

JAXA forest mapping activities in Indonesia

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KC-16

Oct. 20, 2011

Contents

1. Introduction
2. Backscattering coefficient
3. Sigma-naught stability
4. Algorithm tuning
 - Gamma-naught change
 - LULUCF
 - FNF
 - Effectiveness of slope/off-slope
5. Planning

ロンドニア州における森林伐採監視：JERS-1 SAR/PALSARの利用

JERS-1 SAR
1996

ALOS PALSAR
2007

はたして、SARはどれくらい使えるの？
森林監視に



2。後方散乱係数

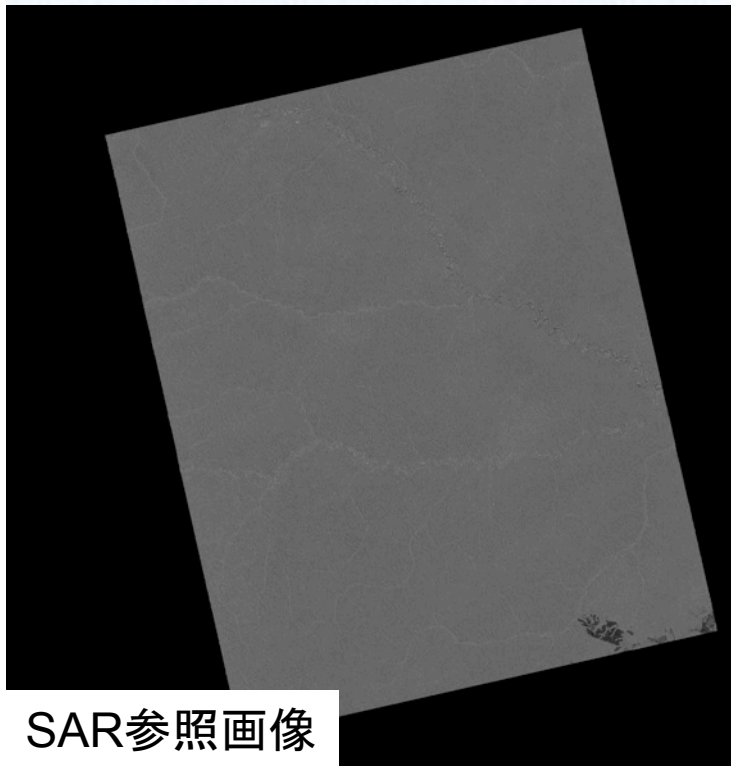
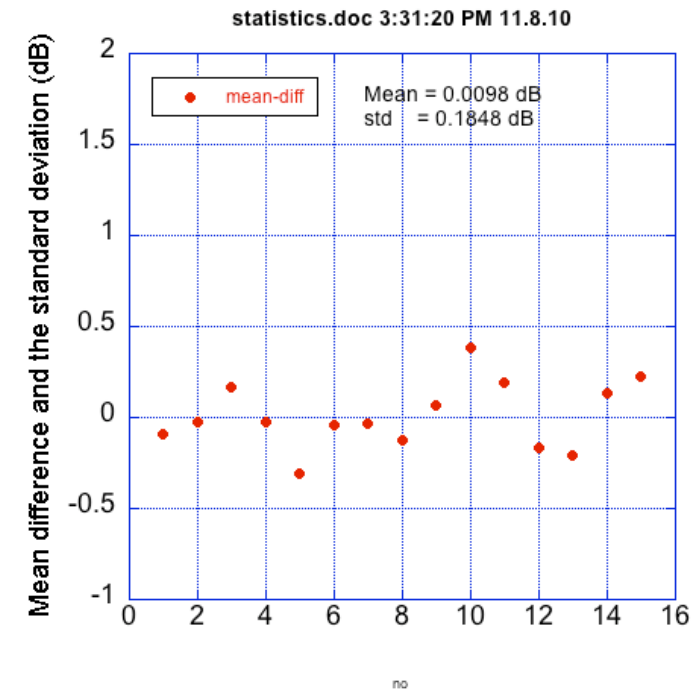
- 単位面積当りの明るさを表したものの
- SARは
 - 全天候性。
 - 偏波、入射角に依存
 - 衛星の特性は安定（常時モニター）
- Question
 - 森林（炭素）やその変化抽出にSARのどのパラメータが使用可能なのか？

4. Stability of PALSAR

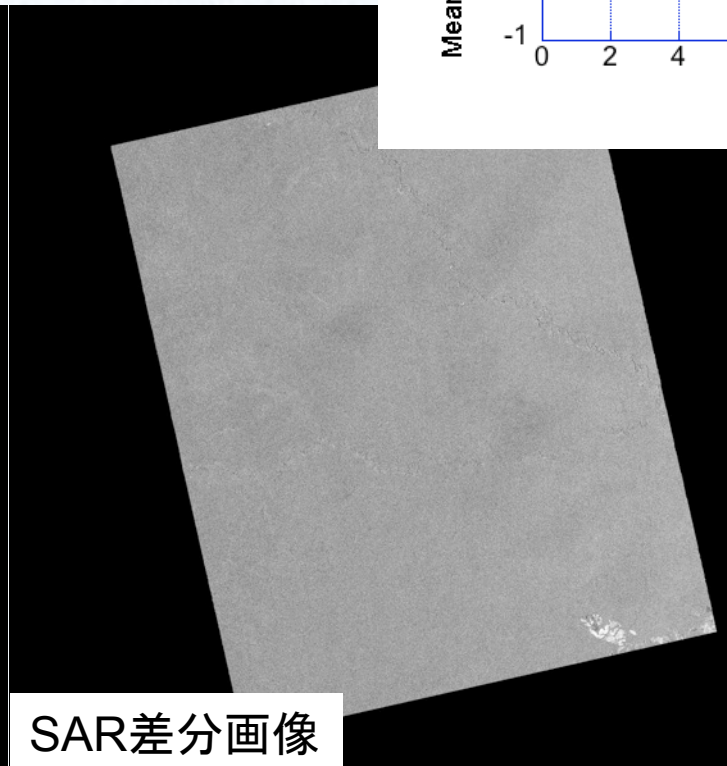
Temporal variation of the SAR data was evaluated. Amazon PALSAR 4 look data was used.

Ortho, Slope corrected data were evaluated.

Average: **0.01dB**, (**0.185dB**): High stability was confirmed.

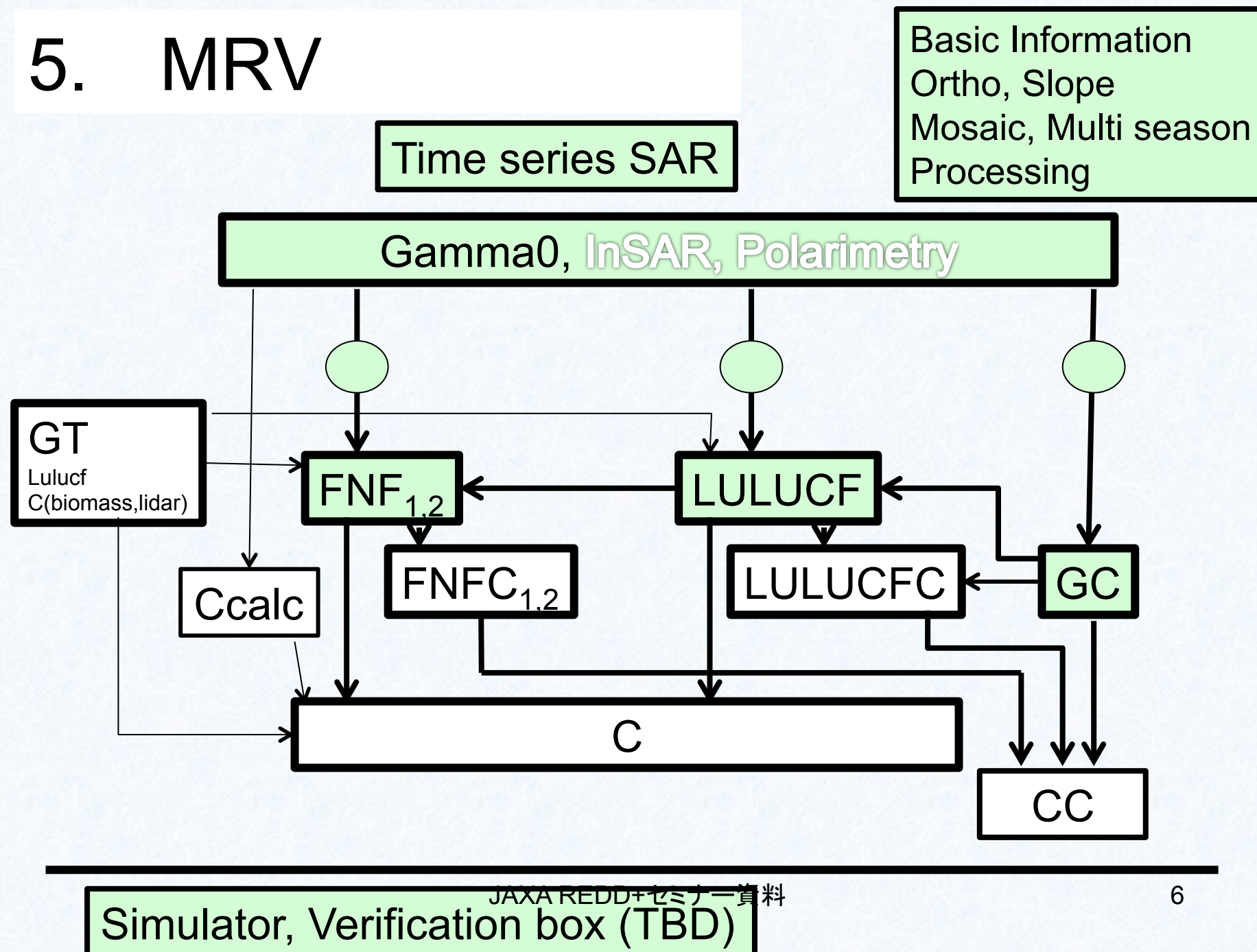


SAR参照画像



SAR差分画像

5. MRV



5.1 Change detection using gamma-naught(GC)

- Raiu
- 2007–2010 data
- HH, HV
- AVNIR-2 data were used
- WWF data were used.

散乱係数の変化 (2007-2009)

