Teak Studies of RFD-JIRCAS FY2006 – 2020 & NAFRI-JIRCAS FY2016-2020

กรมป่าไม้

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Modified from the presentation prepared by TAKAO Gen

RFD-JIRCAS Collaboration

Royal Forest Department (RFD), Thailand, and **Japan International Research Center for Agricultural Sciences (JIRCAS)**, Japan, have jointly promoted research and development in forestry from 2001 until today. Special focus is placed on teak.

Outcomes of the project were published as JIRCAS Working Reports.

Higher Value Forestry: JIRCAS Forestry Project FY2016-2020

- To achieve higher-value plantation products through developing technologies of;
  - Stand Treatment, Soil Analyses & Improvement, Efficient Monitoring, Genetics, etc.

Teak (*Tectona grandis)*

Dipterocarp Sp.

- Partners

Royal Forest Dept. (RFD) Thailand

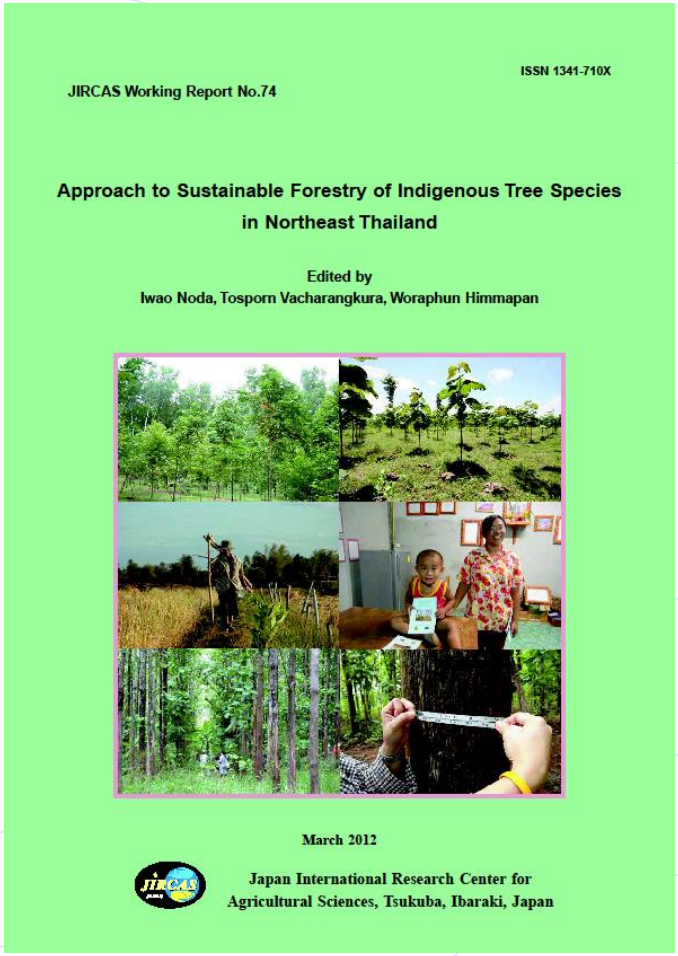
Forestry Research Center (FRC) NAFRI, Lao PDR

Forestry Research Inst. Malaysia (FRIM), Malaysia

Universitas Gadjah Mada (UGM), Indonesia

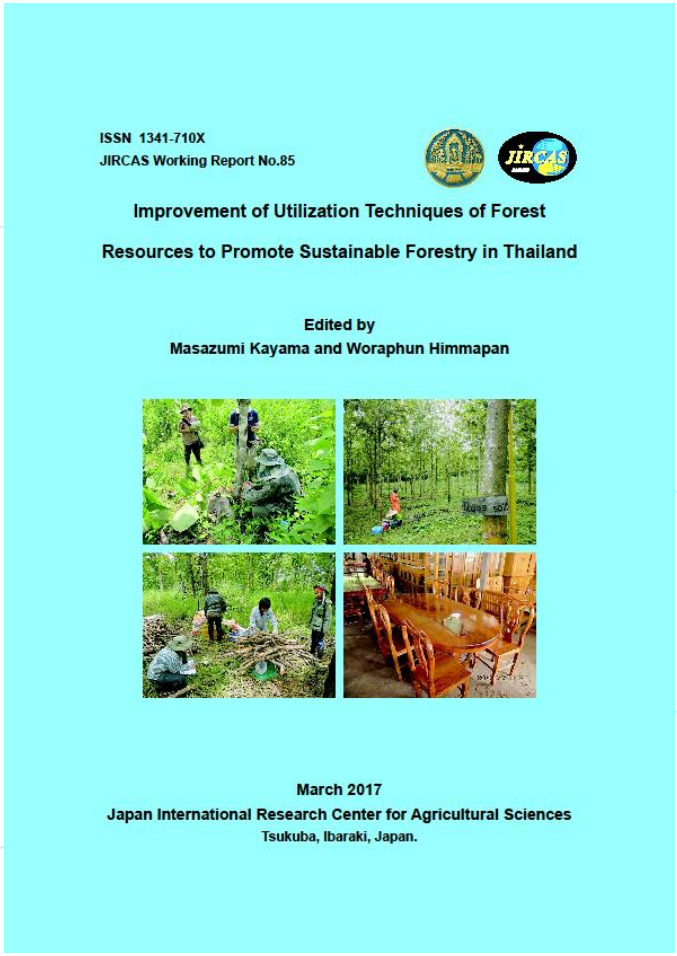
RFD-JIRCAS studies were summarized in JIRCAS Working Reports

