Rocky	rocky lands
Rs	litho sols and red-yellow podzolic soils, sedimentary materials

DEM with Water and Sediment

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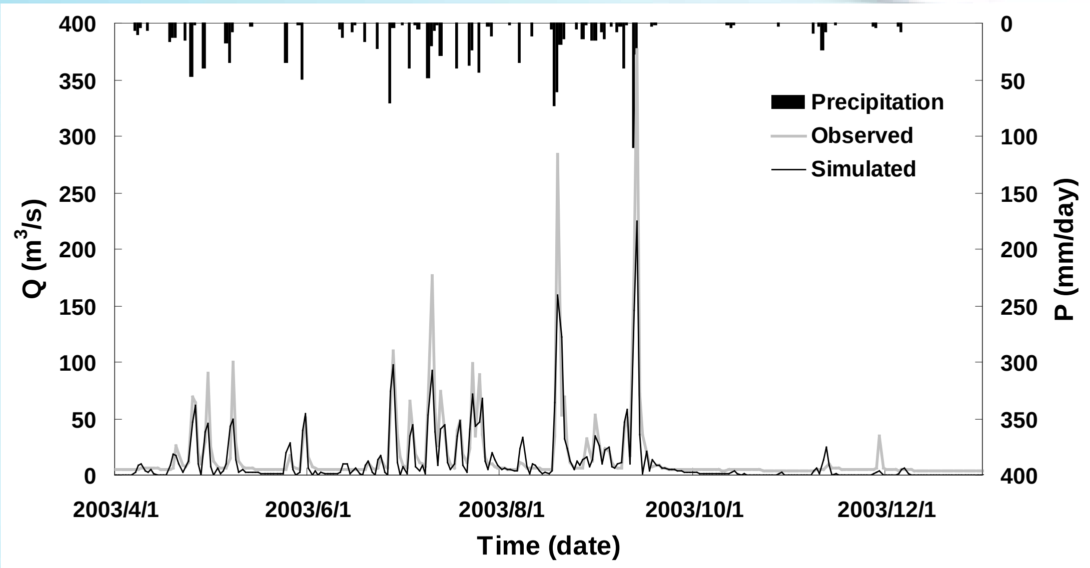
Parameter variation with soil map scale

Scale	SOL_Z mm	SOL_BD g/cm^3	SOL_AWC mm/mm	SOL_K mm/hr	USLE_K	HRU
SB(1:250,000)	590.70	1.38	0.09	36.41	0.17	607
SM(1:50,000)	358.97	1.44	0.10	43.70	0.14	1,567

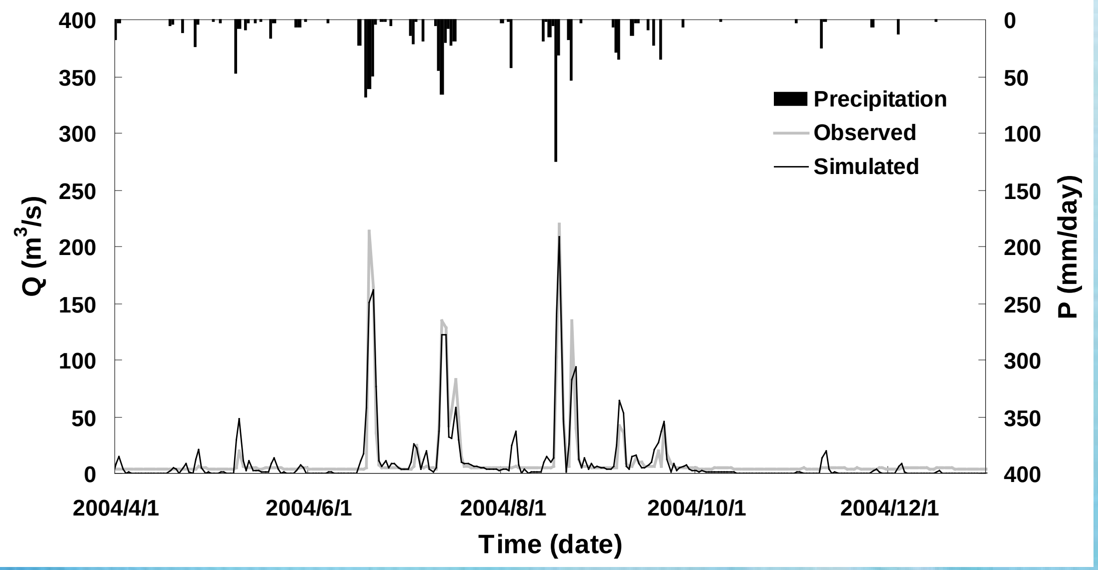
Name	Definition
SOL_Z	Depth from soil surface to bottom of layer
SOL_BD	Moist bulk density (cm^{-3})
SOL_AWC	Available water capacity of the soil layer (mm/mm soil)
SOL_K	Saturated hydraulic conductivity (mm/h)
USLE_K	USLE equation soil erodibility (K) factor
HRU	Multiple hydrologic response unit number

