THAI NGUYEN UNIVERSITY
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Assessment the Impact of Land-use Changes on Sediment Yield Loads for Song Cau Watershed using SWAT Model

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1 Introduction

The Song Cau catchment is located in northern Viet Nam. Nowadays, it is facing with the problems that:

- The rapid increase of population
- Land use changes with negative orientation within the watershed

Which are main causes lead to

Soil erosion ⟷ High variation in runoff discharge, sediment yield and nutrient load

Reduction of soil fertility, loss of nutrients, and declines of crop yields in farmlands → **Threaten the livelihood of local people and environment**

The objectives of this research are:

To apply SWAT in Song Cau catchment to analyze the impact of land use changes on sediment yield load.

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To make policy recommendations for decision makers regarding the impacts of land use changes on sediment yield load.

2 Methodology

Study site

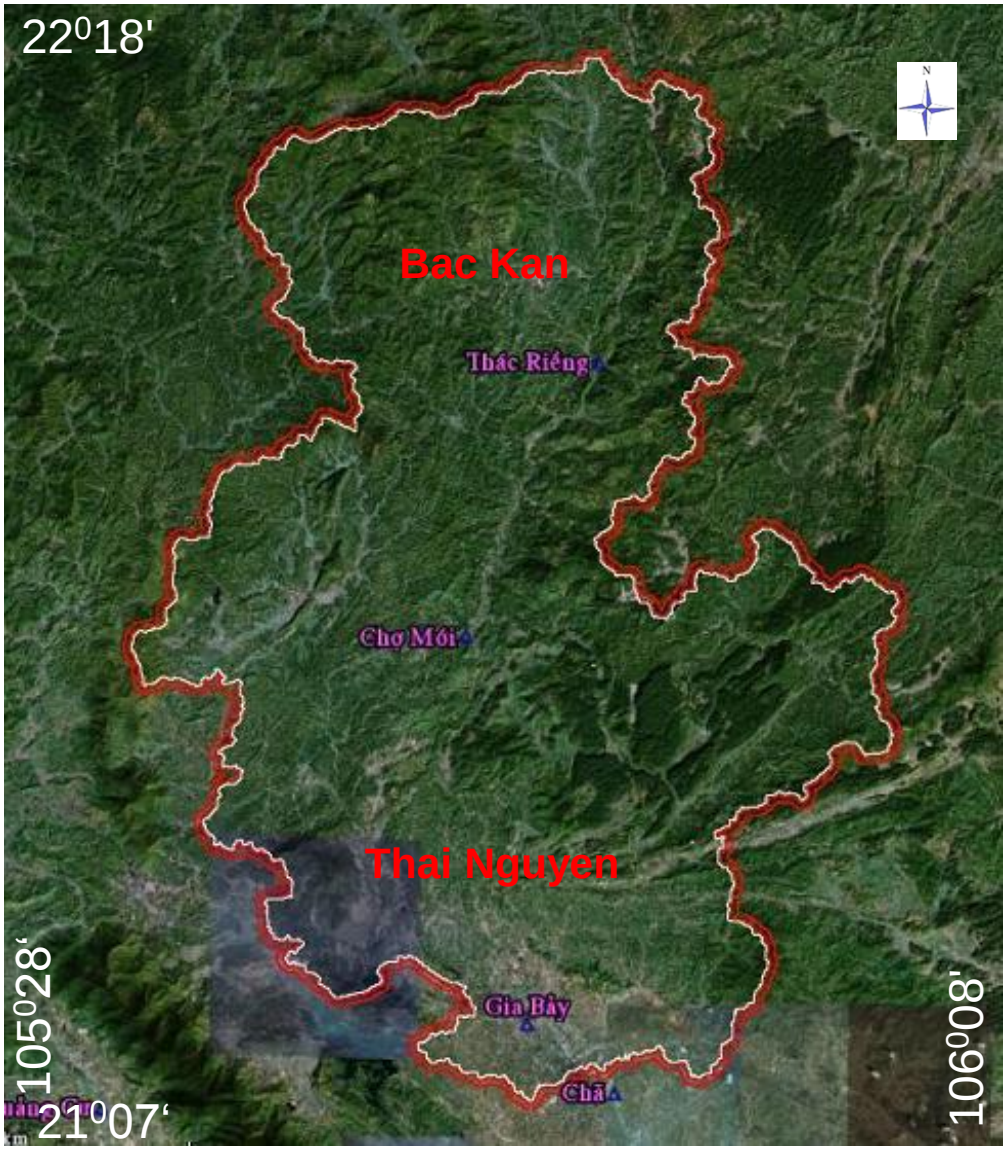


Figure 1. Location of Song Cau Catchment in Northern Viet Nam.

