Biodiversity and climate change in dynamic landscapes of Indonesia

Sonya Dewi and Andree Ekadinata

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

Background

Indonesia had been identified as the third largest GHG emitter world-wide. More than 50% of the emission was rooted from LULUCF, and a large part of it was related with peat burning, draining and conversion. As the second biodiversity rich country with largest tropical peat land in the world, but at the same time experiencing unprecedented forest extraction and forest conversion, Indonesia has a very important role in delivering some ecosystem services to the global community. Forest extraction and conversion are integral parts of land transformation that is often complex and non-linear, and more over, very variable across Indonesia. At the national level, landscape transformation is driven by international market, global/regional climate, such as El Nino that leads to forest fire, and is an aggregated manifestation of local drivers and activities. Integrated assessment of the impacts of LULUCF on emissions and habitat fragmentation within several global priority ecoregion in Indonesia is necessary to find spaces for harmonizing efforts on climate change mitigation, biodiversity maintenance and sustainable development.

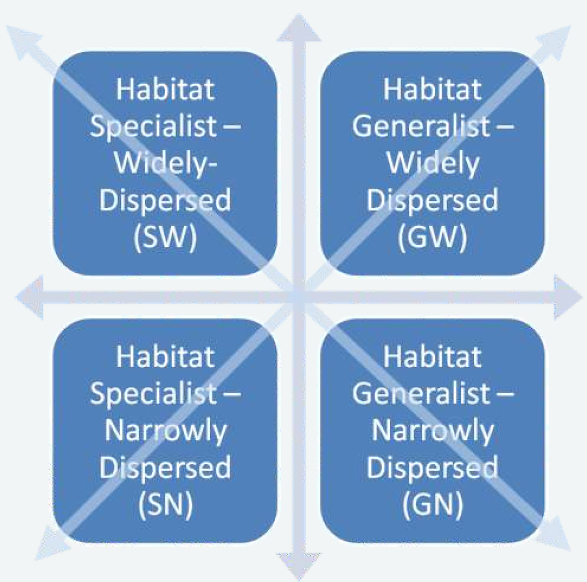
Objectives

1. Forest fragmentations, as approximation of ecosystem reduced function of biodiversity maintenance, is identified and quantified. Roles of agroforestry system in connecting natural ecosystem in multifunctional landscapes are taken into account in defining forest fragmentation. Species differences in responses to habitat and also in dispersal ability is considered.
2. The emissions brought by the land transformation are estimated using the best available dataset, country-wide. Sources and drivers are discussed.
3. Spatial overlap between emissions and reduction in core and connected areas of natural ecosystem is explored within different land designation to find areas where climate change mitigation and biodiversity maintenance can potentially be addressed simultaneously.

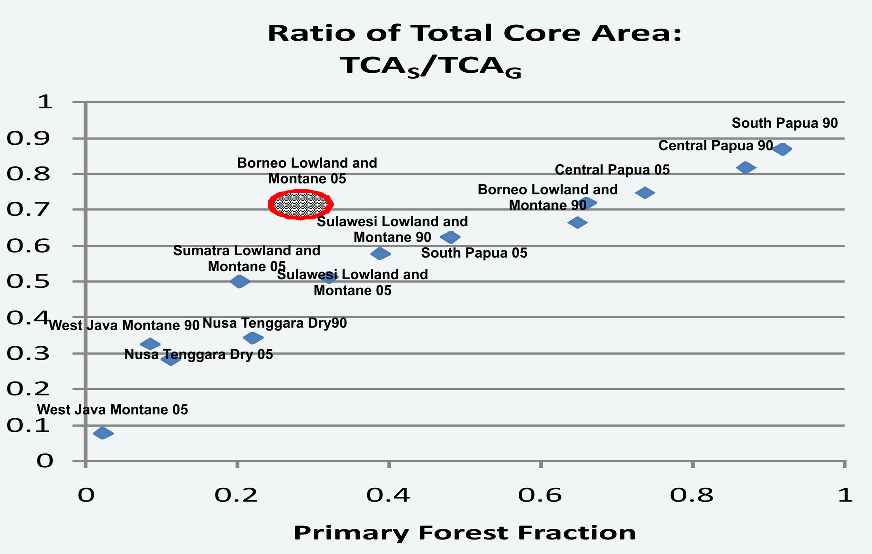
Methods

- Aboveground C-stock estimated based on activity data and emissions factors; for mineral soil, below ground C is not accounted, while for peat land, emissions are estimated using emissions factors taken from (Hooijer et. al, 2009) and peat fire is inferred from the hotspot maps from JICA and Baplan
- Habitat loss per ecoregion is calculated using 3 different methods: (i) consider undisturbed forest only as habitat, (ii) consider matrix of semi-natural mixed tree cover with minimum management, (iii) consider connectivity in calculating habitat. Fragstat 3.3 is used to calculate these spatially-explicit landscape configuration.
- Sensitivity analysis is conducted to compare different habitat responses and dispersal ranges
- Spatial overlay and analysis are conducted to explore relationships among three factor above

