CHAPTER 4

Results

4.1 Medicinal plants used by the Karen in Chiang Mai province

4.1.1 Number of medicinal plant species

In total, 379 species in 271 genera and 117 families used by the Karen in 14 villages for medicinal and general health care purposes were gathered from previous studies and field trip. (Appendix A). However, medicinal plants data which were collected from field trip were shown in Table 10.

The village with the highest number of medicinal plant species recorded (Mai Sa Wan) had 134 species and the one with the lowest number (Yang Tung Pong) had 28 species (Figure 19). Of all used plants, the most widely used plant families were Euphorbiaceae (24%), Zingiberaceae (20%), Papilionaceae (17%), Asteraceae (14%), Lamiaceae (16%), Poaceae (15%), Lauraceae (11%) and Acanthaceae (11%) (Figure 20).

4.1.2 Use records and ailments

A total 8,762 use records were registered in the 14 Karen villages. These belonged to 22 use categories and were used for 122 different ailments according to Cook (1995) (Table 11). The most frequently reported use category was Digestive System Disorders which accounted for slightly more than 21% of all use records, whereas Muscular-Skeletal System Disorders (13%), Infections/Infestations (13%) and Injuries (13%) also were common. Through these use categories, seven ailments that were most commonly mentioned were muscular pain, ureteral stones, cough, fever, wound, diarrhea and flatulence.

Table 10 Medicinal plants used by the Karen in Huay Hea (HH) and Mai Lan Kam (MC) village

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Acanthaceae							
Andrographis paniculata (Burm.f.)	W	HH	-	fever	Lf	De	potion
Nees*		MC	-	fever	Lf	De	potion
Strobilanthes cusia (Nees) Kuntze*	W	HH	Ser ya	fever	Lf	Po	poultice
		MC	Ser ya	fever, typhoid	Lf	Po	poultice
Thunbergia coccinea Wall.*	W	HH	Jaw law lee der	diabetes	Arp	De	potion
Thunbergia laurifolia Lindl.*	W	HH	Jaw law lee der	intoxication, snake bite	St	De	potion
		MC	Jaw law lee der	intoxication	AP	De	potion
Actinidiaceae							
Saurauia napaulensis DC.*	W	HH	Hor tee sa	rash, itching	Lf	Bu	poultice
Anacardiaceae							
Spondias pinnata (L. f.) Kurz*	W	MC	Ma na sa	cough	Fr	No	hold in mouth
		MT		cough	Fr	No	hold in mouth
Annonaceae							
Miliusa thorelii Finet & Gagnep.*	W	HH	Ti si pa do	muscular pain, fever, tonic	Bk, Lf	De	potion
		MC	Ti si pa do	muscular pain, tonic	Bk, Lf	De	potion
Araceae							
Acorus calamus L.*	W	HH	Cha pa mae jae	cold, fever	Al	De	face wash
		MC	Cha pa mae jae	cold	Rt	Ml, So	potion

* plants evaluated in SDM

Table 10 (continued)

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Pothos scandens L.*	W	HH	Jaw sue	muscular pain, tonic, fever	Al	De	potion
		MC	Jaw sue	muscular pain, tonic	Al	De	potion
Arecaceae							
Areca catechu L.	C	MC	Sae	cough	Fr	No	EaF
		MW	Sae	cough	Fr	No	EaF
Asclepiadaceae							
Dischidia nummularia R.Br.*	W	HH	Bi na day	toothache, muscular pain	Lf	No, De	EaF, potion
		MC	Bi na day	toothache, urethral stones	Lf	No, De	EaF, potion
Asphodelaceae							
Aloe vera (L.) Burm.f.	C	HH	-	burn	Lf	No	liniment
Asteraceae							
Ageratum conyzoides L.*	W	MC	Nor ner chu	wound	Lf	Ml	poultice
Chromolaena odorata (L.) R.M. King & H.Rob.*	W	HH	Tee po kaey	wound, haemostatic	Lf	Po	poultice
		MC	Tee po kaey	wound, haemostatic	Lf	Po	poultice
Coix lacryma-jobi L.*	W	HH	Ber na tee	urethral stones	Rt,	De	potion
		MC	Ber na tee	urethral stones	Lf Rt	De	potion
Elephantopus scaber L.*	W	MC	Nor mue klae	muscular pain, tonic	Al	De	potion
Inula cappa (Ham.) DC.*	W	HH	Paw pa ka la	postpartum recovery	Lf	Bu	Sit
		MC	Paw pa ka la	postpartum recovery, muscular pain	Lf	De	bath, potion

Table 10 (continued)

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Betulaceae							
Betula alnoides Buch.-Ham. ex D.Don*	W	HH	Se kaw way	muscular pain, tonic	Bk	De	potion
		MC	Se kaw way	muscular pain, tonic	Bk	FeAl	potion
Bignoniaceae							
Oroxylum indicum (L.) Kurz	C	HH	Dok ka	hepatomegaly, hypertension	Bk	De	potion
		MC	Dok ka	splenomegaly	Bk	De	potion
Boraginaceae							
Heliotropium indicum L.*	W	MC	Nor so por mae	fever	Rt	De	potion
		MW	Nor ka chor gom	fever, typhoid	Rt	De	potion
Caesalpiniaceae							
Senna alata (L.) Roxb.*	W	HH	Ya la mer	laxative	Lf	De	potion
		MC	Ya la mer	laxative, ringworm	Lf, St	De, Po	potion, poultice
Caprifoliaceae							
Sambucus javanica Reinw. ex Blume*	W	HH	Ti si ka jue	joint pain, bruises, bone fracture	Lf	Bu	poultice
		MC	Ti si ka jue	bone fracture, muscular pain	Lf	Bu	poultice
Viburnum sambucinum Blume var. *tomentosum* Hallier f.*	W	MC	Por bue kli	fever	Rt	De	potion
Celastraceae							
Celastrus paniculatus Willd.*	W	MC	Ti si bler	diarrhea	Bk	De	potion
		MW	Ter si bler	muscular pain, tonic	Arp	De	potion

Table 10 (continued)

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Costaceae							
Costus speciosus (J.König) Sm.*	W	HH	Su ley bo	otorrhea, wound	St	Bu	ear drop
		MC	Su ley bo	otorrhea, wound	St	Bu	ear drop
Dipterocarpaceae							
Dipterocarpus obtusifolius Teijsm. ex Miq.*	W	MC	Cor la ter	fever, cold	Exd	No	potion
Equisetaceae							
Equisetum debile Roxb. ex Vuncher*	W	HH	Hrue sor por dua	urethral stones, dysuria	St	De	potion
		MC	Hrue sor por dua	urethral stones, muscular pain	St	De	potion
Euphorbiaceae							
Croton kongensis Gagnep.*	W	MC	Sa ko wa po	amenorrhea	Lf	De	stem bath
Croton roxburghii N. P. Balakr.*	W	HH	Sa ko wa pa do	postpartum recovery,	Lf, Bk	De	bath
		MC	Sa ko wa pa do	amenorrhea postpartum recovery, amenorrhea	Lf	De	bath
Flacourtiaceae							
Flacourtia jangomas (Lour.) Raeusch.*	W	MC	Ser pae	toothache	Bk	De	Hol
Iridaceae							
Eleutherine americana (Aubl.) Merr.*	W	HH	Por bee bae	wound	Blb	Po	poultice
		MC	Por bee bae	wound	Blb, Lf	Po	poultice

Table 10 (continued)

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Juglandaceae							
Engelhardtia spicata Blume	W	MC	Klue por	skin disease	Bk	De	bath
var. *colebrookeana* (Lindl. ex Wall.)		HH	Klue por	gastric ulcer, muscular pain	Bk	De	potion
Kuntze*							
Lamiaceae							
Clerodendrum serratum (L.) Moon*	W	HH	Kwee do jaw	amenorrhea	Lf	De	steam bath
		MC	Kwee do jaw	amenorrhea, muscular pain	Lf	De	potion
Gmelina arborea Roxb.*	W	HH	Ker ma	athlete's foot, muscular pain	Bk,	De	soak, EaF
		MC	Ker ma	athlete's foot, muscular pain	Fl Bk	De	soak, EaF
Microtoena insuavis (Hance)	W	MC	Por nor	fever	Lf	So	face wash
Prain ex Briq.*							
Lauraceae							
Litsea cubeba (Lour.) Pers.*	W	MC	Ser ler sa	malaria	Fr	No	EaF
		KP	Ser lu sa	dengue fever	Rt	De	potion
Malvaceae							
Sida acuta Burm.f.*	W	MC	Nor ta mea	abscess	Lf	Po	poultice
Melastomataceae							
Melastoma malabathricum L.*	W	HH	Se la play	mouth ulcer, geographic tongue	Fr	No	chew
		MC	Se la play	mouth ulcer, geographic tongue	Fr	No	chew
Menispermaceae							
Cyclea barbata Miers*	W	MC	Ti si po	fever	Rt	De	potion

Table 10 (continued)

