2014

SWAT

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Application of SWAT: Assessing environmental efficiency of various land use scenarios in Haean catchment South Korea

1st August 2014

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BoPhy

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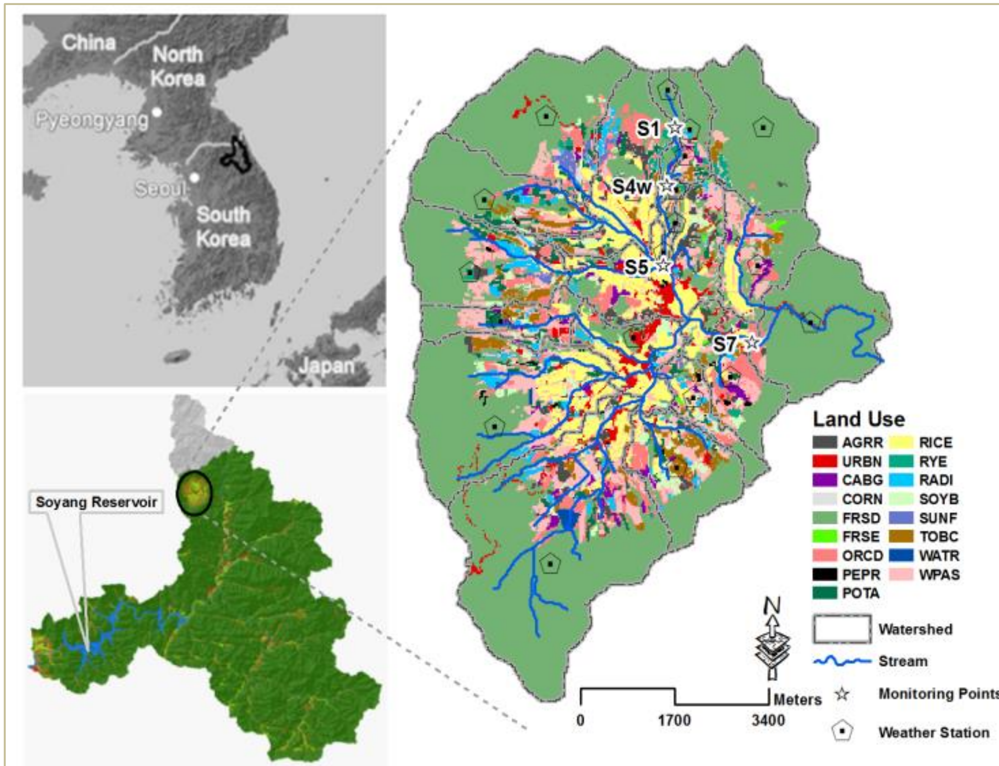
Contents

General issues of the Haean Catchment

- ❖ High Economic Activity Based on agriculture
- ❖ Yield oriented land use system increasing Urbanization and Deforestation
- ❖ Intensive dry and wet land Agriculture system
- ❖ Excess use of Fertilization
- ❖ Expert large amount of nutrients and Sediment

Location of Study Area



Source: Arnhold

- Haean Catchment Geographically located at 128˚5' to 28˚11'E, 38˚13' to 38˚20'N
- In Gangwon Provience near Demilitarized Zone (DMZ) between south and noth korea.
- Watershed Area: 62 Km^2

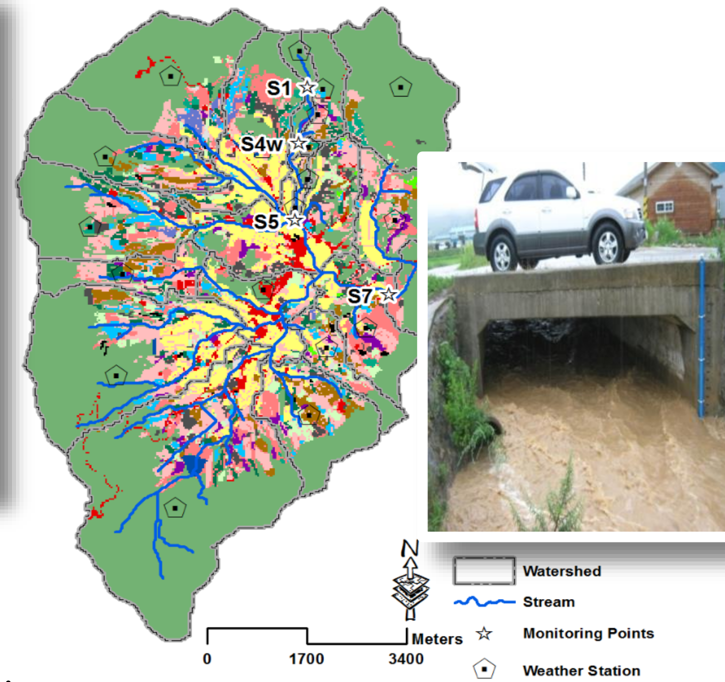
Annual Dry land	Forest and Ochard	Wet land/Paddy
26.5%	62.5%	8.5%

- Elevation range 340 - 1320 m
- Annual precipitaion of 1650 mm monstly concentrated (70%) within June - August.
- Consider as hot spot for muddy water discharge to Soyang reservoir.

2. Objectives

- ❖ To evaluate different land use system to determine environmentally efficient Land Use in retaining sediment and nutrients to the stream network.
- ❖ To evaluate economic efficiency - based on cost benefit analysis of environmentally efficient land use system
- ❖ To recommend best land use system by trade off analysis with other land use system.

Experimental Setup: Field Campaigns 2009-2014

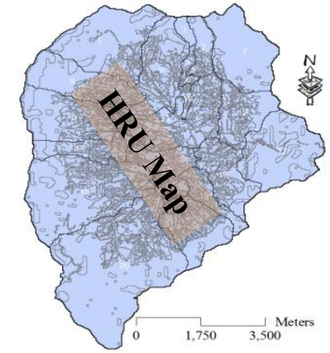


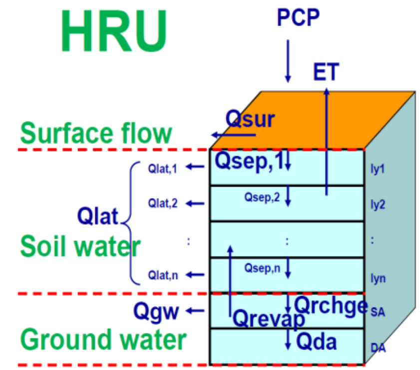
Time Step Measurements

- ❖ Meteorological Data
- ❖ LAI and Biomass/Yeild
- ❖ Field level Erosion
- ❖ Stream discharge and sediment

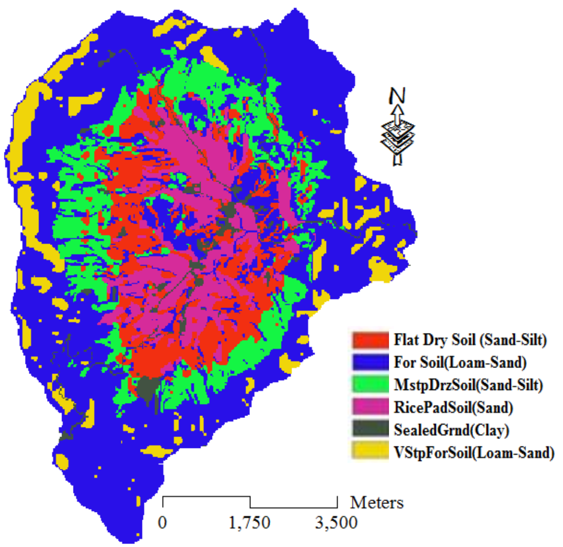
4. Model Setup (In put Maps)

- Study area: Haean catchment, South-korea
- Watershed area: 62.7 km^2
- Total number of sub-watershed: 21
- Number of HRU formation: 792
- MULTIPLE HRUs LandUse/Soil/Slope OPTION :THRESHOLDS : 0 / 0 / 0 [%]
- Number of calibration points: 5 (S1, S2, S3, S4W, S5 and S7)