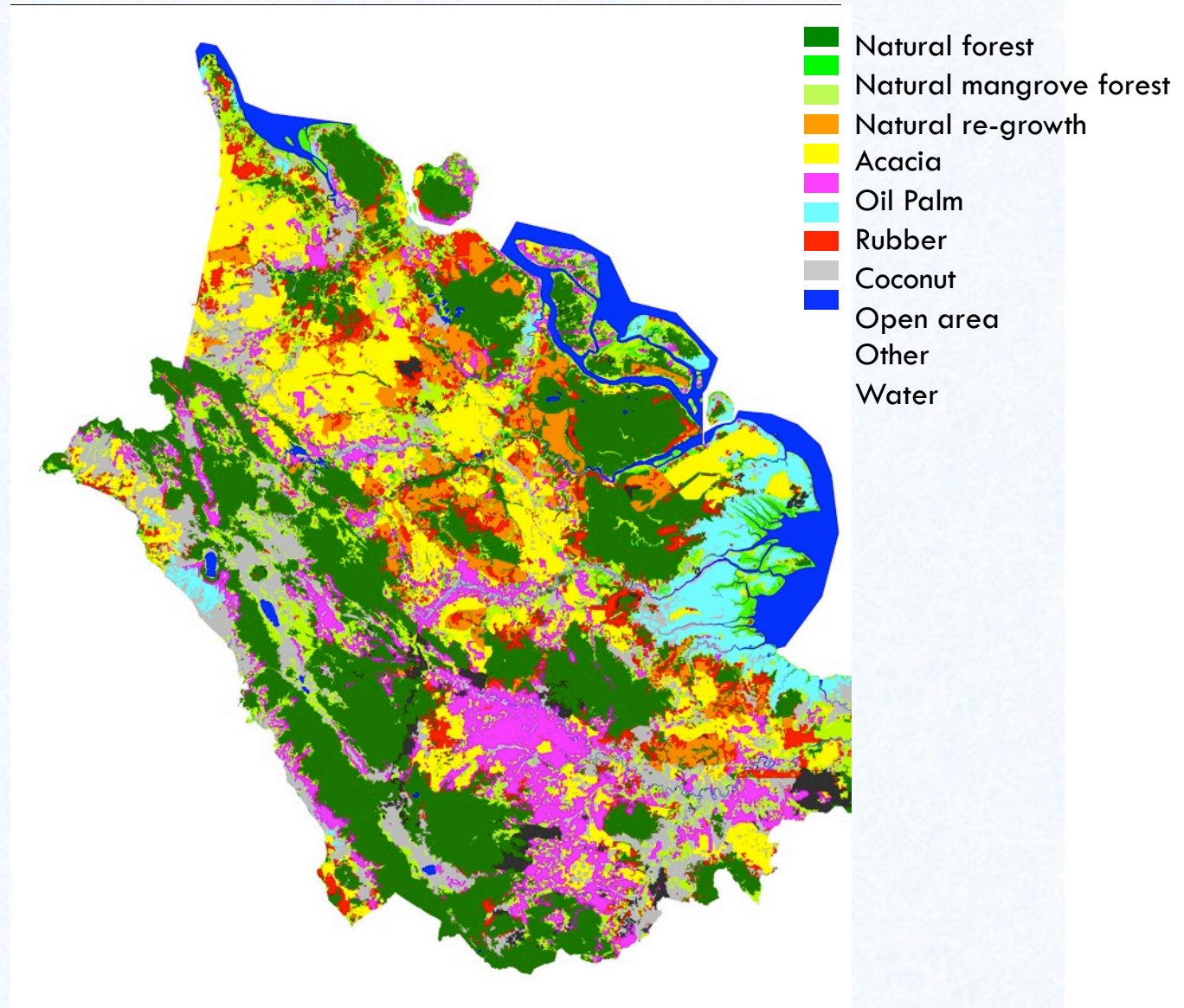
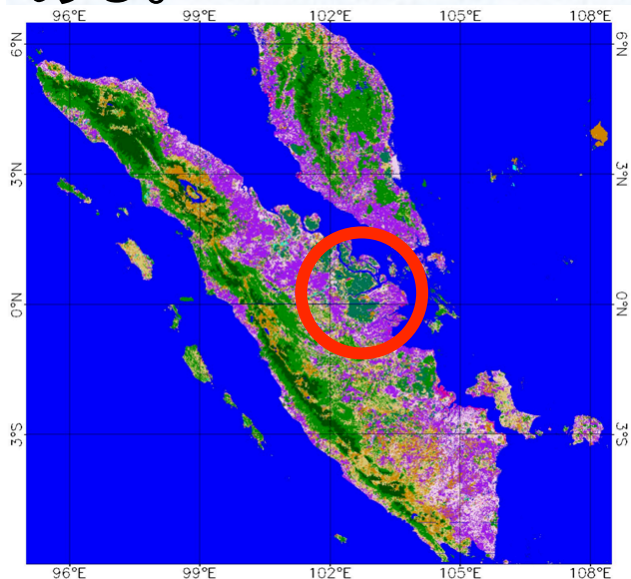
Three colors

Green: No change

Blue: decrease

Red: Increase

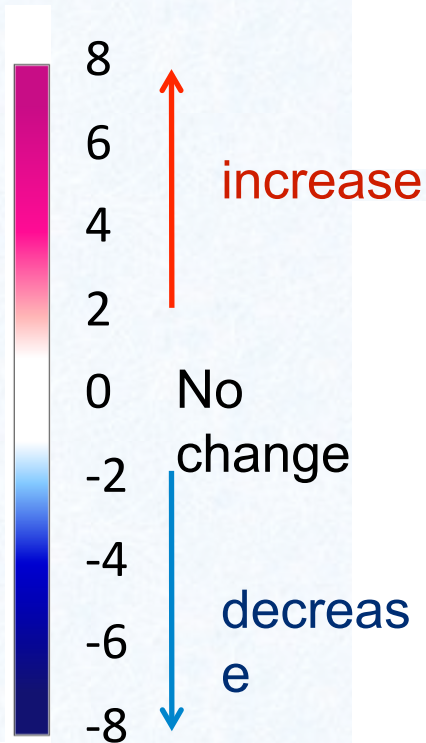
全体に青が多い:つまり
森林減少の過程に
ある。



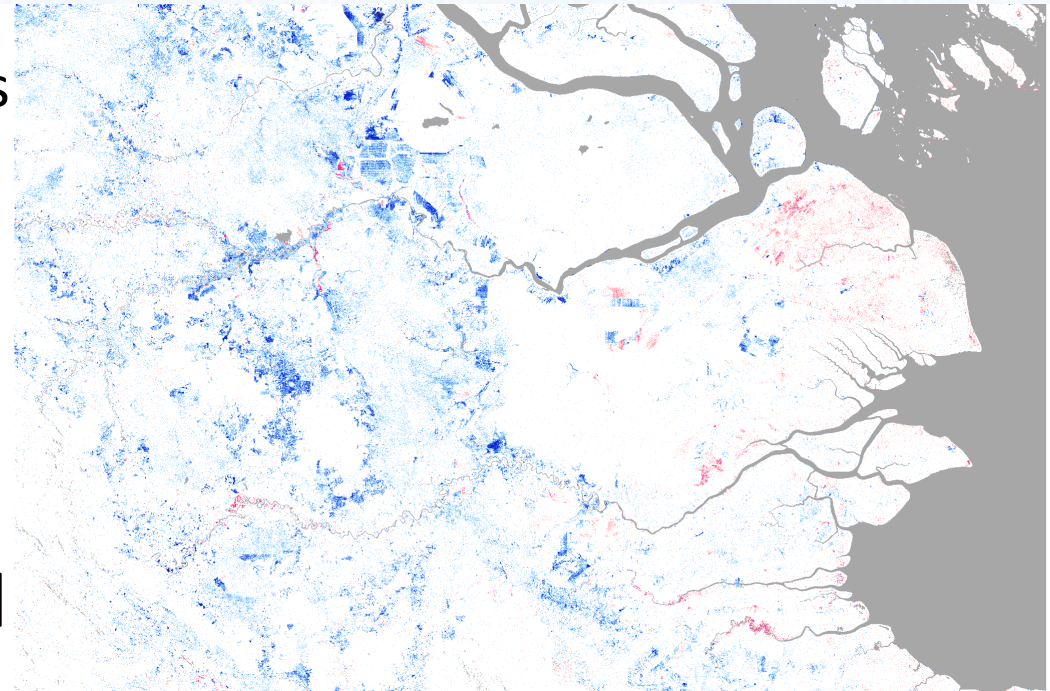
Using gamma-naught changes for deforestation monitoring

2009 mosaic - 2008 mosaic
Riau province, Indonesia

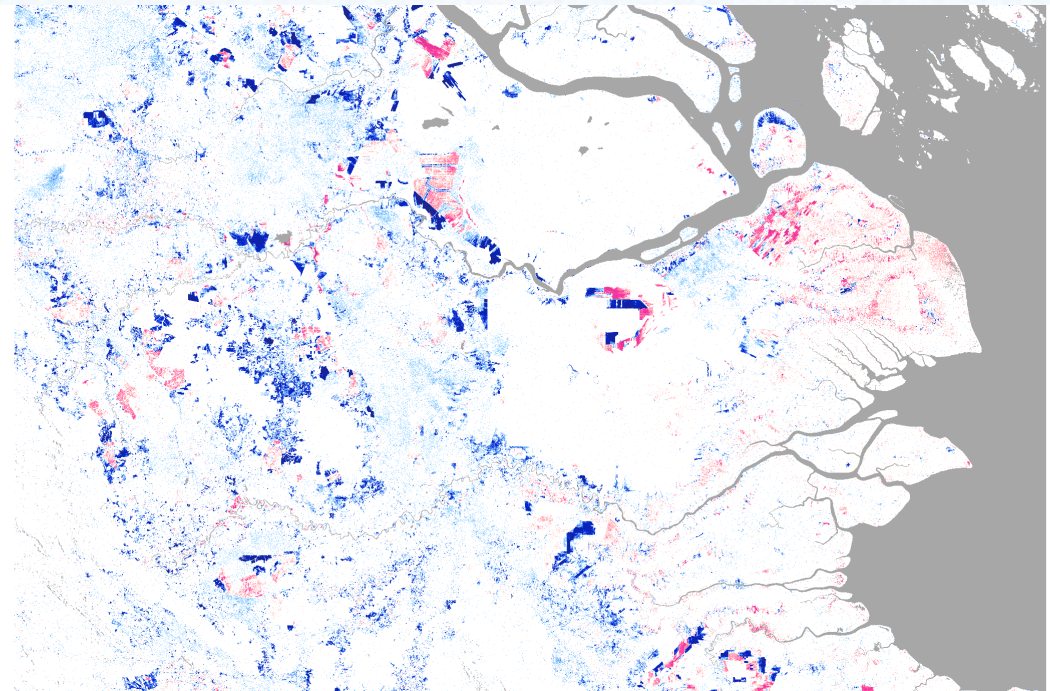
$\Delta\gamma^0$
(dB)



