

Oil Palm Expansion in Indonesian Borneo: Impacts on land cover and C flux

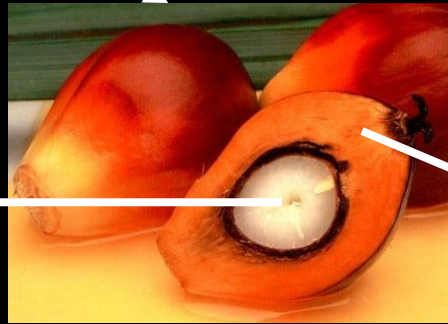
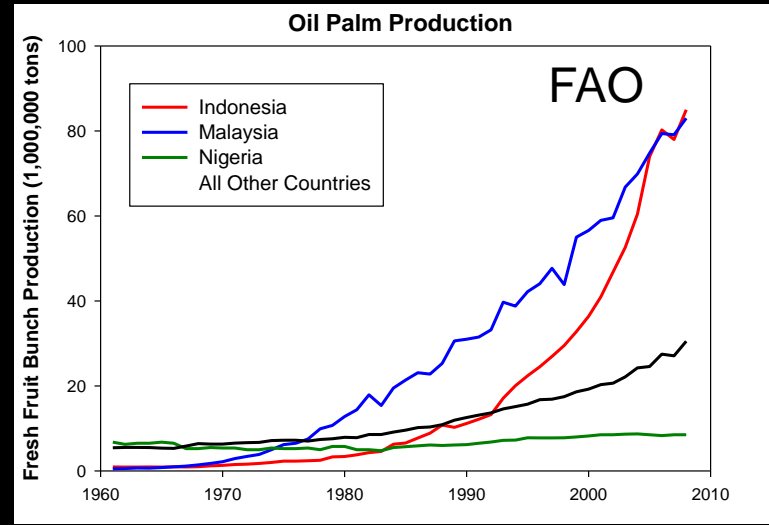
Kimberly Carlson

