Methodology to Develop REL (National and Sub-National)

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Outline

- Approaches for determining REL
- Quantifying REL using the approaches
- Validity of REL based historical emissions
- Adjustment of National REL based on improvement of ADs and EFs of the sub-nationals or projects

REL (Reference Emission Level)

- The SB 28 decision (ref) describes Reference Emissions Levels (REL) as follows: "*Means to establish reference emission levels, based on* ***historical data****, taking into account, inter alia,* ***trends****,* ***starting dates*** *and* ***the length of the reference period****,* ***availability and reliability of historical data, and other specific national circumstances****.*"

Proposal on Defining REL from Deforestation

- There are three general approaches
  1. REL = Historical Emission (mean rate of extrapolation).
     1.1. Reference levels equal to national historical rates for countries with historically high deforestation; Reference levels higher than national historical rates for countries with historically low deforestation rates (Santilli *et al*, 2005; Mollicone *et al*, 2007)
     1.2. Reference levels weighted average of national and global historical rates (Strassburg *et al*, 2009)
  2. REL = Adjusted Historical Emission. This assumed that future emission can be estimated from historical with various adjustment factors (population density, agriculture land demand GDP etc; e.g. Amano *et al.*, 2008)

Proposal on Defining REL from Deforestation

3. REL = Forward looking. To model future emissions taking into account factors that drive and constraint emissions from land use (might or might not included the consideration of historical data)
   - 3.1. To project forest cover change using a number of predictors (drivers of deforestation), e.g. GEOMOD (Petrova *et al.* 2007)
   - 3.2. Reference level is a uniform fraction of at-risk forest stock into the future, based on biophysical, economic and legal considerations (Ashton *et al.*, 2008)
   - 3.3. Applying threshold value, a minimum forest cover that should be maintained by countries (can be approximated using population density, GDP etc.; e.g. Boer, 2008)

Defining REL (Approach 1.1)

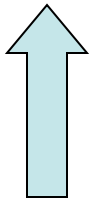
Countries	Rate of deforestation (% loss per year)	REL Approach
D.R. Congo	0.2	Country that can apply REL higher than national historical emission
Brazil	0.6	
Venezuela	0.6	
Sudan	0.8	
Zambia	1.0	
Tanzania	1.1	
Myanmar	***1.4***	Country that can apply national historical emission for REL
Zimbabwe	***1.7***	
Indonesia	***2.0***	
Nigeria	***3.3***	
Global	**1.3**	

Source: Deforestation data from UNFAO (2006)

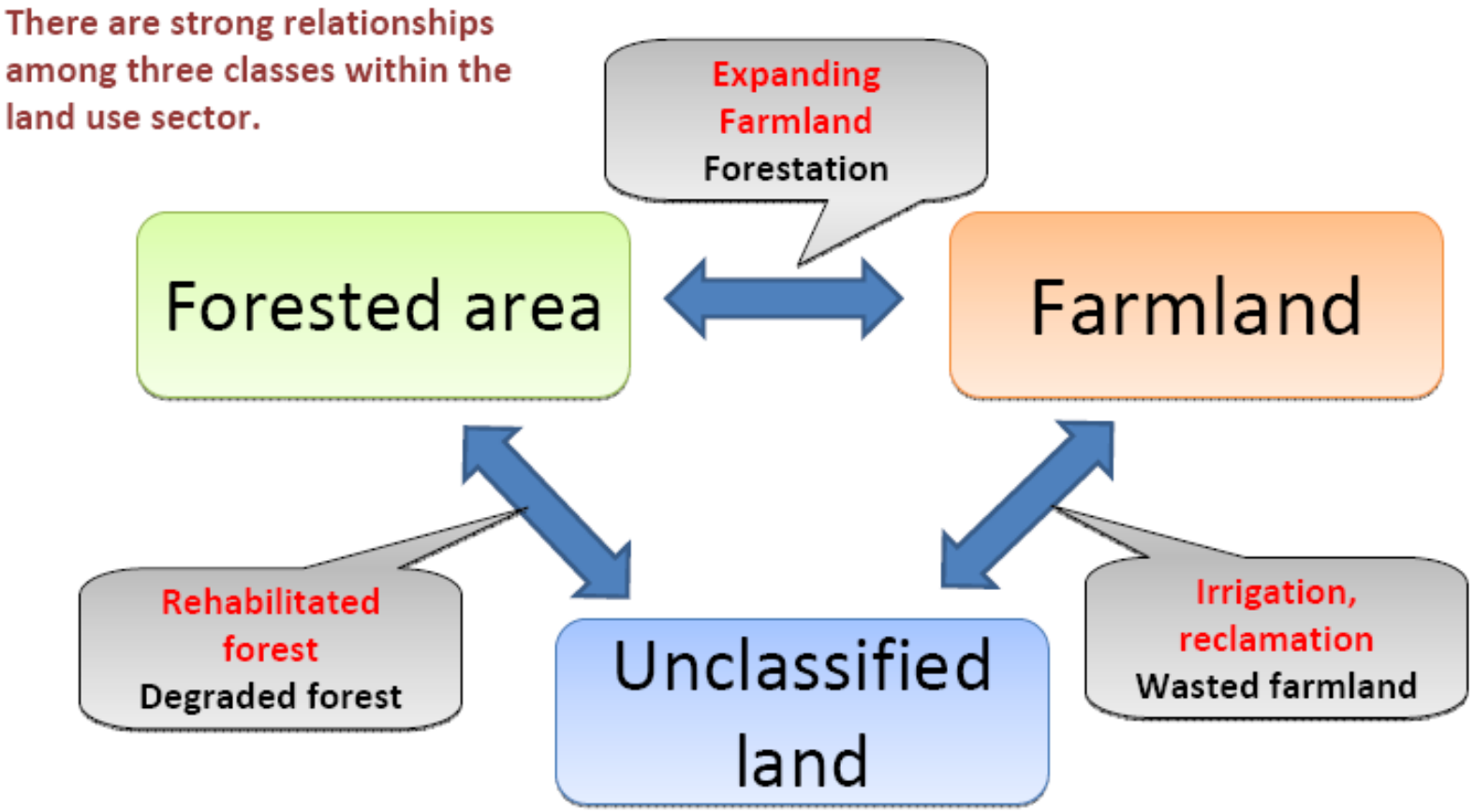
Defining REL (Approach 1.2)

Countries		Rate of deforestation (% loss per year)	REL (% loss per year)
D.R. Congo	133610	0.2	1.139
Brazil	477968	0.6	1.046
Venezuela	47713	0.6	1.238
Sudan	67546	0.8	1.239
Zambia	42452	1.0	1.258
Tanzania	35257	1.1	1.264
Myanmar	32222	***1.4***	1.274
Zimbabwe	17540	***1.7***	1.278
Indonesia	88495	***2.0***	1.332
Nigeria	11089	***3.3***	1.293
Total/Mean	**953892**	**1.3**	

Source: Deforestation data from UNFAO (2006)