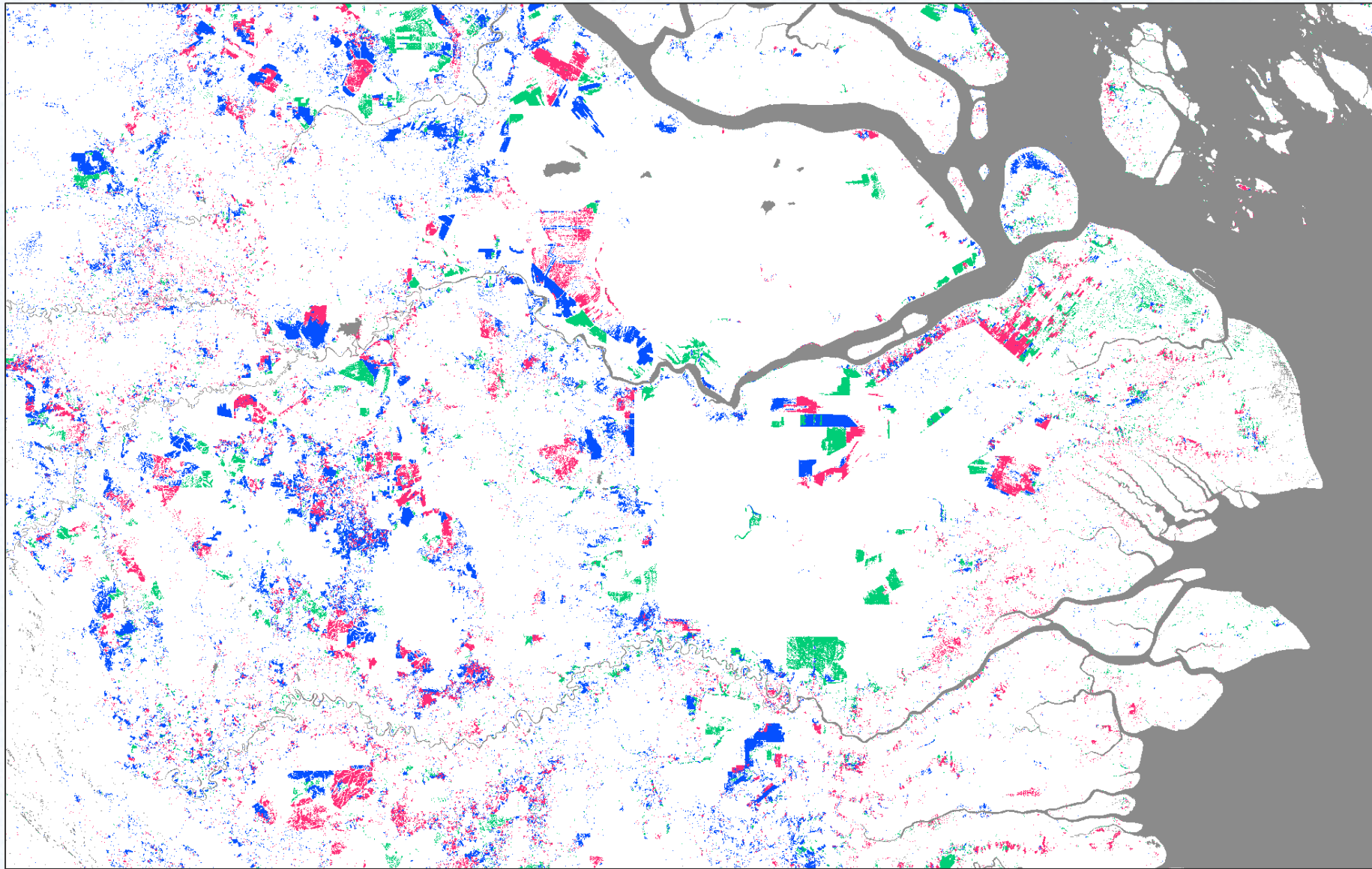
HH



HV



Annual decrease of gamma naught HV ... $\Delta\gamma^0 < -2$ dB



2007-2008

2008-2009

2009-2010

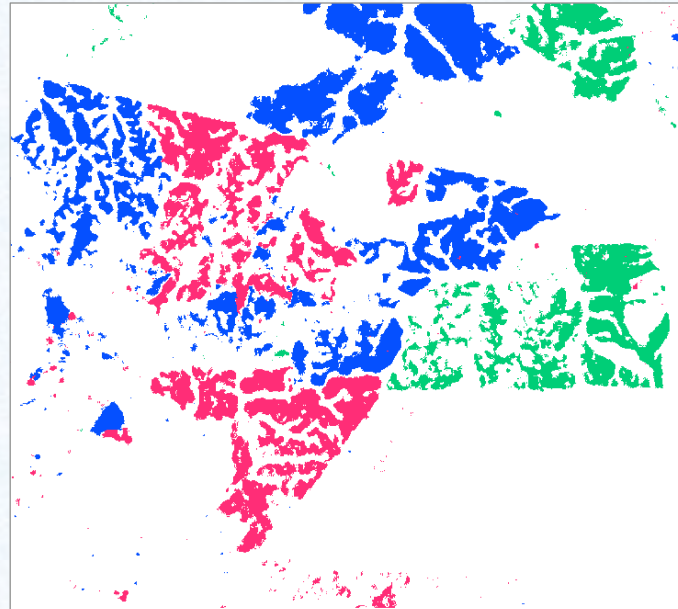
Example-1)
Acasia
consession

2007-2008

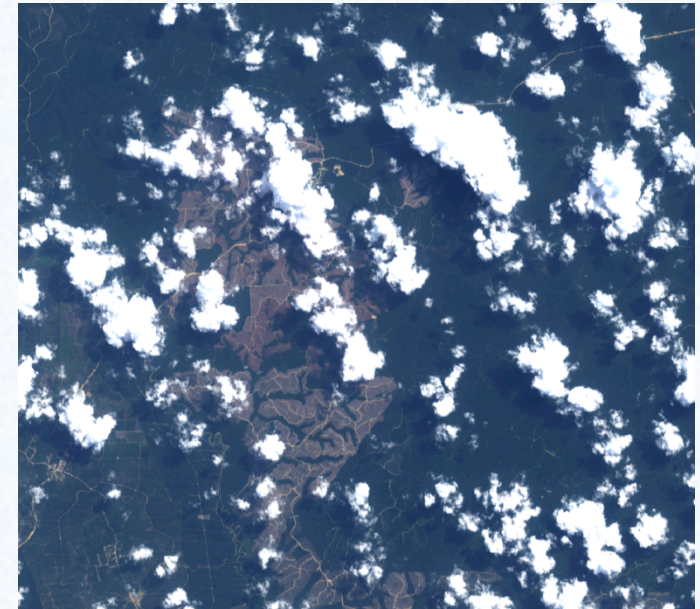
2008-2009

2009-2010

PALSAR 2007-2010



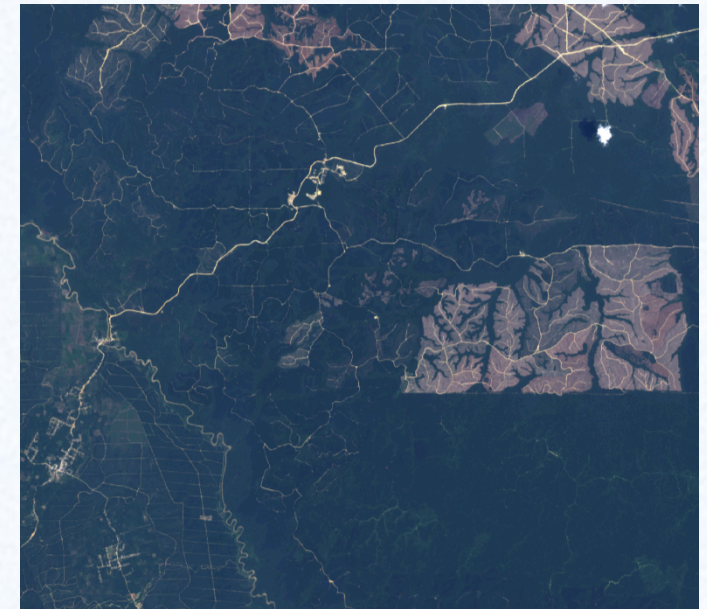
AVNIR-2 2008/07/05



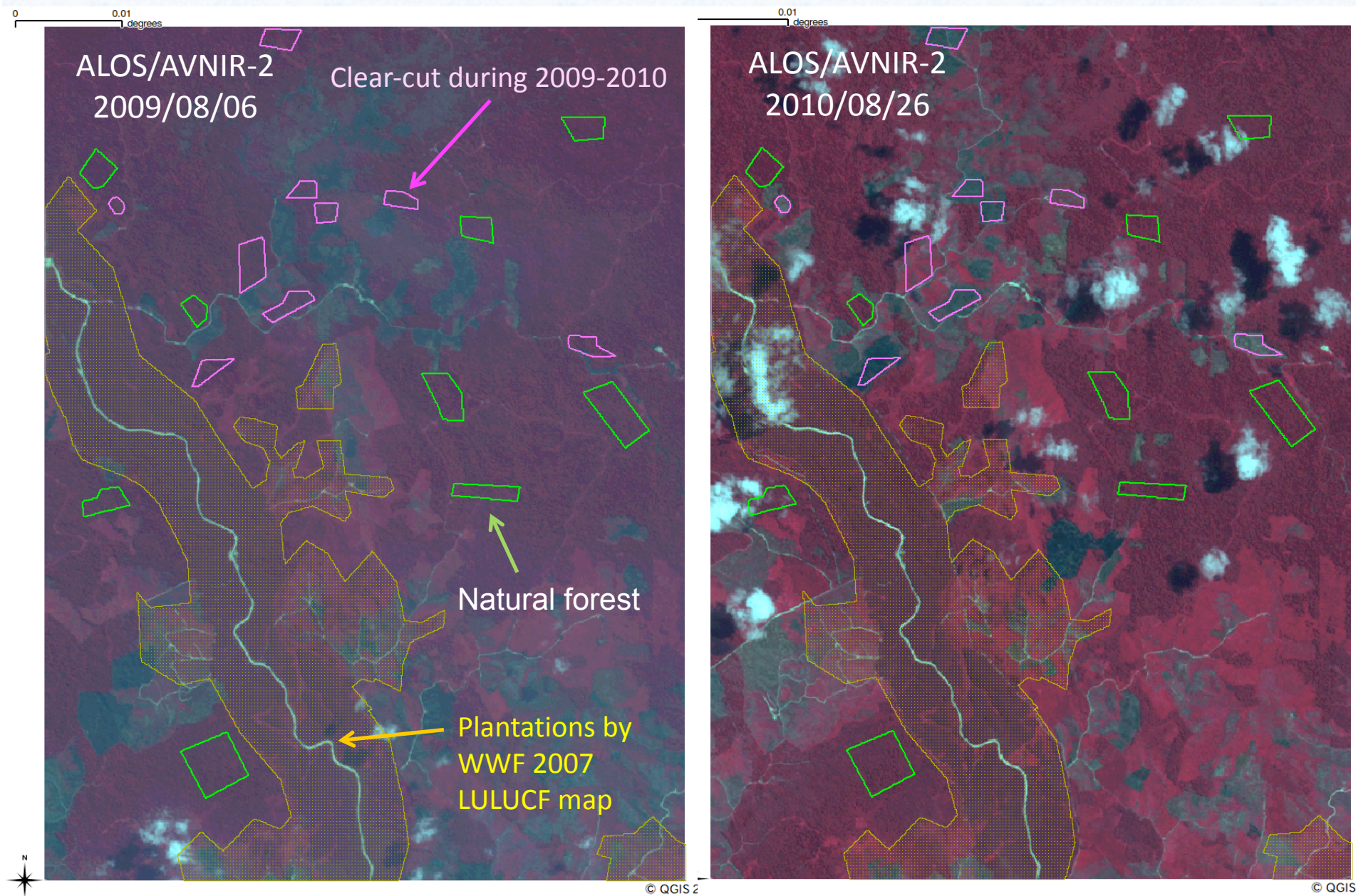
AVNIR-2 2009/10/08



AVNIR-2 2010/10/11



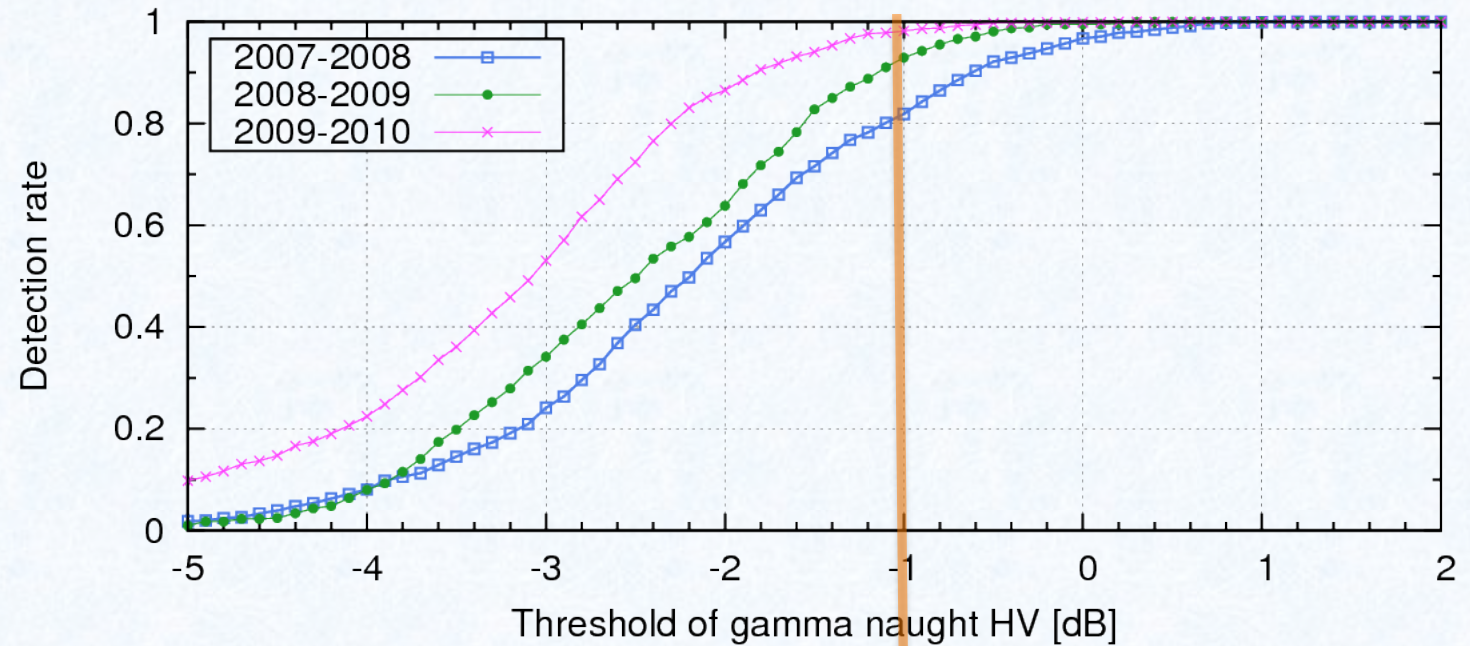
Example-2) Tesso Niro natural forest, Riau, Indonesia