(Source: http://www.pickkatrail.com/jupiter/map/vietnam.gif and Google Earth)

Data collection

Table 1. Sources and Types of Data collected for SWAT.

N^0	Types of data	Sources of data
1	Precipitation (rainfall), temperature and others meteorological data	Thai Nguyen, Bac Can, and Dinh Hoa weather stations
2	Sediment yield (observed data)	Gia Bay gauging station.
3	Topography (DEM), Land use map	Department of Information and Communication technology for Natural Resources and Environment, Ministry of Natural Resources and Environment plus field survey data.
4	Soil map	Viet Nam Soil and Fertilizers Research Institute.
5	Forest, Agricultural land	Department of Natural Resources and Environment of Thai Nguyen and Bac Can provinces, and field survey data.

Land use scenarios

Table 2. Land Use Planning Scenarios for Song Cau Catchment.

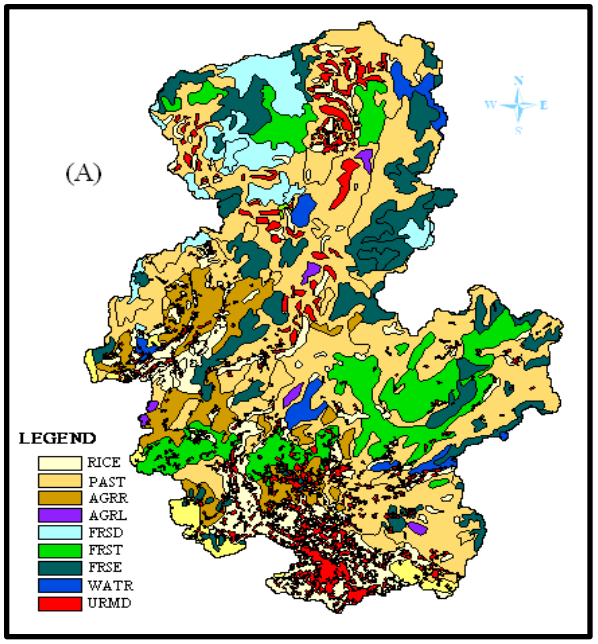
SWAT Code*	Baseline		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
WATR	39948.11	13.58	39948.11	13.58	39948.11	13.58	39948.11	13.58	39948.11	13.58
URMD	16384.72	5.57	16384.72	5.57	16384.72	5.57	16384.72	5.57	43075.18	14.65
FRSD	15214.7	5.17	15214.70	5.17	15214.70	5.17	0.00	0.00	15214.70	5.17
FRSE	38391.23	13.05	38391.23	13.05	38391.23	13.05	38391.23	13.05	38391.23	13.05
FRST	17332.68	5.89	17332.68	5.89	84867.29	28.86	0.00	0.00	17332.68	5.89
RICE	26690.46	9.08	26690.46	9.08	26690.46	9.08	26690.46	9.08	0.00	0.00
PAST	135069.2	45.93	67534.61	22.96	67534.61	22.96	135069.21	45.93	135069.21	45.93
AGRL	126.82	0.04	126.82	0.04	126.82	0.04	126.82	0.04	126.82	0.04
AGRR	4928.73	1.68	72463.34	24.64	4928.73	1.68	37476.11	12.74	4928.73	1.68
	294086.66	**100**	**294086.66**	**100**	**294086.66**	**100**	**294086.66**	**100**	**294086.66**	**100**

