Forestry and Forest Products Research Institute (FFPRI)

Promoting Forest-based Disaster Risk Reduction (F-DRR) in Developing Countries

30-31 January 2024, Japan

Integrated land use scenario to enhance forest ecosystem services in Nan Province, Thailand

Prof. Yongyut TRISURAT
Kasetsart University, Thailand
IPBES Bureau Member

Evolution of Forest Mgt. in Thailand

Logging concession

Phase 1, 1864 - 1953:
Forest exploitation

Phase 2, 1954-1980:
USFM & land conversion for agr.

Forest Village Project
(Taungya system): 3 ha/hh

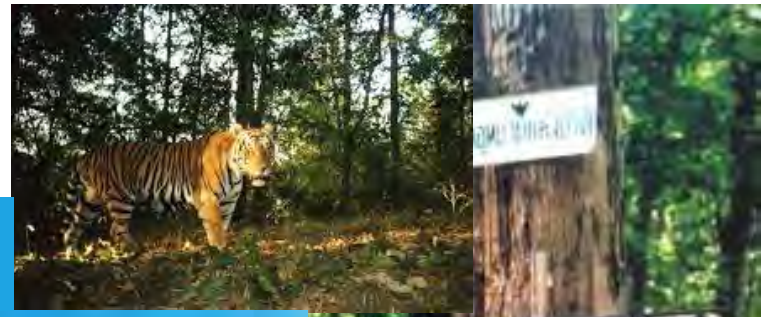
Evolution of Forest Mgt. in Thailand

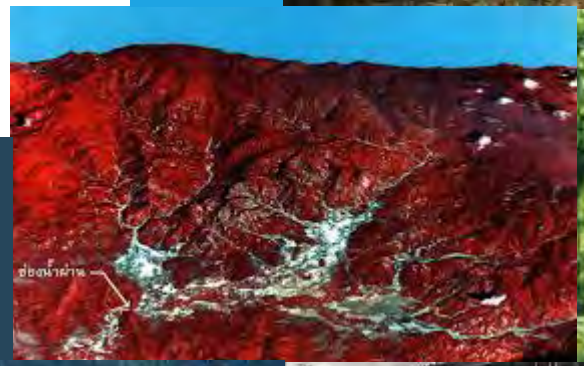
Phase 4, 1990-present:
Biodiversity conservation (more Pas)
People and forest co-exist & decentralization

Phase 3, 1981 - 1990:
transition to collaborative forest management
Logging banned in natural forests (1989)

Phase 2:
USFM & land conversion for agr.

Phase 1:
Forest exploitation





22 Nov 1988
Landslide @Katoon, Nakhonsri Thammarat Prov.
Dead > 700; damaged 1,500 units

Frequently Asked Questions?

What are future LU/LC and landscape patterns
driven by socio-economic development?

How will **forest and the nature's benefits** be **affected** by CC and land use change?

What **strategies** could increase the climate change resilience of people and nature?

Advancing Co-Design of Integrated Strategies with AdaPtation to Climate Change in Thailand (ADAP-T): 2018-2021

Thai Researchers/PIs

- Prof. Dr. Yongyut Trisurat — Kasetsart Uni.
- Dr. Wanchai Arunpraparut — Kasetsart Uni.
- Dr. Venus Tuankrua — Kasetsart Uni.
- Mr. Teerawach P. — MSc student

Socio-Eco Scenario Grp. at Provincial Scale

Forest Grp. at catchment (local) scale

Japanese Researchers

- Prof. Dr. Kuraji Koichiro — Tokyo Uni.
- Dr. Hiroaki Shirakawa — Nagoya Uni.

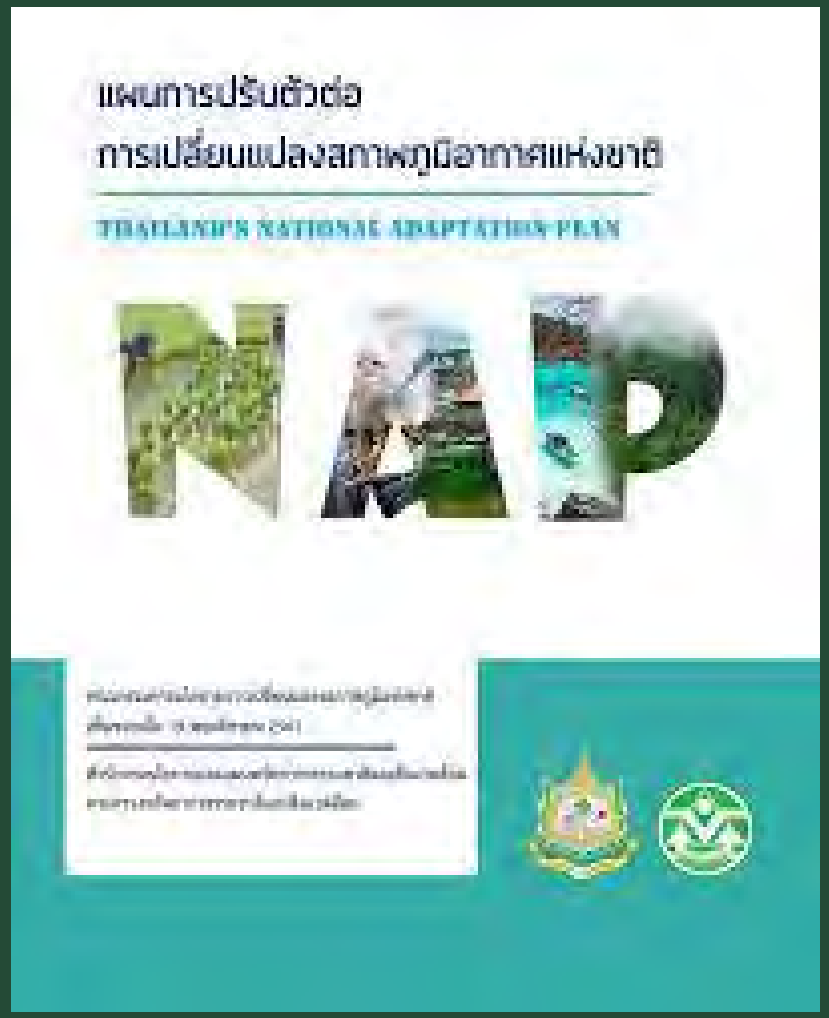
Counterparts

Royal Forest Department

Dept. of National Parks, Wildlife and Plant Conserv.

Ministry of Environment

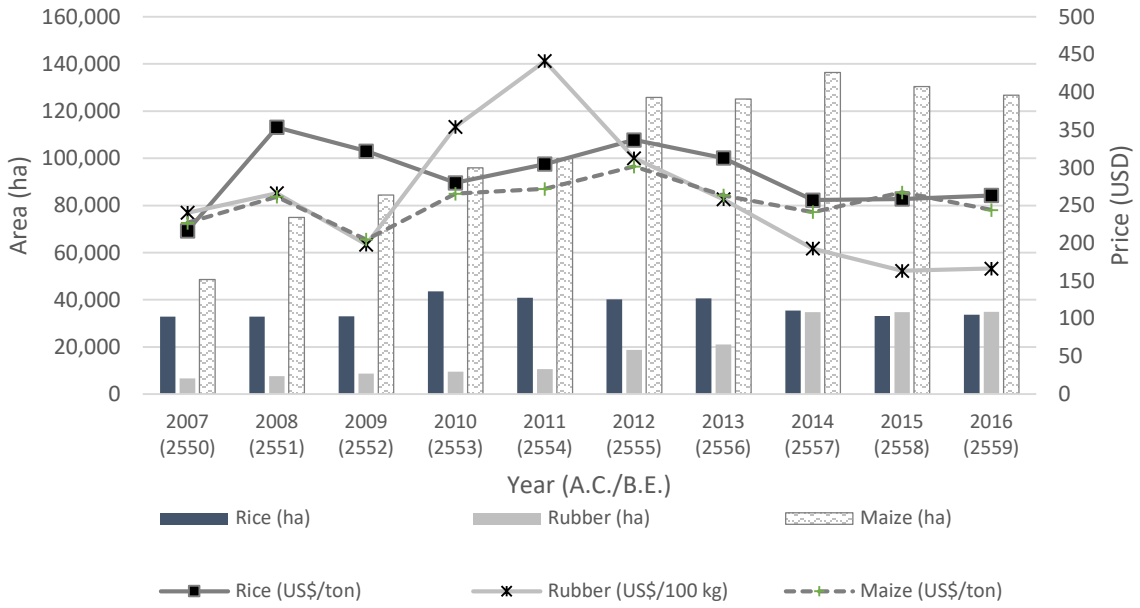
Policy Relevance



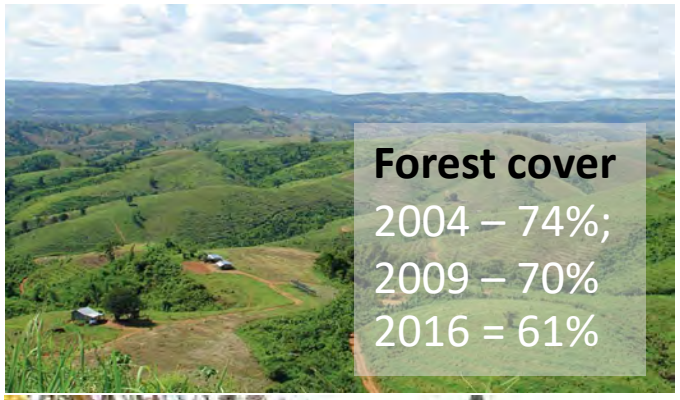
National Adaptation Plan (NAP) for Climate Change

