

APPENDIX A

Species of trees planted in 1998, 2002 and 2007

No.	Species	1998	2002	2007
1	<i>Acrocarpus fraxinifolius</i>	-	/	/
2	<i>Adinandra integerrima</i>	-	-	/
3	<i>Aglaiia lawii</i>	-	-	/
4	<i>Alangium kurzii</i>	-	-	/
5	<i>Albizia odoratissima</i>	-	-	/
6	<i>Alseodaphne andersonii</i>	-	-	/
7	<i>Aphanamixis polystachya</i>	/	-	/
8	<i>Apodytes dimidiata</i>	-	-	/
9	<i>Aquilaria crassna</i>	-	/	/
10	<i>Archidendron clypearia</i>	-	-	/
11	<i>Artocarpus gomezianus</i>	-	-	/
12	<i>Artocarpus lakoocha</i>	-	-	/
13	<i>Baccaurea ramiflora</i>	-	-	/
14	<i>Balakata baccata</i>	-	-	/
15	<i>Bauhinia variegata</i>	-	-	/
16	<i>Betula alnoides</i>	-	-	/
17	<i>Bischofia javanica</i>	/	/	/
18	<i>Bridelia glauca</i>	-	-	/
19	<i>Canarium subulatum</i>	-	-	/
20	<i>Carallia brachiata</i>	-	-	/
21	<i>Careya arborea</i>	-	-	/
22	<i>Castanopsis armata</i>	-	-	/
23	<i>Castanopsis calathiformis</i>	/	-	/
24	<i>Castanopsis diversifolia</i>	-	/	/
25	<i>Castanopsis tribuloides</i>	-	/	/
26	<i>Cephalotaxus griffithii</i>	-	-	/
27	<i>Cinnamomum caudatum</i>	-	-	/
28	<i>Cinnamomum iners</i>	/	-	-
29	<i>Cryptocarya amygdalina</i>	-	-	/
30	<i>Dalbergia oliveri</i>	-	-	/
31	<i>Debregeasia longifolia</i>	-	-	/
32	<i>Diospyros glandulosa</i>	/	-	/

No.	Species	1998	2002	2007
33	<i>Dipterocarpus costatus</i>	-	-	/
34	<i>Elaeocarpus lanceifolius</i>	-	/	/
35	<i>Erythina stricta</i>	-	/	-
36	<i>Erythrina subumbrans</i>	/	/	/
37	<i>Eugenia albiflora</i>	/	/	-
38	<i>Eugenia cinerea</i>	-	-	/
39	<i>Eugenia formosa</i>	-	-	/
40	<i>Eugenia tetragona</i>	-	-	/
41	<i>Euodia meliifolia</i>	-	-	/
42	<i>Eurya acumminata</i>	/	-	-
43	<i>Ficus altissima</i>	/	-	-
44	<i>Ficus auriculata</i>	-	-	/
45	<i>Ficus benghalensis</i>	-	-	/
46	<i>Ficus benjamina</i>	-	-	/
47	<i>Ficus benjamina</i> var. <i>benjamina</i>	-	/	-
48	<i>Ficus callosa</i>	-	/	-
49	<i>Ficus capillipes</i>	-	/	-
50	<i>Ficus fistulosa</i>	-	-	/
51	<i>Ficus fistulosa</i> var. <i>fistulosa</i>	-	/	-
52	<i>Ficus hispida</i>	-	-	/
53	<i>Ficus microcarpa</i>	-	-	/
54	<i>Ficus racemosa</i>	-	-	/
55	<i>Ficus subincisa</i>	-	/	-
56	<i>Garcinia mackeaniana</i>	/	-	-
57	<i>Gmelina arborea</i>	/	/	/
58	<i>Helicia nilagirica</i>	/	-	-
59	<i>Heynea trijuca</i>	-	/	/
60	<i>Horsfieldia amygdalina</i>	/	-	-
61	<i>Horsfieldia thorelii</i>	/	-	-
62	<i>Hovenia dulcis</i>	/	/	/
63	<i>Lithocarpus elegans</i>	-	-	/
64	<i>Litocarpus sootepensis</i>	-	-	/
65	<i>Macaranga denticulata</i>	-	/	/
66	<i>Machilus boombycina</i>	-	/	-
67	<i>Magnolia liliifera</i>	-	-	/
68	<i>Mahonia nepalensis</i>	-	-	/
69	<i>Manglietia garrettii</i>	/	-	/
70	<i>Markhamia stipulata</i>	-	-	/

No.	Species	1998	2002	2007
71	<i>Melia toosendan</i>	/	/	/
72	<i>Michelia baillonii</i>	-	-	/
73	<i>Michelia champaca</i>	-	-	/
74	<i>Michelia floribunda</i>	-	-	/
75	<i>Morus macroura</i>	-	-	/
76	<i>Nyssa javanica</i>	/	/	/
77	<i>Oroxylum indicum</i>	-	-	/
78	<i>Ostodes paniculata</i>	-	/	/
79	<i>Phoebe lanceolata</i>	/	-	-
80	<i>Phoebe</i> sp.	/	-	-
81	<i>Phyllanthus emblica</i>	-	-	/
82	<i>Podocarpus neriifolius</i>	-	/	/
83	<i>Polyalthia viridis</i>	-	-	/
84	<i>Prunus cerasoides</i>	/	/	/
85	<i>Quercus brandisiana</i>	-	-	/
86	<i>Quercus kingiana</i>	-	-	/
87	<i>Quercus semiserrata</i>	/	/	/
88	<i>Quercus vestita</i>	/	-	-
89	<i>Rhus rhesoides</i>	-	/	/
90	<i>Sapindus rarak</i>	/	/	/
91	<i>Sarcosperma arboreum</i>	/	/	/
92	<i>Spondias axillaris</i>	/	/	/
93	<i>Styrax benzoides</i>	-	-	/
94	<i>Trichilla connaroides</i>	/	-	-
	Total species	27	24	46

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APPENDIX B

Soil profile description

Pedon 1 control or non-planted site

Location: Ban Mae Sa Mai, Mae Rim District, Chiang Mai Province

N18° 51' 410'', E098° 50' 881''

Elevation: 1,332 m.asl.

