Climate Change and Land Use Change Effects on Water Accounting in Upper Nan Watershed

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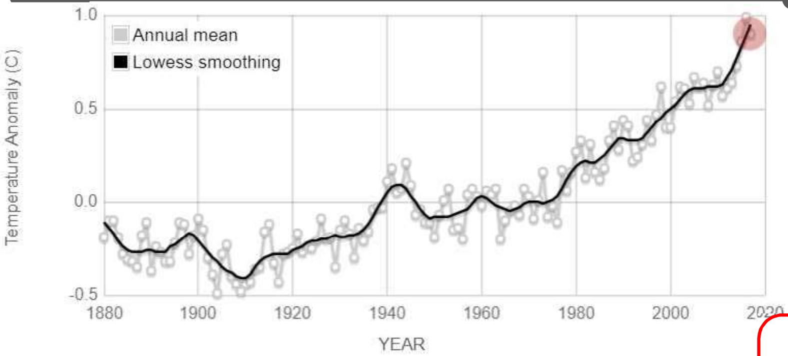
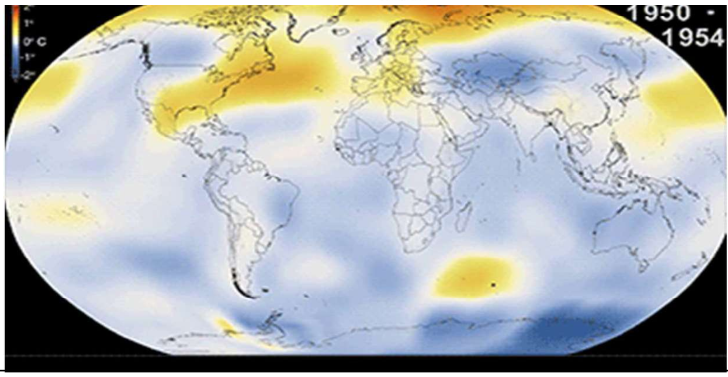
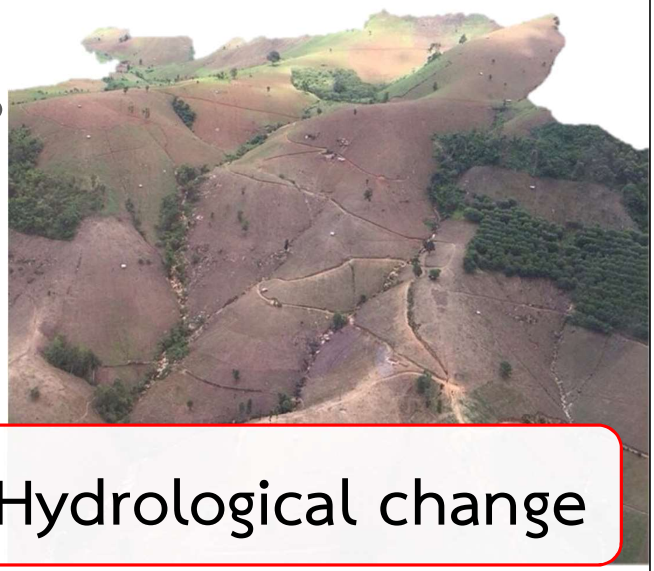
INTRODUCTION