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Tinospora crispa (L.) Hook. f. & Thomson*	W	MC	Lor lu mue	fever, tonic, muscular pain	Arp	De	potion
Mimosaceae							
Mimosa pudica L.*	W	MC	Nor we mae	muscular pain	Rt	De	potion
Myrtaceae							
Psidium guajava L.	C	MC	Ma kwuy	diarrhea	Sh, Lf	De	potion
Ochnaceae							
Ochna integerrima (Lour.) Merr.*	W	MC	-	anthelmintic	Rt	De	potion
Papilionaceae							
Desmodium oblongum Benth.*	W	MC	Ti si bor	anthelmintic	St, Rt	De	potion
Phyllodium pulchellum (L.) Desv.*	W	HH	Nor so por mae	amenorrhea, urethral stones	Al	De	potion
		MC	Nor jaw bi	amenorrhea, muscular pain	Al	De	potion
Plantaginaceae							
Plantago major L.*	W	MC	Por ko	joint pain	Lf	Po	poultice
Polygonaceae							
Muehlenbeckia platyclados (F.Muell.) Meisn.*	W	HH	Por la bor	urethral stones	Lf	De	potion
Polypodiaceae							
Platycerium wallichii Hook.*	W	MC	Krue chor na por	fertility	Lf	No	EaF
		MT	-	edema, postpartum recovery	Al	De	bath

Table 10 (continued)

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Proteaceae							
Heliciopsis terminalis (Kurz) Sleumer*	W	HH	Se jaw ba	ophthalmitis, muscular pain	Bk	So, De	eye wash, potion
		MC	Se jaw ba	ophthalmitis, food poisoning	Bk	So, De	eye wash, potion
Rosaceae							
Rubus alceifolius Poir.	W	HH	Chu pee sa	cough	Sh	No	EaF
Rubiaceae							
Mussaenda sanderiana Ridl.*	W	HH	Por jor kaw pe	itching	Rt	De	bath
		MC	Por jor kaw pe	muscular pain, toothache	Rt	De	potion, Hol
Paederia foetida L.*	W	MC	Chuy nor mue	gastric ulcer	Rt	De	potion
Rutaceae							
Melicope pteleifolia (Champ. ex Benth.) T.G. Hartley*	W	HH	Ti si sae saw	cough, muscular pain	Rt	De	potion
		MC	Ti si sae saw	cough, postpartum recovery	Rt	De	potion
Sapotaceae							
Xantolis cambodiana (Pierre ex Dubard) P.Royen*	W	HH	Se nu tee	lactation stimulant, cold	Bk	De	potion
		MC	Se nu tee	cough, cold	Bk	De	potion
Saururaceae							
Houttuynia cordata Thunb.	C	HH	Ta ner chuy do	cold	Sh	No, De	EaF
		MC	Ta nae chi do	cough, cancer	Sh	No, De	EaF

Table 10 (continued)

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Schizaeaceae							
Lygodium flexuosum (L.) Sw.*	W	HH	Kik gu la	wound, haemostatic	Lf	Po	poultice
		MC		wound, haemostatic	Lf	Po	poultice
Simaroubaceae							
Eurycoma longifolia Jack*	W	HH	Hae pa ja	fever, muscular pain	Al	De	potion
		MC	Hae pa ja	fever, muscular pain	Al	De	potion
Smilacaceae							
Smilax griffithii A.DC.*	W	HH	Hor ka ar	muscular pain	Rt	De	potion
		MC	Hor ka ar	muscular pain	Rt	De	potion
Stemonaceae							
Stemona sp.	W	HH	Nor to hu sa	cancer	Rt	De	potion
Theaceae							
Schima wallichii (DC.) Korth.*	W	HH	Ter sue sa	cold, fever	Exd	No	potion
		MC	Se sue sa	cold, fever, asthma	Exd	No	potion
Usneaceae							
Usnea siamensis Vain.*	W	HH	Kho lee nu wae	dizziness, amenorrhea	Al	Dr, De	cigarette, steam bath
		MC	Khu lee nu wae	dizziness	Al	Dr	cigarette

Table 10 (continued)

Family name Scientific name	PT	VL	Karen name	Application	PU	PP	Route of administration
Vitaceae							
Cissus bicolor Domin*	W	HH	Ya mang bong	allergic contact dermatitis, itching	Lf	Po	poultice
		MC	Som por cha	allergic contact dermatitis, itching	Lf	Po	poultice
Zingiberaceae							
Zingiber ottensii Valeton	C	HH	Blae ko sue	flatulence, muscular pain	Rh	De	potion
		MC	Blae ko sue	flatulence, carminative	Rh	De, No	potion, Eaf

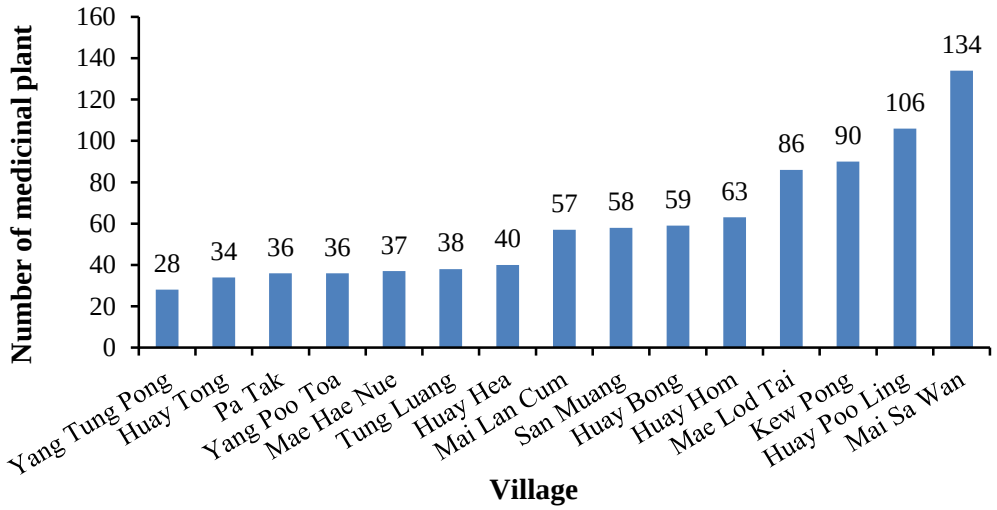

Figure 19 Number of medicinal plant species recorded in 14 Karen villages in Chiang Mai province.

4.1.3 Culture important medicinal plant

The Cultural importance index (CI) varied between 0.02 and 1.24 (Appendix A). Moreover, CI values for each species differ among the Karen villages. Medicinal plants that were used in several Karen villages tend to have high CI values. On the other hand, the medicinal plant species that have the lowest CI values were used in a single or few villages. Five species which have high CI values (greater than 1) in most villages were *Phyllanthus emblica*, *Blumea balsamifera*, *Chromolaena odorata*, *Croton roxburghii*, and *Curcuma longa*. Of those, *Chromolaena odorata* had the highest CI value in six villages (Huay Hea, Mai Lan Kam, Huay Tong, Huay Bong, Huay Hom, Mai Sa Wan), *Phyllanthus emblica* had the highest CI values in two villages (San Muang, Huay Pu Ling) whereas *Blumea balsamifera*, *Croton roxburghii* and *Curcuma longa* had the highest CI values in only one village (Tung Luang, Yang Tung Pong, Kew Pong, respectively).