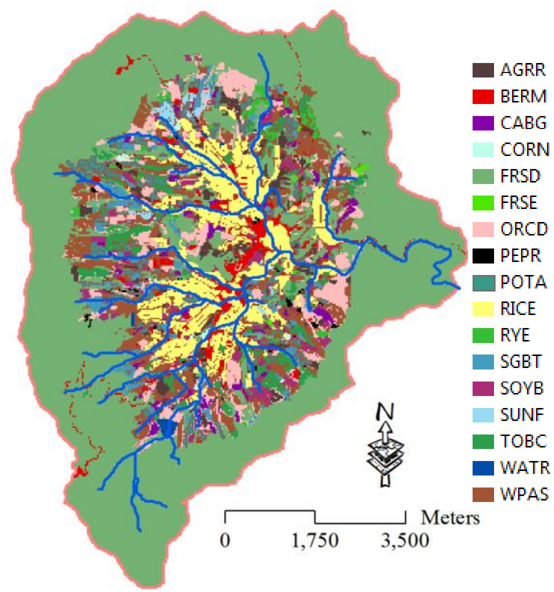




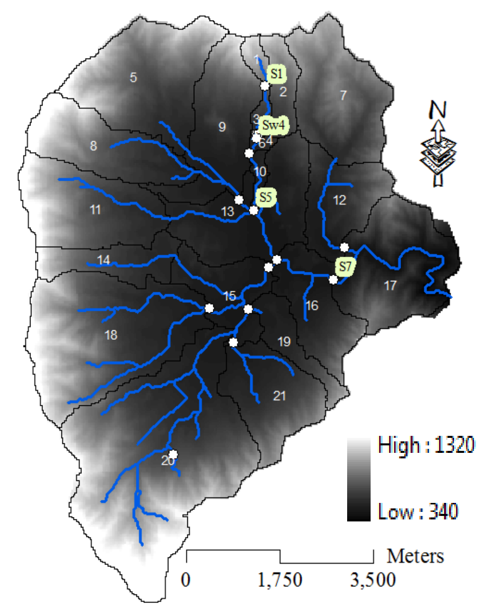
Soil type Map



Land Use Map

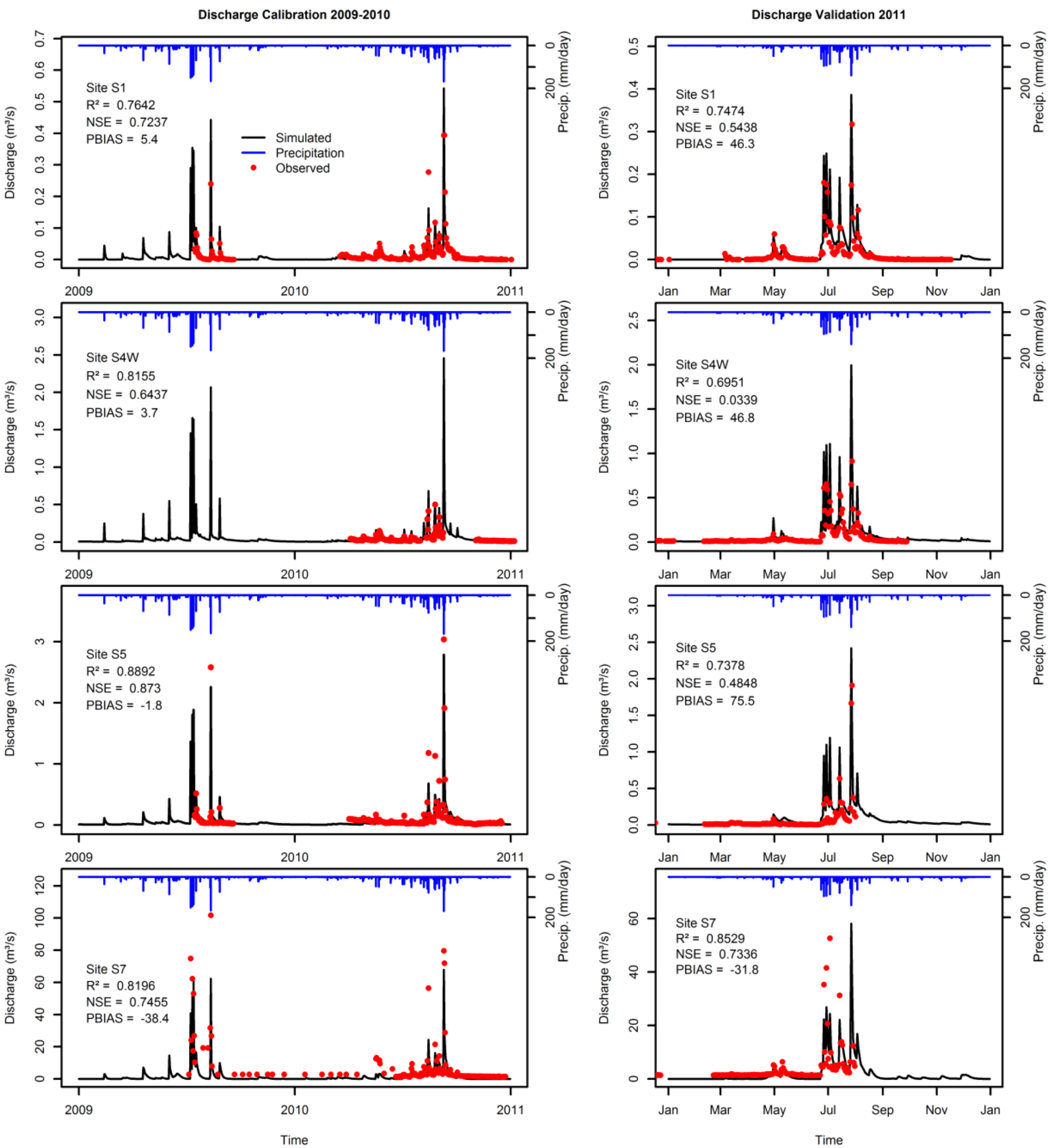


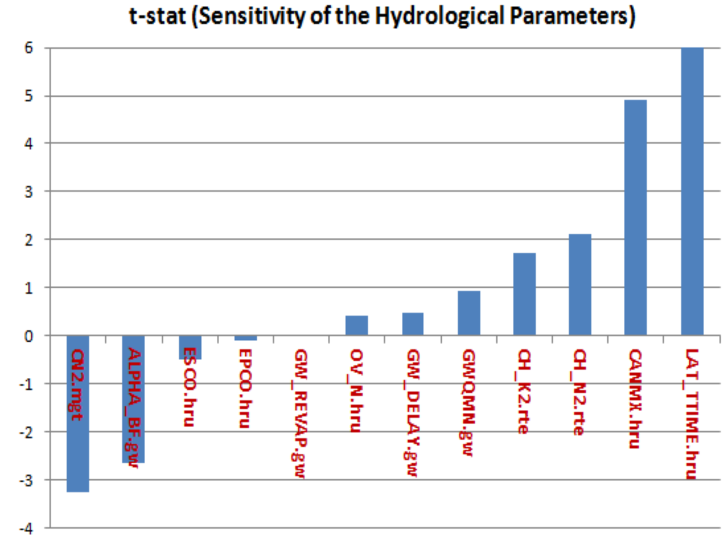
DEM

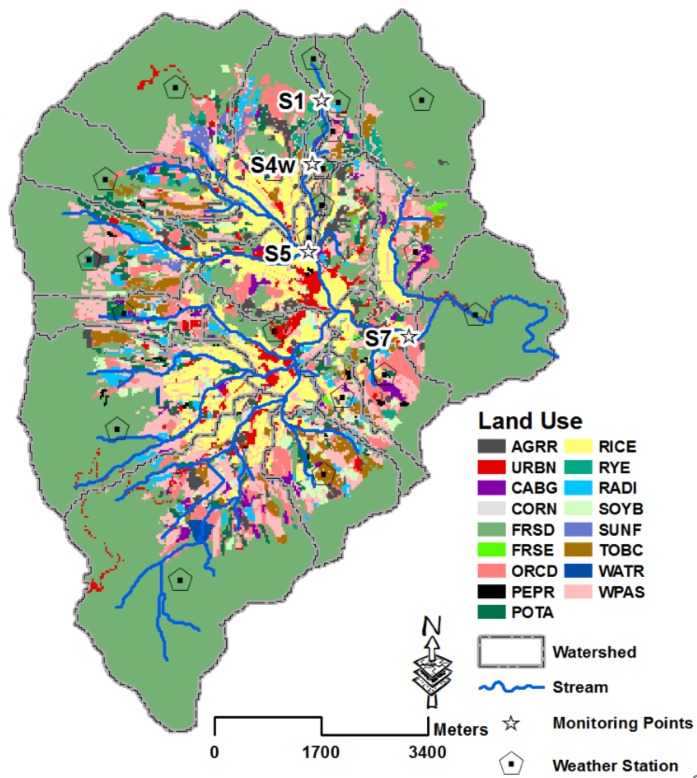


Model Calibration and Validation

A. Stream Flow Calibration and Validation

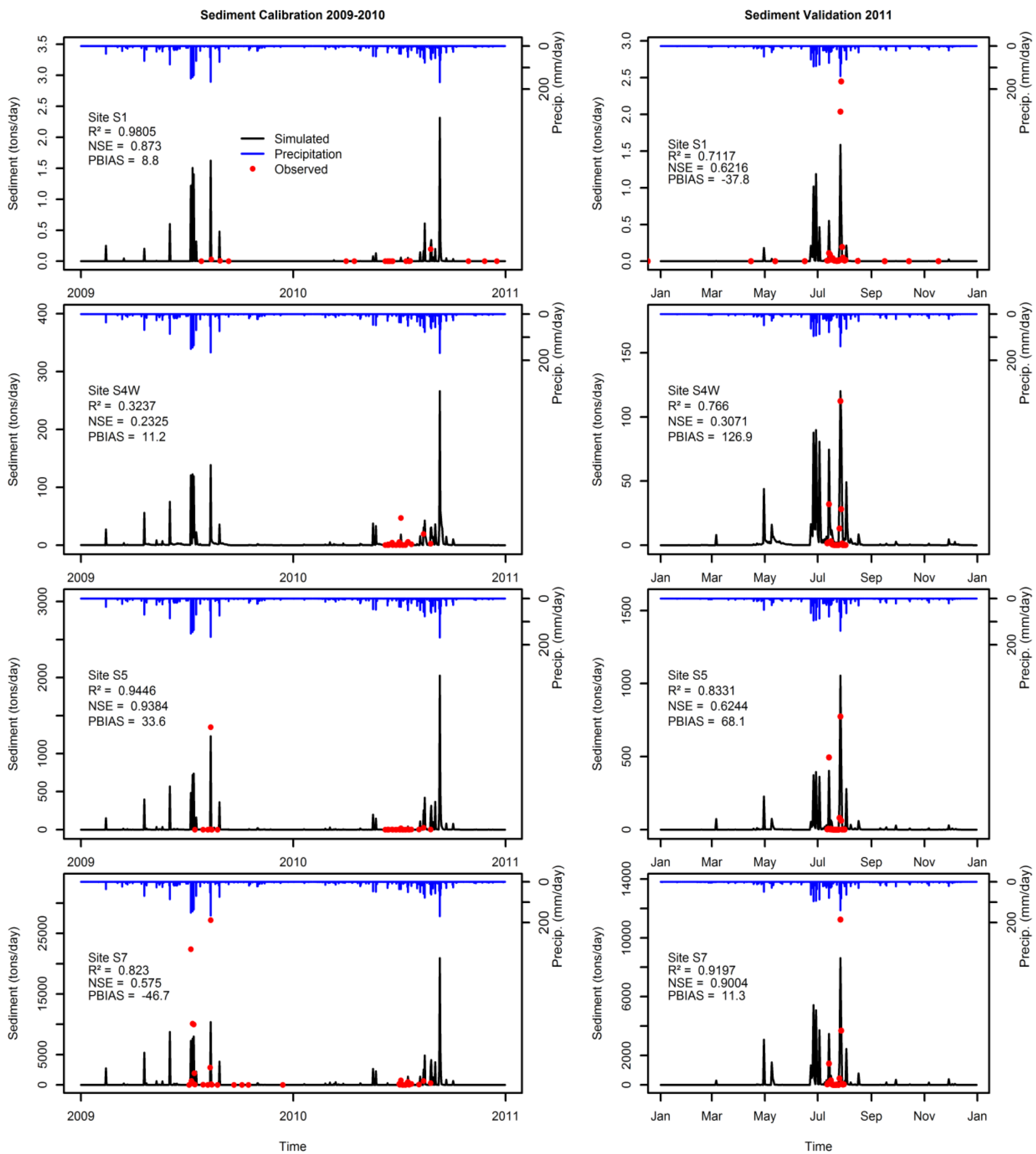


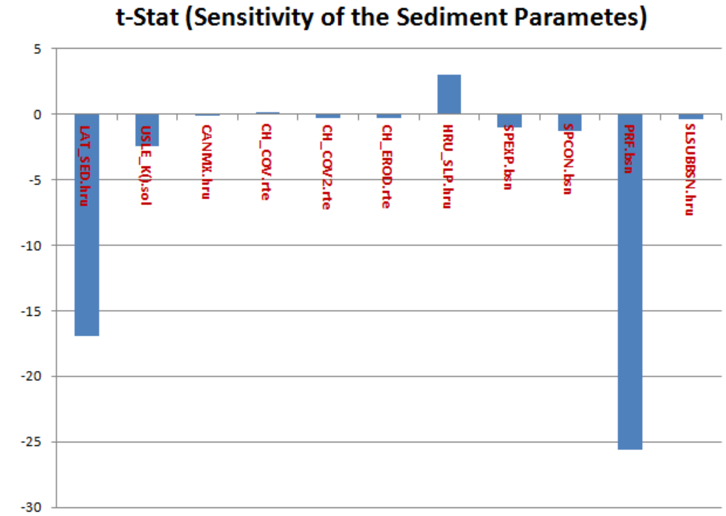


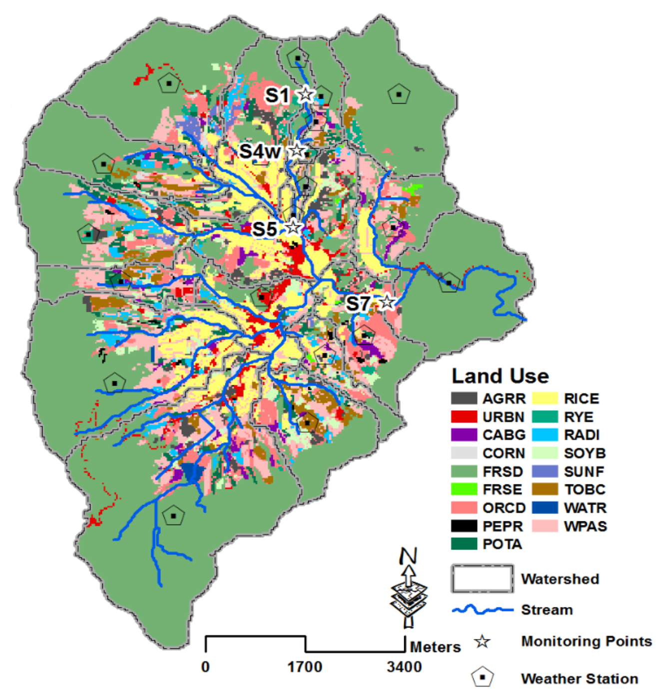


Model Calibration and Validation

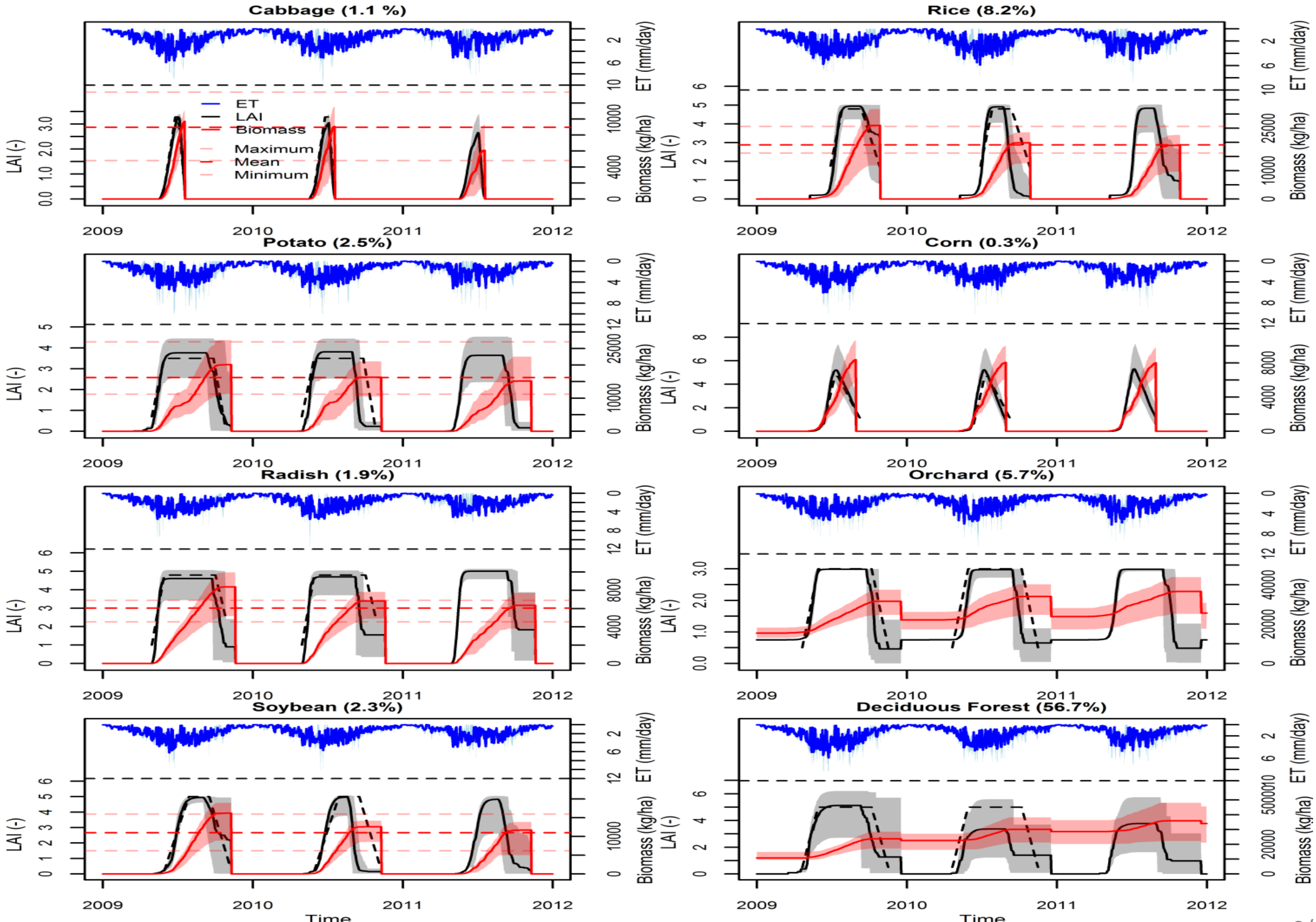
B. Sediment Calibration and Validation







Bio Mass and Yield Simulation



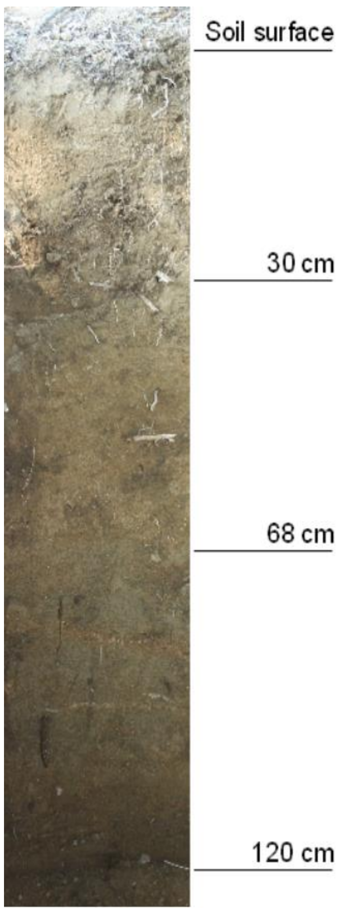
Development Of Land Use Scenario (Expansion Scenario)

Four major Dry land crops
- ❖ Cabbage
- ❖ Soybean
- ❖ Radish
- ❖ Potato

USLE_C=0.20

