Different land use effect on earthworms at SAFE Project site in Sabah, Borneo

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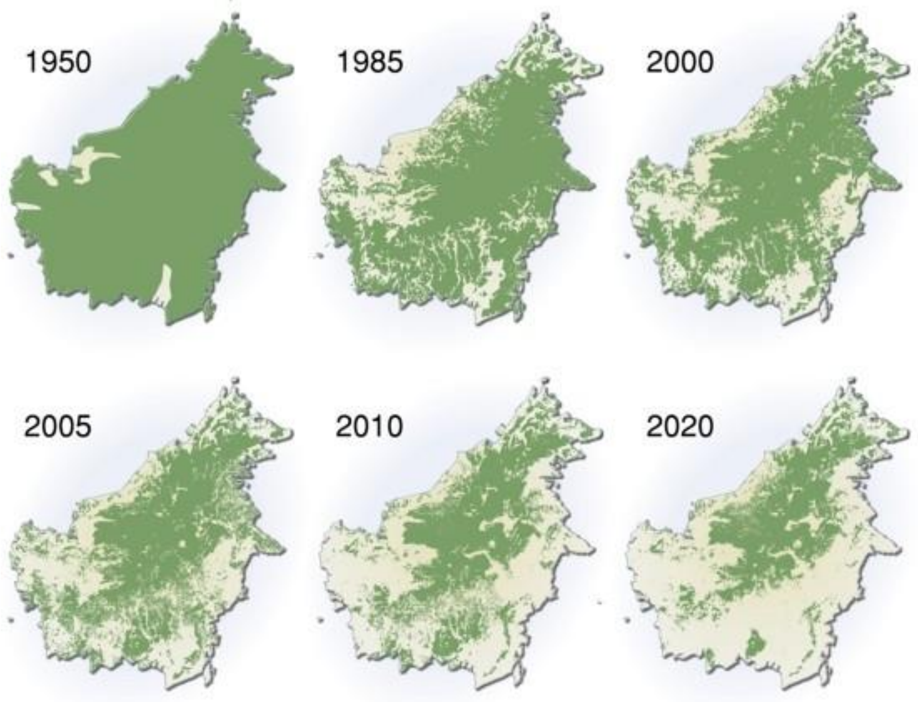
BACKGROUND

The tropical rainforest of Borneo is a mega-diverse region that is fast disappearing due to logging and intensive agriculture that have caused significant changes to species diversity and composition across the modification gradient [1].



Extent of deforestation in Borneo 1950-2005 and projection towards 2020 [2]

Many taxa that make up the natural ecosystem are being lost due to this process while their natural patterns and ecological significance is little understood. One of such taxa is the earthworm - a major component of the soil biota as 'ecosystem engineers' and their presence plays a dominant role in the regulation of soil processes, function and fertility [3].

