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SUSTAINING FORESTS, SUSTAINING PEOPLE
THE ROLE OF RESEARCH

Biodiversity and ecosystem carbon budget in the upland landscapes following shifting cultivation by small-holder *kaingin* farmers in the Philippines

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Background – Shifting cultivation

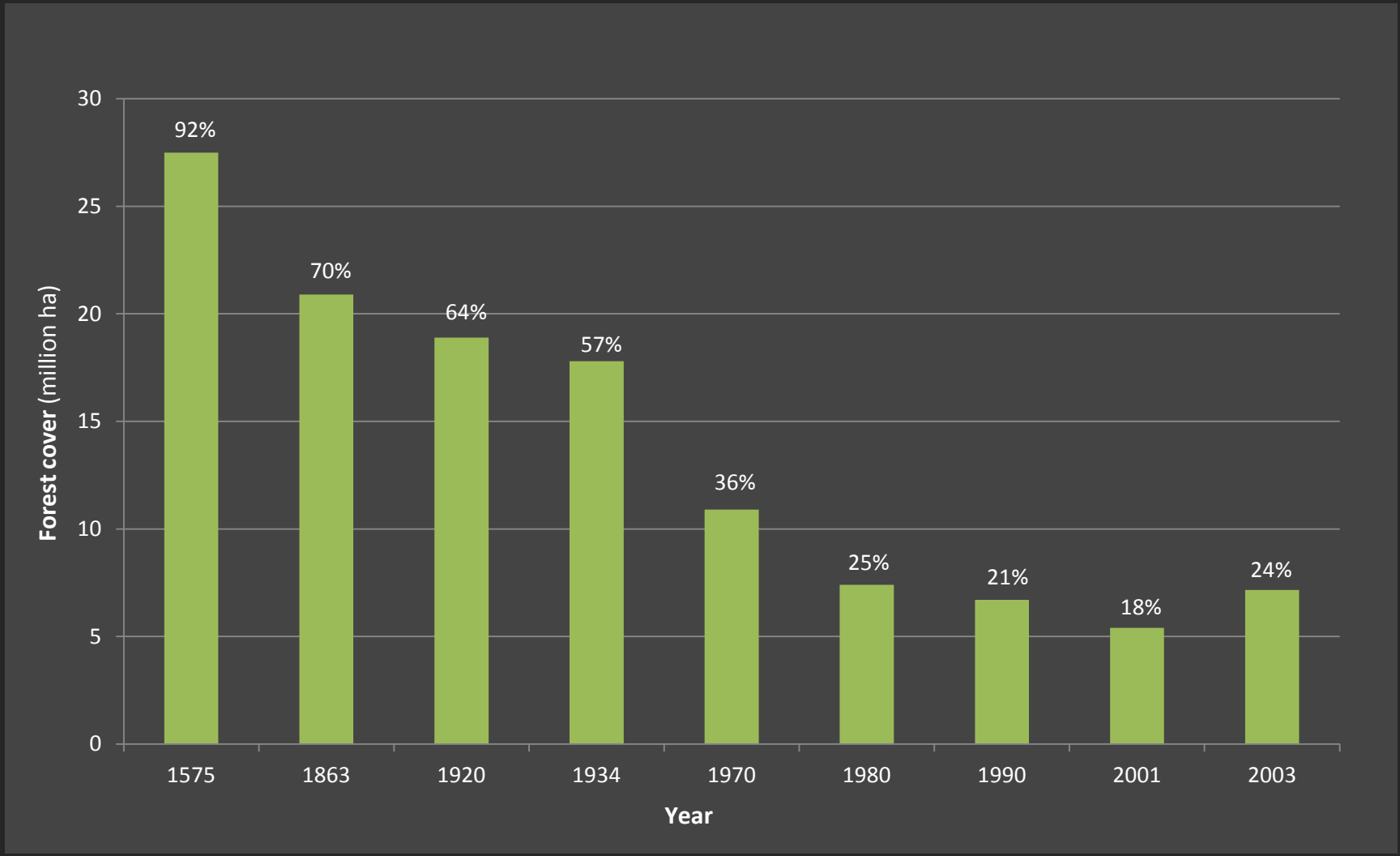
- 1/3 of the tropics were under some kind of shifting cultivation (Dove 1983);
- About 40 million-1 billion people rely on shifting cultivation for food security and livelihoods (Mertz et al. 2009);
- Blamed as a major drivers of deforestation and biodiversity loss in most scientific and policy documents;
- As a consequence of shifting cultivation, regenerating secondary forests following SC are becoming prominent in the tropics;

A shifting cultivation landscape in the Chittagong Hill Tracts of Bangladesh
(Photo credit: MR Hasan)

Background – Forest biodiversity & deforestation in the Philippines

- Forest area – 7.17 million ha (24% of the total land);
- One of the worlds '17 mega-biodiversity countries'/'34 global biodiversity hot-spots' with about 20, 000 endemic species;
- Experienced one of the highest rates of deforestation in the Southeast Asia;
- A pioneer countries to introduce massive reforestation program to address the issue of forest loss and degradation (Chokkalingam et al. 2006);
- 7620 plant species (77% endemic) (Sodhi et al. 2004)

Trends of deforestation in the Philippines



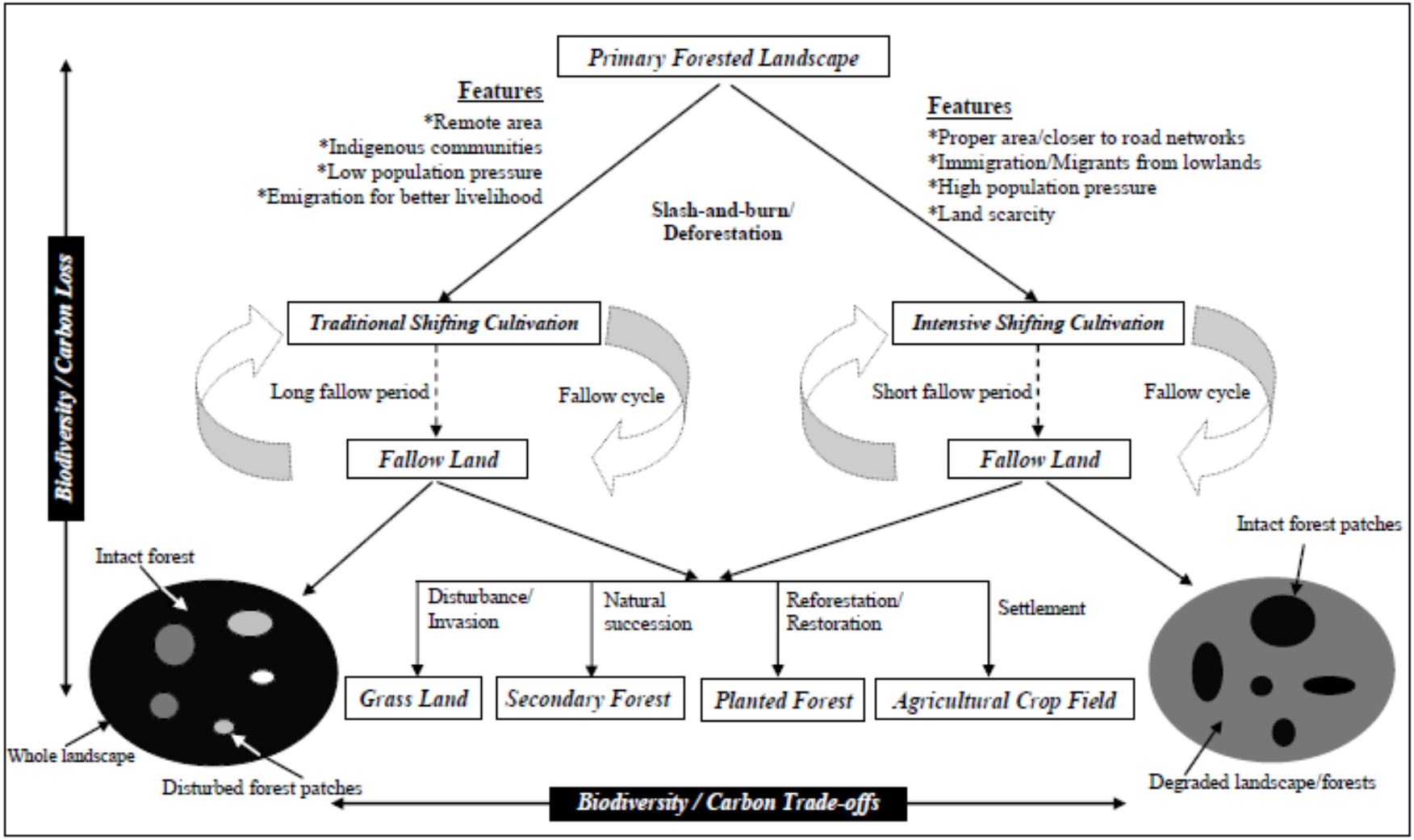
Source: RMPFD 2003

Shifting cultivation in the Philippines context

- Locally familiar as – *kaingin*;
- Blamed for majority of the country's deforestation and forest degradation in the upland areas (Kummer 1992);
- Major forestry policies (e.g. *kaingin* Management and Land Settlement Regulation, 1971), tried to impose restriction on it assuming a minor or negative consequences on ecosystem and the environment (Harrison et al. 2004) .

A complex mosaic of secondary regrowth following *kaingin* and other disturbances in the Philippines upland

Study context



Research question

~o~

"What is the tree diversity and carbon storage in post-kaingin secondary forests in the upland Philippines, and what implication they have for land-use policy development integrating small-holder farmers?"