Crop Choice based on
- ❖ Market price
- ❖ Labour
- ❖ Farmers attitude toward
- ❖ Subsidies/Intervention
- ❖ others

Moderate Steep Dry farmland

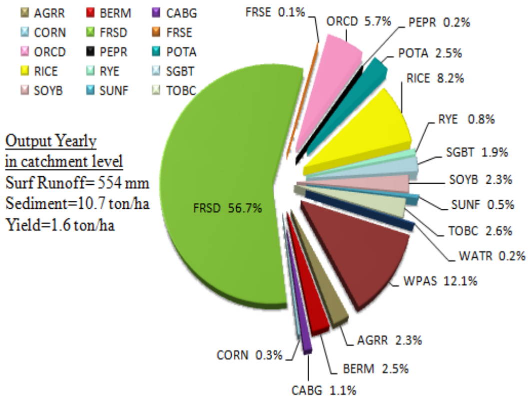


Base line Land use land cover map was analyze for 4 Major Crops
- ❖ Crops grown dominated in **Moderate Steep Dry farmland** and **Flat Dry farmland land** with soil texture of Sand – Silt

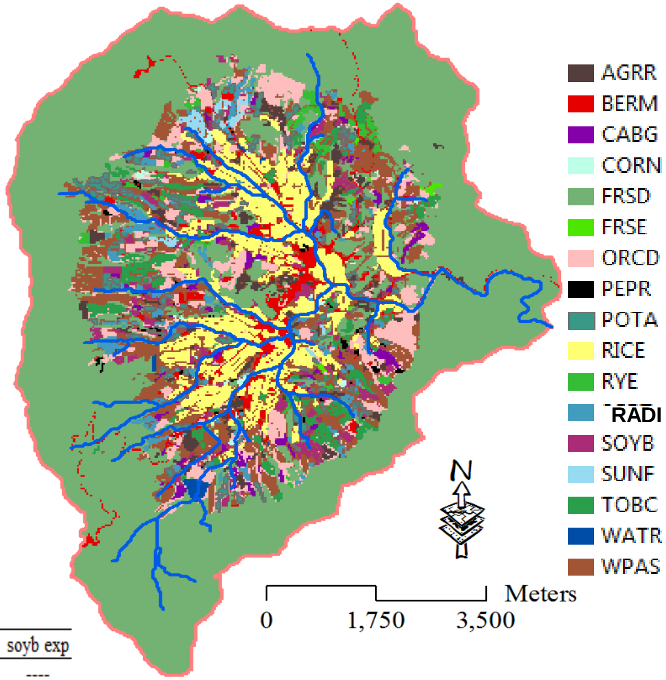
Soil Type	Texture	Hydrologic group	Area (km^2)	Percentage catchment
Flat dryland soil	Sand – Silt	**D**	8	12.8
Forest soil	Loam – Sand	C	32.6	51.9
Moderate steep dry land	Sand – Silt	**D**	9.2	14.7
Rice paddy soil	Sand	C	6.6	10.5
Sealed ground	caly	D	1.7	2.7
Very steep forest soil	Loam – Sand	C	4.7	7.5

Flat Dry farmland

Application of Crop Expansion Scenarios

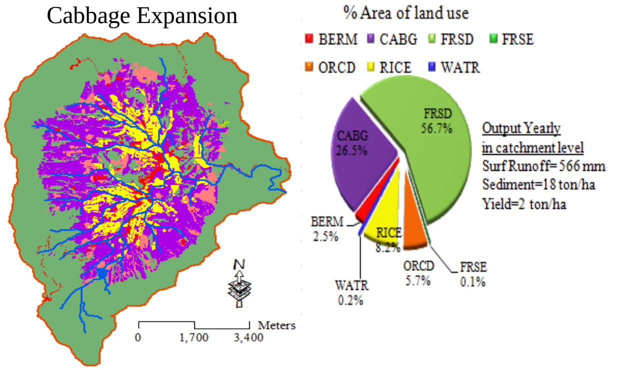