Adjusted Historical Emission: Approach 2



Source: Waseda University and Kasertsat University

Adjusted Historical Emission: Approach 2

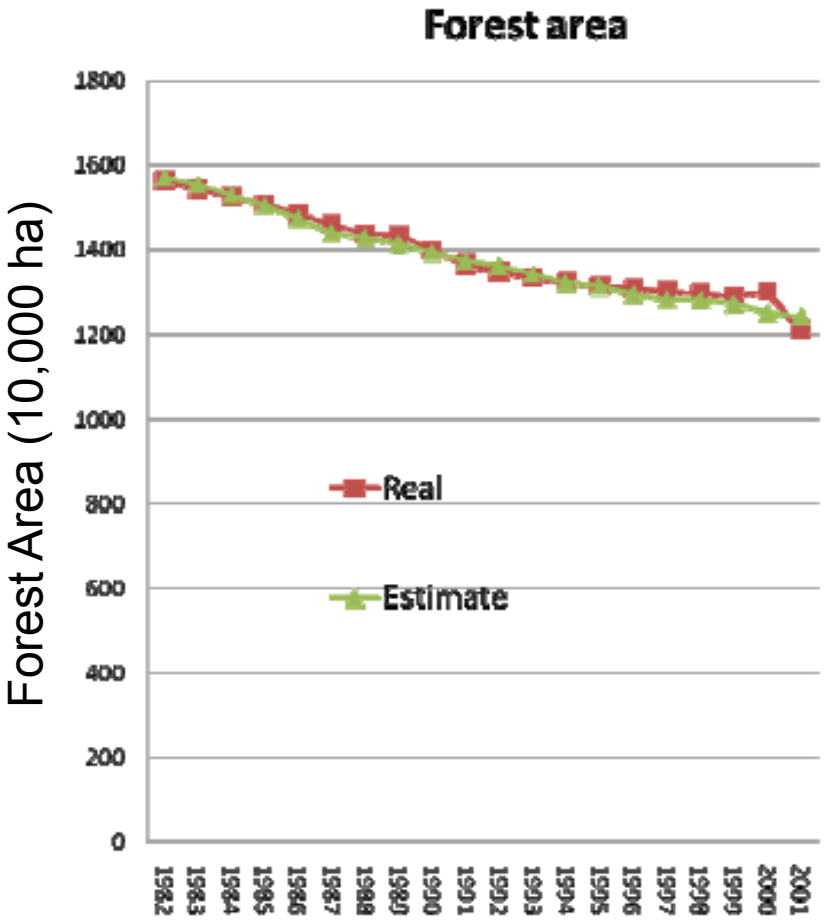
- $For_i = f(For_{(i-1)}, FL_i, FL_{(i-1)}, UL_i, UL_{(i-1)})$
  - $FL_i = f(FL_{(i-1)}$, GDP, $Population_i$, Agriculture $Productivity_i$, National Park/WL $Sactuary_i)$
  - $UL_i = f(UL_{(i-1)}$, crop $production_i$, cattle $population_i)$

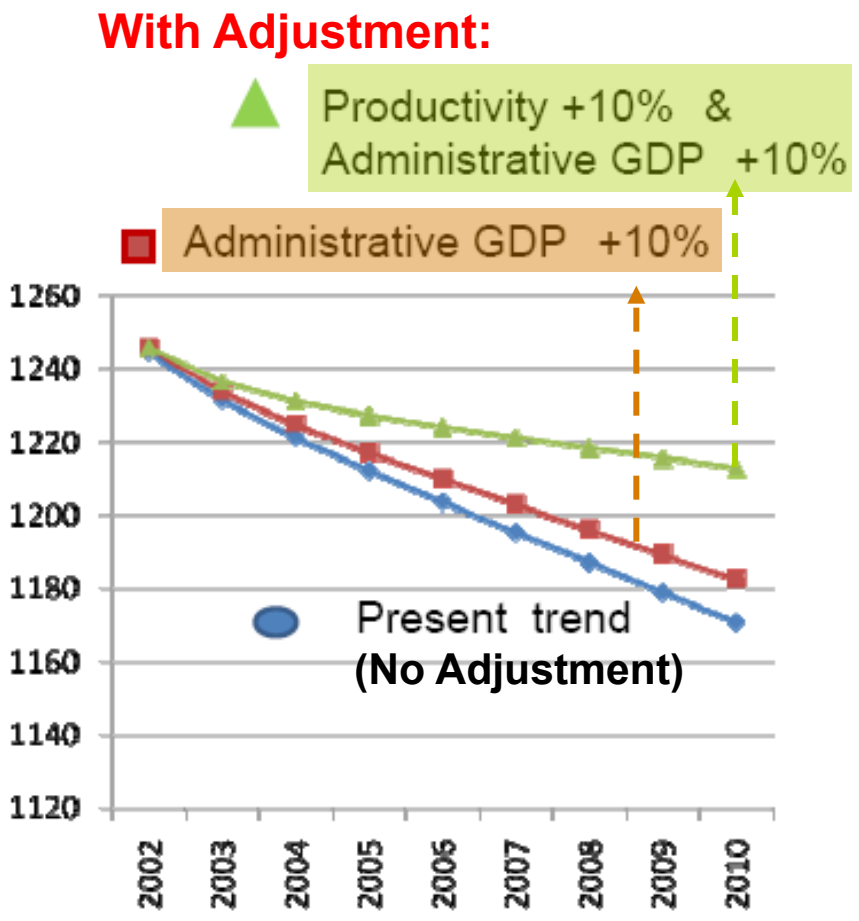
Thailand Case

- $For_i = 1769.7 + 0.652*For_{(i-1)} - 1.02*FL_i + 0.684*FL_{(i-1)} - 0.99*UL_i + 0.613*UL_{(i-1)}$
  - $FL_i = 632.9 + 0.349*FL_{(i-1)} - 0.000780*GDP + 0.0162*Population_i - 28.6*Agriculture\ Productivity_i - 0.000846*National\ Park/WL\ Sactuary_i)$
  - $UL_i = 930.3 + 0.431*UL_{(i-1)} + 0.0000576*crop\ production_i - 0.000013*cattle\ population_i$

Source: Waseda University and Kasertsat University

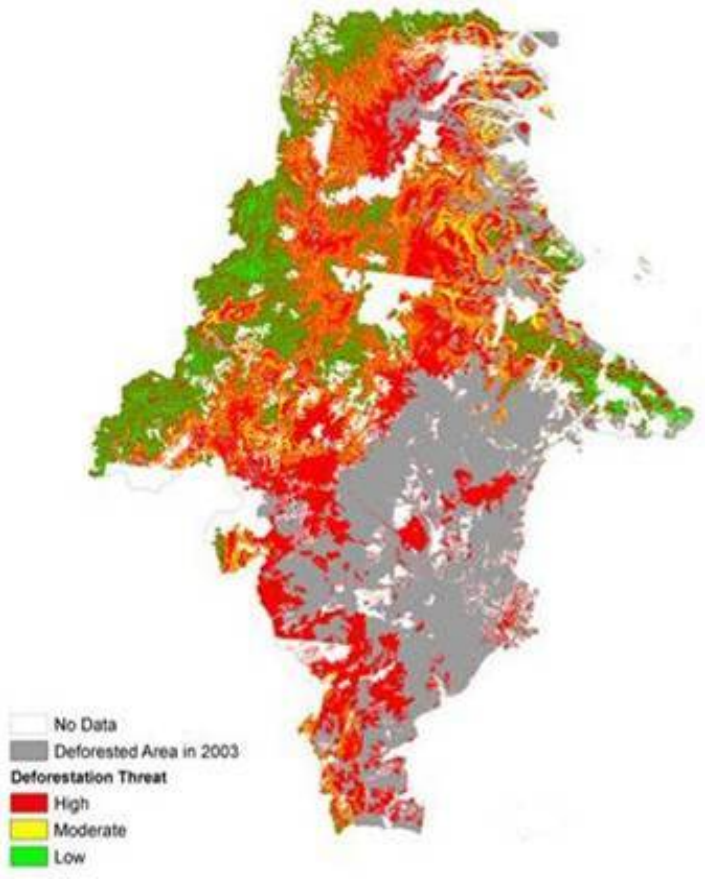
Adjusted Historical Emission: Approach 2