No. 74, 2012



Approach to Sustainable Forestry of Indigenous Tree Species in Northeast Thailand

No. 85, 2017



Improvement of Utilization Techniques of Forest Resources to Promote Sustainable Forestry in Thailand

Contents of the Working Reports

No. 74, 2012

Growth performance of indigenous tree species under uneven-aged forest management in Northeast Thailand

A modeling approach to sustainable forest management: "Virtual Forest" predicts forest growth and canopy structure

A preliminary result of coppicing trials in teak plantations in Kanchanaburi, Thailand

Two-year results of a clonal test of teak (*Tectona grandis* L.f.) in the Northeast of Thailand

A preliminary result of soil improvement trial on teak in Khon Kaen, Thailand

Improvement of soil suitability mapping for teak plantations in Northeast Thailand

Variable density yield model for teak plantations in the Northeast of Thailand

Current situation and solution on management of Nong Bua Lam Phu Private Forest Plantation Cooperative Limited

Current functions and expected roles of Private Forest Plantation Cooperatives in Thailand

Trends of forestry and wood processing industry in Thailand: Analysis using historical forestry statistics from 1997 to 2008

The present circumstances of teak wood processing, marketing and future prospects in Northeast Thailand

Current situation of teak farm forestry after Economic Tree Plantation Promotion Project in Northeast Thailand

Financial analysis of private teak plantation investment in Thailand

Profitability of combined farm management with teak plantations in Northeast Thailand

No. 85, 2017

Estimation of biomass and carbon stock in young teak plantations in Thailand

Potential stereoscopic tree height measurement of teak plantations using Pléiades high-resolution satellite imagery

Effects of first thinning on growth and stem form of teak plantations in Thailand

The growth of coppiced teak in Northern Thailand

Preliminary Results of a Second Clonal Test of Teak (*Tectona grandis* L.f.) in Northeastern Thailand

Growth characteristics of teak seedling planted on different types of sandy soil in Northeast Thailand

Growth Performance of 6-year-old Teak Plantation under Different Soil Improvement Methods in Khon Kaen Province, Thailand

Effect of perlite for soil improvement and on growth characteristics of teak seedling planted in sandy soil in Northeast Thailand

Improved Yield Prediction Model for Teak Plantations in Northeastern Thailand

Effects of coppicing and seedling options on financial evaluation of teak (*Tectona grandis* L.) farm plantation management in Thailand

Case studies on enterprise types of processing and sales of planted teak timbers

Downloadable at: https://www.jircas.go.jp/en/publication/jircas_working_report

Excerpts from the Working Reports

- Management of teak plantations
  1. **Improved soil suitability map for teak plantations**
  2. **Growth characteristics of teak seedlings planted on sandy soils**
  3. Second clonal test of teak in Northeast Thailand
  4. The Growth of coppiced teak in Northern Thailand
  5. Improved yield prediction model for teak plantations
  6. Effects of first thinning on growth and stem form of planted teaks
  7. **Estimation of biomass and carbon stock in young teak plantations**

- Socio-economic aspects of the teak industry
  - 8 Trends of forestry and wood processing industry in Thailand
  - 9 Current functions and expected roles of Private Forest Plantation Cooperatives (PFPC)
  - 10 Current situation and solution on management of Nong Bua Lam Phu PFPC
  - 11 The present circumstances of teak wood processing, marketing and future prospects
  - 12 Current situation of teak farm forestry after Economic Tree Plantation Promotion Project
  - 13 Profitability of combined farm management with teak plantations
  - 14 Case studies on enterprise types of processing and sales of planted teak timbers

- From fast-growing species to indigenous trees
  - 15 Growth performance of indigenous tree species under uneven-aged forest management
  - 16 “Virtual Forest” predicts forest growth and canopy structure

Improved soil suitability map for teak plantations

1

- Objectives and methods
  - To improve the soil suitability mapping for teak plantation in northeast Thailand (after Sukchan & Sakai, 2009)
  - Soil classification based on the Soil Group Map (LDD, 2004)
- Key Findings
  - The soil suitability classes were revised from three classes to five classes
  - In Udon Thani Province for example, the suited soil covers 42.3%, while the not-suited 23.6%
  - Correctly classified samples accounted for 69%, which was acceptable