Relationships between detection rate and thresholds

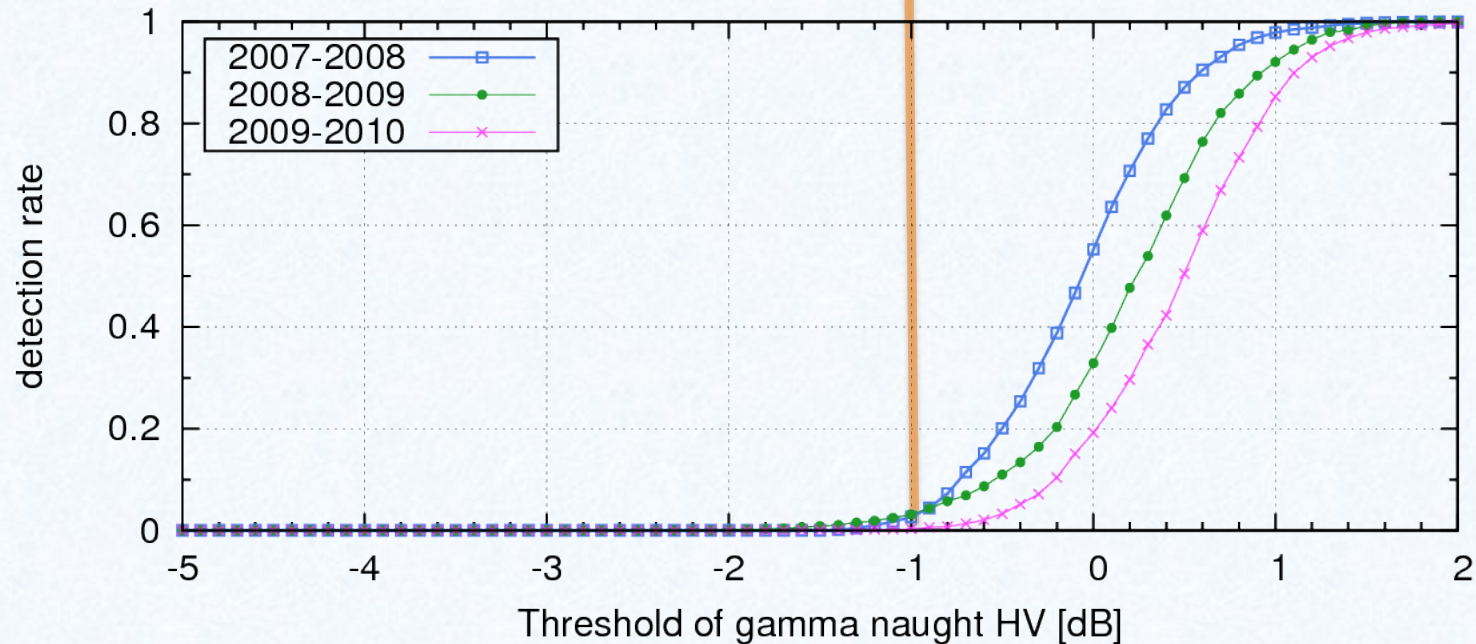
Clear-cut pixels

n = 1200
Randomly
selected

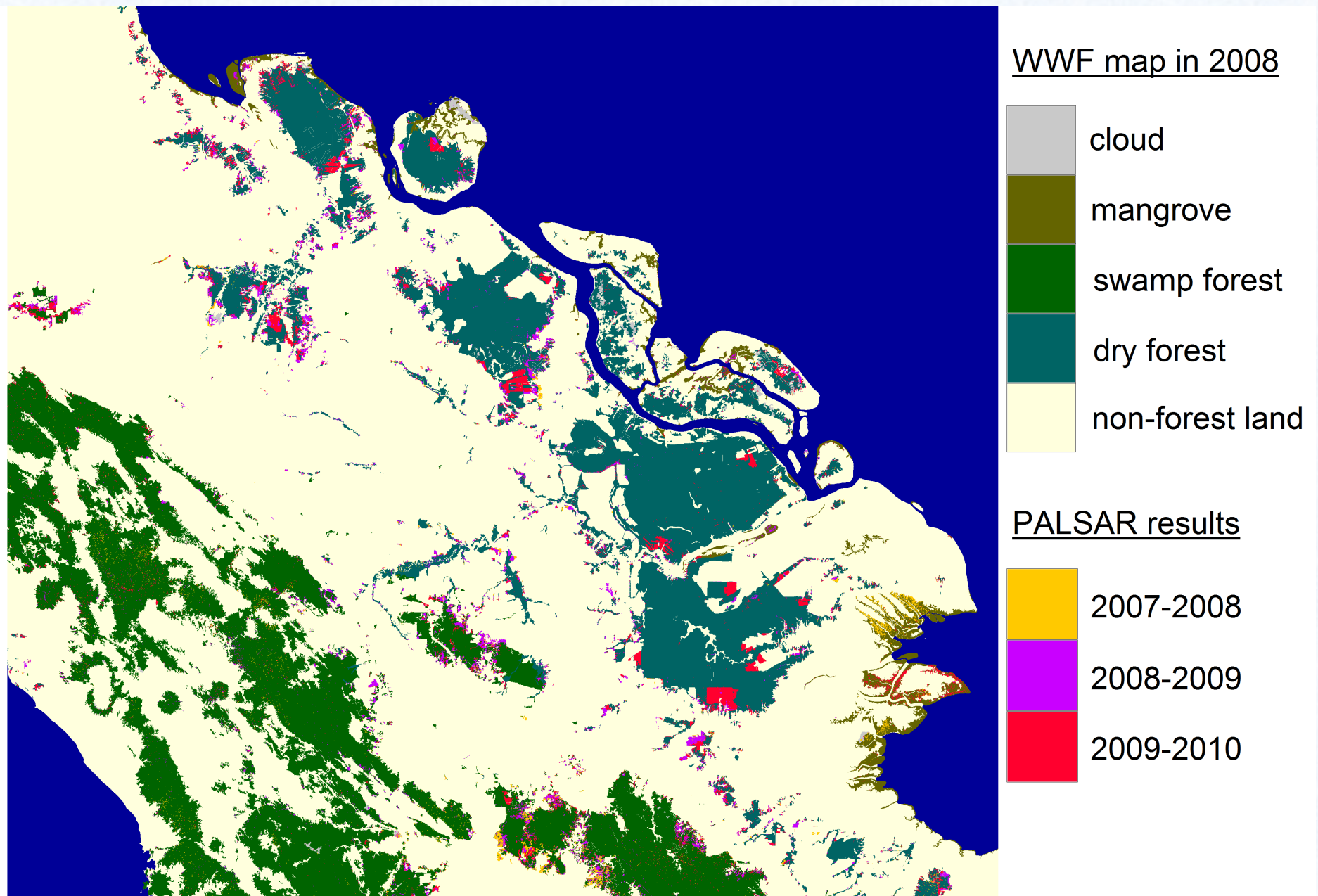


Natural forest
pixels

n = 1200
Randomly
selected



Deforestation map of central Sumatra derived by PALSAR 25-m mosaics



5.2 LULUCF Classification development

- Area : Riau
- Method : Several
- SVM, eCOG MDM, eCOG Bayesian, SubSpace(SS)
- Output, LULUCF & FNF
- SS>SVM>eCOGs at FNFの順位で, SS showed the best with 88% accuracy.

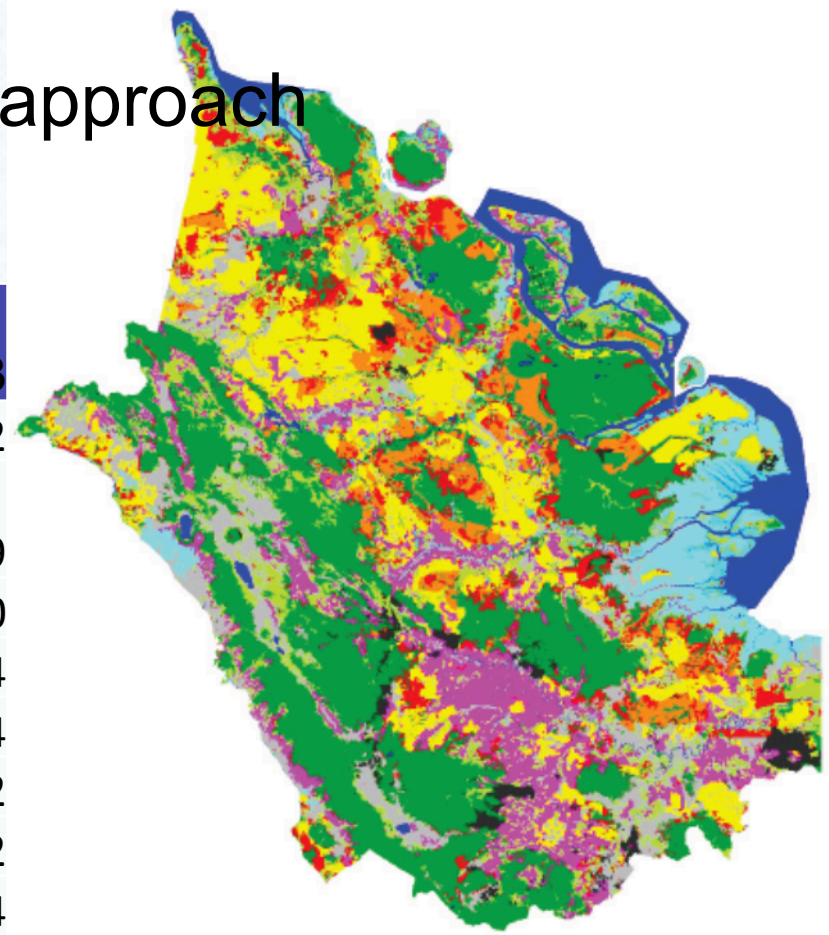
Land use classification

- Approaches
 - Sub-space
 - Decision tree
 - Nearest Neighbor
 - Support Vector Machine

Accuracy assessment

- Stratified random sampling approach

Land cover class	% Landscape	CI ± 3
Natural forest	30.19	322
Natural mangrove forest	1.79	19
Natural re-growth	12.17	130
Acacia	5.09	54
Oil Palm	13.53	144
Rubber	9.53	102
Coconut	3.95	42
Open area	6.94	74
Other	10.98	117
Water	5.83	62
Total	100.00	1067

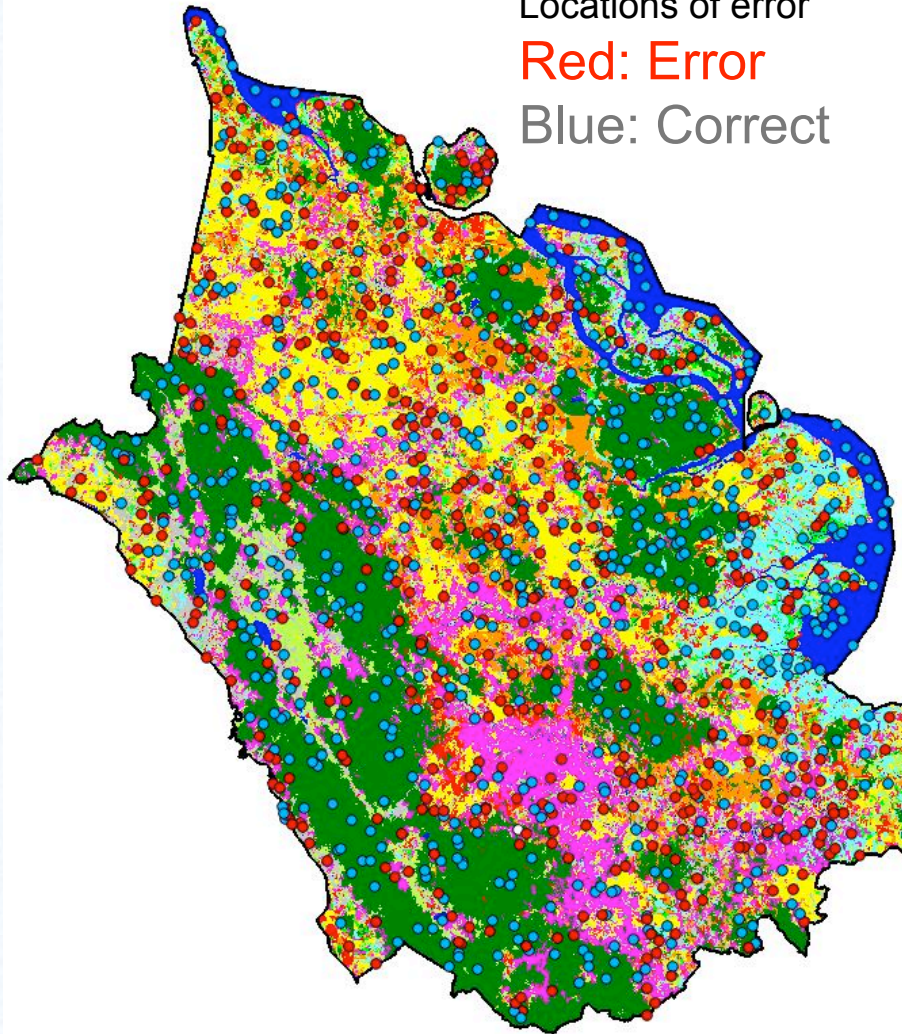


Ground truth WWF₁₇ Map (2009)

