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Biodiversity and ecosystem services of communally reserved forests managed by indigenous people in a human-modified landscape in Borneo

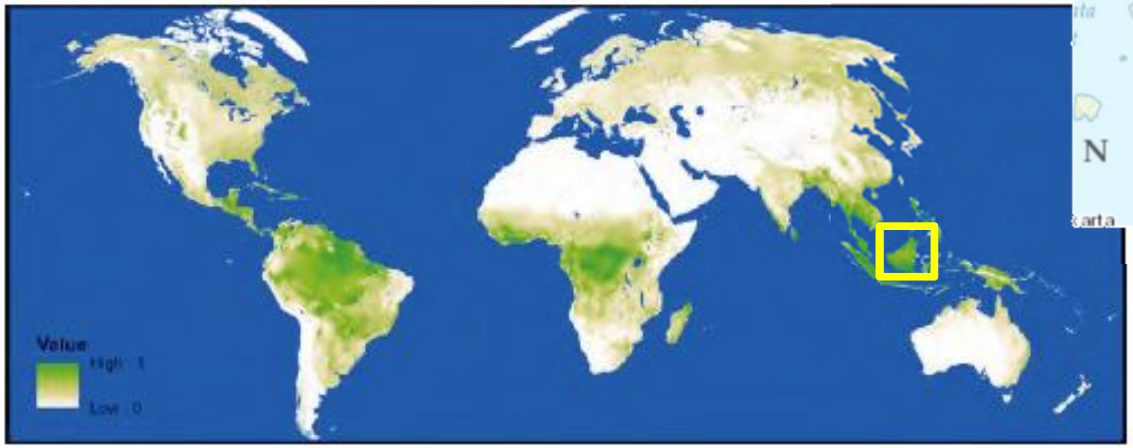
Yayoi Takeuchi (National Institute for Environmental Studies, Japan)

Tropical forests – “Hotspot” of ..

Biodiversity

Supplementary Figure 3. Integrated biodiversity layer, incorporating data on threat and plant diversity.

Ecosystem services

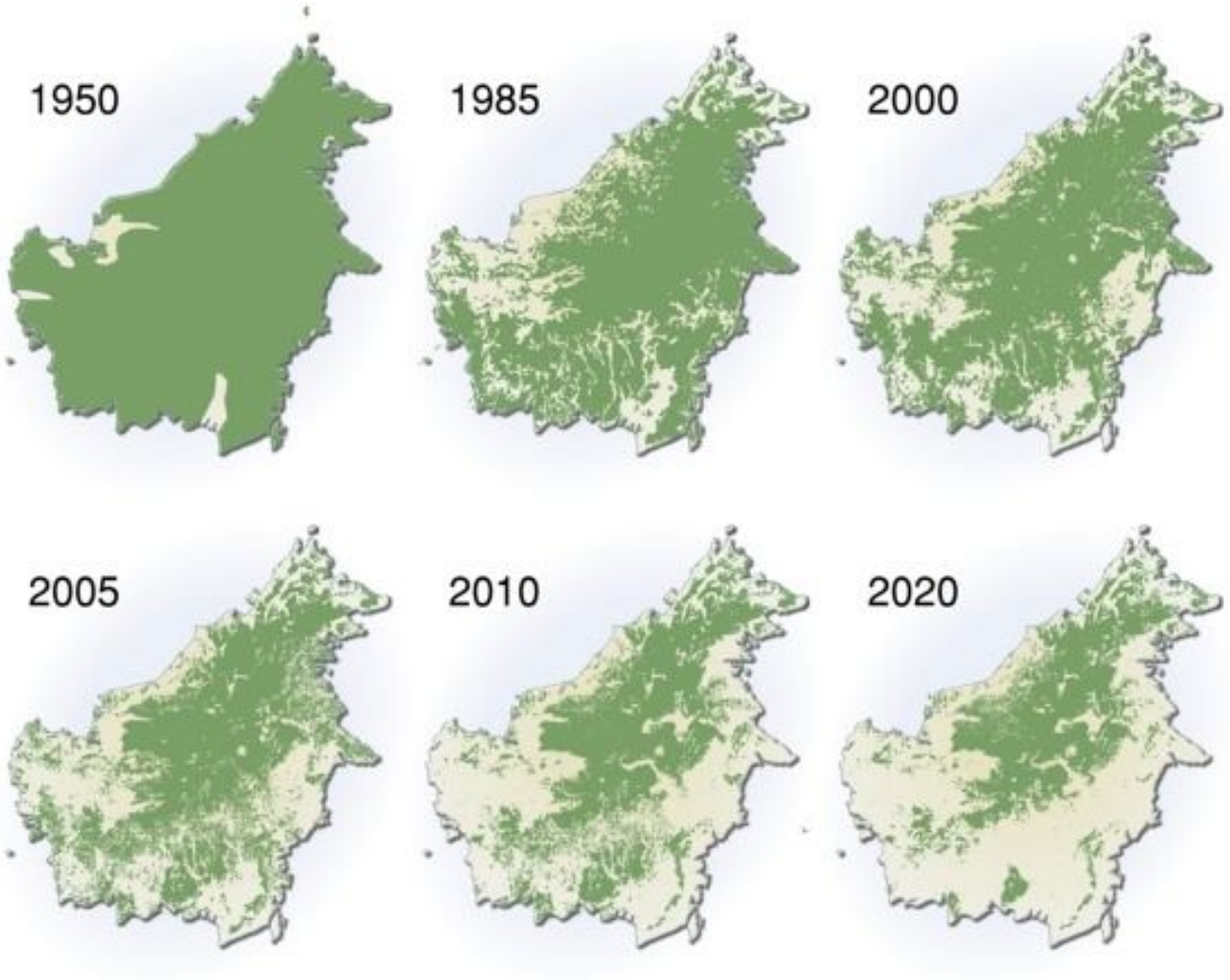


Supplementary Figure 10. Magnitude of climate-regulation services (0-1 index of temperature and moisture regulation) from natural terrestrial vegetation.

Laurence et al. Nature 2014

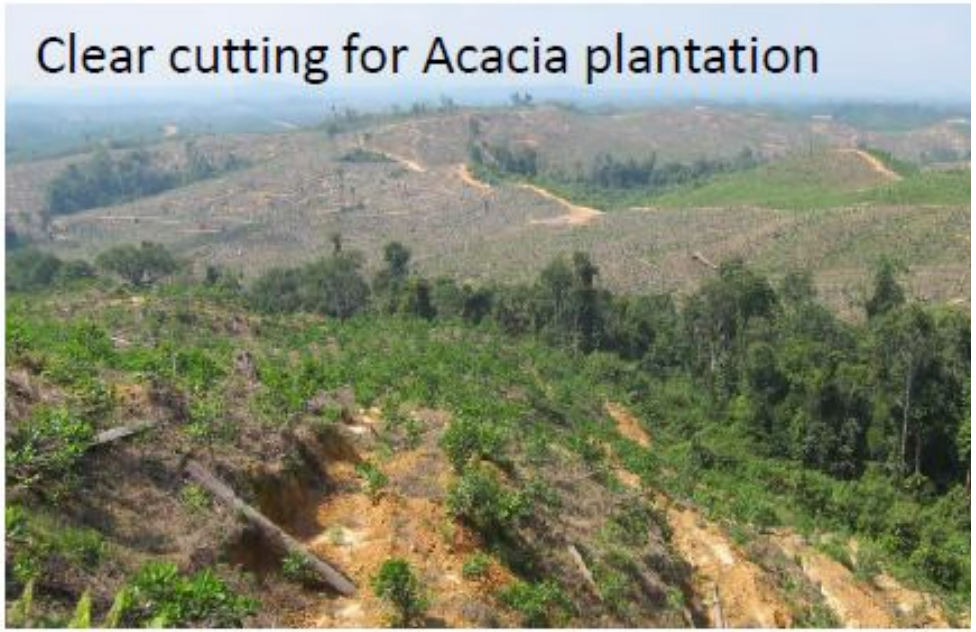
Borneo

Deforestation in Borneo



Radday, M, WWF Germany. 2007. 'Borneo Maps'

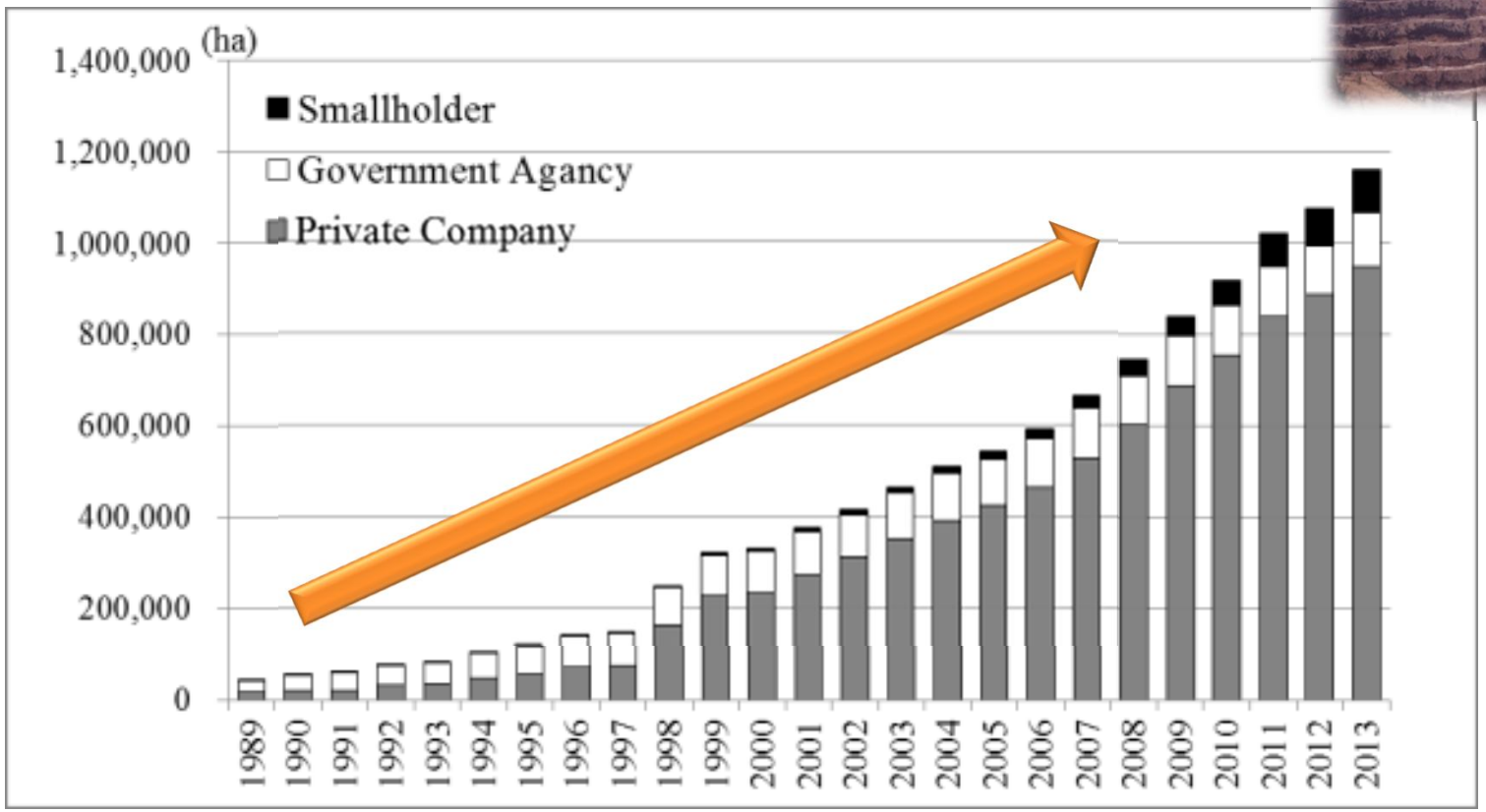
Drivers of deforestation



Rapid transformation into Market-oriented land

Drivers of deforestation

Area of oil palm planation in Sarawak, Malaysia



Total land
0.5％

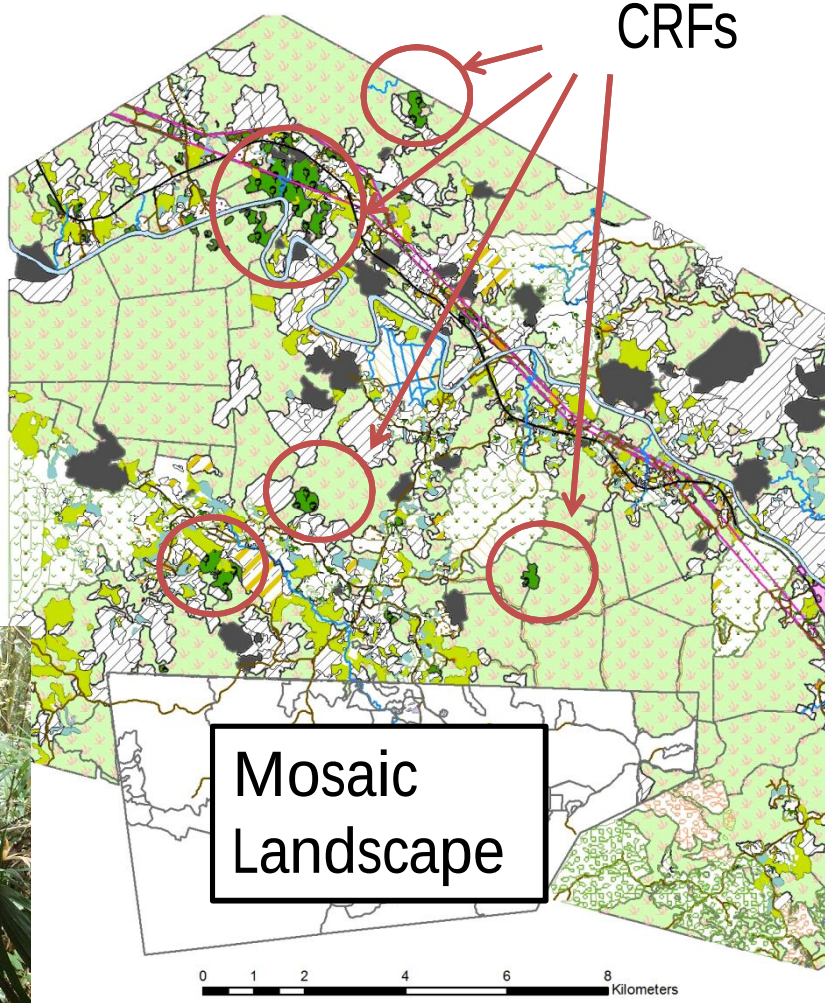
10 ％

Toward biodiversity conservation

Communally reserved forest (CRF)