Prediction of daily flow using SWAT

Cheongsong

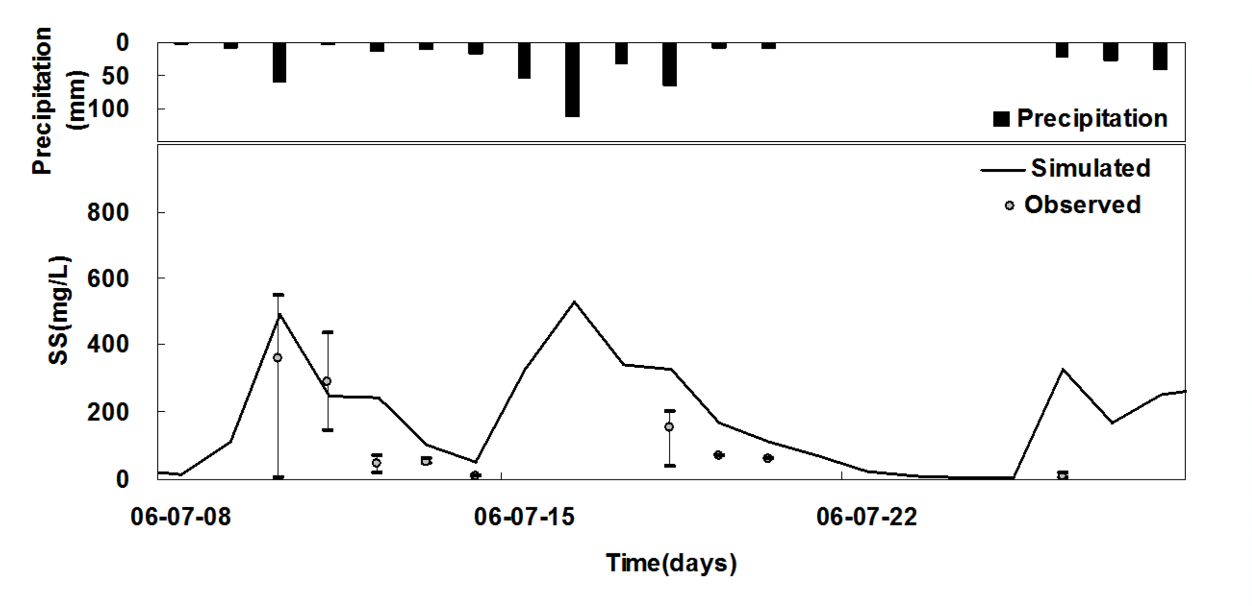


Youngyang

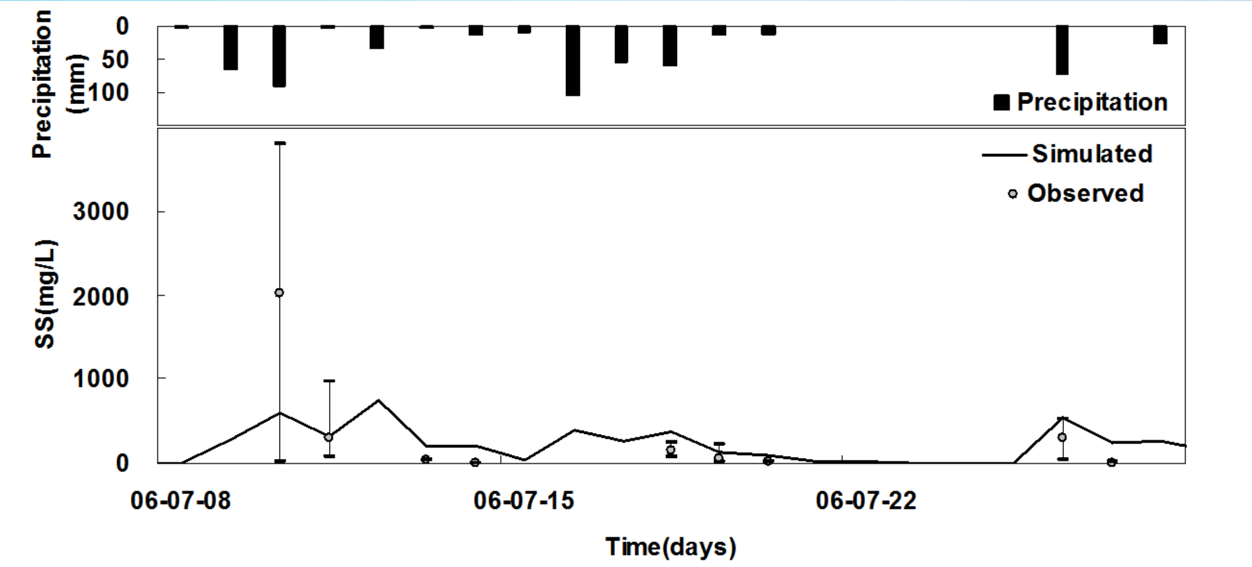


Prediction of daily Suspended Sediment using SWAT

Cheongsong



Youngyang



Statistical indexes for runoff computation

$$R_{eff} = 1 - \frac{\sum_{i}^{n} (Q_{obs,i} - Q_{pred,i})^2}{\sum_{i}^{n} (Q_{obs,i} - \overline{Q_{obs,i}})^2}$$