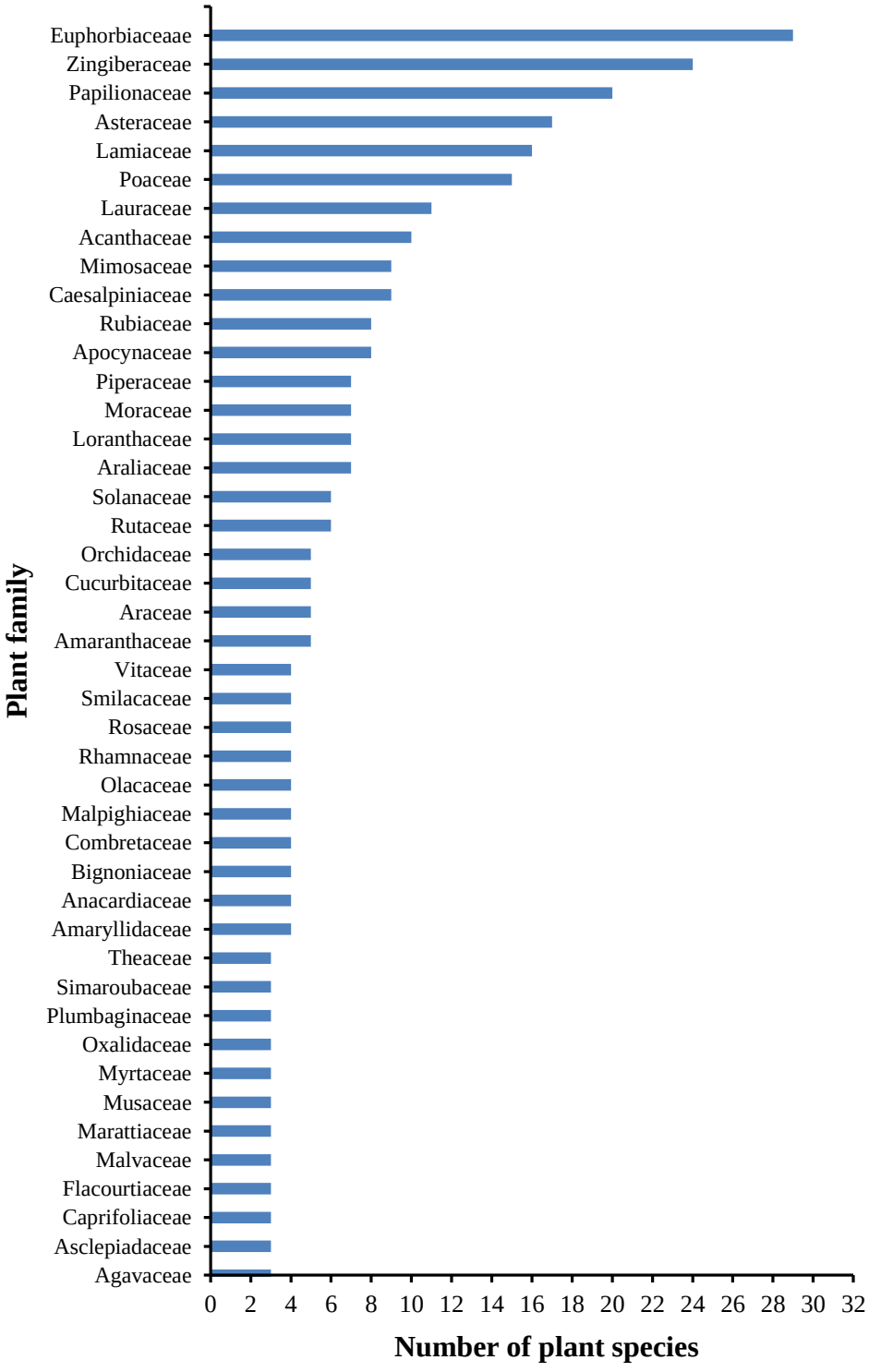

Figure 20 Number of all useful plant species in each family reported from fourteen villages studied

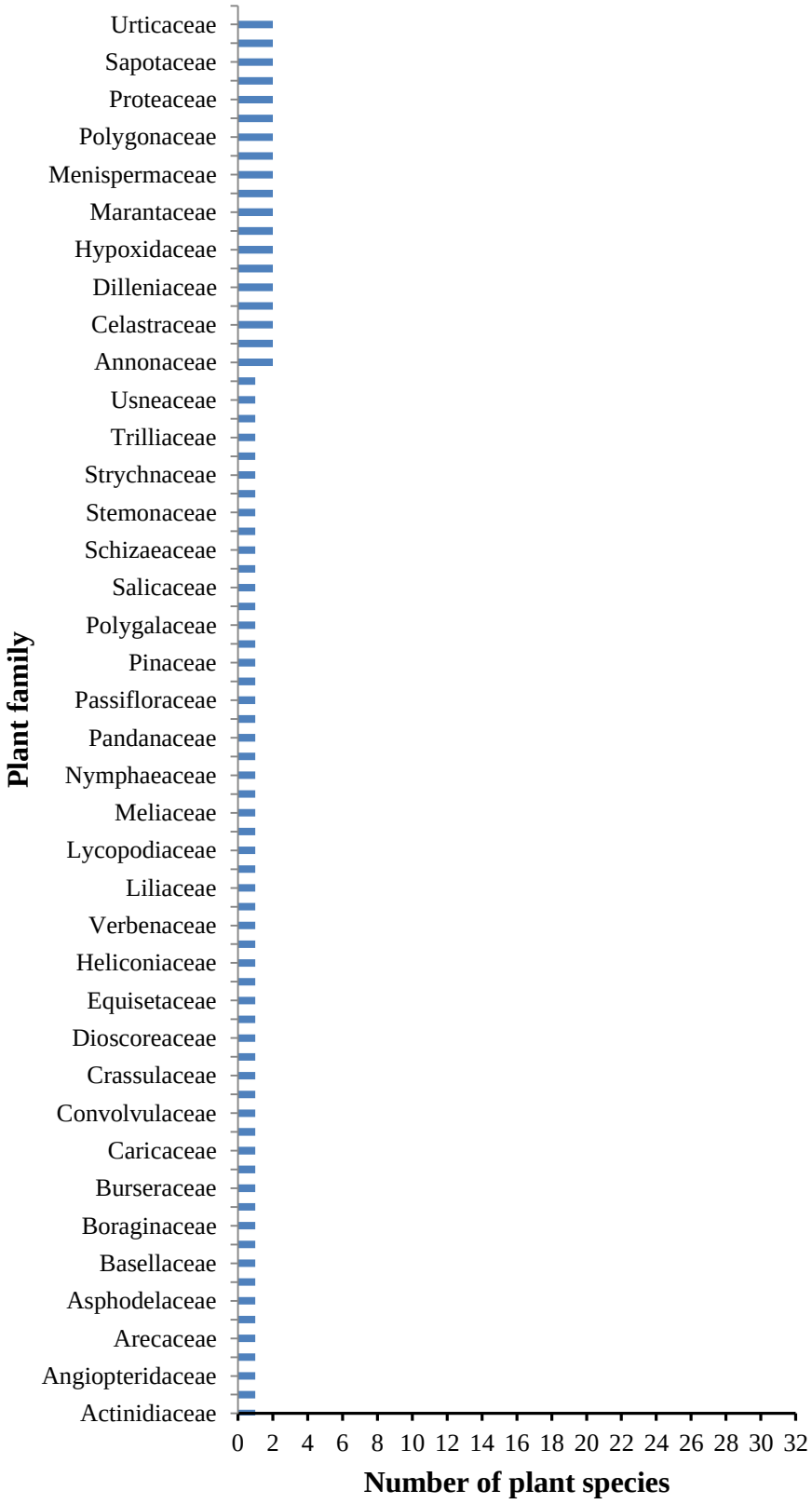

Figure 26 (continued)

Table 11 Number of use records and number of plant species in each use category and disorder treated

No.	Use category	Disorders treated	No. of use recorded	No. of species
1	Circulatory System Disorders	circulatory regulation	10	11
		edema	62	27
		heart disease	1	1
		hypertension	27	18
		shake	5	5
		Total	**105**	**62**
2	III-Defined Symptoms	dizziness	371	117
		faint	8	8
		giddy	4	4
		headache	44	38
		fatigue	12	11
		Total	**439**	**178**
3	Digestive System Disorders	carmianative	16	6
		colic	2	1
		constipation	5	5
		decayed tooth	3	3
		diarrhea	420	103
		flatulence	367	84
		gastric ulcers	411	143
		geographic tongue	7	6
		hemorrhoid	47	38
		hepatomegaly	1	1
		jaundice	187	63
		laxative	240	35
		mouth ulcer	24	10
		splenomegaly	4	1
		vomitting	1	1
		sore tongue	2	1
		toothache	144	45
		Total	**1881**	**546**
4	Endocrine System Disorders	diabetes	41	30
		Total	**41**	**30**

Table 11 (continued)

No.	Use category	Disorders treated	No. of use recorded	No. of species
5	Genitourinary System Disorders	dysuria	35	15
		kidney disease	2	1
		urethral stones	533	106
		Total	**570**	**122**
6	Immune System Disorders	immunostimulant	2	2
		Total	**2**	**2**
7	Infections/Infestations	AIDS	2	2
		anthelmintic	71	18
		antimicrobial	1	1
		athlete's foot	32	8
		chickenpox	1	1
		cold	341	103
		dengue fever	6	4
		fever	400	177
		lice infestations	3	3
		malaria	34	17
		preventing for leech	1	1
		ringworm	86	24
		typhoid	60	27
		Total	**1040**	**386**
8	Inflammation	conjunctivitis	28	5
		festering wound	9	9
		inflammed	8	9
		ophthalmia	32	11
		otitis	45	11
		sore throat	85	53
		Total	**207**	**98**
9	Injuries	bruises and swallen	226	96
		burn	39	23
		haemostatic	253	35
		wound	480	120
		Total	**998**	**274**
10	Mental Disorders	relaxant	4	4
		Total	**4**	**4**

Table 11 (continued)

No.	Use category	Disorders treated	No. of use recorded	No. of species
11	Metabolic System Disorders	gout	5	3
		heartburn	31	19
		temperature regulation	33	26
		Total	**69**	**48**
12	Muscular-Skeletal System Disorders	bone fracture	32	20
		muscular relaxant	1	1
		sprain	292	44
		Total	**1114**	**65**
13	Neoplasms	cancer	21	12
		neoplasm	1	1
		Total	**22**	**13**
14	Nervous System Disorders	carsickness	1	1
		drunk	9	2
		epilepsy	4	4
		migraines	1	1
		insomnia	3	1
		paralysis	4	3
		Total	**22**	**12**
15	Nutritional Disorders	appetite stimulant	64	40
		beri beri	14	11
		haematonic	72	16
		longevity	1	1
		malnutrition	9	7
		tonic	192	70
		vitamin C deficiency	2	2
		Total	**354**	**147**
16	Pain	chest pain	20	13
		feet pain	7	6
		hand pain	3	3
		joint pain	87	50
		muscular pain	653	239
		tenodynia	19	13
		Total	**789**	**324**