'*pulau*' (means a 'island')

Conservation strategies <u>integrating with</u> the knowledge and practices of indigenous communities (CBD 1992)



Communally Reserved Forest (CRF)

- Remnant forest in slash-and-burn agricultural land
- Special functions associated with social well-being
- Supposed to be less disturbed for a source of timber
- Surrounded by secondary forests

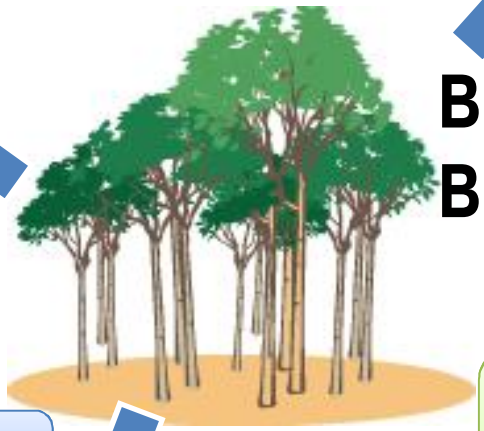
Benefits (Ecosystem services) from CRFs

Water resource

Carbon storage

CRFs

Regulating services



Biomass &
Biodiversity

Habitat/supporting
services

Provisioning services

Foods

Materials for
cultural use

Cultural services

Nuts
Vegetables

Wild meat

Rattans

Rattan crafts

Objective

To evaluate the conservation values of CRFs

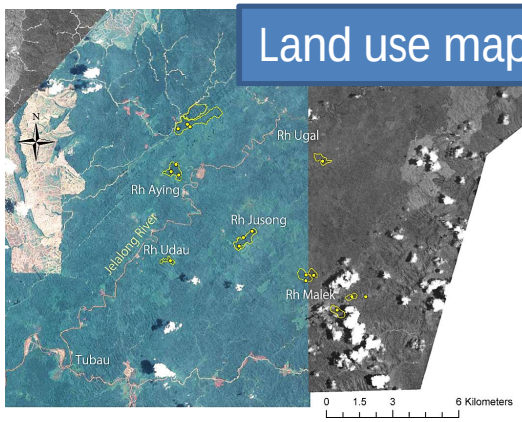
1. CRFs and Development
2. Biodiversity of CRFs in a fragmented landscape
3. Ecosystem services from CRFs

Social Survey

Interview in villages

GIS Analysis

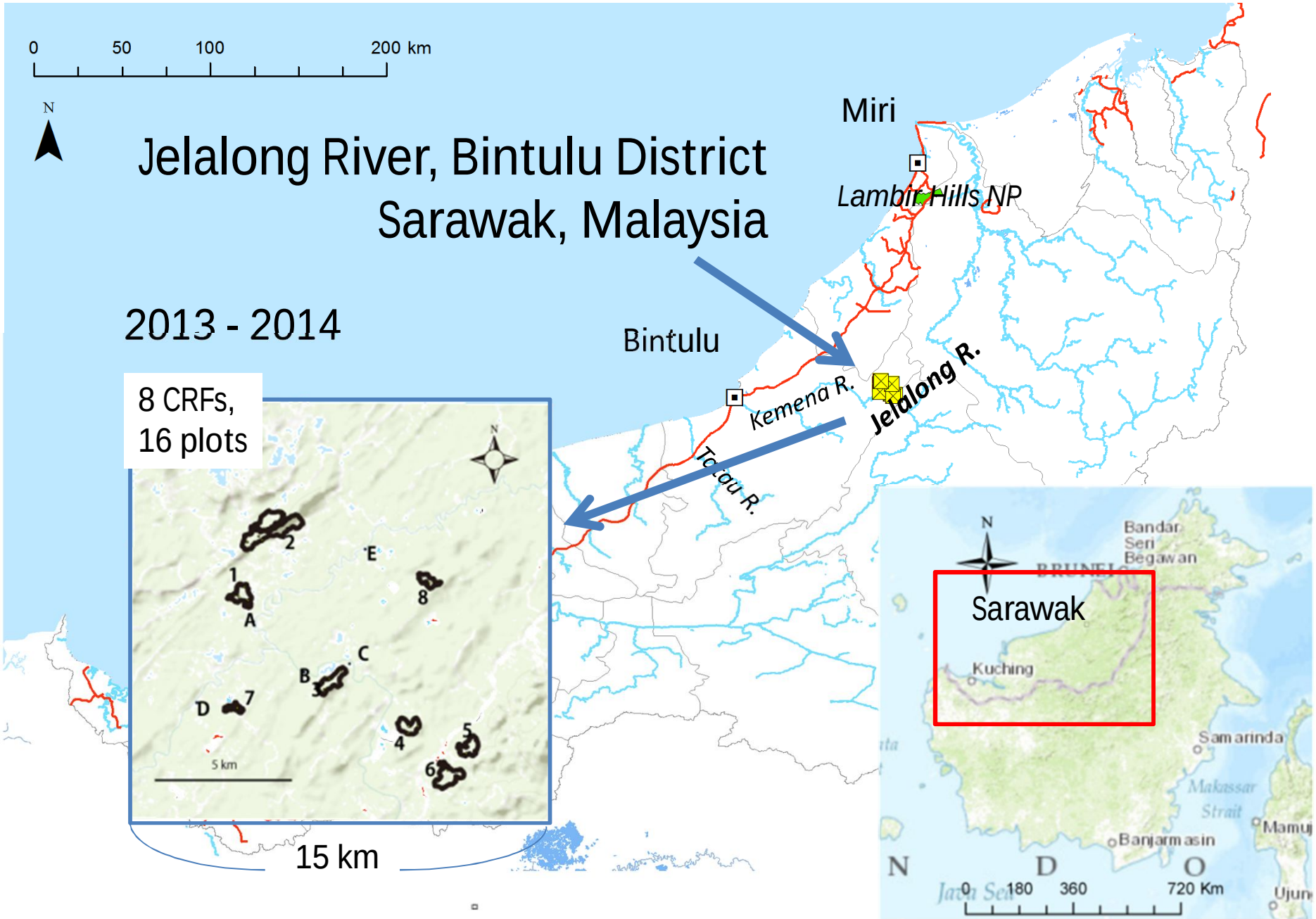
Land use maps



Ecological Survey

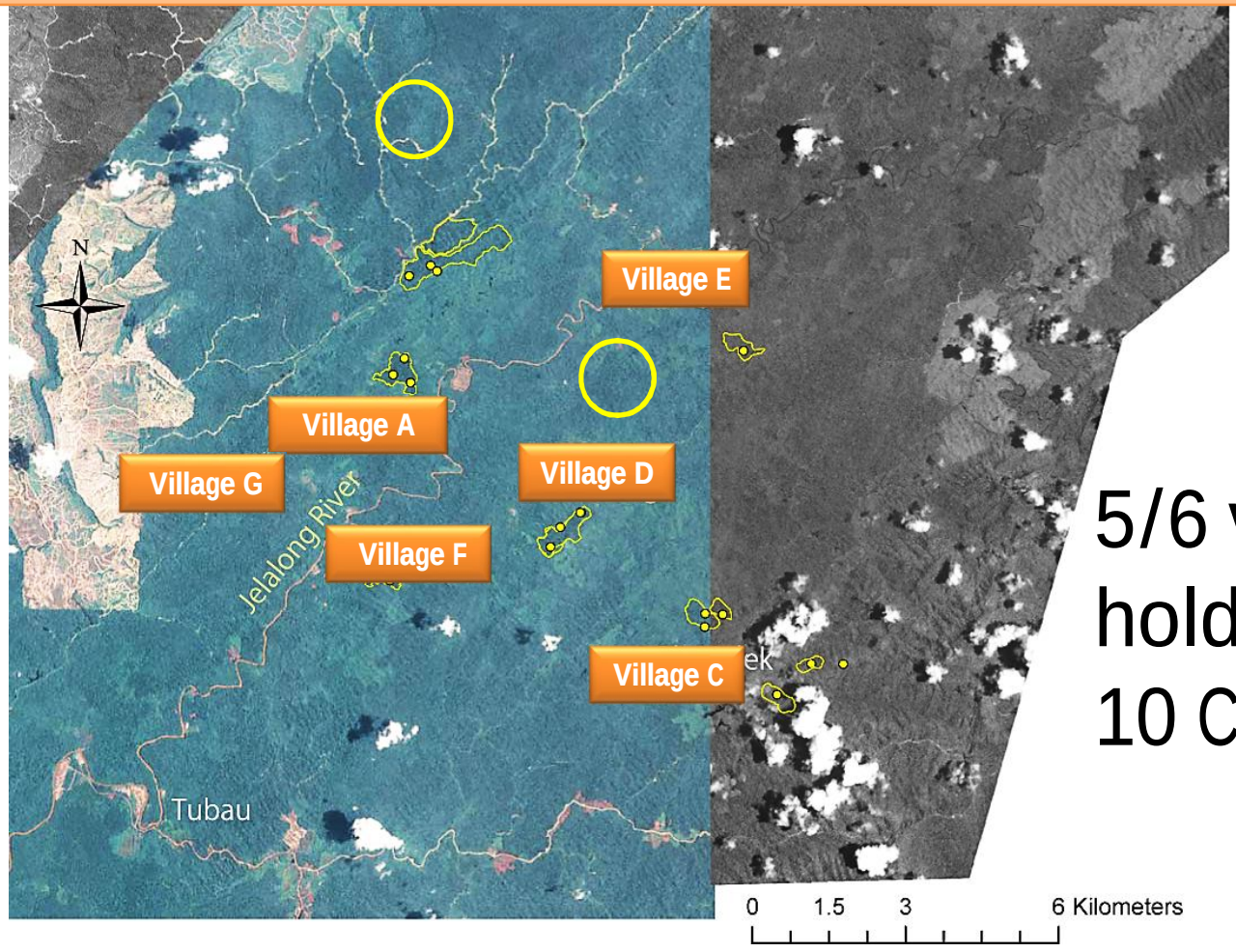
Plot species Survey

Study site


0 50 100 200 km
N
Jelalong River, Bintulu District
Sarawak, Malaysia
2013 - 2014
8 CRFs,
16 plots
Miri
Lambir Hills NP
Bintulu
Kemena R.
Jelalong R.
Tatau R.
15 km
5 km
A
B
C
D
E
1
2
4
5
6
7
8
Sarawak
Kuching
Bandar Seri Begawan
Samarinda
Banjarmasin
Makassar Strait
0 180 360 720 Km

1. CRFs and Development

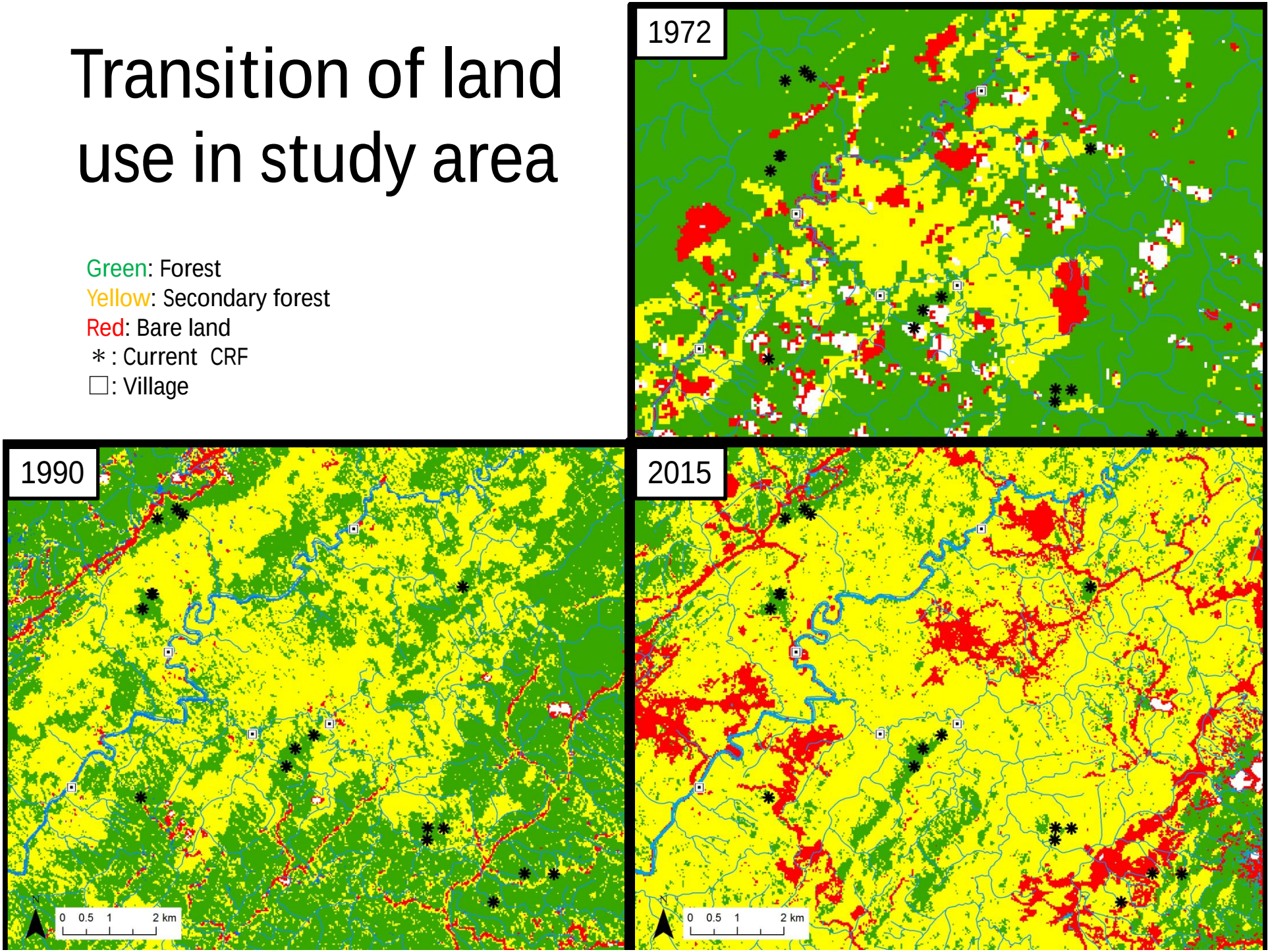
How does the status of CRFs change in a human-modified landscape?