LULC Map 2010

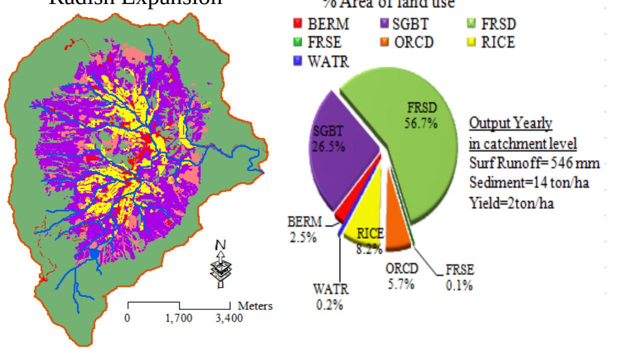


Category	AREAkm2	Initial % Area	cabg exp	pota exp	sgbt exp	soyb exp
			Scenarios			
AGRR	1.46	2.3%	----	----	----	----
CABG	0.70	1.1%	25.4%	----	----	----
CORN	0.18	0.3%	----	----	----	----
PEPR	0.15	0.2%	----	----	----	----
POTA	1.56	2.5%	----	24.1%	----	----
RYE	0.50	0.8%	----	----	----	----
RADI	1.21	1.9%	----	----	24.6%	----
SOYB	1.42	2.3%	----	----	----	24.3%
SUNF	0.30	0.5%	----	----	----	----
TOBC	1.61	2.6%	----	----	----	----
WPAS	7.56	12.1%	----	----	----	----
BERM	1.56	2.49%	2.49%	2.49%	2.49%	2.49%
FRSD	35.56	56.69%	56.69%	56.69%	56.69%	56.69%
FRSE	0.07	0.12%	0.12%	0.12%	0.12%	0.12%
ORCD	3.55	5.67%	5.67%	5.67%	5.67%	5.67%
RICE	5.17	8.24%	8.24%	8.24%	8.24%	8.24%
WATR	0.15	0.25%	0.25%	0.25%	0.25%	0.25%