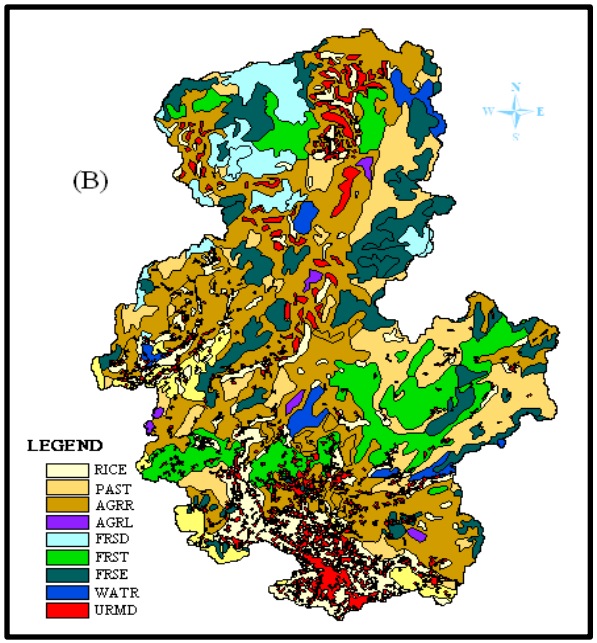
22.96%

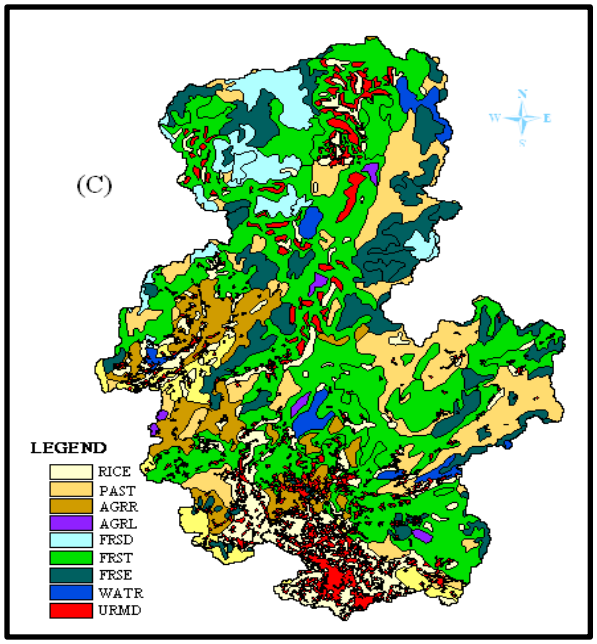
22.96%

* *WATR: Water bodies including natural and manmade ponds and reservoirs, URMD: Urban residential medium density, FRSD: Forest-Deciduous, FRSE: Forest-Evergreen, FRST: Forest-Mixed, RICE: Rice cultivation, PAST: Pasture, AGRL: Agricultural Land-Generic, AGRR: Agricultural Land-Row Crops (almost occupied by Tea).*

Map of land use scenarios







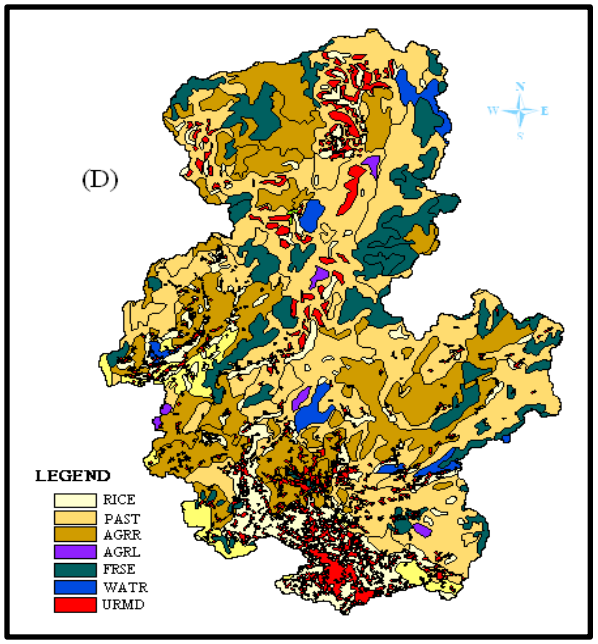
(A) Baseline Scenario

(B) Scenario 1: converted 22.96% Pasture land into Agricultural Land-Row Crops, other unchanged

(C) Scenario 2: converted 22.96% Pasture land to Forest-Mixed land

(D) Scenario 3: converted 5.17% Forest-deciduous and 5.89% Forest-Mixed land into Agricultural Land-Row Crops

(E) Scenario 4: converted 9.08% Rice land to Urban area.



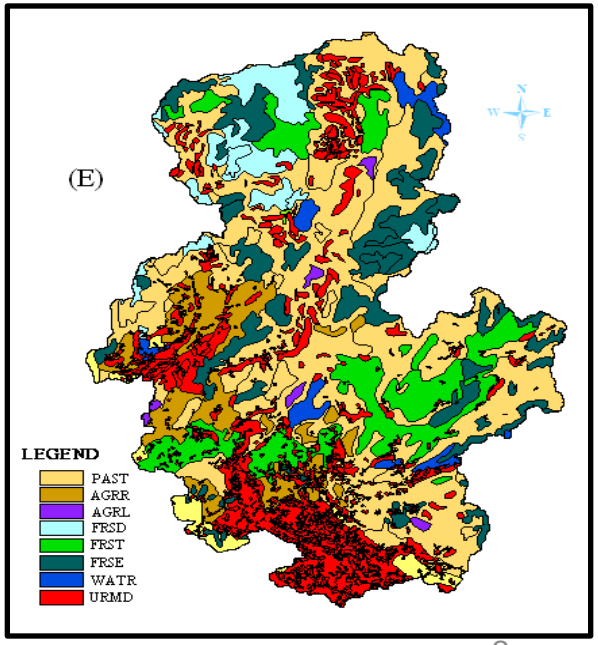


Figure 2. Different Land-use Scenarios Generated for Song Cau Catchment.