5/6 villages hold
10 CRFs in total

Transition of land use in study area

Green: Forest
Yellow: Secondary forest
Red: Bare land
＊: Current CRF
□: Village



Transition of land use in study area

Green: Forest
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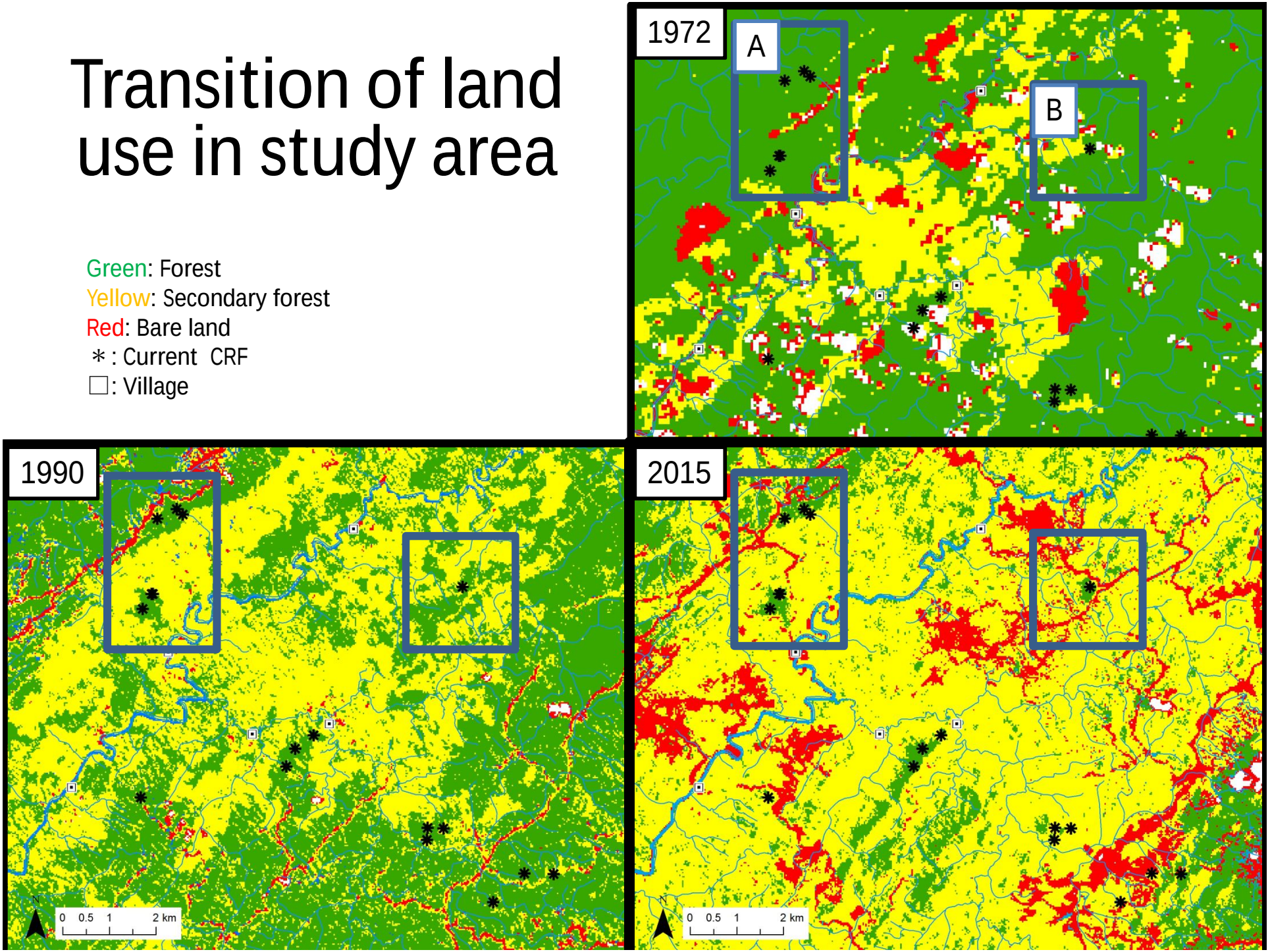
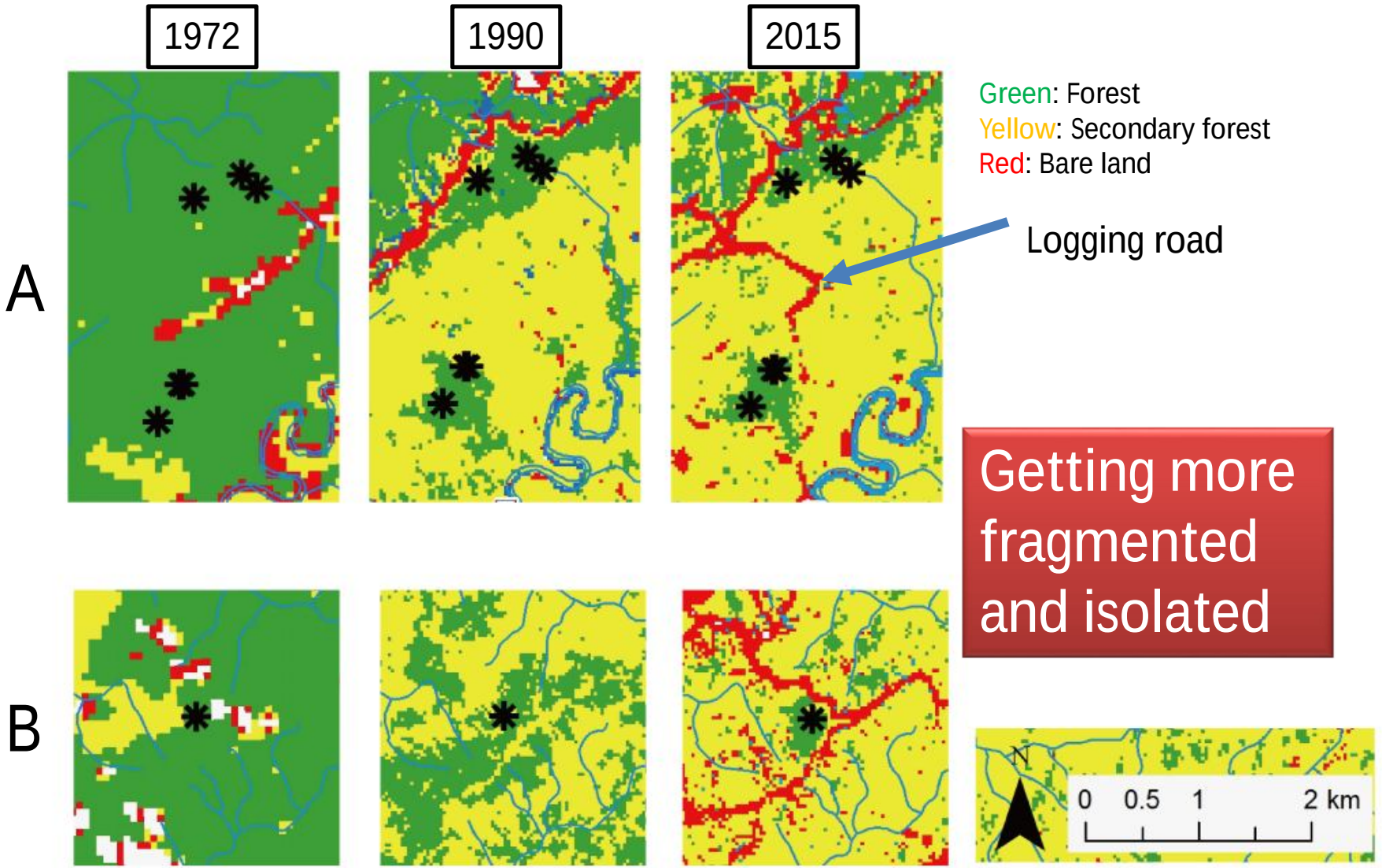
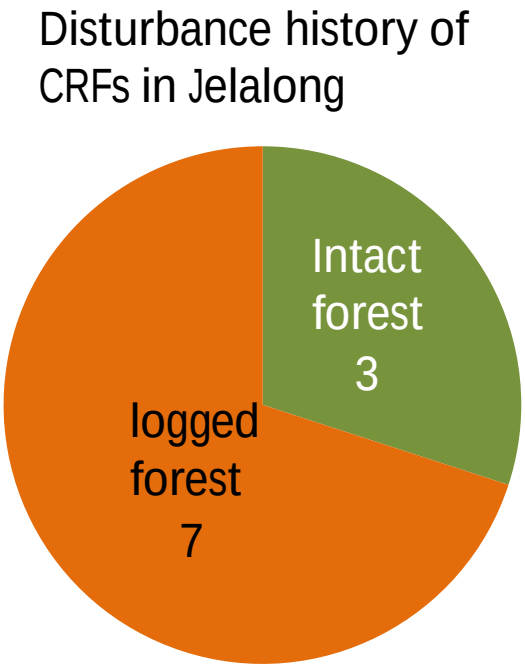


Transition of CRFs



Change in peoples' perception toward CRFs

- Definition of CRFs
  - Traditionally, CRFs were intact forests
  - Currently, CRFs includes disturbed forests
- Existence of CRFs
  - The numbers or existence of CRFs per village is decreasing (Takeuchi, unpublished data)

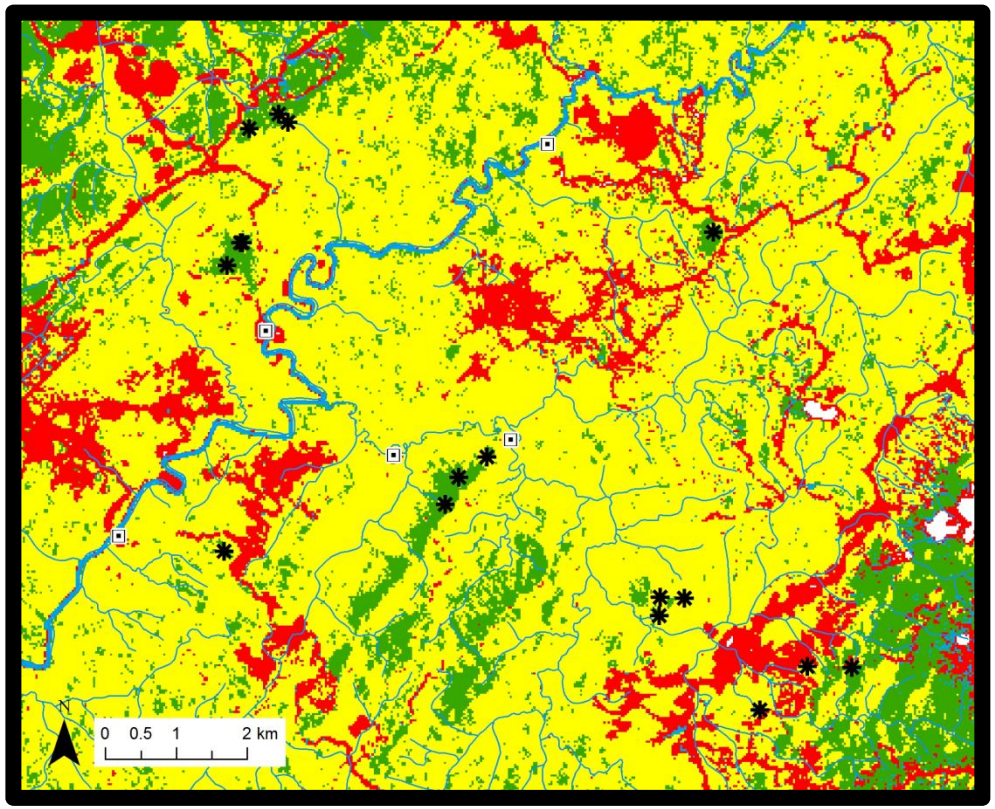


2. Biodiversity of CRFs in a fragmented landscape

Do CRFs have high biodiversity?
Do CRFs have threatened species?

Negative effect of forest fragmentation

- Lead to a decline in local and regional diversity by edge and isolation effect
  (Brook *et al.*, 2003; Sodhi *et al.*, 2004; Laurance *et al.*, 2011)



Tree species diversity survey

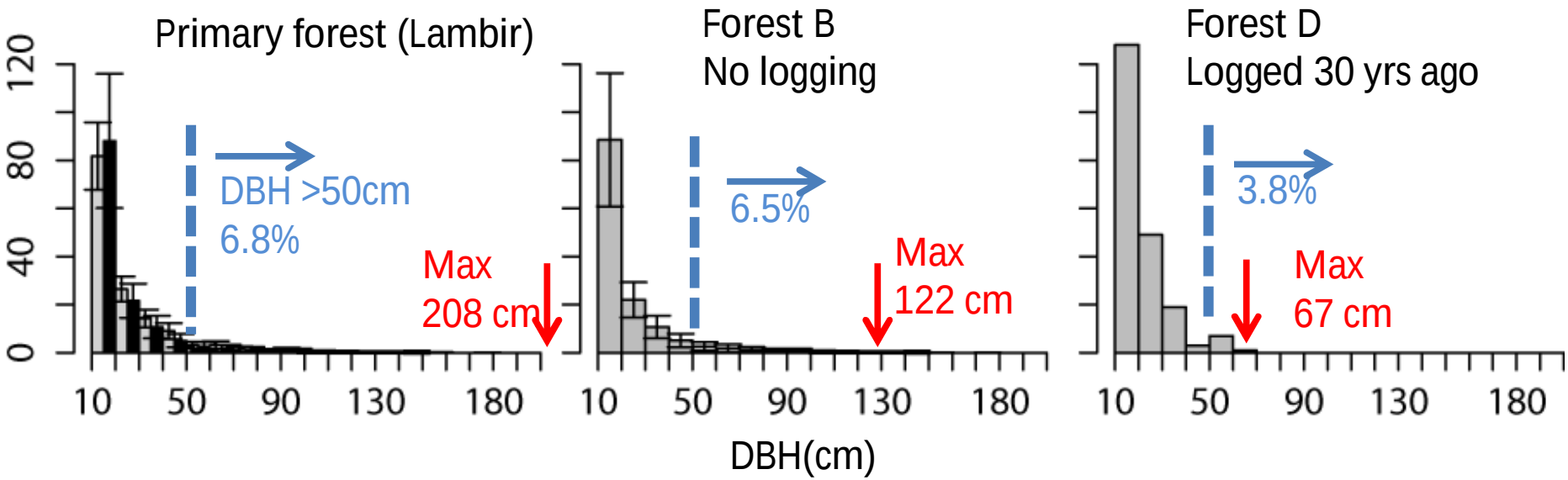
- 8 CRFs, 16 plots
- 50 x 50 m vegetation plot
  - All trees with > 10 cm diameter at breast height
  - Height
  - Specimen for species identification
- Control: Primary forest data (Lambir Hills NP.)