~o~

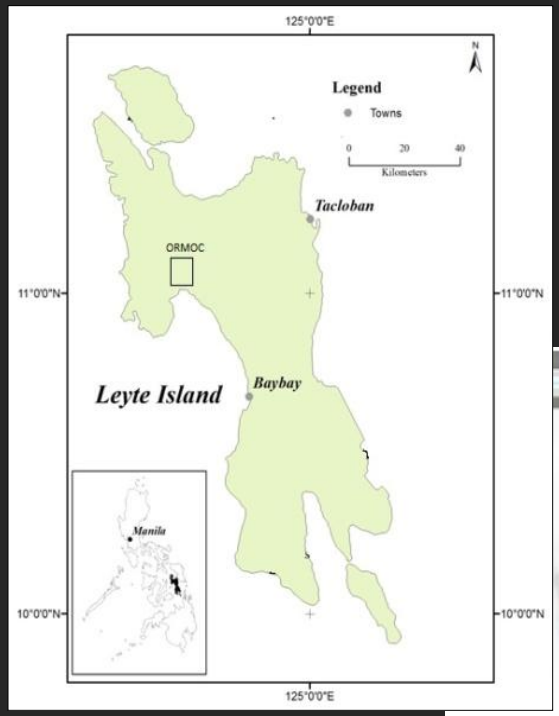
Methodology

- Modified Gentry plot approach: transect (50 m x 5 m) surveys in 20 *kaingin* sites (> 1 ha), and in secondary forests (n=5);

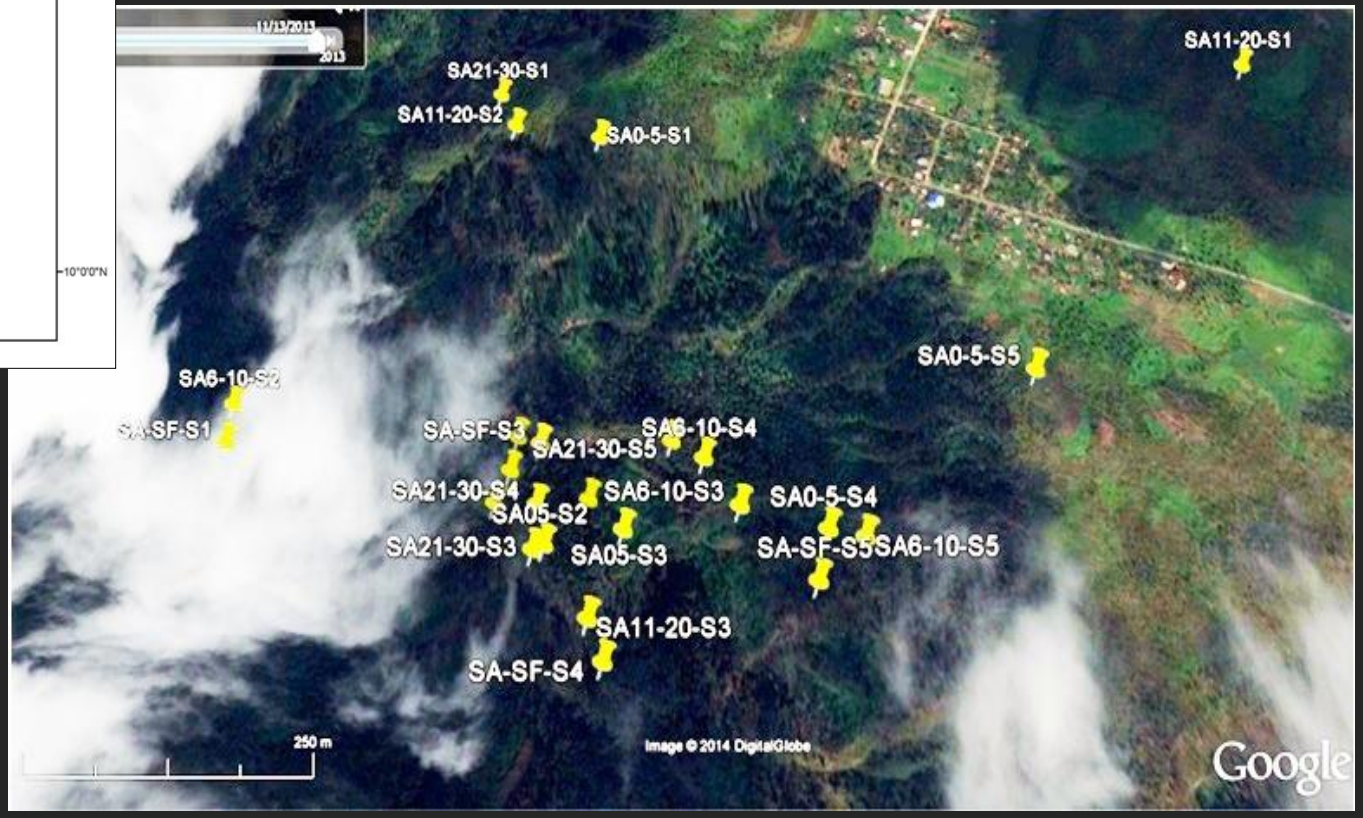
- 4 transects from each sites of the following fallow categories,

    - *Less than 5 years*
    - *More than 5 years and less than 10 years*
    - *More than 10 years and less than 20 years and*
    - *More than 20 years and less than 30 years under fallow*

Study area



Barangy Gaas, Ormoc, Leyte Island



Methodology – *cont.*

Vegetation survey (@ transect level) **-**

- diameter of standing tree (≥ 5 cm at dbh); (***N = 2918***)
- height of individuals, and respective position in transect (X/Y);
- diameter and length of dead trees (freshly cut; moderately decomposed, rotten, burnt; standing/lying on ground) with dbh ≥ 5 cm (***N = 1281***);

Site parameters –

- fallow age, patch size, GPS coordinates, elevation, distance, slope, LAI, topographic position, adjacent land-use/cover, disturbances.

Data analysis

Biodiversity indices:

- Species richness (S)
- Shannon-Weiner index (H)
- Species evenness / Pilou's diversity index (J)
- Stem number (N)

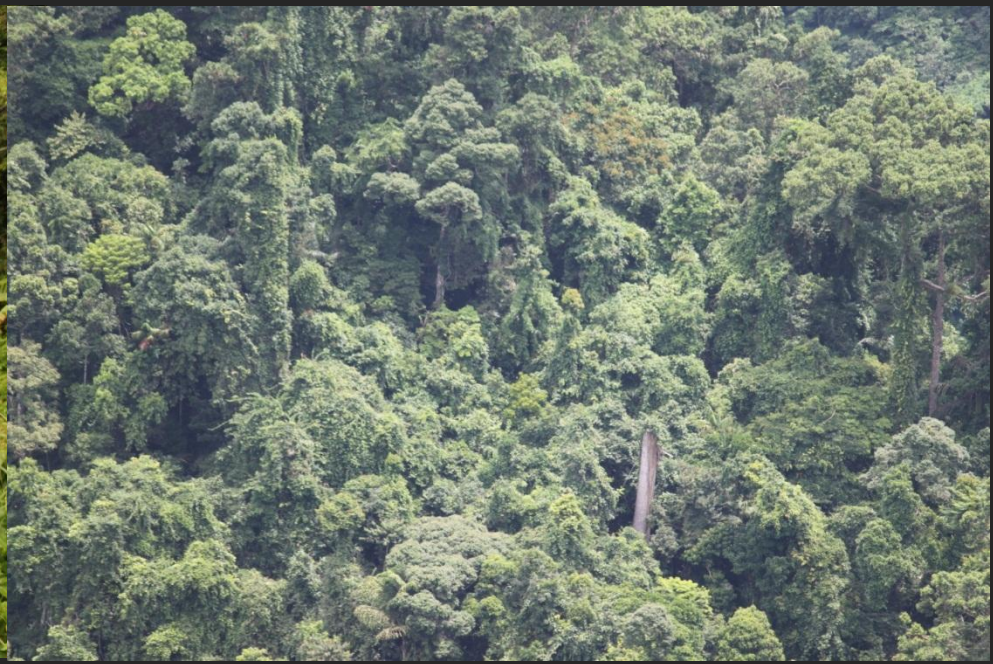
Considerations for ecosystem carbon budget

Above ground	Below ground
Allometric relationships Standing trees (≥ 5 cm dbh) (N= 2918) Dead/burnt trees (≥ 5 cm dbh) (N=1281) Tree ferns (> 5 cm dbh) (N = 184) Abaca (> 5 cm dbh) (N= 124) (Brown 1997, Chave et al. 2005; Ketterings et al. 2001) Destructive sampling Seedlings Saplings Leaf litter and Woody debris	Laboratory analysis Soil (0-30 cm) (N = 900) Fine roots (0-5 cm) (N= 300) Coarse root (15% of AGB)