Model performance evaluation

Nash-Sutcliffe efficiency (NSE), and percent bias (PBIAS) were use to evaluate model performance:

$$NSE = 1 - \{\sum^{n}_{i=1}(Q^{i}_{obs} - Q^{i}_{sim})^2\} / \{\sum^{n}_{i=1}(Q^{i}_{obs} - Q_{obs\text{-}mean})^2\} \quad (1)$$

$$PBIAS = \{\sum^{n}_{i=1}(Q^{i}_{obs} - Q^{i}_{sim}) \times 100 / \sum^{n}_{i=1}(Q^{i}_{obs})\} \quad (2)$$

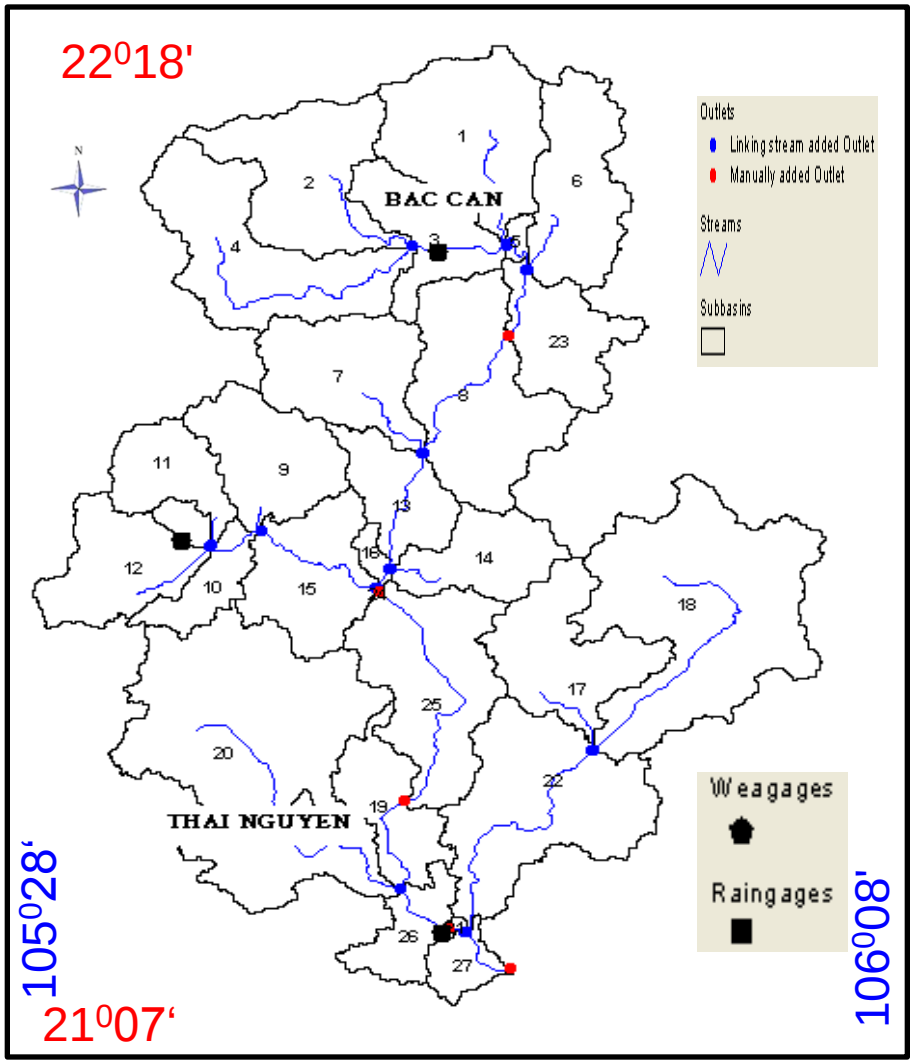
Where: ***n*** is the number of registered data points,

Q^{i}_{obs}, and Q^{i}_{sim} are the observed and simulated data, respectively, on the i^{th} time step, and

$Q_{obs\text{-}mean}$ is the mean of observed data (Q^{i}_{obs}) across the ***n*** evaluation time steps.