"Nan Sandbox Model"

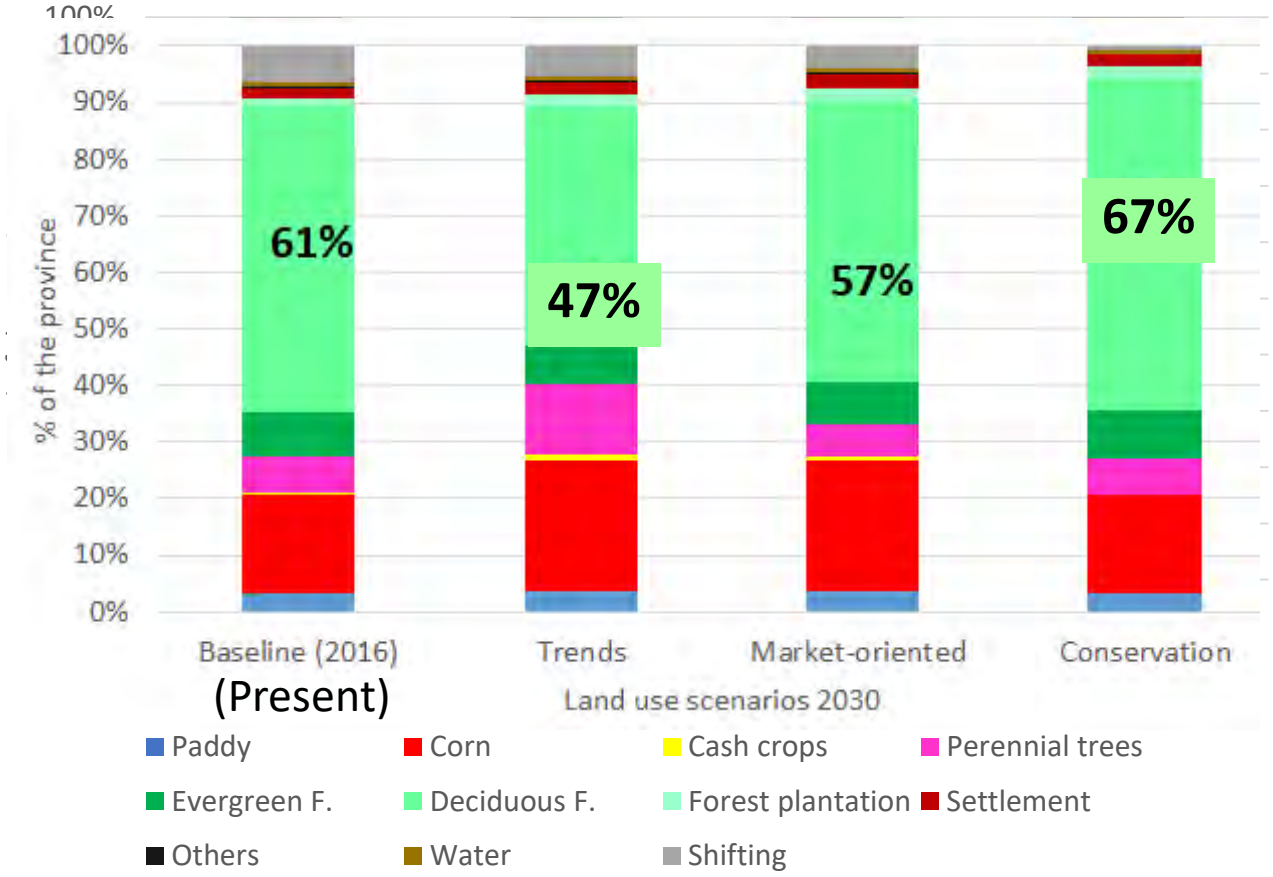
Land Use Change Scenarios

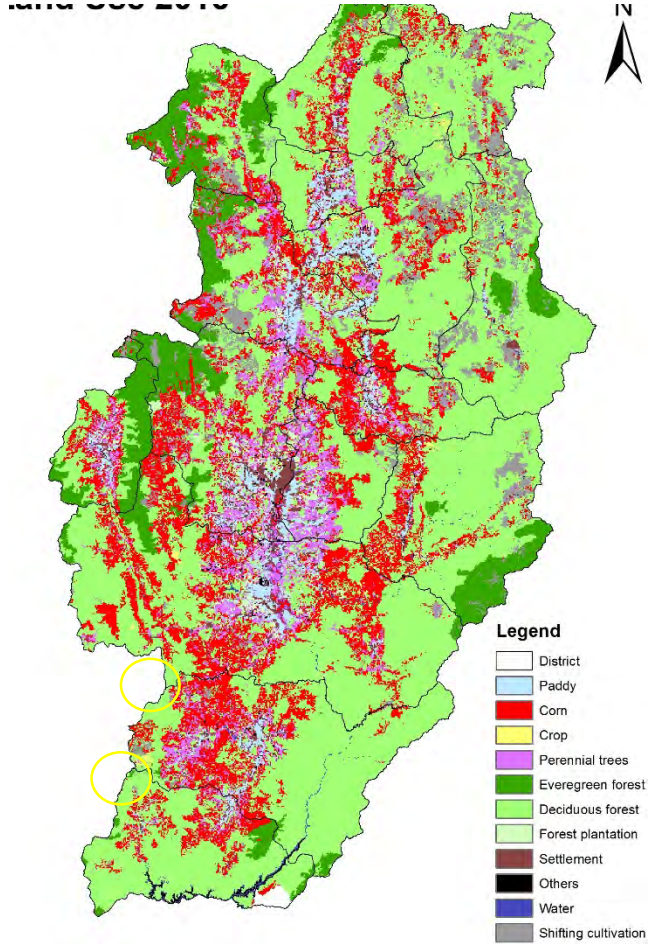


Approx. 12,000 km^2
PAS = 35%; slope complex 70%

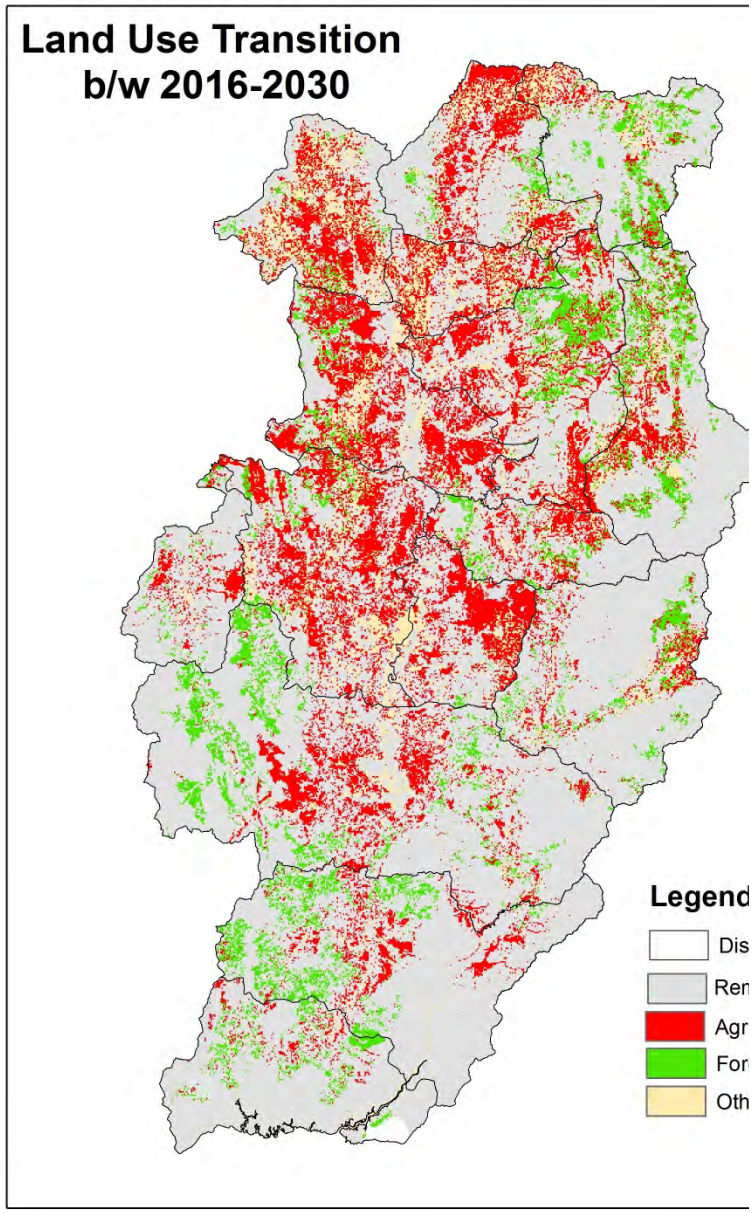


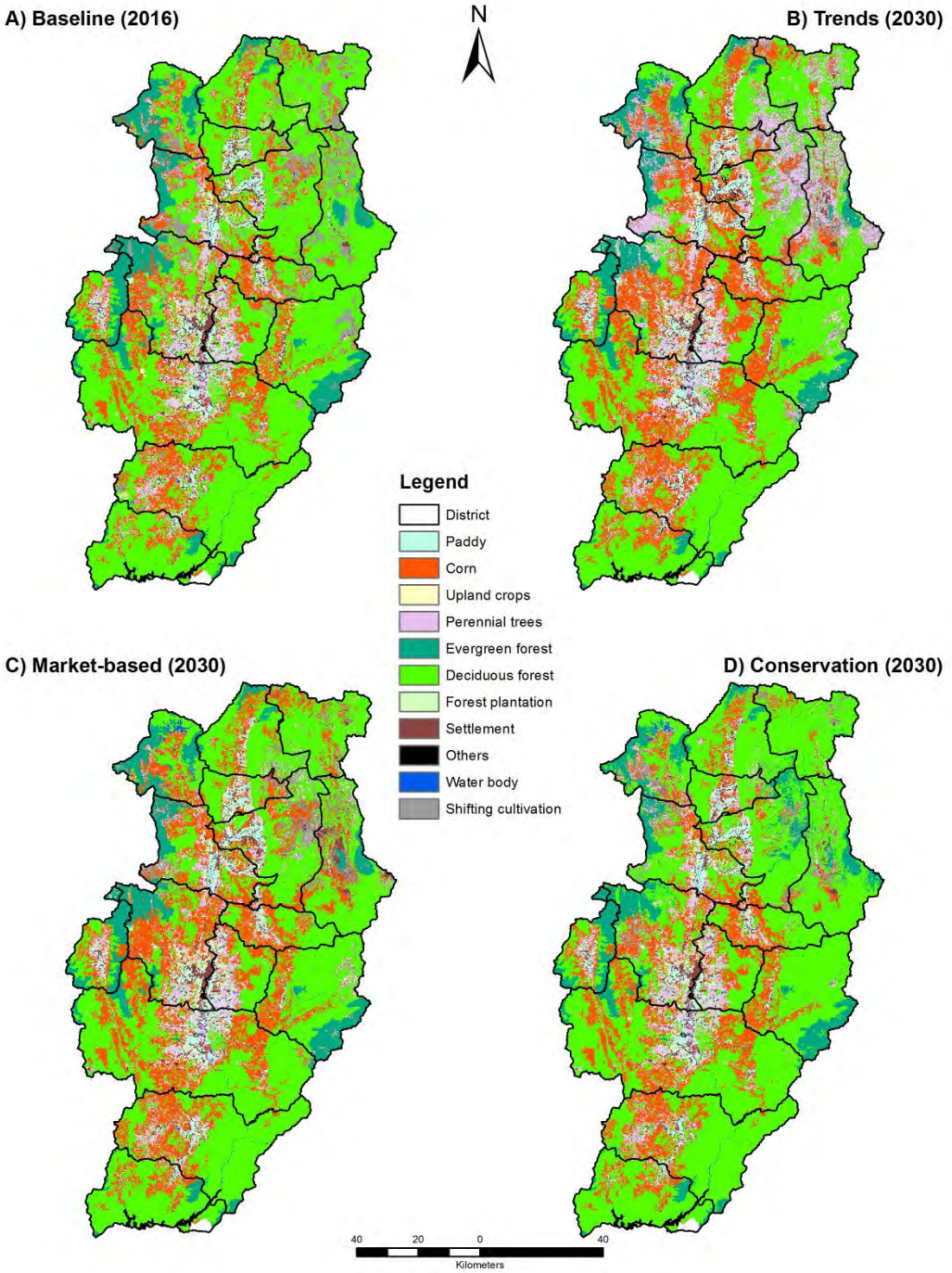
Land Use Scenarios 2030





1. **Trends or business as usual scenario 47%** forest cover
2. Market-oriented scenario : 57% forest cover (*2% agr. products*)