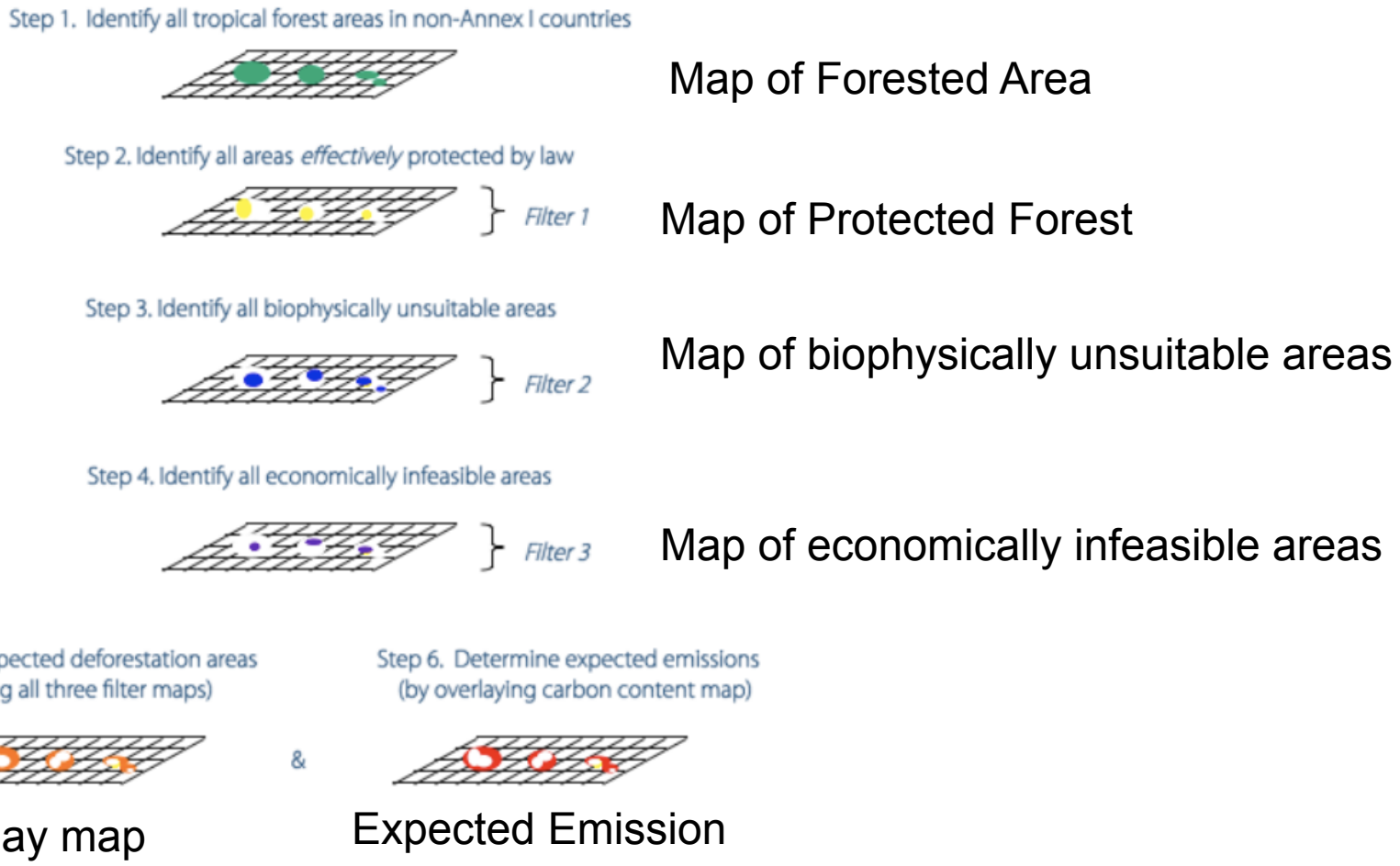
FORWARD LOOKING: MODELING APPROACH (Approach 3.1)

- Example of projecting where, and what level of risk of particular forested land will be deforested in the future using GEOMOD if there are changes in number of key drivers of deforestation like distance to infrastructure, population centers, already cleared areas and distance to transportation corridors (roads and rivers). The REL will be emission from forested area being deforested in the future (area with level of risk more than certain level)



Source: IFCA Report (2008)

Reference level is a uniform fraction of at-risk forest stock into the future (Approach 3.2)



Source: Strassburg et al. (2009) from Terrestrial Carbon Group

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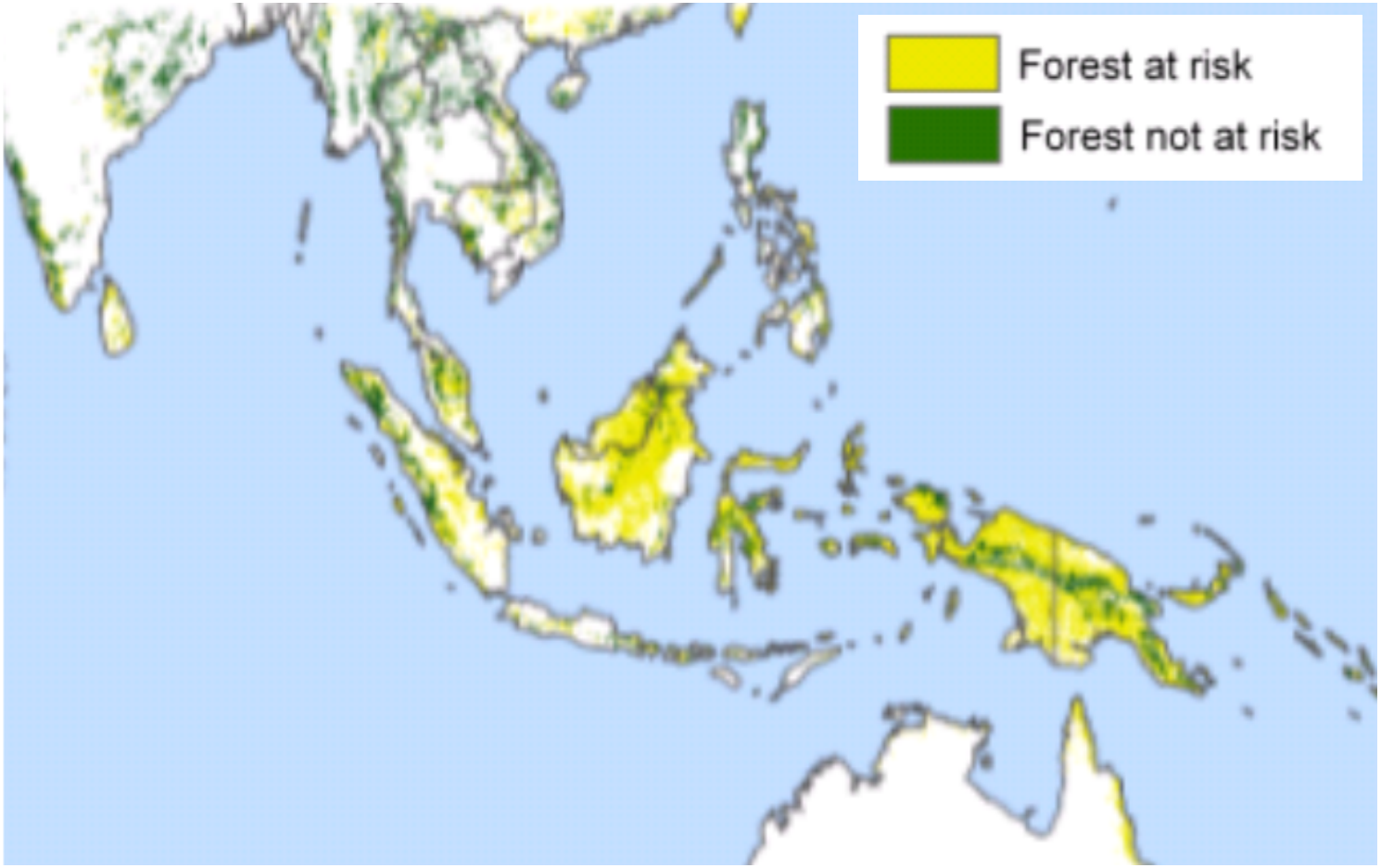
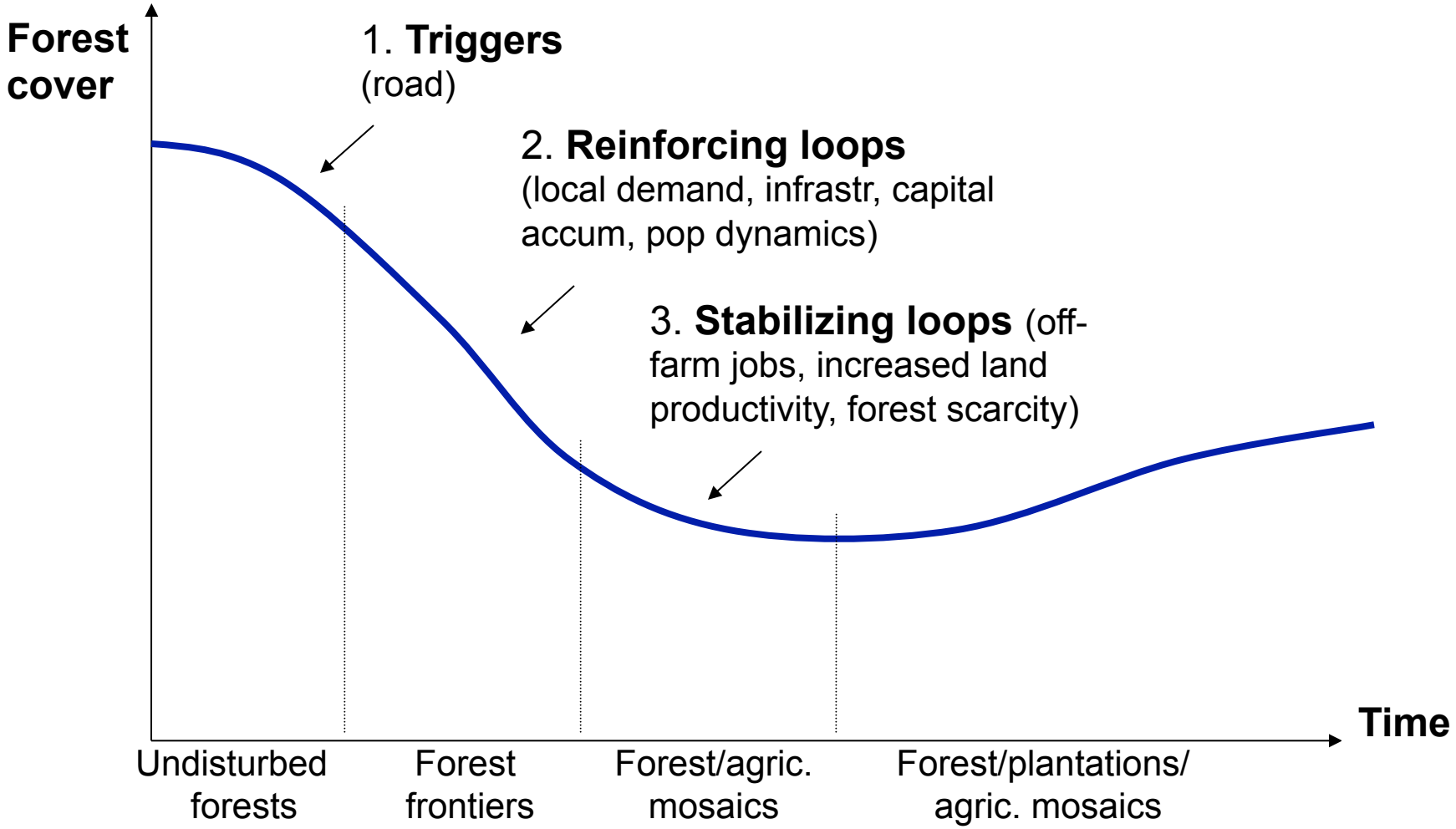