Table 11 (continued)

No.	Use category	Disorders treated	No. of use recorded	No. of species
17	Poisonings	allergic reactions	8	7
		centipede bite	1	1
		food poisoning	96	51
		insect bites	58	22
		insect sting	2	2
		intoxication	66	24
		intoxication due to drugs	3	3
		snake bite	27	12
		Total	**261**	**122**
18	Pregnancy/Birth/ Puerperium Disorders	amenorrhea	276	120
		dysmenorrhea	3	2
		inducing labour	4	2
		lactation stimulant	19	6
		postpartum recovery	278	90
		Total	**580**	**220**
19	Respiratory System Disorders	asthma	13	7
		choking	7	6
		cough	505	154
		hiccough	6	3
		pneumonia	2	2
		nosebleed	1	1
		remove phlegm	1	1
		sinus	19	3
		stuffed nose	5	4
		Total	**559**	**181**
20	Sensory System Disorders	bleary eyes	2	2
		otorrhea	36	7
		remove insect in ear	3	3
		tinnitus	76	16
		Total	**117**	**28**
21	Skin/Subcutaneous Cellular Tissue Disorders	abscess	29	15
		acne	1	1
		allergic contact dermatitis	37	2

Table 11 (continued)

No.	Use category	Disorders treated	No. of use recorded	No. of species
21	Skin/Subcutaneous Cellular Tissue Disorders	chapped skin	10	6
		corns	1	1
		dandruff	16	6
		inducing shiny hair	1	1
		itching	212	81
		rash	41	26
		scar	1	1
		skin disorder	1	1
		Total	**350**	**141**
22	Other	panacea	14	5
		recovery	17	13
		Total	**31**	**18**

4.2 Model performance

A model with AUC values approaching 1.0 is usually considered a good model, while AUC values are lower than 0.5 are considered poor predictive power (Wang et al., 2009). In this study, the predictive accuracy as measured by AUC values for all species distribution models revealed good performance (Appendix B). AUC values for the training data varied from 0.998 to 0.713 (mean 0.935) whereas the test data varied from 0.999 to 0.547 (mean 0.896). The best predictive models were found for *Polygala crotalarioides, Usnea siamensis* and *Xantolis cambodiana* (AUC training = 0.998) while *Belamcanda chinensis* showed the lowest predictive accuracy (AUC testing = 0.547).

4.3 Current predicted distributions

The suitable areas of most medicinal plant species were in the west and central to the north of Chiang Mai province and the northern Thailand (Figure 21). Moreover, it was also indicated that 223 plant species (91%) had suitable ranges more than 50% of total area in Chiang Mai province (Appendix C). The largest extent of suitable ranges were predicted for *Alstonia scholaris*, *Dendrocnide stimulans*, *Dendrophthoe pentandra*, *Desmodium oblongum*, *Kaempferia rotunda*, *Markhamia stipulata*, *Phyllodium vestitum*, *Scoparia dulcis*, *Terminalia bellirica* and *Ziziphus oenoplia* which covers all of the study area whereas *Berchemia floribunda*, *Lycopodium cernuum* and *Viscum articulatum* had the suitable ranges less than 10% of total area.

Regard to 13 variables which were used in this study, the relationships to the climatic and non-climatic factors varied from species to species. Soil type was the most important contributor for 65 species follow by temperature diurnal range (bio2) (54 species), temperature seasonality (bio4) (27 species), slope (24 species), precipitation of the hottest quarter (bio18) (20 species), precipitation of the driest period (bio14) (17 species), annual precipitation (bio12) (12 species), isothermality (bio3) (8 species), mean minimum temperature of the coldest period (bio6) (7 species), Human influence index (HII) (5 species), precipitation of the driest quarter (bio17) (3 species), mean maximum temperature of the hottest period (bio5) (1 species) and annual mean temperature (bio1) (0 species) (Figure 22, Appendix B).

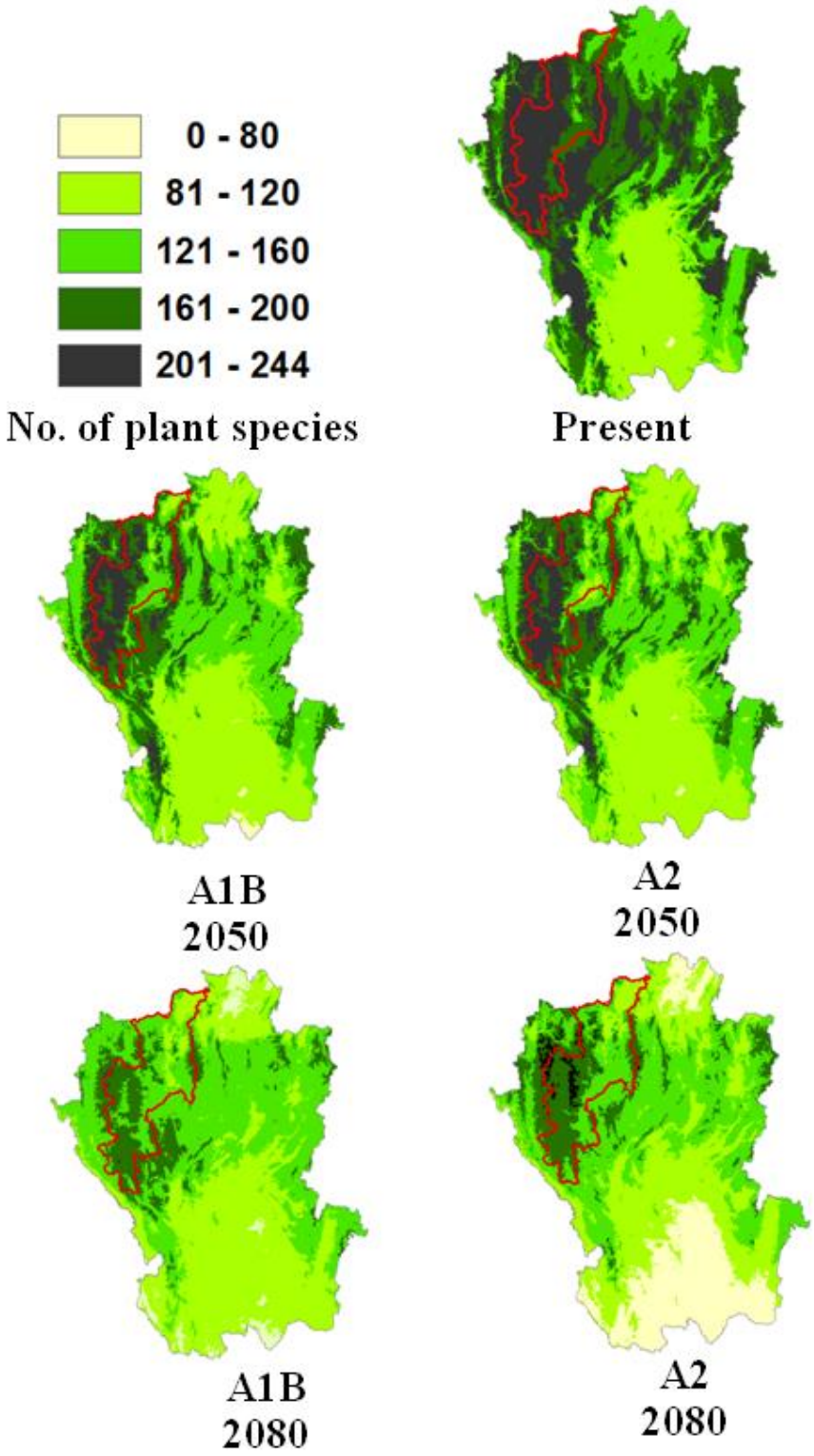

Figure 21 Spatial patterns in the suitable area for 244 medicinal plant species at present, in 2050 and 2080 in northern Thailand and Chiang Mai province (red-line area).