3. **Conservation scenario: 67%** forest cover

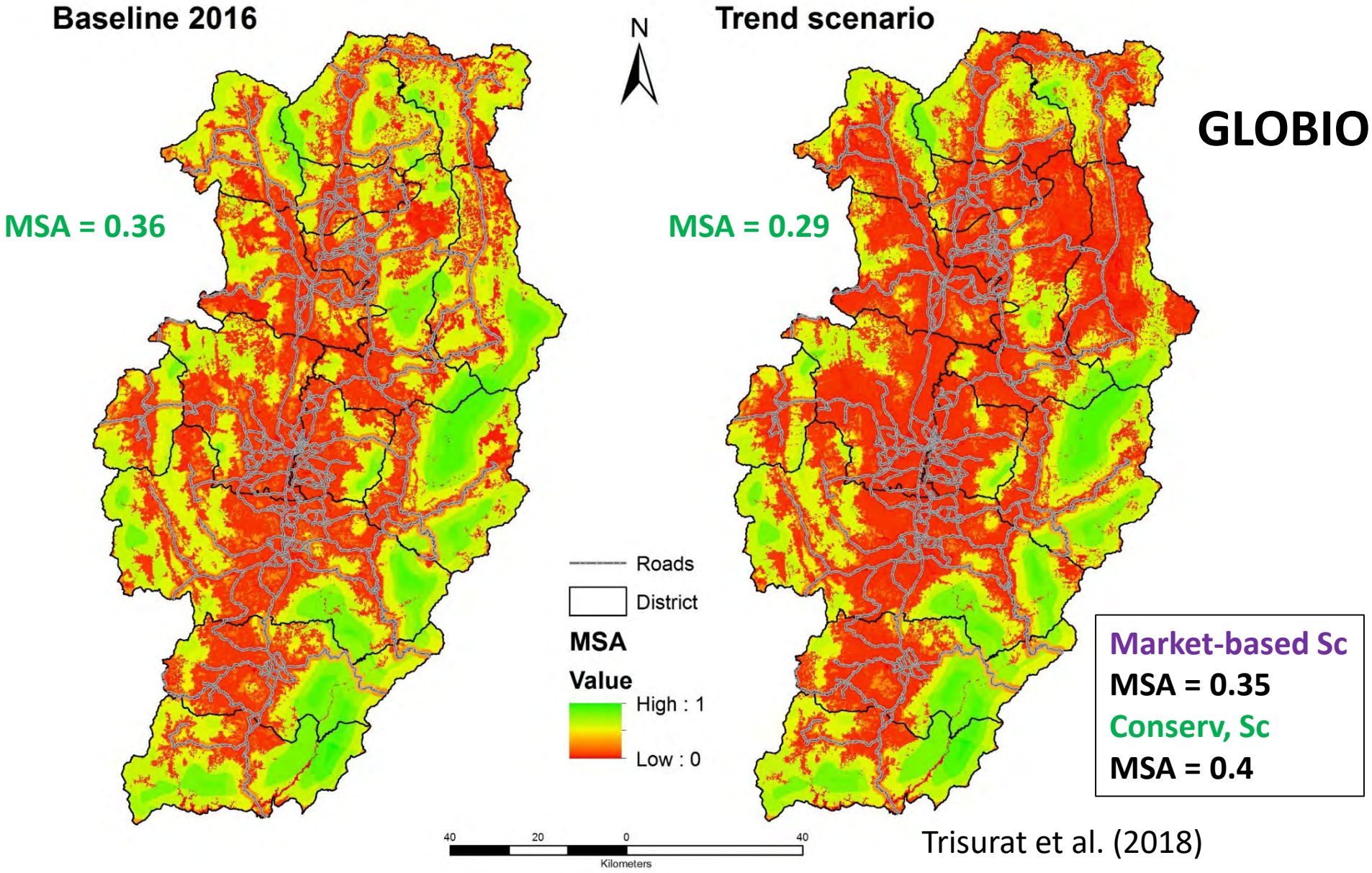

Land Use Transition
b/w 2016-2030
Legend
Dis
Ren
Agr
For
Oth


A) Baseline (2016)
N
B) Trends (2030)
Legend
District
Paddy
Corn
Upland crops
Perennial trees
Evergreen forest
Deciduous forest
Forest plantation
Settlement
Others
Water body
Shifting cultivation
C) Market-based (2030)
D) Conservation (2030)
40
20
0
40
Kilometers

CLUE Model

Mean Species Abundance (Biodiversity):