Yale University School of Forestry and Environmental Studies





Oil Palm



Palm Kernel Oil

Crude Palm Oil

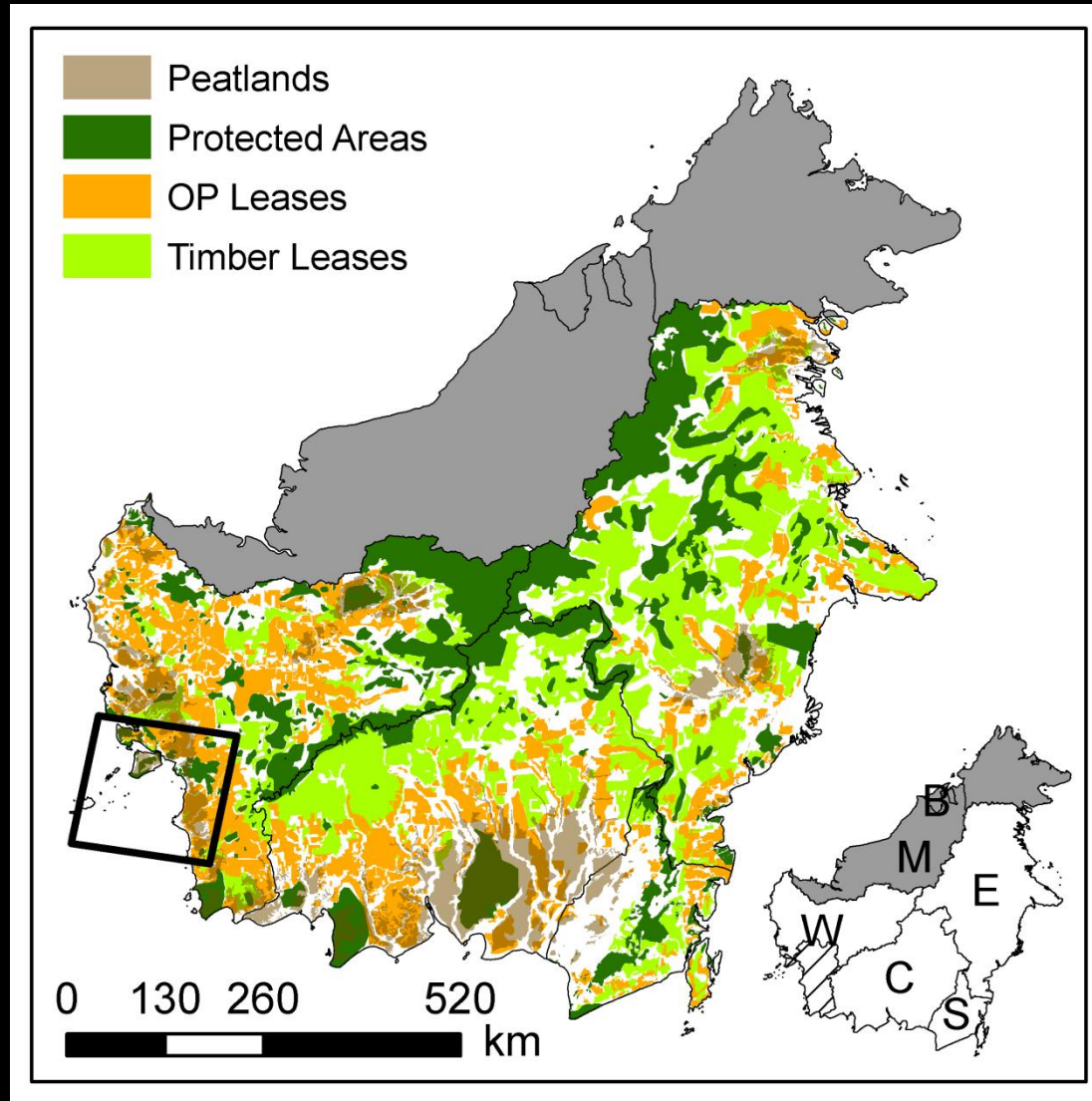
BEAUTY PRODUCTS

FOOD

BIODIESEL

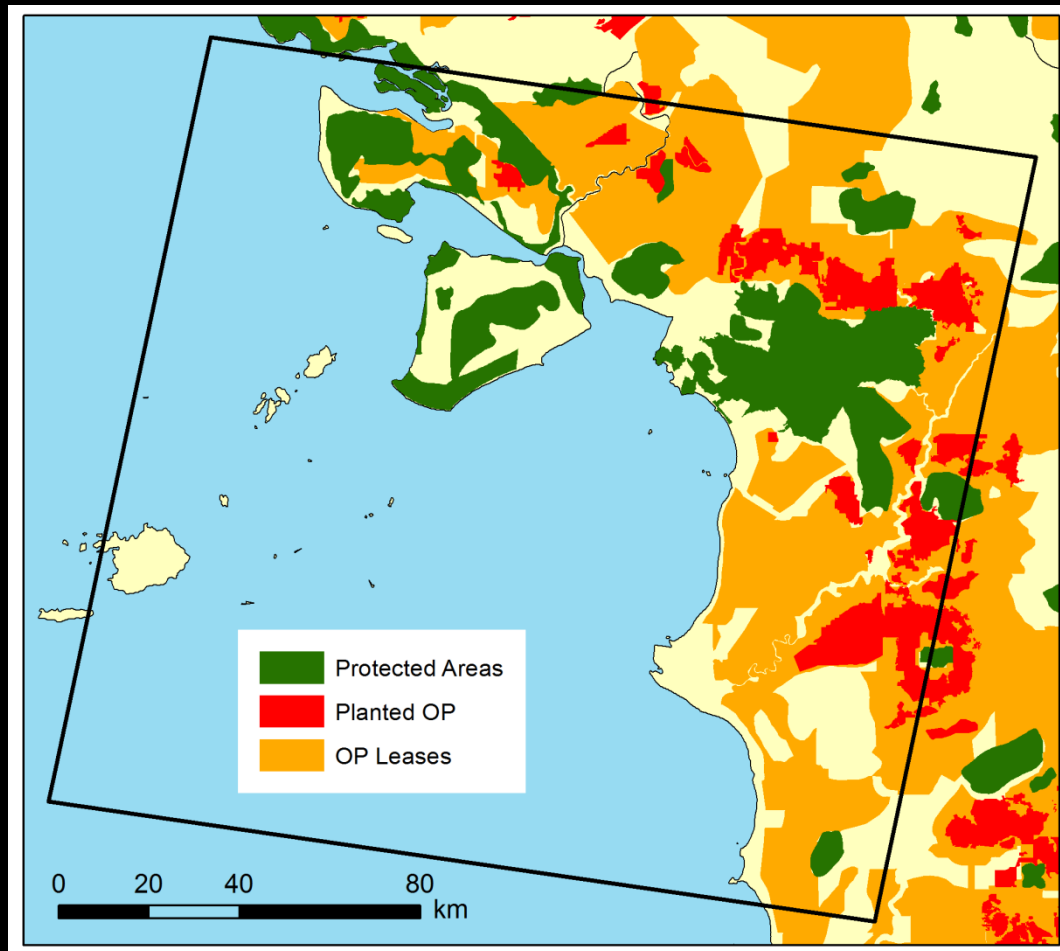


Kalimantan Land Allocation

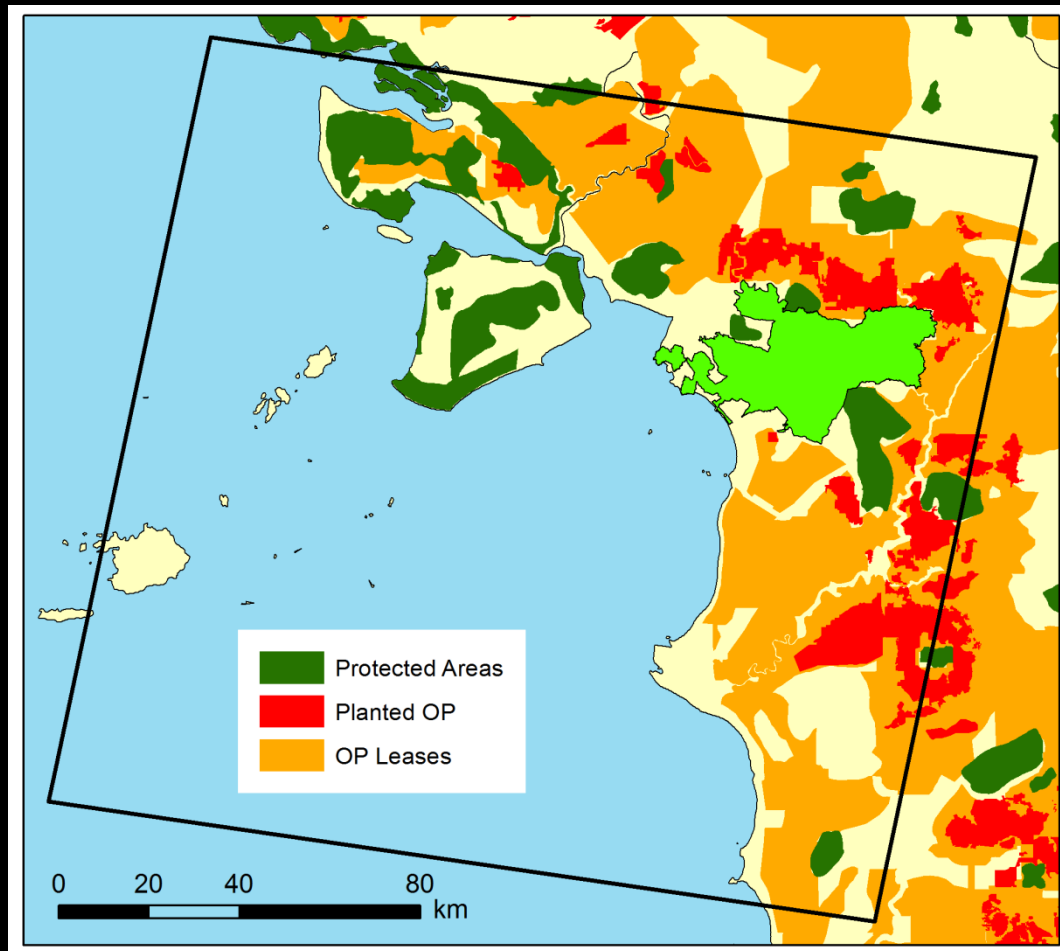


OP leases = ~117,500 km², 22% of Kalimantan

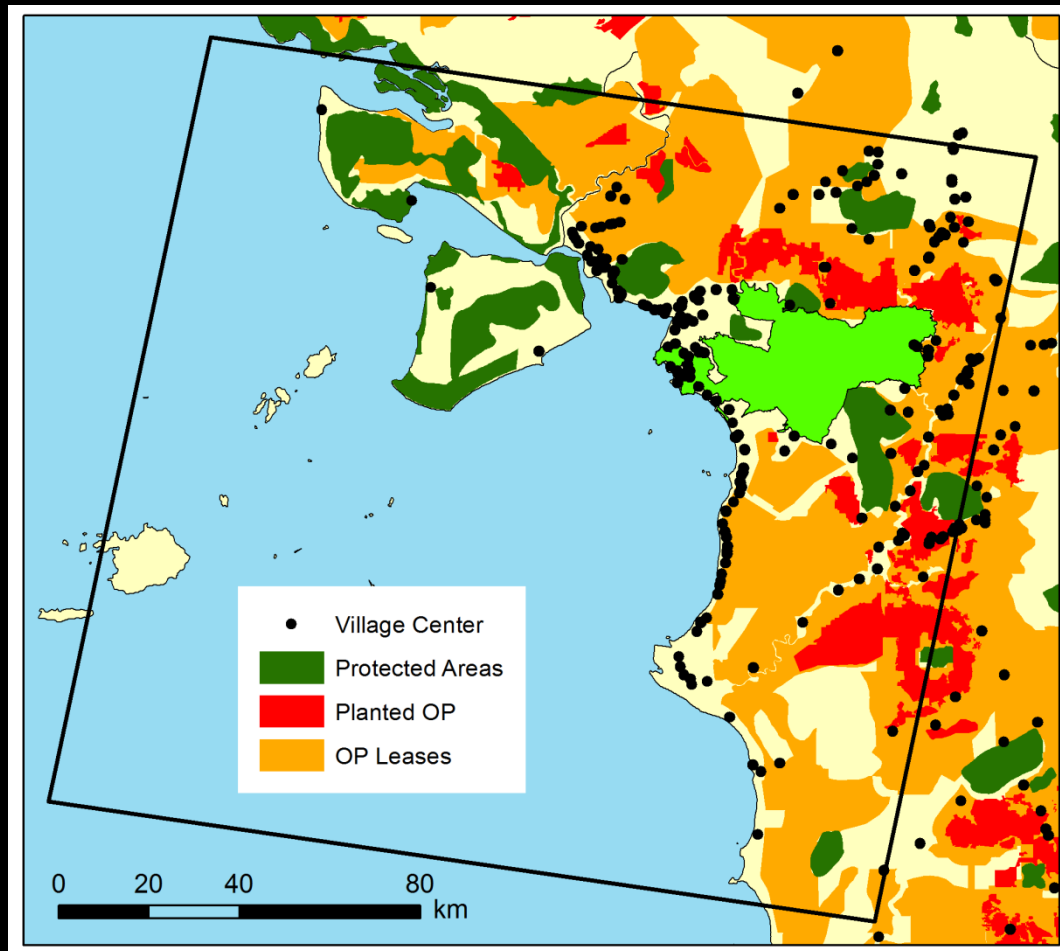
Study Region - Ketapang



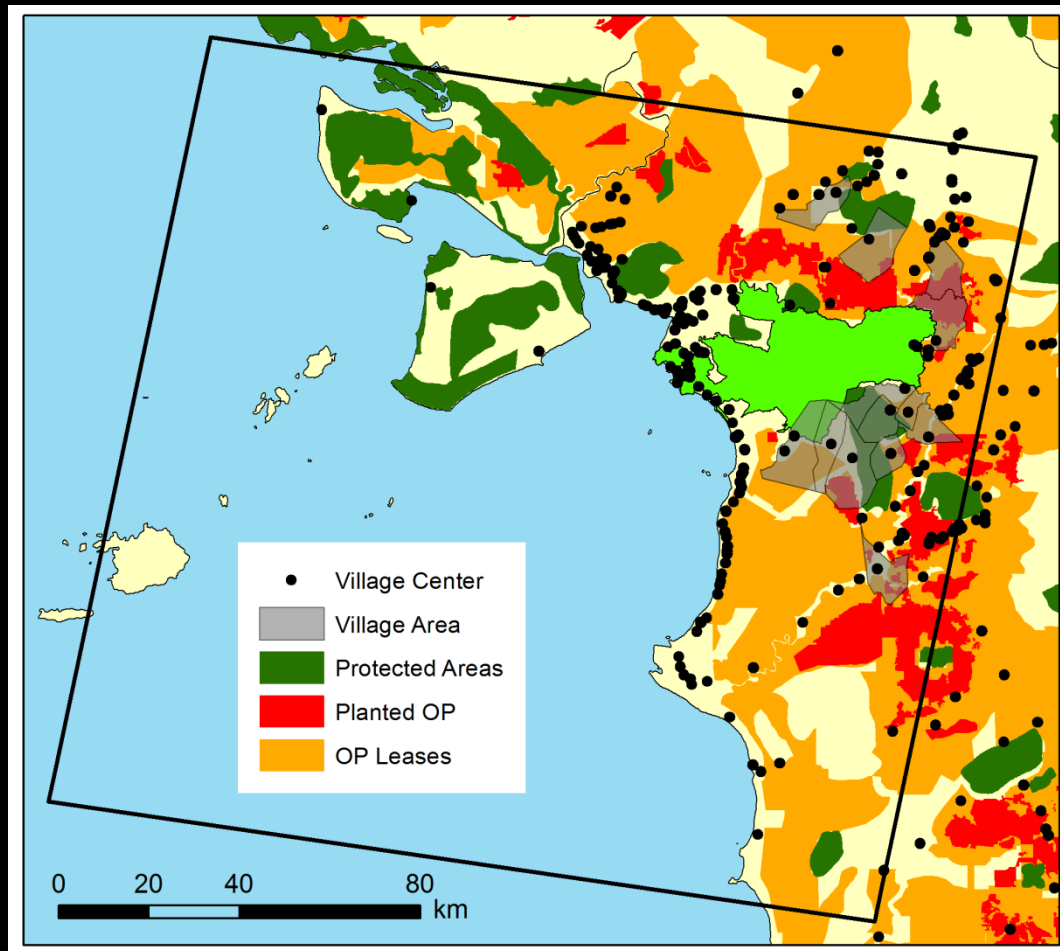
Study Region - Ketapang



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Questions

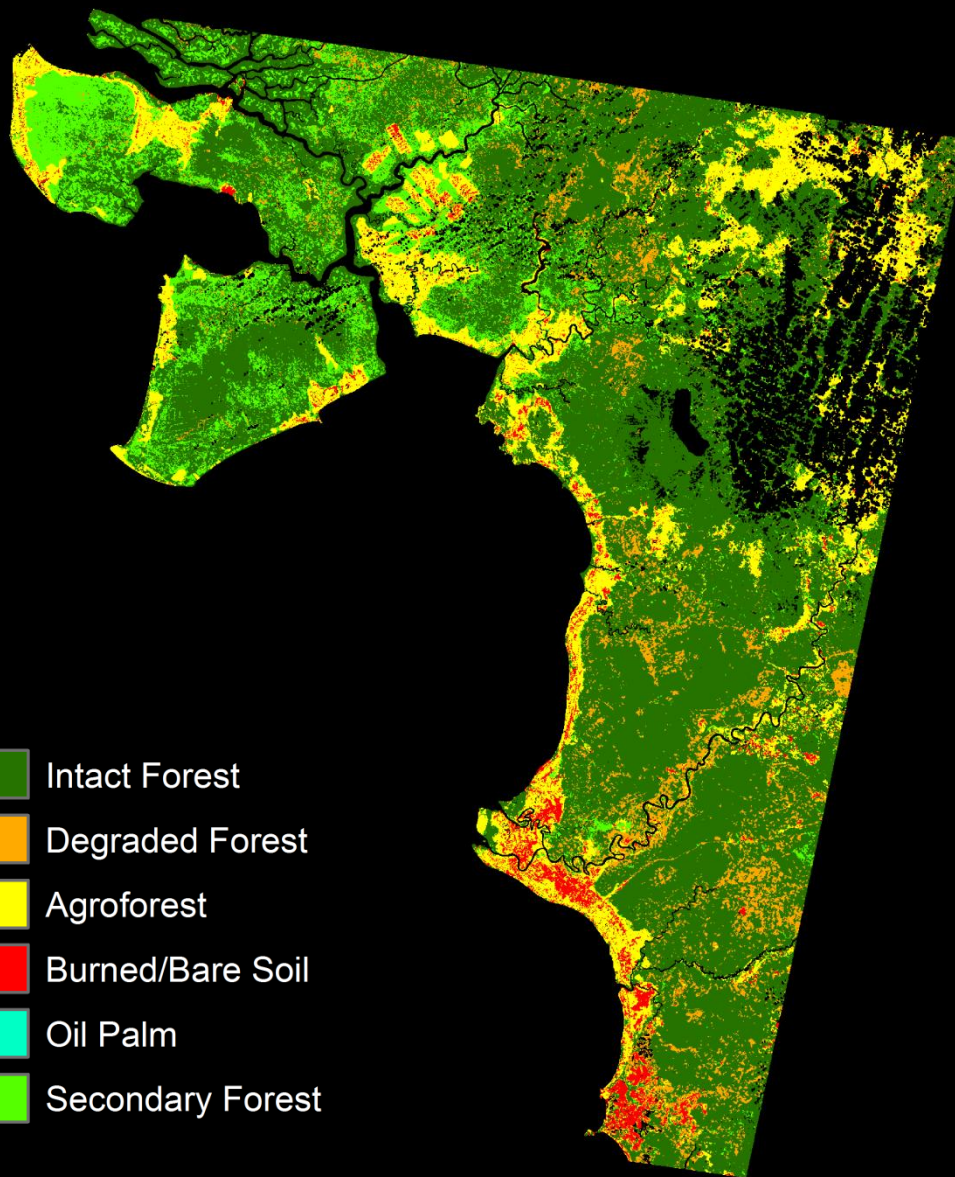
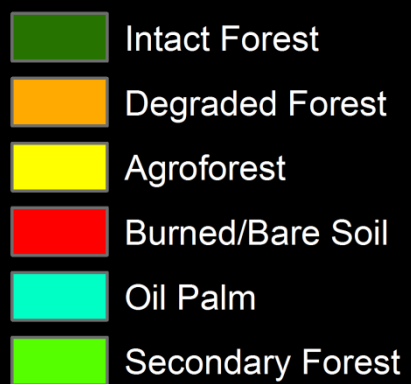
1. What land cover types have historically been converted to oil palm?
2. How might future scenarios of oil palm expansion impact land cover, C emissions, and communities?

Methods

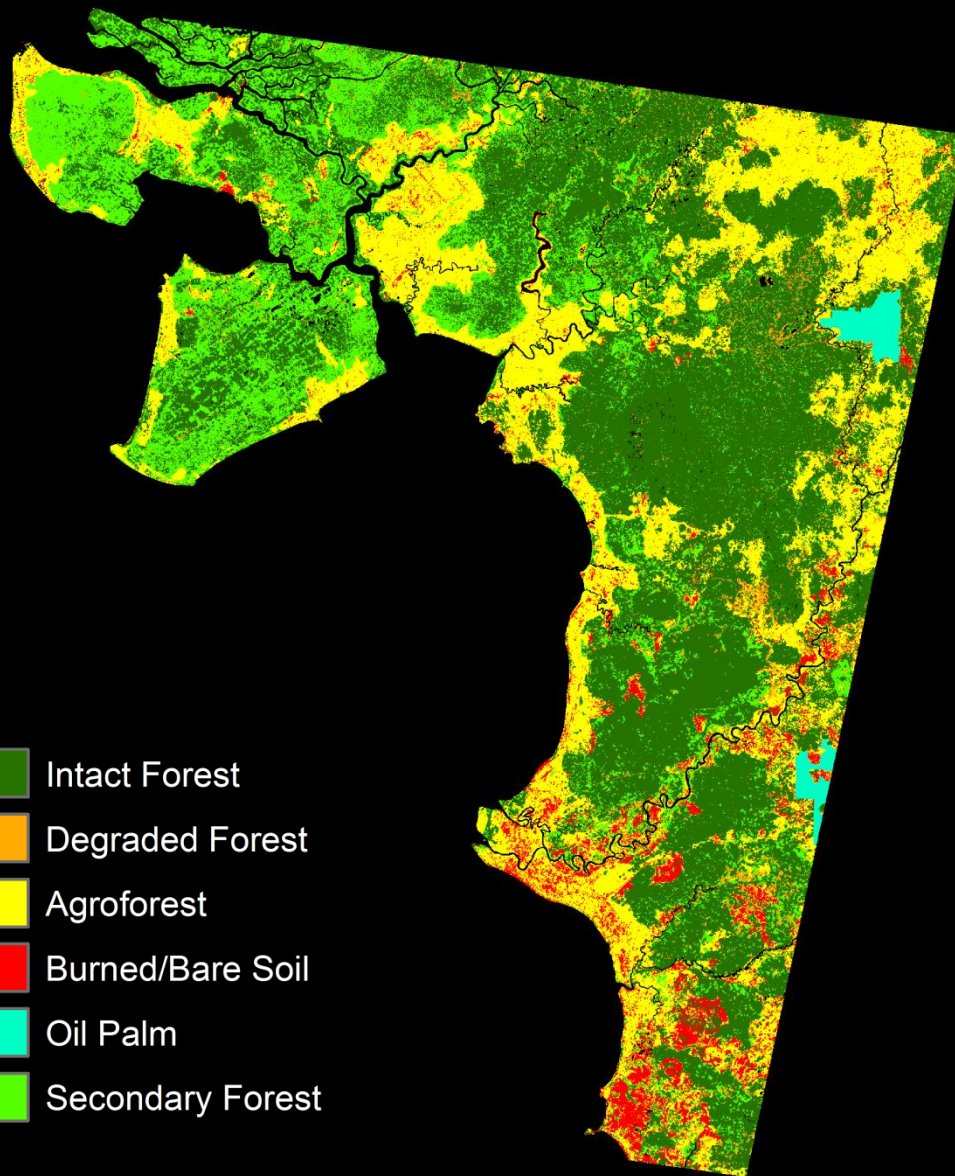
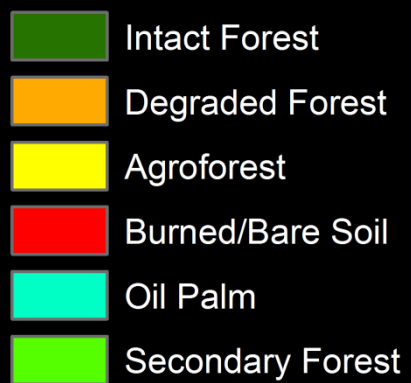
- Compiled 11 Landsat images, 1989-2008
- Classified land cover with CLASLite and eCognition
- Modeled future scenarios of land cover change 2009-2020 with Dinamica EGO
- Assessed outcomes for land cover and C flux



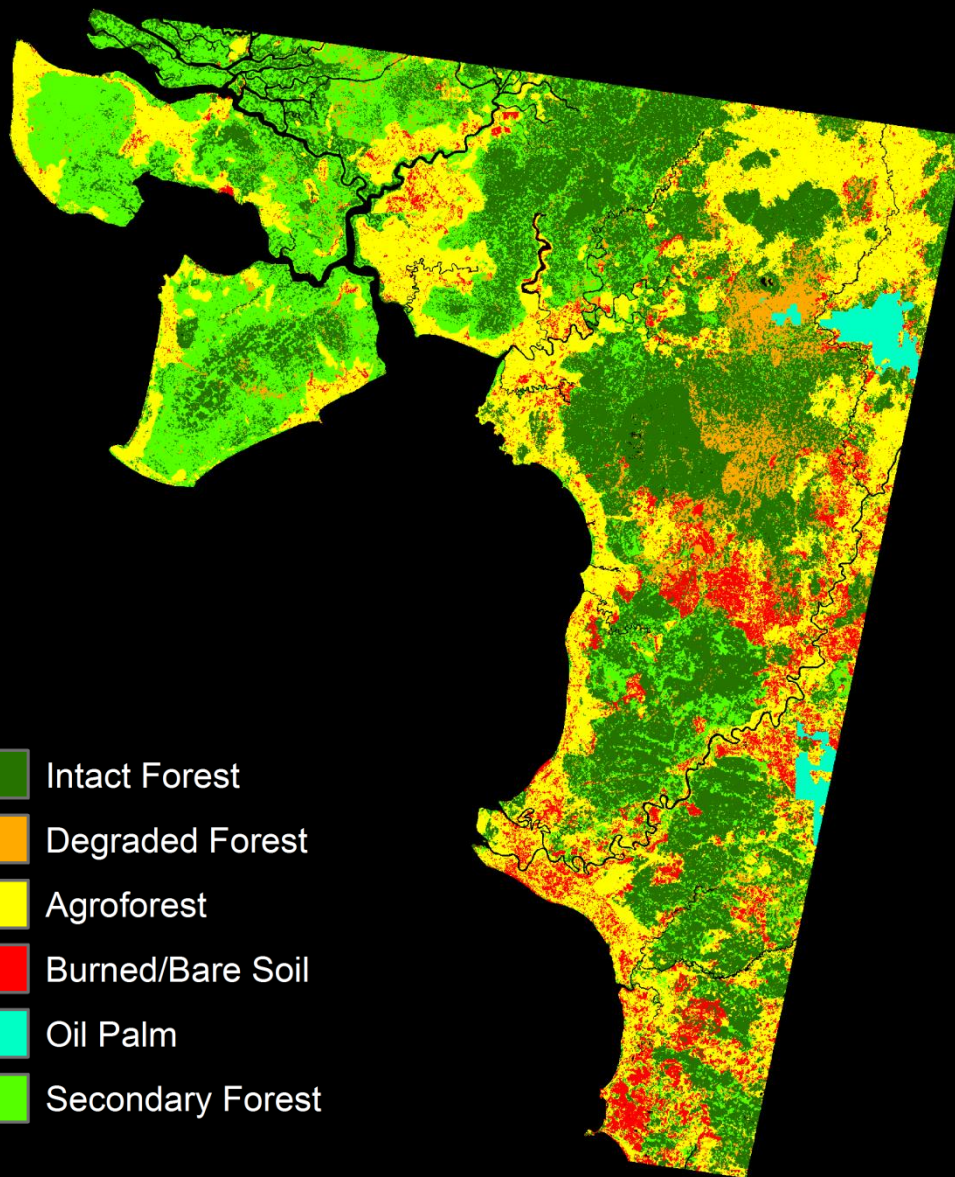
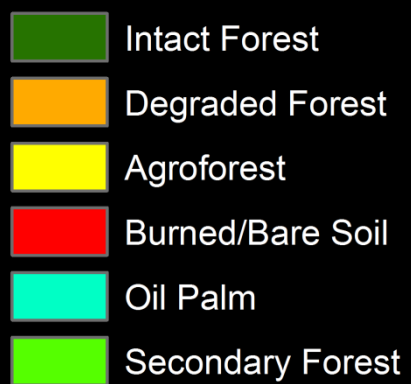
1989