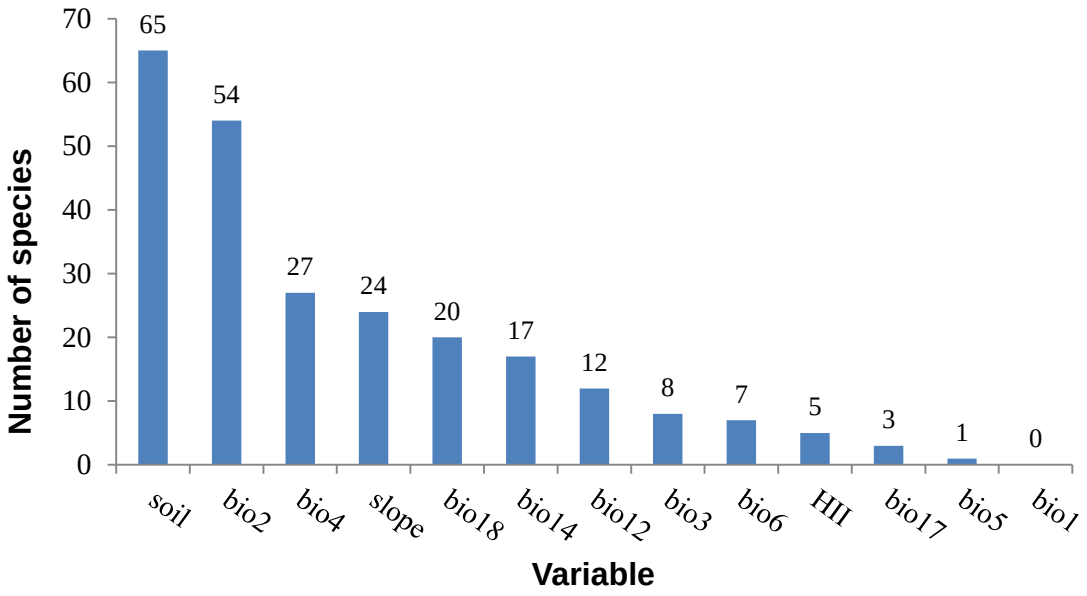

Figure 22 The most important variables of 244 plant species

4.4 Forecasted spatial patterns of changes

The potential impacts of forecasted climate scenarios reveal a profound change in the spatial patterns of medicinal plants in study area. In 2050, 60% and 61% of total plant species were predicted to loss their suitable range in Chiang Mai province under A1B and A2 respectively whereas 22% and 20% of total plant species were predicted to gain thire suitable range and 18% and 17% of total plant spcies were predicted to have no change in their suitable area under A1B under A2 scenario respectively (Figure 21, Figure 23, Figure 24, Appendix C).

However, the climate scenarios in 2080 showed an increase relative loss of 61% and 68% of suitable range in Chiang Mai province under A1B and A2 respectively whereas 20% and 18% of total plant species were predicted to gain thire suitable range and 16% and 13% of total plant spcies were predicted to have no change in their suitable area under A1B under A2 scenario respectively (Figure 21, Figure 23, Figure 24, Appendix C). However, there was no significant difference between the change in suitable range under A1B and A2 scenario by year 2050 (*t*-test: $p = 0.963$) and 2080 (*t*-test: $p = 0.378$).

The spatial patterns of species distribution before and after climate change are significantly different for most species due to the variation in species-specific responses. The percentage of species turnover was predicted increasing in average by year 2050 and 2080 respectively (Appendix C, Figure 25). However, the number species losses increase much faster than species gain. The highest turnover rate in 2050 was found in *Lycopodium cernuum*, as well as 2080 was found in *Lilium primulinum*, *Lycopodium cernuum* and *Vitex trifolia* which were 100% loss and no gain area in their suitable range in Chaing Mai province.

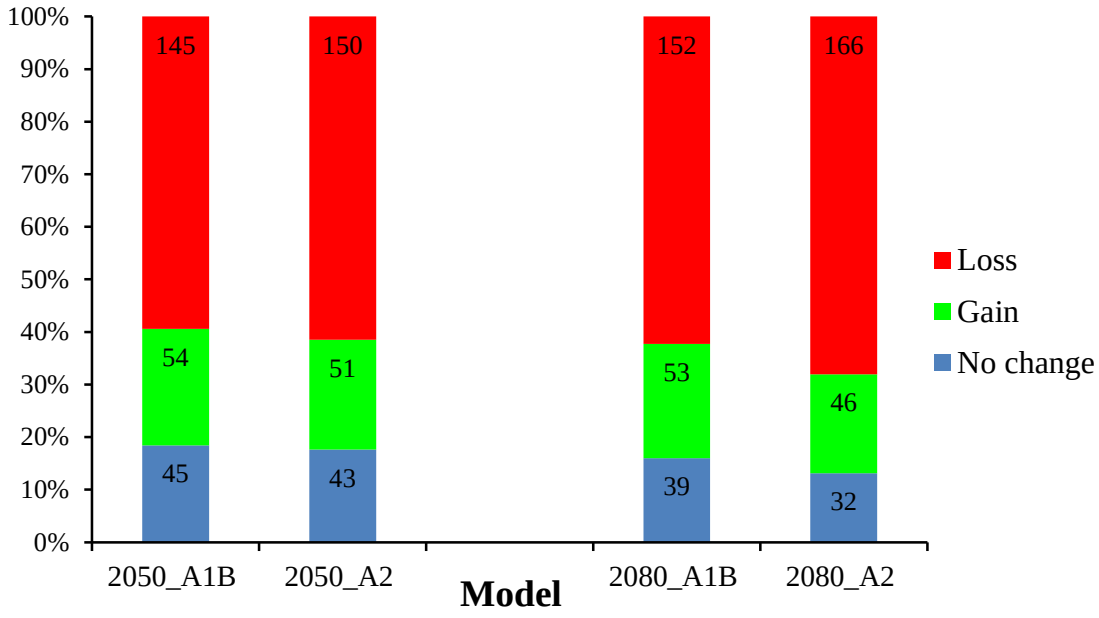

Figure 23 Proportion of predicted suitable area changes of medicinal plant species in Chiang Mai province under A1B and A2 scenario by 2050 and 2080. Number on bar indicated number of species based on the change categories.

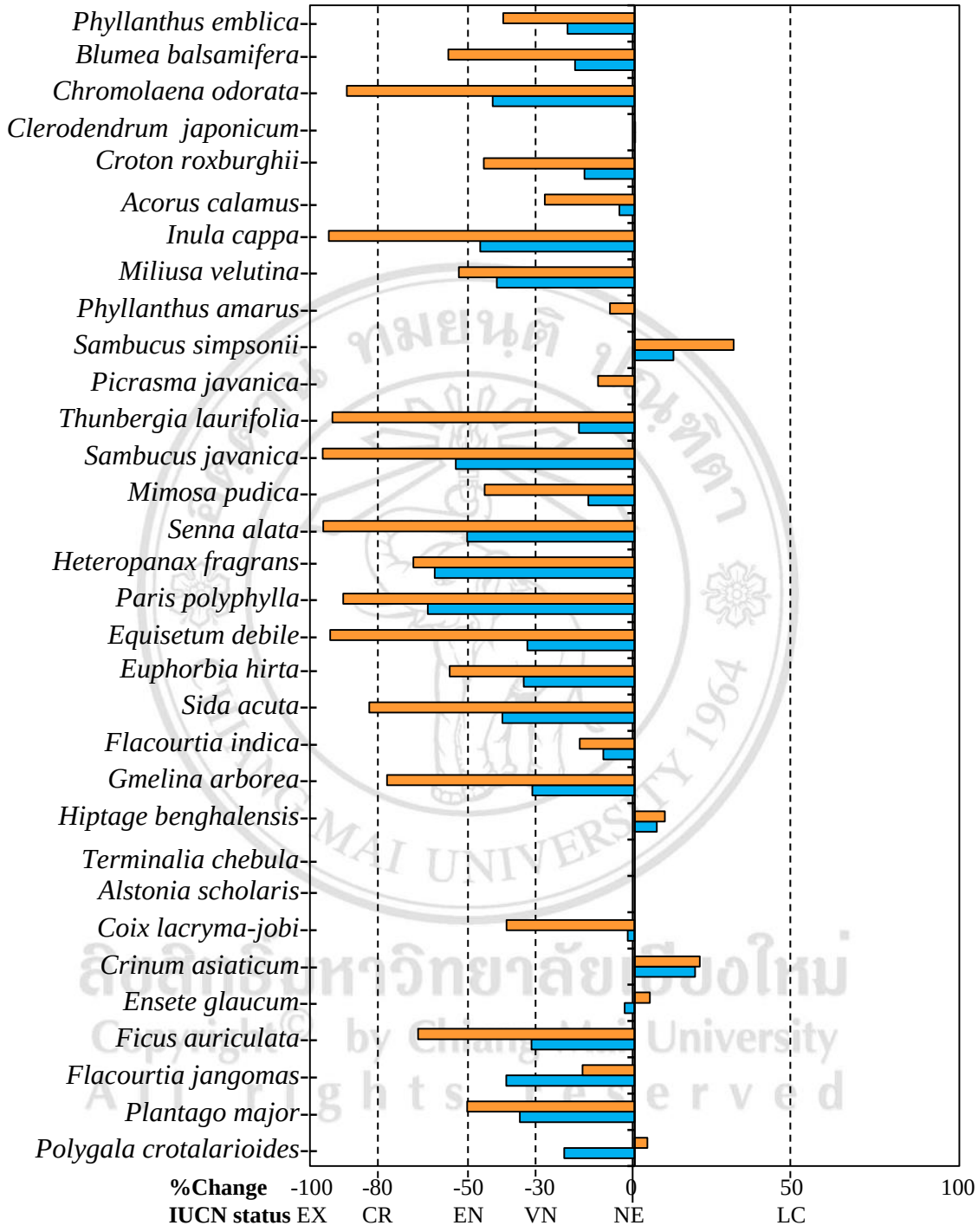

Figure 24 Average predicted changes in spatial patterns of plant species and their IUCN status in 2050 (blue bar) and 2080 (orange bar). The Bars rank with high to low CI value.