3 Results and Discussion

Watershed Delineation



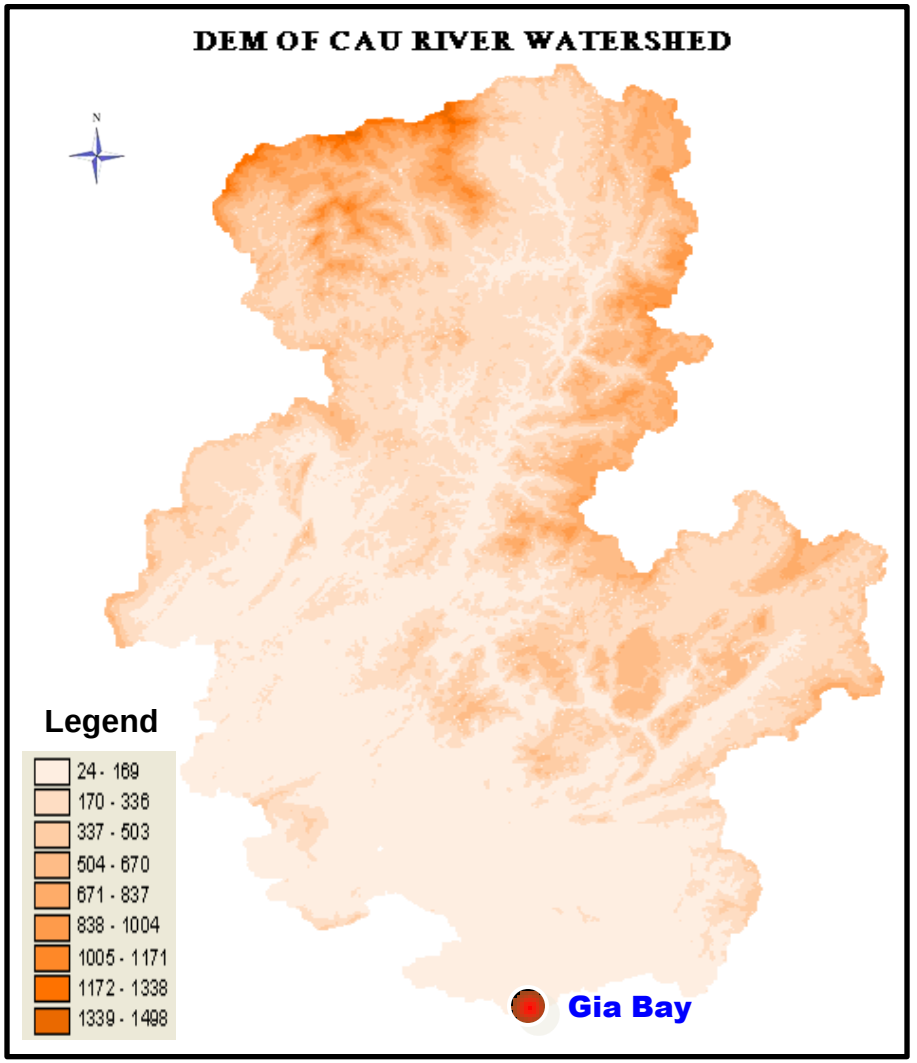