Slope: 10 %

Aspect: ESE 99°

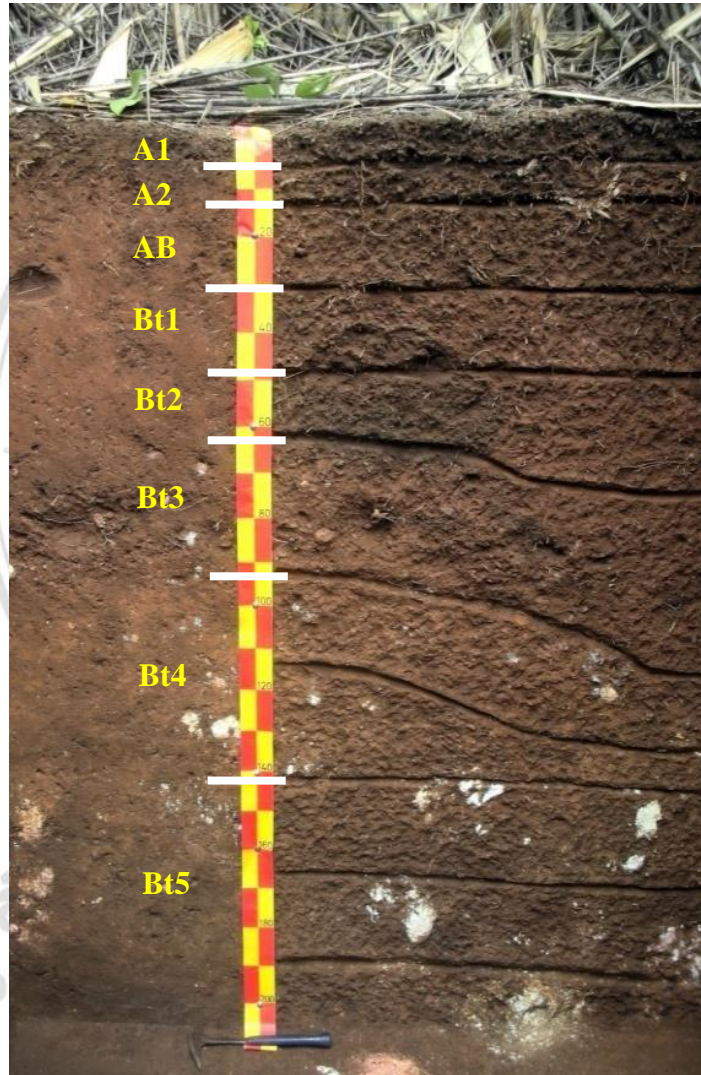
Vegetation type: Non-planted area dominated by the grasses *Thysanolaena latifolia*,
Phragmites vallatoria and *Imperata cylindrical*

Horizon	Depth (cm)	Description
A1	0-5 gray	Very dark grey (5YR 3/1) moist and dark reddish (5YR 4/2) dry; sandy clay loam; very fine subangular blocky; many ($\geq 10 \text{ dm}^3$) very coarse (diameter $\geq 10 \text{ mm}$) root, coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; very strongly acid (pH = 5.0)
A2	5-14	Dark reddish brown (5YR 3/2) moist and dark brown (7.5 YR 4/4) dry; sandy clay loam; very fine subangular blocky; ; many ($\geq 10 \text{ dm}^3$) very coarse (diameter $\geq 10 \text{ mm}$) root, coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; very strongly acid (pH = 4.7); gradual and smooth boundary

AB	14-30	Dark reddish brown (5YR 3/3) moist and strong brown (7.5 YR 4/6) dry; sandy clay loam; very fine subangular blocky; many ($\geq 10 \text{ dm}^3$) very coarse (diameter $\geq 10 \text{ mm}$) root, coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; extremely acid (pH = 4.4); gradual and smooth boundary
Bt1	30-48	Dark reddish brown (5YR 3/4) moist and strong brown (7.5 YR 4/6) dry; clay loam; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter $\geq 10 \text{ mm}$), coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; extremely acid (pH = 4.3); gradual and smooth boundary
Bt2	48-62/72	Dark reddish brown and dark red (5YR 2/2) moist and brown (7.5 YR 4/2) dry; sandy clay loam; very fine angular blocky; common (1 -5 root/dm ³) very coarse (diameter $\geq 10 \text{ mm}$), coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; very strongly acid (pH = 4.6); gradual and smooth boundary
Bt3	62/72-93/115	Reddish brown (5YR 4/4) moist and yellowish red (5YR 5/8) dry; clay loam; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter $\geq 10 \text{ mm}$), coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; very strongly acid (pH = 4.8); gradual and smooth boundary

Bt4	93/115-142	<p>Reddish brown (5YR.4/4) moist and yellowish red (5YR 5/8) dry; clay loam; very fine subangular blocky; few ($< 1 \text{ root/dm}^3$) very coarse (diameter ≥ 10 mm), coarse (diameter ≥ 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.8); gradual and smooth boundary</p>
Bt5	142-200 ⁺	<p>Dark reddish brown (5YR 3/3) moist and strong brown (7.5 YR 5/6); loam; very fine subangular blocky; very strongly acid (pH = 4.8); few ($< 1 \text{ root/dm}^3$) very coarse (diameter ≥ 10 mm), coarse (diameter ≥ 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.8); gradual and smooth boundary</p>

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Pedon 1 Control site

Pedon 2 2-year-old (2007 site)

Location: Ban Mae Sa Mai, Mae Rim District, Chiang Mai Province

N18° 51' 410'', E098° 50' 931''

Elevation: 1,311 m.asl.