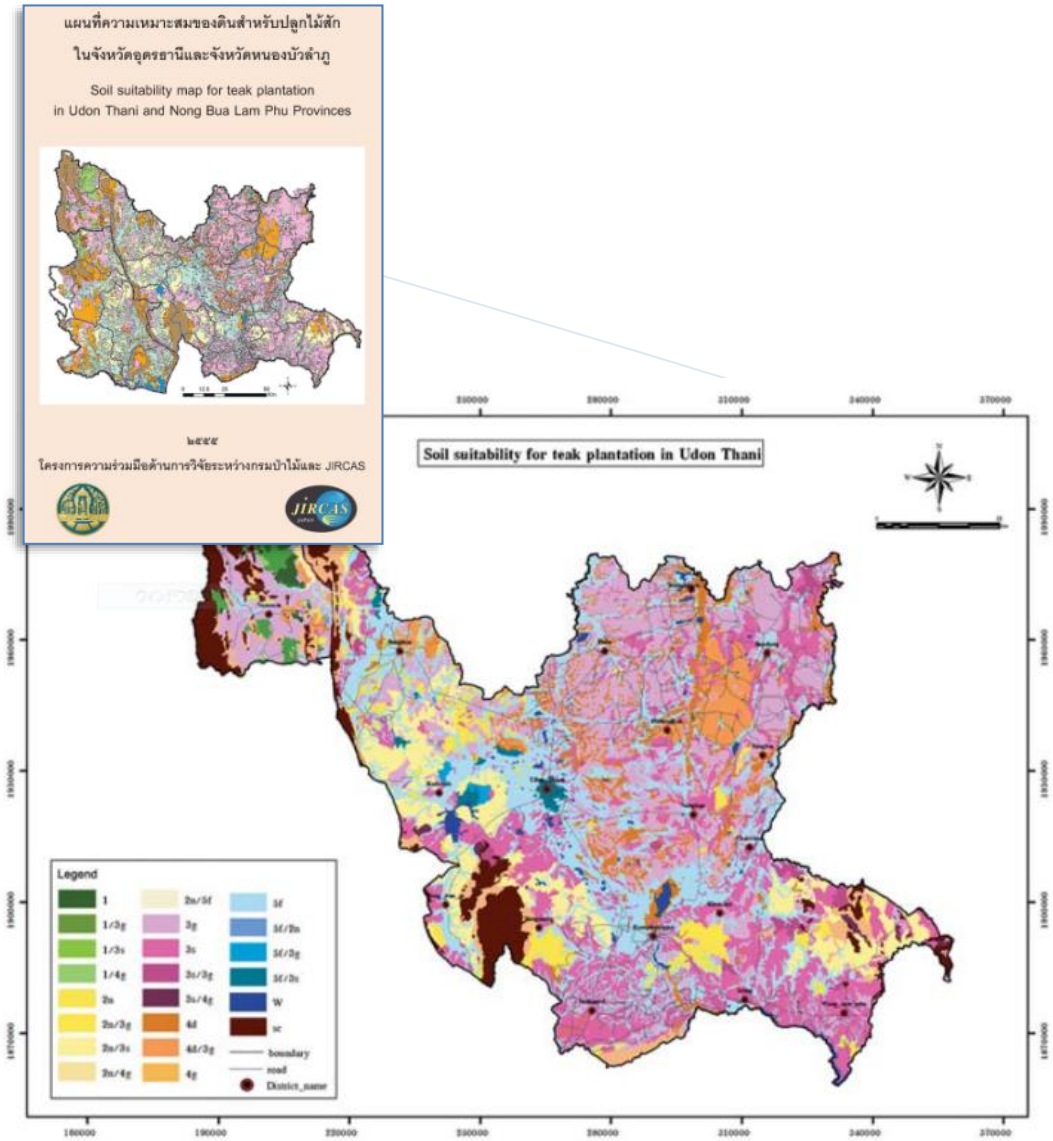


Fig. 2. Revised soil suitability map for teak plantation in Udon Thani Province

Sukchan, S. and I. Noda (2012) JIRCAS Working Report 74: 27-32

Table 5. The comparisons of the revised soil suitability class with actual teak growth classes

No.	Observed sitecode	Revised soil suitability class	Actual teak growth class	Result of comparison
1	NS1	1	1-2	accord
2	NS2	3g	2-3	accord
3	NS3	3g	2-2.5	underestimated
4	NS4	3g/4d	4	accord
5	NS5	3g	2-2.5	underestimated
6	NS6	3g	3-3.5	accord
7	NS7	3g	3.5-4	accord
8	NY1	SC	1-2	accord
9	NY2	1/3g	2-2.5	accord
10	NY3	1/3g	3	accord
11	NY4	3g	3-3.5	accord
12	NS9	3g	3.5-4	accord
13	BP1/1	4d/3g	4.5-5	accord
14	BP2	2n/3g	1-2	accord
15	Nbm5	2n	3.5	overestimated
16	Nbm6	2n	4	overestimated
17	Nbm7	5f	3-4	underestimated
18	Nbm8	5f	2-2.5	underestimated
19	Nbm4	3s/3g	5	overestimated
20	Nbm3	3s/3g	4	accord
21	Nbm2	5f	4.5-5	accord
22	Nbm1	2n/3s	5	overestimated
23	Nb s1	1/3g	1-1.5	accord
24	Nb s2	1/3g	2	accord
25	Nb s3	1/3g	3-4	accord
26	Nb n1	4d/3g	3	accord
27	Nb n2	4g	4	accord
28	Nb n3	5f/4d	4	accord
29	Nb n4	5f/4d	1	underestimated