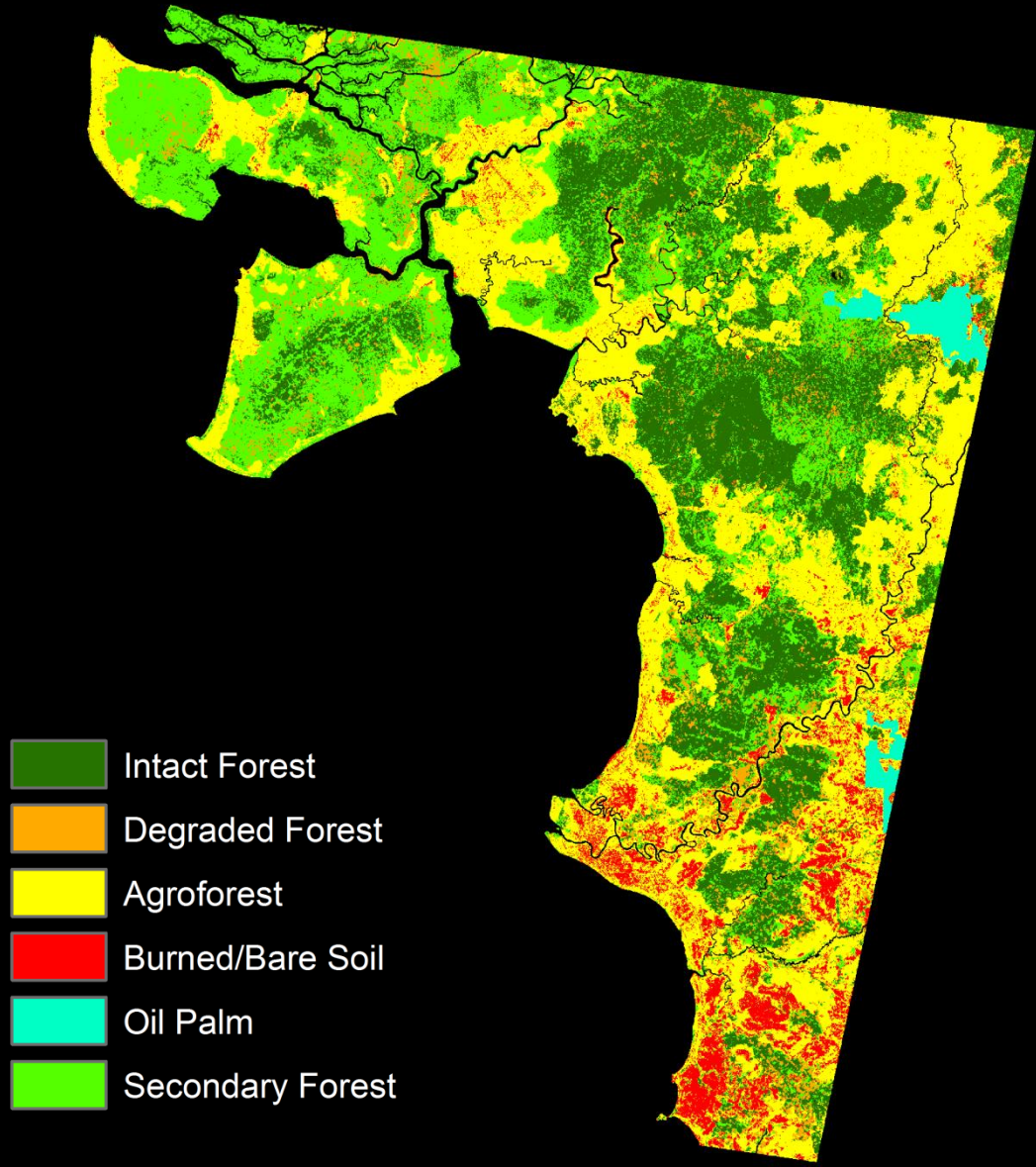
1996



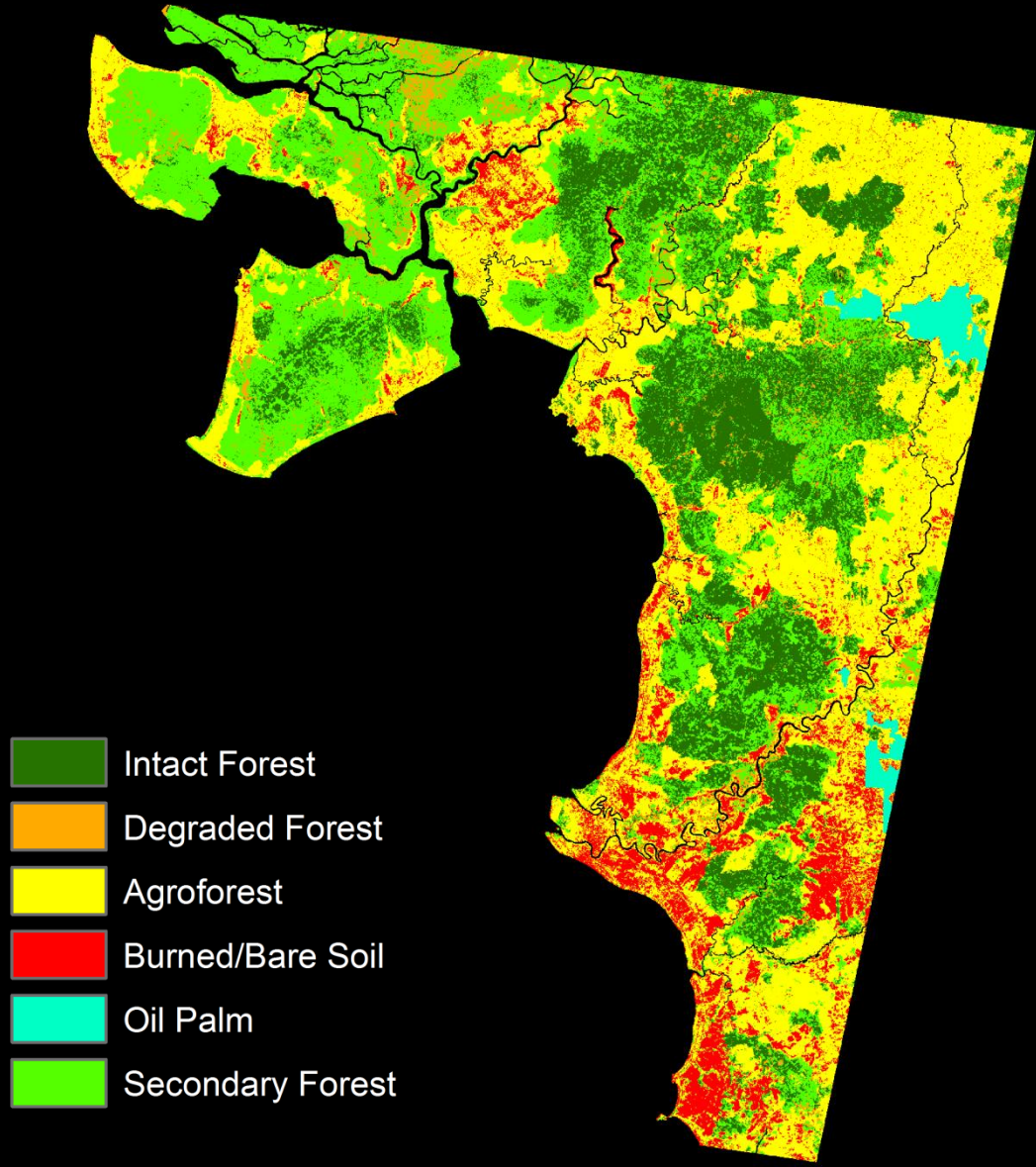
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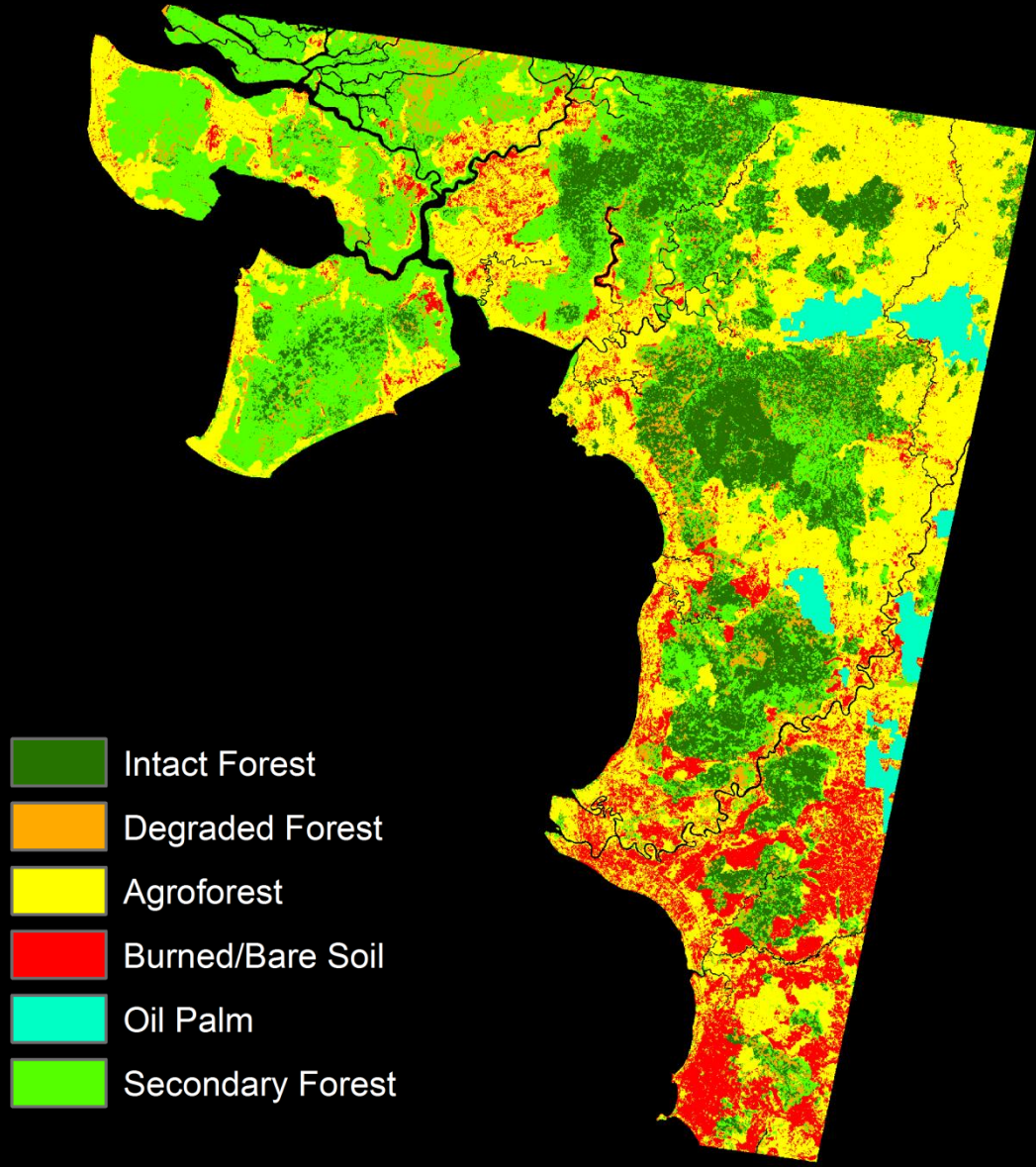
2001



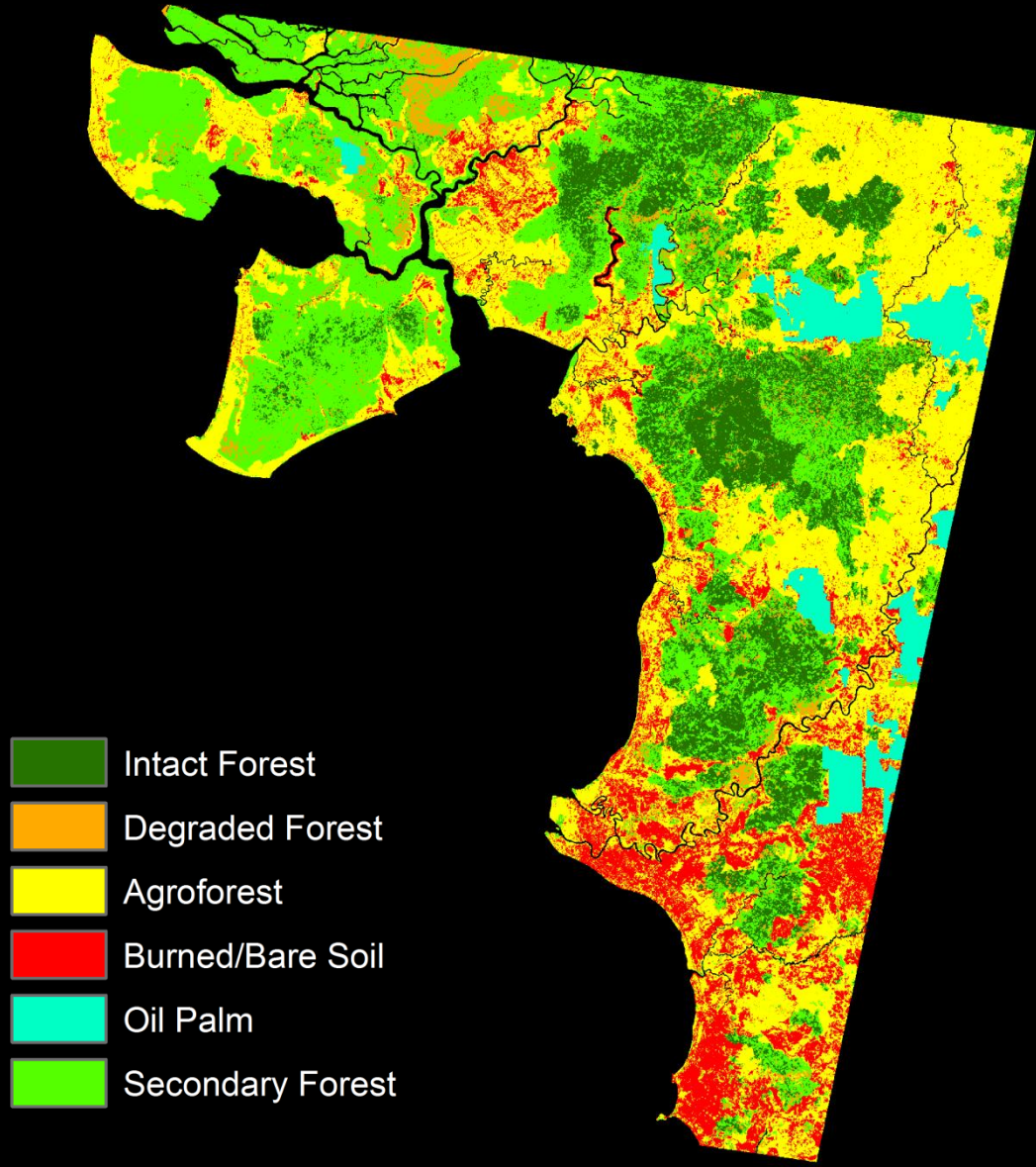
2005

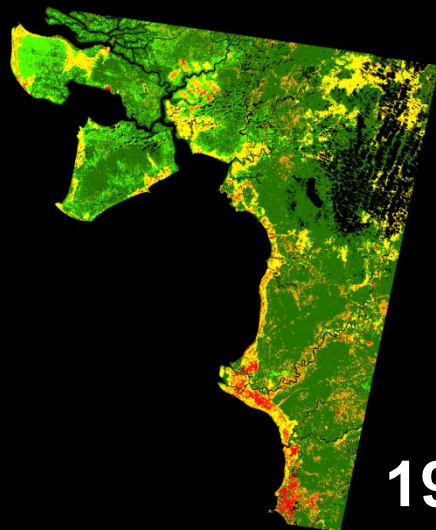
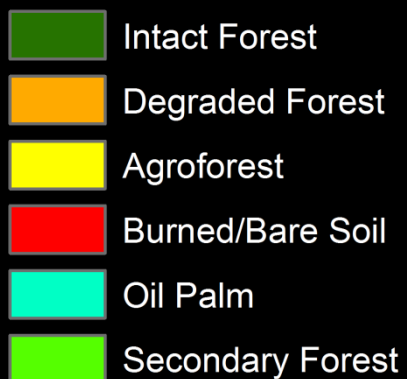


2007

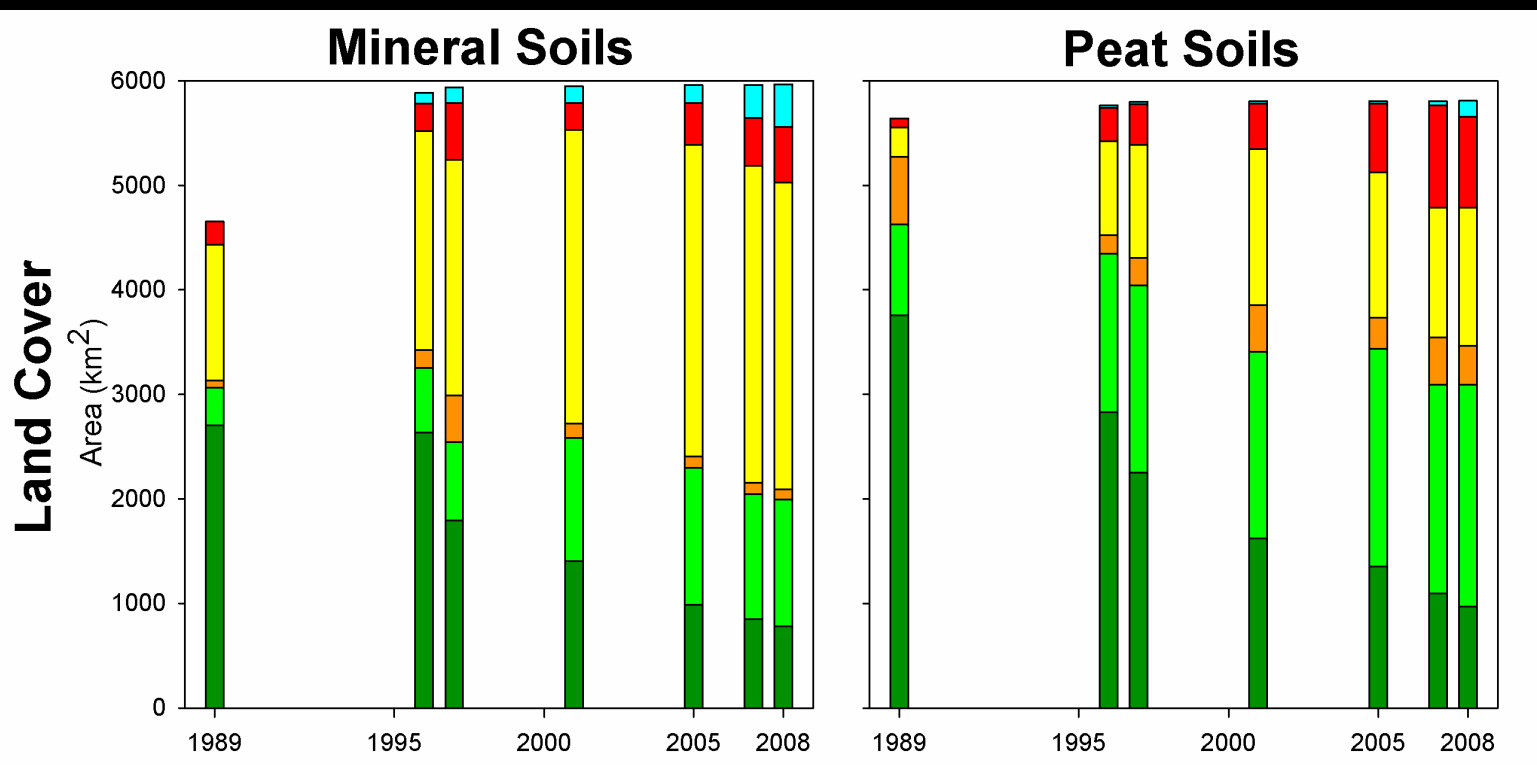
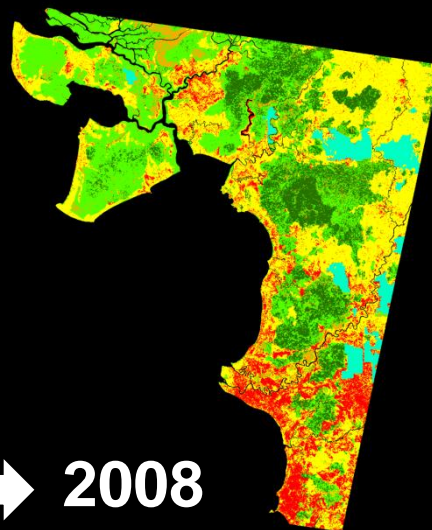