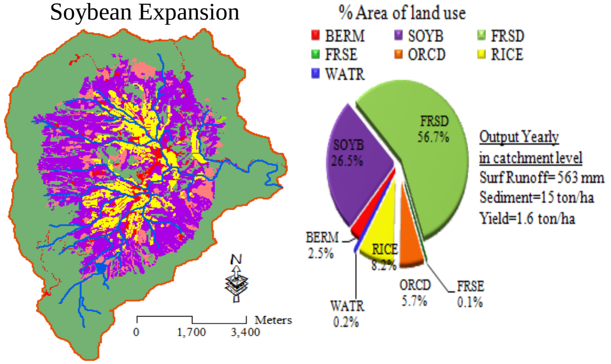
Cabbage Expansion



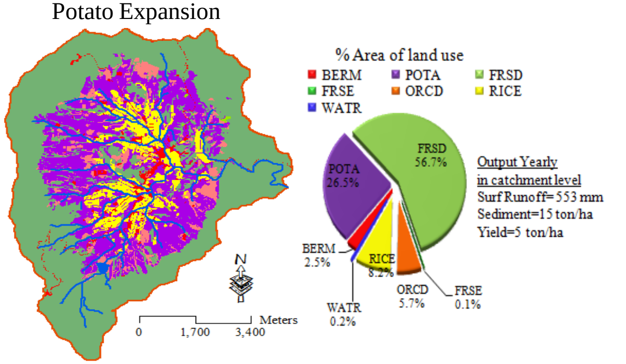
Radish Expansion



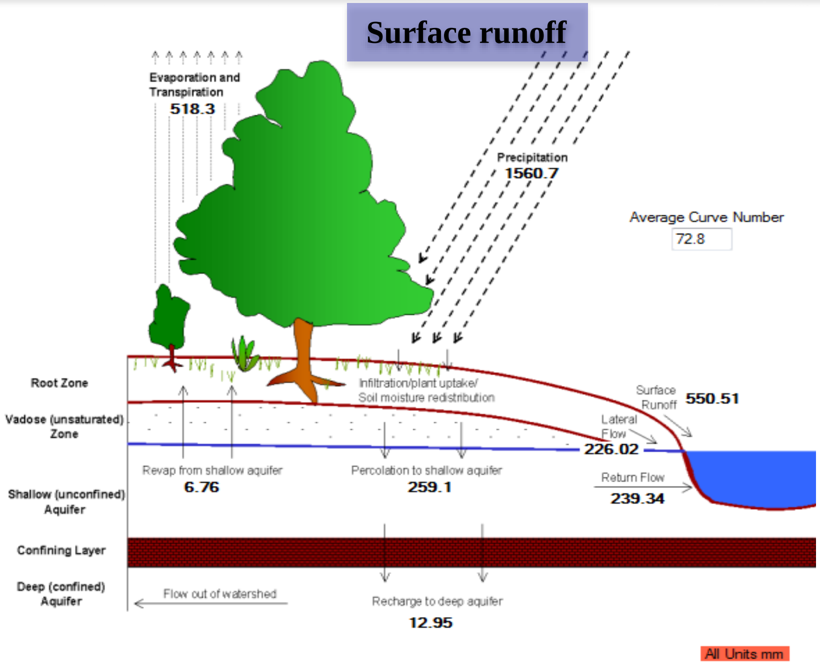
Soybean Expansion

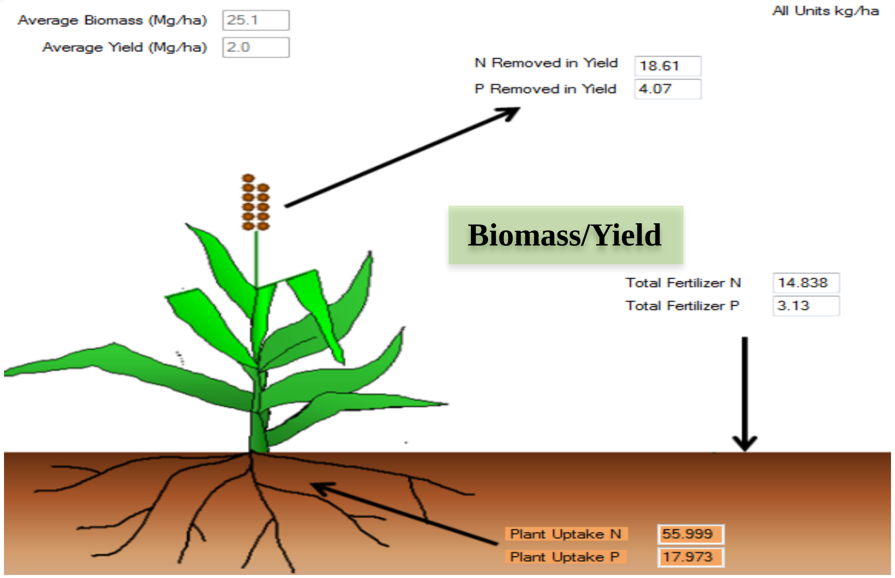


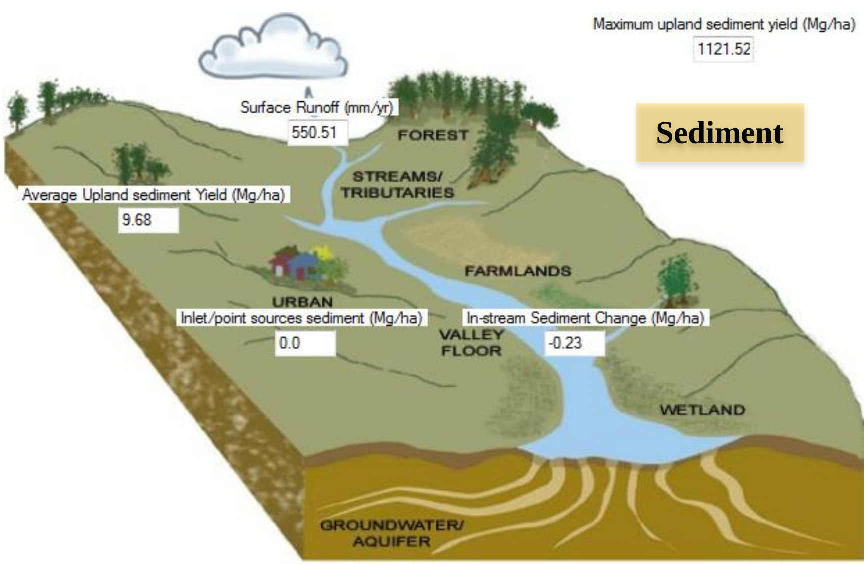
Potato Expansion



Output Indicator for Different Scenario







Crop Yield Linking Farm Income

Presumption/Constrains

Farm Income Calculation Based on Crop Price
Field Survey in 2010

$$\text{Income} = \sum_{i=1}^{N} (\text{MYld} \times \text{P-PC}) A_i / A$$

Where,
Icome = *Won/ha*
Myld = *Marketable Yield ton/ha*
P = *Price Won/kg*
PC = *Production cost Won/ha*
N = *Total Number of HRU*
A_i = Area of Hru
A = Total Area

Field Survey (300 farms)

Production Cost: f (fertilizer, tillage, seed, labor)

Crop Price (Price taker) Regional Price
Crop allocation difficult
Assumption of Extreme Scenario

Production cost estimates for potato, cabbage, radish, and soybean

Crop	Price (Won/kg)	Production cost (Won/ha)
Radish	516	784,444
Cabbage	263	711,327
Potato	790	916,201
Soybean	4770	585,945

Biomass/yield: f(micro climate/water/nutrients)