Target CRFs

CRF	1	2	3	4	5	6	7	8
Village	A		B	C			D	E
Area (ha)	36	125	38	31	48	32	10	20
No of Plots	3	3	3	3	1	1	1	1
Forest type	Kerangas /peat swamp	Mixed dipterocarp forest						
Water supply		✓	✓	✓	✓		✓	
Last Commercial logging	1950s			1980s	2007	1980s	1980s	1980s

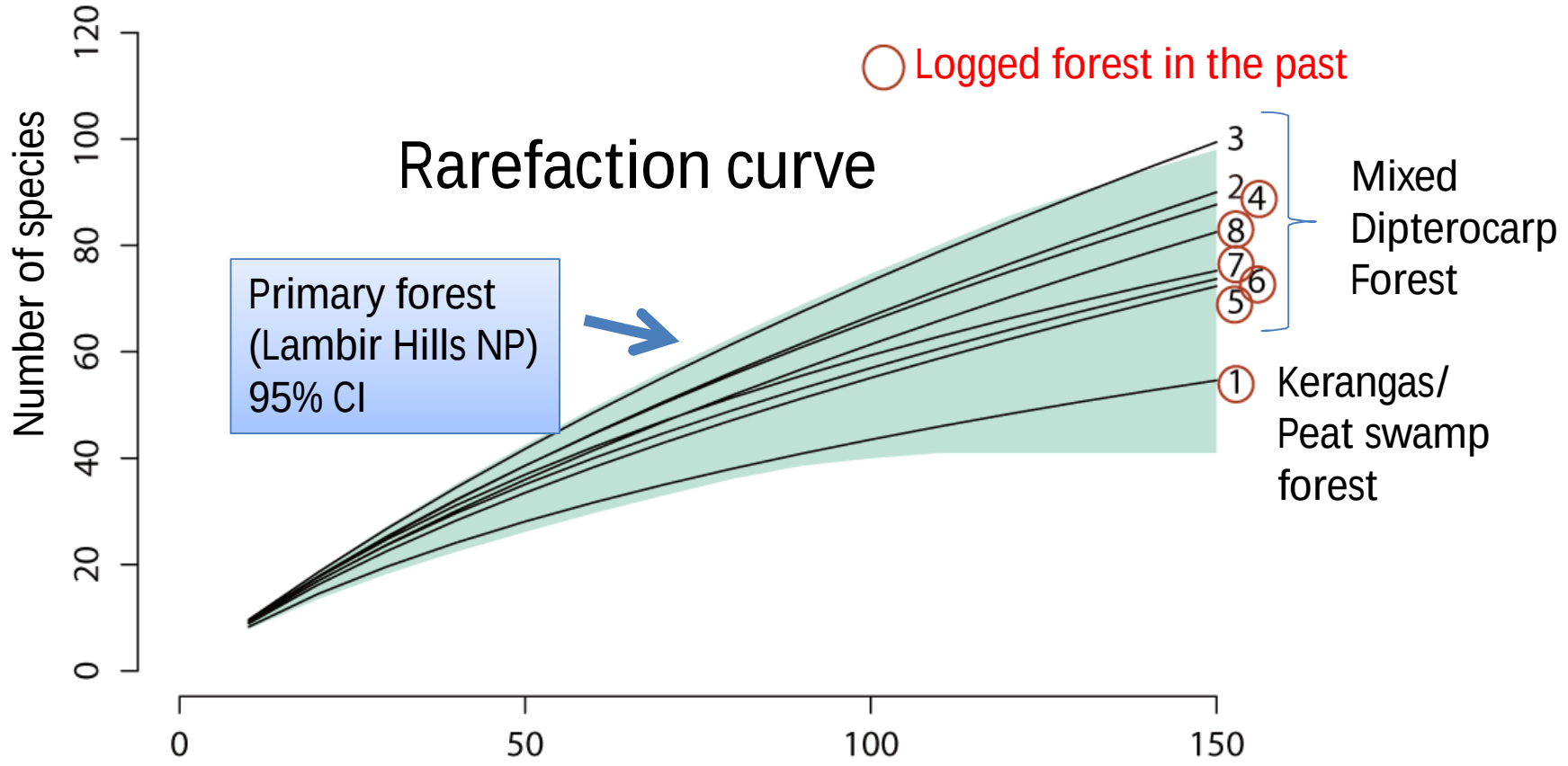
Size structure in CRFs

- Past logging effect
  - The size of trees was smaller in logged CRFs



Species diversity in CRFs

16 plots (4 ha) 2556 individuals, 63 families, 183 genera, 559 spp.



Species diversity of CRFs is equivalent to that of the primary forest

Threatened/endangered tree species

– 50/559 species were in the IUCN Red list or Sarawak protected species (including CITES list species)

-> Those CRFs could cover at least 20% of the IUCN Red List Threatened species occurring in Sarawak

Ramin
Gonystylus spp.

Penyau
Upuna bornensis

IUCN Red list -Vulnerable

CITES

IUCN Red list -Endanger

CRFs holds threatened/endangered species

3. Ecosystem services from CRFs

What are the essential ecosystem services from CRFs to local communities?

1. Bioresources — Provisioning service — Cultural service
2. Water resources — Provisioning service

Ecosystem service from CRFs: Bioresources

Ecosystem service from CRFs: Bioresources

Provisioning service

Foods & Medicines

No. of plant species for local use in two area of indigenous communities in Sarawak (Chai, 2000)

	Area 1	Area 2
Food	**176**	**113**
Medicine	**57**	**61**
Craft	**4**	**18**
Ritual	**4**	**3**
Other	**4**	**38**
	245	**233**

Rattan crafts

Rattan crafts

Local name

10 kinds of rattans

Species diversity of rattans

5 CRFs, 9 plots, 935 individuals

Local name	Scientific name
Genus *Calamus*	
batu	gonospermus
	jevensis
buloh	erioacanthus
buluh	sarawaknensis
jelayang	ornatus
lia	laevigatus
matahari	marginatus
mulong	psilosellus
rengo/tinkas	paepalanthus
sabet	hispidulus
sega	optimus
semanbu	scipionum
seru	convallium
takong	flabellatus
tunggal	ashtonii
tut	pogonacanthus

Local name	Scientific name
Genus *Daemonorops*	
duduk	macrostachys
	oxycarpa
	ruptilis
empunuk	cristata
	periacantha
jerenan	didymophylla
lepoh	sabut
ruak ai	sparsiflora
sagan	ingens
tekuyong	hystrix
	longistipes
	fissa

Local name	Scientific name
Genus *Korthalsia*	
seruk	echinometra
semut/akap	furcata
	hispida
	rigida
chit	rostrata
danan	jala
	flagellaris

1 name
for several species

Local name: 26

Scientific name: 3 genus, 35 species

Rattans for craft

5 CRFs, 9 plots, 935 individuals

Local name	Scientific name
Genus *Calamus*	
batu	gonospermus
	jevensis
buloh	erioacanthus
buluh	sarawaknensis
jelayang	ornatus
lia	laevigatus
matahari	marginatus
mulong	psilosellus
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semanbu	scipionum
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takong	flabellatus
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tut	pogonacanthus

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	ruptilis
empunuk	cristata
	periacantha
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semut/akap	furcata
	hispida
	rigida
chit	rostrata
danan	jala
	flagellaris

20 species

Rattans for craft

5 CRFs, 9 plots, 935 individuals

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buluh	sarawaknensis
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mulong	psilosellus
rengo/tinkas	paepalanthus
sabet	hispidulus
sega	optimus
semanbu	scipionum
seru	convallium
takong	flabellatus
tunggal	ashtonii
tut	pogonacanthus

body

Strings

Spine, Lim

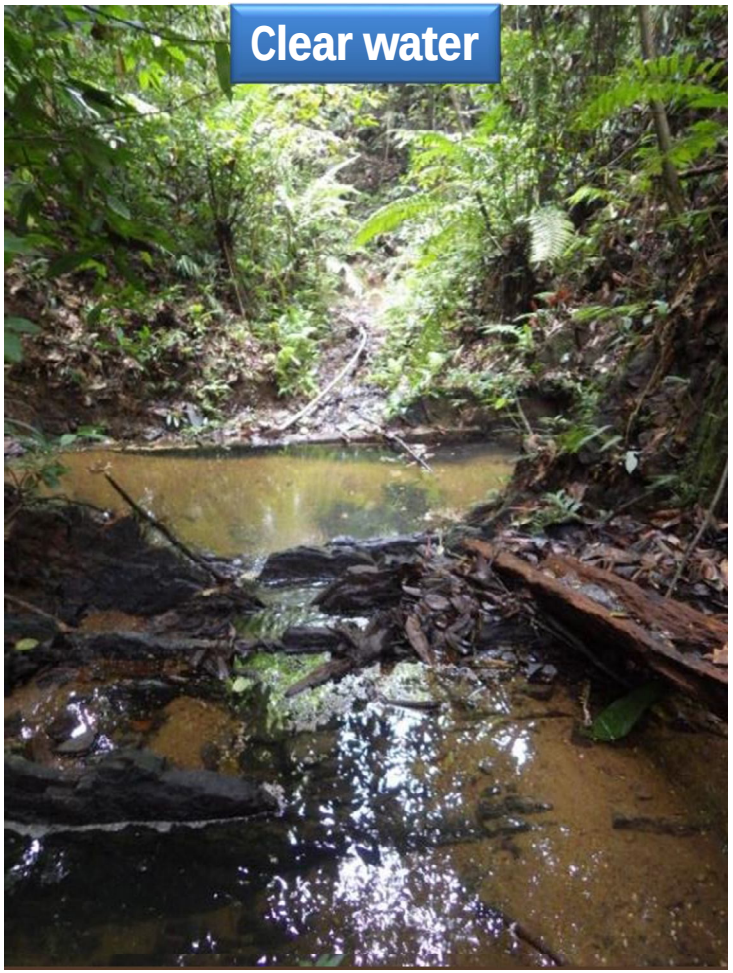
Local name	Scientific name
Genus *Korthalsia*	
seruk	echinometra
semut/akap	furcata
	hispida
	rigida
chit	rostrata
danan	jala
	flagellaris

Use appropriate types of rattans according to their characteristics

Local and indigenous knowledge

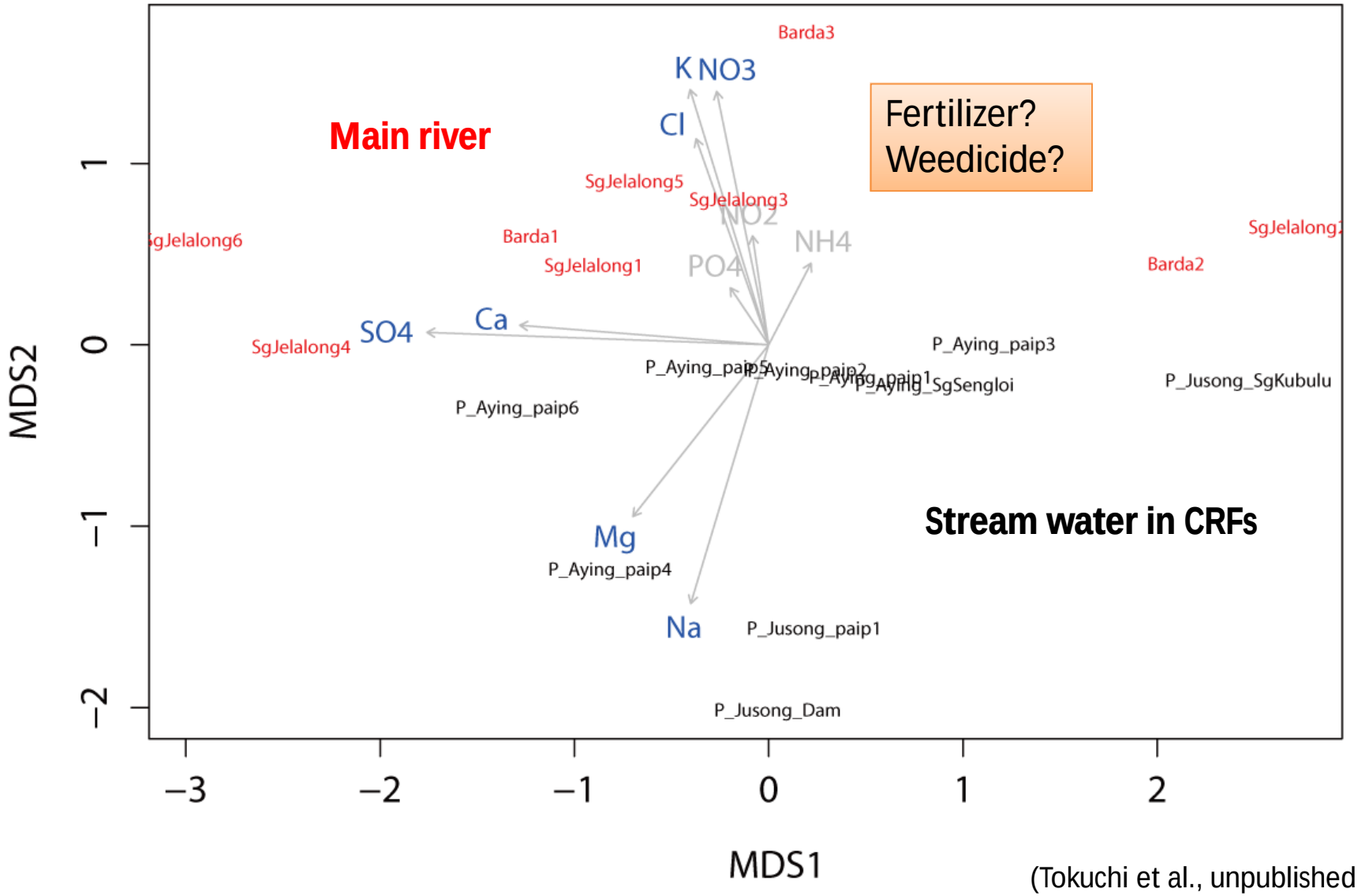
Ecosystem service from CRFs: water resources

Main river



Stream in a CRF

Water chemistry



(Tokuchi et al., unpublished data)

Summary

- Development and CRFs
  - CRFs getting more Isolated
  - Changing the traditional conception of CRFs; including disturbed forests
- Biodiversity in CRFs
  - High tree species diversity in CRFs
  - Unique and endangered species
- Ecosystem services from CRFs
  - Bioresources; Based on ILK
  - Water resource; Growing demand

Take-home messages

- CRFs restore regional biodiversity and preserve ecosystem services for local communities
- A lot of the traditional landscape, including CRFs, are now under development pressure
- Social demand for ecosystem services changes according to the social circumstances

Thank you for your attention !