Slope: 16 %

Aspect: ENE 60°

Vegetation type: Restored forest with framework species since 2007

Horizon	Depth (cm)	Description
A1	0-5	Dark reddish brown (5YR 3/2) moist and strong brown (7.5 YR 4/6) dry; sandy clay loam; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter ≥10 mm) root, coarse (diameter 5 – 10 mm) and medium (diameter 2 -5 mm), many (≥ 10 root/dm ³) fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.7)
A2	5-18	Dark reddish brown (5YR 3/2) moist and strong brown (7.5 YR 4/6) dry; clay loam; very fine sub angular blocky; common (1 -5 root/dm ³) very coarse (diameter ≥10 mm) root, coarse (diameter 5 – 10 mm) and medium (diameter 2 -5 mm), many (≥ 10 root/dm ³) fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.7); gradual and smooth boundary
BA	18-32	Dark reddish brown (5YR 3/4) moist and strong brown (7.5 YR 5/6); clay; very fine subangular blocky; gravel content 6.18 % ; common (1 -5 root/dm ³) very coarse (diameter ≥10 mm), coarse (diameter 5 – 10 mm) and medium (diameter 2 -5 mm), many (≥ 10 root/dm ³) fine (diameter 1 -2 mm)

and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.5); gradual and smooth boundary

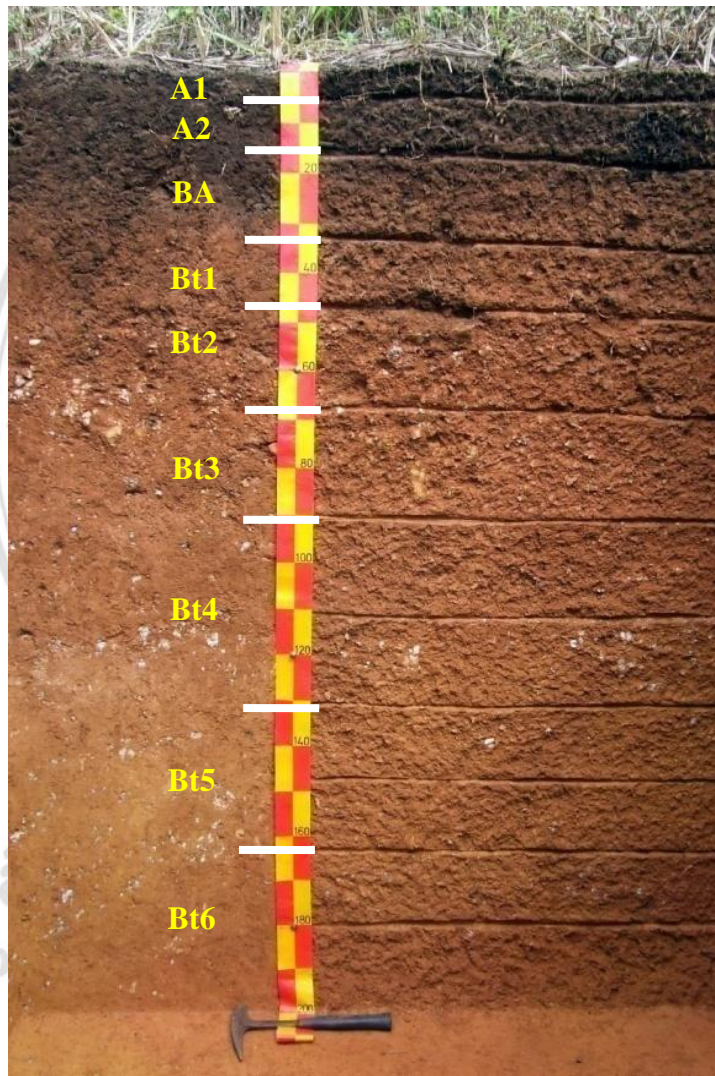
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| Bt1 | 32-46 | Yellowish red (5YR 4/6) moist and reddish yellow (7.5 YR 6/6) dry; clay; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter ≥10 mm), coarse (diameter 5 – 10 mm) and medium (diameter 2 -5 mm), many (≥ 10 root/dm ³) fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.5); gradual and smooth boundary |
| Bt2 | 46-67 | Yellowish red (5YR 5/6) moist and reddish yellow (5YR 6/6); clay; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter ≥10 mm), coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.5); gradual and smooth boundary |
| Bt3 | 67-90 | Yellowish red (5YR 5/6) moist and reddish yellow (5YR 6/6) dry; clay; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter ≥10 mm), coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.5); gradual and smooth boundary |
| Bt4 | 90-130 | Yellowish red (5YR 5/6) moist and reddish yellow (5YR 6/8) dry; clay; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter ≥10 mm), coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm) root; very strongly acid (pH = 4.6); gradual and smooth boundary |