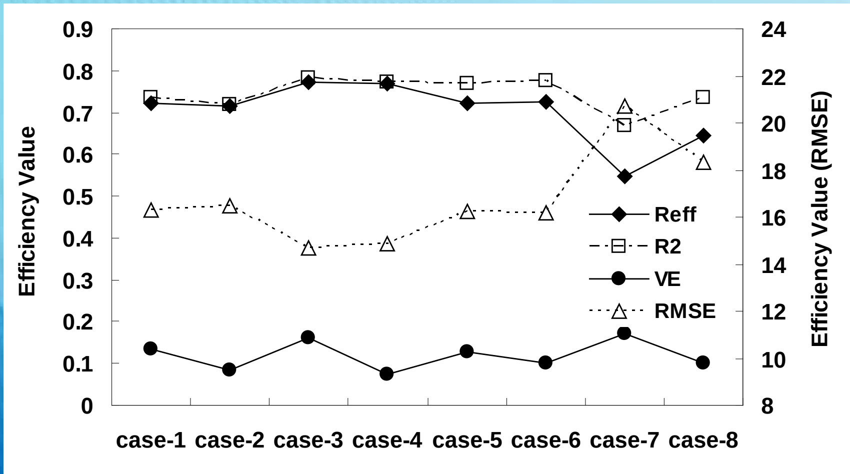
$$R^2 = 1 - \frac{(\sum_{i}^{n} Q_{obs,i} \times Q_{pred,i} - n\overline{Q_{obs}} \times \overline{Q_{pred}})^2}{(\sum_{i}^{n} Q_{obs}{}^2 - n\overline{Q_{obs}}{}^2)(\sum_{i}^{n} Q_{pred}^2 - n\overline{Q_{pred}^2})}$$

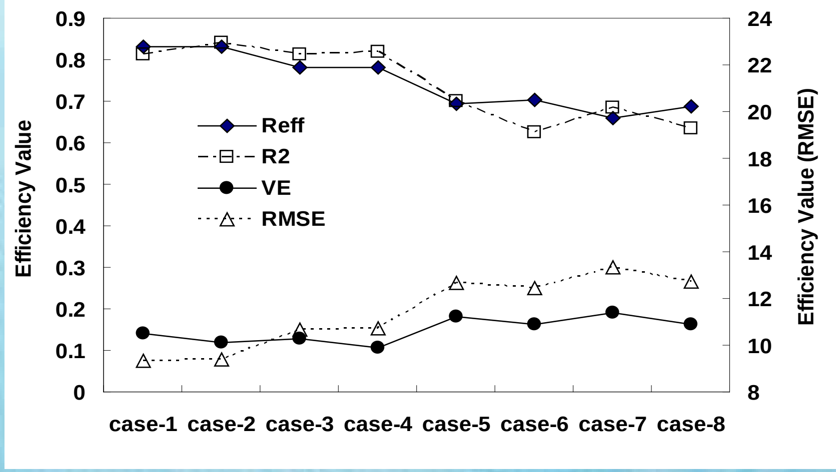
$$V_E = \left| \frac{\sum_{i}^{n} (Q_{obs,i} - Q_{pred,i})}{\sum_{i}^{n} (Q_{obs,i})} \right|$$