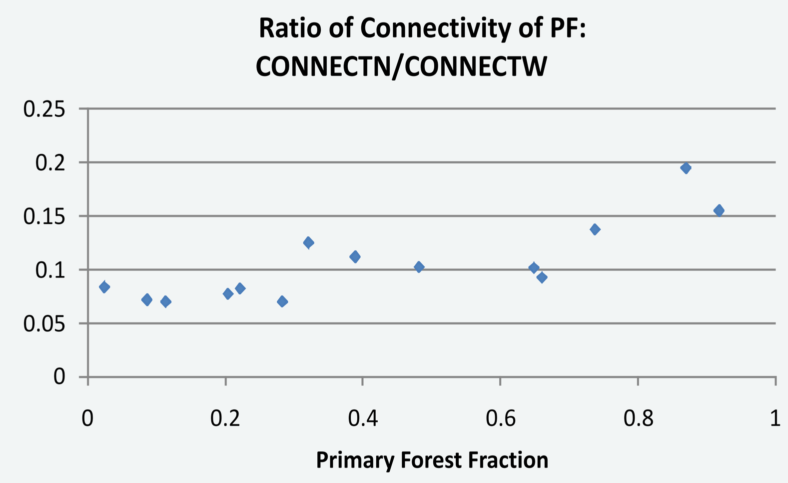
Results and discussion



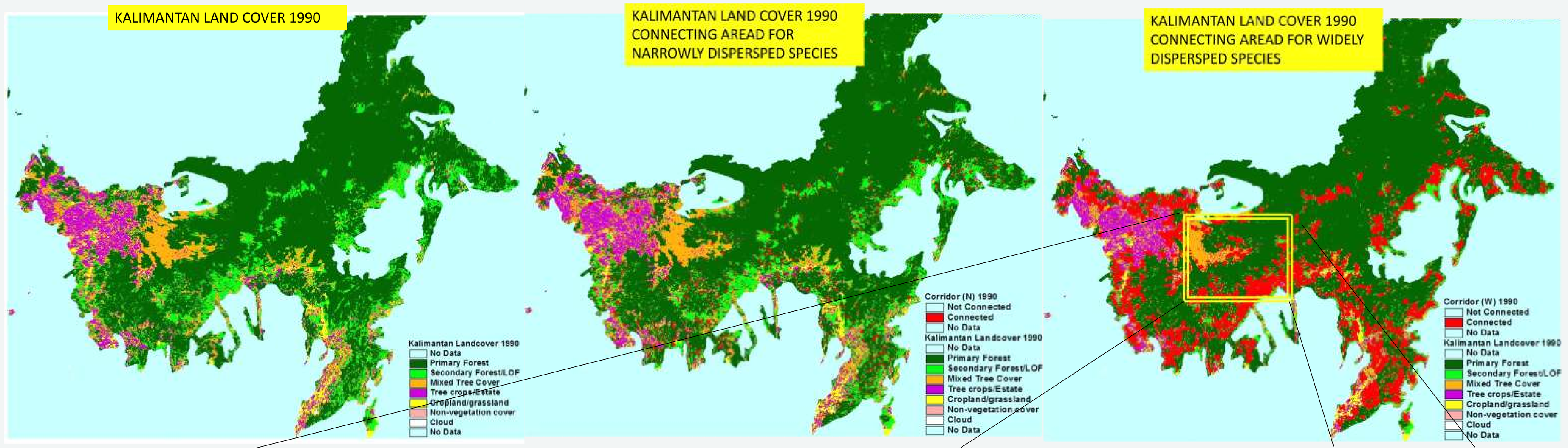
- Dispersal ranges (Narrow versus Wide: N-W) (vertical arrow)
- Habitat responses (specialist vs generalist: S-G) (horizontal arrow)
- Combination (SN-GW and SW-GN) (diagonal arrows)