LUC, infrastructure and fragmentation



GLOBIO Model

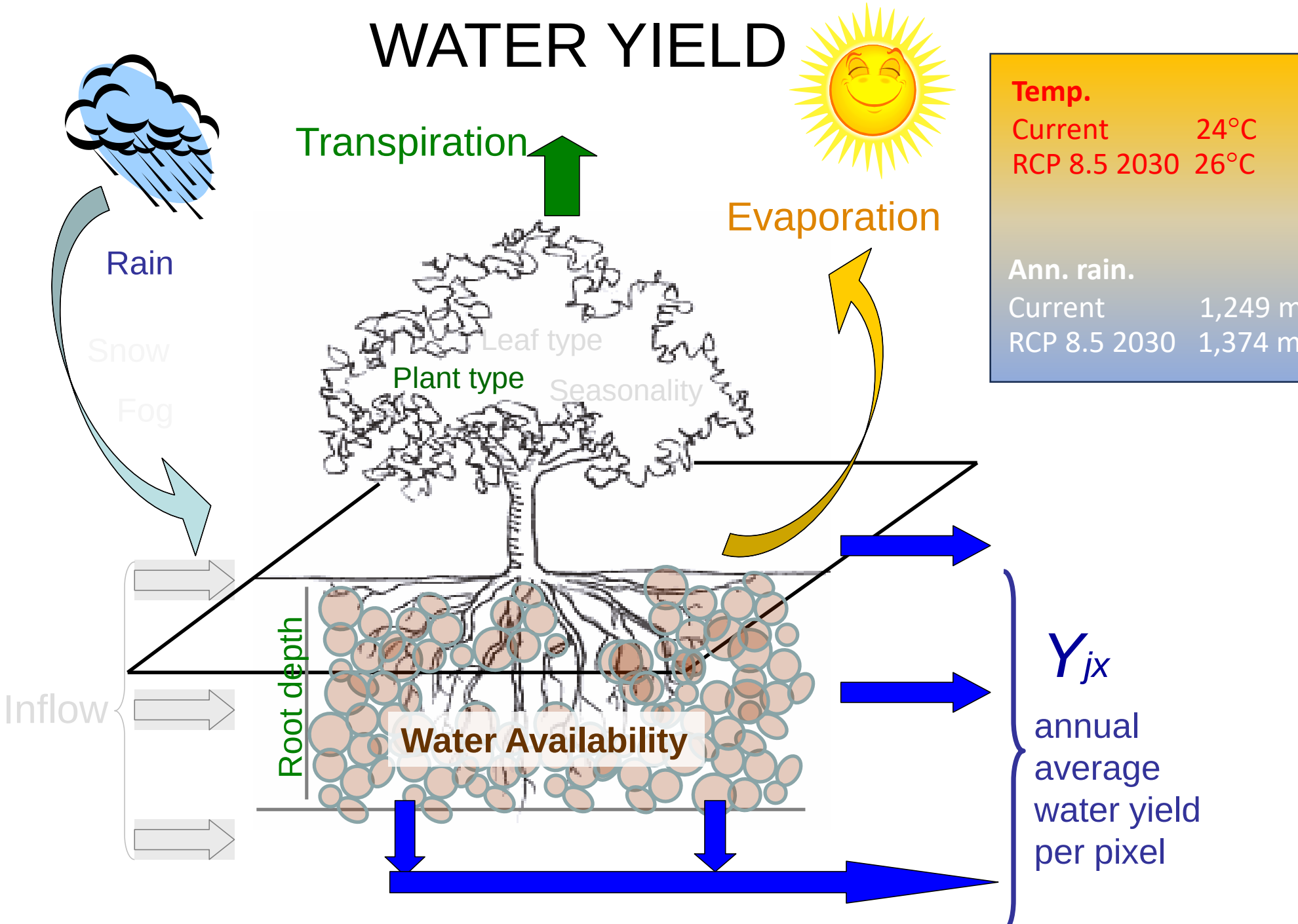
Market-based Sc
MSA = 0.35
Conserv, Sc
MSA = 0.4

Trisurat et al. (2018)

natural capital PROJECT

INVEST Model

WATER YIELD



Temp.

Current	24°C
RCP 8.5 2030	26°C

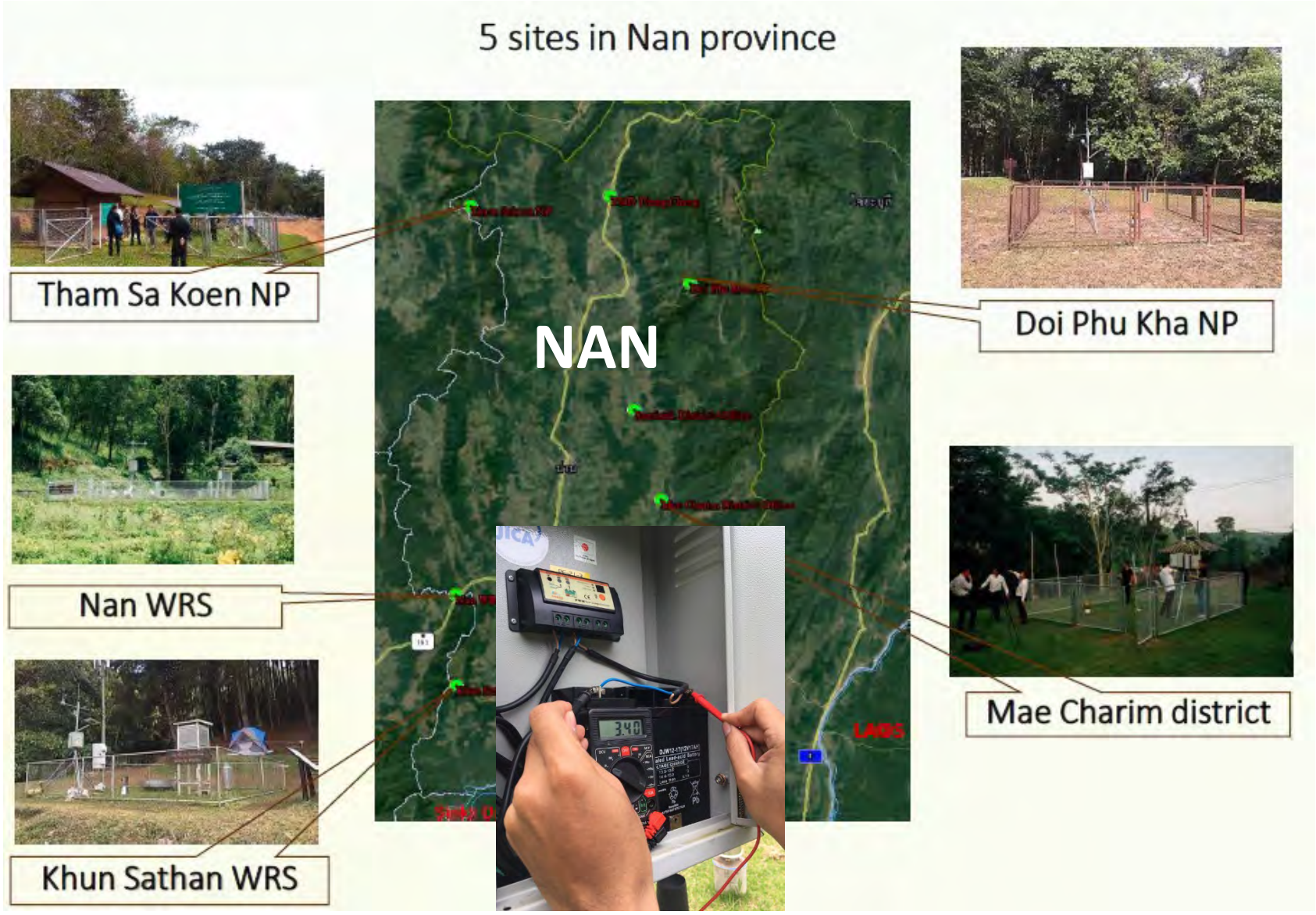
Ann. rain.

Current	1,249 mm
RCP 8.5 2030	1,374 mm

Y_{jx}

annual average water yield per pixel

Installation of AWS at 5 sites in Upper Nan Watershed and calibration with Metro Stations