A newly opened site for *kaingin* in the area

A ~ 20 years *kaingin* fallow site

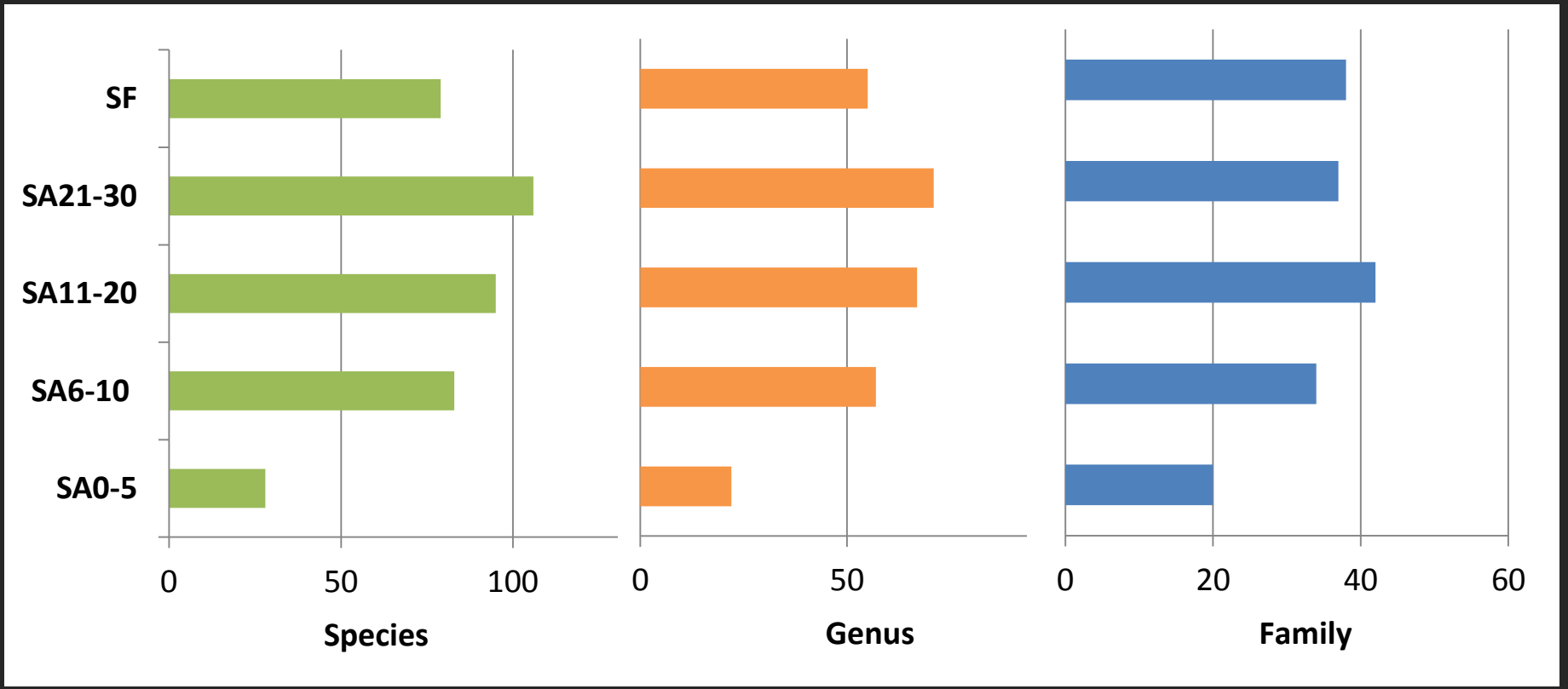
A ~ 30 years *kaingin* fallow site

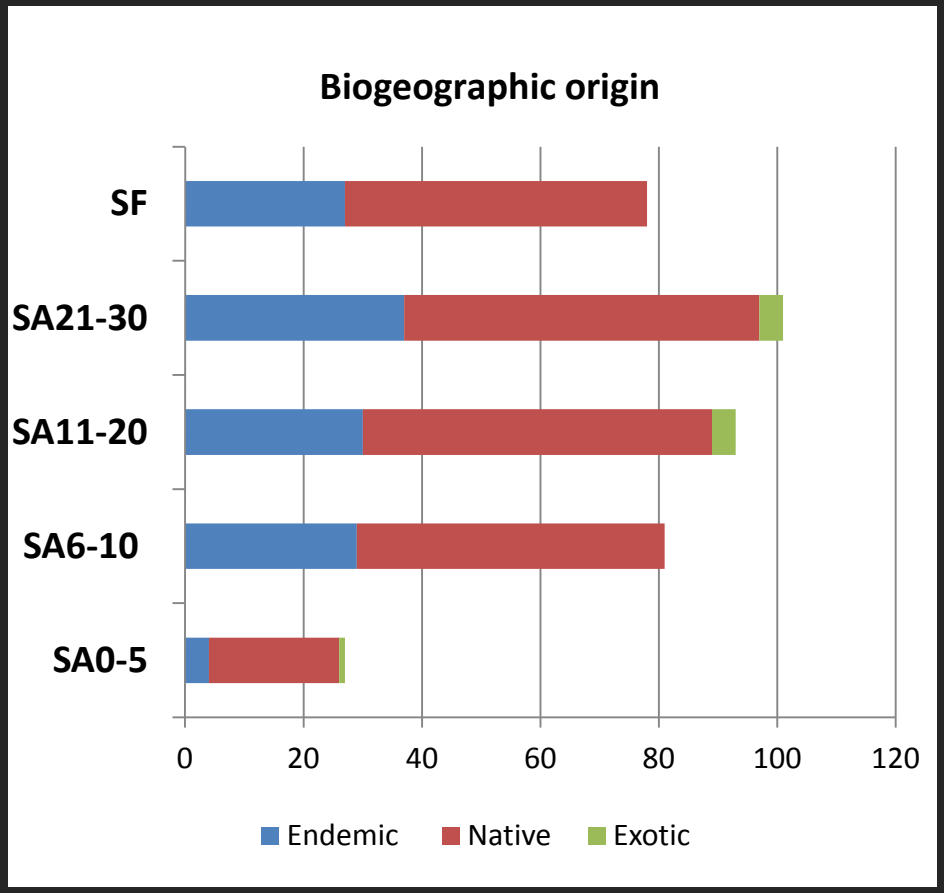


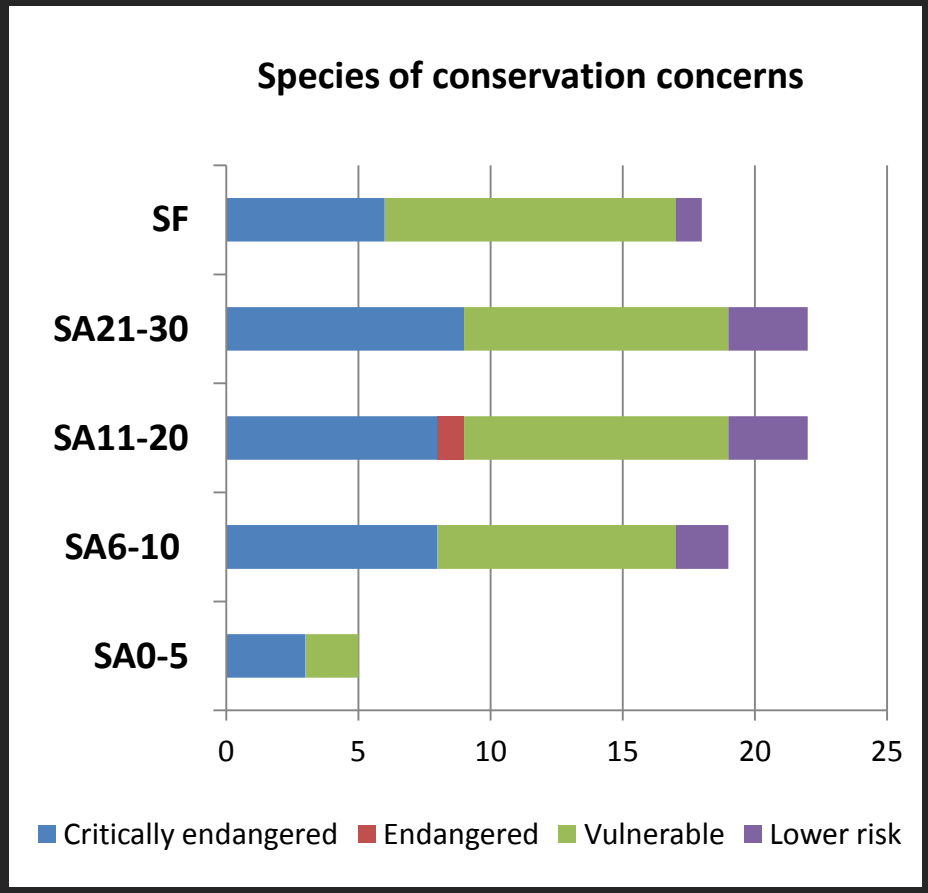
A secondary forest site without any *kaingin*

Study finding

- 131 species belonging to 86 genera and 46 families;
- 12 late successional/climax; 58 intermediate; 61 pioneer species
- Moraceae (14 species); Dipterocarpaceae (10 species)