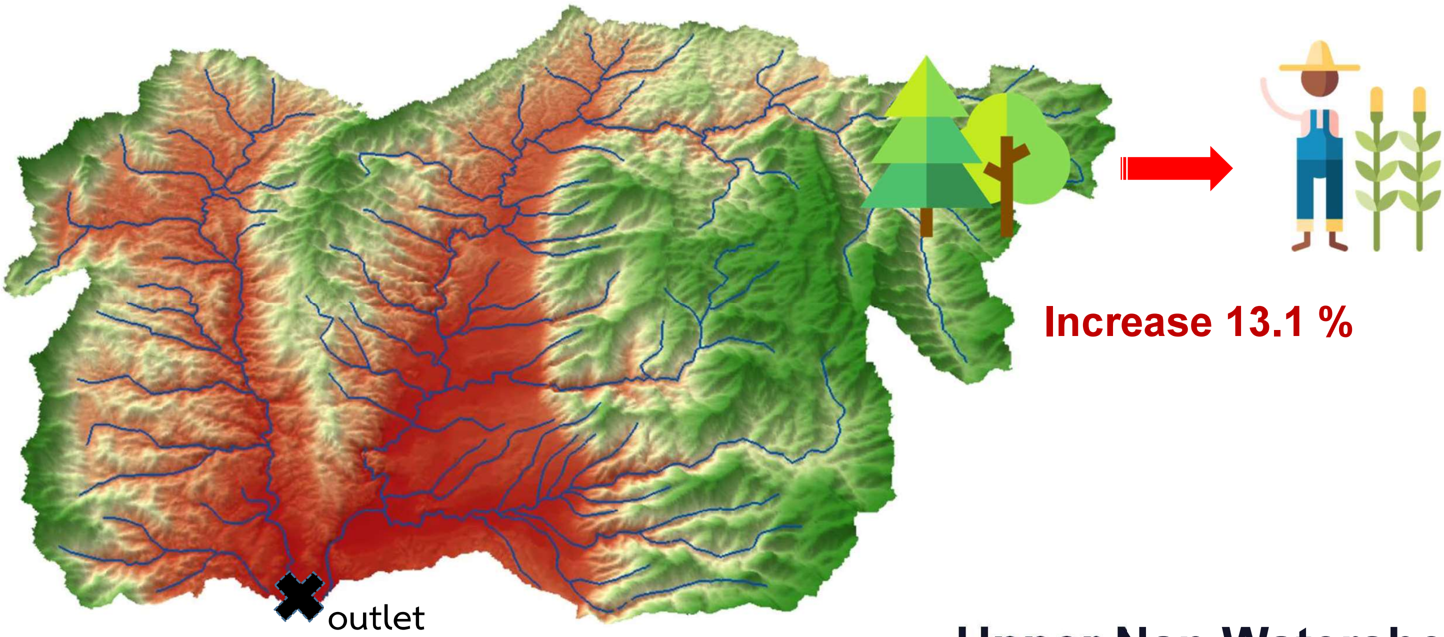




Hydrological change

Water Imbalance

INTRODUCTION



Increase 13.1 %

Upper Nan Watershed

INTRODUCTION

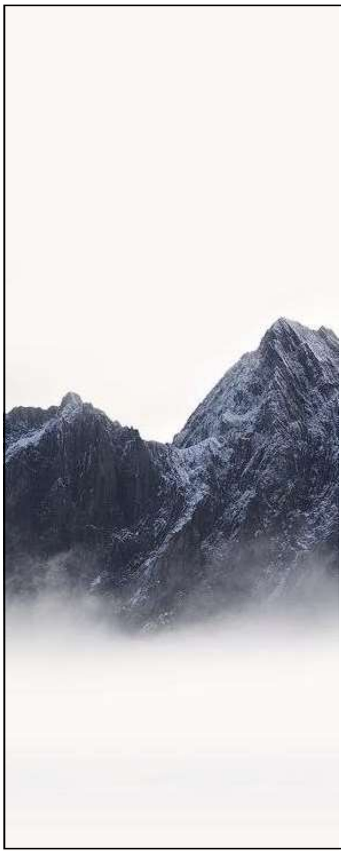
18 August 2018

INTRODUCTION

source: Thai PBS

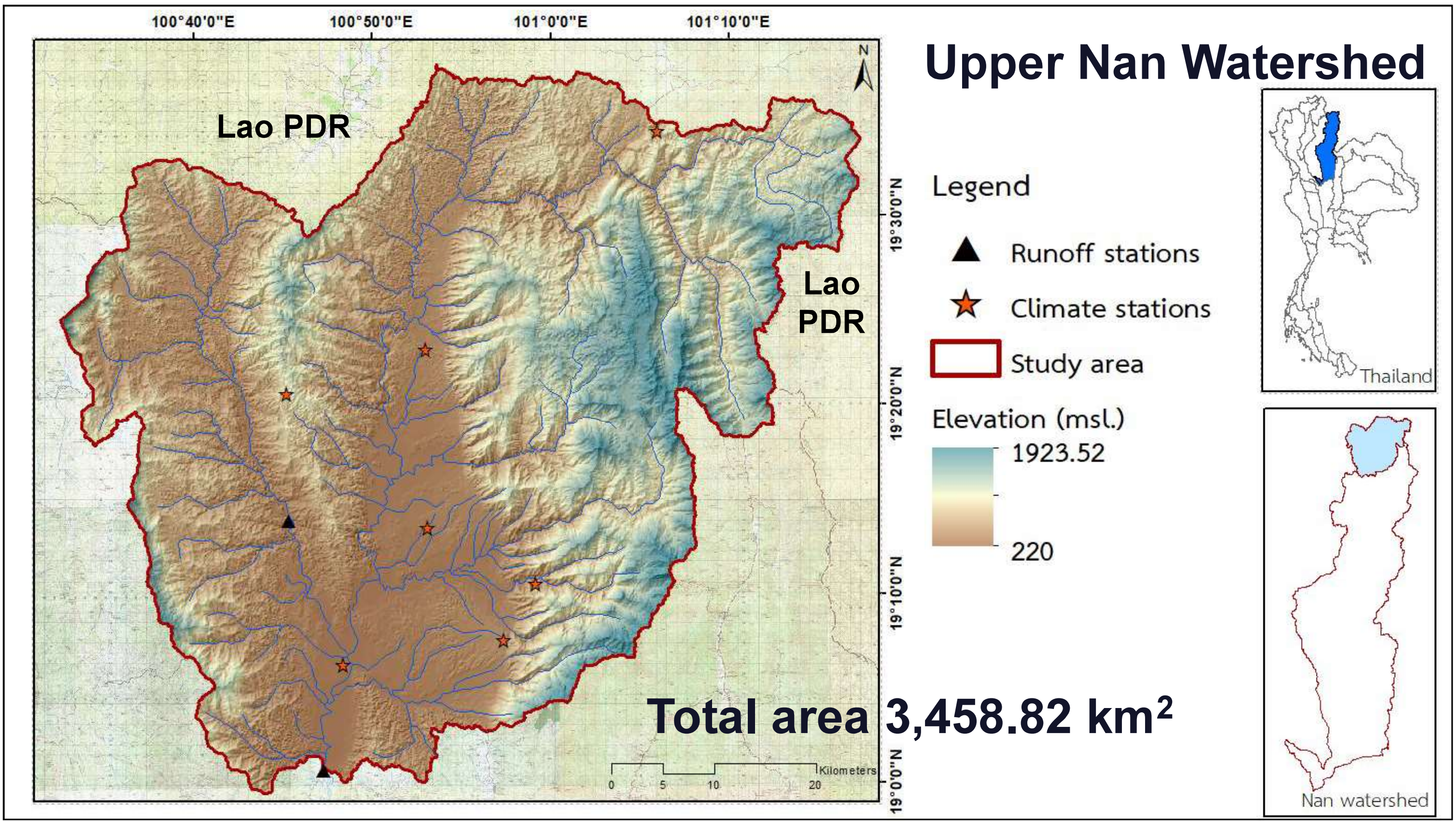
น่านประกาศภัยแล้ง 2 อำเภอ 7 พันกว่าครัวเรือนเดือดร้อน