2008

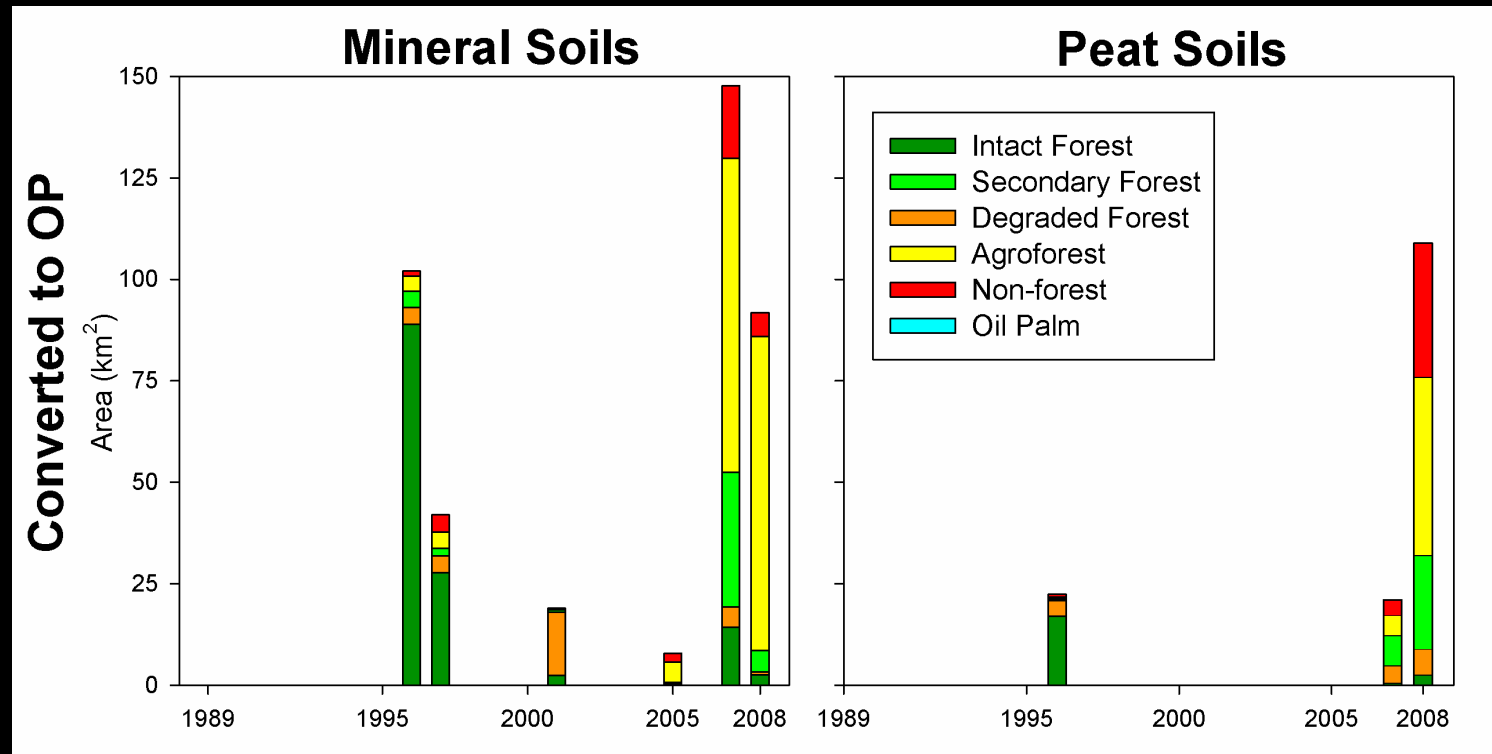




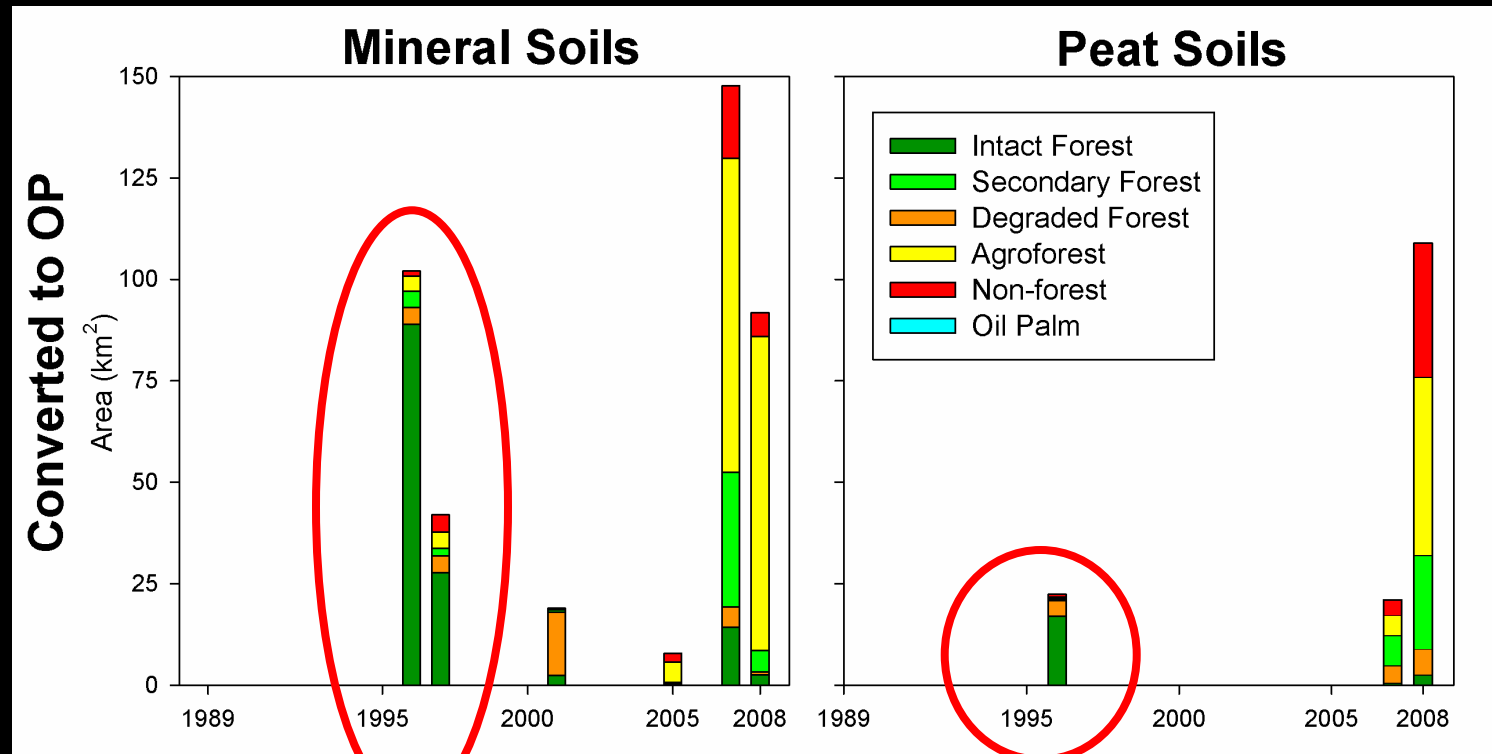
1989 → 2008



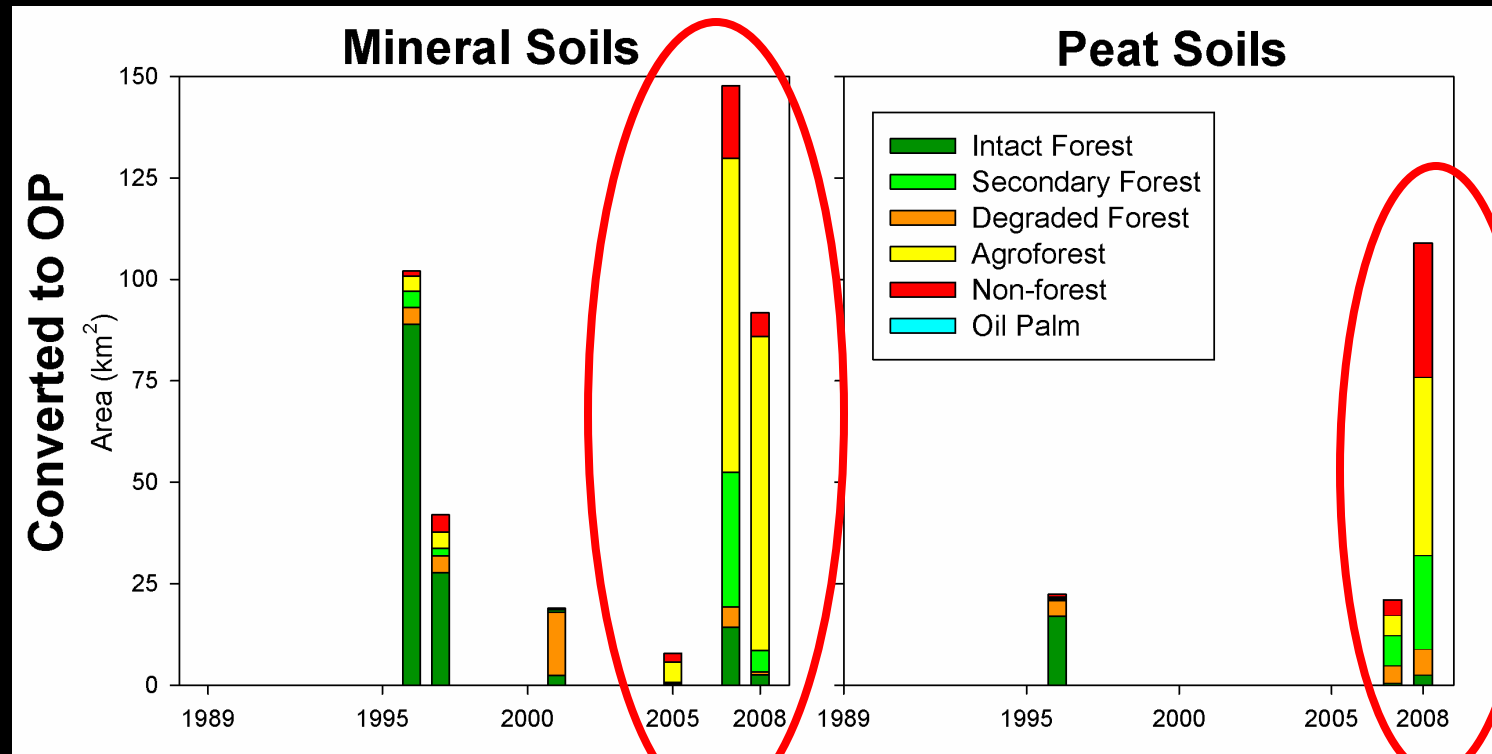
Land Cover Sources



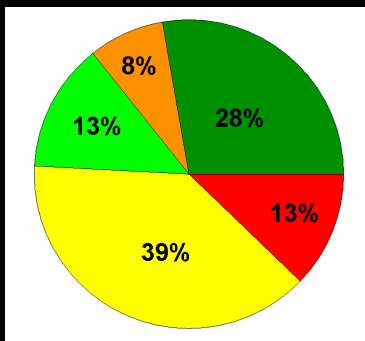
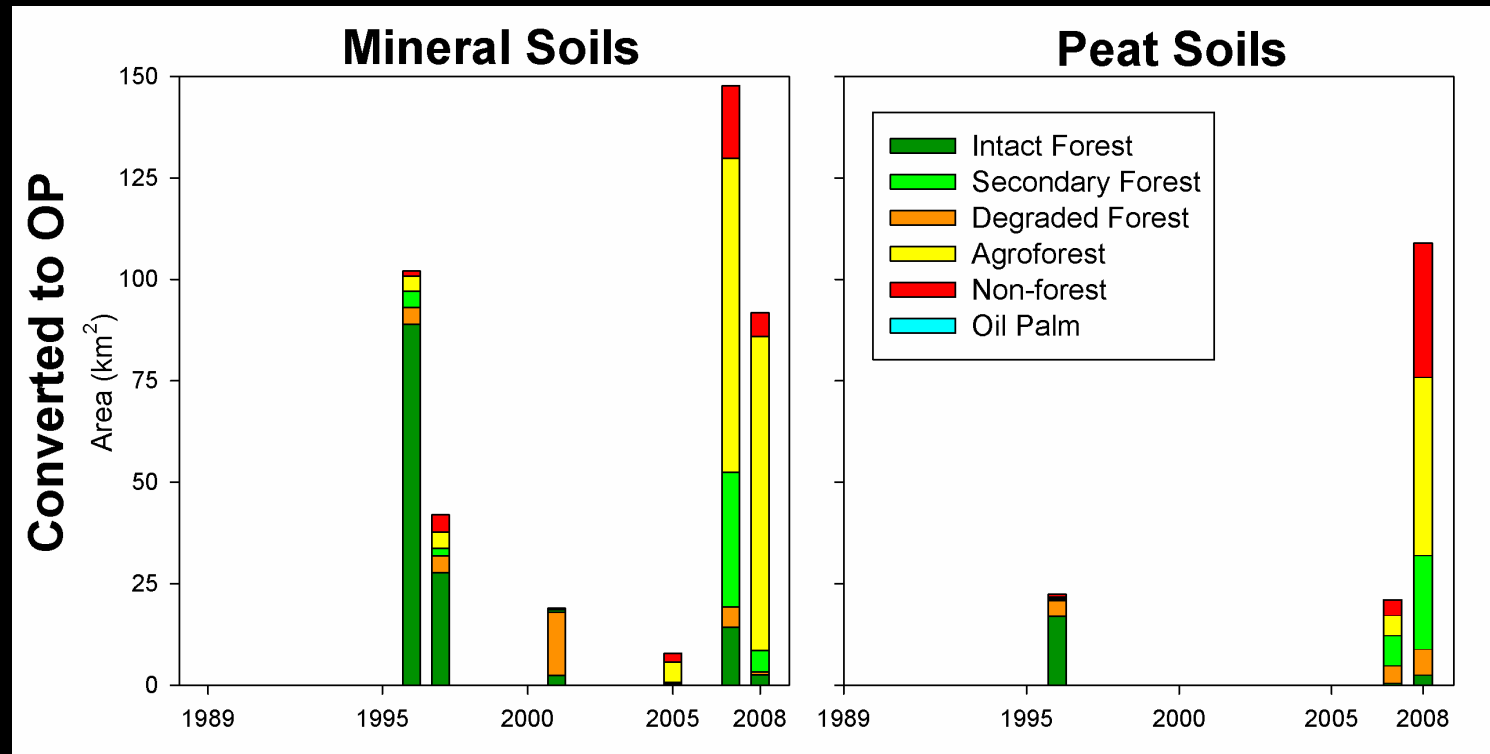
Land Cover Sources



Land Cover Sources



Land Cover Sources



87% of oil palm expansion cleared forested lands

27% cleared peatlands

Scenarios

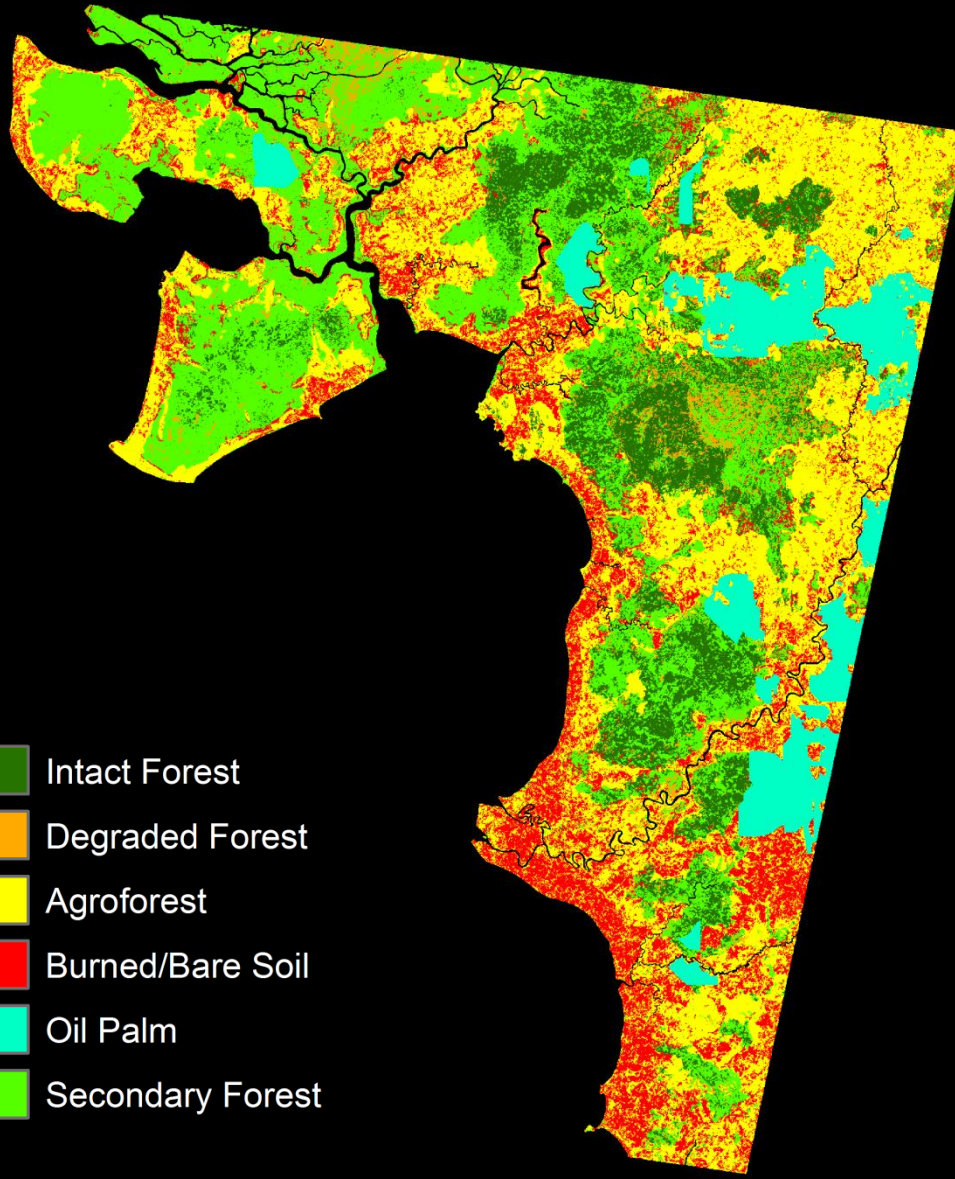
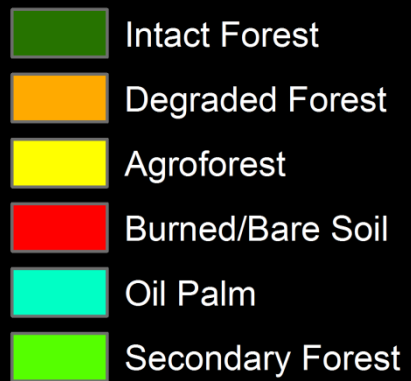
#	Scenario	New Plantations (# yr ⁻¹)	Clearing Rate (ha yr ⁻¹)	OP in forests and peatlands	Intact and Degraded Forest Protection
1	BAU	2	2,900	yes	no
2	Rapid	4	5,400	yes	no
3	Moratorium	2	2,900	no	no
4	Zero Conversion	0	2,900	no	yes