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Jason Hon

Research outcome sharing in the village

Summary

The conservation value of CRFs

- Society and Ecosystem services
  - Traditional conception of CRFs has been changed, but local communities still gain the essential benefits (e.g., water, food, materials)
- Biodiversity
  - Tree species diversity in CRFs was high and equivalent to that of the primary forest, though disturbed CRFs still consist of relatively smaller trees
  - All CRFs contained unique and endangered species

Use and history

Local use

- Water catchment area
- Timbers for house /boat construction (less frequent)
- Foods (Vegetables, Hunting animals)
- Materials (Rattans)

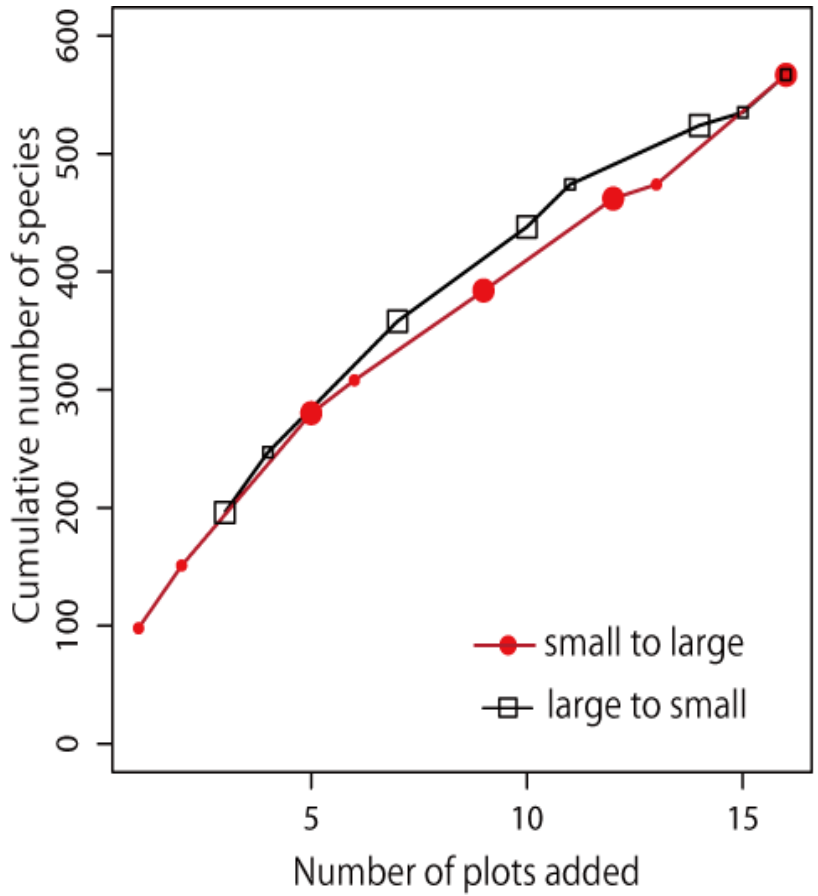
Commercial logging

- Starting from 1950s (Golden age: 1980s)
- 7/10 CRFs were logged once in the past

⇔ Traditional definition: less disturbed forest

Landscape species diversity

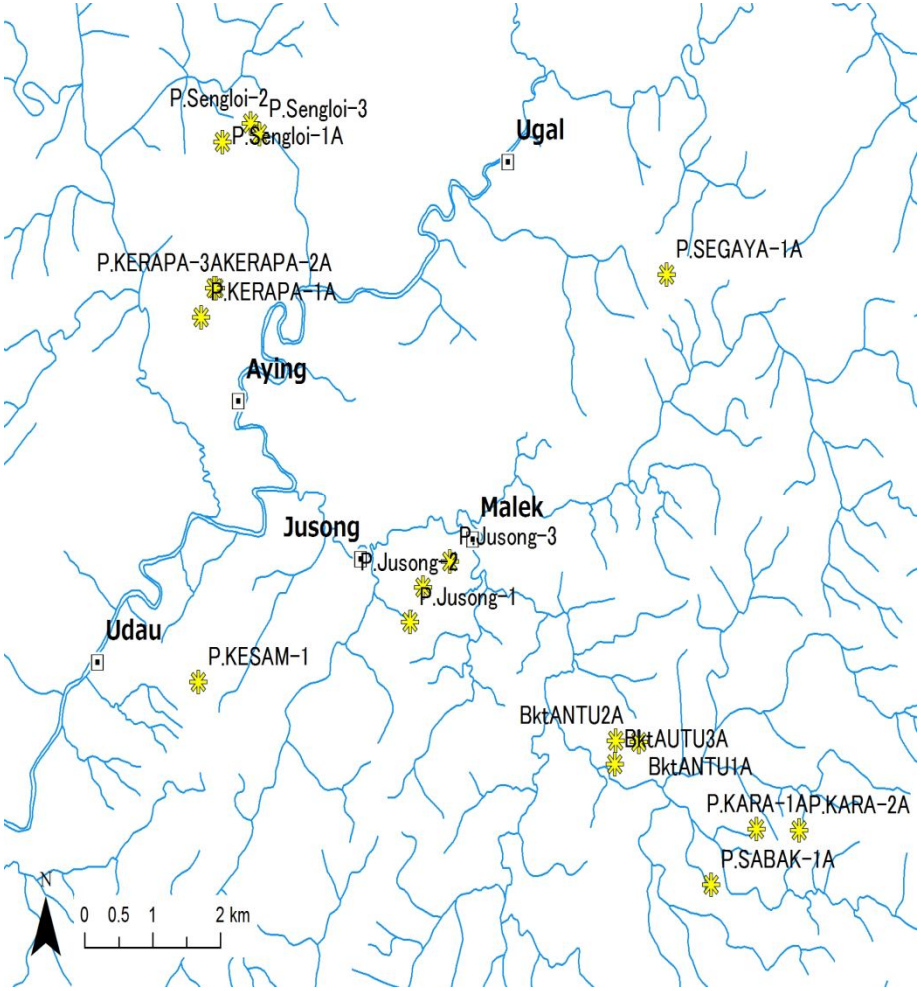
- Species number-density relationship

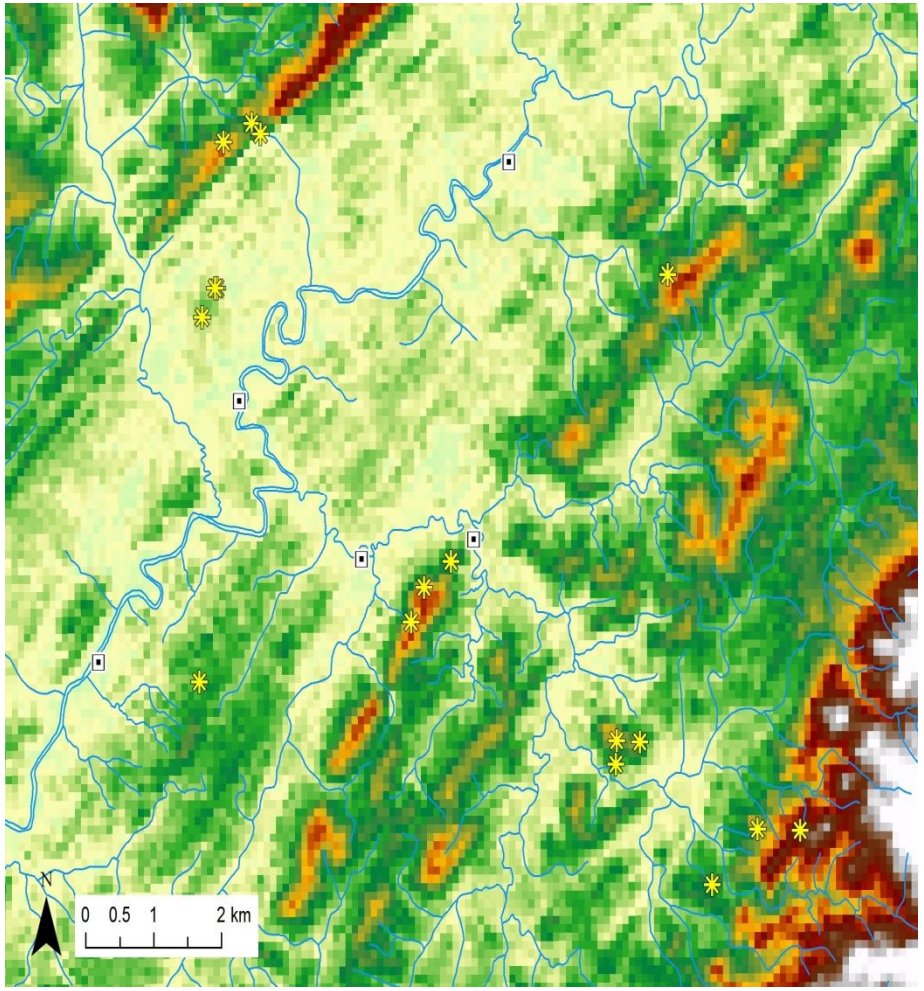


Linear increase:
Plot specific Species

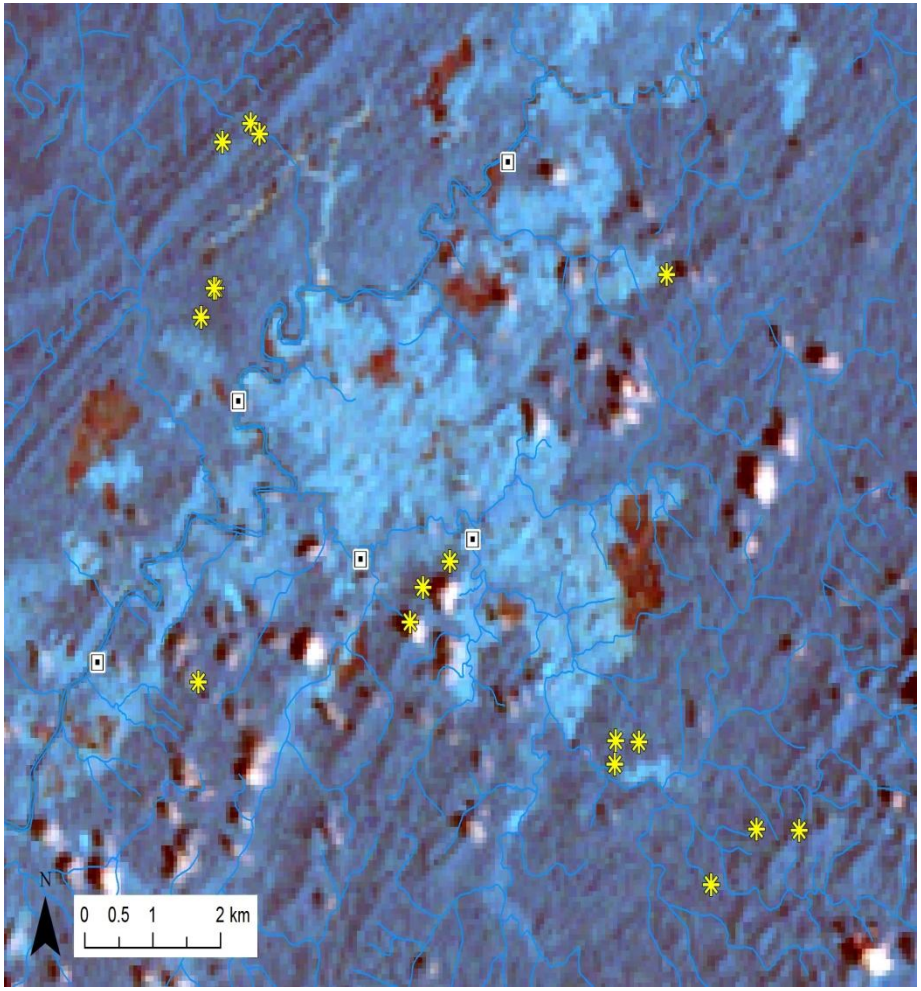
Small forest =large forest:
Both contribute landscape-level species diversity