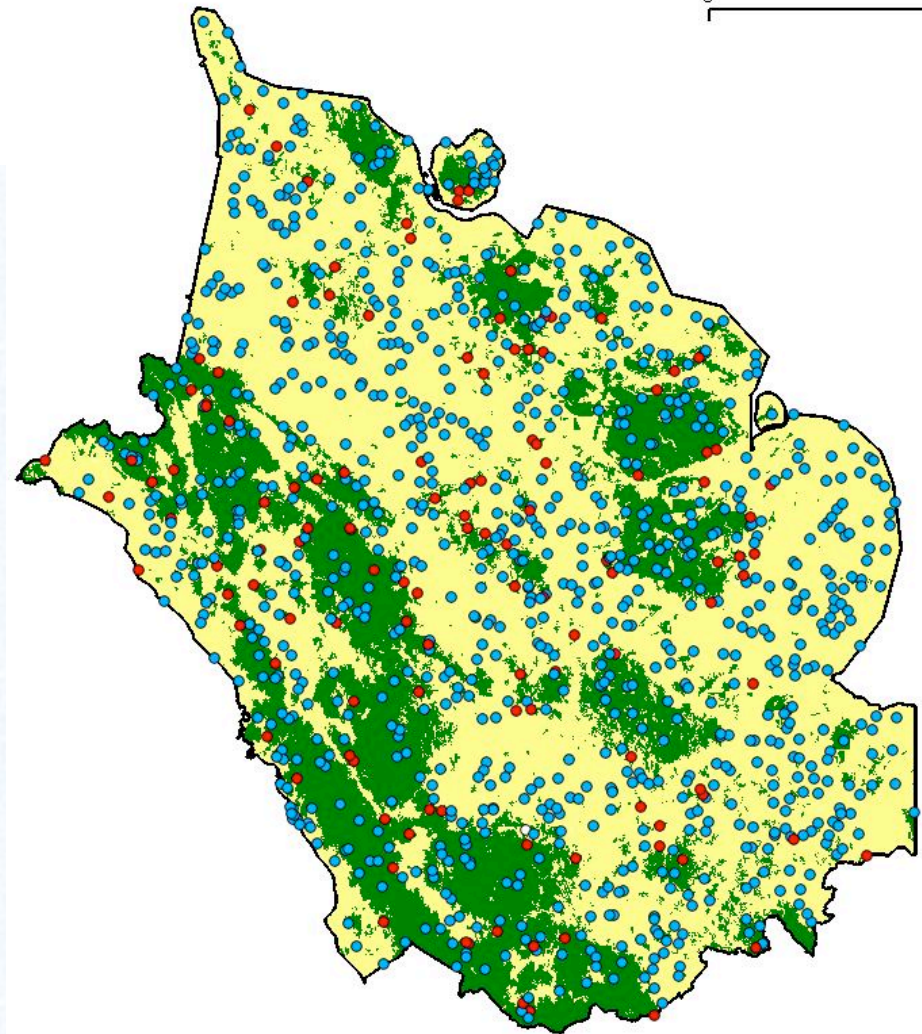
Accuracy assessment :Sub-space Approach

10 Classes: 55.4%

Locations of error
Red: Error
Blue: Correct



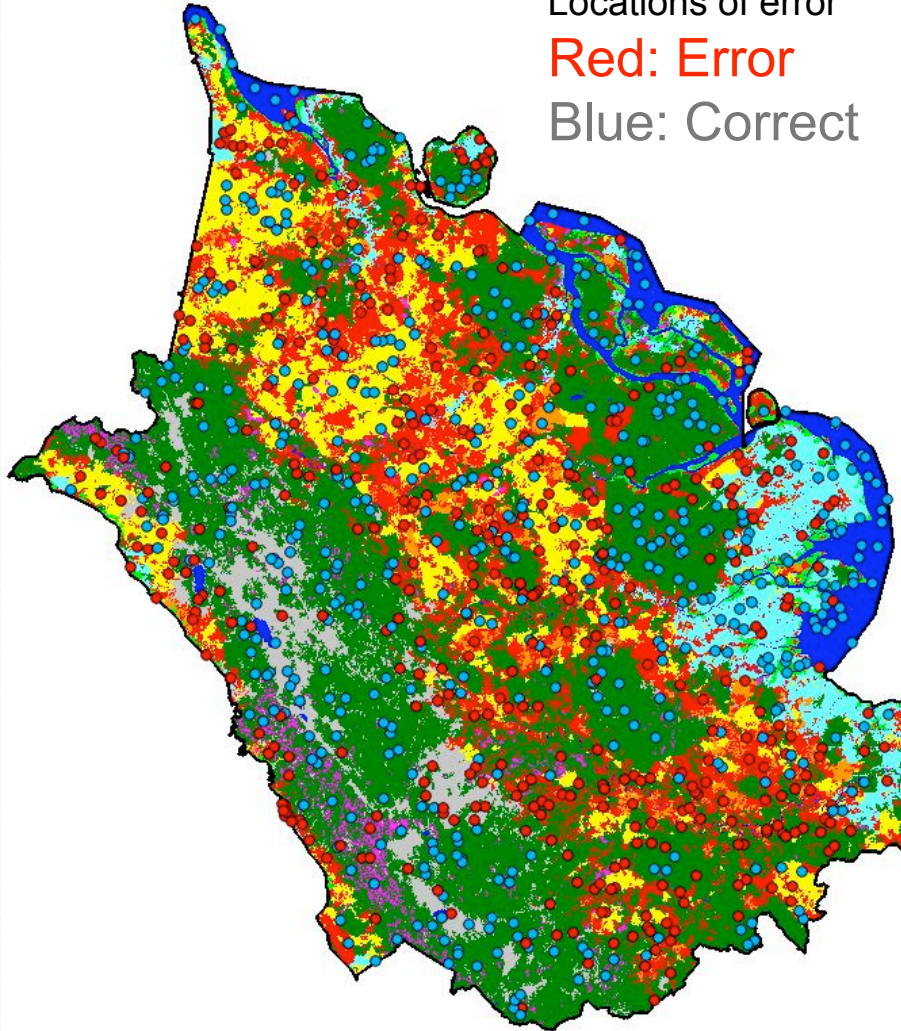
Forest/Non-forest: 88.17%



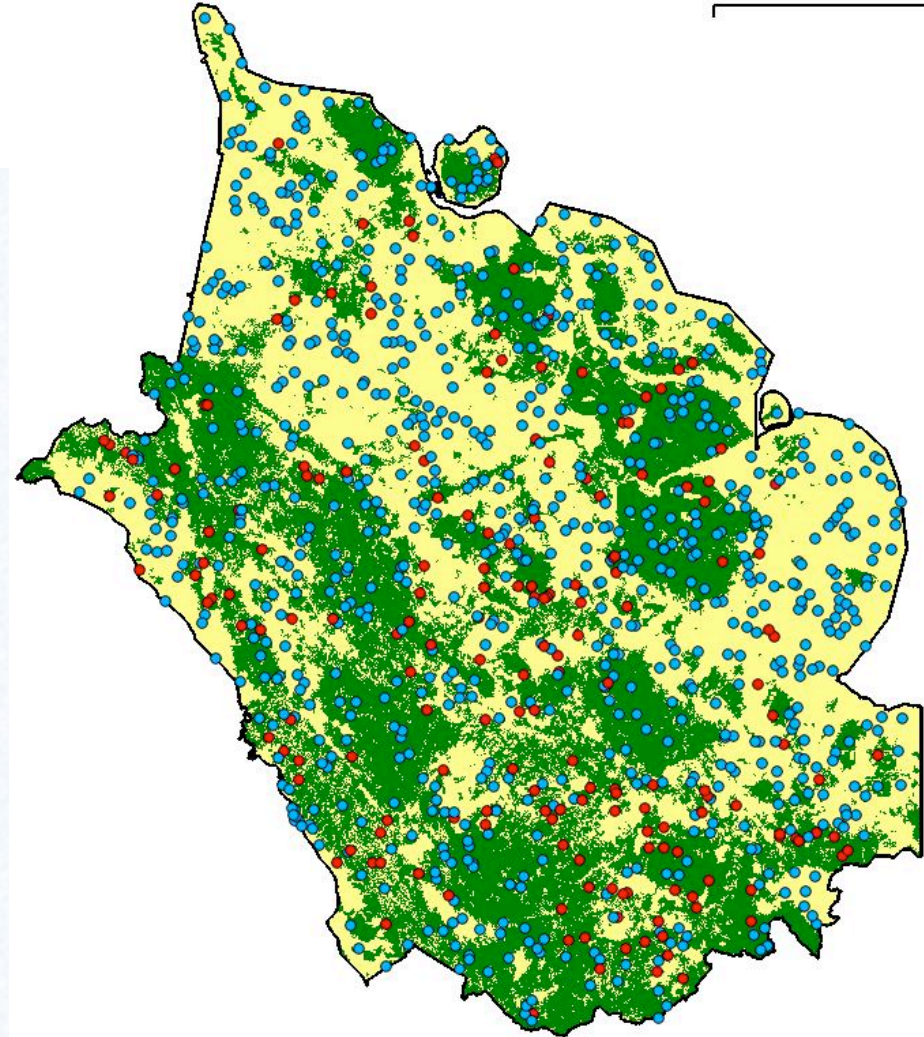
Accuracy assessment: Decision Tree Approach