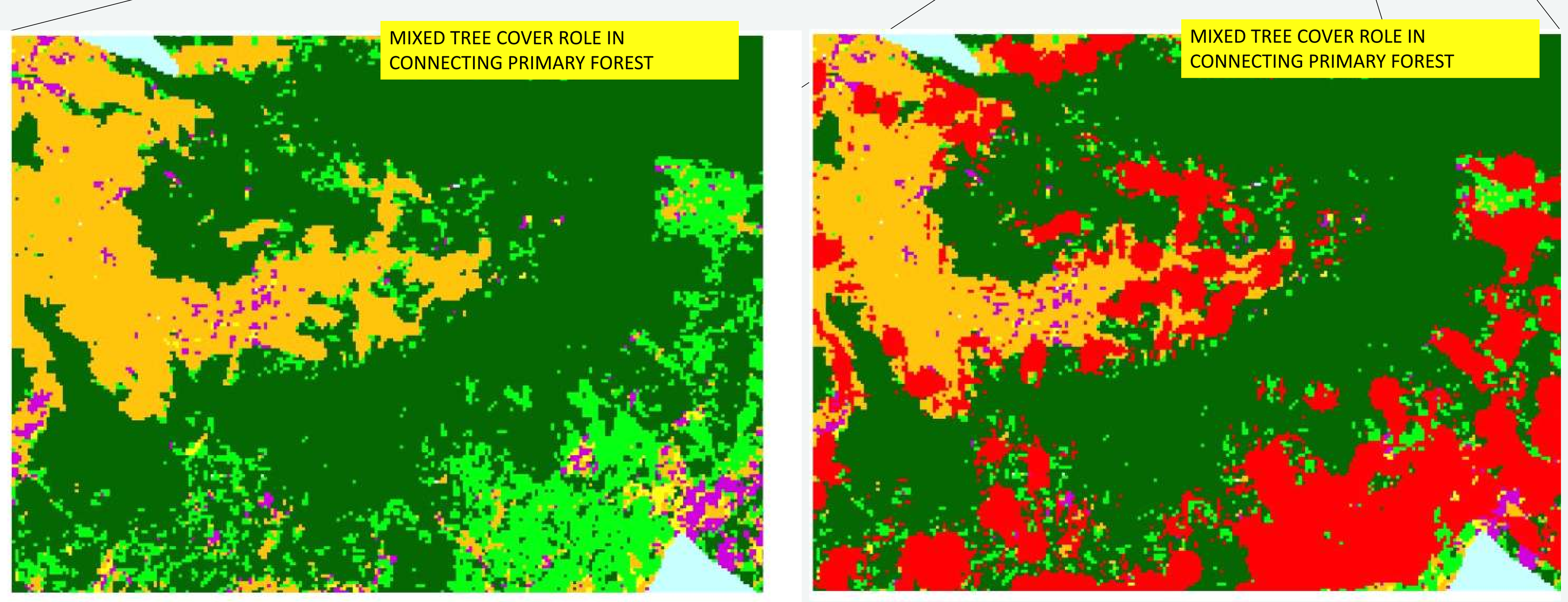


- Habitat specialist is very sensitive to reduced area of primary forest – high rate of local extinction is expected
- Habitat Specialist perceives the same landscape differently from Generalist; the size of total core area of specialist is about 87% as large as that of generalist when landscape is dominated by primary forest, like those in Papua. For West Java montane ecoregion, habitat specialist species perceives less than 10% total core area compared to habitat generalist. Extinction is not-proporsional and non-linear
- Habitat Specialist in Borneo ecoregion in 2005, however perceives similar total core area with much higher landscape of high primary forest fraction, due to highest extent of degraded forest.Landscape composition matters.



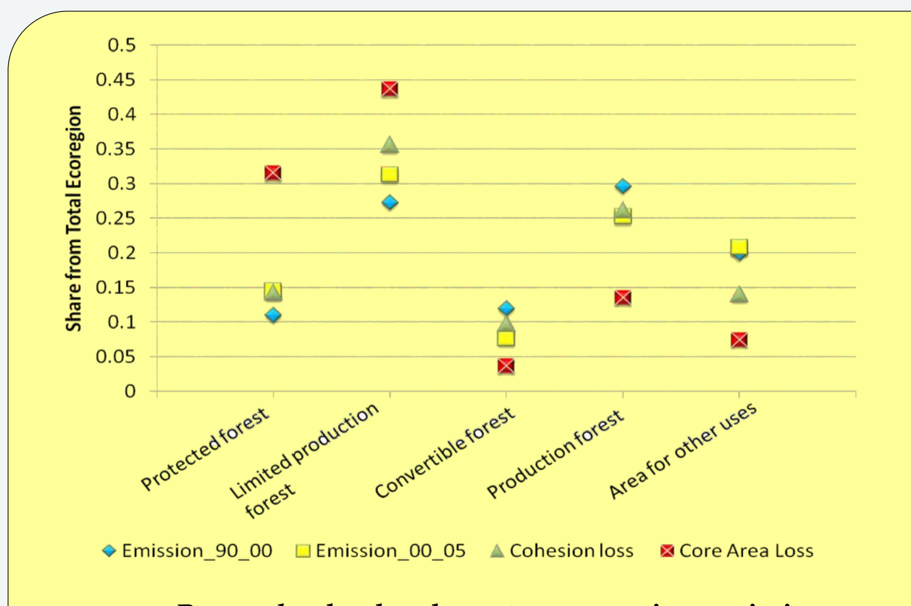
In terms of connectivity, species is very sensitive to dispersal range; species with narrow range of dispersal (2 km radius) only can take advantage of less than 20% connected primary forest cover in highest PFF and less than 10% in lowest PFF compared to widely dispersed species (10 km radius)