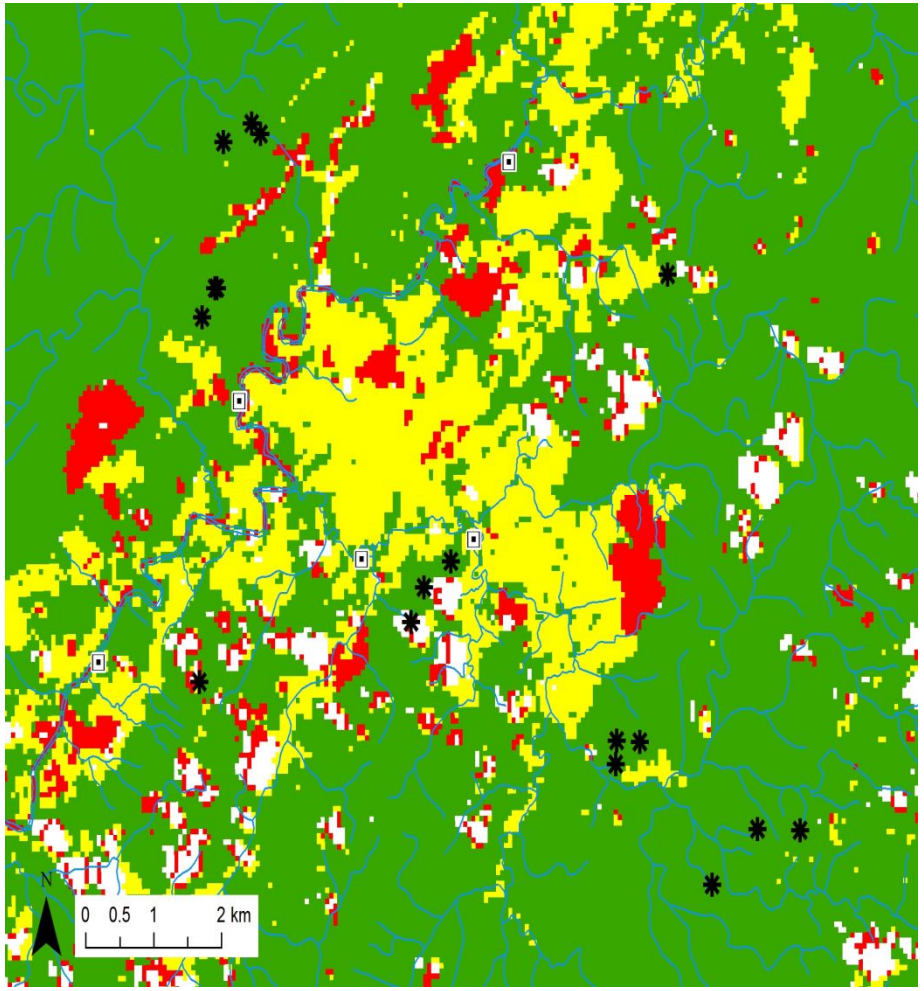
Elevation


P.Sengloi-2
P.Sengloi-3
P.Sengloi-1A
Ugal
P.KERAPA-3AKERAPA-2A
P.KERAPA-1A
P.SEGAYA-1A
Aying
Jusong
Malek
P.Jusong-3
P.Jusong-2
P.Jusong-1
Udau
P.KESAM-1
BktANTU2A
BktAUTU3A
BktANTU1A
P.KARA-1AP.KARA-2A
P.SABAK-1A
N
0 0.5 1 2 km

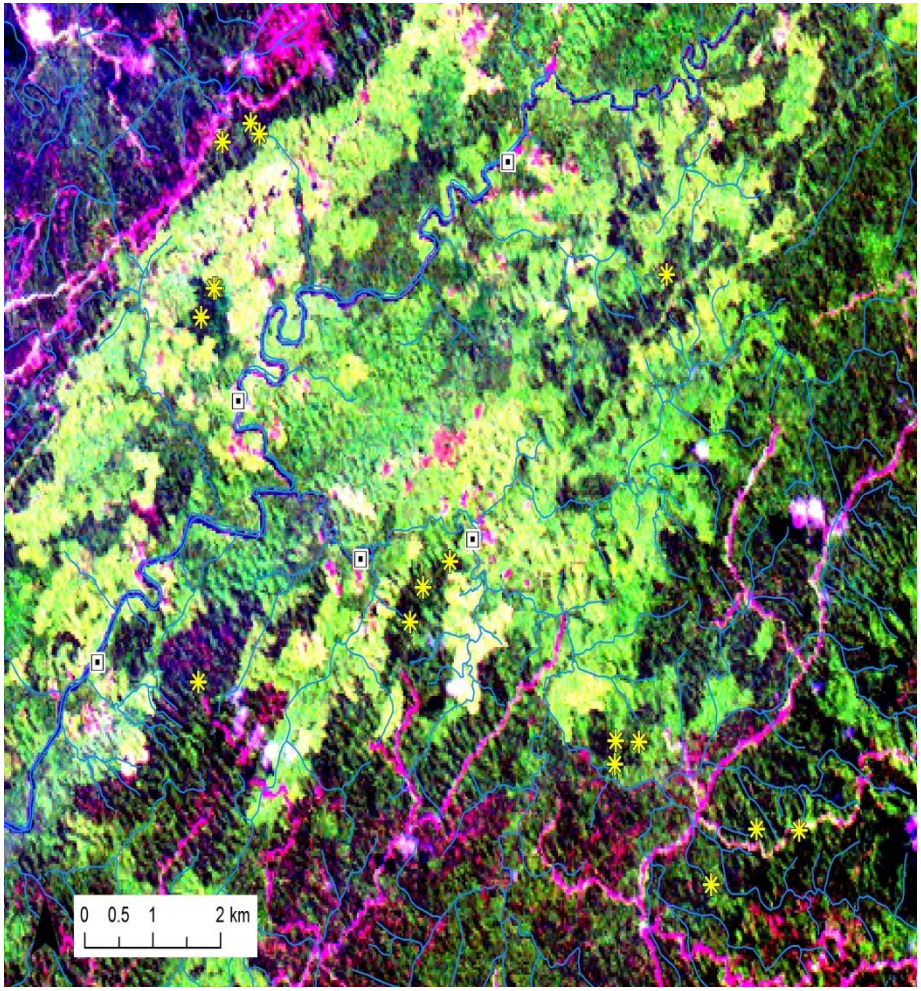

N
0 0.5 1 2 km

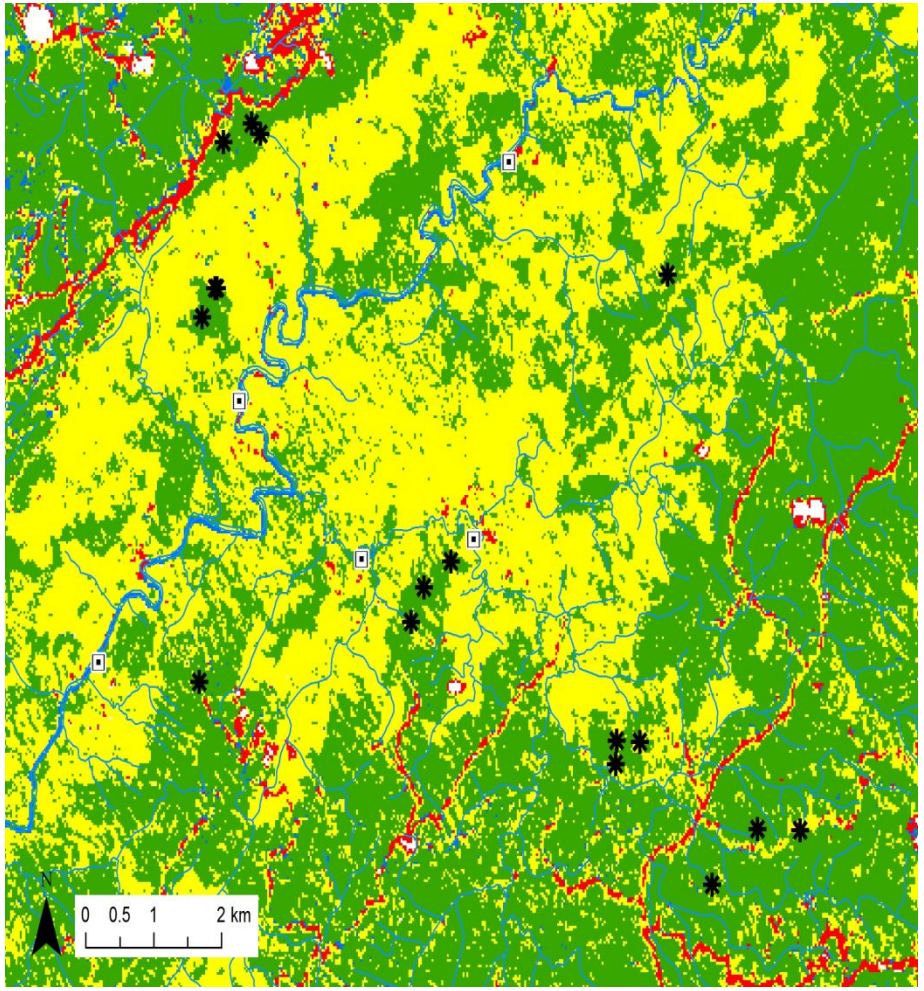
1972



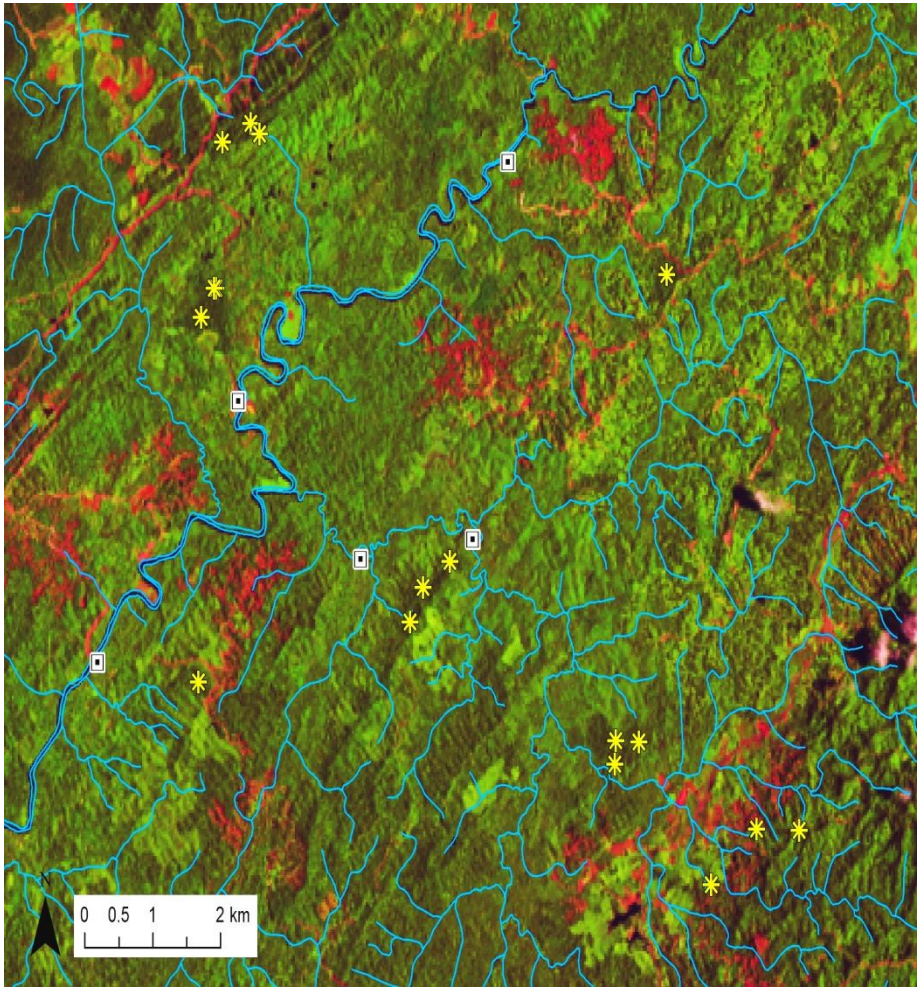


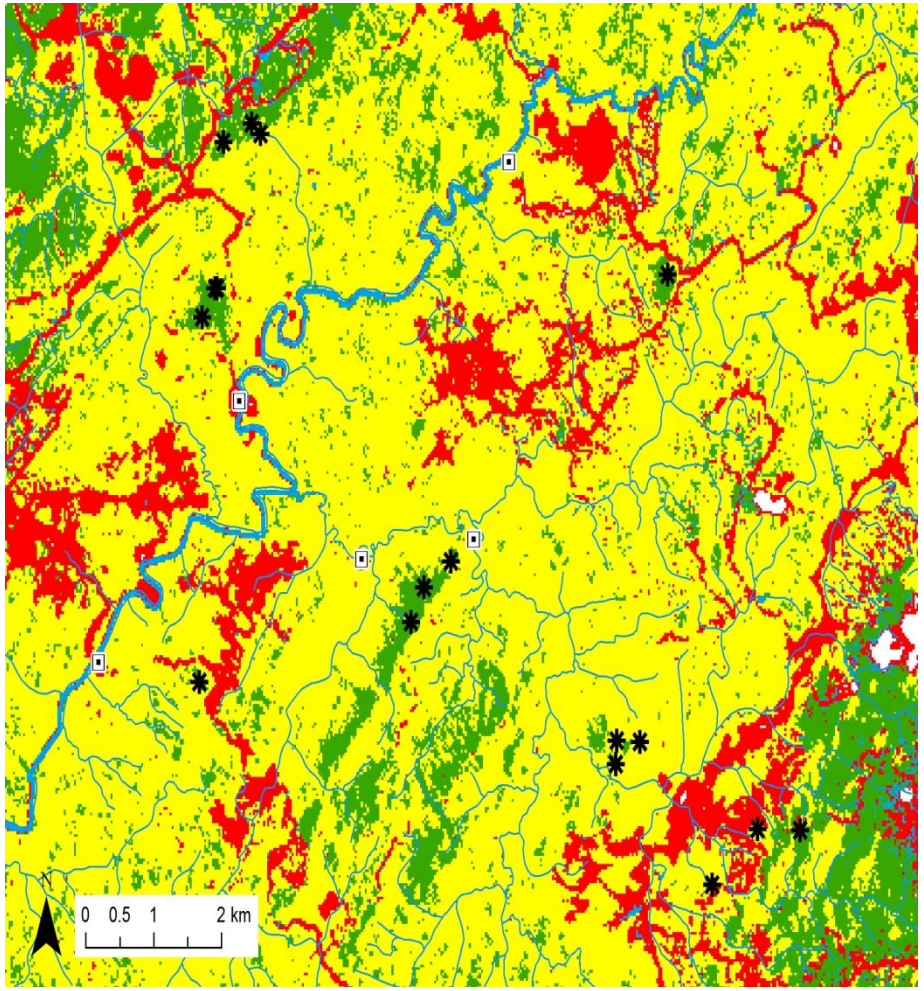
1990





2015





プラウの成立条件・概念の変化

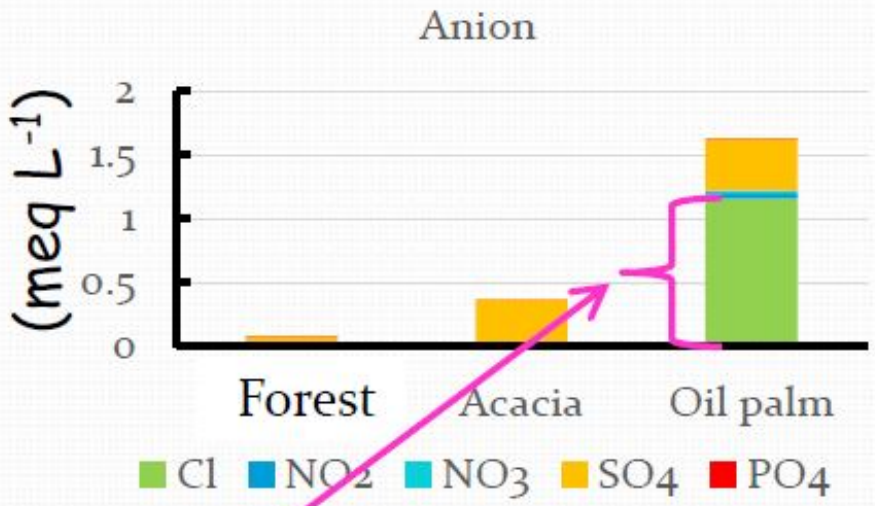
	過去 **(イバン辞典/過去の文献)**	**現在** **(今回の調査)**
かく乱	完全な**原生林**	一度**商業伐採**された森を含む
禁忌林	精霊が住むため**立ち入り禁止**	アクセス、**利用あり**
成立条件	難アクセスの地形、自然条件(農耕に不向き)	**河川局が水源林として指定**(50年ほど前から)
利用内容	**水源林**、建築材(家屋、ボート用) 食糧(果物、野菜)、材料（ラタン等）の調達、狩猟	

社会的環境に応じて概念、利用の変化？

Stream water chemistry was different among landuse.