9 Classes: 56.0%

Locations of error
Red: Error
Blue: Correct



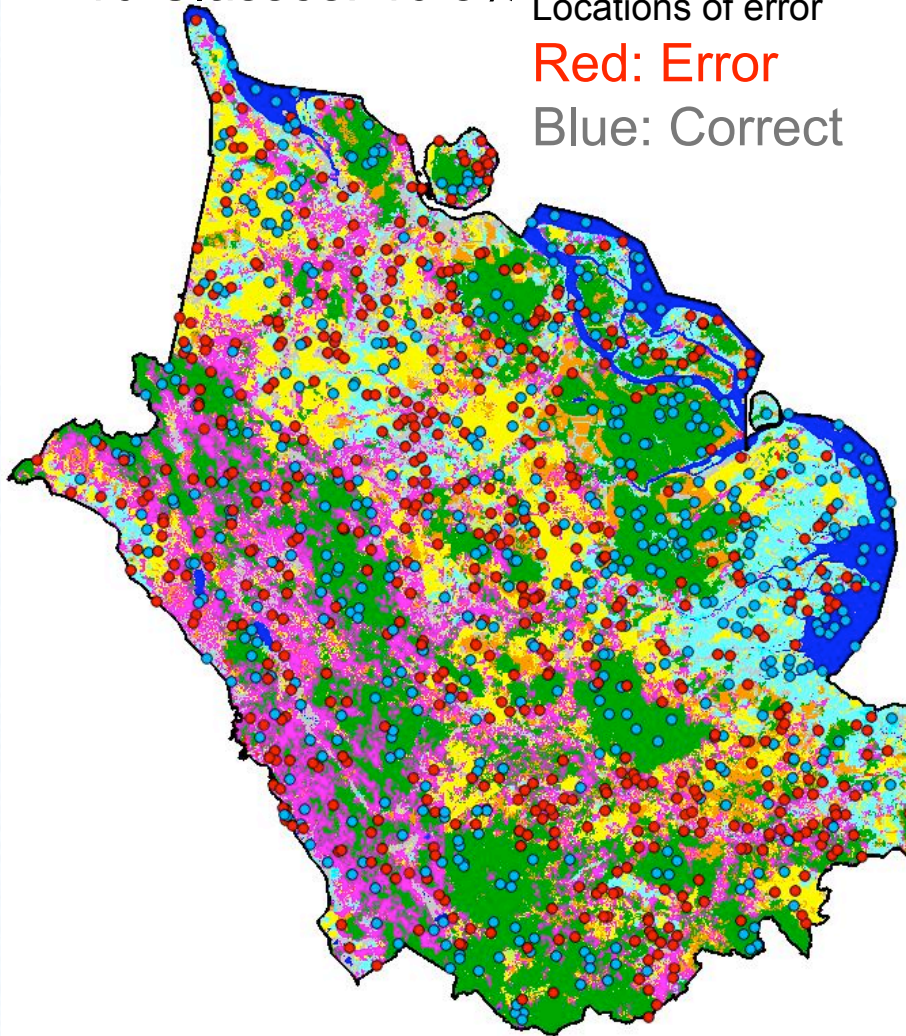
Forest/Non-forest: 80.45%



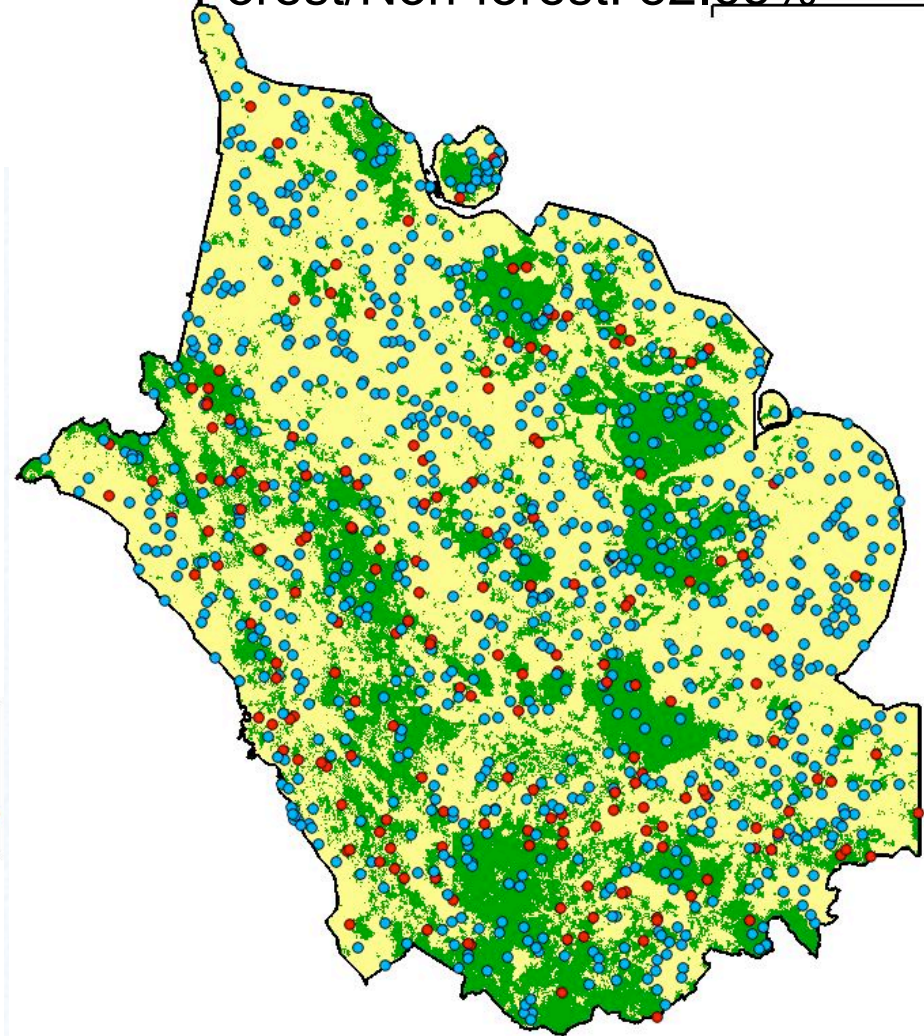
Accuracy assessment: Nearest Neighbor Approach

10 Classes: 46.8%

Locations of error
Red: Error
Blue: Correct

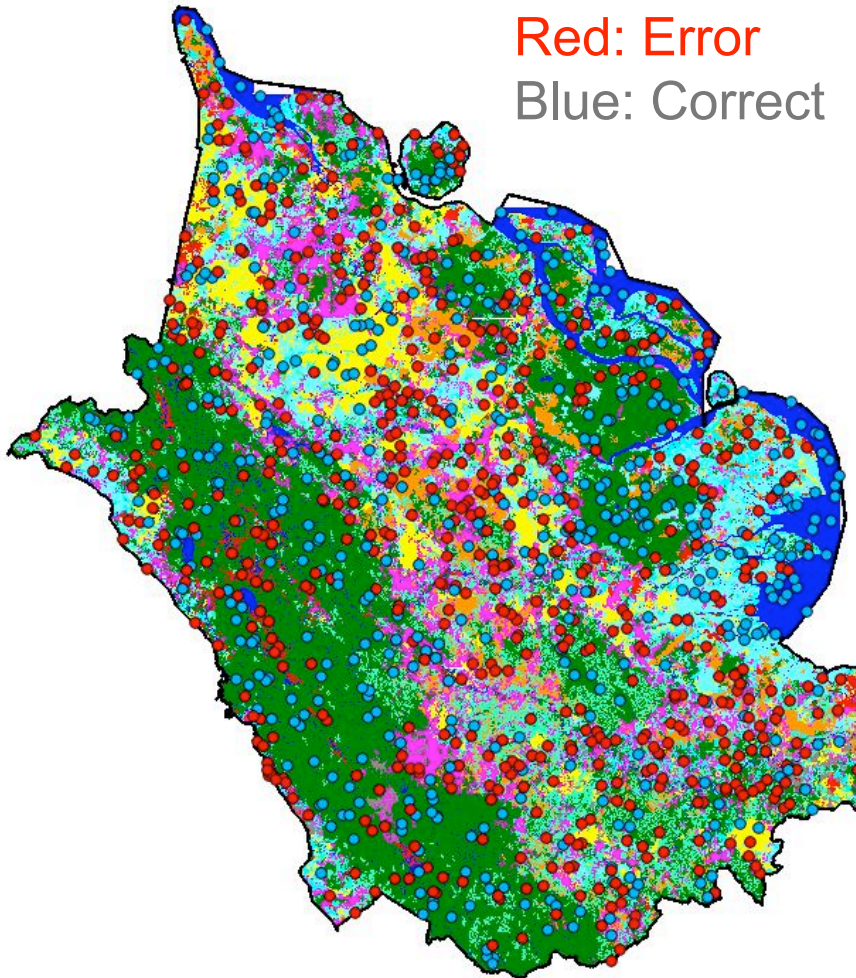


Forest/Non-forest: 82.65%

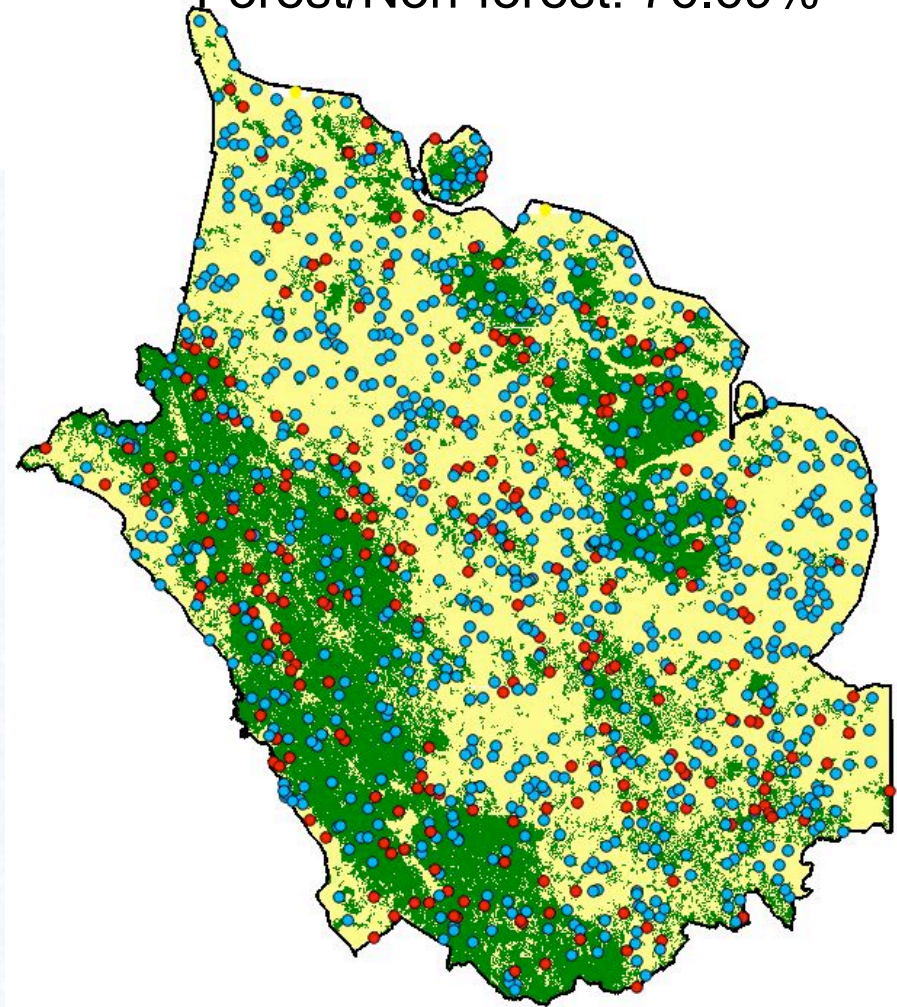


Accuracy assessment: Support Vector Machine Approach

10 Classes: 43.4%
Locations of error
Red: Error
Blue: Correct



Forest/Non-forest: 76.69%



Accuracy assessment: four approaches

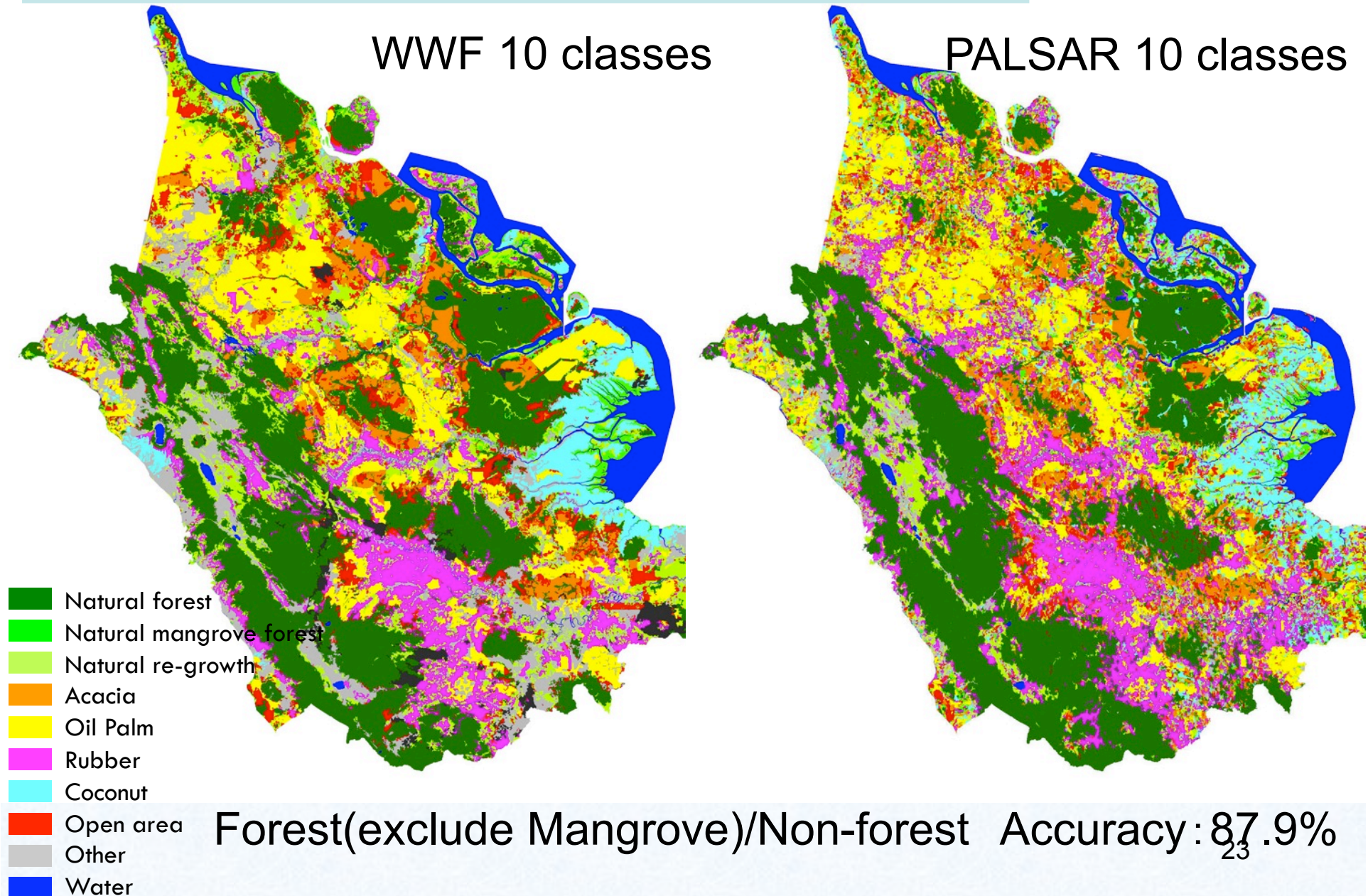
User's accuracy	Methods					
	Class	ID	Subspace	Decision tree	Nearest Neighbor	SVM
	Forest	1	79.70	67.08	70.33	58.94
	Non-forest	2	91.97	90.74	88.34	88.00
	Overall		88.17	80.45	82.65	76.69