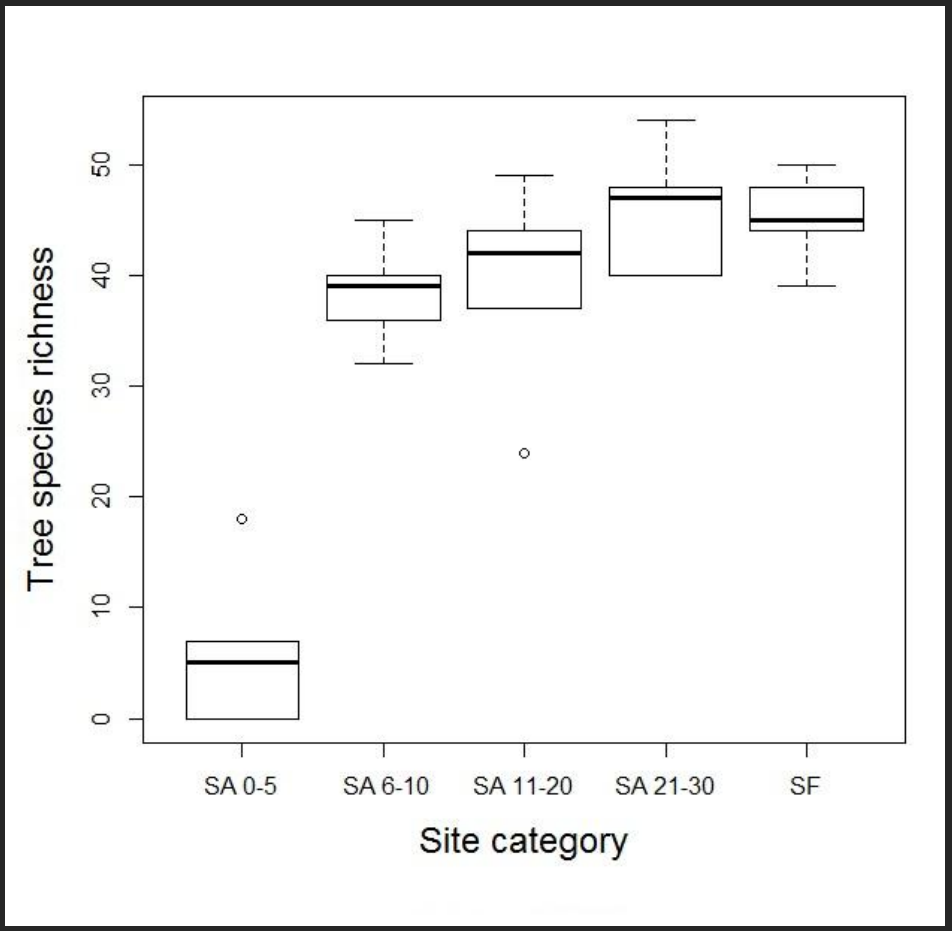

Biogeographic origin
SF
SA21-30
SA11-20
SA6-10
SA0-5
0
20
40
60
80
100
120
Endemic
Native
Exotic

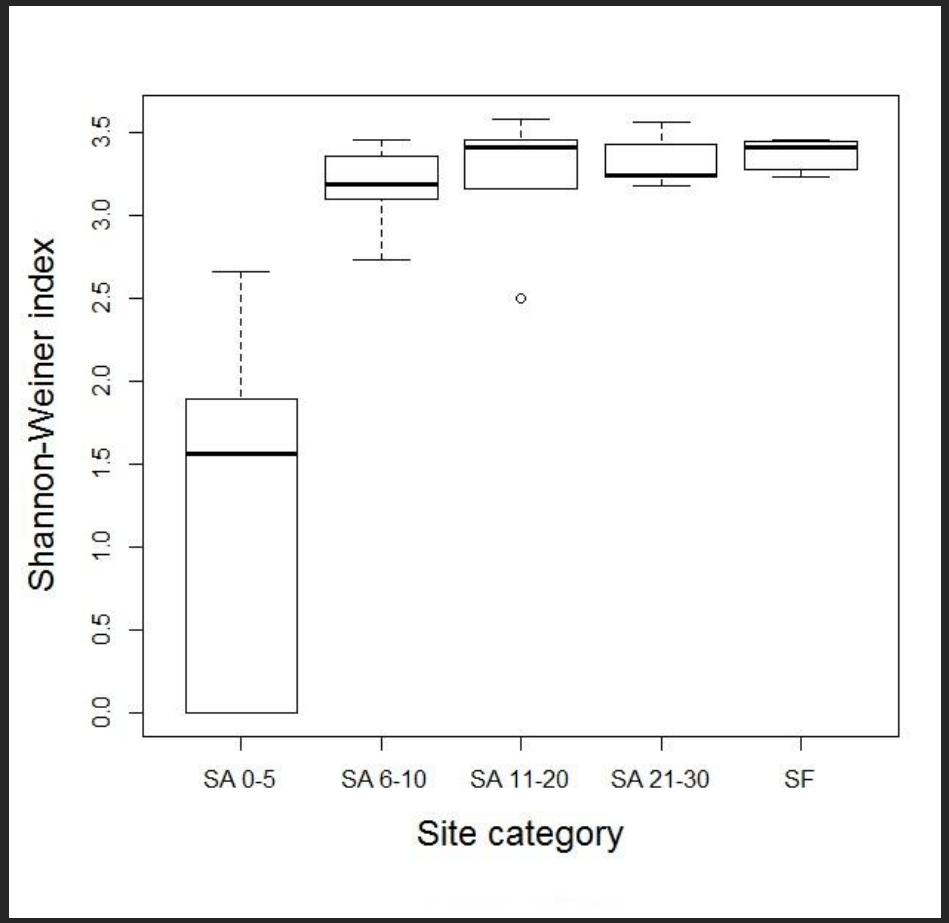

Species of conservation concerns
SF
SA21-30
SA11-20
SA6-10
SA0-5
0
5
10
15
20
25
Critically endangered
Endangered
Vulnerable
Lower risk

Diversity indices

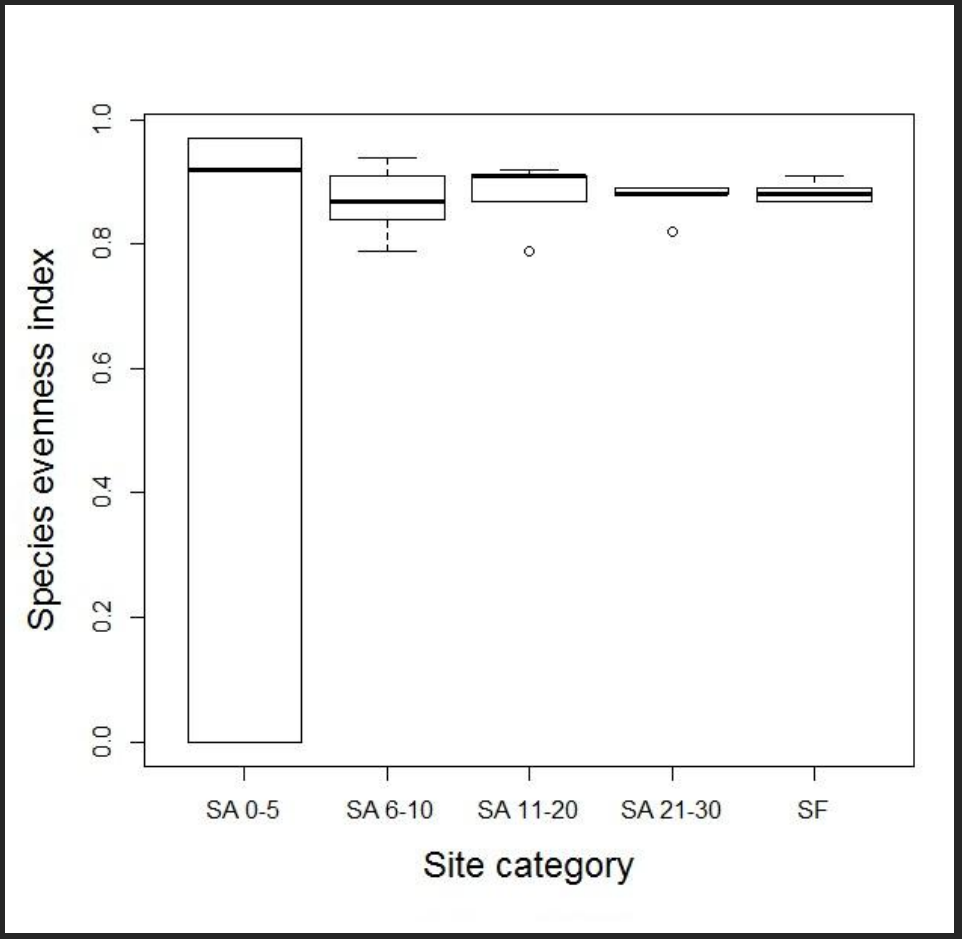
Diversity indices	Fallow category				Secondary forest
	0-5 years	6-10 years	11-20 years	21-30 years	
Species richness (*S*)	6 (±7.38)	38.4 (±4.82)	39.2 (±9.52)	45.8 (±5.93)	45.2 (±4.21)
Shannon-Wiener index (*H*)	1.22 (±1.18)	3.17 (±0.28)	3.22 (±0.43)	3.33 (±0.16)	3.37 (±0.11)
Species Evenness index (*J*)	0.57 (±0.52)	0.87 (±0.06)	0.88 (±0.06)	0.87 (±0.03)	0.88 (±0.02)
Stem number (*N*)	10.8 (±13.52)	142.6 (±20.5)	140.8 (±26.94)	143.6 (±4.45)	145.8 (±16.53)