Tokuchi et al. unpublished

oil palm plantation >> acacia plantation > forest



- Largest differences were shown in Cl^-. 除草剤起源？

④開発が生物資源の利用に与える影響　–ラタンを例に-

- ラタン- 食用・工芸品製作用
- 伝統的知識、利用

日常生活

農業

儀式

漁業

ラタンの種多様性
人の認識と科学名

5 プラウ、9 プロット、935 個体

Local name	Scientific name
Genus *Calamus*	
batu	gonospermus
	jevensis
buloh	erioacanthus
buluh	sarawaknensis
jelayang	ornatus
lia	laevigatus
matahari	marginatus
mulong	psilosellus
rengo/tinkas	paepalanthus
sabet	hispidulus
sega	optimus
semanbu	scipionum
seru	convallium
takong	flabellatus
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tut	pogonacanthus

15 種類 16 種

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Genus *Daemonorops*	
duduk	macrostachys
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empunuk	cristata
	periacantha
jerenan	didymophylla
lepoh	sabut
ruak ai	sparsiflora
sagan	ingens
tekuyong	hystrix
	longistipes
	fissa

7 種類 12 種

Local name	Scientific name
Genus *Korthalsia*	
seruk	echinometra
semut/akap	furcata
	hispida
	rigida
chit	rostrata
danan	jala
	flagellaris

4 種類 7 種

1つの現地名
複数種含む

現地名: 26 種類
科学名: 3属, 35 種

ラタンの工芸品利用

Local name	Scientific name
Genus *Calamus*	
batu	gonospermus
	jevensis
buloh	erioacanthus
buluh	sarawaknensis
jelayang	ornatus
lia	laevigatus
matahari	marginatus
mulong	psilosellus
rengo/tinkas	paepalanthus
sabet	hispidulus
sega	optimus
semanbu	scipionum
seru	convallium
takong	flabellatus
tunggal	ashtonii
tut	pogonacanthus

15 種類 16 種

12 12

Local name	Scientific name
Genus *Daemonorops*	
duduk	macrostachys
	oxycarpa
	ruptilis
empunuk	cristata
	periacantha
jerenan	didymophylla
lepoh	sabut
ruak ai	sparsiflora
sagan	ingens
tekuyong	hystrix
	longistipes
	fissa

7 種類 12 種

1 1

Local name	Scientific name
Genus *Korthalsia*	
seruk	echinometra
semut/akap	furcata
	hispida
	rigida
chit	rostrata
danan	jala
	flagellaris

4 種類 7 種

4 7

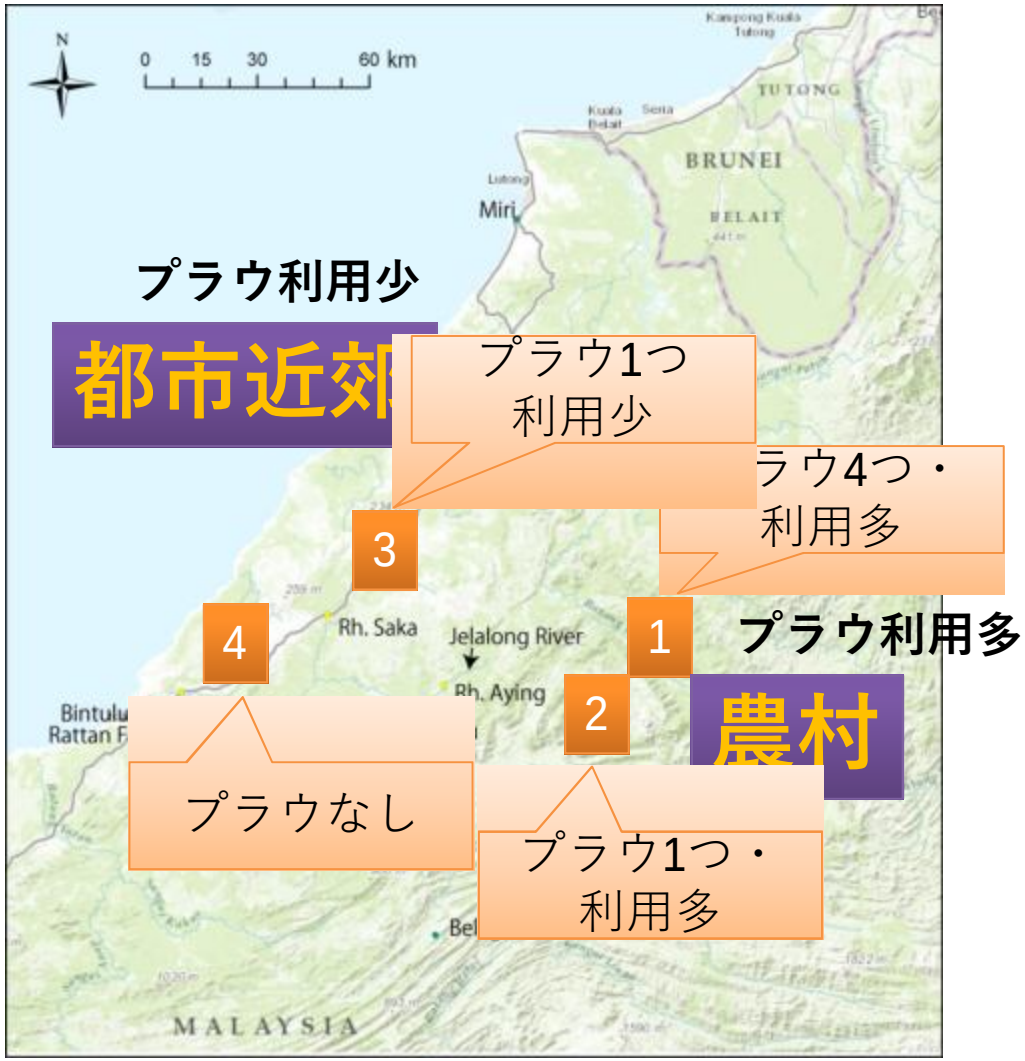
現地名: 26 種類

17種類

科学名: 3属, 35 種

20種

ラタンの利用



- プラウの利用が異なる4つの村で聞き取り調査
- 都市近郊と農村部で利用する種類数が異なるのか？

Rh Aying 農村 プラウ利用多

Rh Aying 農村 プラウ利用多

10 種類

ラタンの種多様性
人の認識と科学名

5 プラウ、9 プロット、935 個体

Local name	Scientific name
Genus *Calamus*	
batu	gonospermus
	jevensis
buloh	erioacanthus
buluh	sarawaknensis
jelayang	ornatus
lia	laevigatus
matahari	marginatus
mulong	psilosellus
rengo/tinkas	paepalanthus
sabet	hispidulus
sega	optimus
semanbu	scipionum
seru	convallium
takong	flabellatus
tunggal	ashtonii
tut	pogonacanthus

15 種類 16 種

Local name	Scientific name
Genus *Daemonorops*	
duduk	macrostachys
	oxycarpa
	ruptilis
empunuk	cristata
	periacantha
jerenan	didymophylla
lepoh	sabut
ruak ai	sparsiflora
sagan	ingens
tekuyong	hystrix
	longistipes
	fissa

7 種類 12 種

Local name	Scientific name
Genus *Korthalsia*	
seruk	echinometra
semut/akap	furcata
	hispida
	rigida
chit	rostrata
danan	jala
	flagellaris

4 種類 7 種

1つの現地名
複数種含む

現地名: 26 種類
科学名: 3属, 35 種

ラタンの工芸品利用

Local name	Scientific name
Genus *Calamus*	
batu	gonospermus
	jevensis
buloh	erioacanthus
buluh	sarawaknensis
jelayang	ornatus
lia	laevigatus
matahari	marginatus
mulong	psilosellus
rengo/tinkas	paepalanthus
sabet	hispidulus
sega	optimus
semanbu	scipionum
seru	convallium
takong	flabellatus
tunggal	ashtonii
tut	pogonacanthus

15 種類 16 種

12 12

Local name	Scientific name
Genus *Daemonorops*	
duduk	macrostachys
	oxycarpa
	ruptilis
empunuk	cristata
	periacantha
jerenan	didymophylla
lepoh	sabut
ruak ai	sparsiflora
sagan	ingens
tekuyong	hystrix
	longistipes
	fissa

7 種類 12 種

1 1

Local name	Scientific name
Genus *Korthalsia*	
seruk	echinometra
semut/akap	furcata
	hispida
	rigida
chit	rostrata
danan	jala
	flagellaris

4 種類 7 種

4 7

現地名: 26 種類

17種類

科学名: 3属, 35 種

20種

Development
Plantation, logging

Ecosystems

Society

Landscape

Ecosystem service supply potential

CRFs

Biodiversity

Water

Perception

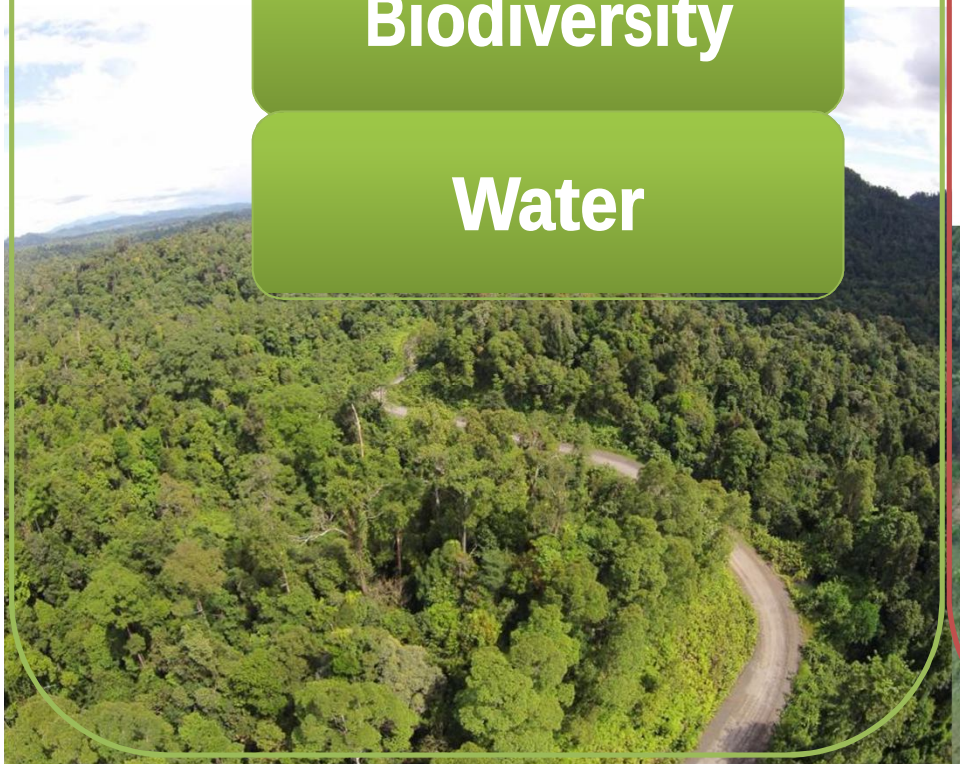
Ecosystem service use

Bioresources

Water resources

Motivations for conservation

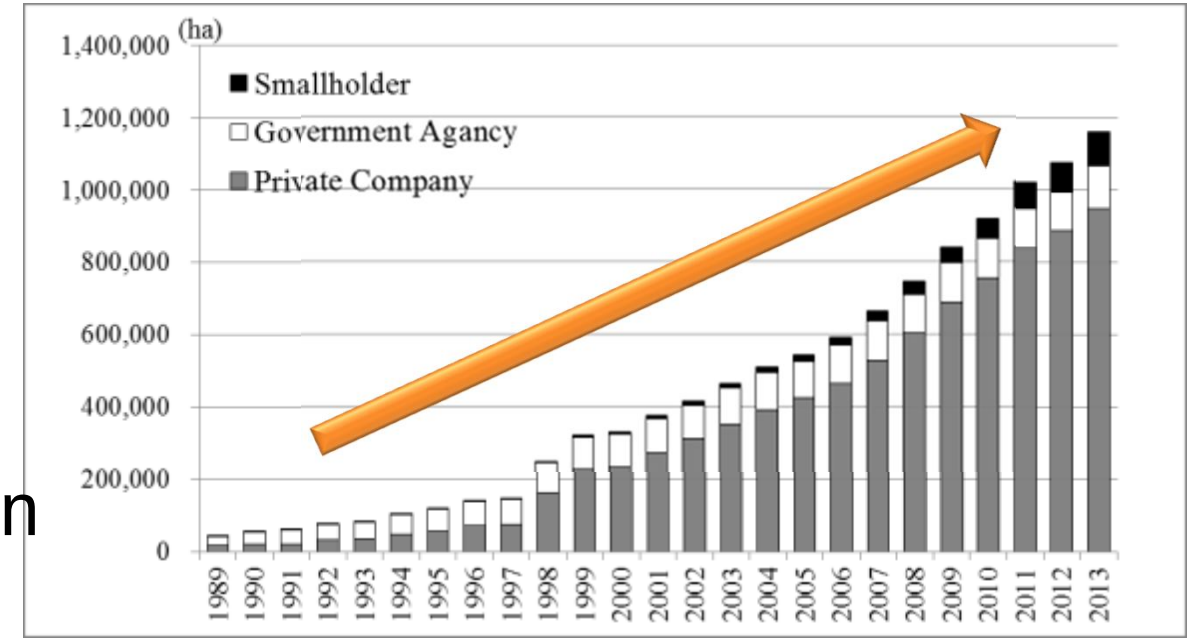
Demand ↑ ?