น่านประกาศเป็นเขตภัยแล้ง 2 อำเภอ "ปัว-เฉลิมพระเกียรติ" ครอบคลุมพื้นที่ 11 ตำบลกว่า 7 พันครัวเรือน พื้นที่การเกษตรเสียหายนับหมื่นไร่จากภัยแล้งคุกคาม



OBJECTIVES

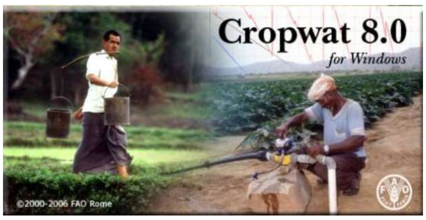
01 To assess spatial and temporal water accounting in present and future under climate change and land use change



MATERIALS

Soil & Water Assessment Tool SWAT

ESRI ArcGIS



METHODS

01 Data preparation

02 Assess streamflow by SWAT model

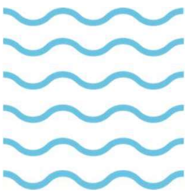
03 Assess temporal water accounting

04 Assess spatial water accounting

05 Scenario

1. Data preparation

Scale 1: 50,000



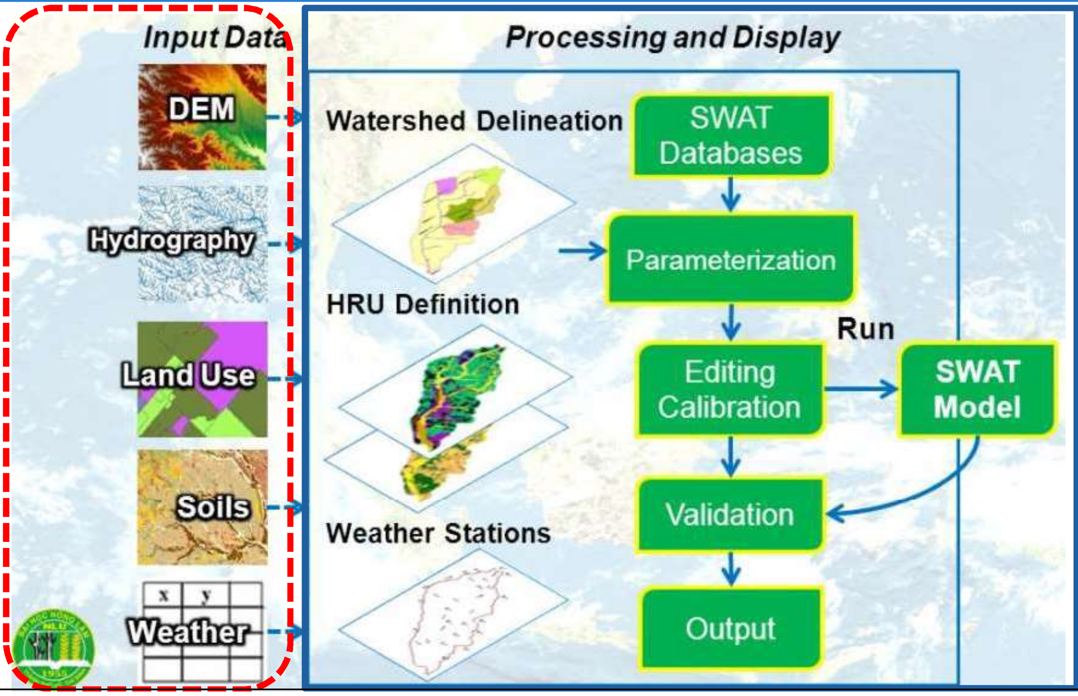
Runoff Daily year 1998 to 2017

Weather daily year 1998 to 2017

Soil map
Land use map year 2016

METHODS

2. Assessment streamflow using the SWAT model



METHODS

2. Assessment streamflow using the SWAT model

Parameters Calibration

No.	Name	Definition
1	CN2	SCS runoff cure number for moisture condition 2
2	ESCO	Soil evaporation compensation factor
3	SOL_AWC	Available water capacity of the soil layer
4	Alpha_bf	Baseflow alpha factor (days)
5	Gwqmn	Theshold depth of water in the shallow aquifer required for return flow to occur (mm)
6	Gw_Revap	Groundwater “revap” coefficient
7	Rchrg_DP	Deep aquifer percolation fraction