Growth characteristics of teak seedling planted on different types of sandy soil

- Objectives and methods
  - To determine the factors that suppress teak growth, which occurs on sandy soil, we planted teak seedlings in sandy soil at two sites
    - One of the sites exhibited suppressed teak growth but the other did not
  - We compared growth, photosynthetic rate, leaf water potential, and the concentrations of elements in plant organs between the two sites
- Key Findings
  - The suppressed site showed low concentrations of nutrients in the soil, especially Ca
  - The low growth rates correlated with decreases photosynthetic rate and drought stress in the dry season
  - the concentration of Ca in soil was important for teak growth
    - the site with low Ca showed drastic suppression of teak growth and Mg toxicity caused by Ca deficiency

Table 1. Texture and chemical properties of soils from the moderate and suitable sites with sandy soil (Mean ± SE, n=9). Mean values of each parameter were analyzed by t-test. ** $P<0.01$, *** $P<0.001$, and n.s. not significant.

Treatment	Texture (%)			pH
	Sand	Silt	Clay	
moderate	80.2±0.5	14.1±0.7	5.7±0.9	4.53±0.08
suitable	81.5±0.6	13.8±0.4	4.7±0.4	5.95±0.05
Statistical test	n.s.	n.s.	n.s.	***
	CEC (cmol kg^{-1})	C (mol kg^{-1})	N (mmol kg^{-1})	P (mmol kg^{-1})
moderate	1.30±0.10	0.58±0.19	21.6±2.5	0.278±0.065
suitable	2.50±0.14	1.35±0.09	6.9±1.1	0.341±0.070
Statistical test	***	**	***	n.s.
	Ca (mmol kg^{-1})	Mg (mmol kg^{-1})	K (mmol kg^{-1})	Na (mmol kg^{-1})
moderate	1.31±0.21	0.94±0.12	0.58±0.07	0.103±0.026
suitable	8.37±0.79	2.93±0.20	2.62±0.27	0.184±0.046
Statistical test	***	***	***	n.s.

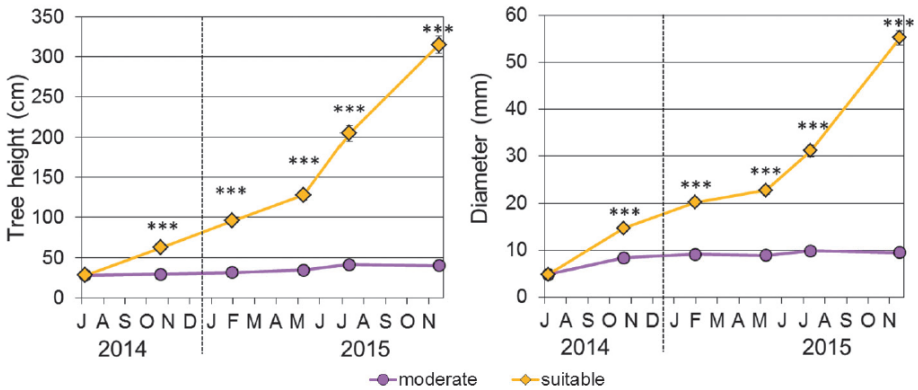


Fig. 2. Tree height and basal diameter of teak seedlings grown at the moderate and suitable sites with sandy soil (mean ± SE, n=60). Mean values of each parameter were analyzed by t-test. *** $P<0.01$.

Note. Divisions on the horizontal axis over the letters are the first day of each month. The same format is used in subsequent figures.

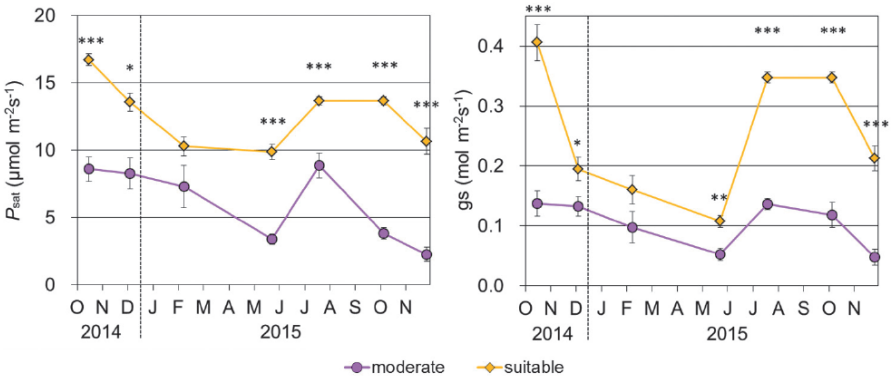


Fig. 4. Photosynthetic rate at light saturation (P_{sat}) and stomatal conductance (gs) for teak seedlings grown at the moderate and suitable sites with sandy soil (9:00-11:00, mean ± SE, n=6). Mean values of each parameter were analyzed by t-test. * $P<0.05$, ** $P<0.01$, *** $P<0.001$.