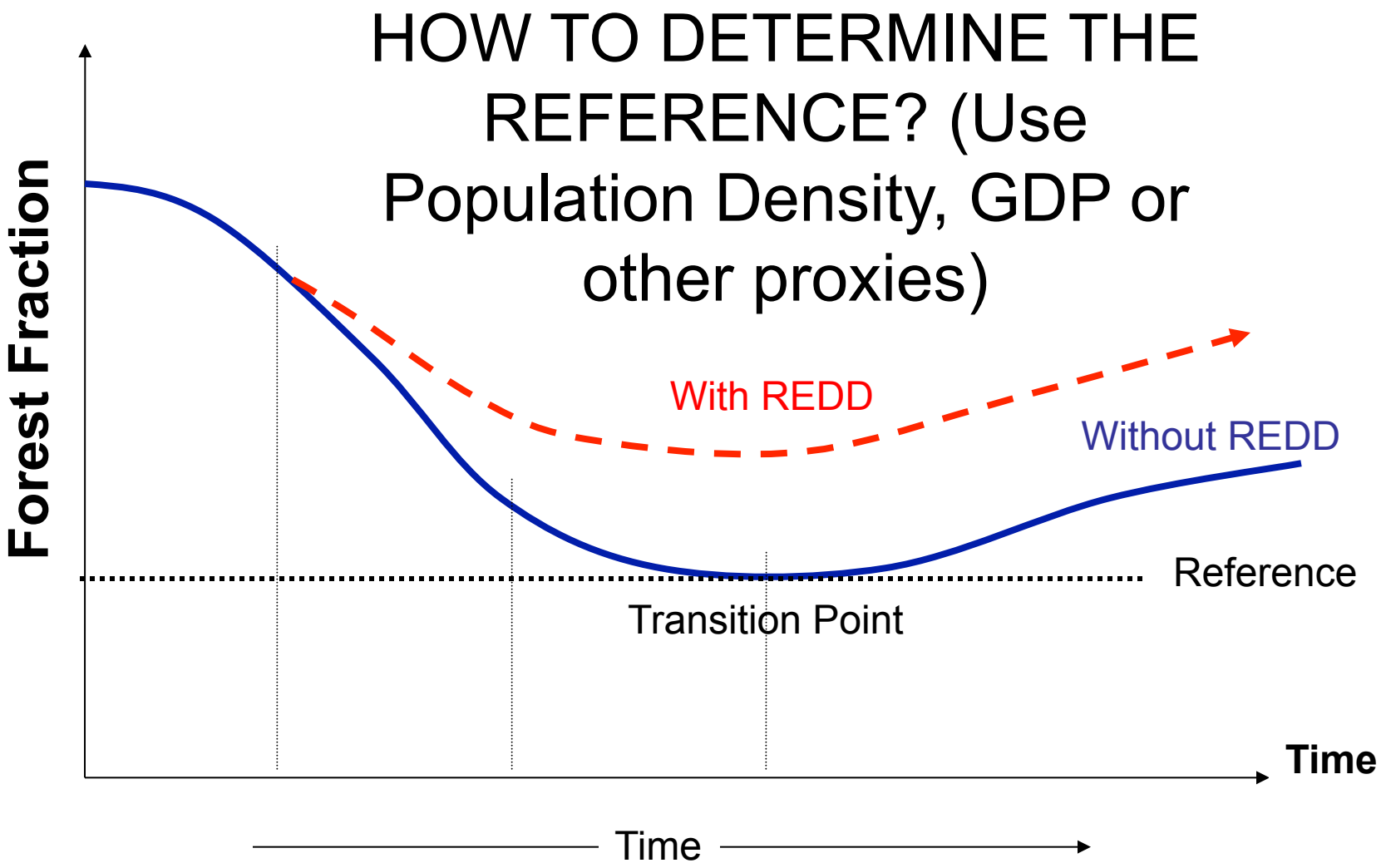
Source: Strassburg et al. (2009) from Terrestrial Carbon Group

Applying threshold value (Approach 3.3)



Source: Kaimowitz and Angelsen (1997): Murdiyarso Slide

Applying threshold value (Approach 3.3)



Applying threshold value (Approach 3.3)