METHODS

2. Assessment streamflow using the SWAT model

Model efficiency evaluation by using "Nash-Sutcliffe Efficiency" (NSE)

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

Where O_i = Streamflow observed from N64 measurement station

P_i = Streamflow simulated from SWAT model

$\bar{o}$ = Average streamflow observed

Performance rating	NSE
Very good	0.75 < NSE < 1.00
Good	0.65 < NSE < 0.75
Satisfactory	0.50 < NSE < 0.65
Unsatisfactory	NSE ≤ 0.50

Moriasi et al. (2007)

****NSE has no more than 1 values.**

METHODS

3. Assessment temporal water accounting

3.1 Inflow (I_i)

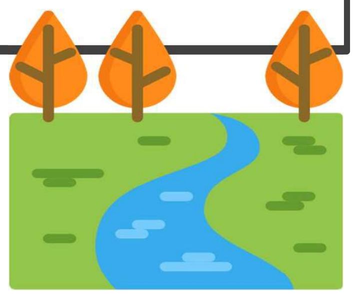
Inflow = GI - ΔS

- Gross inflow: GI such as precipitation
- net inflow: ΔS such as surface storage or soil moisture

3.2 Outflow (O_i)

Outflow were separated 2 type calculated by SWAT model include

- **Surface runoff**
- **Lateral Flow**

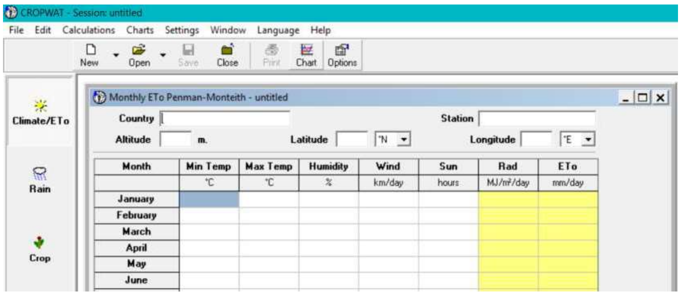


METHODS

3. Assessment temporal water accounting

3.3 Depleted water (DP_i)

- Process depleted were used in agriculture which calculated by **CROPWAT 8.0**



- Beneficial non-process was evaporation from forest calculated by **Penman-Monteith**
- Get value from **SWAT model**

METHODS

3. Assessment temporal water accounting

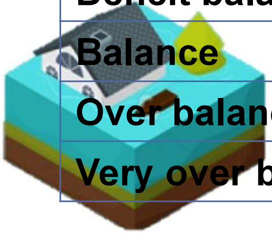
$$\text{water accounting} = I_i - O_i - DP_i$$

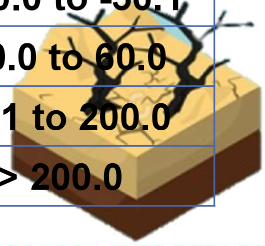
Unit : mm

Positive value (+)
: over balance

Negative value (-)
: under balance

Class	Values
Very deficit balance	< -170.0
Deficit balance	-170.0 to -50.1
Balance	-50.0 to 60.0
Over balance	60.1 to 200.0
Very over balance	> 200.0



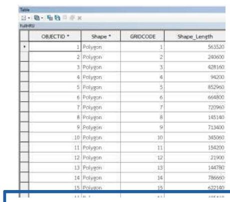


METHODS

4. Assessment spatial water accounting

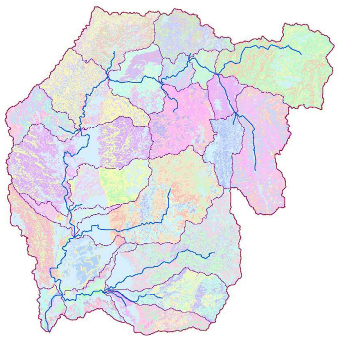
Temporal water accounting = Attribute Table