SWAT Scenario

Farm Income:
Yield Revenue – Prod Cost

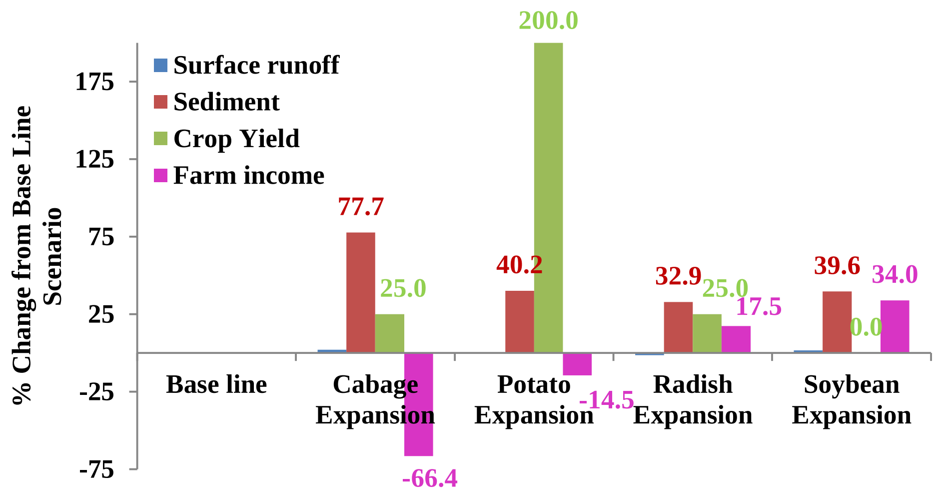
Surface Runoff / Sediment

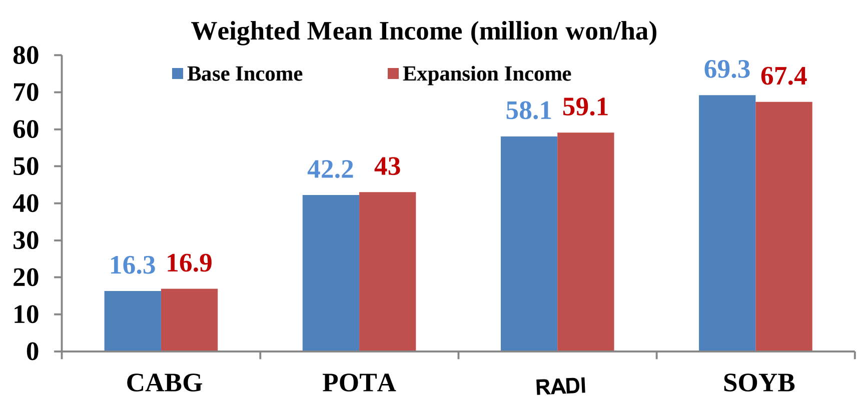
Agri Based Economy

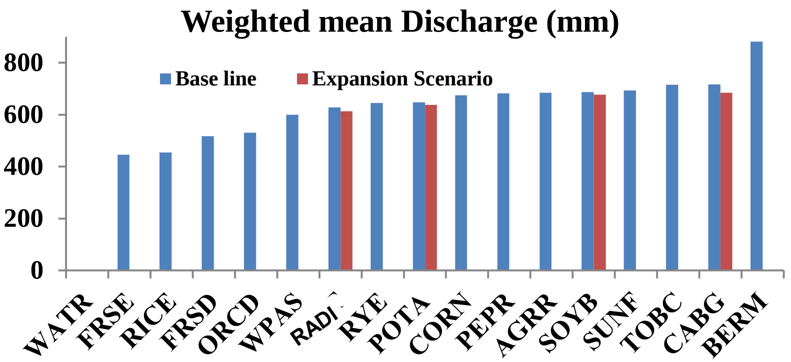
Agri Based Environmental Effect

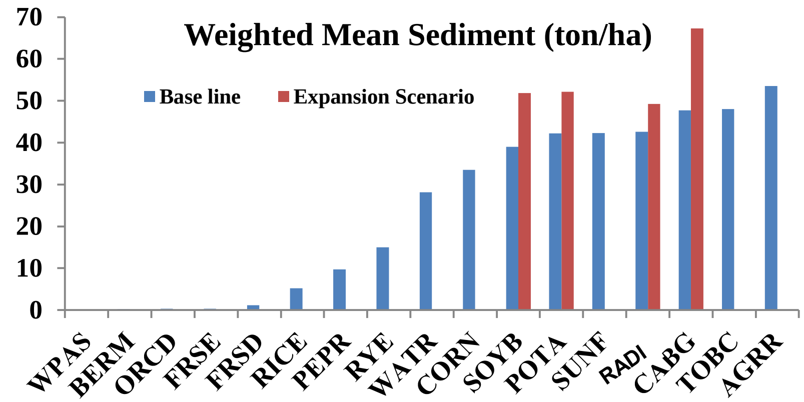
Results for Crop Expansion Scenarios

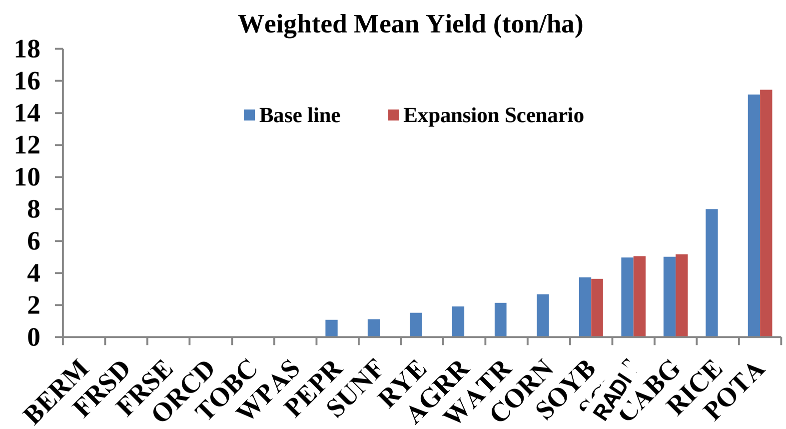
Expansion scenarios	Surface runoff (mm)	Sediment (ton/ha)	Crop Yield (ton/ha)	Farm income (Million Won/ha)
Base line	553.92	**10.7**	1.6	50.3
Cabage Expansion	565.49	**19.01**	2	16.9
Potato Expansion	552.88	15	**4.8**	43
Radish Expansion	546.4	14.22	2	59.1
Soybean Expansion	563.24	14.94	1.6	**67.4**



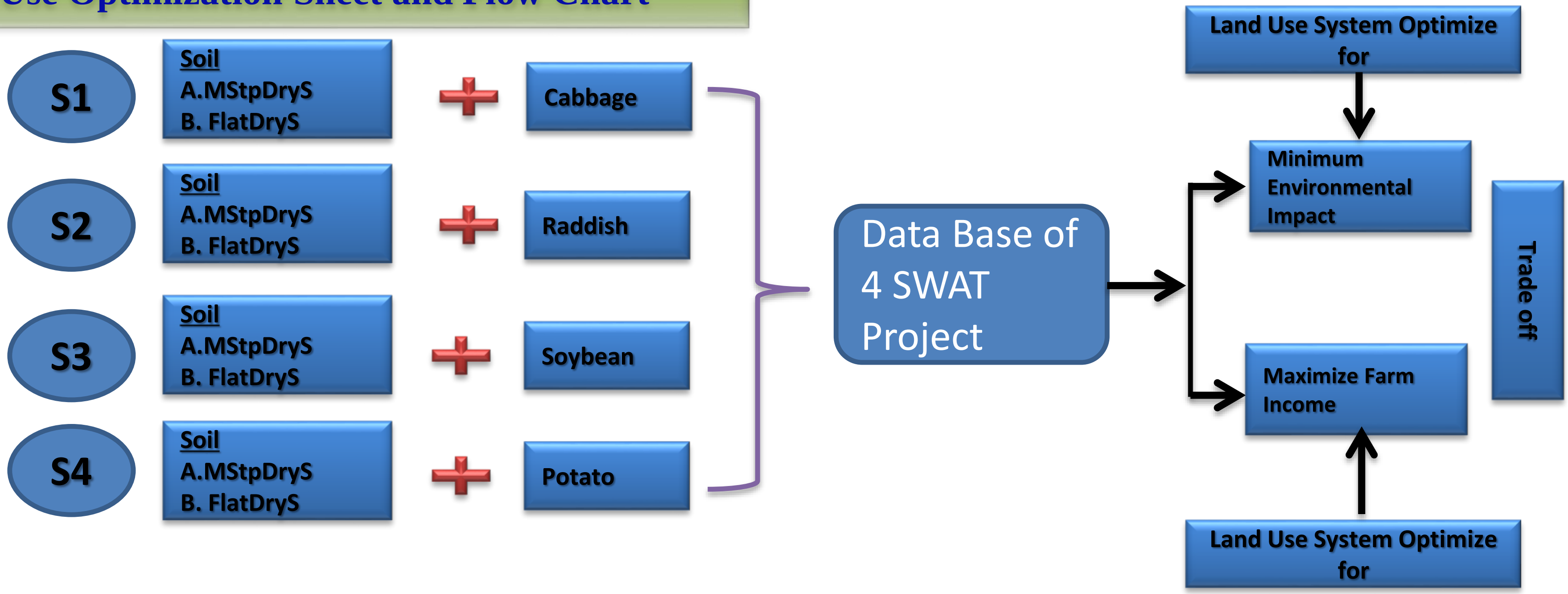








Land Use Optimization Sheet and Flow Chart



HRU no	S1 Project LULC1	S1 Project Env Surf/SE/YLD	S1 Project Income Rev-Prn	S2 Project LULC2	S2 Project Env Surf/SE/YLD	S2 Project Income Rev-Prn	S3 Project LULC3	S3 Project Env Surf/SE/YLD	S3 Project Income Rev-Prn	Baseline …….. ……..	LUS Optimization Mini (ENV) LULC	LUS Optimization Max Income LULC	LUS Optimization Max YLD LULC
1	FRSD	……..	……..	FRSD	……..	……..	FRSD	……..	……..	FRSD	LU from S1	LU from S2	LU from BL
2	URBN	……..	……..	URBN	……..	……..	URBN	……..	……..	URBN	LU from S2	LU from S4	LU from S1
3	CABG	……..	……..	RADI	……..	……..	SOYB	……..	……..	SOYB	LU from BL	LU from S1	LU from S4
4	RICE	……..	……..	RICE	……..	……..	RICE	……..	……..	RICE	LU from S3	LU from BL	LU from BL
……..	CABG	……..	……..	RADI	……..	……..	SOYB	……..	……..	SUNF	LU from BL	LU from BL	LU from S2
……..	……..	……..	……..	……..	……..	……..	……..	……..	……..	……..	LU from S4	LU from BL	LU from BL
……..	……..	……..	……..	……..	……..	……..	……..	……..	……..	…..	……..	……..	……..
792	CABG	……..	……..	RADI	……..	……..	SOYB	……..	[illegible]	POTA	LU from BL	LU from S1	LU from [illegible]