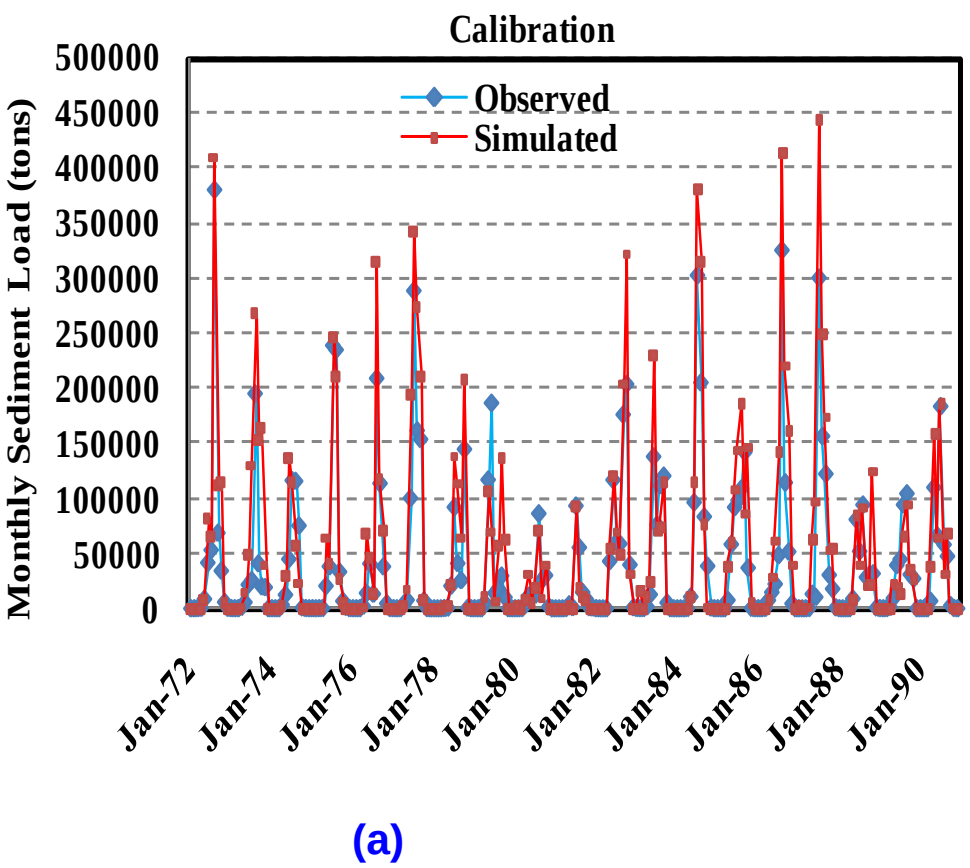
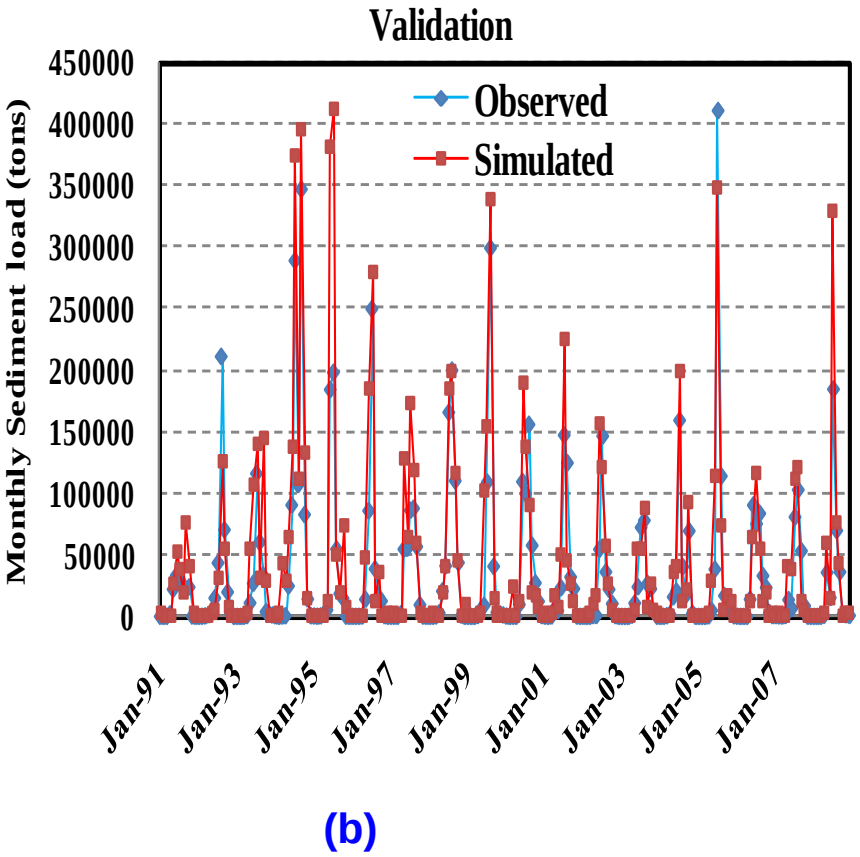