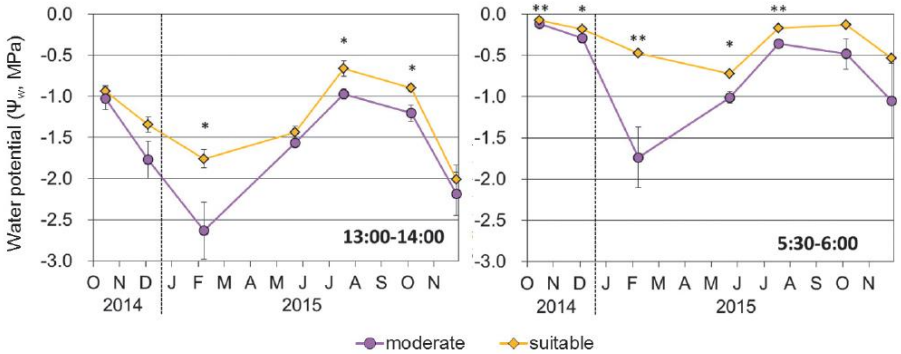


Fig. 5. Leaf water potential in the afternoon (13:00–14:00) and predawn (05:30–06:00) for teak seedlings grown at the moderate and suitable sites with sandy soil (mean ± SE, n=6). Mean values of each parameter were analyzed by t-test. * $P<0.05$, ** $P<0.01$.

Kayama, M., S. Nimpila, S. Hongthong , W. Himmapan (2017) JIRCAS Working Report 85: 44-56

Estimation of biomass and carbon stock in young teak plantations in Thailand

- Objectives and methods
  - We estimated biomass and carbon stock from allometric relationships between tree size parameters and plant part biomass (leaves, stems, total root biomass) in young teak (*Tectona grandis* L.f.) plantations
    - 177 trees harvested to estimate above- and below-ground biomass
- Key Findings
  - Tree DBH shows high correlation with biomass
  - Similar wood density of the sampled trees might have reduced site-specific differences
  - Above-ground and below-ground carbon stock ranged from 1.3 to 67.7 Mg ha-1 and from 0.4 to 13.7 Mg ha-1, respectively.

– Mean wood density of stem samples from the plots ranged from 0.49 ± 0.04 to 0.59 ± 0.05 g cm-3 for heartwood and 0.47 ± 0.05 to 0.60 ± 0.08 g cm-3 for sapwood

Table 2. Coefficient of equations for leaves, branches, stems, and above-ground and below-ground biomass. Corrected coefficient by correction factor (CF). Stem diameter at breast height (DBH), stem diameter at the lowest branch (D_B), and tree height (H)

Dependent variable	Independent variable						correcting bias using CF
(y)	(x)	n	a	b	R^2	CF	a
Leaf dry biomass (kg)	DBH (cm)	100	0.0199	1.7702	0.50	1.100	0.0219
	$DBH^2 \times H$ (cm^2m)	100	0.0201	0.5951	0.44	1.111	0.0223
	H (m)	101	0.0387	1.5726	0.28	1.146	0.0443
Branch dry biomass (kg)	DBH (cm)	100	0.0044	2.8904	0.94	1.018	0.0045
	$DBH^2 \times H$ (cm^2m)	100	0.0033	1.0067	0.89	1.029	0.0034
	H (m)	101	0.0048	2.9488	0.70	1.082	0.0052
Stem dry biomass (kg)	DBH (cm)	100	0.0446	2.6074	0.98	1.004	0.0448
	$DBH^2 \times H$ (cm^2m)	100	0.0289	0.9328	0.99	1.003	0.0290
	H (m)	101	0.0241	2.9273	0.89	1.022	0.0246
Above-ground biomass (kg)	DBH (cm)	100	0.0647	2.5715	0.99	1.003	0.0649
	$DBH^2 \times H$ (cm^2m)	100	0.0447	0.9125	0.98	1.004	0.0449
	H (m)	101	0.0436	2.8063	0.85	1.030	0.0449
Below-ground biomass (kg)	DBH (cm)	75	0.0453	2.1839	0.90	1.017	0.0461
	D_0 (cm)	75	0.0794	1.9571	0.92	1.014	0.0132
	$DBH^2 \times H$ (cm^2m)	75	0.0393	0.7553	0.85	1.026	0.0403
	H (m)	76	0.0577	2.1754	0.66	1.061	0.0612

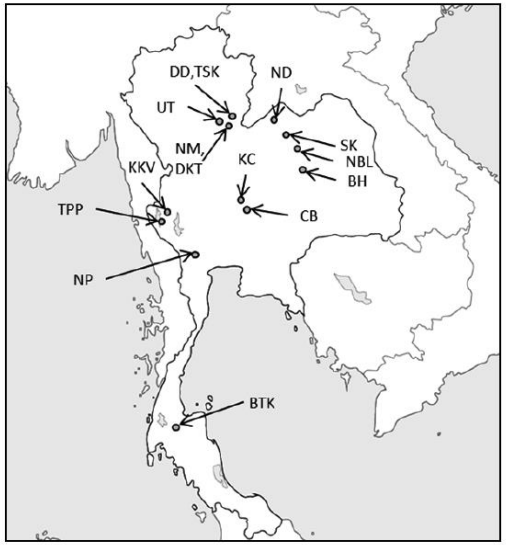


Fig.1. Location of each research site in Thailand.