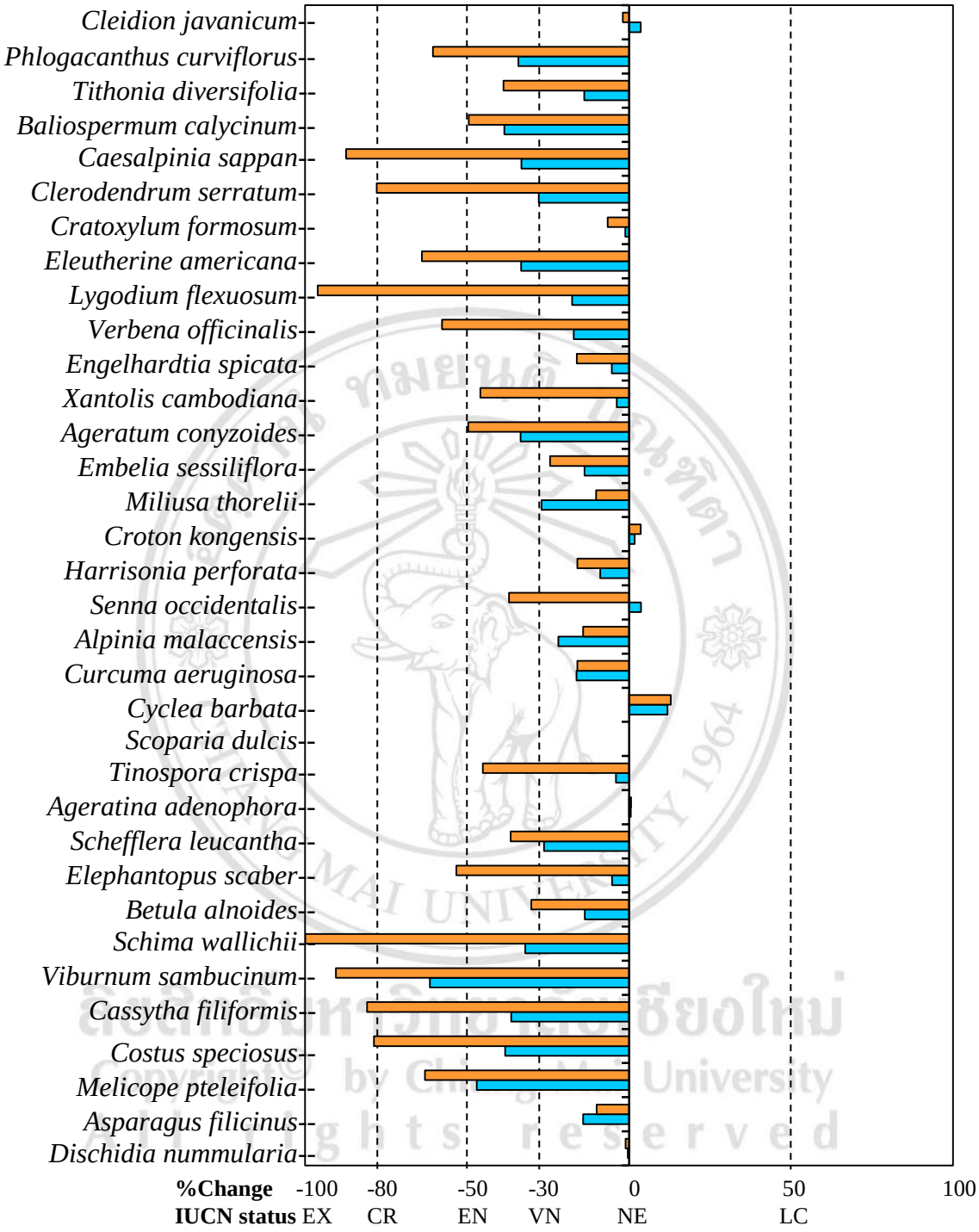

Figure 24 (continued)

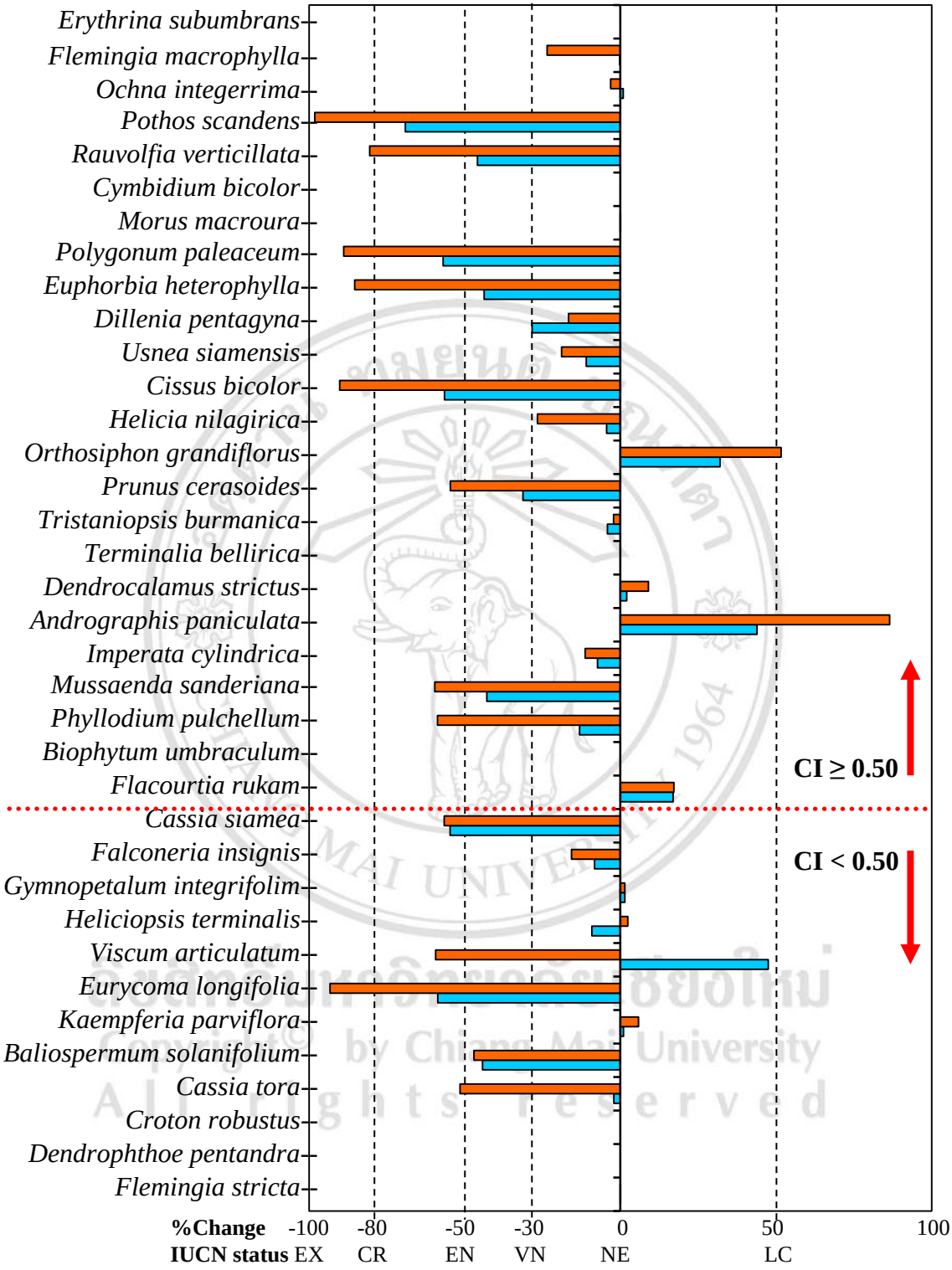

Figure 24 (continued)