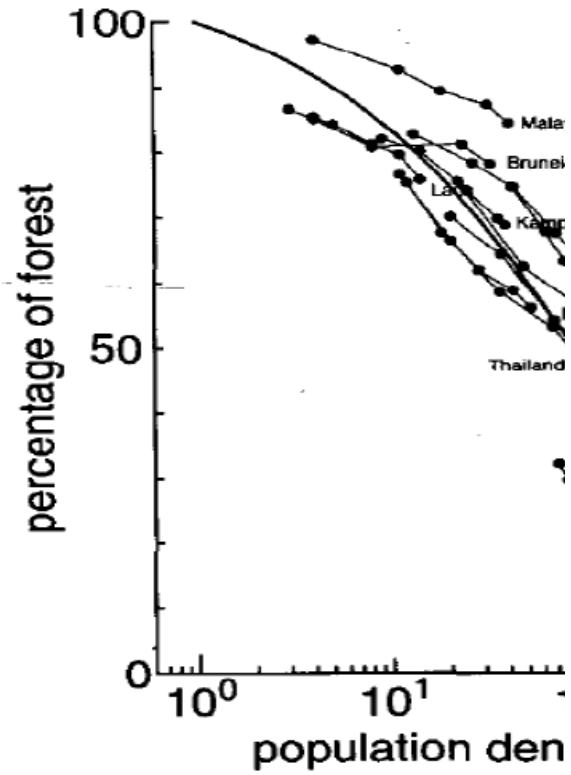
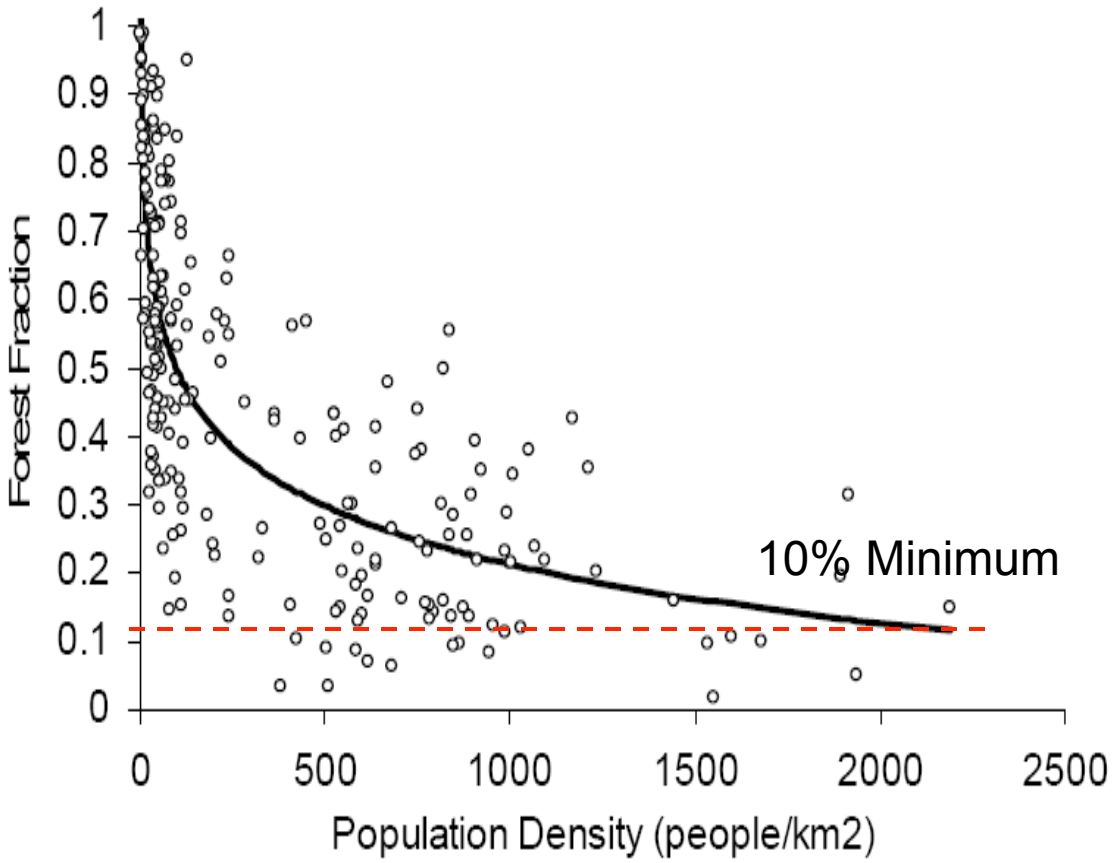


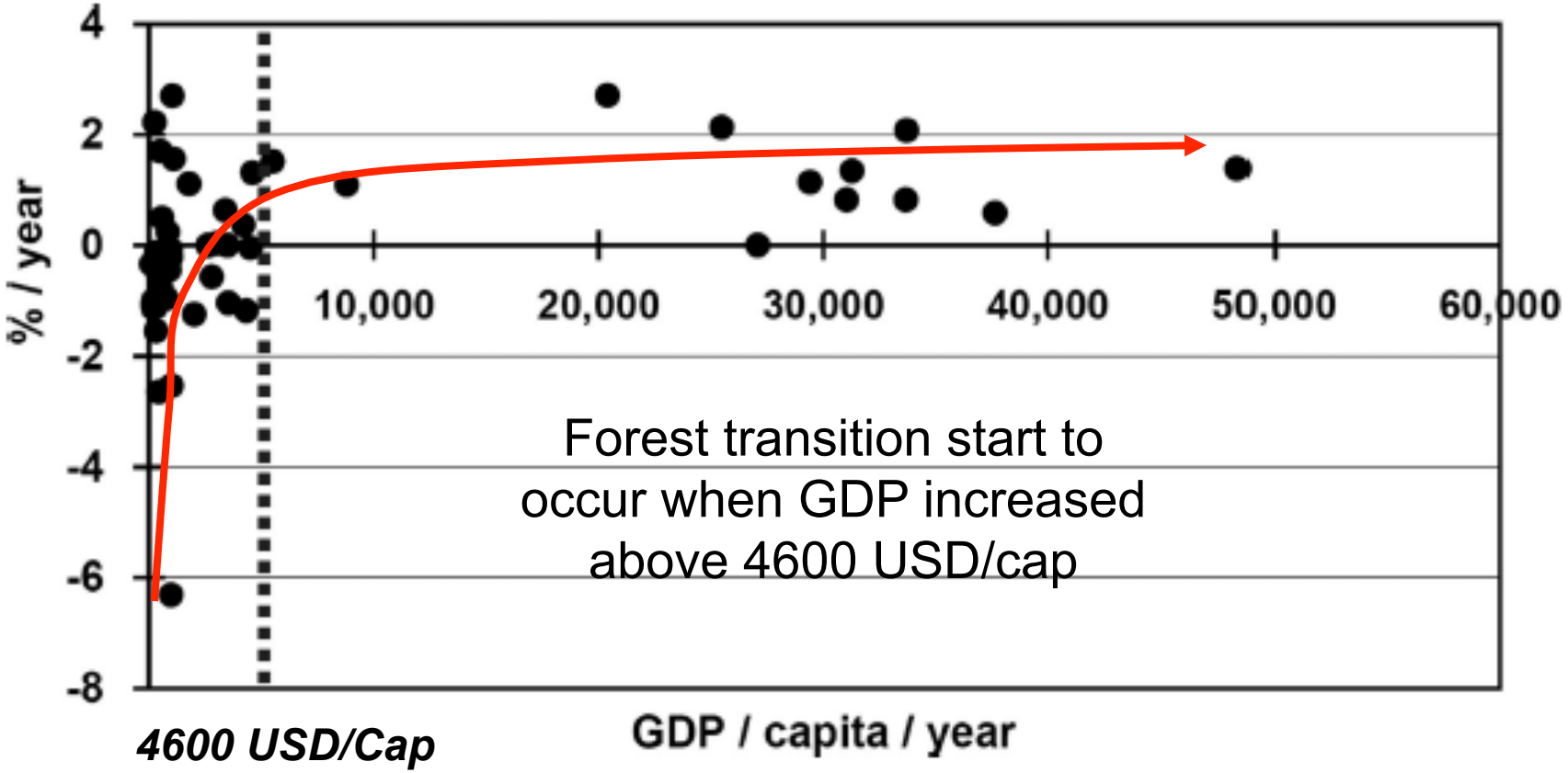
Figure 2. Relationship between percen
density in tropical Asian coun



Relationship between Population Density and Paddy Rice Fraction/Forest Fraction in Indonesia (Murdiyarso *et al.*, 2005)

Applying threshold value (Approach 3.3)