OBJECTIVE

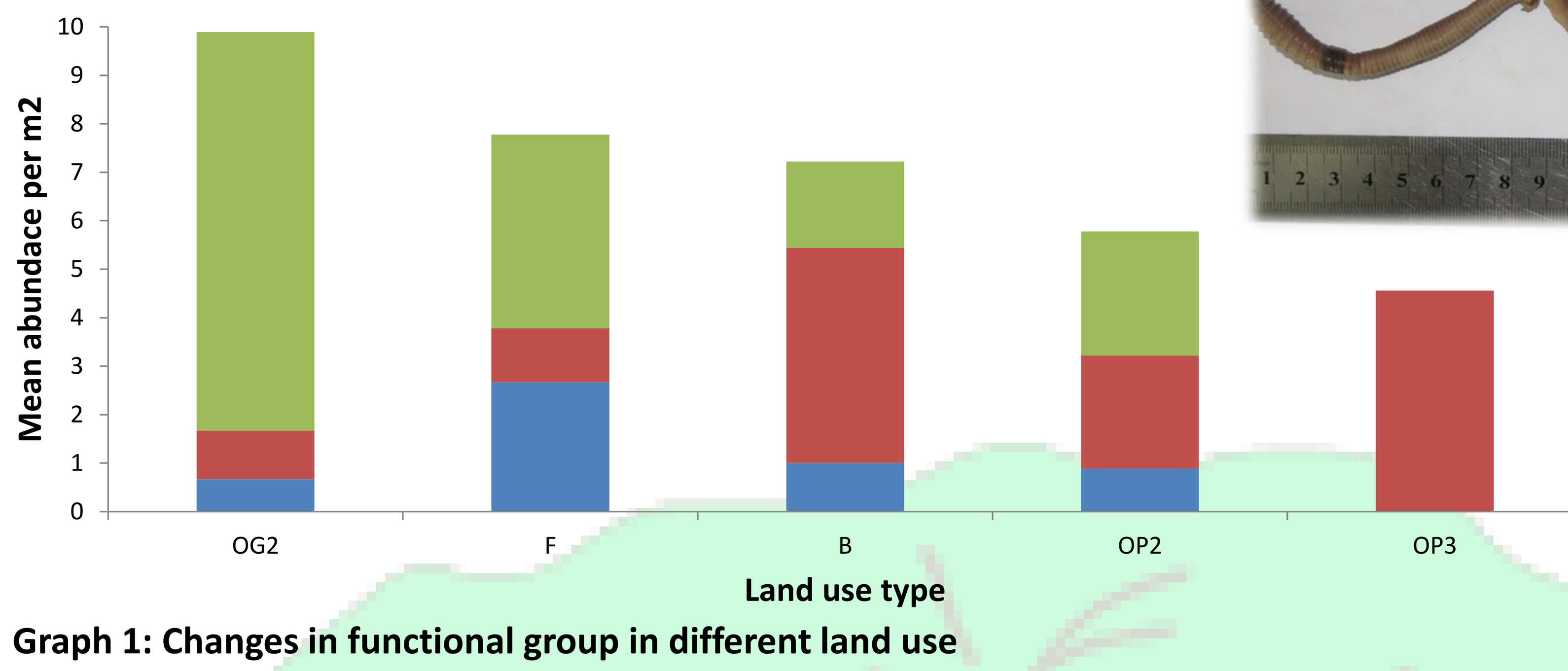
In an attempt to understand how earthworm are being impacted by deforestation and fragmentation and as a result how they may influence soil properties this project aimed to:

1. Compare earthworm density (per m^2) across forest modification gradient to understand how they response to land use change.
2. Identify environmental and soil characteristics that may influence such response.
3. Provide insight on how changes in functional groups can potentially influence soil ecosystem.

METHODS [4,5]

1. Earthworms were sampled from soil using transect and monolith digging method at 9 sites in each different land use (old growth (OG2), logged secondary forest (B & F) and oil palm (OP2 & OP3)).
2. At each monolith, environmental variables were measured to characterise canopy exposure and forest quality and soil samples taken to analyse soil properties.
3. Earthworms were classified to functional groups.

RESULTS



Graph 1: Changes in functional group in different land use

Land use	Total	Epigeic	Endogeic	Anecic	Adult	Juvenile
OG2	24.89±6.306^{a}	8.22±1.824$^{b, c, d}$ (33.0%)	1.00±0.289^{g} (4.0%)	0.67±0.373^{j} (≈3.0%)	9.89±1.594^{n} (40.0%)	15.00±5.225^{o} (60.0%)
F	15.00±3.131	4.00±1.424^{e} (26.7%)	1.11±0.564^{h} (7.4%)	2.67±0.726$^{j, k, l}$ (17.8%)	7.78±1.956 (51.9%)	7.22±2.146 (48.1%)
B	16.00±3.682	1.78±0.909^{b} (11.1%)	4.44±0.835$^{g, h, i}$ (27.8%)	1.00±0.333^{m} (6.3%)	7.22±1.310 (45.2%)	8.78±2.798 (54.8%)
OP2	9.78±2.817^{a}	2.56±1.144$^{c, f}$ (26.2%)	2.33±0.667^{i} (23.8%)	0.89±0.512^{k} (9.1%)	5.78±1.854^{n} (59.1%)	4.00±1.667^{o} (40.9%)
OP3	12.22±6.355	0.00±0.000$^{d, e, f}$ (0.0%)	4.56±2.109 (37.3%)	0.00±0.000$^{l, m}$ (0.0%)	4.56±2.109 (37.3%)	7.67±4.387 (62.7%)