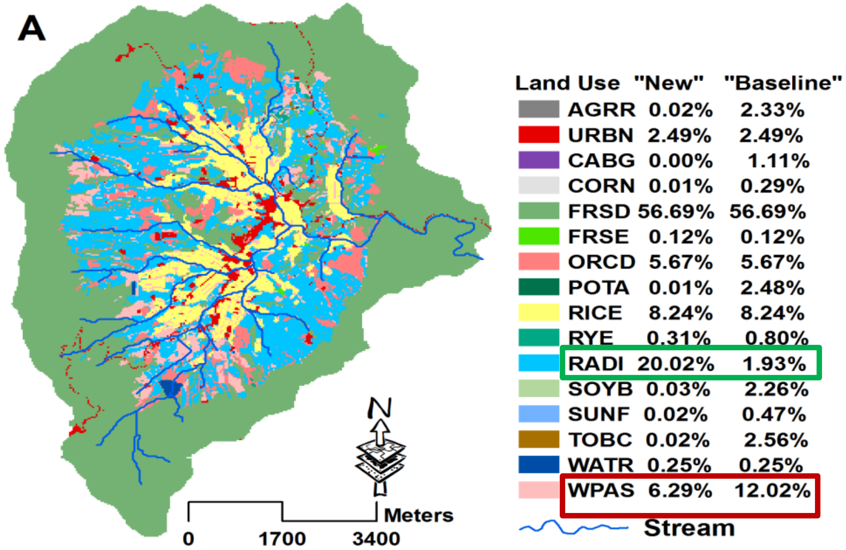
??Farm Income status: Simulate swat

??Env status: Simulate swat

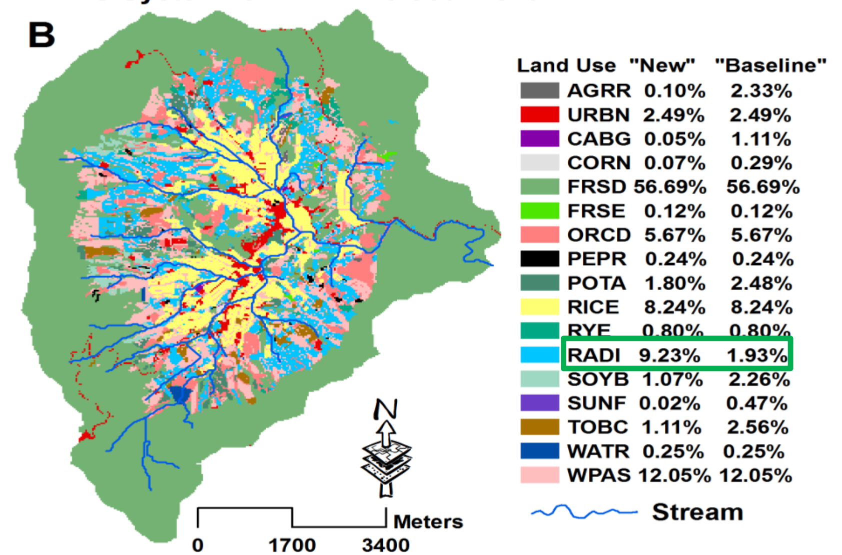
??Farm Income N Env status : Simulate swat