ECOREGION_YEAR	LIFE-HISTORY STRATEGY	TOTAL AREA	PRIMARY FOREST FRACTION	PRIMARY FOREST CHANGE (2005/1990)	TOTAL CORE PRIMARY FOREST	CONNECTING AREA	RATIO OF CONNECTING AREA TO CORE
WJAVAM_05	SN	2655400	0.02	0.28	600	484	80.67%
	GN				8000	484	6.05%
	SW				600	2942	490.33%
	GW				8000	2942	36.78%
WJAVAM_90	SN	2653800	0.09		29600	602	2.03%
	GN				91500	602	0.66%
	SW				29600	3802	12.84%
	GW				91500	3802	4.16%
NTDRY_05	SN	6186100	0.11	0.51	86500	907	1.05%
	GN				307100	907	0.30%
	SW				86500	6111	7.06%
	GW				307100	6111	1.99%
NTDRY_90	SN	6183900	0.22		195500	1795	0.92%
	GN				572600	1795	0.31%
	SW				195500	12249	6.27%
	GW				572600	12249	2.14%
SUMAML_05	SN	29067500	0.20	0.52	1359300	9321	0.69%
	GN				2728400	9321	0.34%
	SW				1359300	62640	4.61%
	GW				2728400	62640	2.30%
SUMAML_90	SN	29080700	0.39		3733700	12403	0.33%
	GN				6495300	12403	0.19%
	SW				3733700	71532	1.92%
	GW				6495300	71532	1.10%
SULAML_05	SN	20765200	0.32	0.67	1773100	9321	0.53%
	GN				3477600	9321	0.27%
	SW				1773100	49086	2.77%
	GW				3477600	49086	1.41%
SULAML_90	SN	20758900	0.48		3866800	8527	0.22%
	GN				6216500	8527	0.14%
	SW				3866800	44676	1.16%
	GW				6216500	44676	0.72%

- Species-area theory of island biogeography has been widely used to predict species loss at a global level; among critiques are the assumptions that matrix are non-habitable and non-permeable and that edge effect does not matter (basically dichotomy of land cover by oversimplifying landscape composition and ignoring landscape configuration altogether). These work assume none of the two, plus recognizing species differences in response to habitat and also in dispersal ability;
- Landscape composition (in this case fraction of primary forest) and landscape configuration (in this case edge density and edge contrast) both matters in determining core area and connecting areas;
- "Perceived" extent of core habitat and connecting areas of specialist and narrowly-dispersed species can be as low as 7 % and 13% from those of generalist and widely-dispersed species
- Decreases of core areas with loses of primary forest consistently happens across Indonesian ecoregions during the past 15 years with various rates;
- In region like West Java montane forest, the fraction of primary forest is only 2% of the total areas, leaving island of remnant forests; connecting areas become very important and in some cases is even larger than the core area itself;
- As portion of ecoregion becomes more advanced in land transformation, the importance of connecting areas becomes more significant



Borneo lowland and montane ecoregion: emission, reduction of habitat and fragmentation vs land designation

CO-BENEFIT BETWEEN CLIMATE CHANGE MITIGATION AND BIODIVERSITY MAINTENANCE?

- Spatial covariation between emission and habitat reduction is inconsistent. In Borneo lowland and montane, e.g. , 32% of core habitat loss is within protected areas, while only less than 15% of emission happened within protected area. Within more intensive land uses, loss of habitat shares are lower than emission share.
- Recognition of spatial association, landscape composition, landscape configuration and drivers are necessary in designing strategy to achieve co-benefit between climate change mitigation and biodiversity maintenance.

More info: **Sonya Dewi** (s.dewi@cgiar.org)
World Agroforestry Centre
Southeast Asia Regional Office