Table 1: Mean earthworm abundance per m^2 comparison between land use. Values are mean ± SD, n = 9 per land use. Superscript alphabets show significant differences in comparisons down the columns. Values sharing a letter are significantly different (P<0.05) from each other (Kruskal-Wallis ANOVA). Composition of abundance per land use is indicated in percentage.

Table 2a & 2b: Difference in environmental variables between land use. Values are mean ± SD, n = 9 per land use. Superscript alphabets show significant differences in comparisons down the columns. Values sharing a letter are significantly different (P<0.05) from each other (One way ANOVA).

Land use	Forest quality (range)	SOM (range)	Soil pH	Soil temperature	Soil moisture
OG2	5.00±0.000^{1,2} (5)	1.806±0.4965 (1 – 3.5)	6.556±0.3446^{10}	29.033±0.2764^{12}	43.15±16.544
F	2.67±1.000^{1,3,4,5} (1 – 4)	2.403±0.2635^{8,9} (1.5 – 4)	6.157±0.3806	25.041±2.8689^{12}	57.04±10.483
B	2.56±0.527^{2,3,6,7} (2 – 3)	1.833±0.5520 (1 – 3.5)	6.181±0.1979	26.604±2.7295	46.71±14.795
OP2	0.00±0.000^{4,6} (0)	1.208±0.1083^{8} (1 – 2)	6.522±0.2954^{11}	26.467±2.7410	54.22±14.900
OP3	0.00±0.000^{5,7} (0)	1.486±0.2756^{9} (1 – 3.5)	6.050±0.4652^{10,11}	27.303±2.8429	53.33±8.583

Table 2a

Land use	Ground light	Litter depth	Top soil depth	Infiltration rate	Dry bulk density	Porosity
OG2	237.73±105.700^{13,14}	4.429±1.4201^{18,19}	4.299±1.3391^{24,25,26}	220.9042±196.06688	1.143199±0.1325459^{31,32}	56.860±5.0017^{36,37}
F	576.37±475.932^{15,16}	3.863±0.9534^{20,21}	2.581±0.6549^{24,27,28}	212.4842±186.71508	0.941299±0.1028040^{31,33,34}	64.479±3.8794^{36,38,39}
B	1796.40±1856.741^{17}	3.391±2.4815^{22,23}	3.842±1.3811^{29,30}	236.0208±163.87362	0.959312±0.0825194^{32,35}	63.800±3.1139^{37,40}
OP2	7942.04±3797.778^{13,15,17}	0.117±0.1100^{18,20,22}	0.334±0.2295^{25,27,29}	349.7039±99.56419	1.190119±0.1217070^{33}	57.822±5.6479^{38}
OP3	4417.16±2797.519^{14,16}	0.072±0.0573^{19,21,23}	0.375±0.2843^{26,28,30}	429.0156±98.04030	1.070328±0.1533846^{34,35}	55.090±4.5927^{39,40}

Table 2b

CONCLUSIONS

1. Earthworm functional groups changed across the modification gradient with epigeic and anecic showing significant shift between land use while endogeic were less affected by disturbance.
2. Given the role earthworms play as ecosystem engineers in soil, this may alter the ecosystem function of the soil with unknown consequences towards other soil biota.

RECOMMENDATIONS

1. Conduct earthworm exclusion experimental designs to detect environmental variables impacted by their presence/absence.
2. Compare how earthworm absence/presence impact other soil biodiversity.

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