Join field



Attribute data

Feature to Raster



Spatial data

- Inflow
- Depleted water
- Outflow

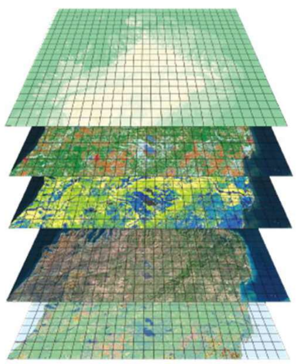
METHODS

4. Assessment spatial water accounting

Spatial data

- Inflow
- Depleted water
- Outflow

Map algebra



Water accounting $= I_i - O_i - DP_i$

Water Accounting Map

METHODS

5. Predict water accounting under climate change and land use change

RCP 4.5

1.4 °c

RCP 8.5

2.0 °c

Download from :www.worldclim.org/

3 %

10 %

By policy of Doi Phu Ka National park

SC1

SC2

SC3

SC4

RESULTS and DISCUSSION

SWAT model

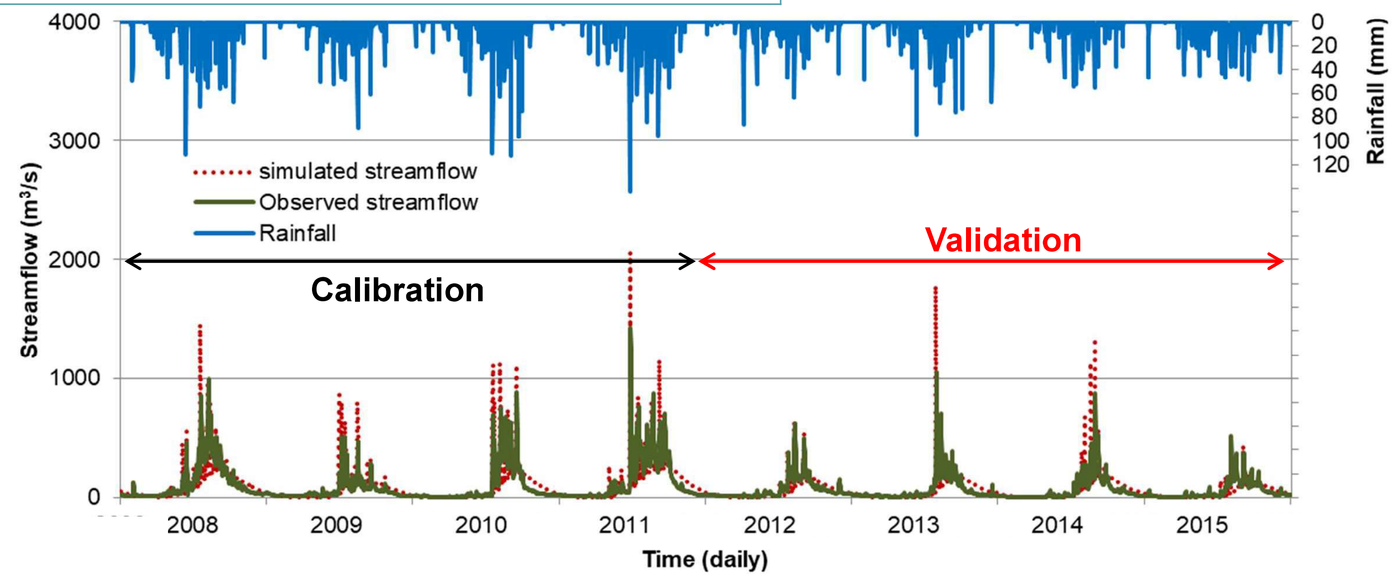
Table 1 Parameter yield by the sensitivity analysis

Rank	Name	Definition	sensitivity
1	CN2	SCS runoff cure number for moisture condition 2	-2
2	ESCO	Soil evaporation compensation factor	0.7
3	SOL_AWC	Available water capacity of the soil layer	1.35

SWAT model

Statistic Index	Calibration	Validation
R^2	0.86	0.74
NSE	0.85	0.72

VERY GOOD

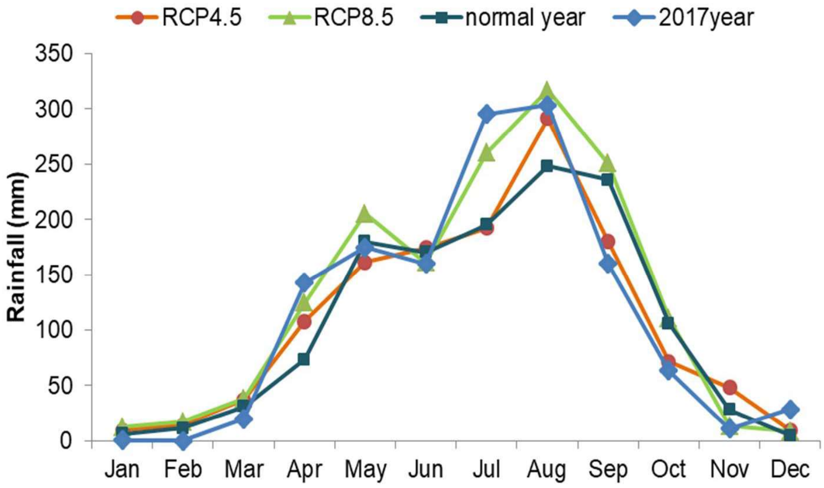


RESULTS&DISCUSSION

Inflow

Table 3 Rainfall at present and each scenarios

Month	2017	SC1	SC2	Normal year
Jan	0.3	9.3	12.4	5.9
Feb	0.0	14.0	17.3	11.4
Mar	20.0	37.2	38.2	31.1
Apr	142.5	108.0	124.7	73.3
May	174.5	161.2	205.2	180.0
Jun	159.6	174.0	161.0	170.4
Jul	295.5	192.2	260.2	195.2
Aug	303.5	291.4	317.1	248.1
Sep	159.8	180.0	250.5	235.6
Oct	63.3	71.3	110.8	106.0
Nov	11.0	48.0	13.3	28.2
Dec	28.6	9.3	8.5	4.8
Ann.	1,358.6	1,295.9	1,519.1	1,290.0
%diff	-	-4.6	11.8	-5.0