Yoneda, R., W. Himmapan, N. Tedsorn, T. Vacharangkura, I. Noda (2017) JIRCAS Working Report 85: 1-9

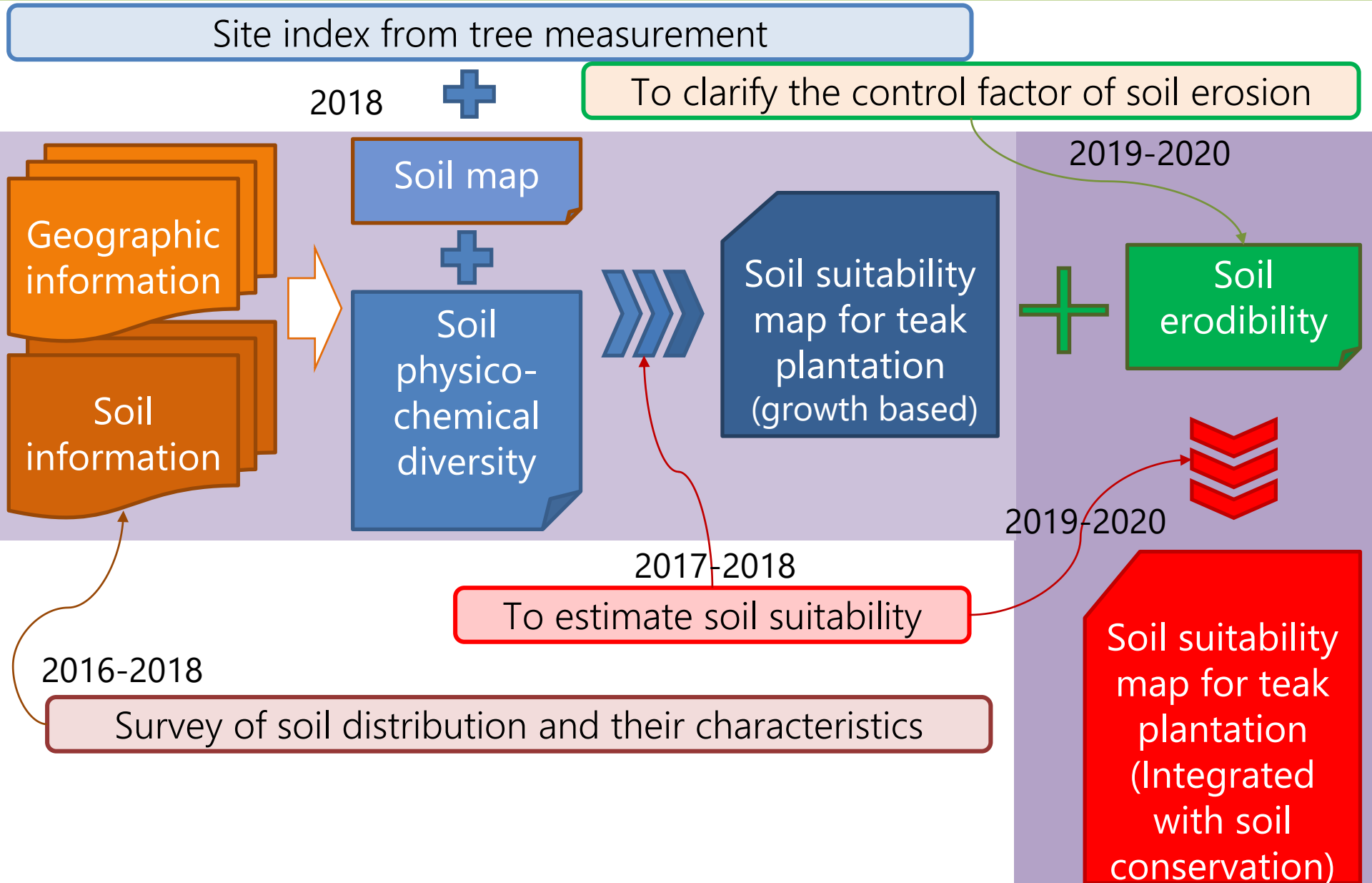
Measurement of below ground biomass and standing trees

Development of Forestry Technologies of the Indigenous Tree Plantations on the Slopes in Laos