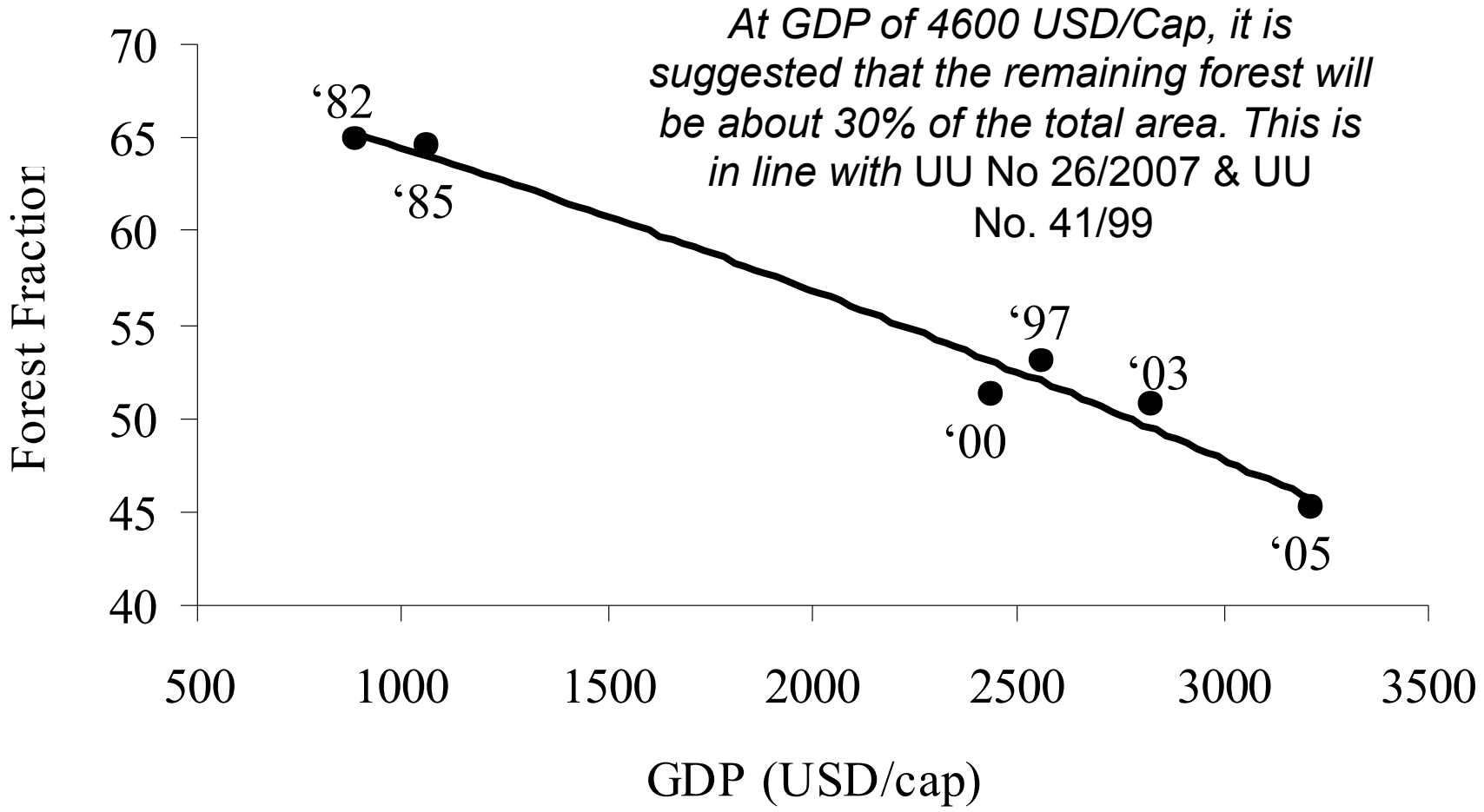
Rate of forest change with GDP in 50 nations



Source: Kauppi et al, 2006, PNAS

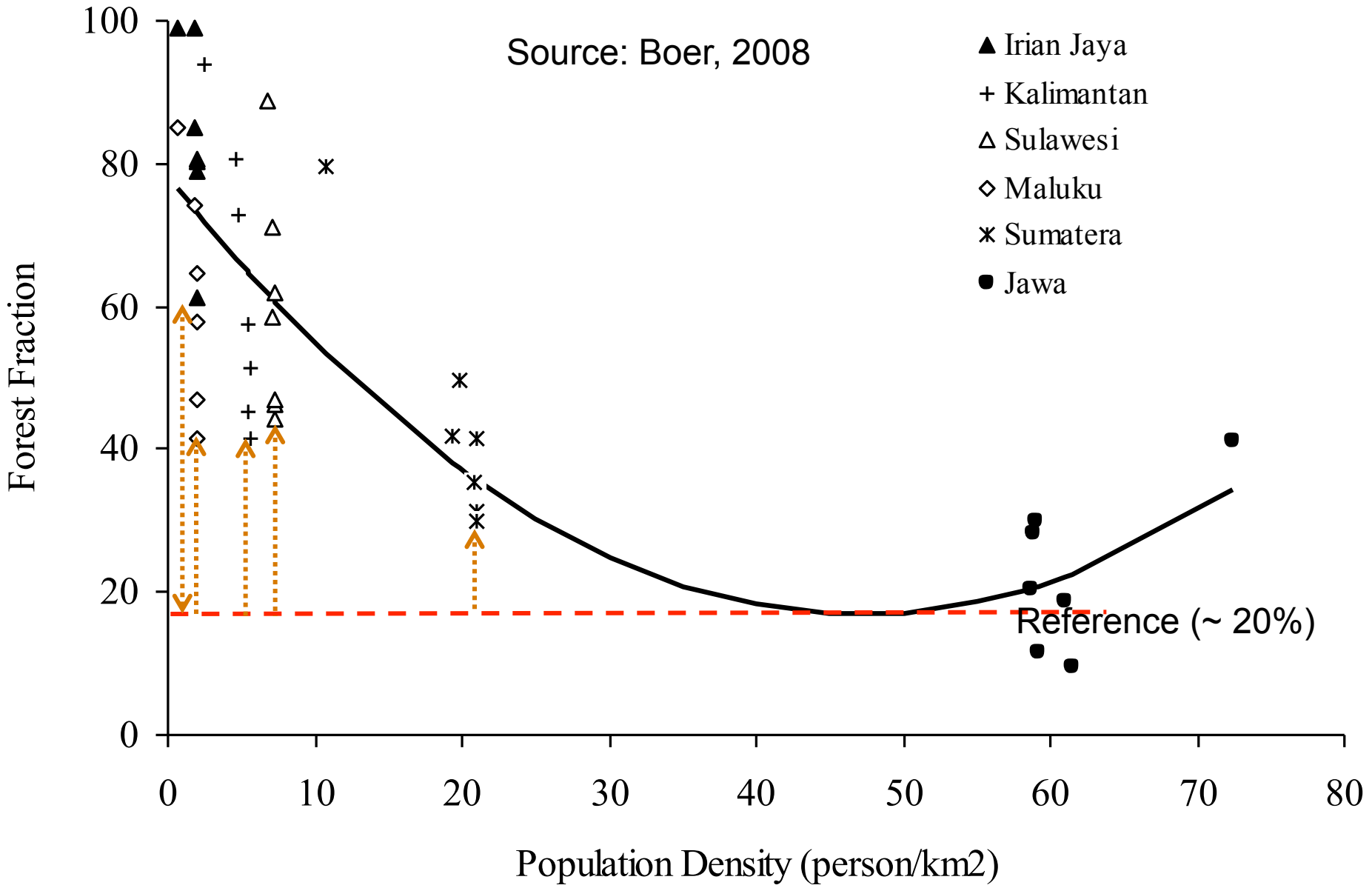
Applying threshold value (Approach 3.3)

Relationship between Forest Fraction and GDP (PPP)