Figure 3. Watershed Delineation and DEM of Song Cau Catchment.

Simulation Sediment load Results



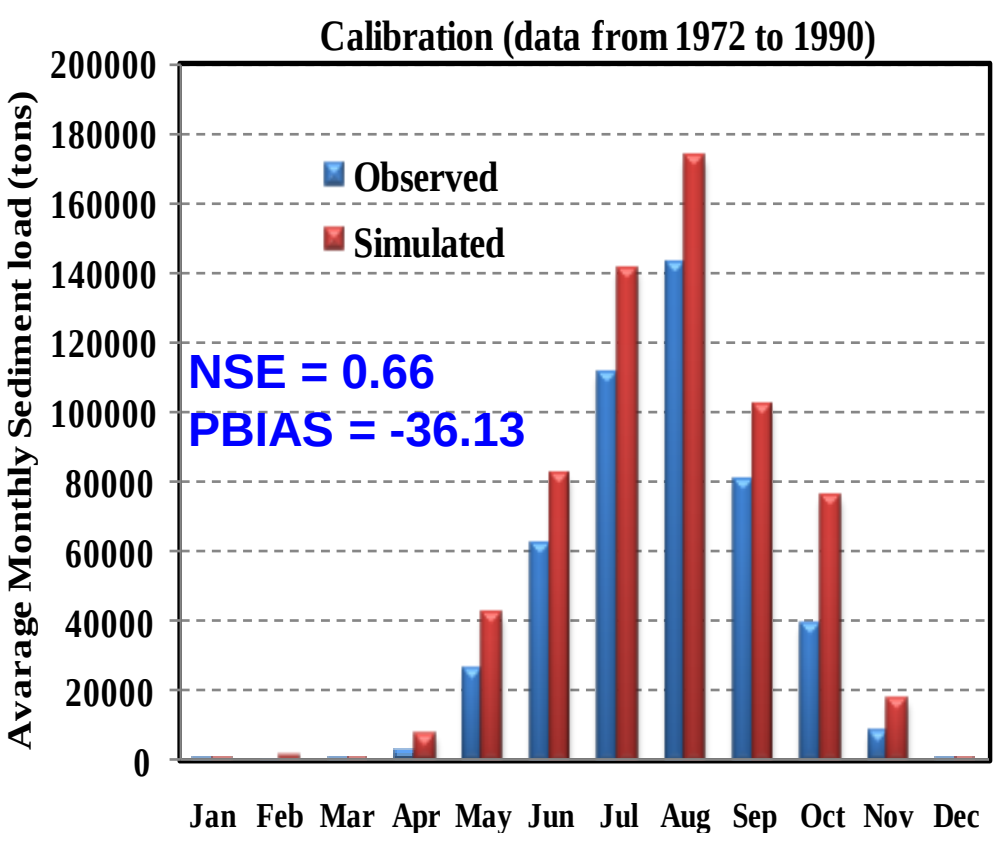
(a)



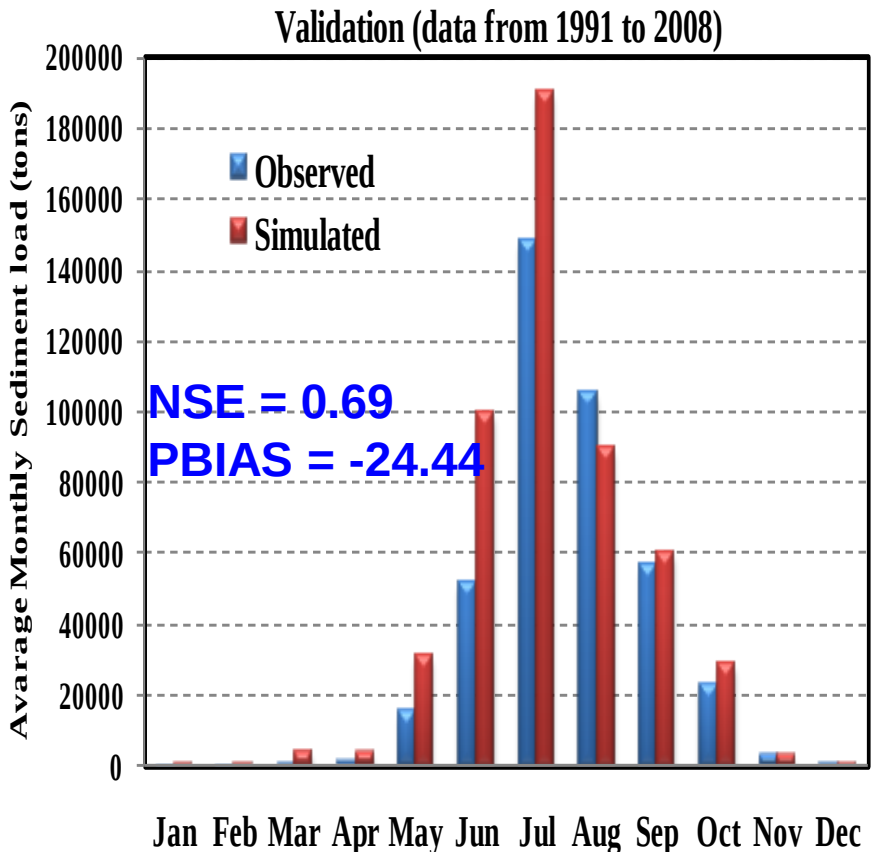
(b)

Figure 4.1. Observed versus Simulated Monthly (a, b) during the Calibration and Validation periods of Song Cau Watershed.