Bt5 130-163 Yellowish red (5YR 5/8) moist and reddish yellow (5YR 7/6) dry; clay; very fine subangular blocky; common (1 -5 root/dm³) very coarse (diameter \geq 10 mm), coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm) root; very strongly acid (pH = 4.5); gradual and smooth boundary

Bt6 163-200⁺ Yellowish red (5YR 5/8) moist and pink (5YR 7/4) dry; clay loam; very fine subangular blocky; common (1 -5 root/dm³) very coarse (diameter \geq 10 mm), coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm) root; very strongly acid (pH = 4.8); gradual and smooth boundary



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Pedon2 2-year-old (2007 site)

Pedon3 7-year-old (2002 site)

Location: Ban Mae Sa Mai, Mae Rim District, Chiang Mai Province

N18° 51' 569'', E098° 50' 968''

Elevation: 1,228 m.asl.

Slope: 22 %

Aspect: ENE 86°

Vegetation type: Restored forest with framework species since 2002

Horizon	Depth (cm)	Description
A1	0-6	Dark reddish brown (5YR 3/2) moist and brown (7.5 YR 4/4) dry; sandy loam; very fine granular; common (diameter 5 – 10 mm) very coarse (diameter ≥ 10 mm) root, few (< 1 root/ dm ³) coarse (diameter 5 – 10 mm), common (1 -5 root/dm ³) medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and many (≥ 10 dm ³) very fine (diameter < 1 mm) roots; moderately acid (pH = 5.7)
AB1	6-21	Dark reddish brown (5YR 3/2) moist and brown (7.5 YR 4/4) dry; sandy loam; very fine subangular blocky; common (diameter 5 – 10 mm) very coarse (diameter ≥ 10 mm) root, common (1 -5 root/dm ³) coarse (diameter 5 – 10 mm), many (≥ 10 dm ³) medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; moderately acid (pH = 5.7); gradual and smooth boundary

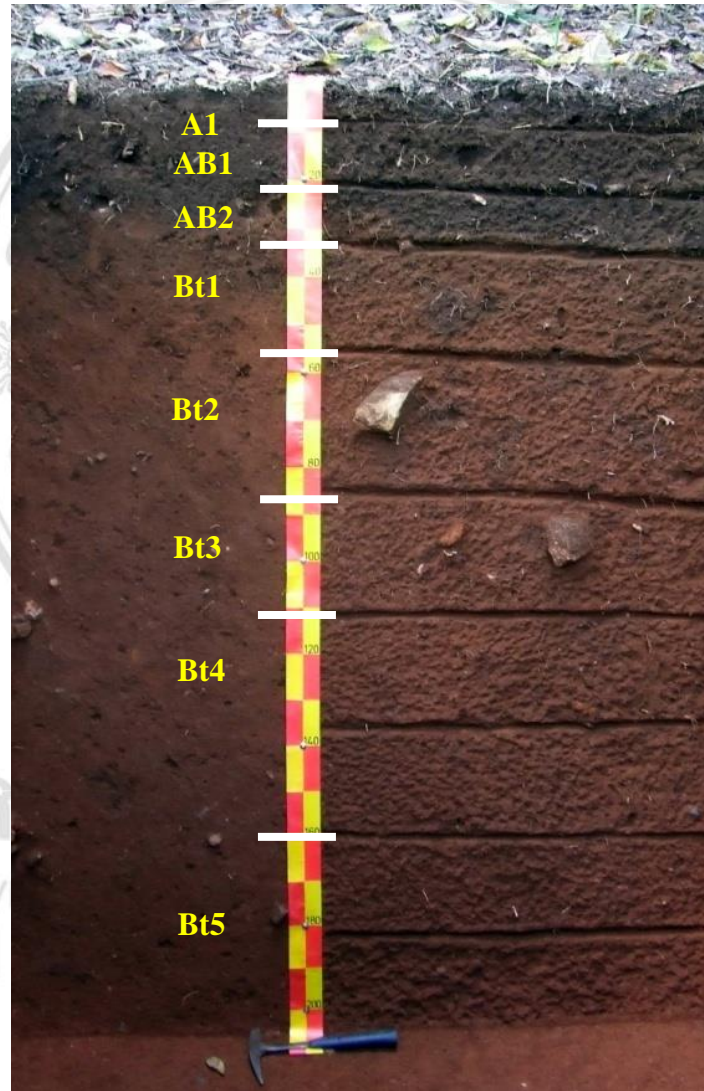
AB2	21-32	:Dark reddish brown (5YR 3/3) moist and brown (7.5 YR 4/4) dry; sandy loam; very fine subangular blocky; few (< 1 root/ dm^3) very coarse (diameter ≥ 10 mm) root, common (1 -5 root/ dm^3) coarse (diameter 5 – 10 mm), many (≥ 10 dm^3) medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; strongly acid (pH = 5.4); gradual and smooth boundary
Bt1	32-55	Dark reddish brown (2.5YR 2.5/4) moist and reddish brown (5 YR 4/4) dry; clay Loam; very fine subangular blocky; strongly acid (pH = 5.1); common (1 -5 root/ dm^3) very coarse (diameter ≥ 10 mm) root, coarse (diameter 5 – 10 mm), many (≥ 10 root/ dm^3) medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; strongly acid (pH = 5.1); gradual and smooth boundary
Bt2	55-85	Dark reddish brown (2.5YR 3/4) moist and red (2.5 YR 4/6) dry; sandy clay loam; very fine subangular blocky; common (1 -5 root/ dm^3) very coarse (diameter ≥ 10 mm), coarse (diameter 5 – 10 mm), many (≥ 10 dm^3) medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.8); gradual and smooth boundary
Bt3	85-110	Dark reddish brown (2.5YR 3/4) moist and red (2.5 YR 4/6) dry; clay loam; very fine subangular blocky; common (1 -5 root/ dm^3) coarse (diameter 5 – 10 mm) root and medium (diameter 2 -5 mm), many (≥ 10 dm^3) fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.8); gradual and smooth boundary