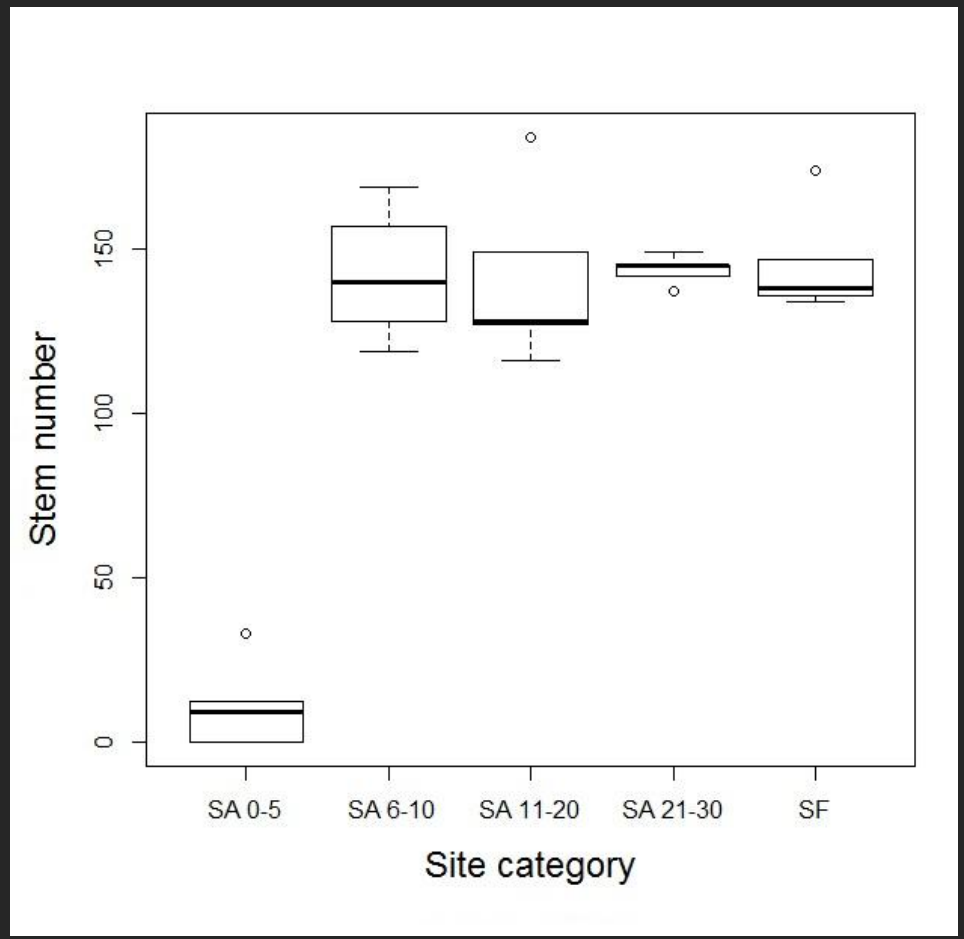
Tree diversity



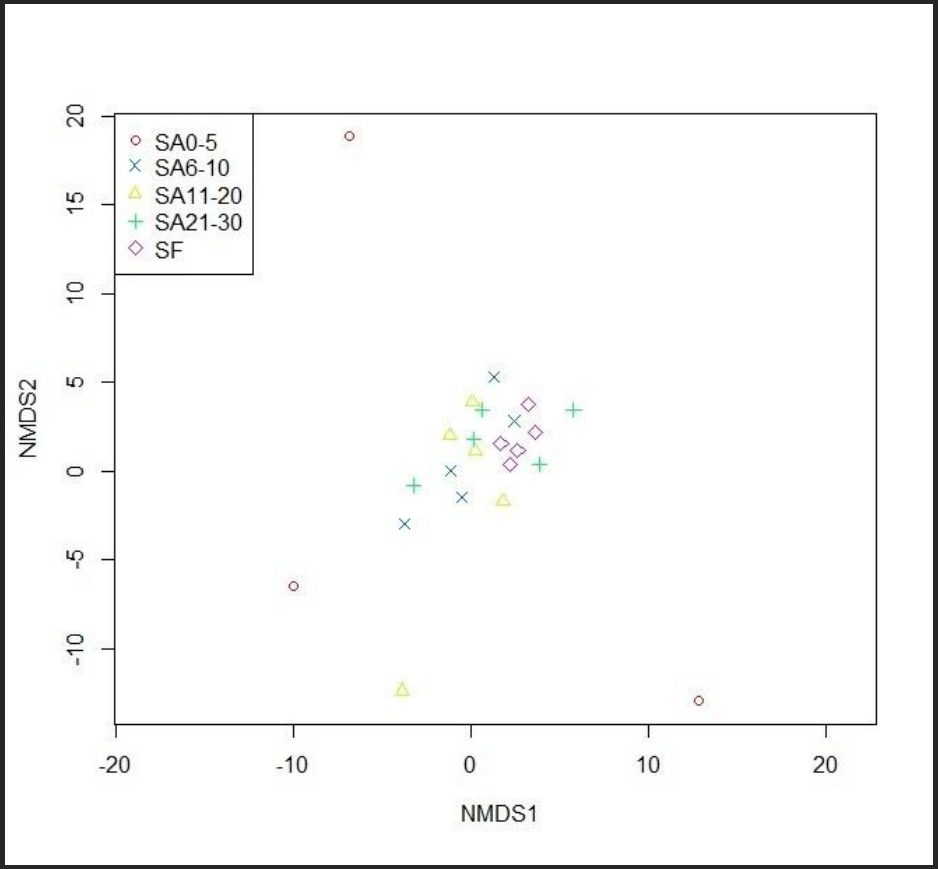


Tree diversity - cont.