Simulation Results



(c)



(d)

Figure 4.2. Observed versus Simulated Average Monthly Sediment Load (c, d) during the Calibration and Validation periods of Song Cau Watershed.

Percentage of Sediment load change

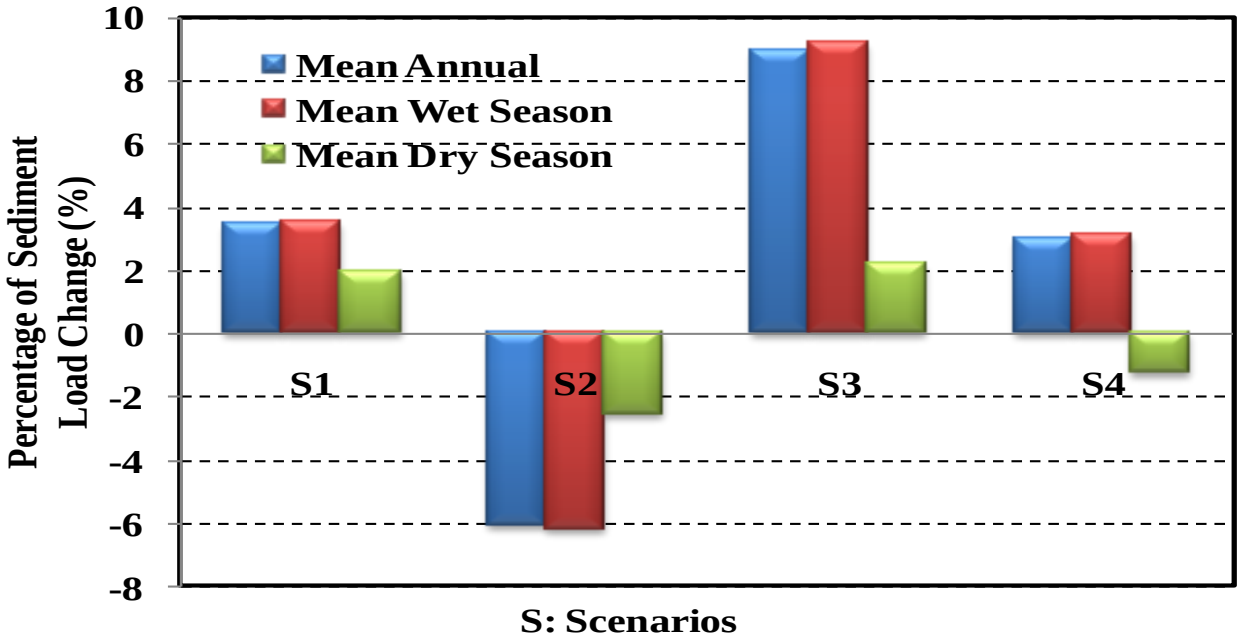


Figure 5. Percentage of Sediment Load Change in Mean Annual, Wet Season and Dry Season with Respect to Baseline Scenario.

Table 3. Percentage of Sediment Load Change (%) from Baseline Scenario for Mean Annual, Wet Season and Dry Season.

Items	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Mean Annual	3.45	-6.08	8.94	2.98
Mean Wet season (May-Oct)	3.51	-6.21	9.18	3.13
Mean Dry season (Nov-Apr)	1.92	-2.56	2.21	-1.25

4 Conclusions and Recommendation

✓ SWAT was able to successfully simulate sediment loads for Song Cau catchment.

✓ Land use change scenarios based on crop conversion on parts of the study catchment seem to be an efficient measure to minimize soil losses

✓ The results of this study suggest the incorporation of pasture with forest-mixed (Scenario 2) and pasture with row crop agricultural land (Scenario 1) cultivation in the study catchment are among the lists of best management practices. Moreover, cultivation of pasture with forest-mixed results in low mean annual reduction in sediment (6.08%).

Acknowledgement

We would like to express our sincere thanks to:

✓ Department of Natural Resources and Environment of Thai Nguyen and Bac Can provinces;

✓ Office of Thai Nguyen, Bac Can, and Dinh Hoa Weather Stations


BanGioc's Waterfall
CaoBang province
Thank you
for your
attention