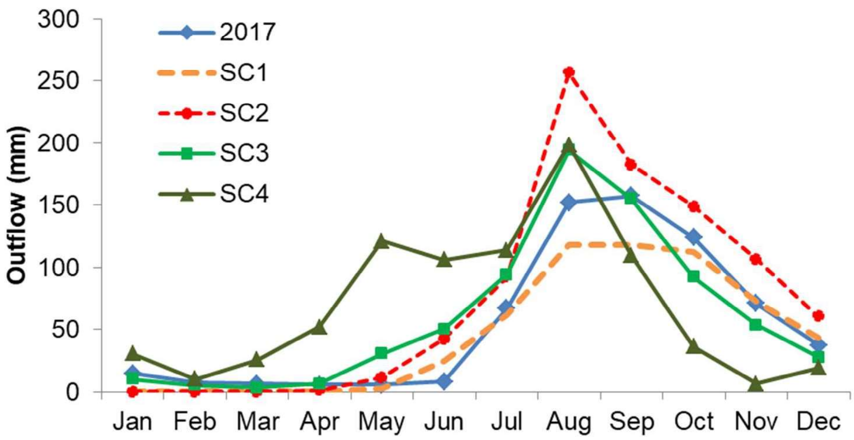


RESULTS&DISCUSSION

Streamflow

Table 2 Streamflow at present and each scenarios

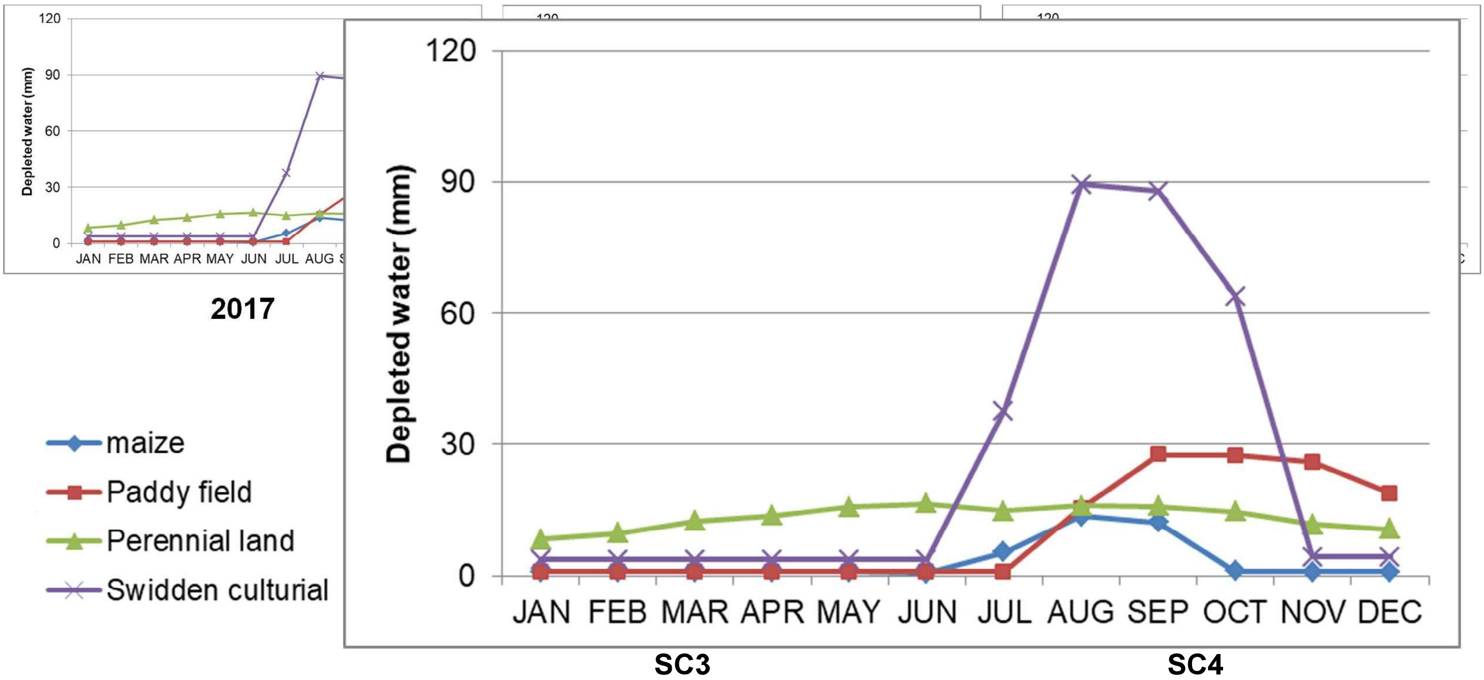
Month	2017	SC1	SC2	SC3	SC4
Jan	14.9	0.0	0.0	10.5	30.7
Feb	7.8	0.0	0.0	5.5	10.2
Mar	6.8	0.0	0.0	3.5	25.6
Apr	6.0	0.1	1.4	6.7	52.0
May	6.0	2.5	11.6	30.5	121.3
Jun	8.2	24.4	42.2	50.6	106.4
Jul	67.0	61.8	92.4	94.4	113.9
Aug	152.0	118.1	256.5	193.9	198.4
Sep	157.3	118.5	182.3	155.1	109.5
Oct	124.3	112.4	148.7	92.2	36.4
Nov	71.2	73.0	106.5	53.9	6.5
Dec	37.5	43.5	60.7	27.8	19.2
Ann	**659.0**	**554.3**	**902.3**	**724.8**	**830.0**
%diff.	-	15.8	36.9	9.9	25.9