$$RMSE = \sqrt{\frac{1}{N} \sum_{i}^{n} (Q_{obs,i} - Q_{pred,i})^2}$$

Model efficiency for runoff

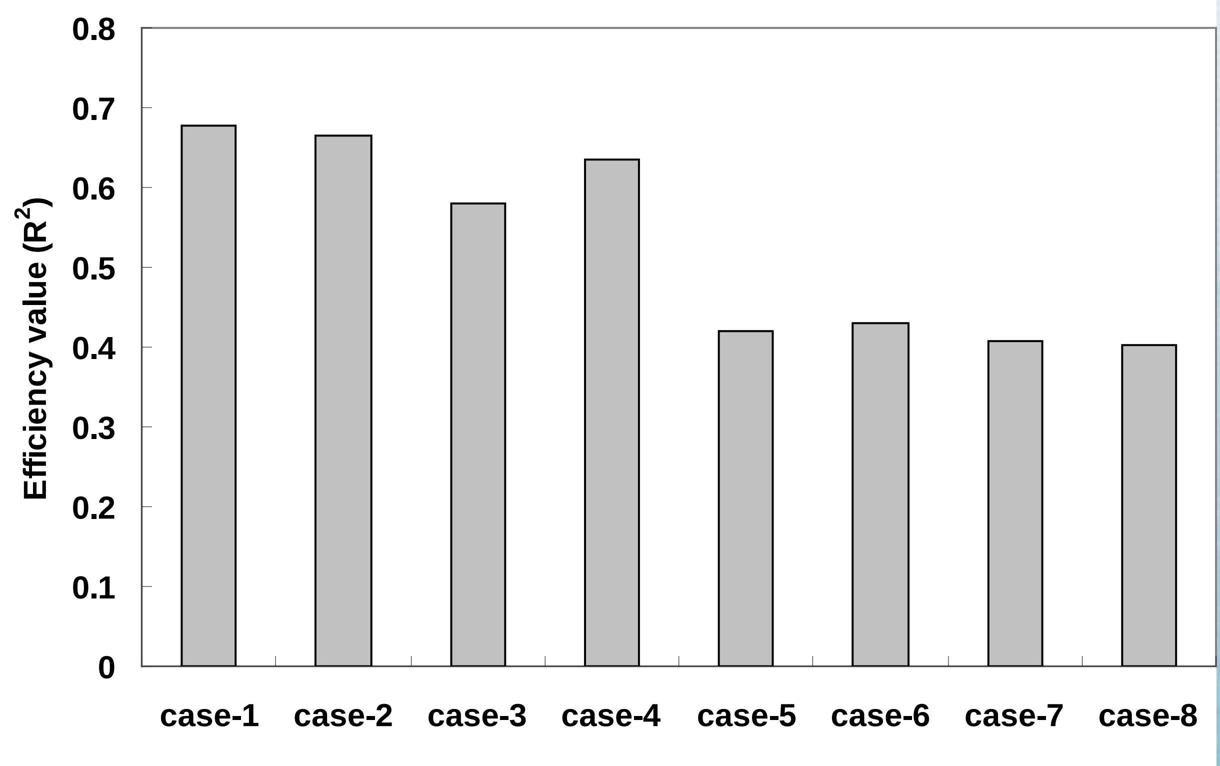
Scenario	DEMs	Land cover	Soil	Scenario	DEMs	Land cover	Soil
Case 1	30 m	1:50,000	1:250,000	Case 5	150 m	1:50,000	1:250,000
Case 2	30 m	1:50,000	1:50,000	Case 6	150 m	1:50,000	1:50,000
Case 3	30 m	1:25,000	1:250,000	Case 7	150 m	1:25,000	1:250,000
Case 4	30 m	1:25,000	1:50,000	Case 8	150 m	1:25,000	1:50,000





Model efficiency for suspended sediment

- Only R2 was used for model assessment



Discussion

- With finer DEM, model efficiency improved for runoff simulation
- With coarser scaled Land use, model efficiency decreases at Yongyang but increases at Chongsong station
- Coarser scaled soil map improves model efficiency only for Ve, while other statistical indexes showed no significant variation
- For sediment, model efficiency decreases with coarser DEM
- Land use and soil maps did not show any effects on the improvement of suspended sediment
- Should find more consistent guidelines in selection of input data resolution

Thank You !!