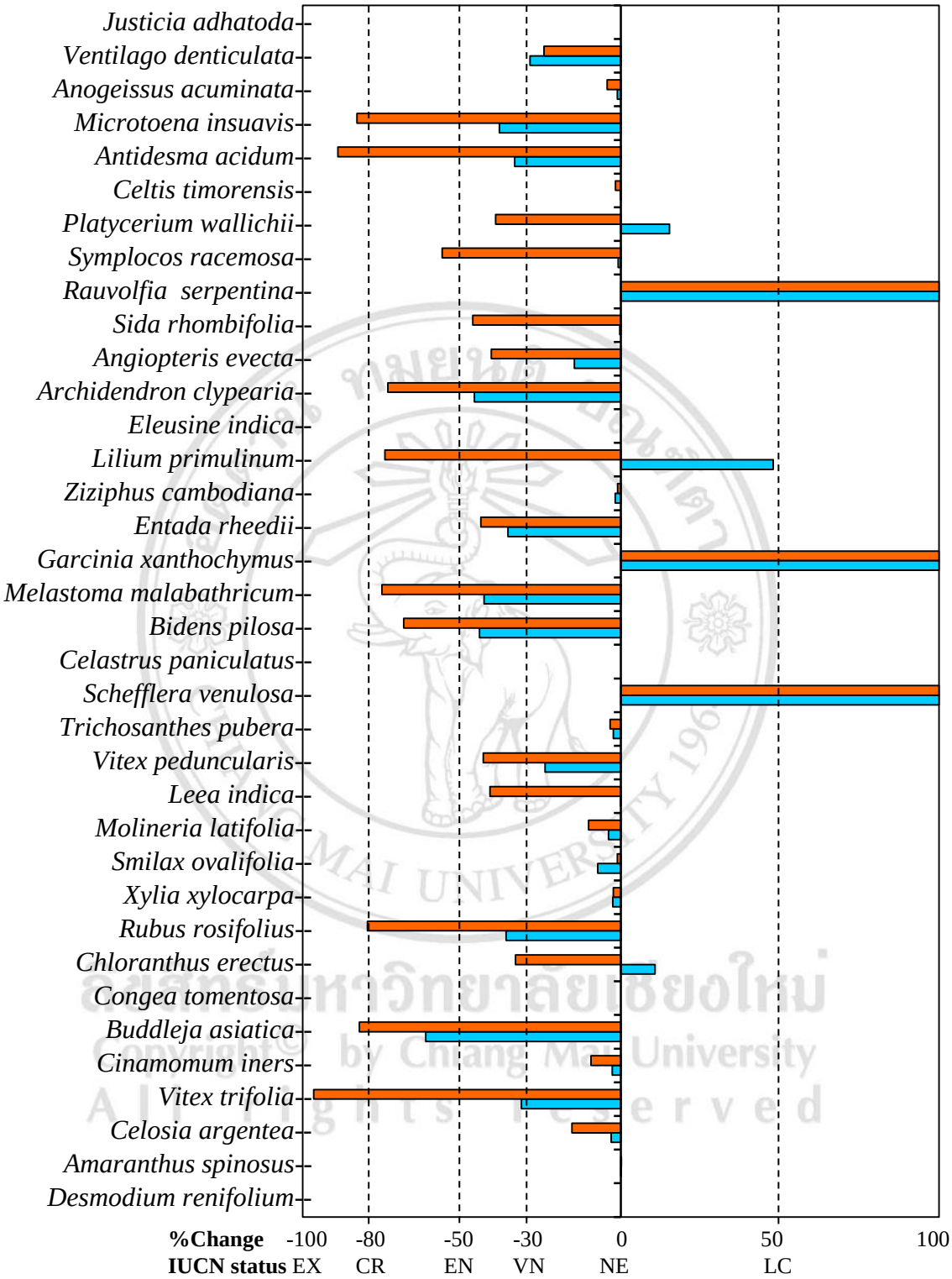

Figure 24 (continued)

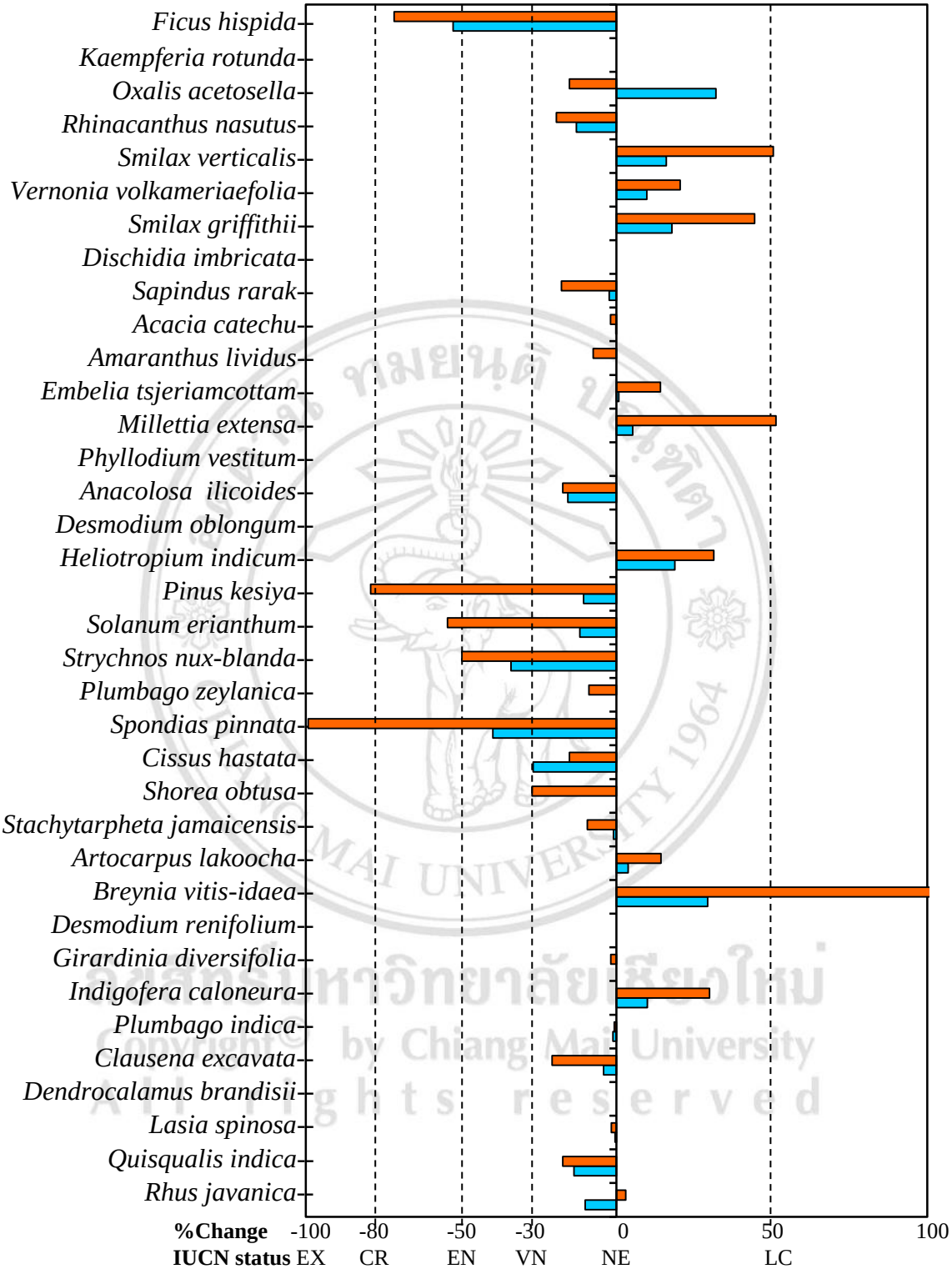

Figure 24 (continued)

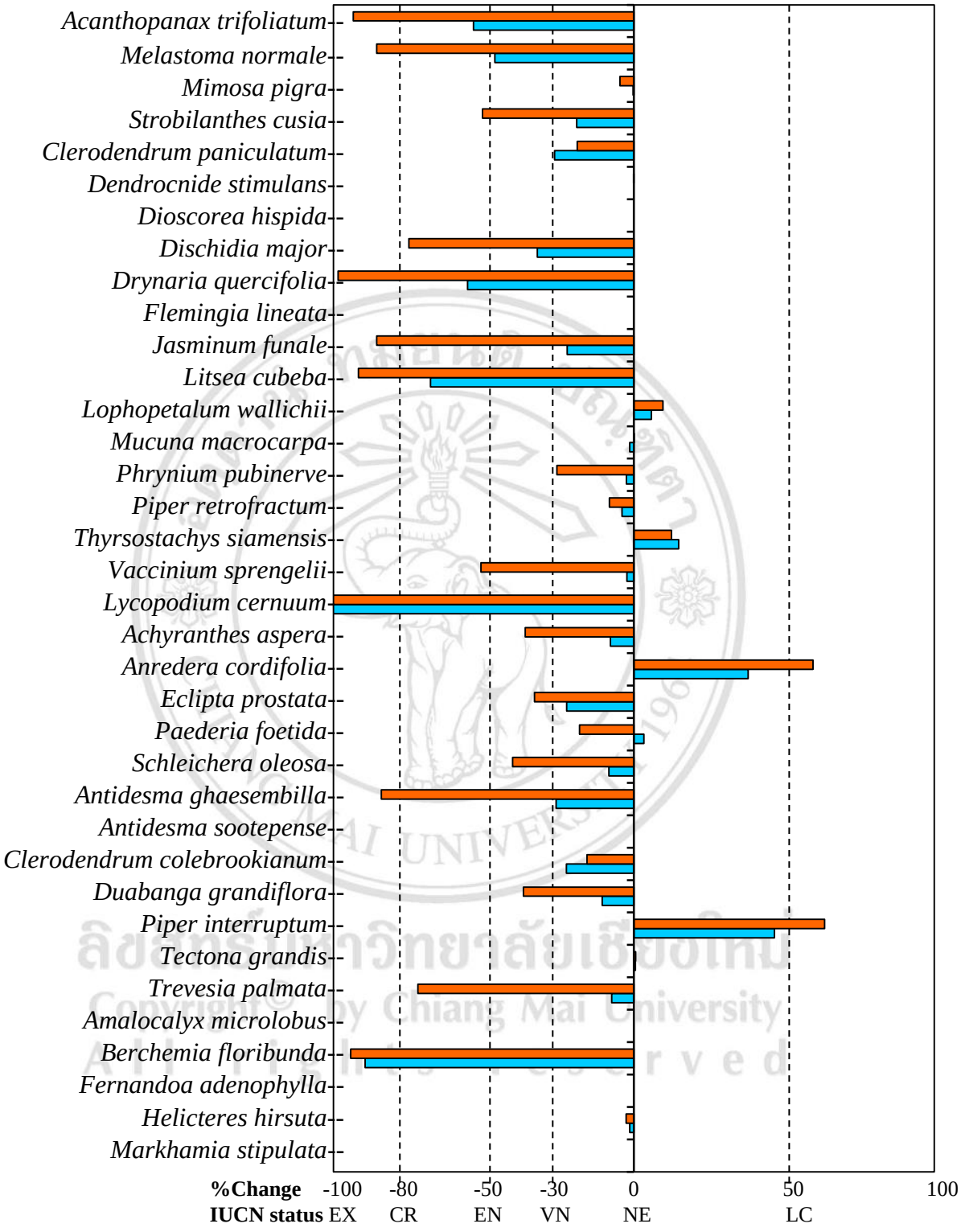

Figure 24 (continued)