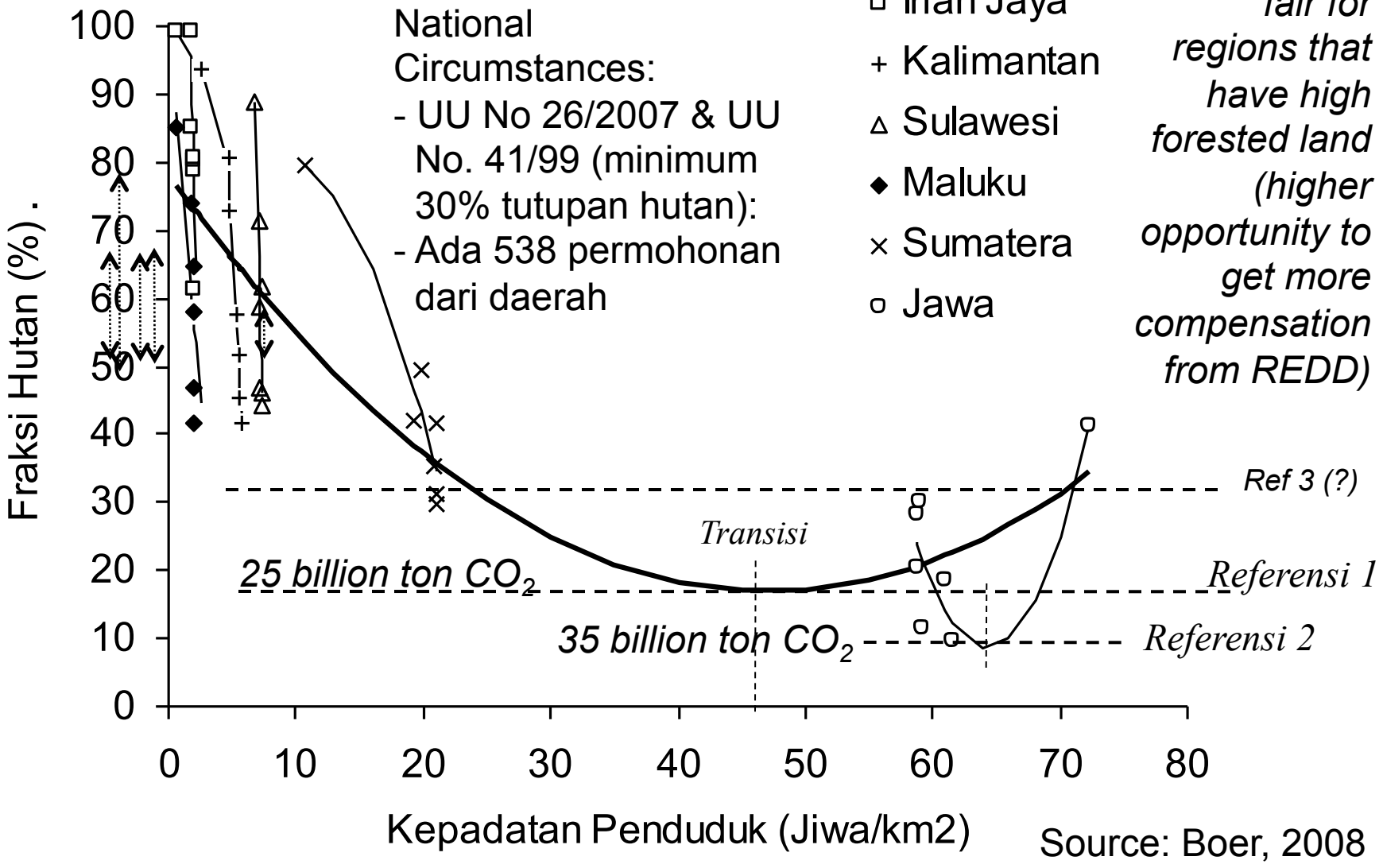


Source: Boer, 2008

Applying threshold value (Approach 3.3)

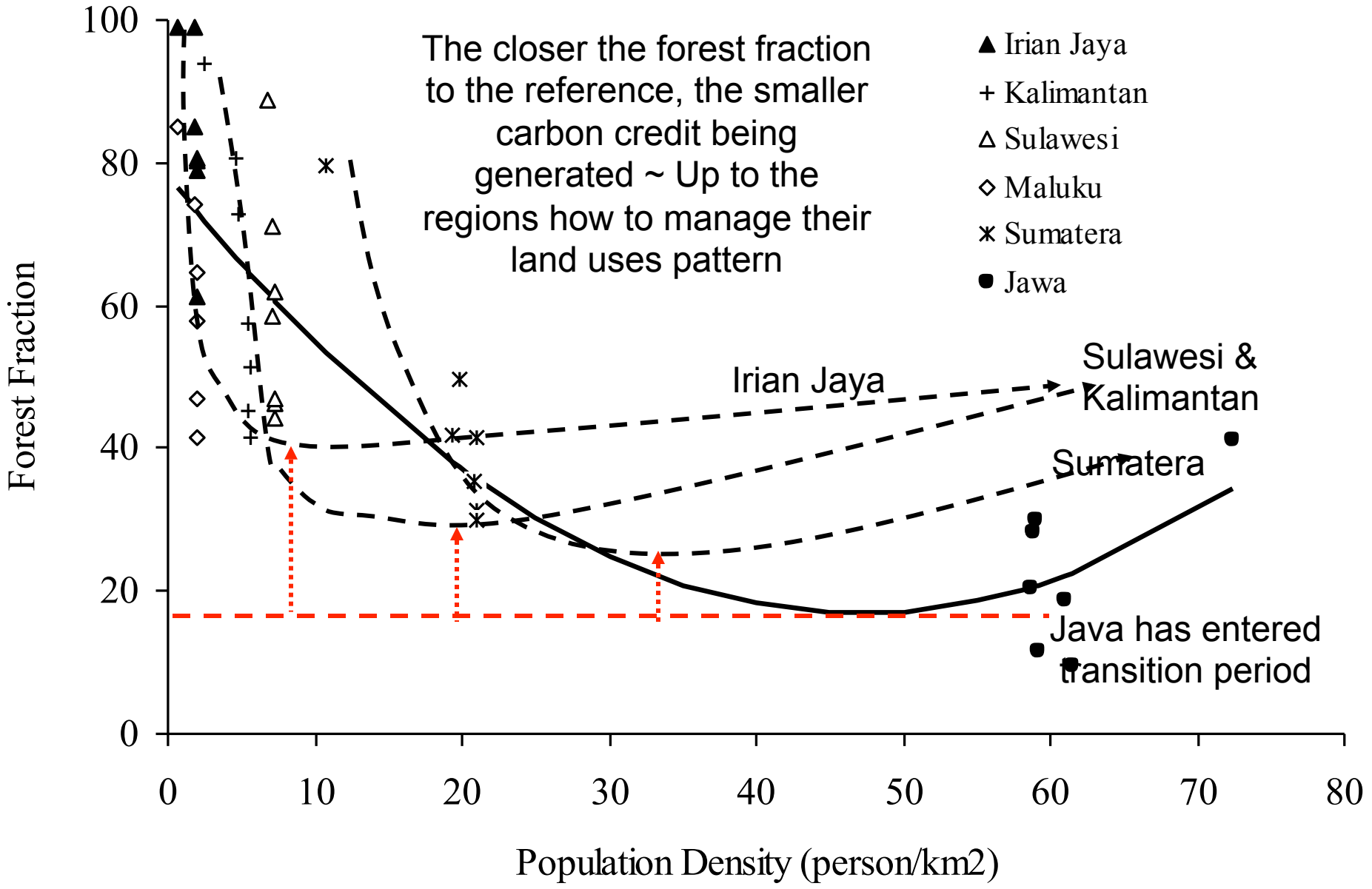


Applying threshold value (Approach 3.3)



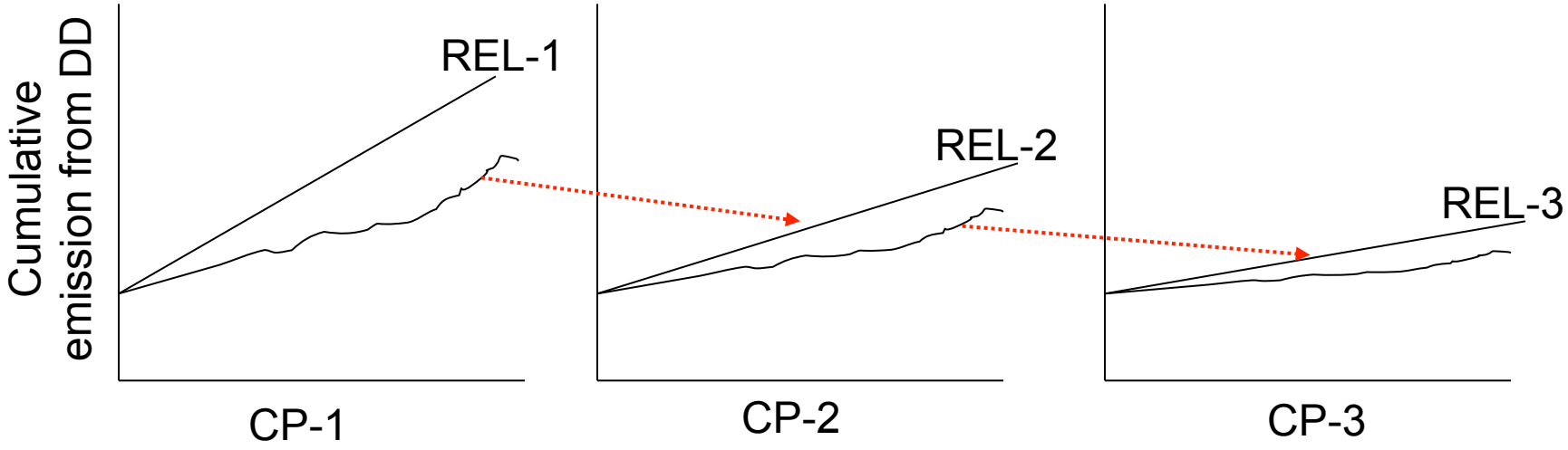
Source: Boer, 2008

Applying threshold value (Approach 3.3)