Bt4 110-160 Dark red (2.5YR 3/6) moist and red (2.5 YR 4/6) dry; clay loam; very fine sub angular blocky; few (< 1 root/ dm^3) very coarse (diameter ≥ 10 mm), common (1 -5 root/ dm^3) coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm) , fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.9); gradual and smooth boundary

Bt5 160-200⁺ Dark red (2.5YR.3/6) moist and red (2.5 YR 5/6) dry; clay loam; very fine subangular blocky; common (1 -5 root/ dm^3) fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.9); gradual and smooth boundary



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Pedon3 7-year-old (2002 site)

Pedon 4 11-year-old (1998 site)

Location: Ban Mae Sa Mai, Mae Rim District, Chiang Mai Province

N18° 51' 410'', E098° 50' 881''

Elevation: 1,332 m.asl.

Slope: 9 %

Aspect: NNW 352°

Vegetation type: Restored forest with framework species since 1998

Horizon	Depth (cm)	Description
A1	0-10	Black (5YR 2.5/1) moist and dark reddish grey (5YR 4/2) dry; sandy loam; very fine subangular blocky; many (≥ 10 dm ³) very coarse root (diameter ≥ 10 mm), coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine roots (diameter < 1 mm); very strongly acid (pH = 4.8); charcoal presented
A2	10-23	Black (5YR 2.5/1) moist and dark reddish grey (5YR 4/2) dry; sandy loam; very fine subangular blocky; many (≥ 10 dm ³) very coarse root (diameter ≥ 10 mm), coarse (diameter 5 – 10 mm) , medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine roots (diameter < 1 mm); extremely acid (pH = 4.4); gradual and smooth boundary; charcoal presented
A3	23-39	Black (5YR 2.5/1) moist and reddish grey (5YR 5/2) dry; sandy loam; very fine subangular blocky; common (1 -5 dm ³) very coarse root (diameter ≥ 10 mm), coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine roots (diameter < 1 mm); strongly acid

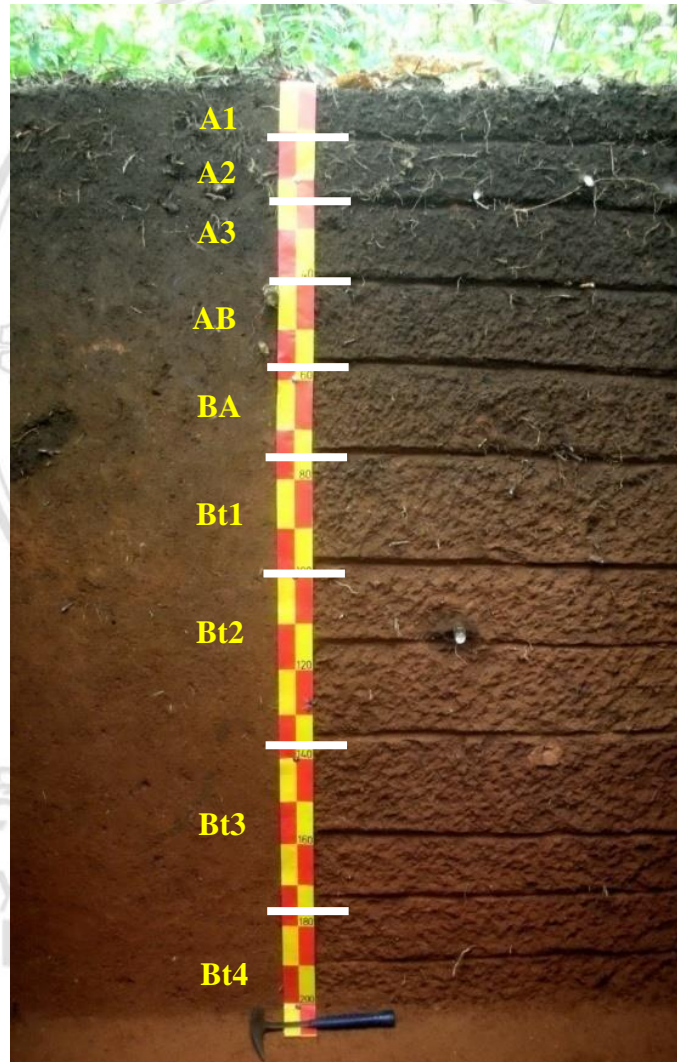
(pH = 5.4); gradual and smooth boundary; charcoal presented