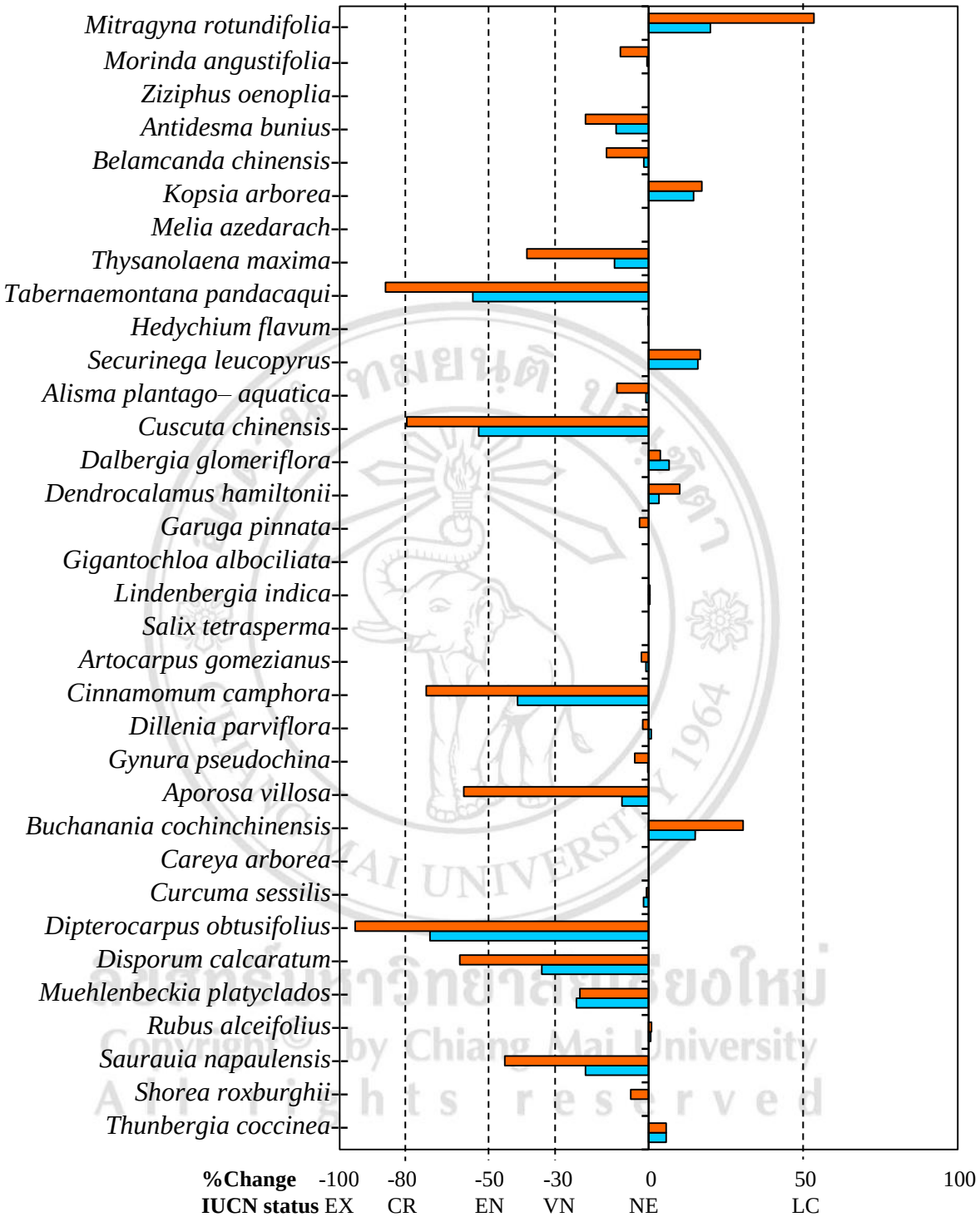

Figure 24 (continued)

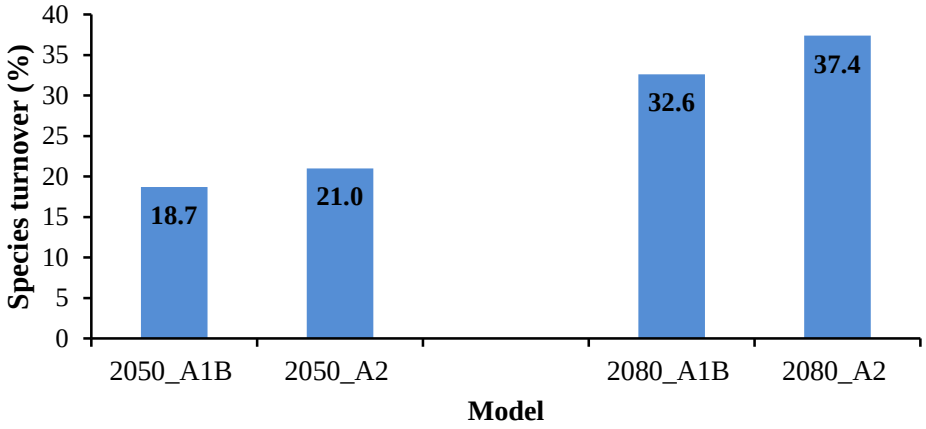

Figure 25 Percentage of average species turnover of medicinal plant species in Chiang Mai province under A1B and A2 scenario by 2050 and 2080.

4.5 Species extinction risk

Based on the IUCN Red List criteria 2001 (IUCN, 2004), in 2050, *Lycopodium cernuum* were predicted as extinction to climate change in Chiang Mai province under A1B and A2 scenario. In 2080, *Lycopodium cernuum* and *Schima wallichii* were predicted as extinct under A1B scenario whereas *Lilium primulinum*, *Lycopodium cernuum* and *Vitex trifolia* were predicted as extinction in Chiang Mai province under A2 scenario. Moreover, the projection of most of medicinal plant species revealed a 62 % (151 species) and 69% (168 species) loss of suitable ranges by year 2050 and 2080 respectively (Table 12, Figure 24, Figure 26).

Table 12 Number of medicinal plant species classified based on the IUCN Red List in Chiang Mai province under A1B and A2 scenario by 2050 and 2080.

IUCN status	Model			
	2050		2080	
	A1B	A2	A1B	A2
EX	1	1	2	3
CR	1	3	42	30
EN	20	19	34	30
VN	33	42	24	23
NE	90	85	50	80
LC	99	94	92	78

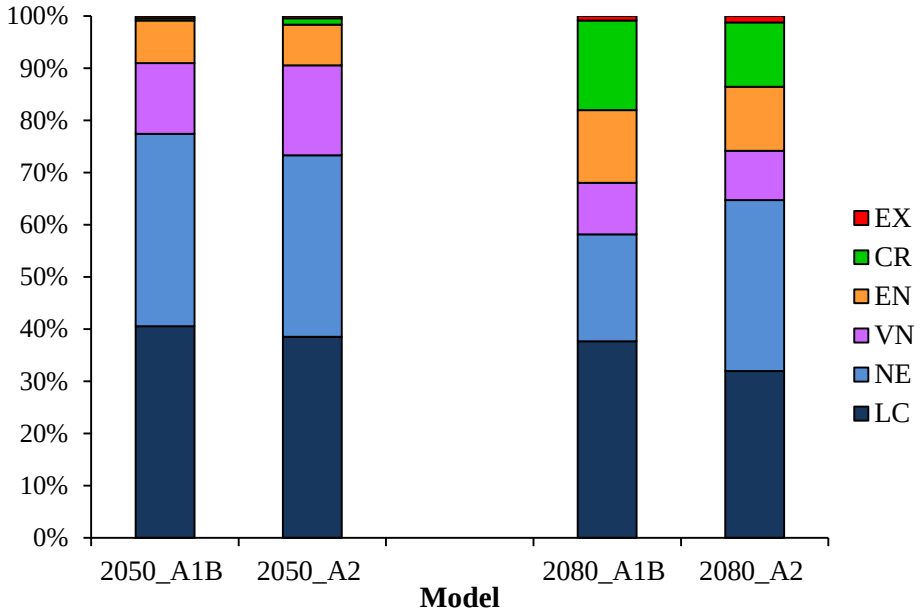

Figure 26 Proportion of medicinal plant species classified based on the IUCN Red List under A1B and A2 scenario by 2050 and 2080.