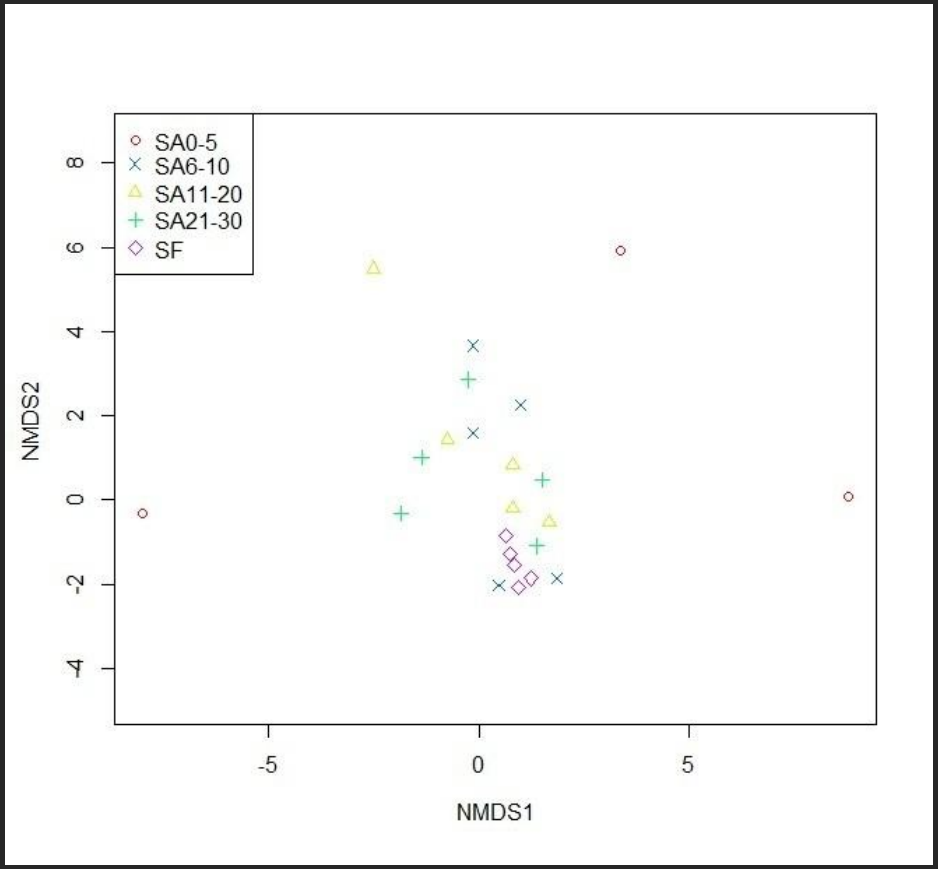




Species compositional similarities

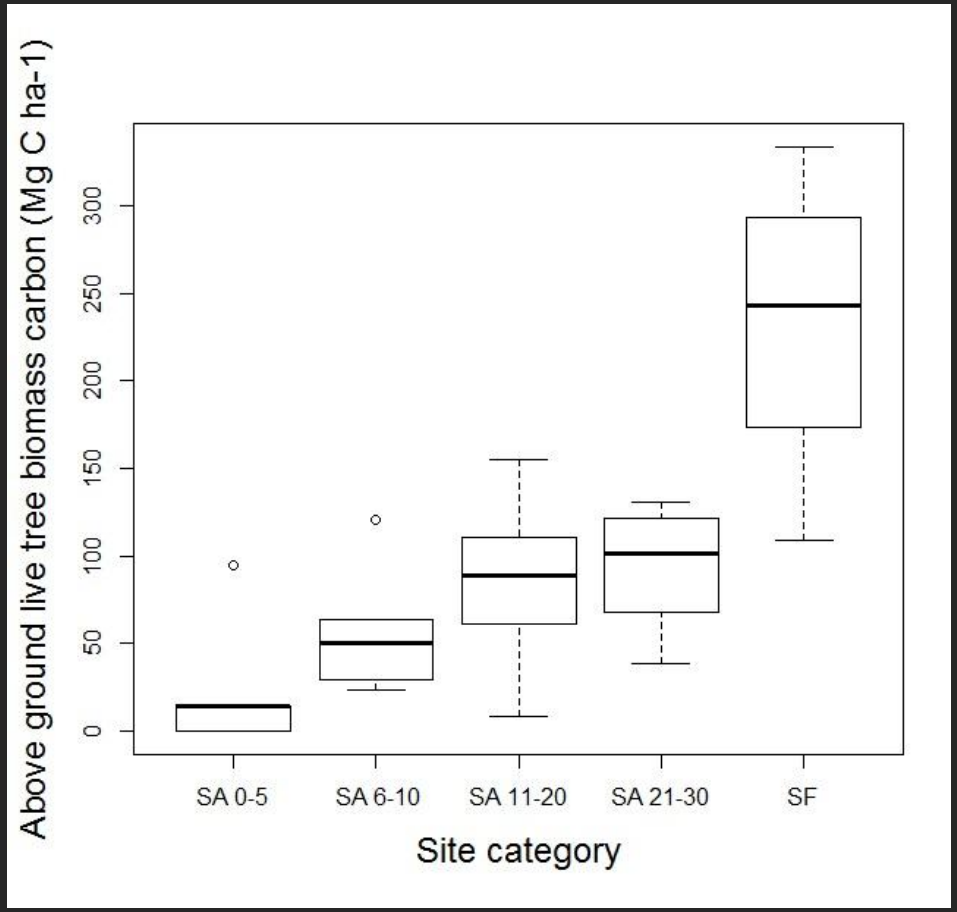


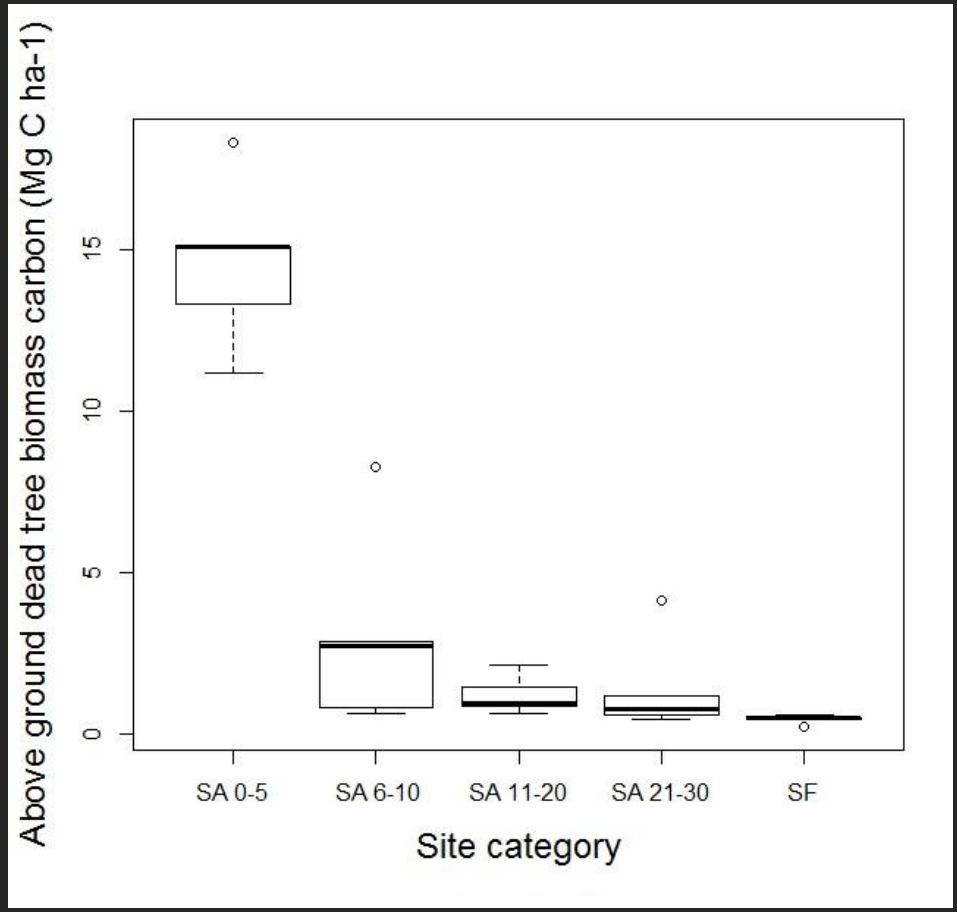
Species richness
Stress: 12.16



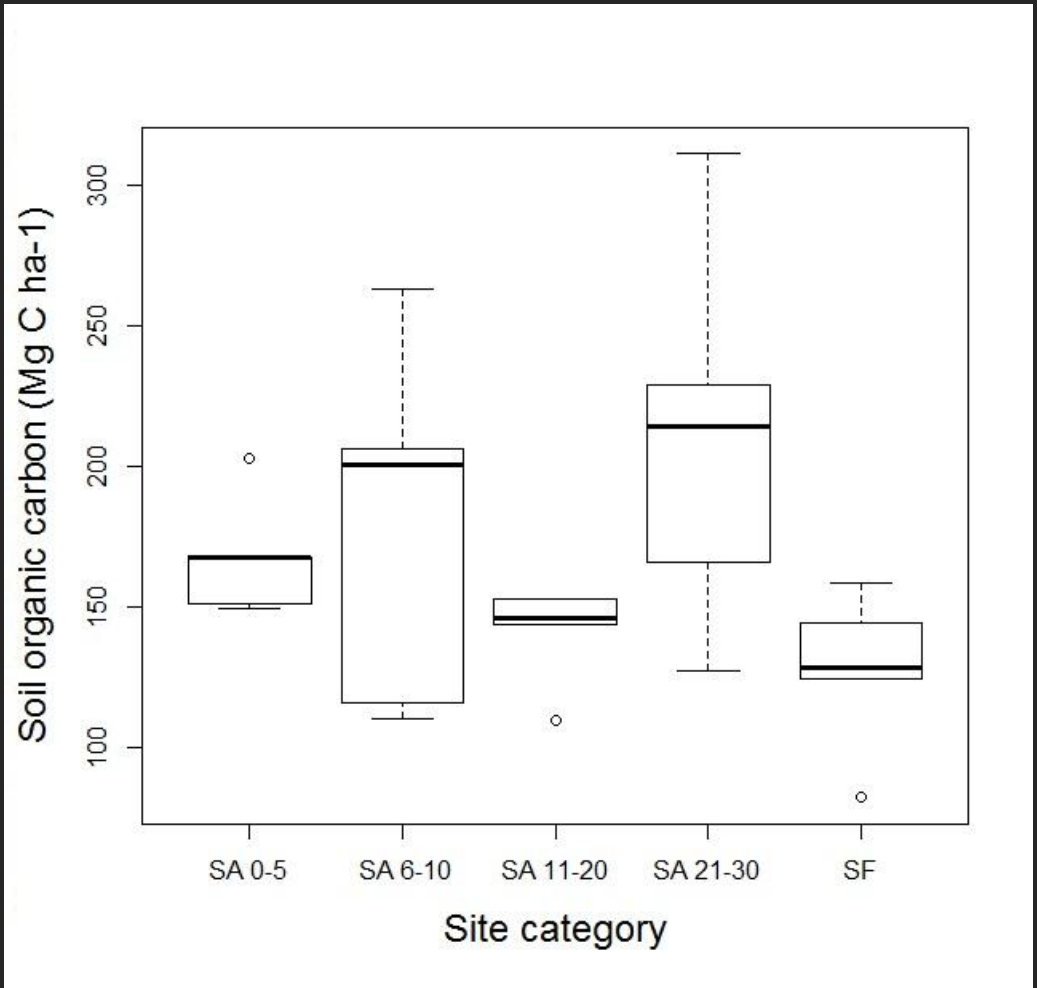
Species abundance
Stress: 13.61

Biomass and soil carbon