- | | | |
|-----|--------|---|
| AB | 39-55 | Dark reddish brown (5YR 3/2) moist and reddish brown (5YR 5/4) dry; sandy clay loam; very fine subangular blocky; common (1-5 root / dm ³) , very coarse root (diameter ≥10 mm), coarse (diameter 5 – 10 mm), many (≥ 10 dm ³) medium, fine and very fine roots; extremely acid (4.4); gradual and smooth boundary; charcoal presented |
| BA | 55-74 | Dark reddish brown (5YR.3/2) moist and reddish yellow (5YR 6/6) dry; sandy clay loam; very fine subangular blocky; few (< 1 root/dm ³) very coarse root (diameter ≥10 mm), coarse (diameter 5 – 10 mm), common medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine roots(diameter < 1 mm); extremely acid (pH = 4.31); gradual and smooth boundary; charcoal presented; weathered root pore presented |
| Bt1 | 74-97 | Dark reddish brown (5YR 3/4) moist and reddish yellow (5YR 6/6) dry; sandy clay loam; very fine subangular blocky; few (< 1 root/ dm ³) very coarse root (diameter ≥10 mm), coarse (diameter 5 – 10 mm), common (1 -5 root/dm ³) medium (diameter 2 -5 mm) , fine (diameter 1 -2 mm) and very fine roots (diameter < 1 mm); extremely acid (pH = 4.31); gradual and smooth boundary; charcoal presented |
| Bt2 | 97-132 | Dark red (2.5 YR 3/6) moist and reddish yellow (5YR 6/8) dry; clay loam; very fine subangular blocky; few (<1 root/dm ³) very coarse (diameter ≥10 mm) , coarse (diameter 5 – 10 mm), medium (diameter 5 – 10 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; extremely acid (4.41); gradual and smooth boundary; charcoal presented |

- | | | |
|-----|----------------------|--|
| Bt3 | 132-171 | Dark red (2.5 YR 3/6) moist and reddish yellow (5YR 6/8) dry; clay loam; very fine subangular blocky few (< 1 root/ dm ³) very coarse (diameter ≥10 mm) root, coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.95); gradual and smooth boundary |
| Bt4 | 171-200 ⁺ | Dark red to red (2.5 YR.3/6) moist and reddish yellow (5YR 7/8) dry; clay; very fine subangular blocky; few(< 1 root/ dm ³) very coarse (diameter ≥10 mm), coarse (diameter 5 – 10 mm), medium (diameter 2 -5 mm) , fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; strongly acid (pH = 5.24); gradual and smooth boundary |



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Pedon 4 11-year-old (1998 site)

Pedon5 Natural site

Location: Ban Mae Sa Mai, Mae Rim District, Chiang Mai Province

N18° 51' 893'', E098° 51' 717''

Elevation: 1,288 m.asl.

Slope: 14 %

Aspect: WSW 266°

Vegetation type: Natural hill evergreen forest

Horizon	Depth (cm)	Description
A1	0-6	Black (5YR 2.5) moist and dark brown (7.5YR 3/4) dry; sandy clay loam; very fine subangular blocky; many ($\geq 10 \text{ dm}^3$) very coarse (diameter $\geq 10 \text{ mm}$), coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; very strongly acid (pH = 4.5)
A2	6-11	Very dark grey (5YR 3/1) moist and dark reddish brown (5YR 3/3) dry; sandy clay loam; very fine subangular blocky; many ($\geq 10 \text{ dm}^3$) very coarse (diameter $\geq 10 \text{ mm}$), coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; very strongly acid (pH = 4.5); gradual and smooth boundary

AB	11-26	Dark reddish brown (2.4YR 2.5/4) moist and yellowish red (5YR 4.5/6) dry ; sandy clay loam; very fine subangular blocky; many ($\geq 10 \text{ dm}^3$) very coarse (diameter $\geq 10 \text{ mm}$) root, coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; extremely acid (pH = 4.4); gradual and smooth boundary
Bt1	26-48	Dark reddish brown (2.5YR 3/4) moist and red (2.5YR 4/6) dry; sandy loam; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter $\geq 10 \text{ mm}$), and coarse (diameter $\geq 10 \text{ mm}$), many ($\geq 10 \text{ dm}^3$) medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; moderately acid (pH = 5.6); gradual and smooth boundary
Bt2	48-70	:Dark reddish brown (2.5YR 3/4) moist and red (2.5YR 4/6) dry; clay; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter $\geq 10 \text{ mm}$), coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; extremely acid (pH = 4.3); gradual and smooth boundary
Bt3	70-91	Dark reddish brown (2.5YR 3/4) moist and red (2.5YR 4/6) dry; clay; very fine subangular blocky; common (1 -5 root/dm ³) very coarse (diameter $\geq 10 \text{ mm}$), coarse (diameter $\geq 10 \text{ mm}$), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter $< 1 \text{ mm}$) roots; extremely acid (pH = 4.3); gradual and smooth boundary

Bt4 91-131 Dark red (2.5YR 3.5/6) moist and red (2.5YR 4.5/8) dry; clay; very fine subangular blocky; few (< 1 root/dm³) very coarse (diameter ≥ 10 mm), coarse (diameter ≥ 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.6); gradual and smooth boundary

Bt5 131-200⁺ Dark red (2.5YR 3.4/6) moist and red (2.5Yr 5.5/8) dry ; clay; very fine sub angular blocky; few (< 1 root/dm³) very coarse (diameter ≥ 10 mm), coarse (diameter ≥ 10 mm), medium (diameter 2 -5 mm), fine (diameter 1 -2 mm) and very fine (diameter < 1 mm) roots; very strongly acid (pH = 4.6); gradual and smooth boundary