natural capital PROJECT

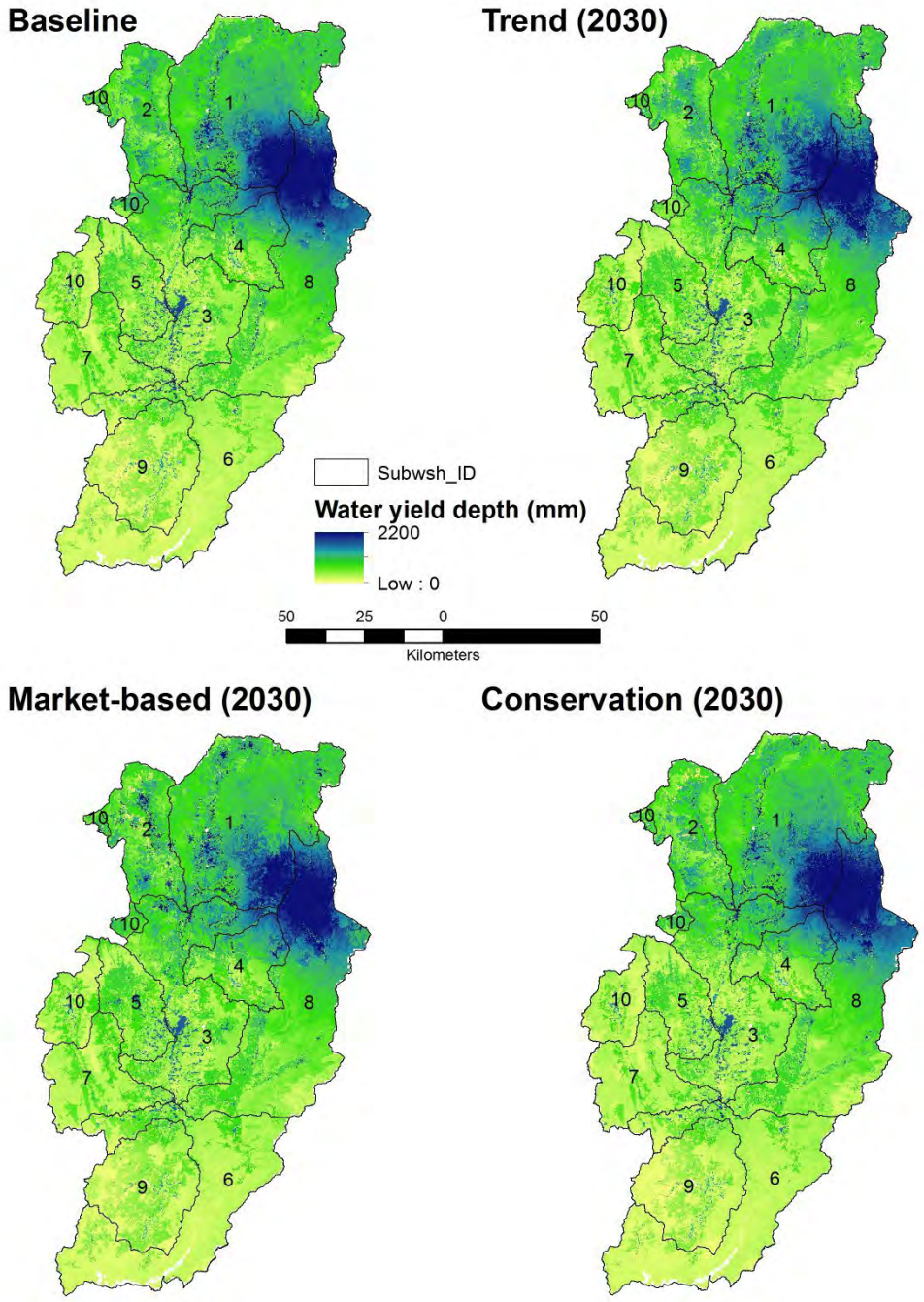
INVEST Model

Predicted Annual Water Yield

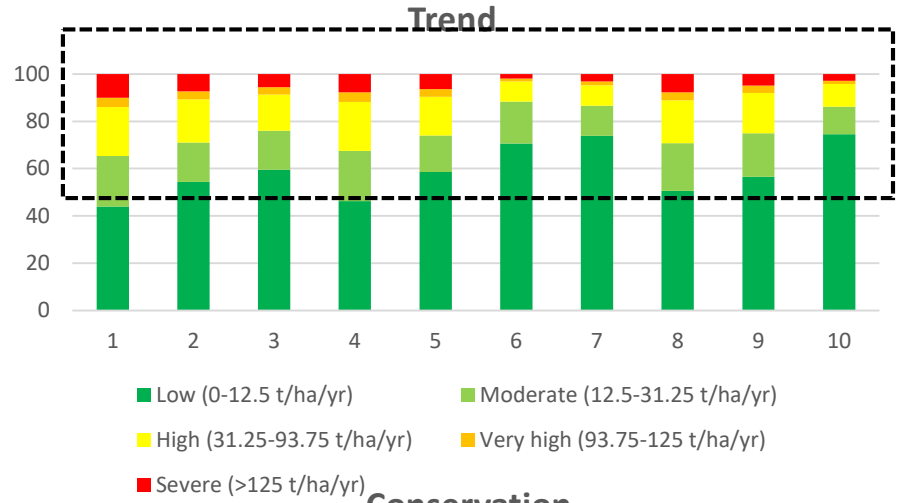
Baseline	4,253 mil m3
Trends	5,350 mil m3
Market-based	4,436 mil m3
Conservation	4,183 mil m3

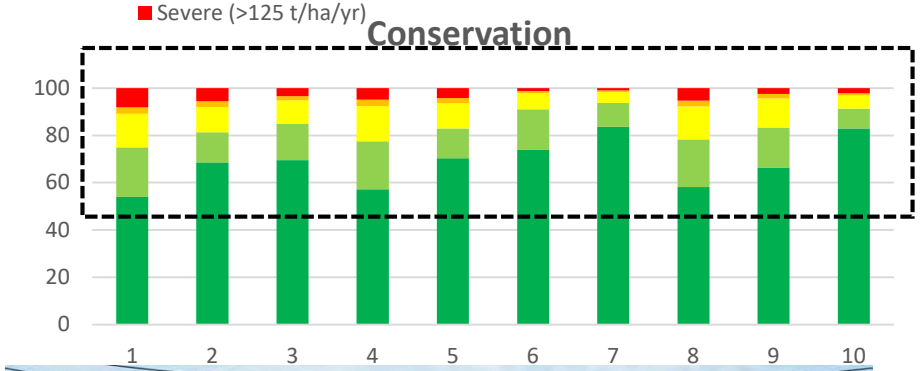
	Current	RCP 8.5
Annual	1,234.5	1,423.4
Wet (%)	82.9	85.6
Dry (%)	17.1	14.4

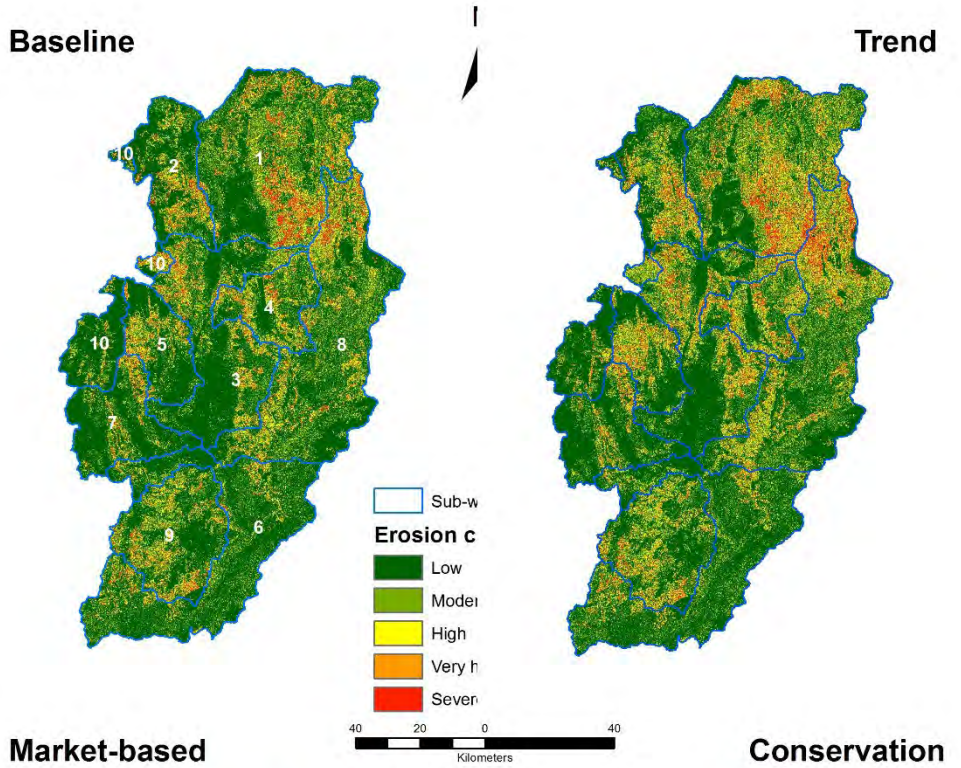
Nash-Sutcliffe efficiency coefficient
E_{ns} = 0.97 (excellent)