FY 2016-2020

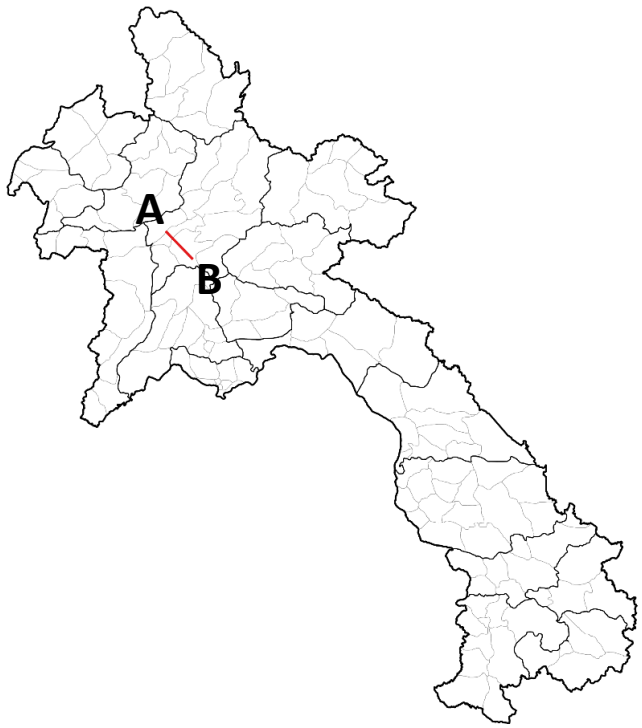
Conducted by Imaya and Simone

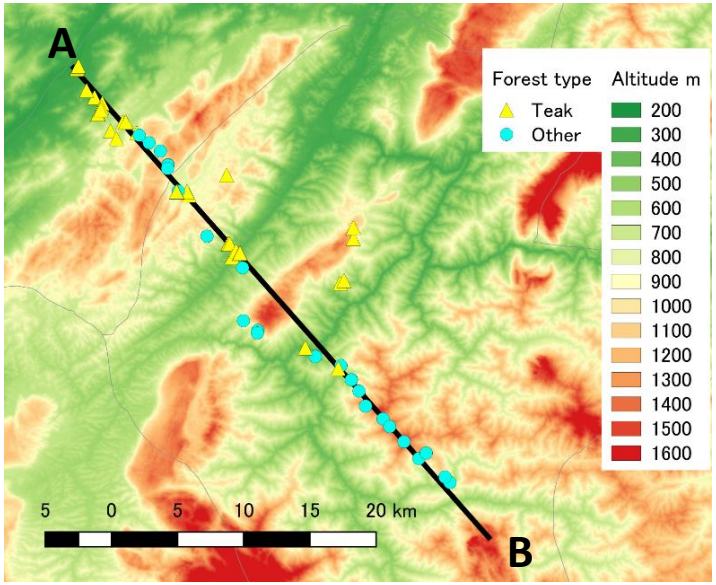
Activities and Outputs (Teak plantation)



Survey line and soil survey points in Luangprabang

A series of soil surveys at 59 forest stands (with 32 teak) along a line of 40 km in length, extending from the lowland in Luangprabang District to the mountain area in Xieng Ngeum District, Luangprabang Province.