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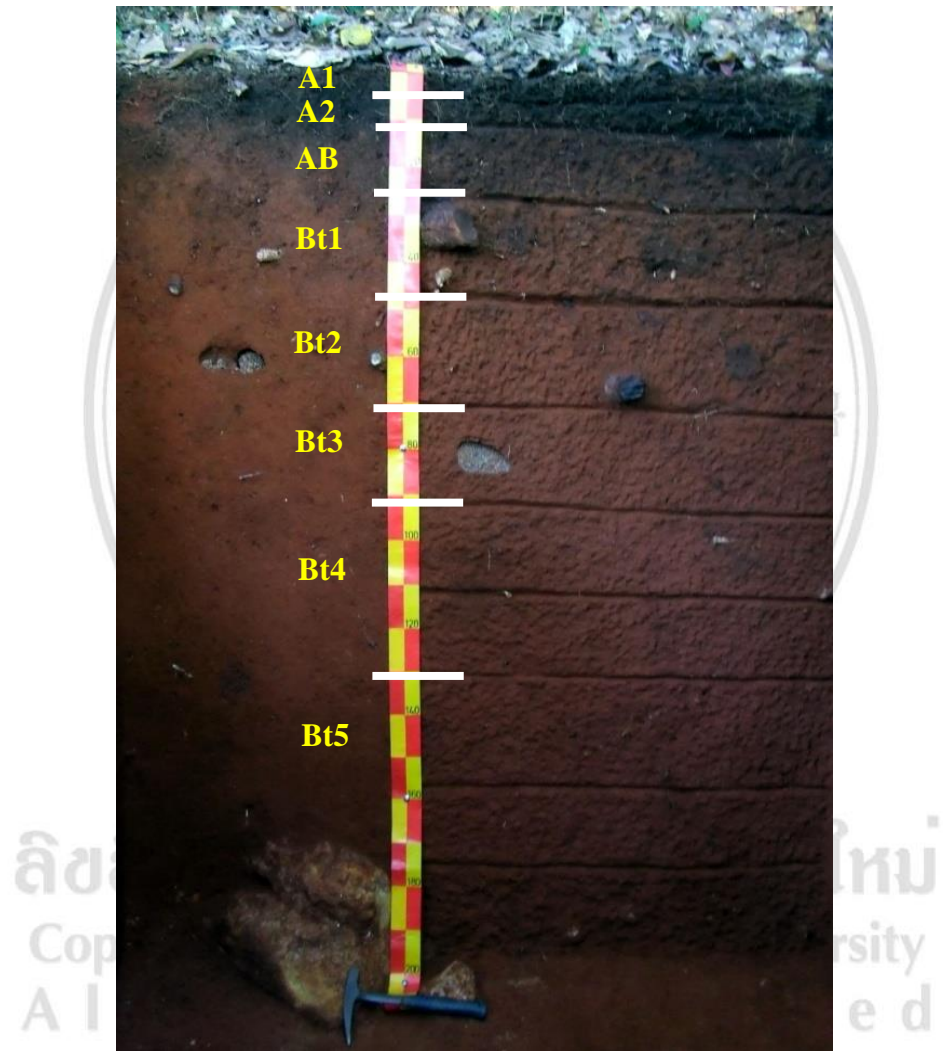


Figure 4. Natural site

Soil horizon designations

Master horizons and layers

Master, or major, horizons in this study are designated by the following capital letters.

- A Mineral horizons at the soil surface: A horizons have humified organic matter mixed with mineral material and result from the decomposition of roots or from cultivation that has physically disturbed the horizon.
- B Mineral horizons formed below A horizons in which parent material has been significantly altered by concentrations of silicate clay, iron, aluminum, carbonates, gypsum, or humus or by removal of the more soluble components: There are many kinds of B horizons, but the main consideration in identifying a B horizon is that it formed as subsoil, below one or more horizons, and is significantly different from the material in which it was formed as a result of pedogenic processes.

Transitional and combination horizons

Where a substantial thickness is present between two master horizons, a transitional or combination horizon may be described. Transitional horizons, which are dominated by properties of one master horizon while having subordinate properties of an adjacent master horizon capital letters. The first letter indicates the dominant master horizon characteristics. In this study found transitional horizon as an AB horizon and a BA horizon. An AB horizon is transitional horizon between the A and B horizons that is more like the A horizon than the B horizon. While BA horizon is more like the B than the A horizon.

Subordinate distinctions within master horizons and layers

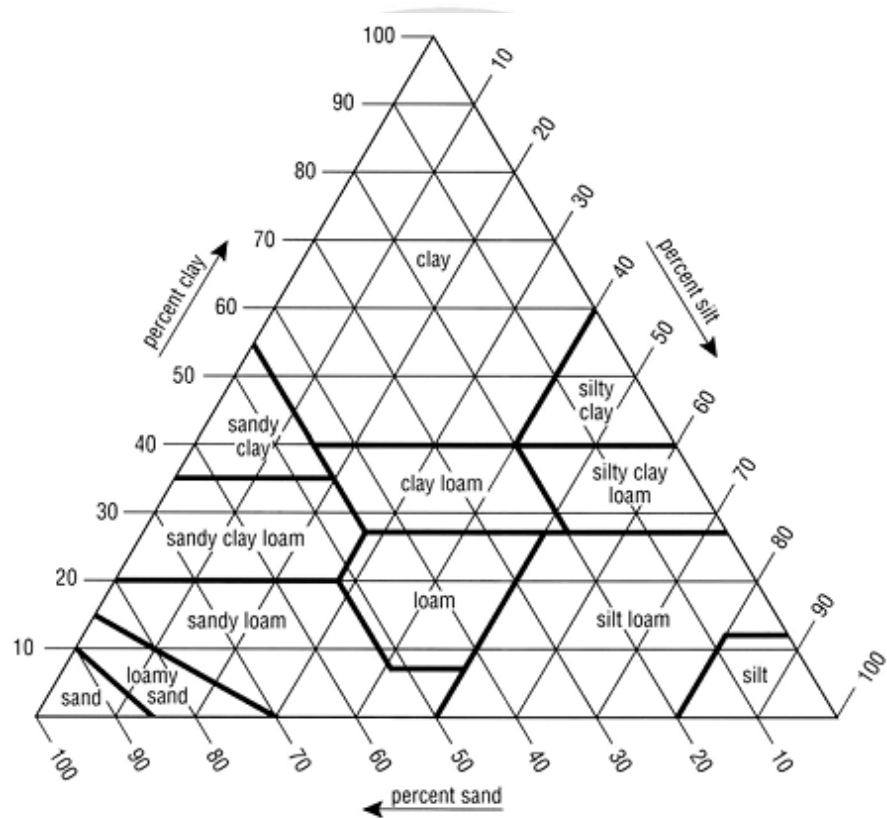
Lowercase letters are used to designate specific features within master horizons. In this study, B horizon followed by t indicates that this horizon is the horizon with accumulation of silicate clay coating on ped faces, in pores, or as bridges between sand-size mineral grains: The clay coats may be formed by either clay illuviation or migration within the horizon.