Optimize Land Use System

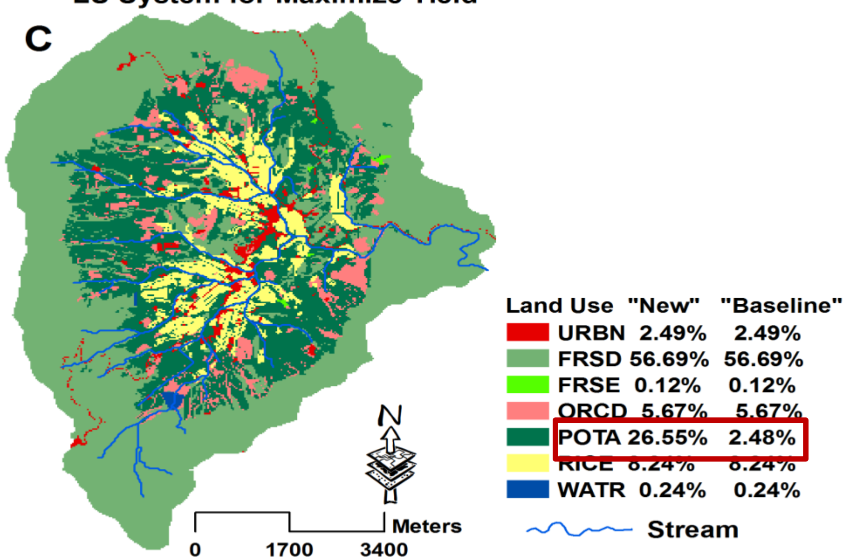
LU System for Minimize SR



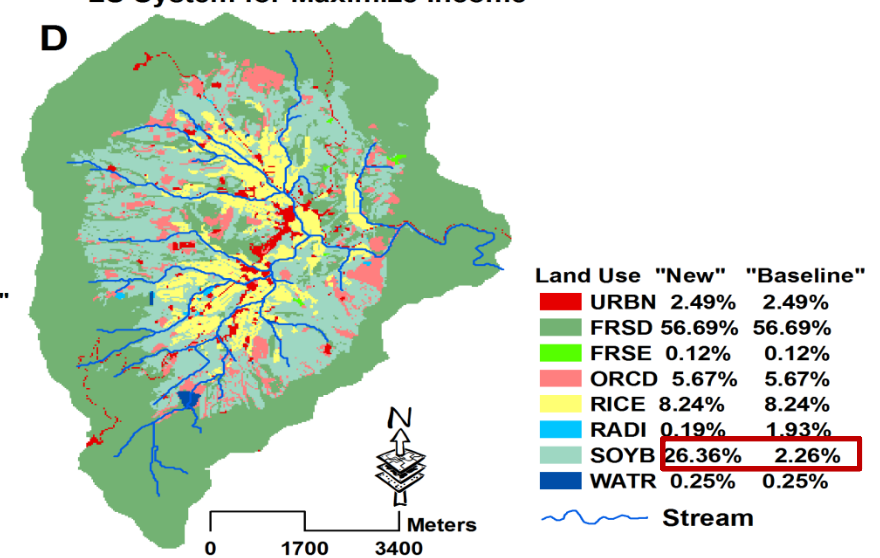
LU System for Minimize Sediment



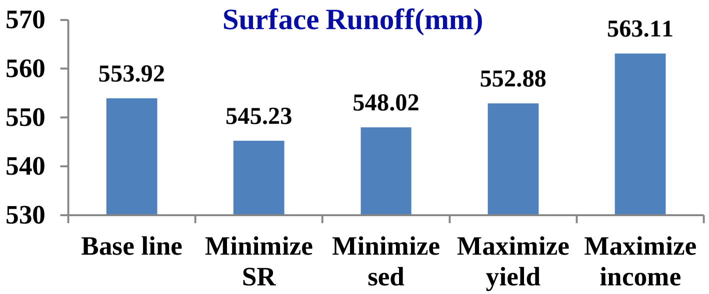
LU System for Maximize Yield

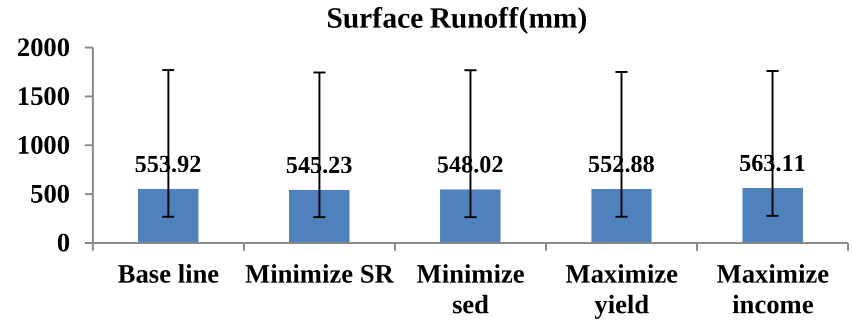


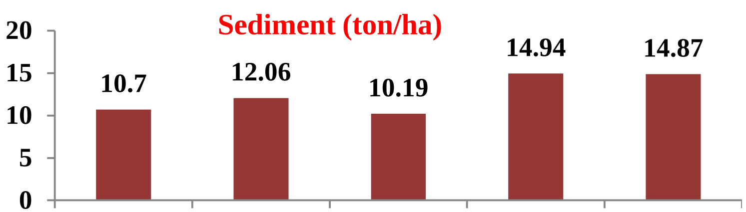
LU System for Maximize Income

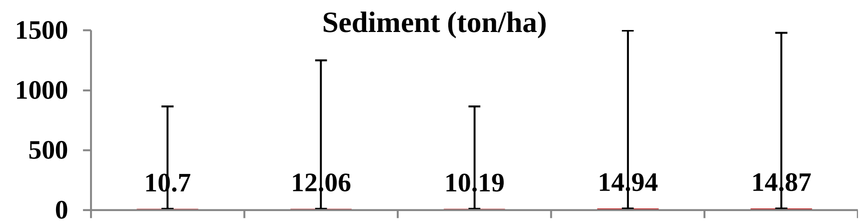


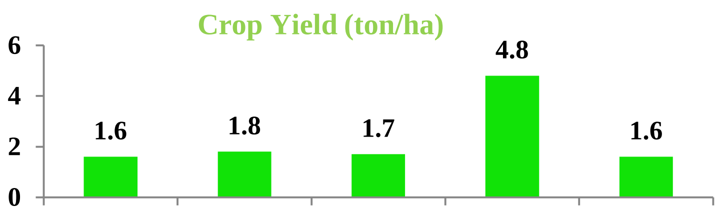
Results for Optimize Land Use System

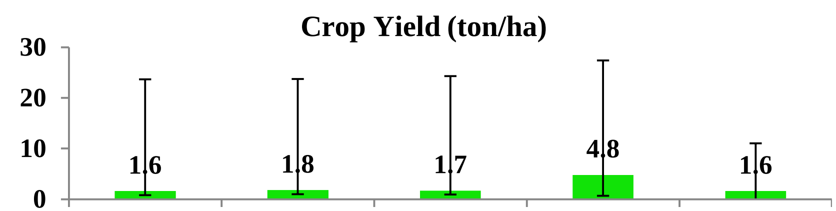


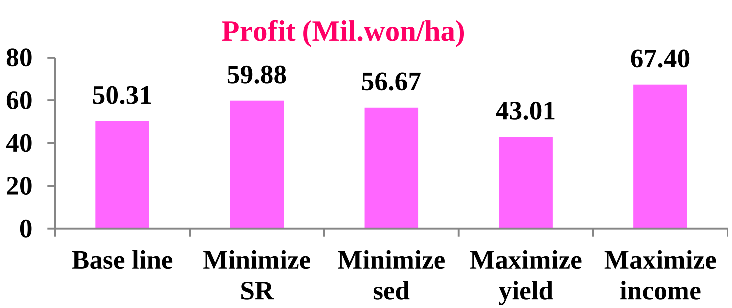


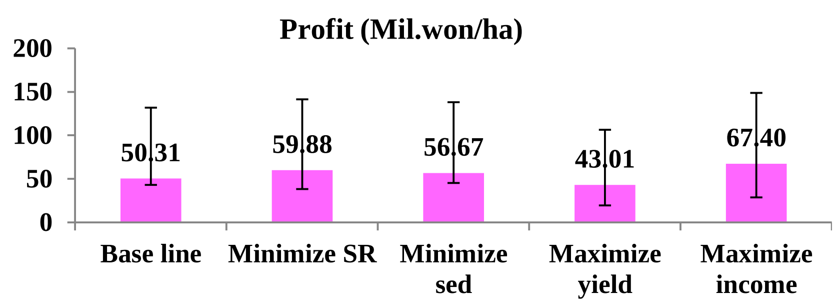




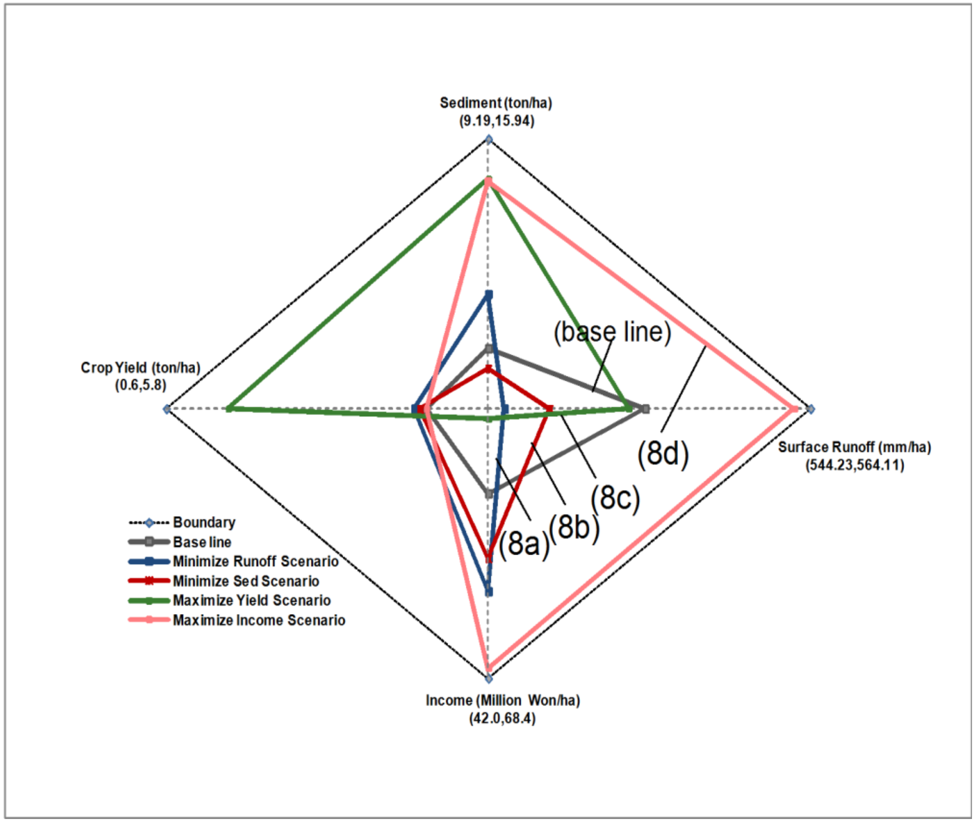






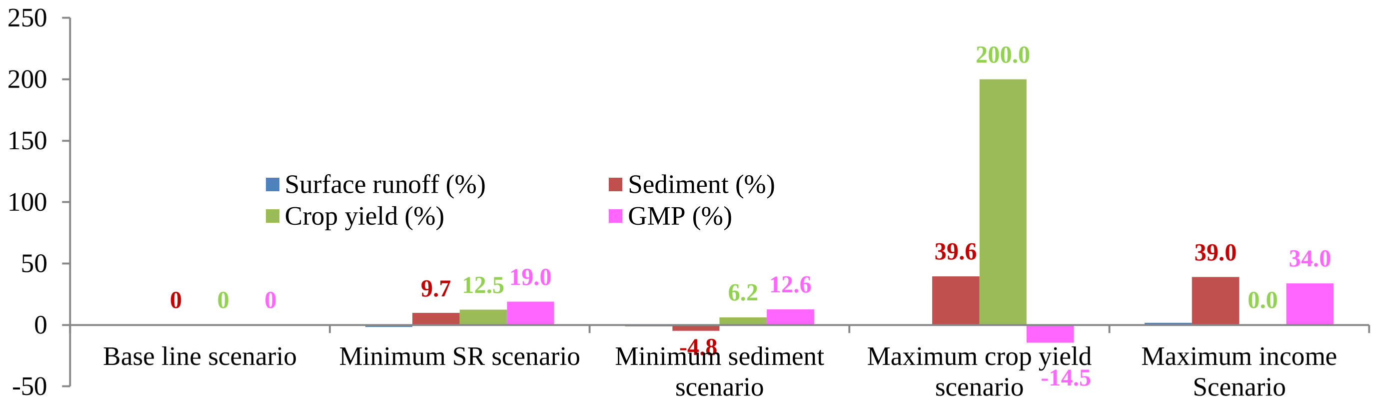


Trade off web plot



Optimized land use scenarios	Surface runoff (mm)	Sediment (ton/ha)	Crop yield (ton/ha)	GMP (Million won/ha)
Base line scenario	553.92	10.7	1.6	50.31
Minimum SR scenario	**545.15**	11.74	1.8	59.88
Minimum sediment scenario	548.3	**10.19**	1.7	56.67
Maximum crop yield scenario	552.88	14.94	**4.8**	43.01
Maximum income Scenario	563.11	14.87	1.6	**67.4**

Optimized land use scenarios	Surface runoff (%)	Sediment (%)	Crop yield (%)	GMP (%)
Base line scenario	0	0	0	0
Minimum SR scenario	-1.6	9.7	12.5	19.0
Minimum sediment scenario	-1.0	-4.8	6.2	12.6
Maximum crop yield scenario	-0.2	39.6	**200.0**	-14.5
Maximum income Scenario	1.7	39.0	0.0	34.0



Conclusion

❖Land use systems that produce Reduced surface runoff, Reduced sediment and Maximize yield were identified.

❖Land use system which produce maximum yield and maximum income also produce higher Sediment and Surface Runoff.

❖Land use system which produce minimize for surface runoff and sediment produce lower economic yield and lower income.

❖Further reduction of sediment and surface runoff are possible from the recommended land use by applying effective filter width in the field of particular sub-basin.

Optimized land use scenarios	Surface runoff (mm)	Sediment (ton/ha)	Crop yield (ton/ha)	GMP (Million won/ha)
Base line scenario	1.6%	5%	-67%	-25%
Minimum surface runoff scenario	**545.15**	15%	-63%	-11%
Minimum sediment scenario	0.6%	**10.19**	-65%	-16%
Maximum crop yield scenario	1.4%	47%	**4.80**	-36%
Maximum income Scenario	3.3%	46%	-67%	**67.4**

“Thank You,,

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