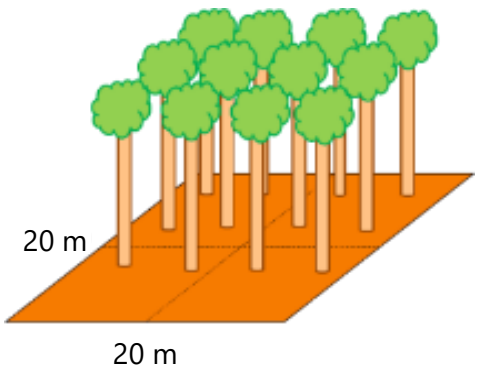


Survey line
Soil survey point

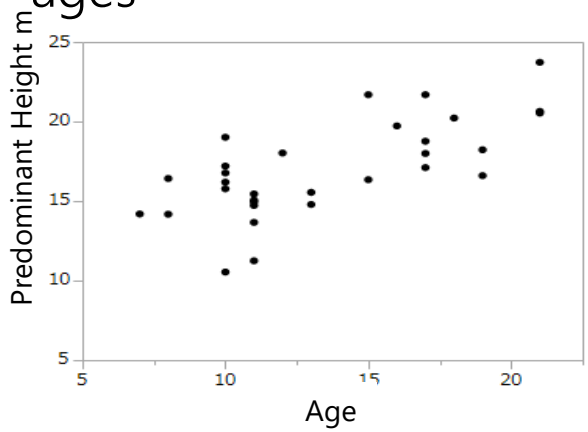
Estimation of **Site Index**

Tree measurement → **Plot predominant heights** → **Site index model**

60 teak plots



Measure the height of dominant trees and their ages

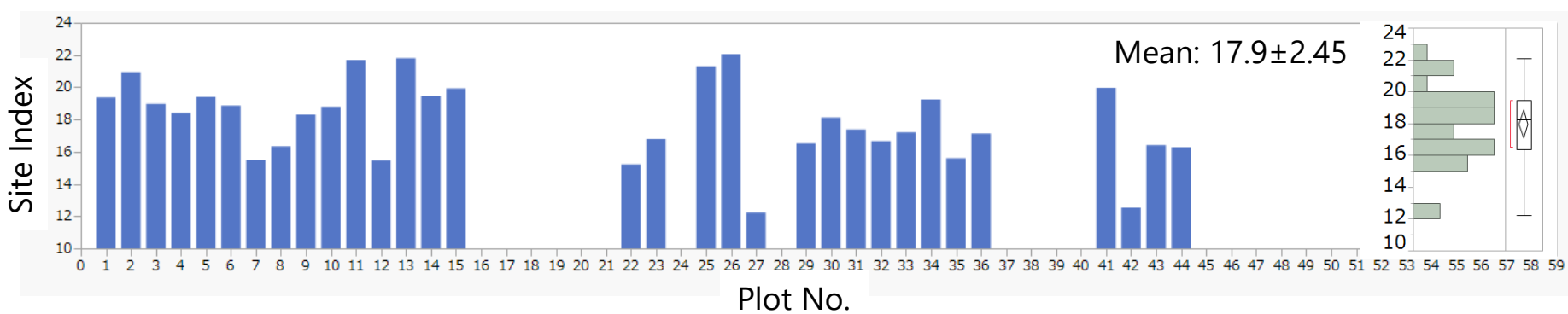


Estimate the dominant tree height at a standard age of 15 years

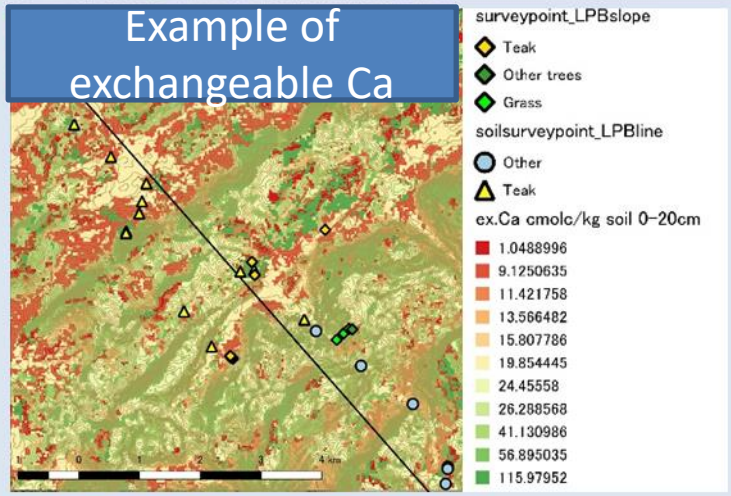
$$SI_{15} = exp\left[\ln(PHeight) - 4.46\left(\frac{1}{15} - \frac{1}{Age}\right)\right]$$

Site index

Estimated heights (m) of dominant trees at the age of 15 years

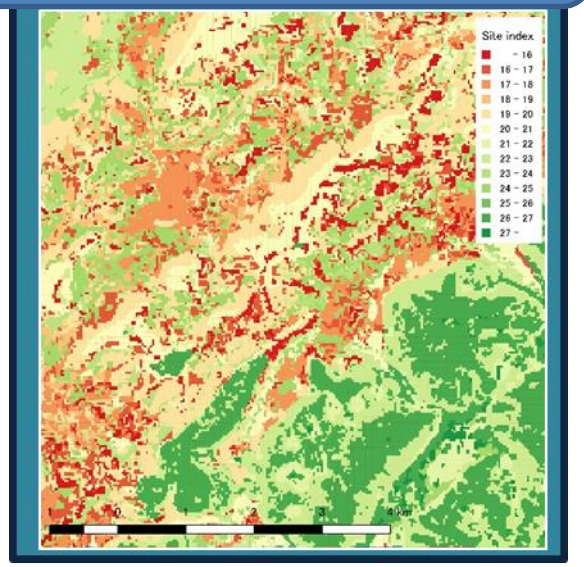


Macro-scale estimation of soil physicochemical properties



A draft of soil physicochemical diversity map was made on the basis of 51 soil cross section survey and its physicochemical analysis by using partition tree analysis with topographical data.

Draft of soil suitability map for teak plantation



A draft of soil suitability map for teak plantation was made on the basis of 60 plots tree census and analysis of relation among site index, topography and soil property.

Key Findings (Laos)

- Relations between soil chemical properties and parent material in Luang Prabang were clarified.
- A draft of soil physicochemical diversity map was made for a part of Luang Prabang Province.
- Relations between site index of teak height growth, topography and soil properties are analyzed by using partition tree method.
- Based on these findings, we made a draft of soil suitability map for teak plantation in a part of Luang Prabang.

Highlight

- Soil suitability map for teak plantations for several provinces in Northeast Thailand.
- Estimation of above- and below-ground biomass of teak in Thailand.
- A draft of soil suitability map for teak plantation in a part of Luang Prabang, based on tree measurement, physico-chemical analysis of soils and geographical information. (Working Report coming soon)
- https://www.jircas.go.jp/en/publication/jircas_working_report