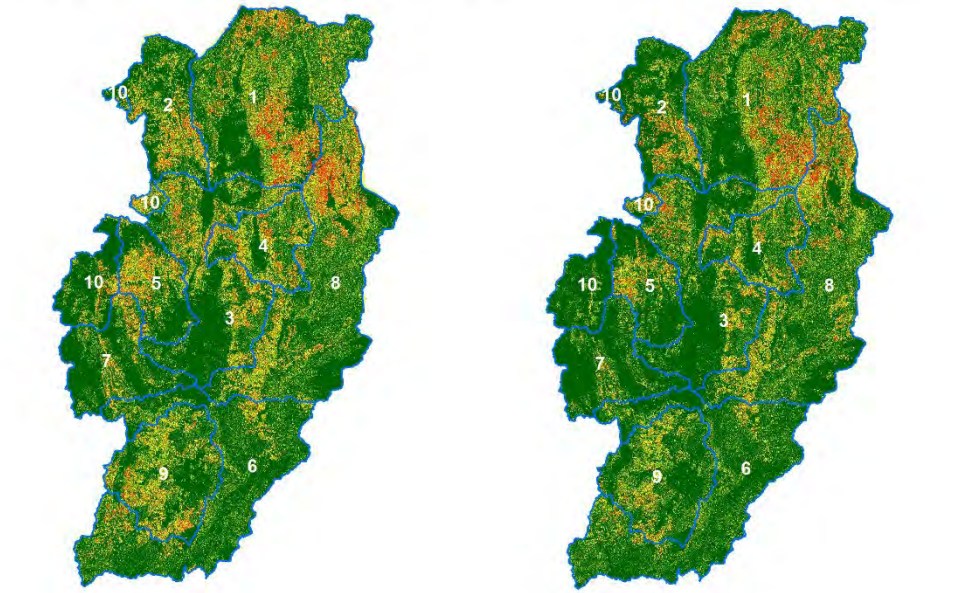


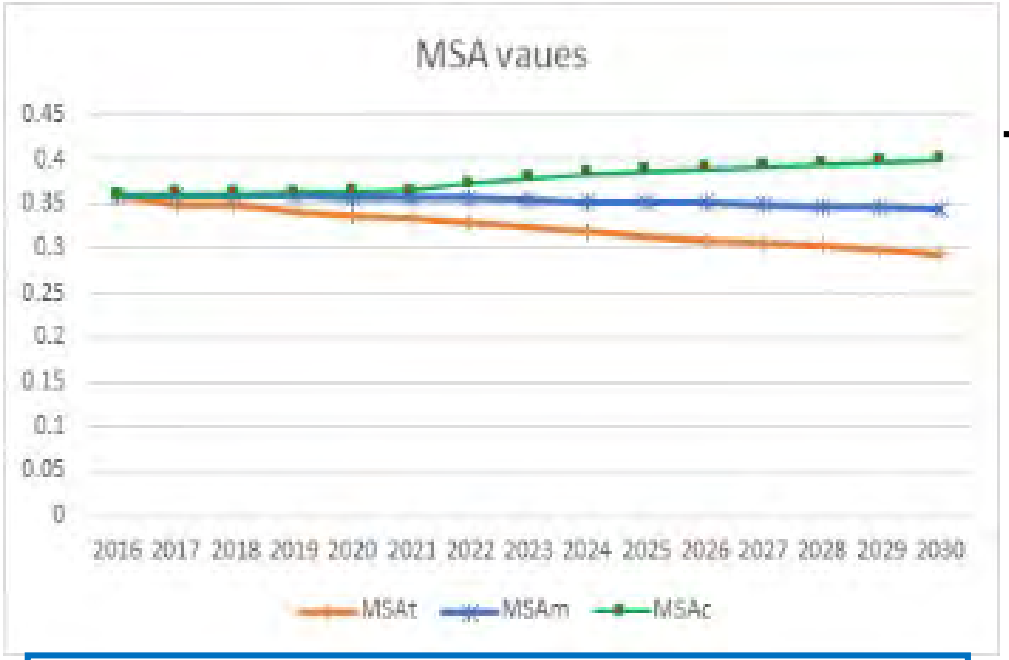
Top Soil Loss (USLE Equation)











Nature benefits or Ecosystem Services

Ecosystem Services change index (ESCI) [Leh et al., 2013)

$$\text{ESCI}_x = \left[\frac{ES_{CURx_j} - ES_{HISx_i}}{ES_{HISx_i}}\right]$$

History/Baseline 2016

Policy Recommendation

Forest cover target (mountainous watershed)

Upper WSH (>1,000 m)

- >70%

Middle WSH (800-1,000 m)

- 60-70%

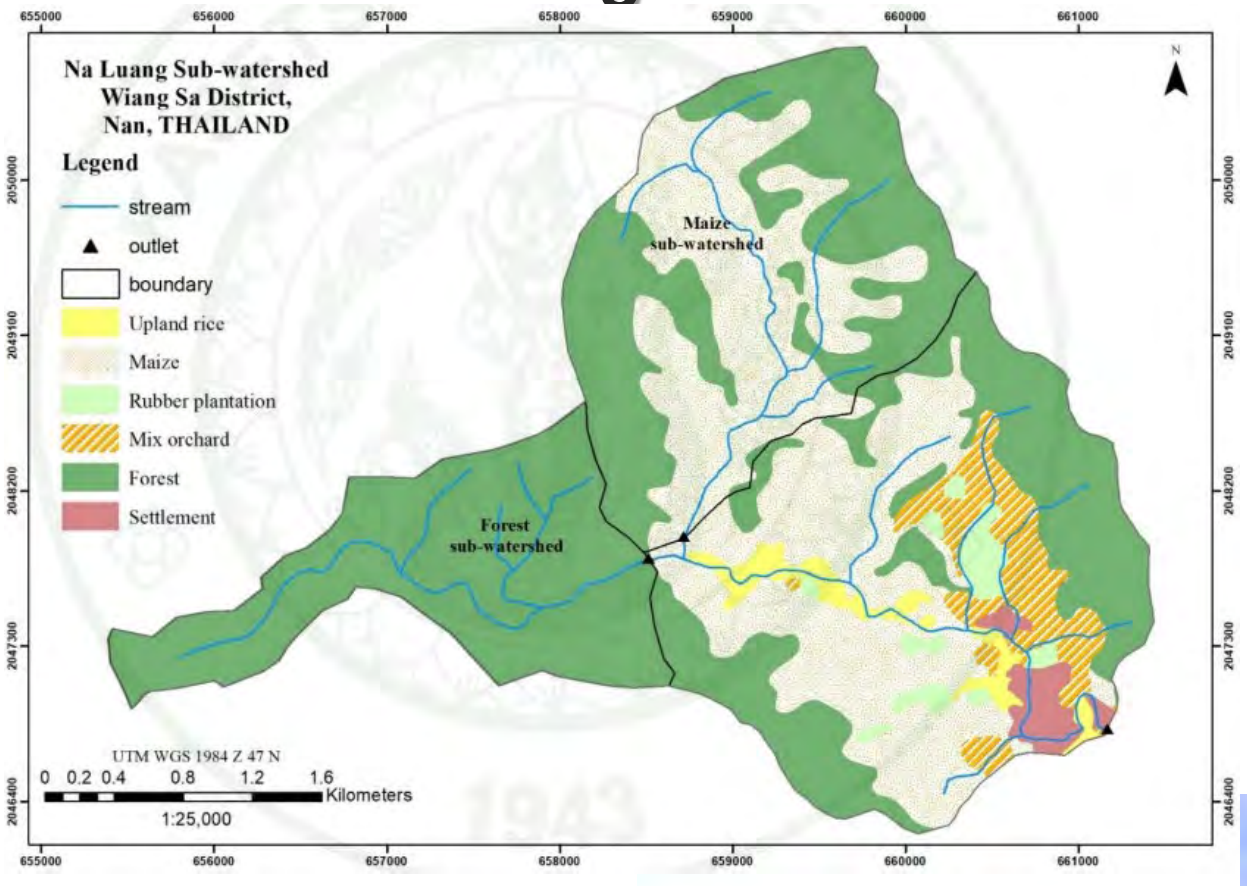
Lower WSH (<800 m)

- 50-60%

Restoration, S&W conservation

Catchment Scale Assessment:

Na Luang Sub-watershed at Wiang Sa District, Nan



Watershed area

Na Luang sub-watershed = 12.45 sq.km.
- Forest dominant catchment = 2.51 sq.km.
- Maize dominant catchment = 4.27 sq.km.

Physical characteristic

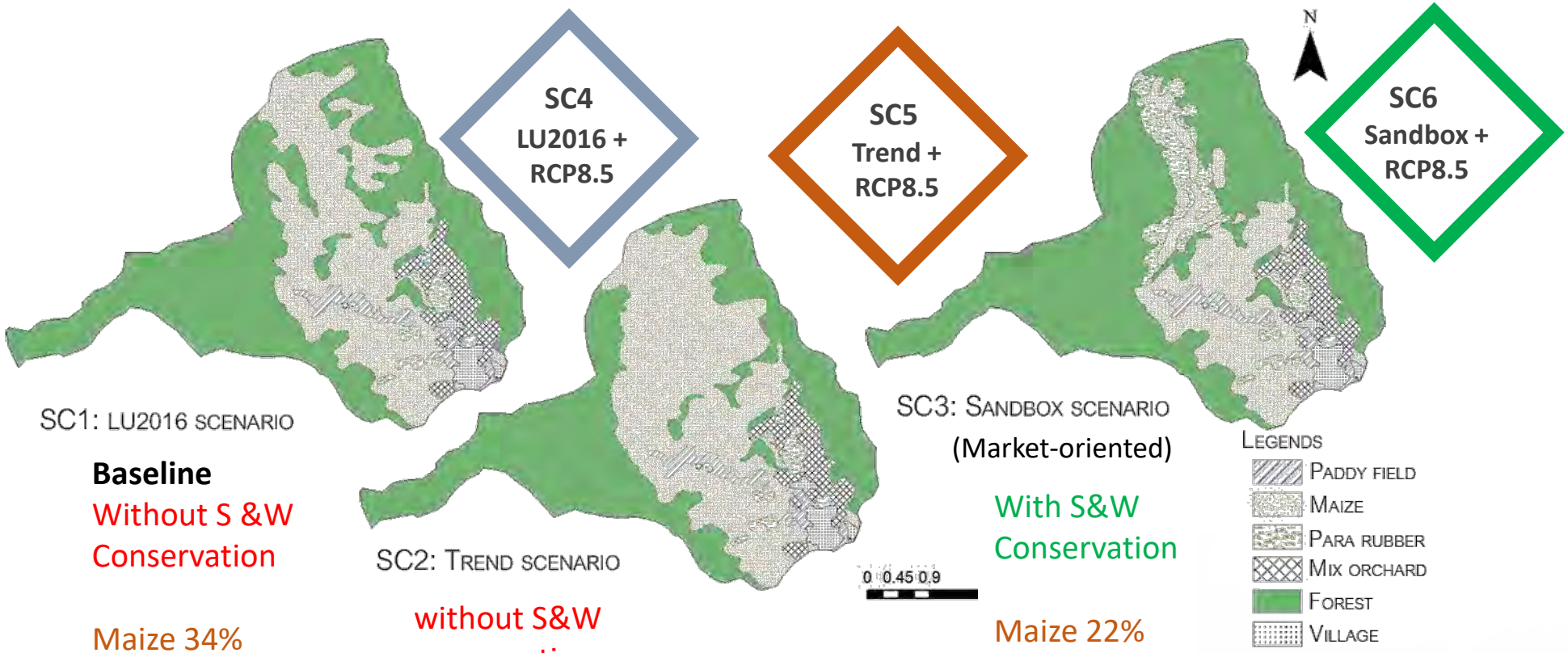
Average elevation : 550 msl.
Average slope : 31.40%