2009-2020

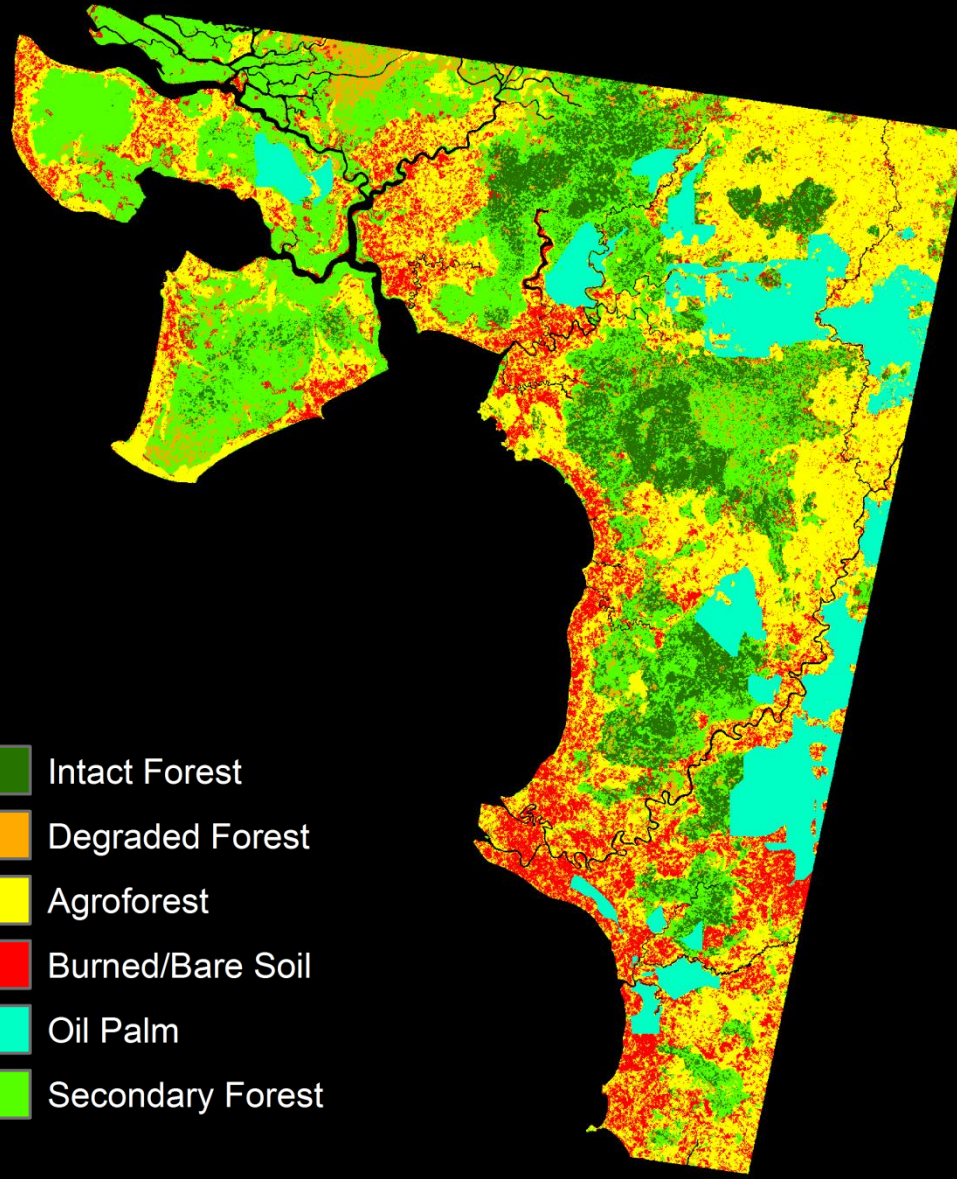
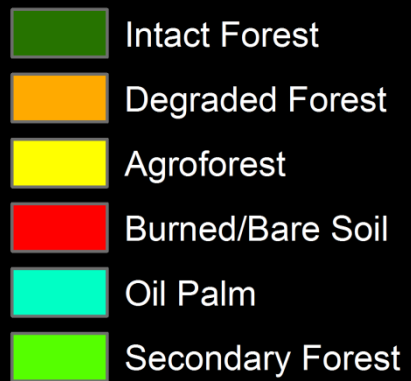
ENSO frequency = 5 years

20 model runs per scenario

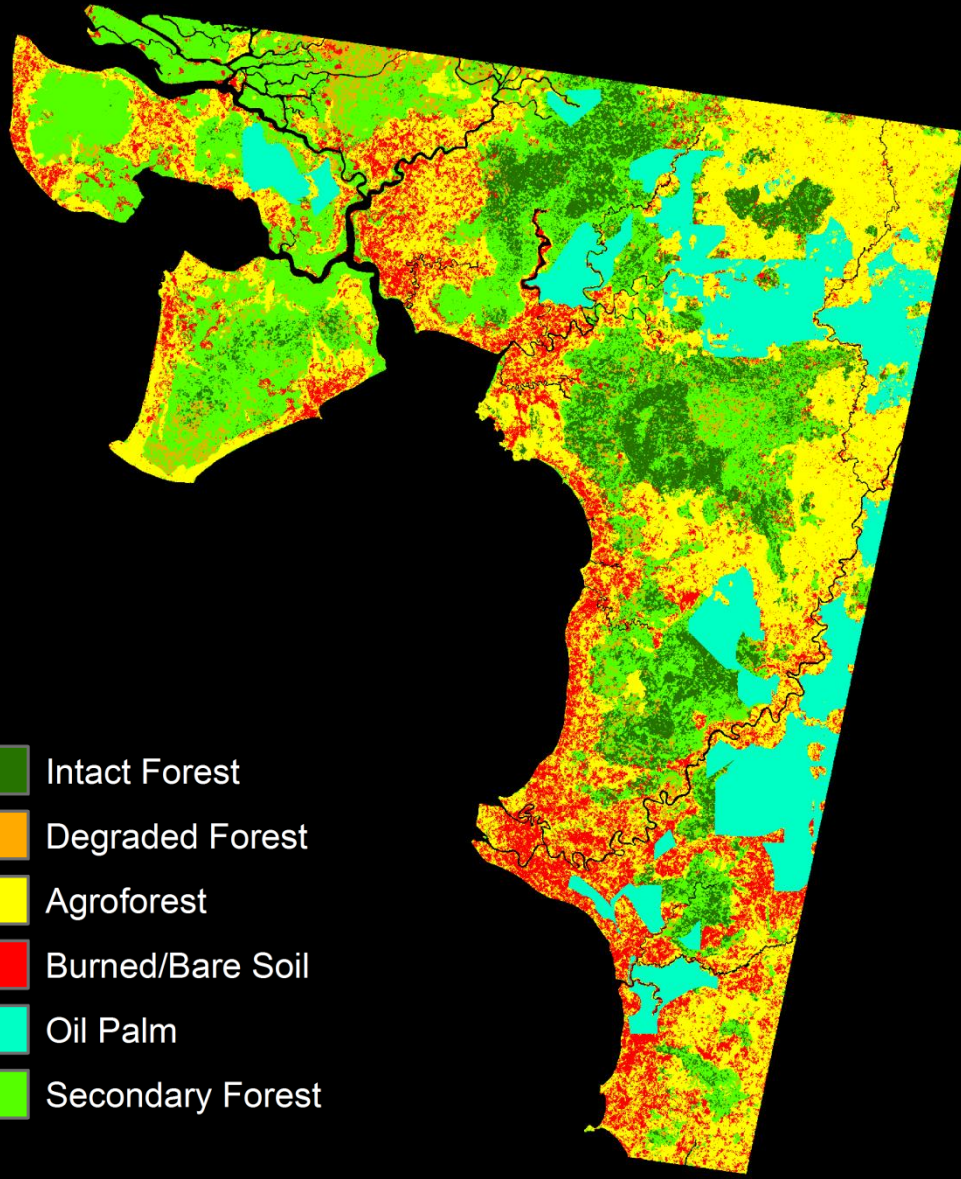
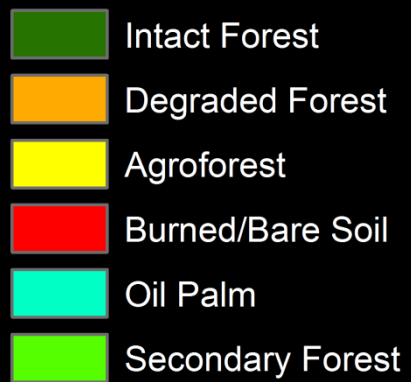
BAU 2009



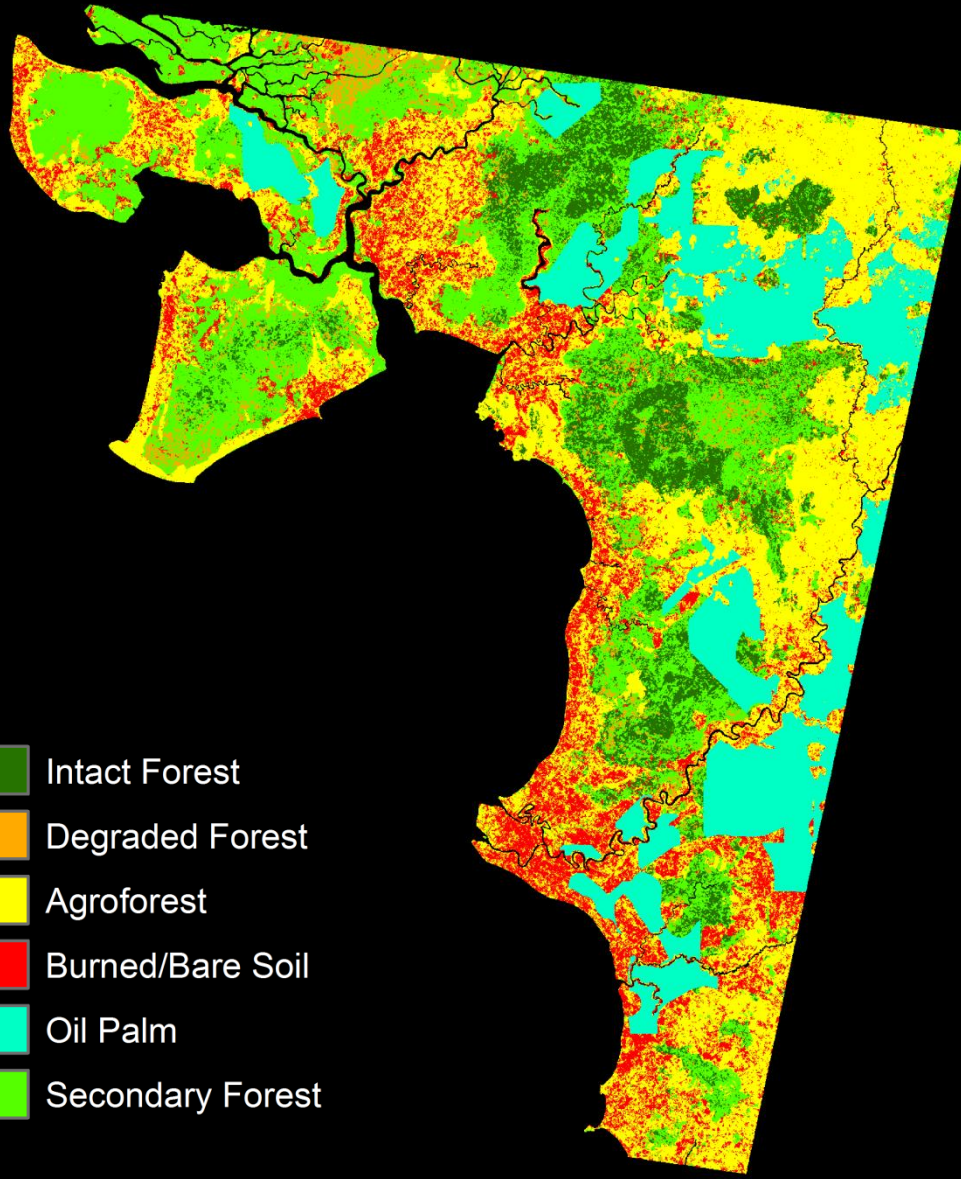
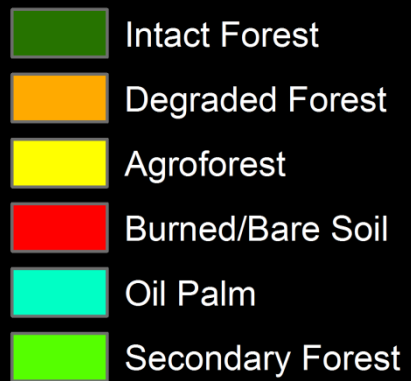
BAU 2010



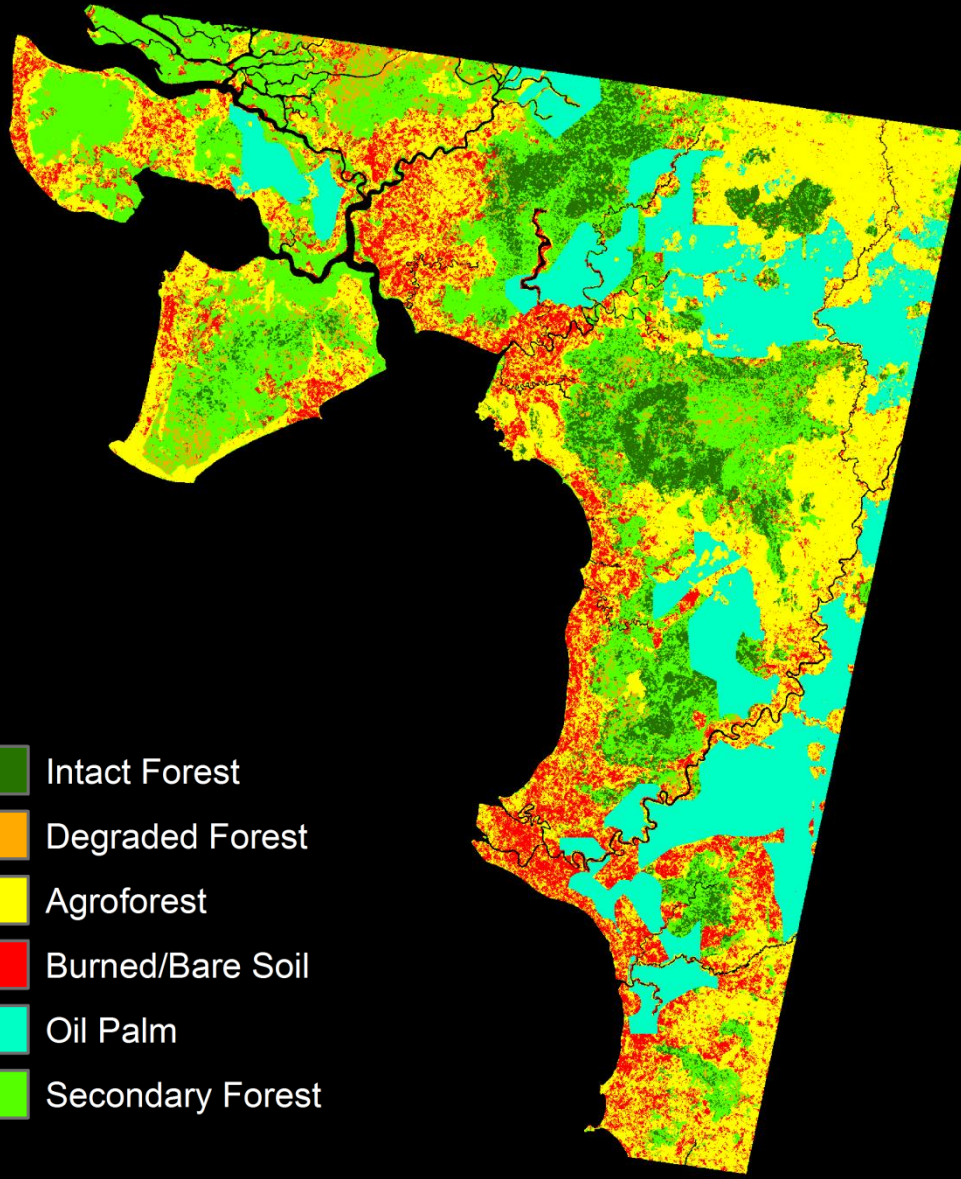
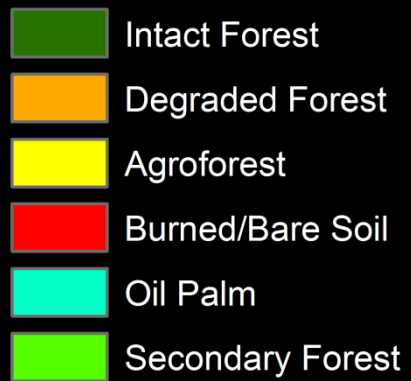
BAU 2011