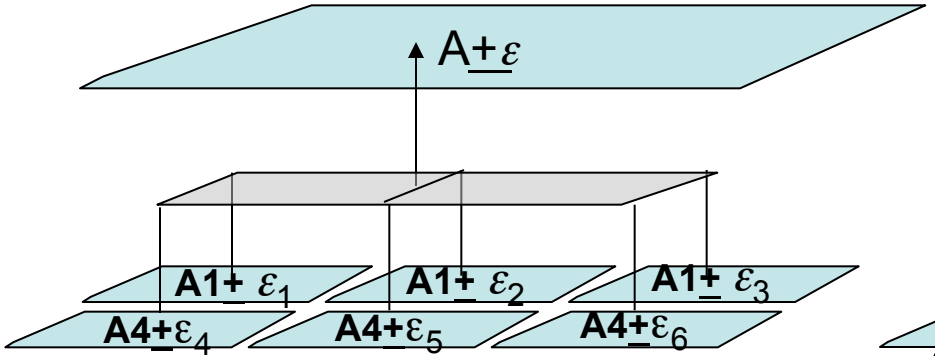
Revision of REL after completing Commitment Period (CP)

Using historical emission for determining REL may not be effective for longer term since factors affecting deforestation may have change a lot. Therefore, the validity of REL using historical emission should be limited only to a certain period (could be 5 years) and then need to be revised again for the following period



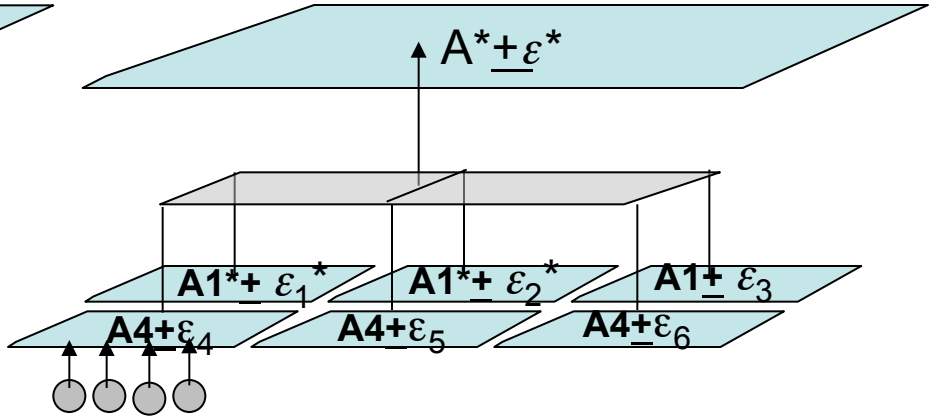
Source: Walsh, 2008

Adjustment of National REL based on improvement of ADs and EFs of the sub-nationals or projects



$\varepsilon = \varepsilon_1 = \varepsilon_2 = \varepsilon_3 = \varepsilon_4 = \varepsilon_5 = \varepsilon_6$

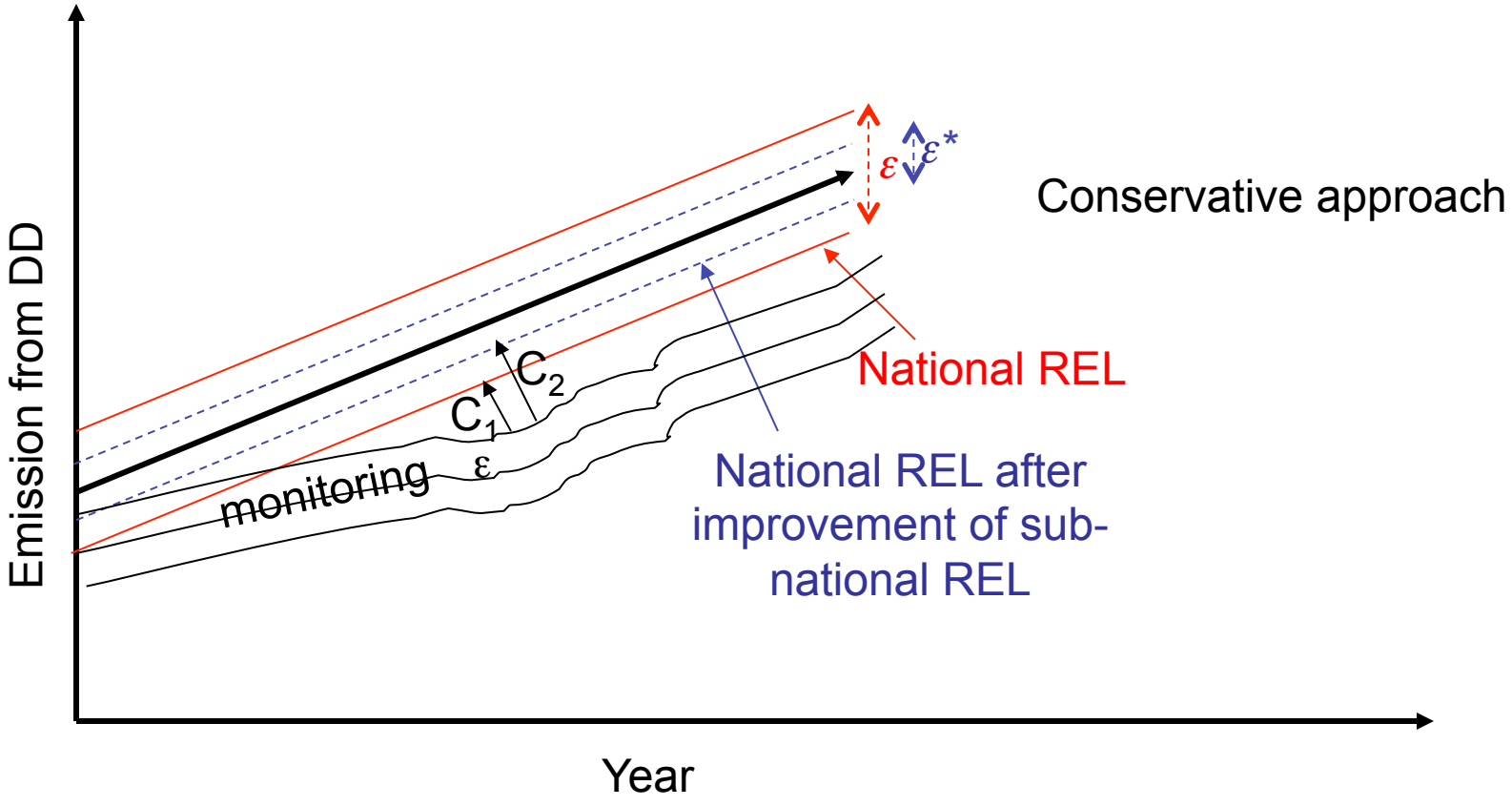
The activity data for region 1, 2..,& 6 were derived from images with the same resolution



$\varepsilon_1^* = \varepsilon_2^*$ and smaller than ε_3, ε_4, ε_5 & ε_6 as A1* and A2* are derived from image with higher resolution

$\varepsilon > \varepsilon^*$

Reducing error means increase the carbon benefit



What need to be done?

- Developing national default values for error of AD interpreted from different resolution of satellite images
- Developing national default factors on carbon stock (EF/RF) for various land categories and forest with different level of degradation ~ sub-national or project can improve it later (can be started from NFI data and expand it later)