Climate characteristic

Total rainfall : 1,237.9 mm.
Average temperature : 24 ˚C

Teerawach Phetcharaburanin (MSc student)

Land use & climate change scenarios 2030



Baseline
Without S &W Conservation

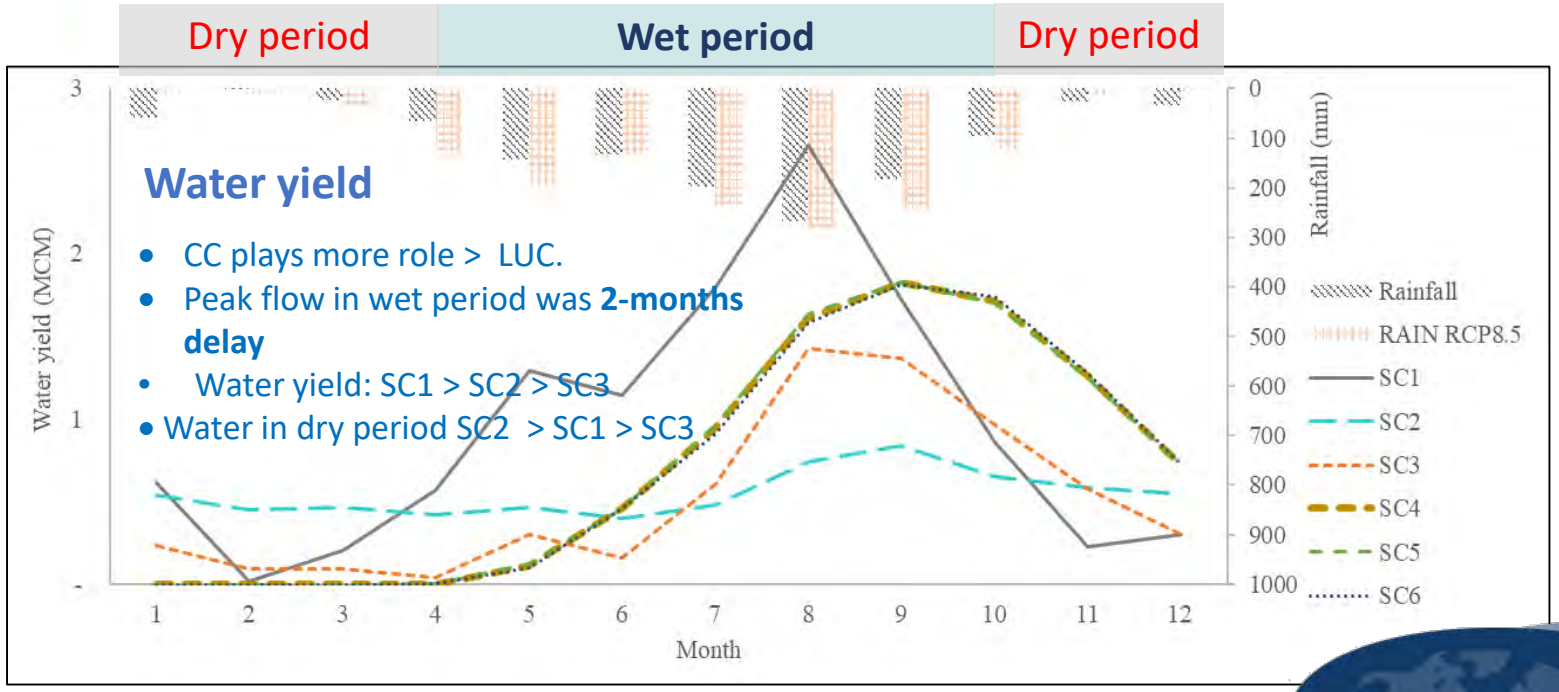
Maize 34%
Forest 54%
Rubber 1%
Others 11%

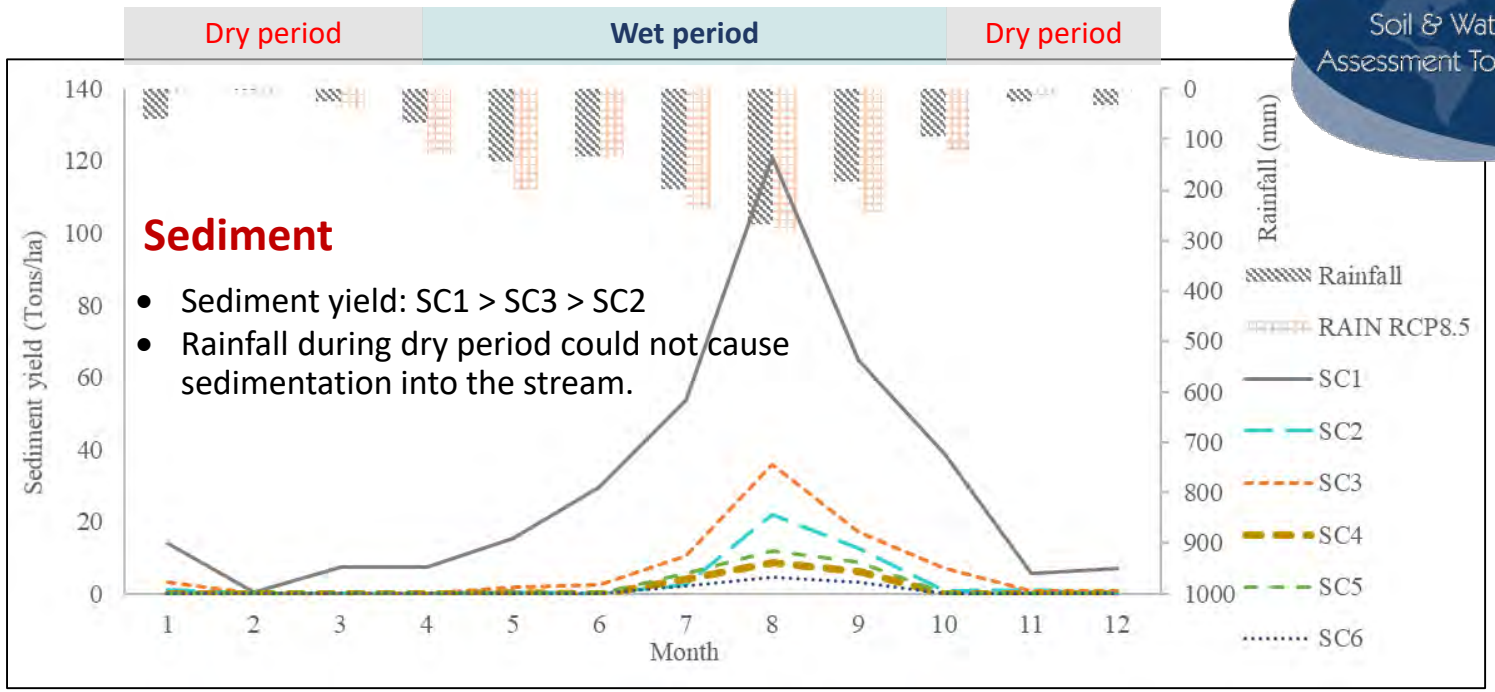
without S&W conservation.