CRFs under the pressure of development

- Land-use change to market-oriented crop agriculture
- Local governance : land tenure

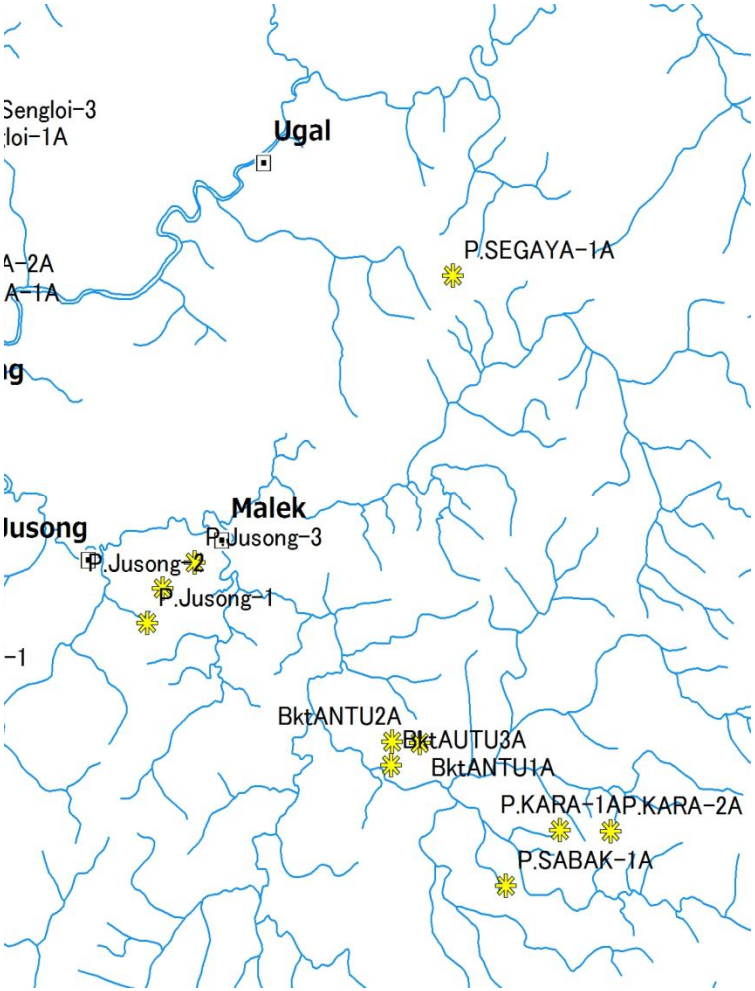
Area of oil palm planation in Sarawak, Malaysia

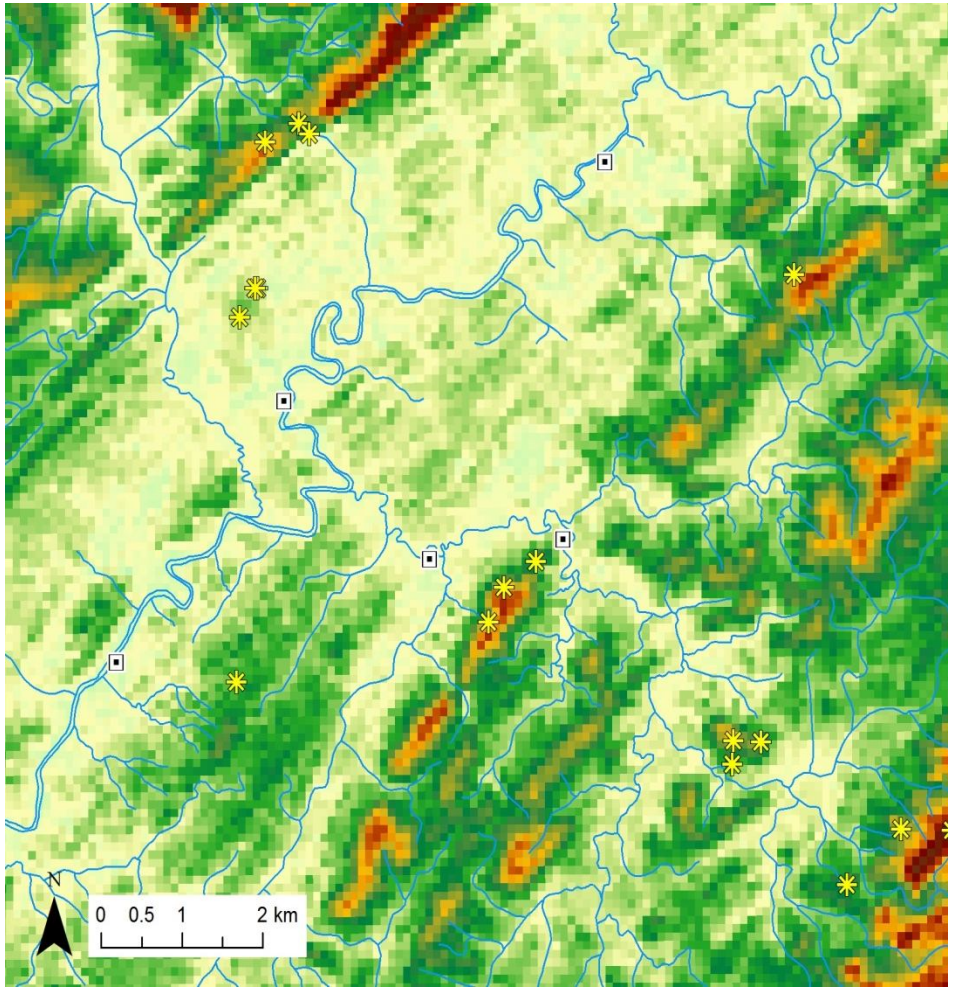


- Changing the perception of CRFs in local communities

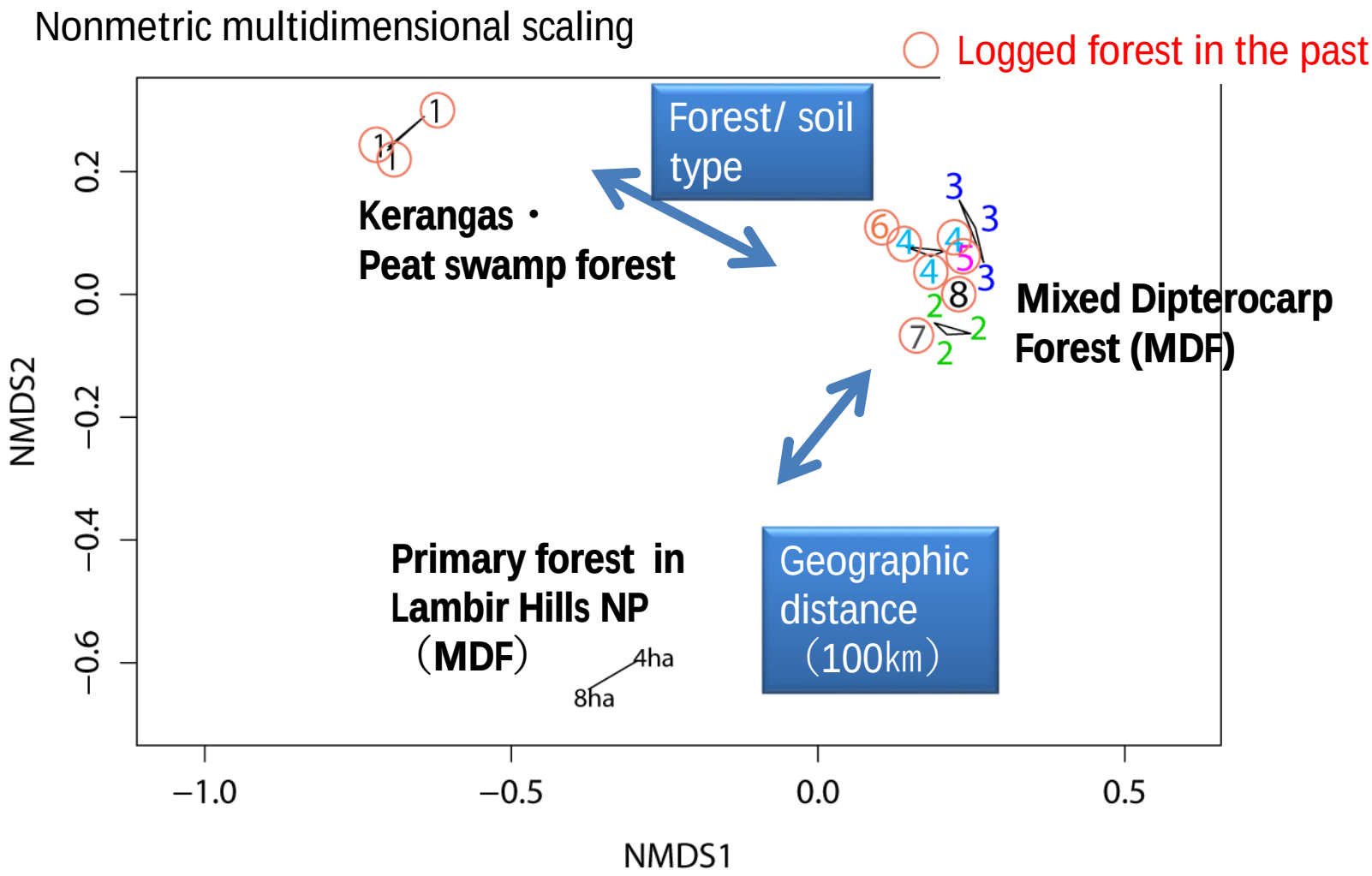
Total land 0.5% → 10 %

Development and CRFs



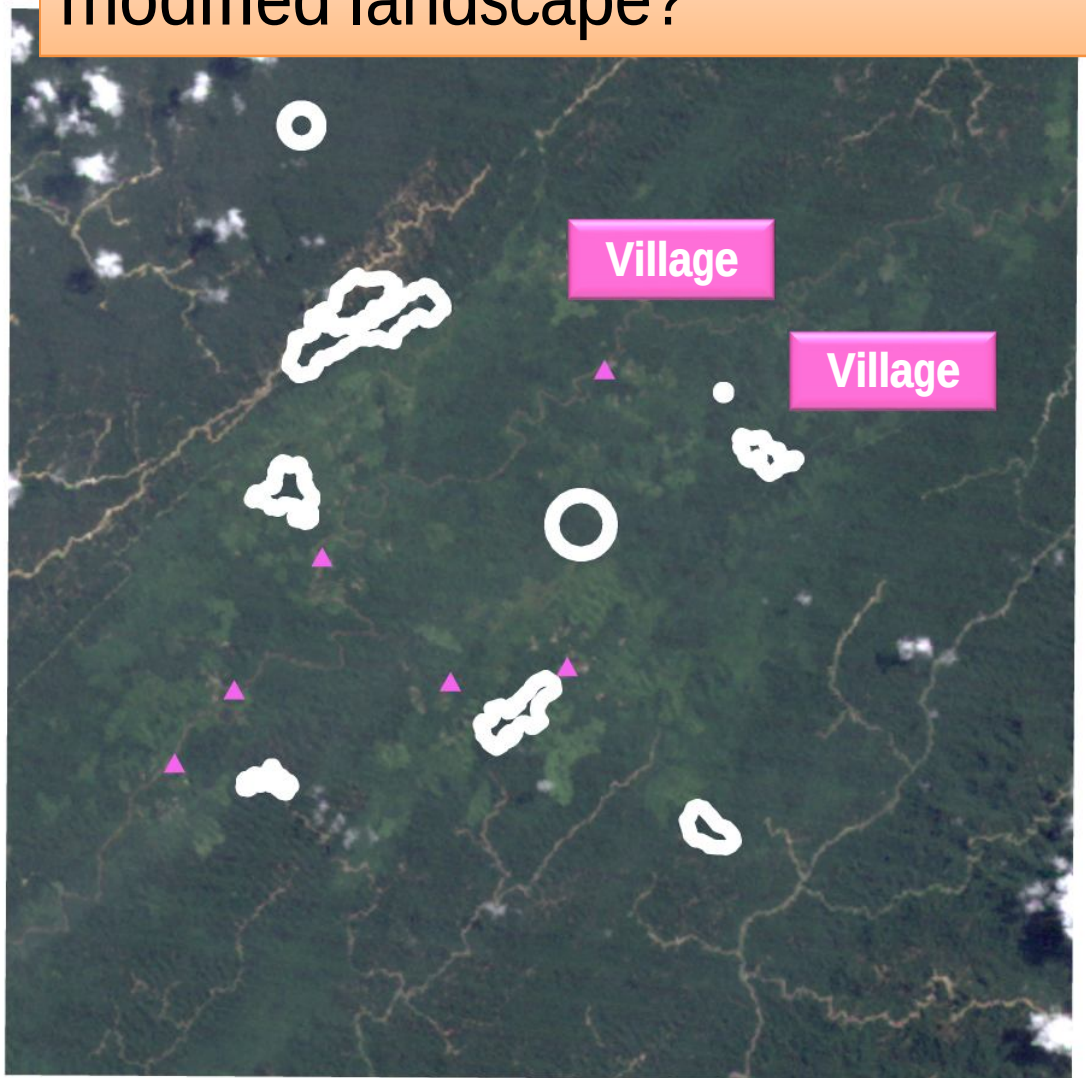


Tree community composition



1. CRFs and Development

How does the status of CRFs change in a human-modified landscape?



5/6 villages hold
10 CRFs in total