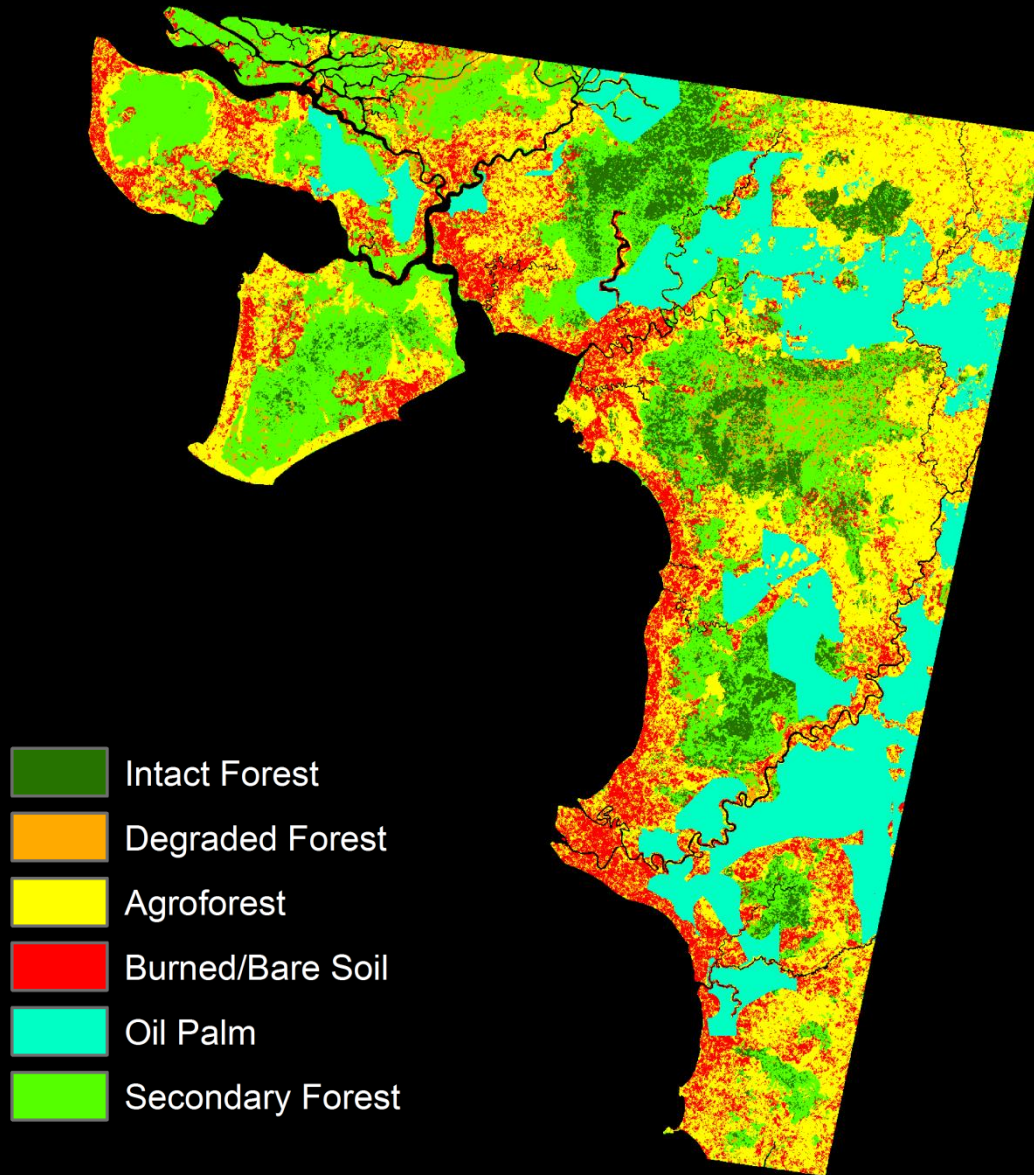
BAU 2012



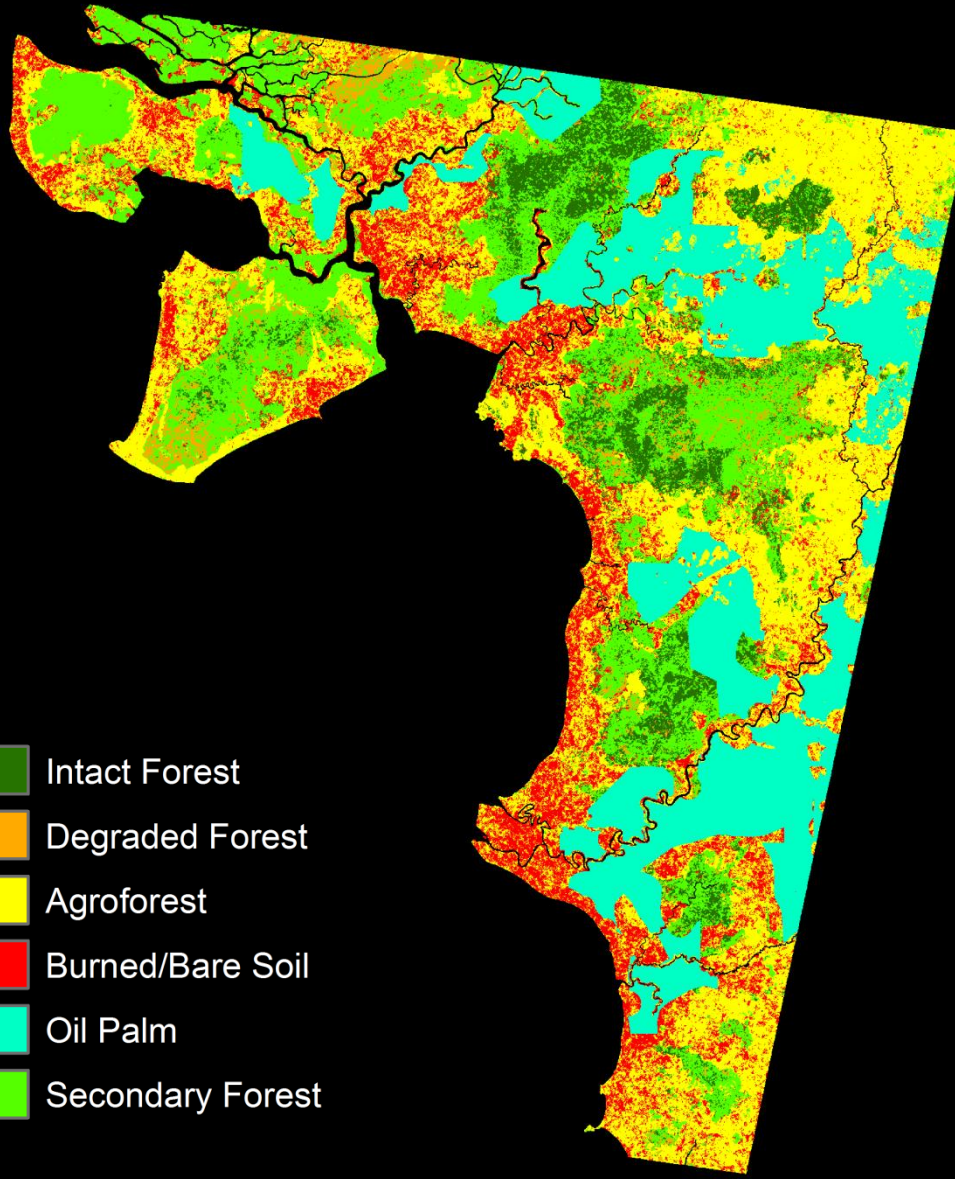
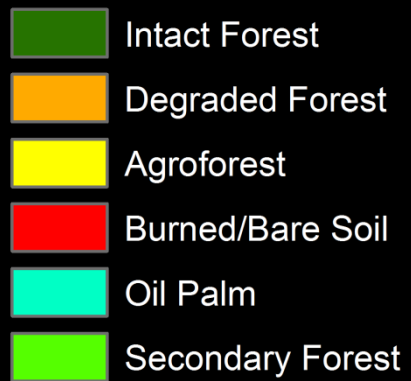
BAU 2013



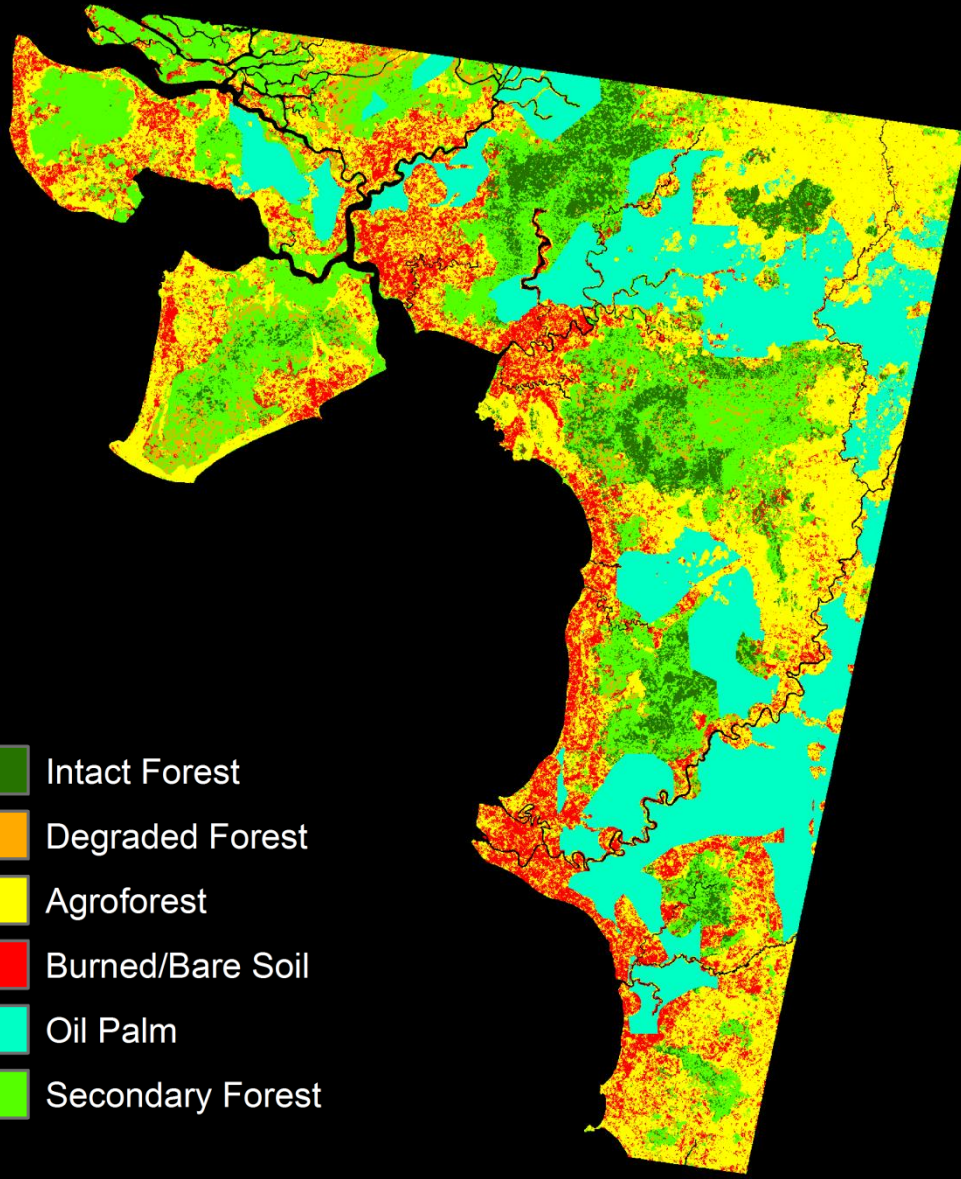
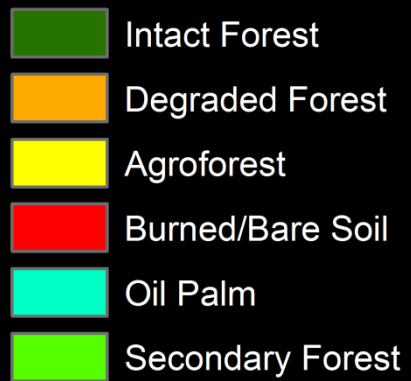
BAU 2019



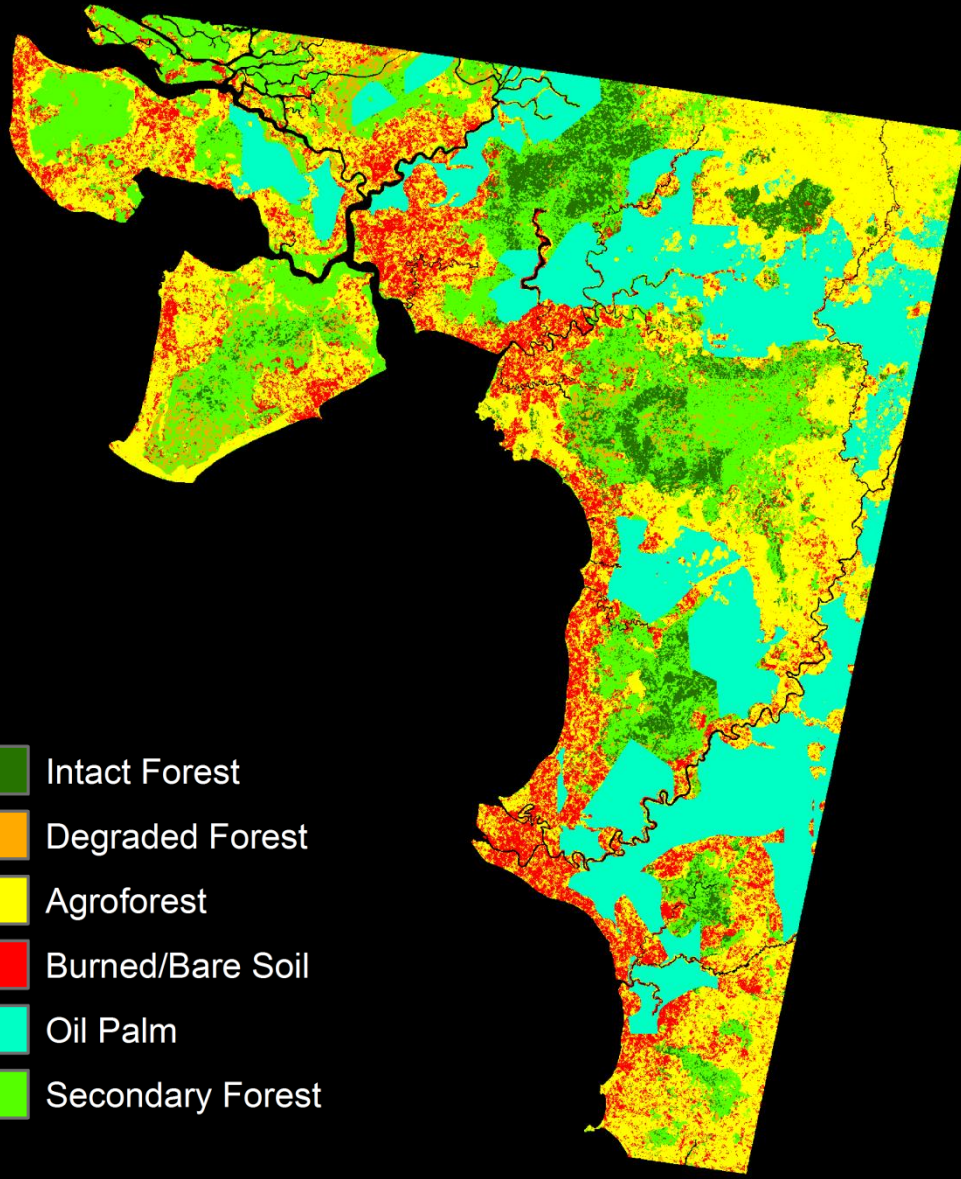
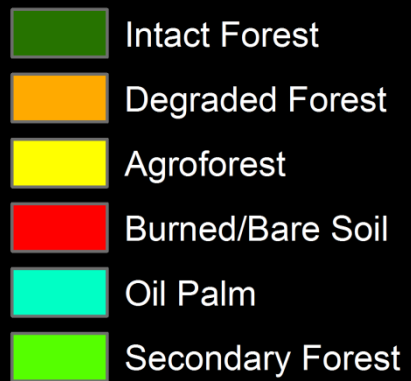
BAU 2015



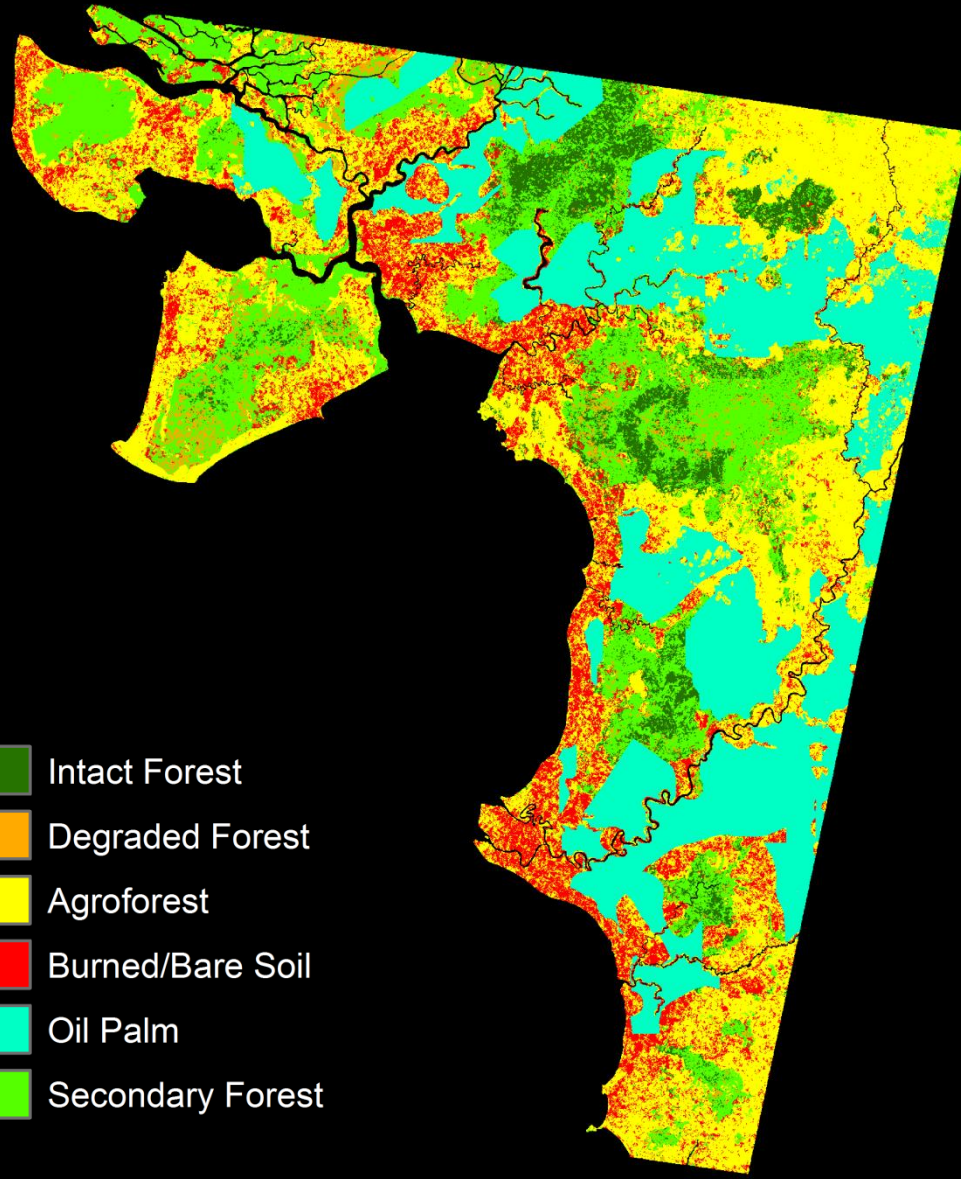
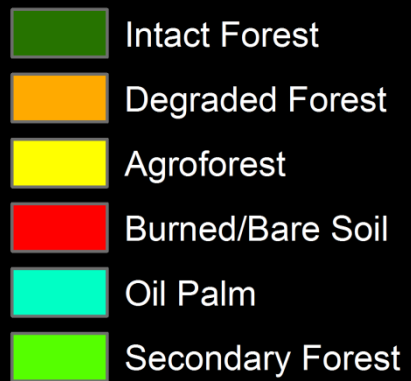
BAU 2016