Maize 41%
Forest 47%
Rubber 1%
Others 11%

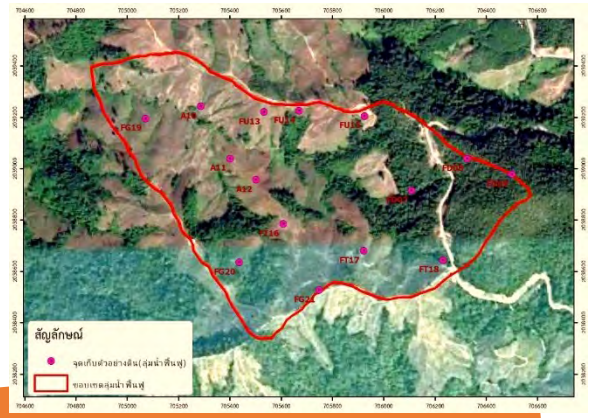
With S&W Conservation

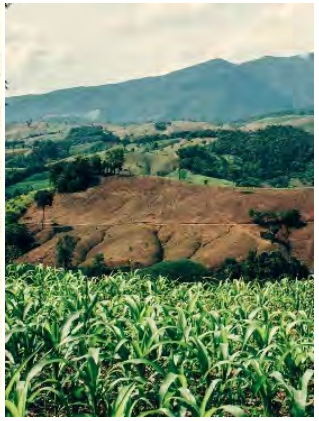
Maize 22%
Forest 60%
Rubber 7%
Others 11%





Soil & Water Assessment Tool | SWAT





Economic value

1 THB = 4.15 ¥ (million baht)

*22-years cultivation

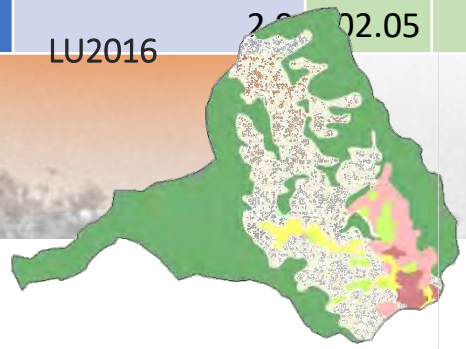
Hydro service = Water charge + dredging cost

SC	Hydrological services value (1)	PV income (2)*		PV cost (3)*		Net benefit (1+2-3)	NPV	B/C ratio
		Maize	Para rubber	Maize	Para rubber			
SC1	40.7	321.76	9.82	263.45	4.03	23.37	13.74	1.08
SC2	6.2	384.13	9.82	314.60	4.03	69.18	15.57	1.21
SC3	9.8	202.05	79.46	165.45	32.57	73.71	40.63	1.35
SC4	3.9.	321.76	9.82	263.45	4.03	60.17	13.74	1.22
SC5	4.7	384.13	9.82	314.60	4.03	70.67	15.57	1.22
SC6	2.[illegible]	[illegible]02.05	79.46	165.45	32.57	82.53	40.63	[illegible].40

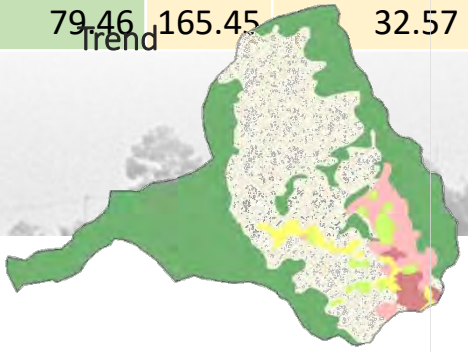
NPV = net present value

B/C = Discounted value of benefits / Discounted value of costs

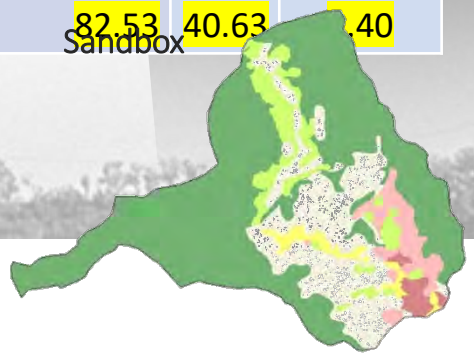
LU2016



Trend



Sandbox



Appraise the land use planning alternatives

Using multicriteria decision analysis (MCDA)

Limitations and criteria

Limitation score (Zhang, 1989)	Hydrological services criteria		Economic criteria			
	Water use (0.25)	Soil loss (0.25)	Water supply service (0.28)	Dredging cost (0.12)	NPV of Maize cropping (0.04)	NPV of rubber planting (0.05)
	(m^3/person/year)[a,b]	(tons/ha/year)[c]	(baht/year)	(baht/year)	(baht/month)[d]	
0	> 438.0	0.0 - 12.5	> 219.0	0.0 – 1,080	> 10,000	
1	357.7 - 438.0	12.6 - 31.3	178.9 - 219.0	1,081 – 2,700	5,001 - 10,000	
3	270.1 - 357.6	31.4 - 93.8	135.1 - 178.8	2,701 – 8,100	3,001 - 5,000	
9	182.5 - 270.0	93.9 - 125.0	91.3 - 135.0	8,101 – 10,792.5	1,500 - 3,000	
27	< 182.4	> 125.0	< 91.2	> 10,792.5	< 1,500	

b is a modified criterion from Department of Water Resources, DWR (2001) was 1.2 m^3/person/day in municipal district,
c is a criterion from Land Development Department, LDD (2000), and
d is a criterion from National Statistical Office, NSO (2015).

Land use appropriate levels

Appraise
the alternatives

Appropriateness (Suit)	Appropriate value range
High appropriate land use	0.0 – 9.0
Moderate appropriate land use	9.1 – 18.0
Low appropriate land use	18.1 – 27.0

Appropriateness	SC1	SC2	SC3	SC4	SC5	SC6
Appropriate score	10.20	1.22	1.25	0.47	0.47	0.12
Land use appropriate level	Moderate	High	High	High	High	High

- **Current LU (SC1)**
  Not recommended due to **lowest B/C ratio** (1.08) and moderate suit.

- **Trend or BUA (SC2)**
  is appropriate for maize cropping only because of low investment cost. BUT soil and water conservation is required such as terracing to reduce surface runoff and sediment in wet season.

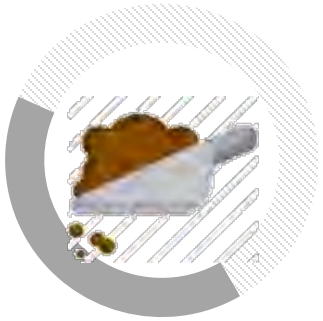
Sandbox (SC3)

is suitable to generate household income from maize and rubber plantations (B/C ratio = 1.35). In addition, **water shortage in dry season and sedimentation is minimal**.

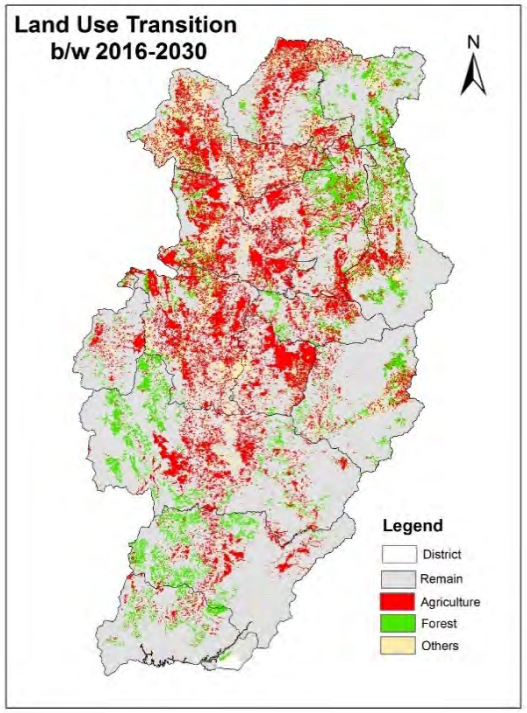
Scenarios 4, 5, and 6 (RCP 8.5)

More rainfall is expected in wet season. Water shortage in late dry season is predicted for all scenarios (but less severe).

CONCLUSIONS

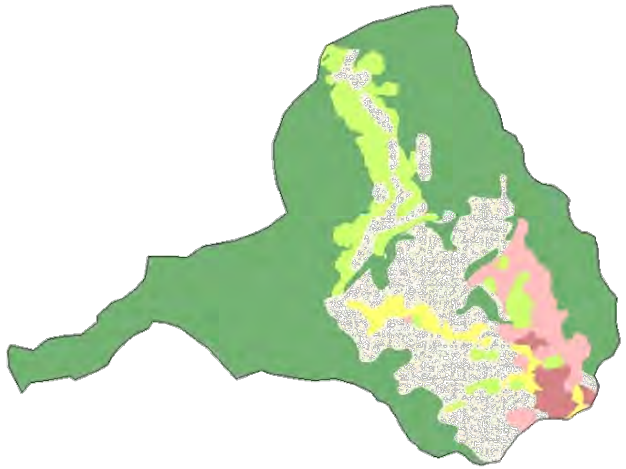


Changes in LU and landscape pattern driven by socio-economic development at local and provincial levels will affect biodiversity and nature benefits although 35% of the province is designated as protected areas.



Current land use generates the highest hydrological services **BUT** it is ranked as the least overall benefits if economic values from crop production is combined.

Appropriate forest cover target at 60-70% (Forest-based Disaster Risk Reduction (F-DRR or NBS) in mountainous watershed is recommended in the face of LU&CC and can generate high economic return **(+ carbon credit)**.



Acknowledgements

Special thanks

Counterparts & Data

sustainability

MDPI

Article

Land-Use/Land-Cover Change from Socio-Economic Drivers and Their Impact on Biodiversity in Nan Province, Thailand

Yongyut Trisurat [1,*], Hiroaki Shirakawa [2] and John M. Johnston [3]

1 Faculty of Forestry, Kasetsart University, Bangkok 10900, Thailand
2 Department of Urban Environment, Graduate School of Environmental Studies, Nagoya University, Nagoya 464-8601, Japan; sirakawa@urban.env.nagoya-u.ac.jp
3 USEPA/ORD/NERL Computational Exposure Division, Athens, GA 30605, USA; Johnston.JohnM@epa.gov
* Correspondence fforyyt@ku.ac.th; Tel.: +66-2579-176

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