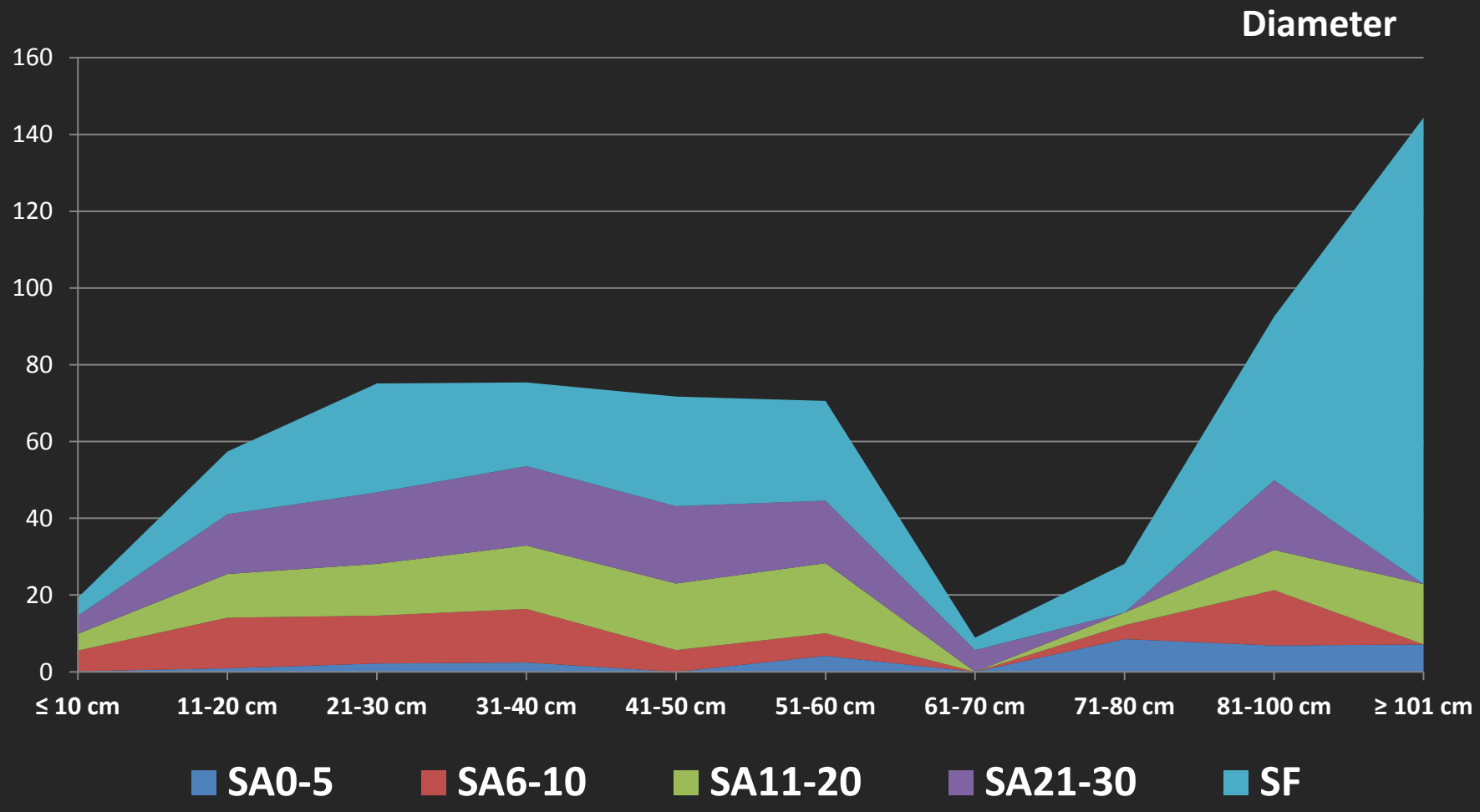




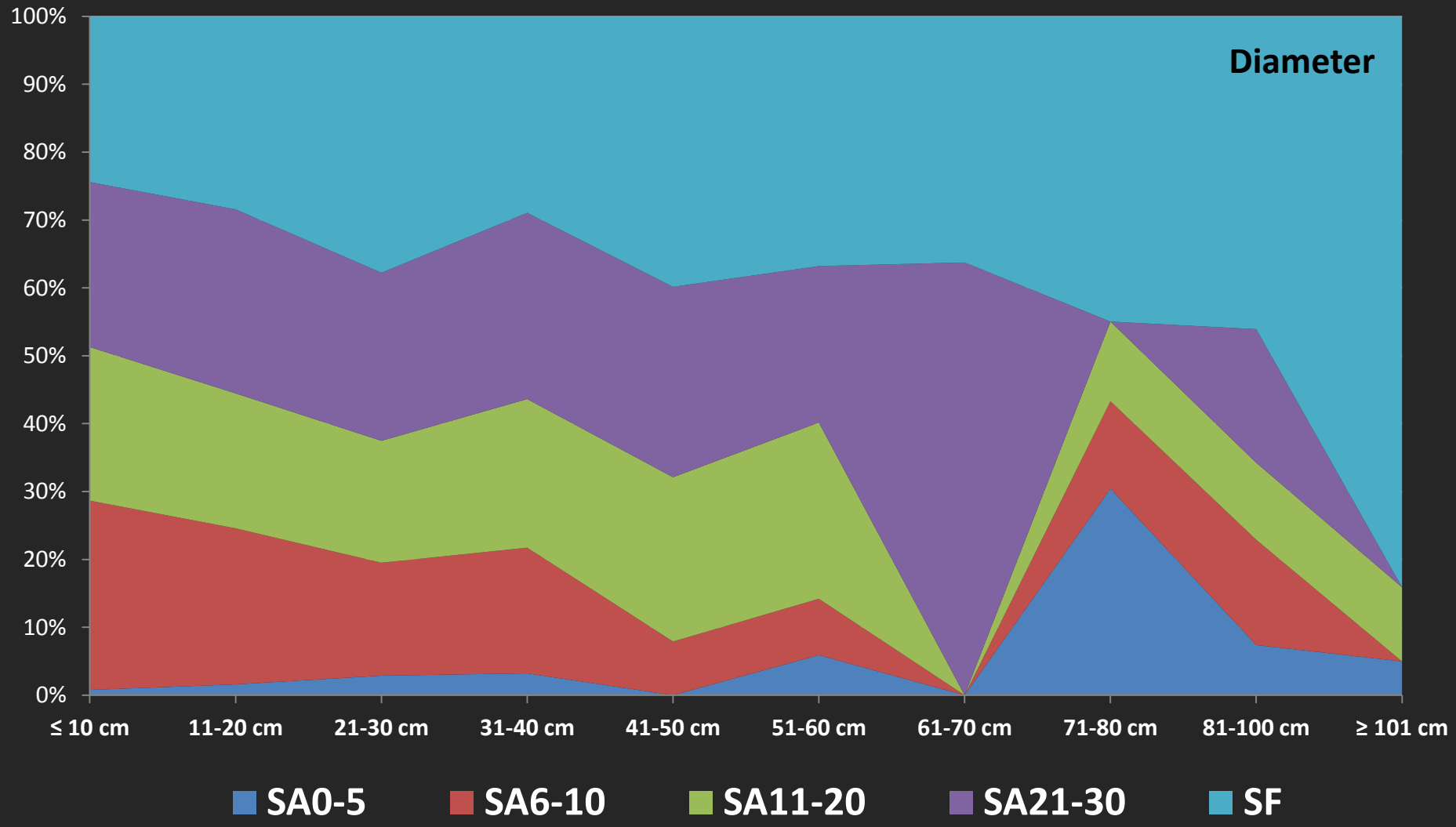
Cont.


Soil organic carbon (Mg C ha-1)
100
150
200
250
300
SA 0-5
SA 6-10
SA 11-20
SA 21-30
SF
Site category

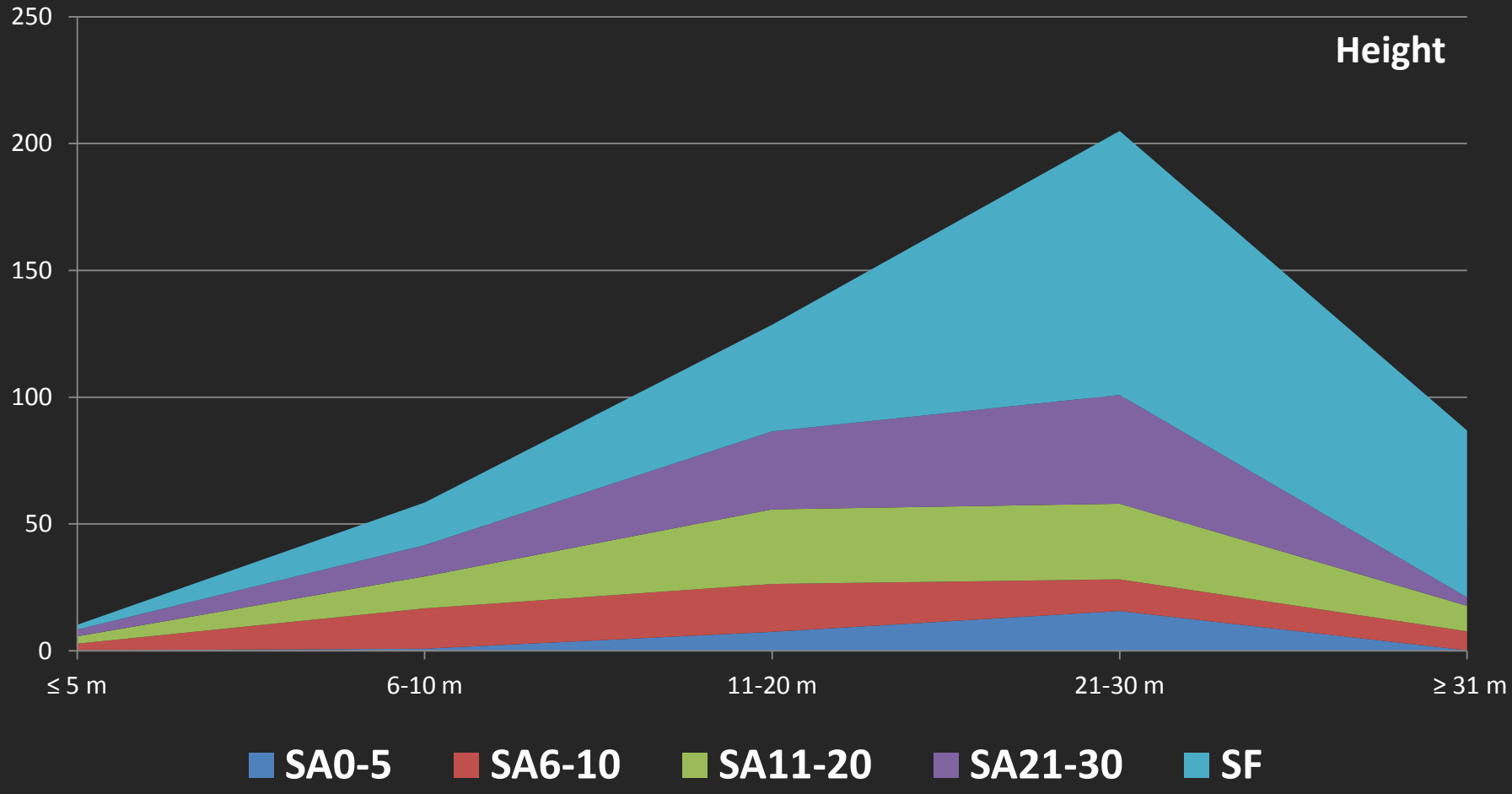
Carbon storage in above ground live tree biomass (Mg C ha $^{-1}$)