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APPENDIX C

Soil texture



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1. Groupings of soil texture classes

General terms	Texture classes
Sandy soil materials:	
Coarse-textured	Sands (coarse sand, sand, fine sand, very fine sand), Loamy sands (loamy coarse sand, loamy sand, loamy fine sand, loamy very fine sand)
Loamy soil materials:	
Moderately coarse-textured	Coarse sandy loam, sandy loam, fine sandy loam
Medium-textured	Very fine sandy loam, loam, silt loam, silt
Moderately fine-textured	Clay loam, sandy clay loam, silty clay loam
Clayey soils:	
Fine-textured	Sandy clay, silty clay, clay

2. Root quantity and size (Soil Survey Division Staff, 1993)

Quantity of roots	Numbers of each size per unit area
Few	< 1 per unit area
Very few	< 0.2 per unit area
Moderately	0.2 – 1 per unit area
Common	1 – 5 per unit area
Many	>5 per unit area

Size class	Diameter size (mm)
Very fine	< 1
Fine	1 – 2
Medium	2 – 5
Coarse	5 – 10
Very coarse	>10

3. Bulk density

Rating	Bulk density (Mg m ⁻³)
Low	<1.2
Moderately Low	1.2–1.4
Medium	1.4–1.6
Moderately High	1.6–1.8
High	1.8–2.0
Very High	>2.0

4. pH (Soil Survey Division Staff, 1993)

Rating	Range
Ultra acid	< 3.5
Extremely acid	3.5–4.4
Very strongly acid	4.5–5.0
Strongly acid	5.1–5.5
Moderately acid	5.6–6.0
Slightly acid	6.1–6.5
Neutral	6.6–7.3
Slightly alkaline	7.4–7.8
Moderately alkaline	7.9–8.4
Strongly alkaline	8.5–9.0
Very strongly alkaline	> 9.0

5. Organic matter (% organic carbon x 1.724)

Rating	Range (g.kg ⁻¹)
Very low	< 5
Low	5– 10
Moderately low	10 – 15
Medium	15 – 25
Moderately high	25 – 35
High	35 – 45
Very high	>45

6. Total nitrogen (Land use planning division, 1993)

Rating	Range (g.kg ⁻¹)
Very low	< 1.0
Low	1.0 – 2.0
Medium	2.0 -5.0
High	5.0 – 7.5
Very high	> 7.5

7. Available P (Bray II)

Rating	Range (g.kg ⁻¹)
Very low	< 3
Low	3 - 6
Moderately low	6 – 10
Medium	10 -15
Moderately high	15 - 25
High	25 – 45
Very high	>45

8. Available K (NH₄OAc)

Rating	Range (mg.kg ⁻¹)
Very low	<30
Low	30 – 60
Medium	60 – 90
High	90 – 120
Very high	>120

9. Extractable bases (NH₄OAc)

Rating	Range (cmol kg ⁻¹)				
	extr. Ca	extr.Mg	extr.K	extr.Na	extr. bases
Very low	<2.0	<0.3	<0.2	<0.1	<2.6
Low	2 - 5	0.3 – 1.0	0.2 – 0.3	0.1 – 0.3	2.6 – 6.6
Medium	5 – 10	1.0 – 3.0	0.3 – 0.6	0.3 – 0.7	6.6 – 14.3
High	10 -20	3.0 – 8.0	0.6 – 1.2	0.7 – 2.0	14.3 – 31.2
Very high	>20	>8.0	>1.2	>2.0	>31.2

10. CEC

Rating	Range (cmol kg ⁻¹)
Very low	<3
Low	3 -5
Moderately low	5 -10
Medium	10 – 15
Moderately high	15 – 20
High	20 – 30
Very high	>30

11. Base saturation

Rating	Range (%)
Low	<35
Medium	35 – 75
High	>75

12. Soil fertility estimation

Soil fertility level	Organic matter (g kg ⁻¹)	Available P (mg kg ⁻¹)	Available K (mg kg ⁻¹)	CEC (cmol kg ⁻¹)	Base saturation (%)
Low	<15 (1)	<10 (1)	<60 (1)	<10 (1)	<35 (1)
Medium	15 – 35 (2)	10 – 25 (2)	60 – 90 (2)	10 -20 (2)	35 – 75 (2)
high	>35 (3)	>25 (3)	>90 (3)	>20 (3)	>75 (3)

Note: If sum of score ≤ 7 indicates low fertility soil

8 – 12 indicates medium fertility soil

≥ 13 indicates high fertility soil

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