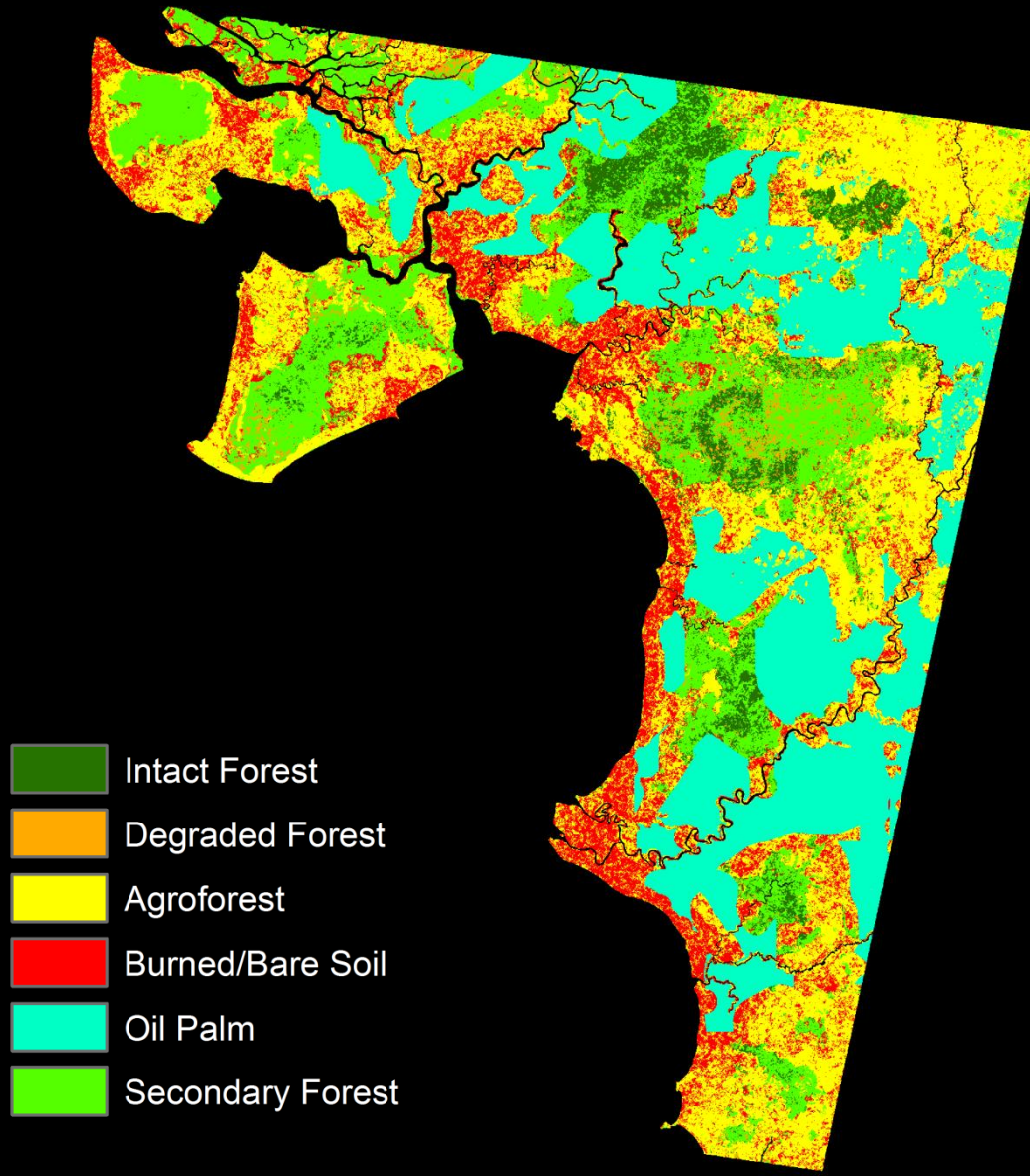
BAU 2017



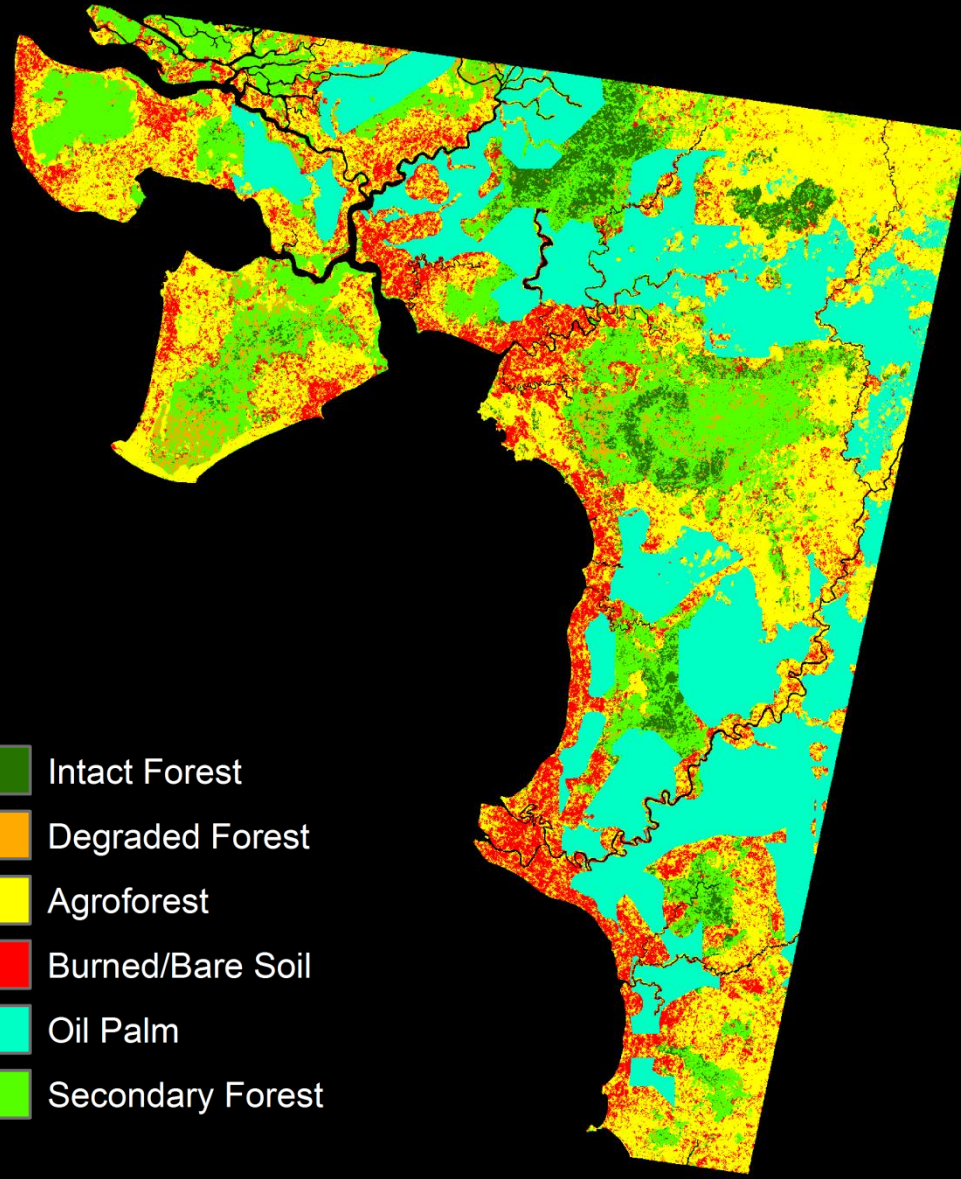
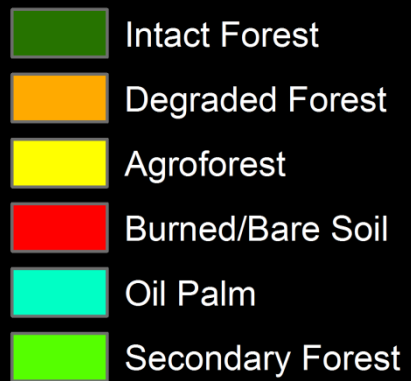
BAU 2018



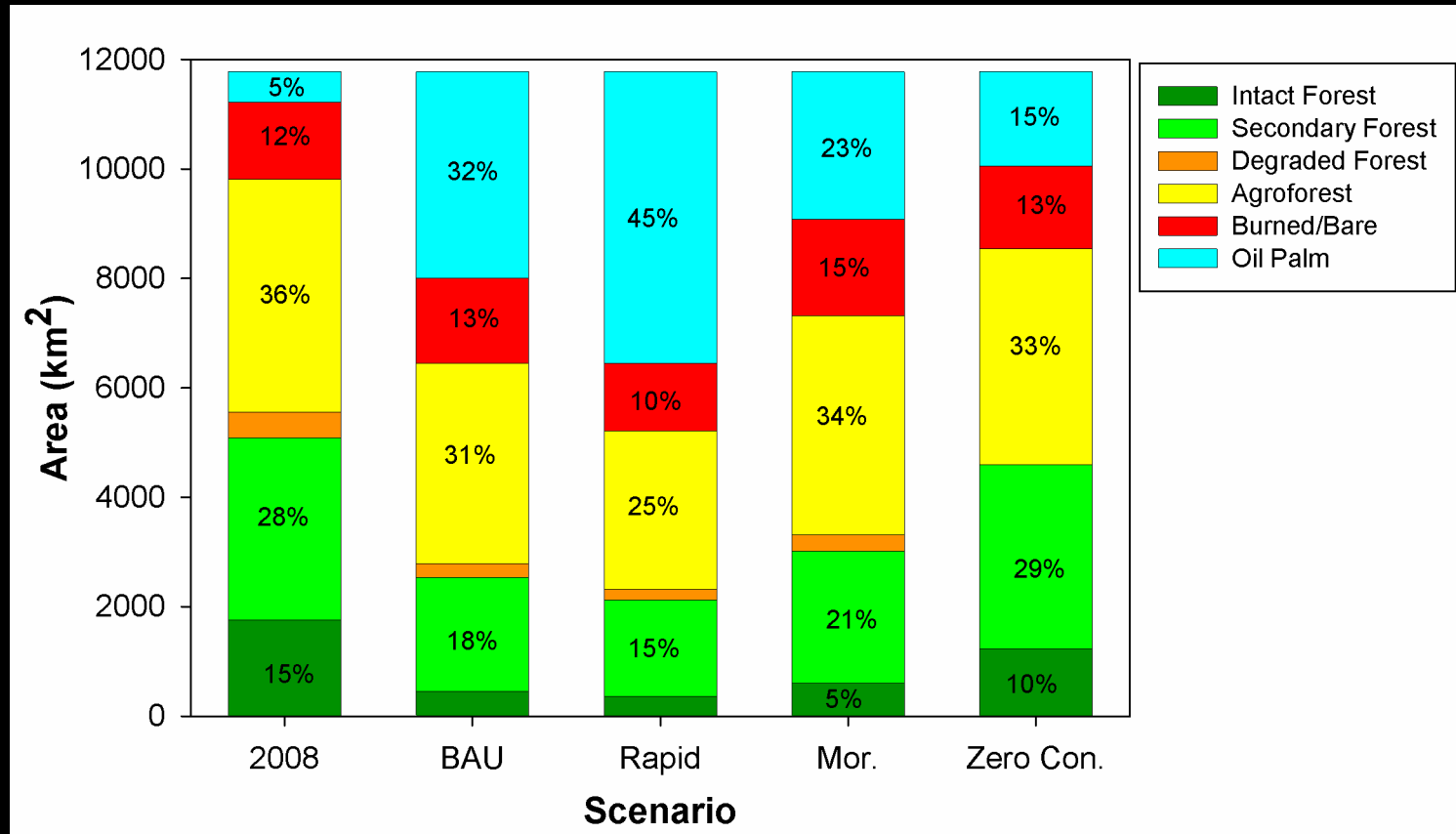
BAU 2019



BAU 2020

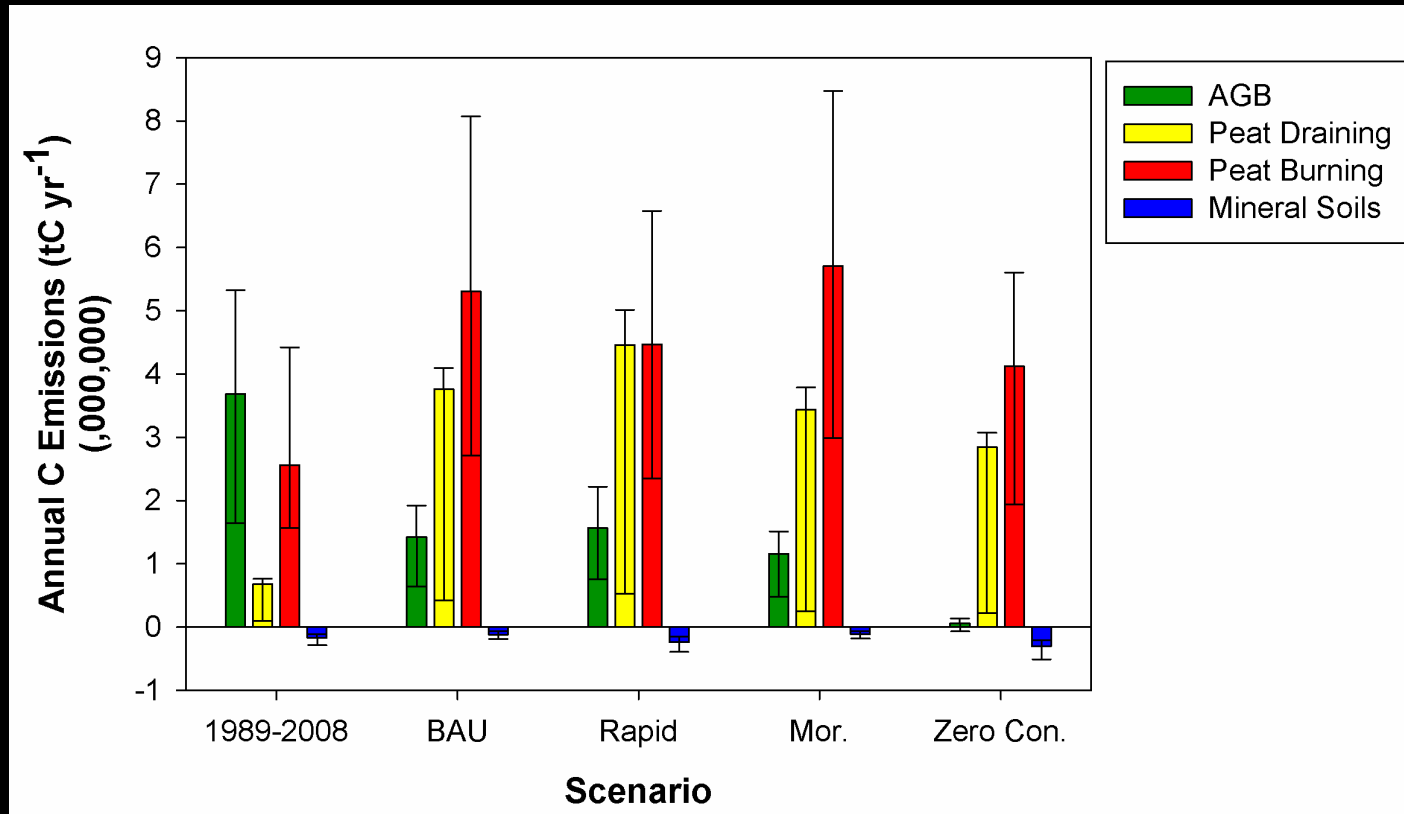


Scenarios - Land Cover in 2020



Scenarios – Annual C Flux by Pool

2009-2020

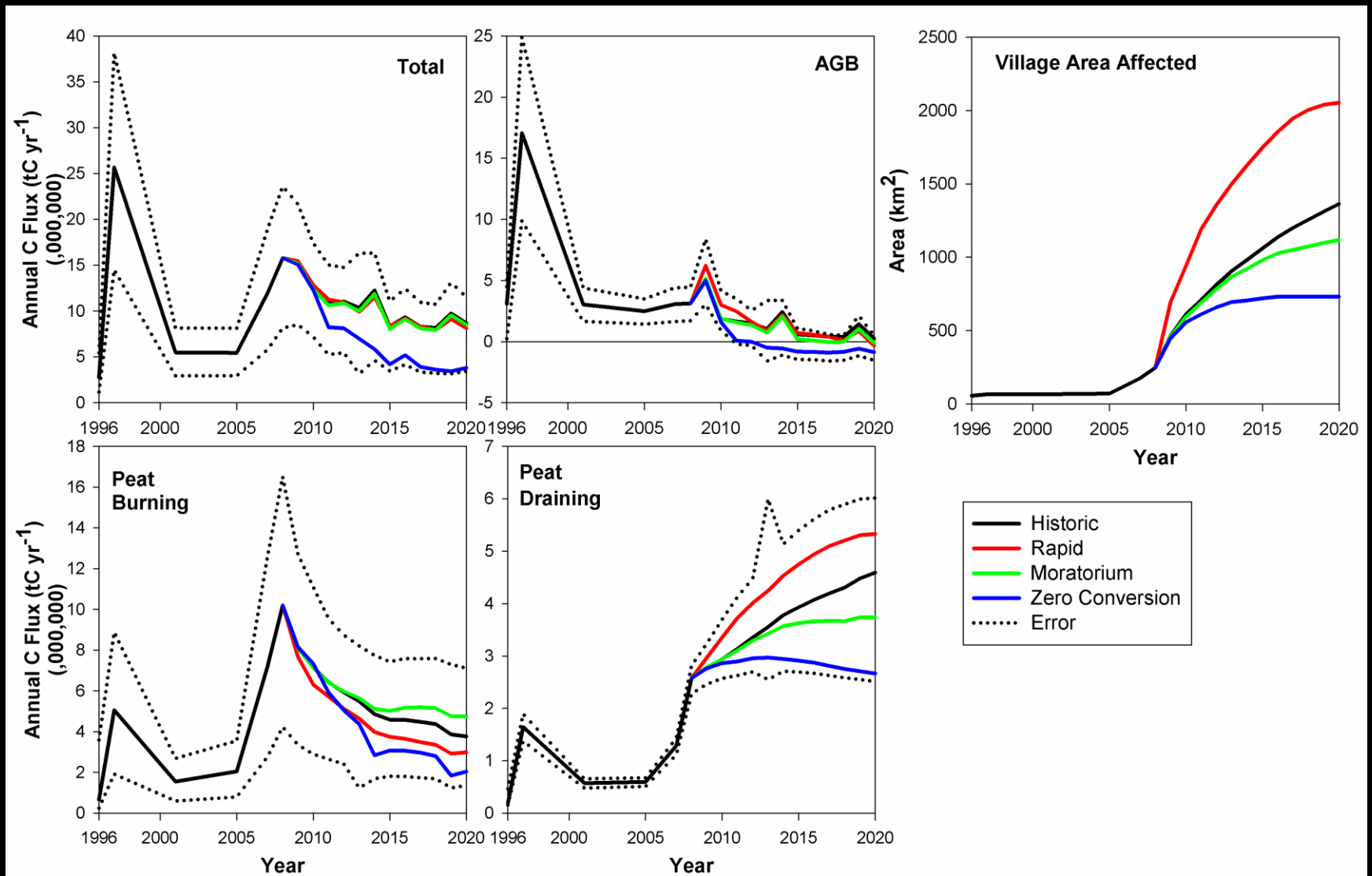


**% Of Total
Net C Flux**

Source	1989-2008	BAU	Zero Conv.
Peatlands	61%	93%	100%
Peat Burning	41%	58%	69%
Oil Palm	2%	22%	17%