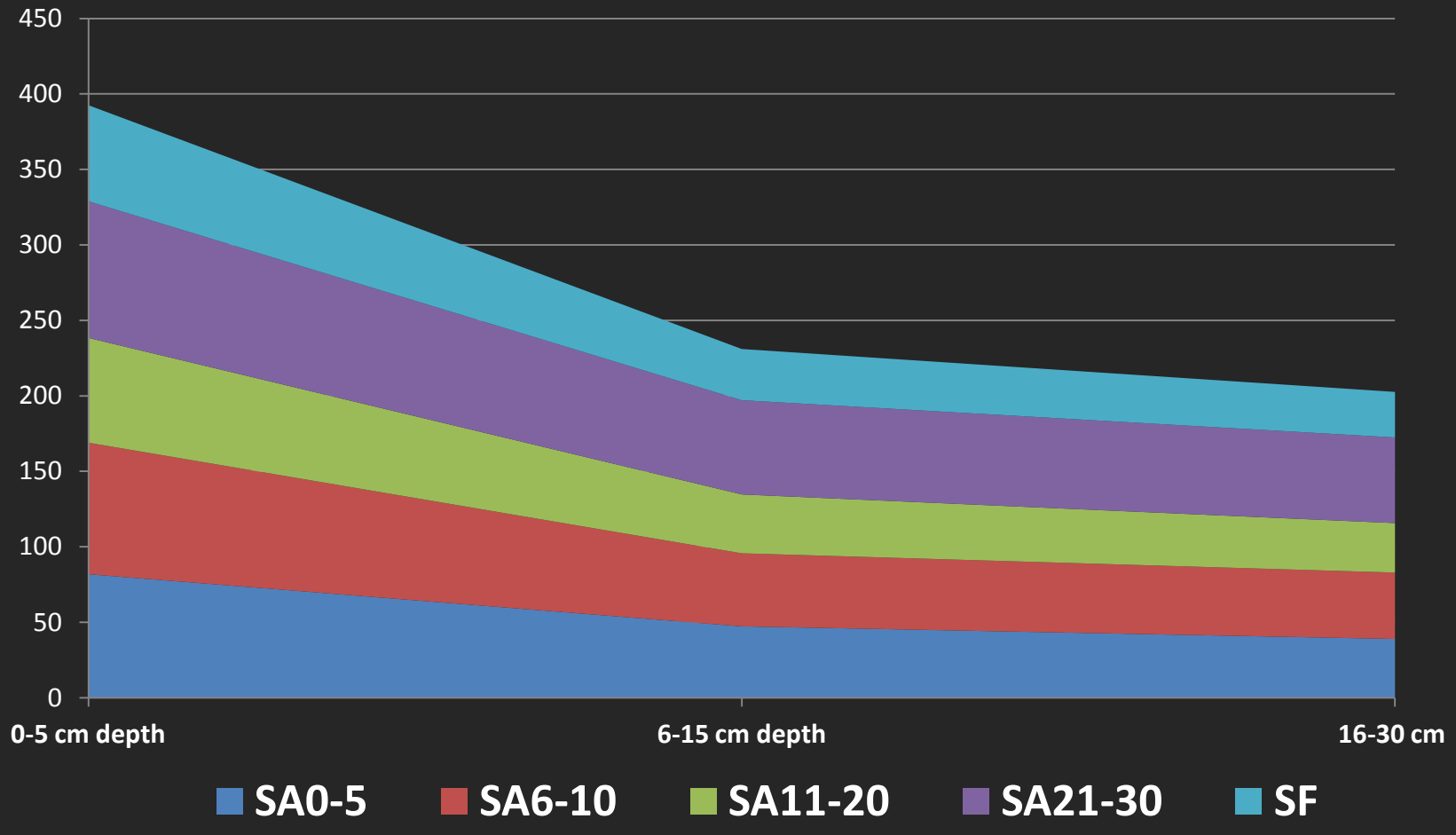
Carbon storage in above ground live tree biomass (Mg C ha $^{-1}$)



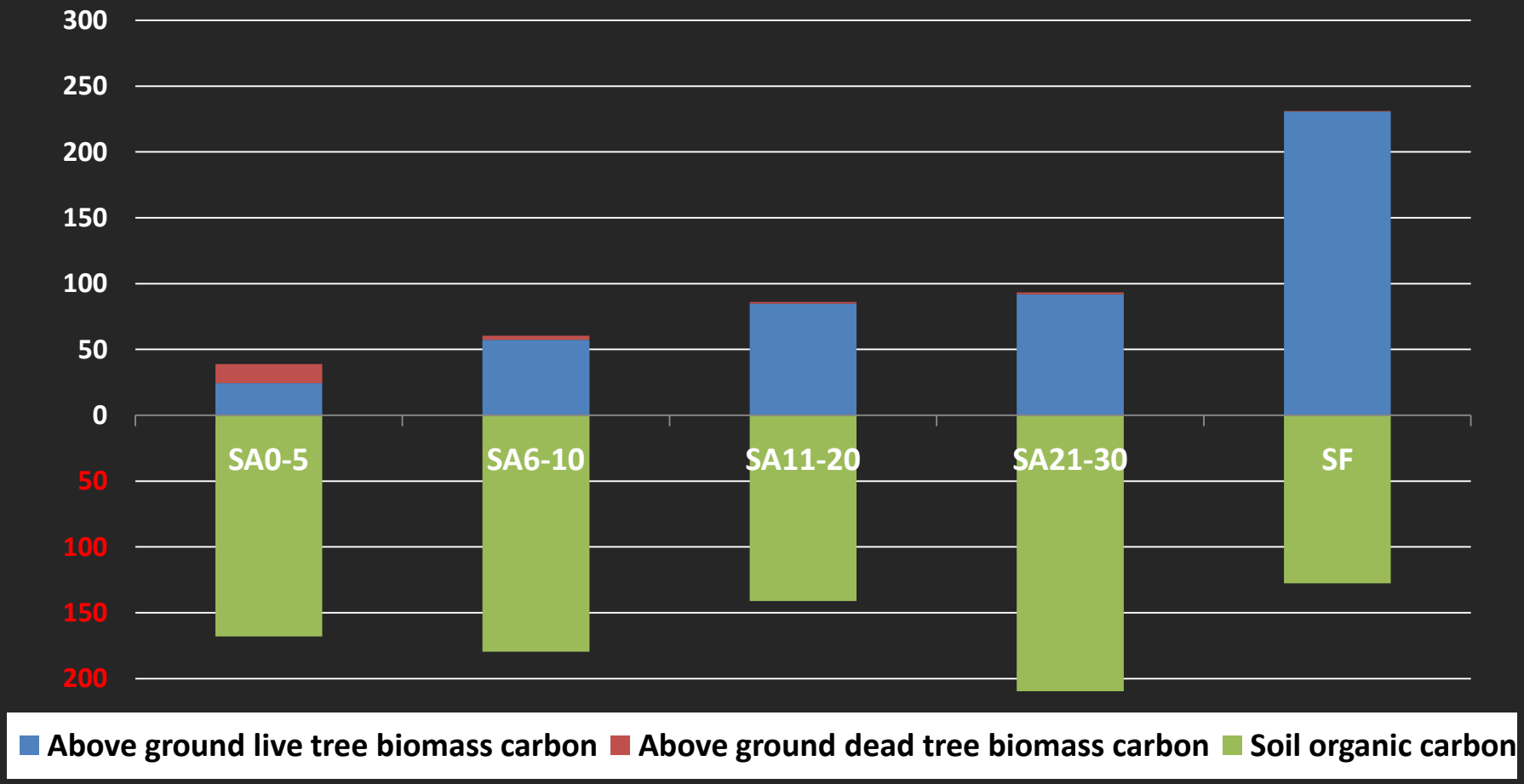
Carbon storage in above ground tree biomass (Mg C ha $^{-1}$)



Organic carbon storage in soil (Mg C ha $^{-1}$)



Total carbon storage at the landscape level (Mg C ha $^{-1}$)



Above ground C in other common upland land-cover/use in Philippines

Land-use	AGB carbon density (Mg C ha^{-1})	Carbon sequestration	Reference
Natural forest	518		Lasco *et al.* (1999)
Imperata grassland	8.5	0, burnt regularly	Lasco *et al.* (1999)
Sacharrum sp.	13.1	0, burnt regularly	Lasco *et al.* (1999)
Rice paddy fields	3.1	0, burnt regularly	Lasco *et al.* (1999)
Plantations			
Mahogany	264		Lasco *et al*. (2000)
Acacia sp.	81		Lasco *et al*. (2000)
Dipterocarp	221		Lasco *et al*. (2000)

Conclusion

- Comparable and rapid recovery of biodiversity;
- Carbon sequestration and storage are largely influenced by fallow length, and it takes as much as 30 years to recover ~40% C as in the undisturbed forests;
- Regenerating secondary forests can be a cost effective restoration strategy in tropical developing countries;
- Incorporation of REDD+ with this land-use can be beneficial for both small-holder rural farmers and for the local environment.

Acknowledgements

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Photo credits: S.A. Mukul