RESULTS&DISCUSSION

Depleted water

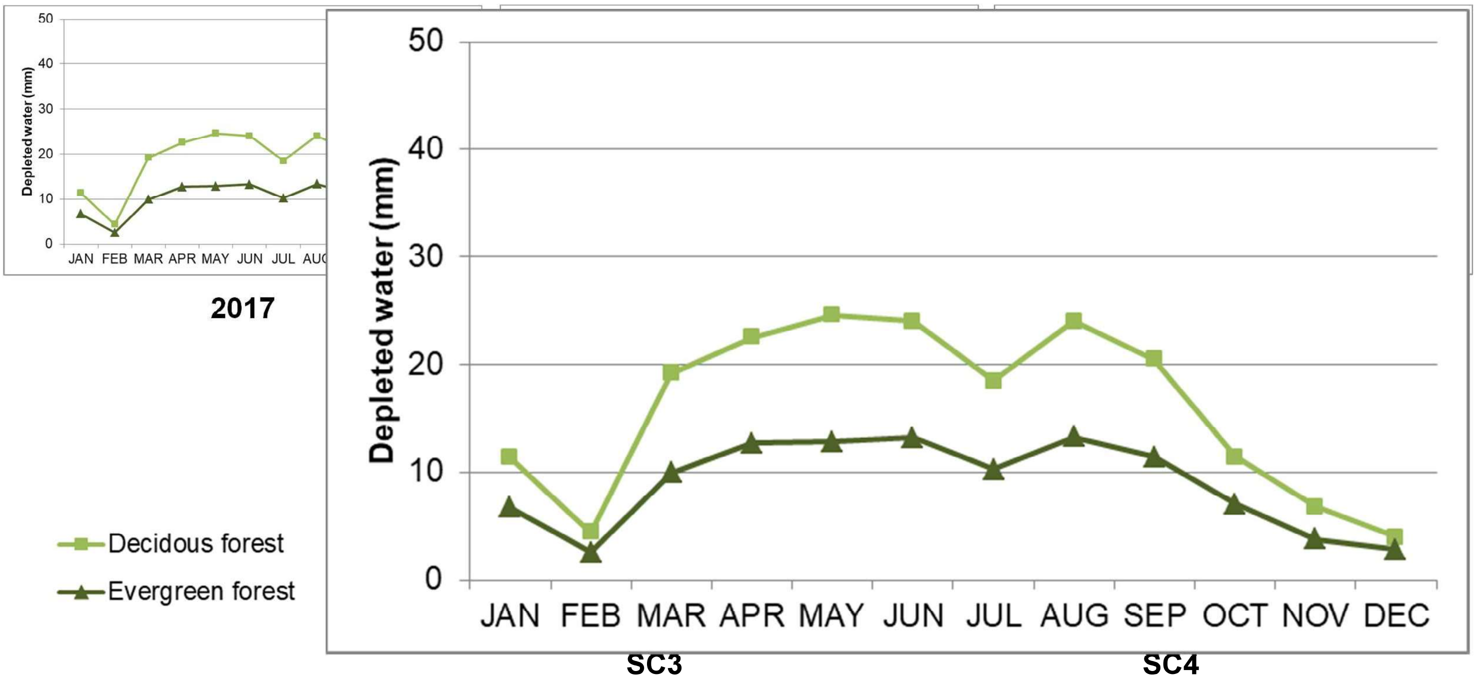
-Agriculture-



RESULTS&DISCUSSION

Depleted water

-Forest-



Depleted water

Table 4 Annual depleted water in each scenarios

LU	Depleted water (mm)							
	Area (km^2)	2017	SC1	SC2	Area (km^2)	SC3	Area (km^2)	SC4
Maize	140.4	38.2	53.7	53.1	125.2	34.1	111.5	30.3
Paddy field	151.9	120.8	115.8	119.4	147.2	117.1	139.1	110.7
Perennial land	212.0	159.6	143.1	144.6	202.4	152.4	84.2	63.4
Swidden cultivation	744.9	308.9	348.4	341.1	698.0	300.1	592.2	281.2
Deciduous forest	1,361.4	191.3	177.8	180.9	1,439.4	191.6	1,690.6	128.1
Evergreen forest	769.9	106.5	95.9	97.3	769.9	105.0	769.9	58.9

Scenario

Table 5 Water accounting under different scenarios.