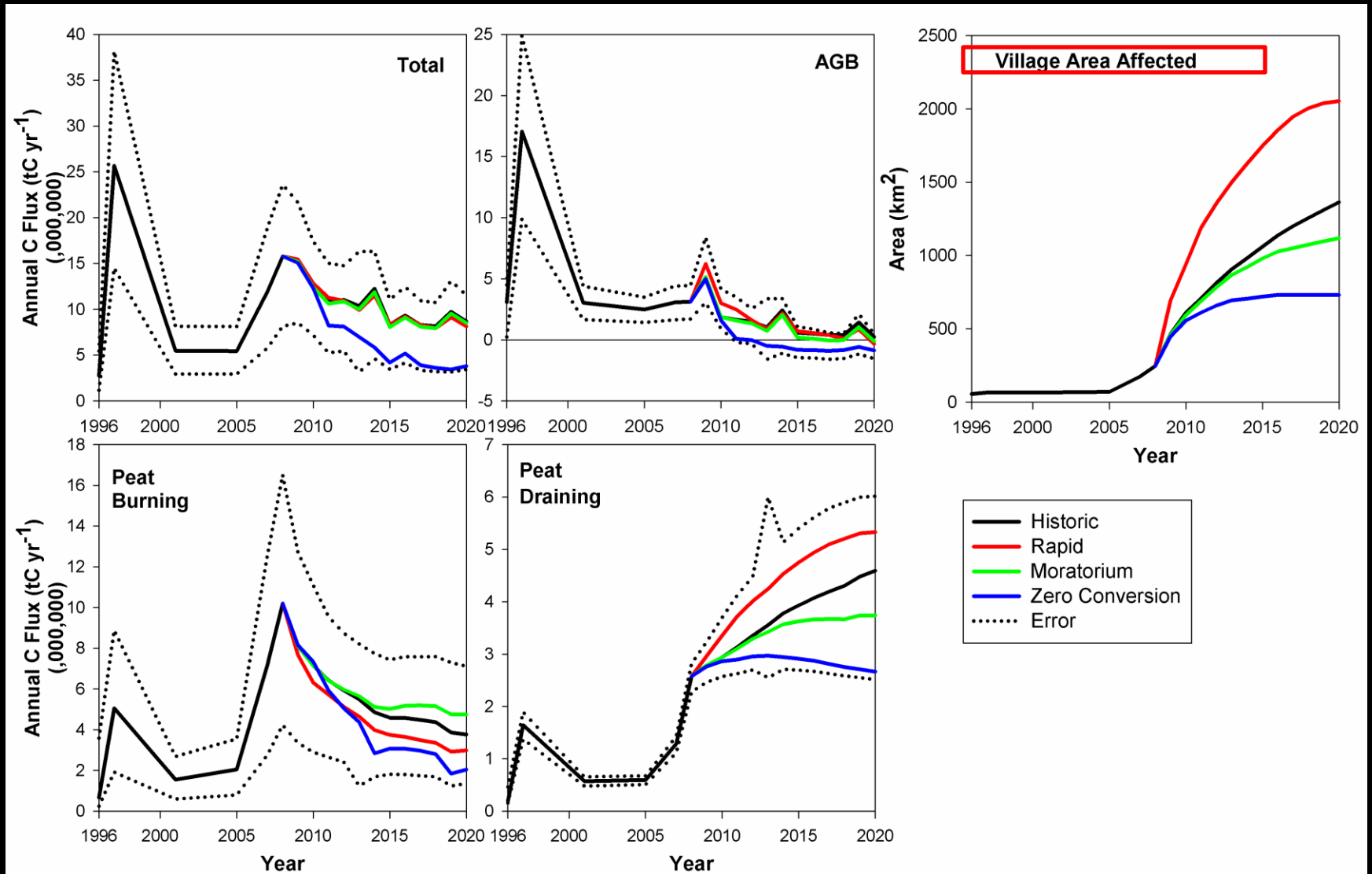
Scenarios – Annual

2009-2020



Scenarios – Annual

2009-2020



Acknowledgements!

- Adviser Lisa Curran
- Indonesian Field Team
- Britaldo Soares-Filho, Hermann Rodrigues, Greg Asner, Alice Pittman
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 - Carbon Science Program
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- Santa Fe Institute
- NSF Graduate Research Fellowship
- Stanford University
- Yale Agrarian Studies, Southeast Asian Studies, MacMillan Center, Tropical Resources Initiative



Conclusions

1. Land Cover Sources for OP

87% forested lands/27% peatlands

2. Future Land Cover

BAU = <5% remaining intact forest

Zero Conv. = 10% remaining intact forest

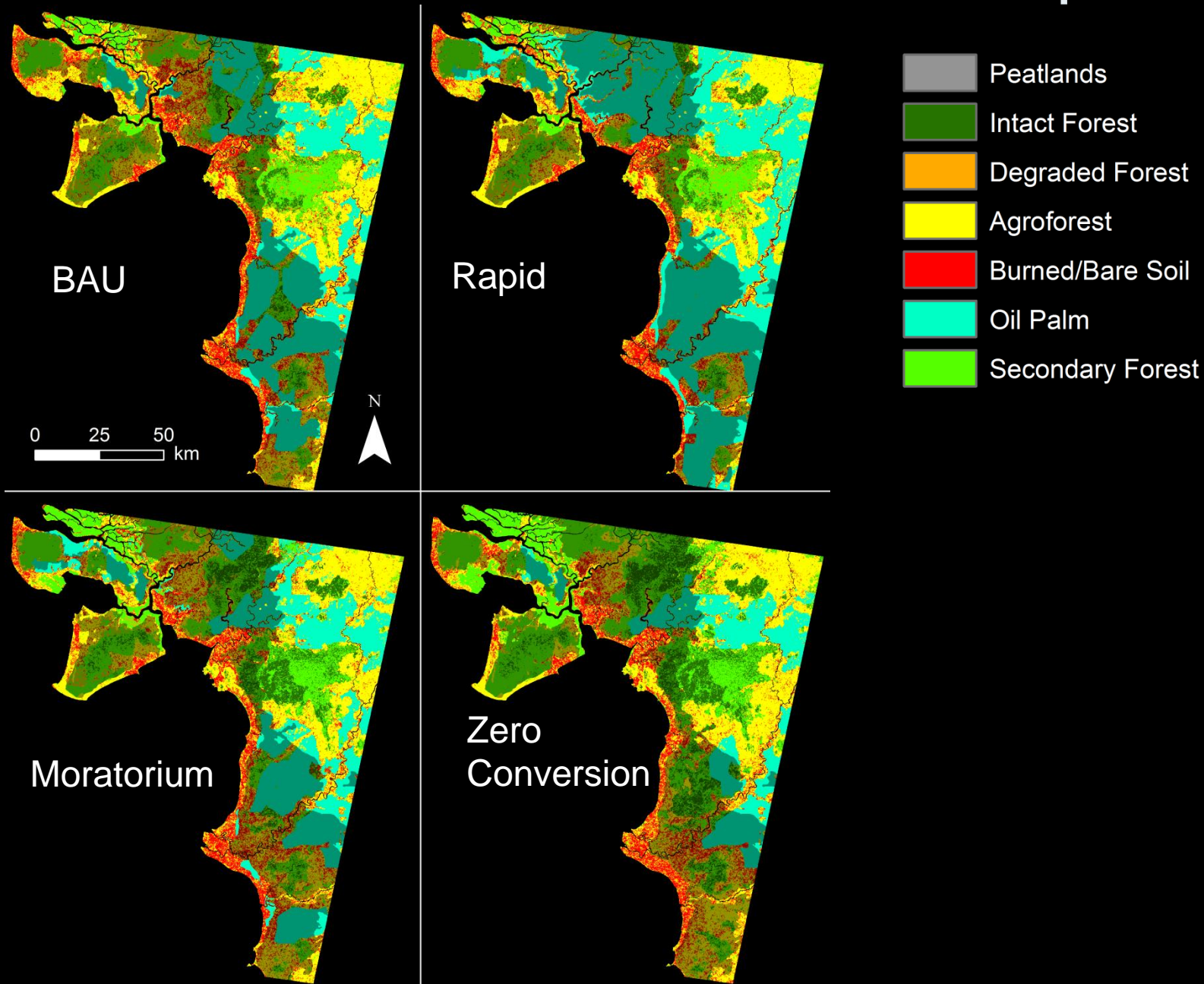
3. Future C emissions from OP

BAU = 22% total net emissions from OP

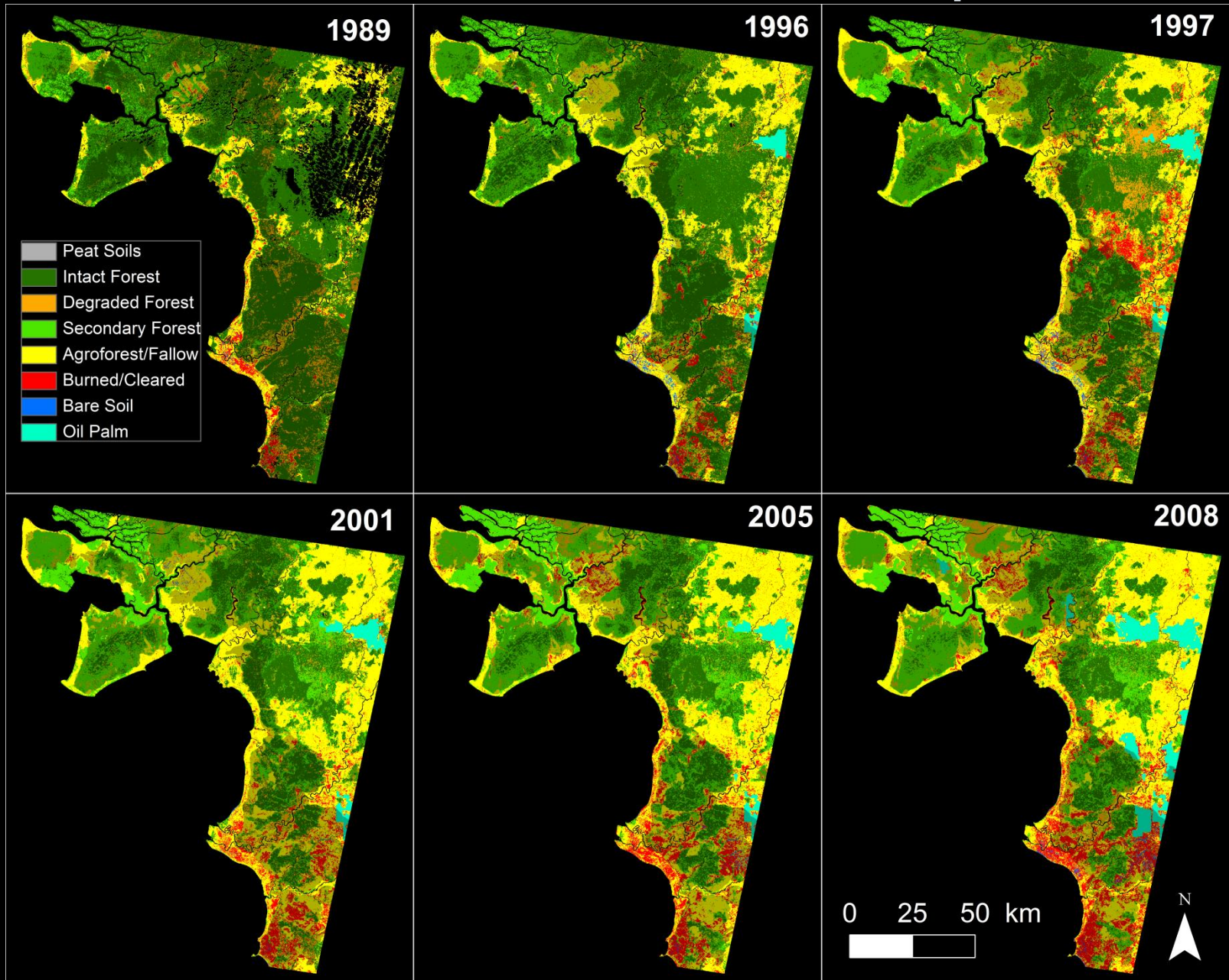
Zero Conv. = 35% emissions reductions over BAU

4. Major impacts on local people

Future Scenarios: Land Cover Maps



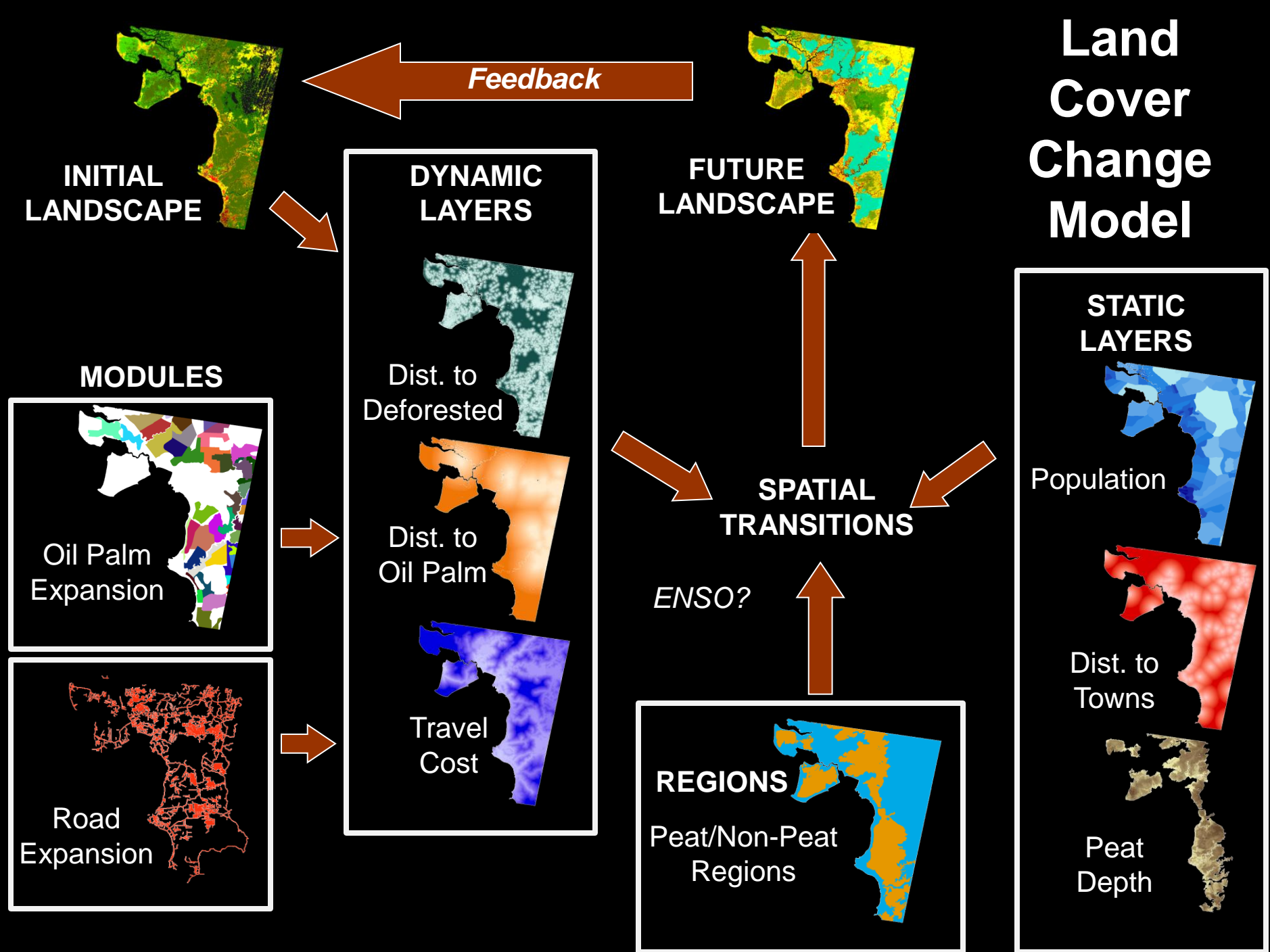
Historic Land Cover Maps



Carbon Pools

Pool	Emit C	Sequester C
Aboveground Live Biomass	Degradation/Deforestation	Re-growth (ABI)
Mineral Soil C	Stock Change	Stock Change
Peat Soil C	Draining (Annual Committed)	none
Peat Soil C	Burning (Depth)	none

Land Cover Change Model



Spatial Layers

Layer Name	Dynamic/Static
Age	Dynamic
Distance to Deforestation	Dynamic
Distance to Degradation	Dynamic
Distance to Oil Palm	Dynamic
Peat Depth	Dynamic
Travel Cost	Dynamic
Protected Areas	Static
Slope	Static
Distance to Towns	Static
Elevation	Static

AGB Inputs (tC ha⁻¹)

#	Land Use	<300m			>300m			Age
		Mean	High	Low	Mean	High	Low	
1	Intact Forest	401	547	255	292	393	191	
2	Low Deg	281	383	179	204	275	133	
3	High Deg	161	219	102	117	157	76	
4	Regrowth	161	219	102	117	157	76	
5	Shifting Agriculture <10 years	0	0	0	0	0	0	
6	Shifting Agriculture >10 years	22	29	14	22	29	14	10
7	Burned/Cleared	0	0	0	0	0	0	
8	Bare Soil	0	0	0	0	0	0	
9	Oil Palm	0	0	0	0	0	0	
10	Peat Intact	180	288	71	180	288	71	
11	Peat Low Deg	126	202	50	126	202	50	
12	Peat High Deg	72	115	28	72	115	28	
13	Peat Regrowth	72	115	28	72	115	28	
14	Peat Non-Forest	0	0	0	0	0	0	
15	Peat Burned/Cleared	0	0	0	0	0	0	
16	Peat Bare Soil	0	0	0	0	0	0	
17	Peat Oil Palm	0	0	0	0	0	0	