Month	2017	SC1	SC2	SC3	SC4
Jan	-45.5	-58.2	-77.6	-50.6	-35.7
Feb	-42.7	-16.0	-15.0	-30.2	-36.0
Mar	-62.5	-34.8	-31.1	-26.1	-12.5
Apr	-50.1	-9.1	-10.7	-13.6	-27.3
May	67.8	53.8	70.3	17.4	-10.1
Jun	99.0	61.1	97.6	92.7	17.0
Jul	54.5	59.0	21.1	50.6	0.8
Aug	110.7	-15.9	12.8	-4.6	-13.3
Sep	12.4	35.5	-73.9	-48.1	-40.9
Oct	-85.7	-12.2	4.2	10.6	61.6
Nov	-96.1	-99.0	-98.4	-28.0	-35.7
Dec	-89.5	-66.6	-136.8	-64.1	-8.0
Dry Period	**-273.4**	**-175.5**	**-271.2**	**-184.6**	**-119.5**
Wet Period	**139.2**	**73.2**	**33.8**	**90.5**	**50.9**
Annual	**-134.2**	**-102.4**	**-237.4**	**-94.1**	**-68.5**

Extreme deficit

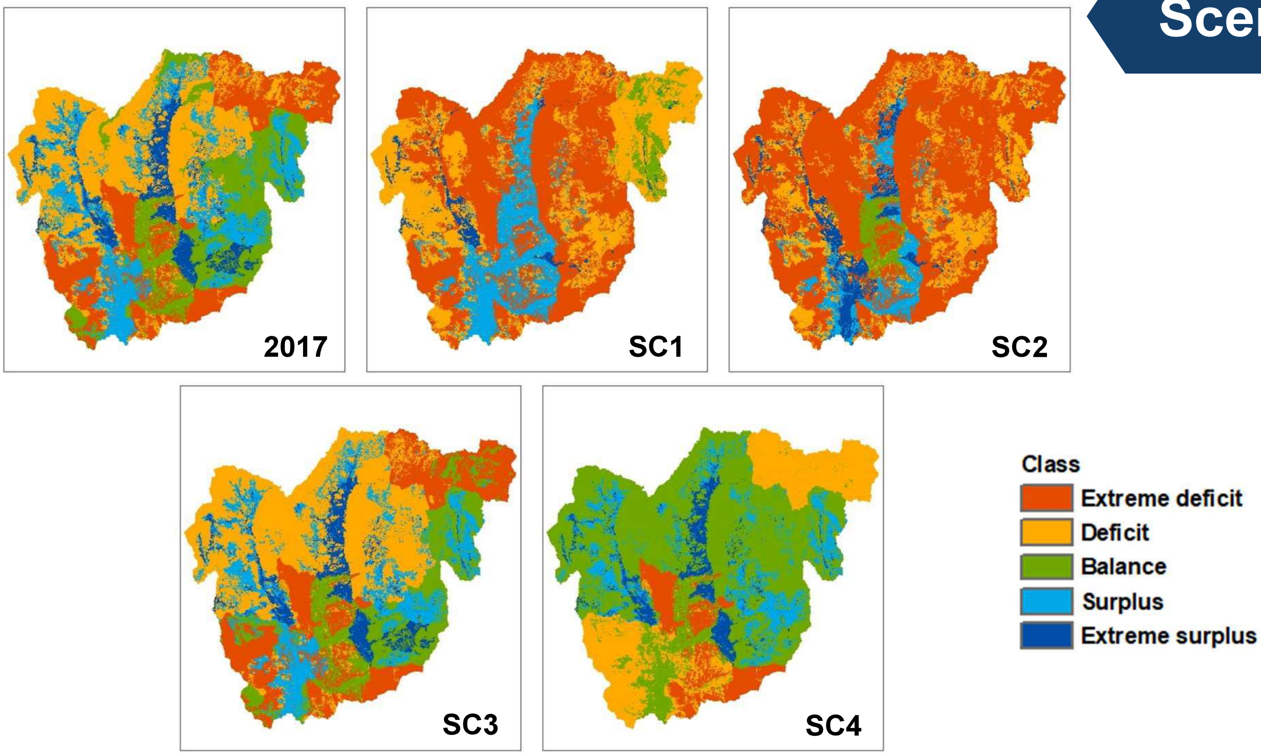
Deficit

Balance

Surplus

RESULTS&DISCUSSION

Scenario



CONCLUSIONS

Water accounting

- **The extreme climate change (SC2) scenario resulted in baseline year of 2017 having a decreased water accounting on annual basis and also for the wet and dry period.**
- **Water accounting in forest increased scenarios which 3% and 10% base on 2017, produced increase in annually and in dry period, but decreased in wet period.**

CONCLUSIONS

Water accounting cont.

- **Climate change had a negative effect on water accounting in wet and dry period, While increased forest area had positive effect on annually and in dry period.**

- **In summary, climate change and land use change influenced to determining water accounting in the upper Nan watershed.**

ACKNOWLEDGEMENTS

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-Thank you

For attention -