User's accuracy	Class	ID	Subspace	Decision tree	Nearest Neighbor	SVM
	Natural forest	1	79.70	67.08	70.33	58.94
	Natural mangrove forest	2	24.14	53.85	10.00	14.29
	Natural re-growth	3	22.00		0.00	17.05
	Avacia	4	29.76	25.00	20.22	29.31
	Oil Palm	5	61.74	60.29	48.31	67.68
	Rubber	6	36.36	20.00	19.21	18.70
	Coconut	7	44.78	47.76	29.81	20.97
	Open area	8	33.33	23.64	0.00	13.64
	Other	9	50.94	49.02	28.38	22.22
	Water	10	90.32	100.00	100.00	80.28
	Overall		55.40	55.98	46.81	43.42

Land Use Classification in Riau, Sumatra

WWF 10 classes

PALSAR 10 classes

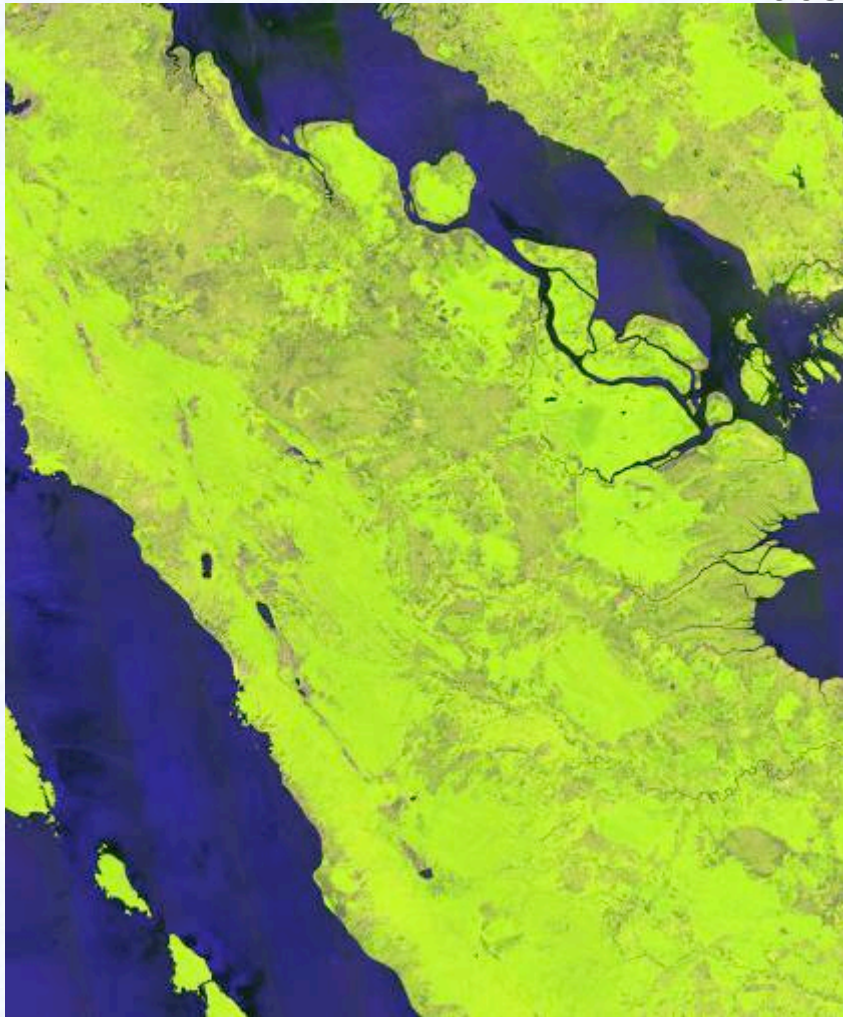


5.3 FNF

- Target area : Riau
- Method : Thresholding using eCOG
(-12dB for γ^0_{HV})
- Output, FNF
- Other: Global FNF
- Comparison with DCP

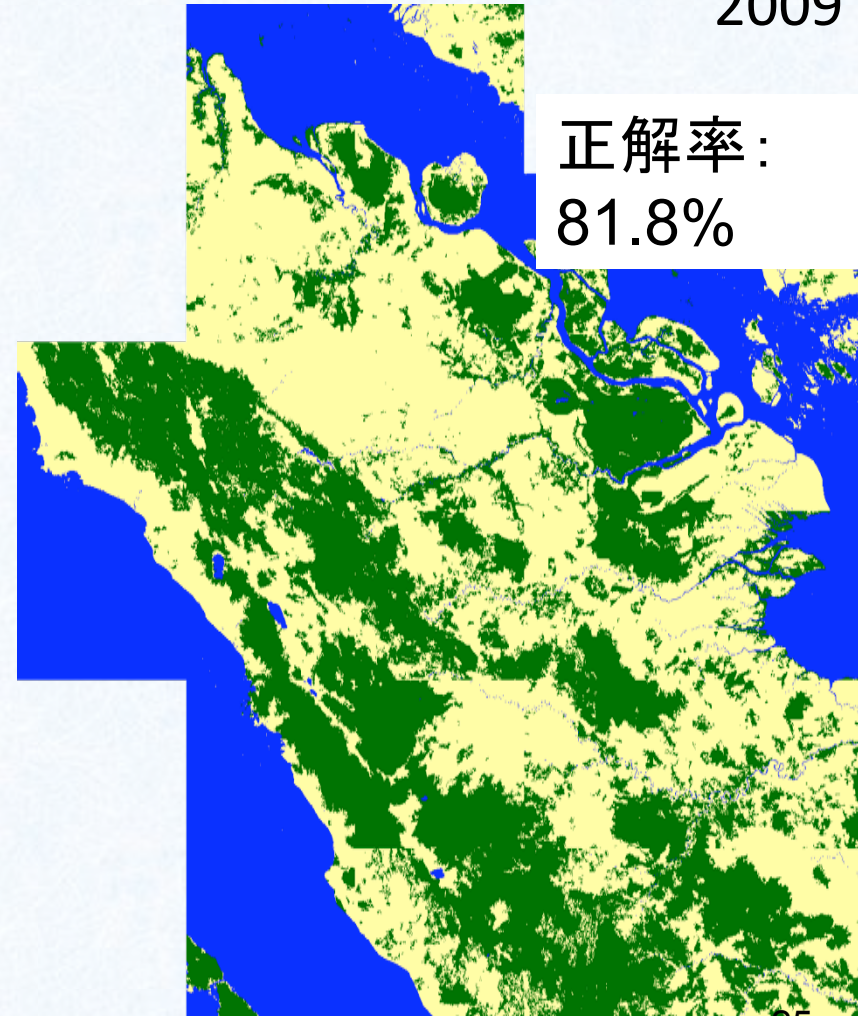
Forest/Non-Forest(FNF)

PALSAR RGB
2009



●: HH, ●: HV, ●: HH/HV

PALSAR Forest/Non-Forest
2009



正解率:
81.8%

●: Forest, ●: Non-Forest, ●: Water

6. Effectiveness of slope correction

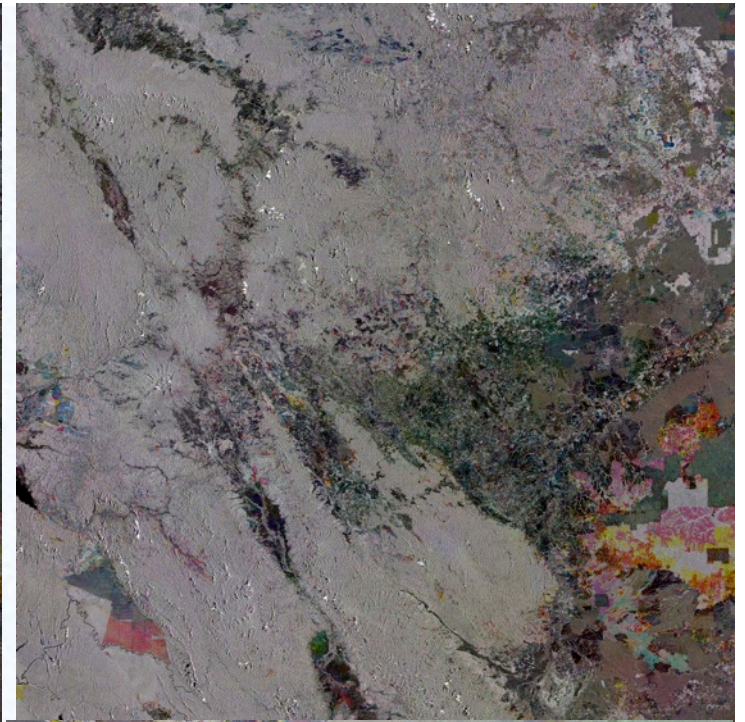
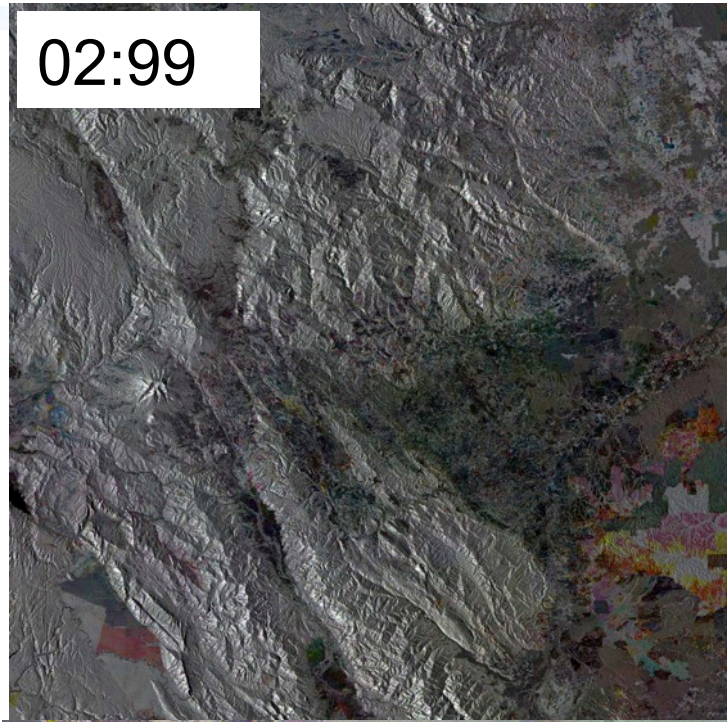
- Visualization
- Through LULUCF(FNF)
- Through FNF

Comparison of
slope-
correction and
nonslope
correction:

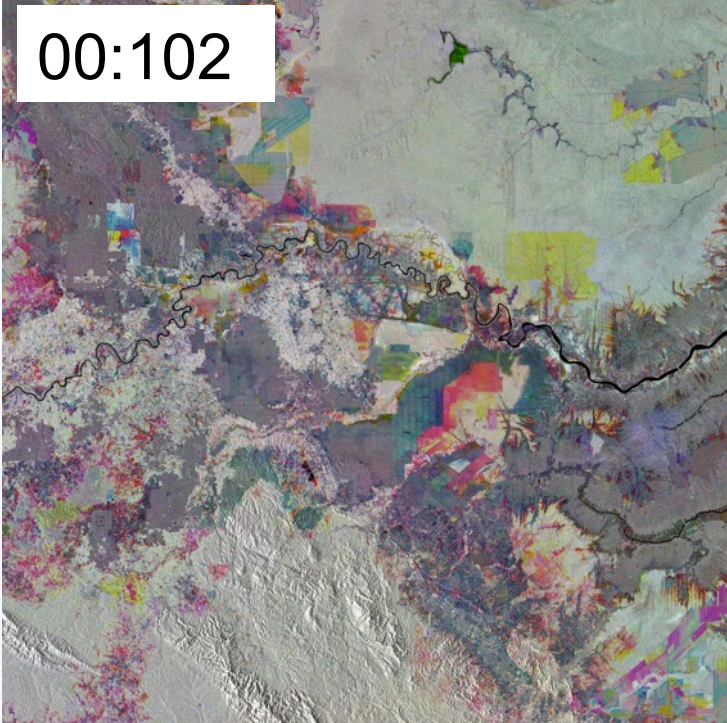
Riau

R:2007, G:
2009:B:2010

02:99

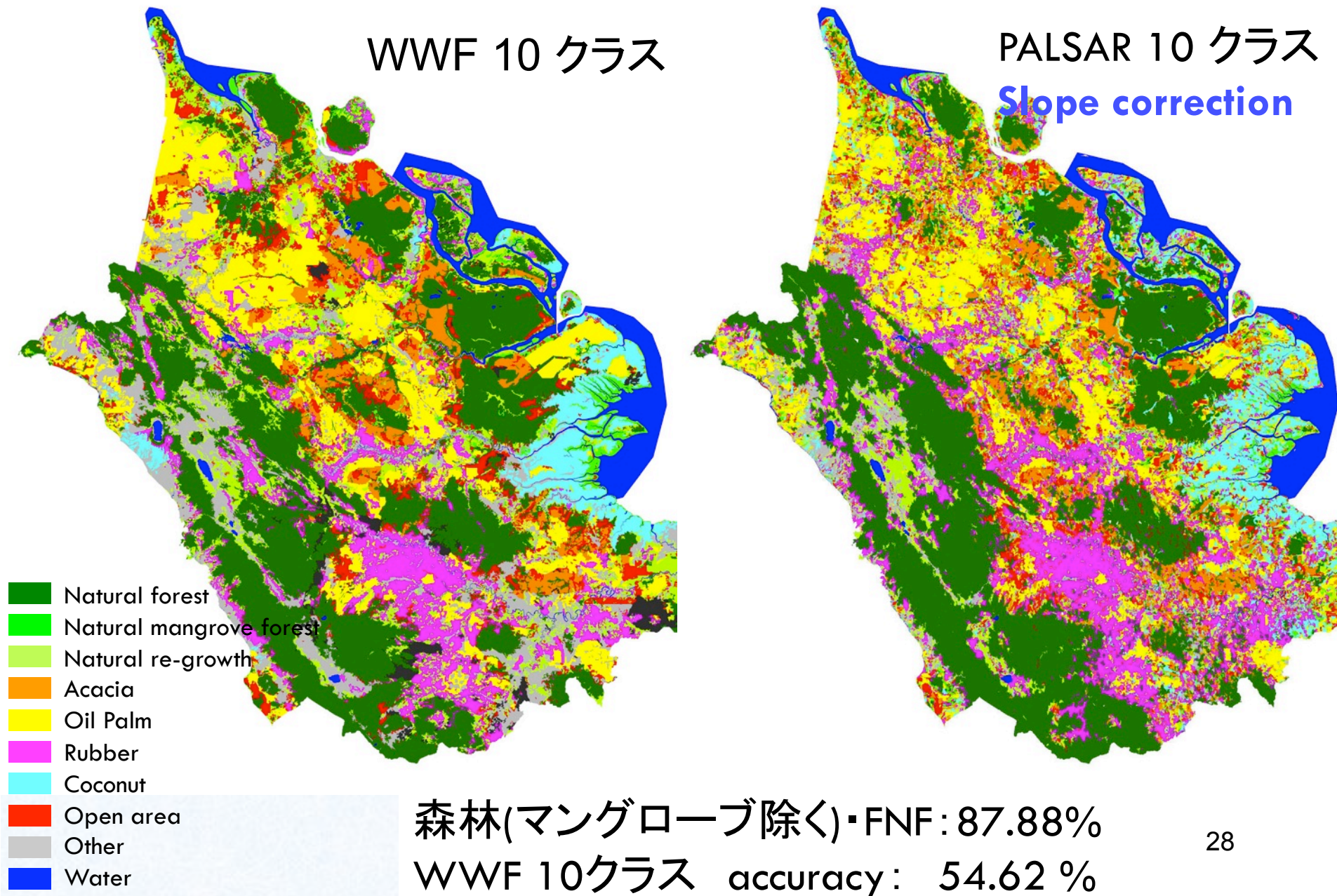


00:102

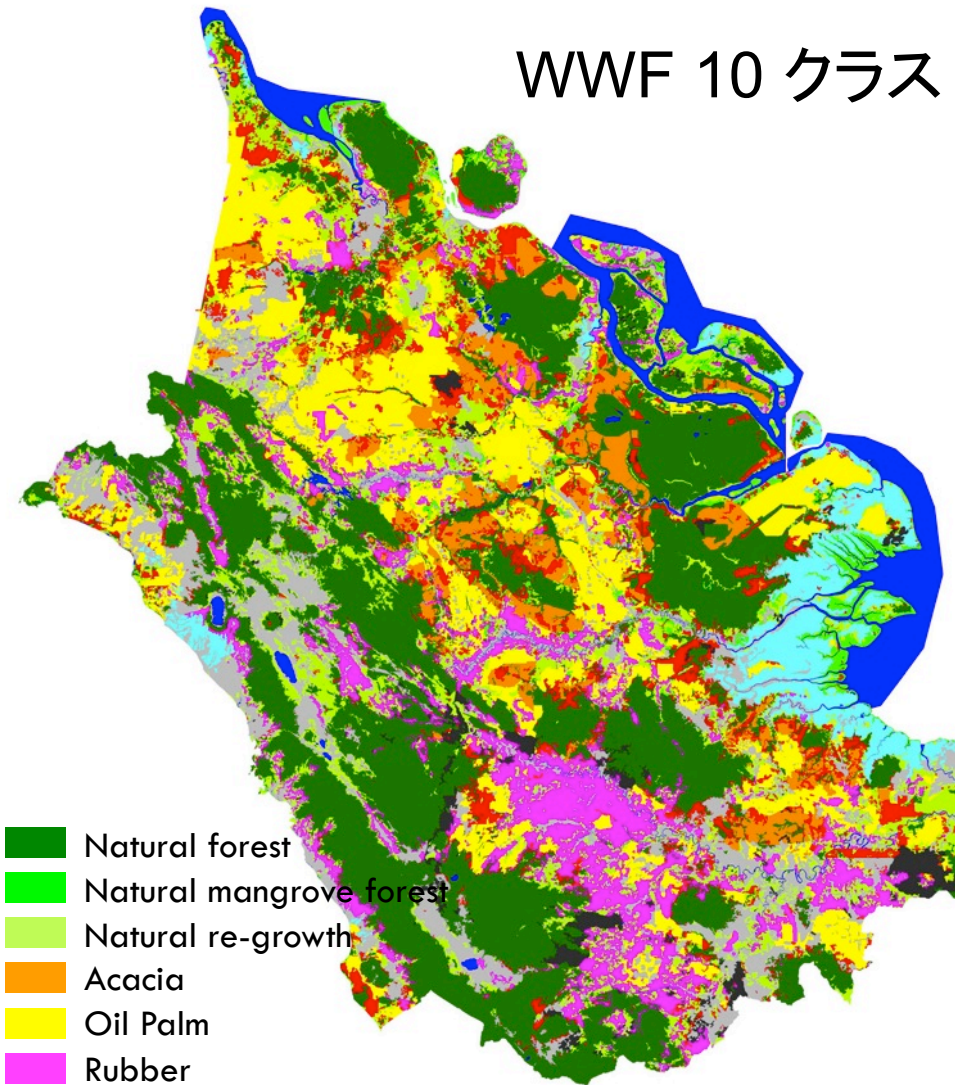


WWF 10 クラス

PALSAR 10 クラス
Slope correction

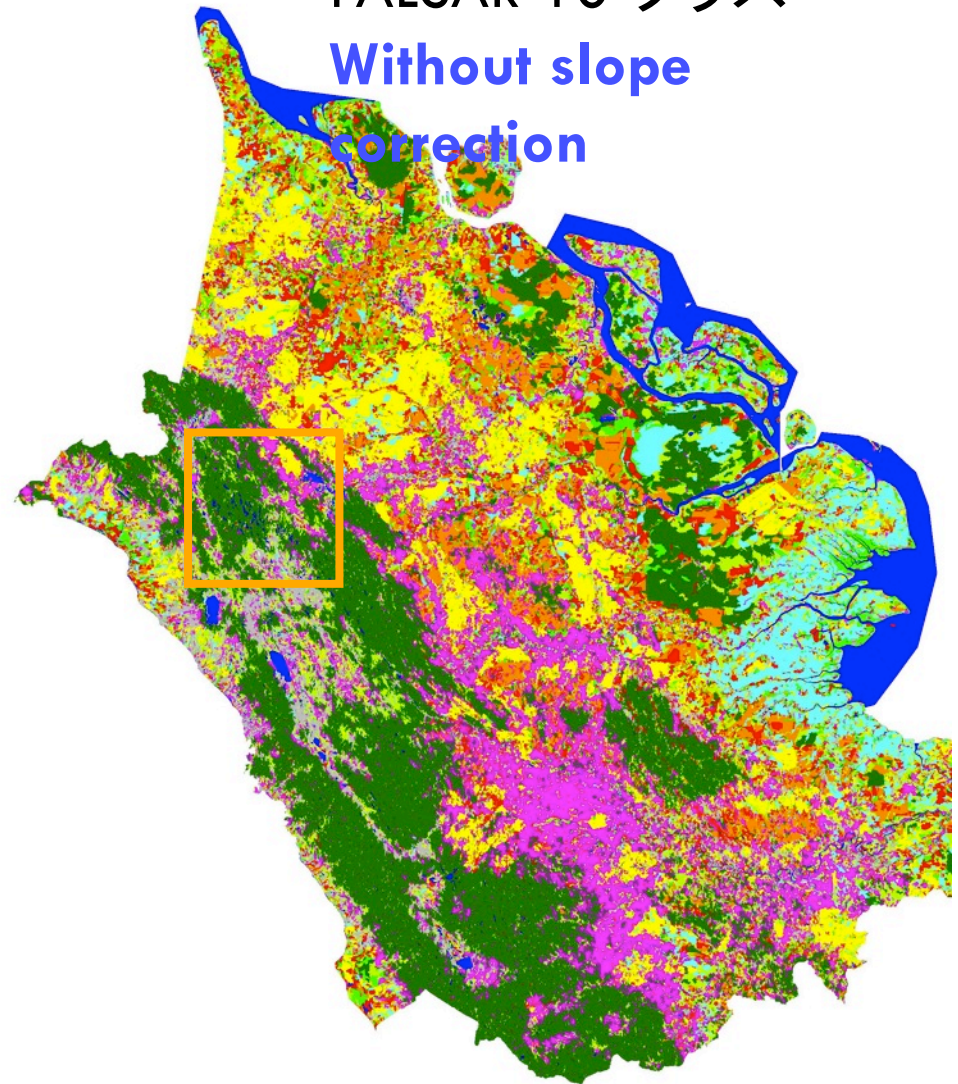


WWF 10 クラス



PALSAR 10 クラス

Without slope
correction

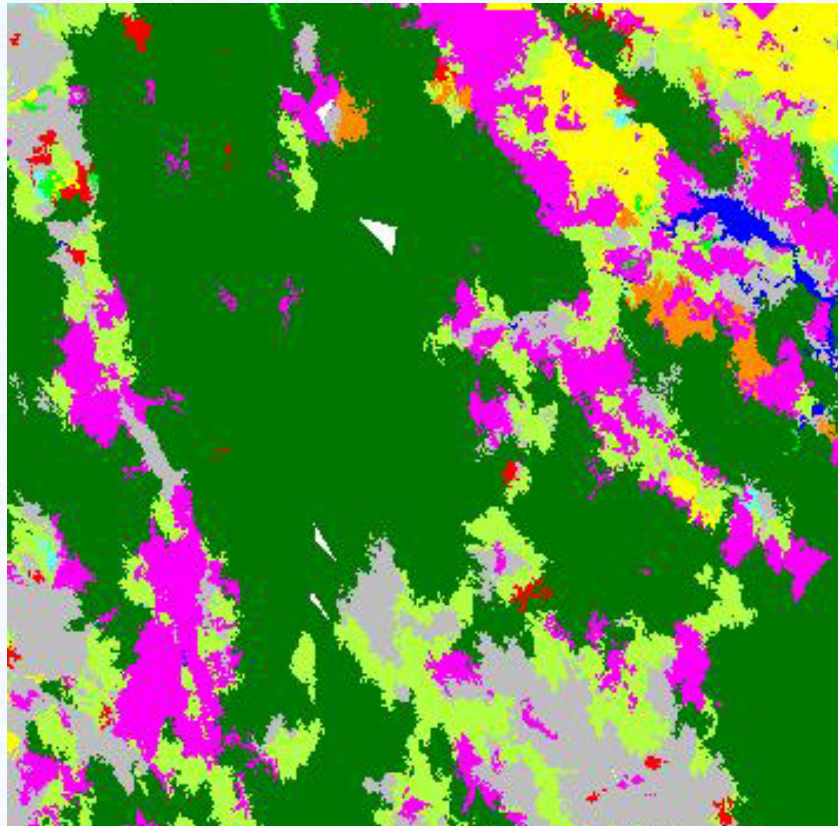


- Natural forest
- Natural mangrove forest
- Natural re-growth
- Acacia
- Oil Palm
- Rubber
- Coconut
- Open area
- Other
- Water

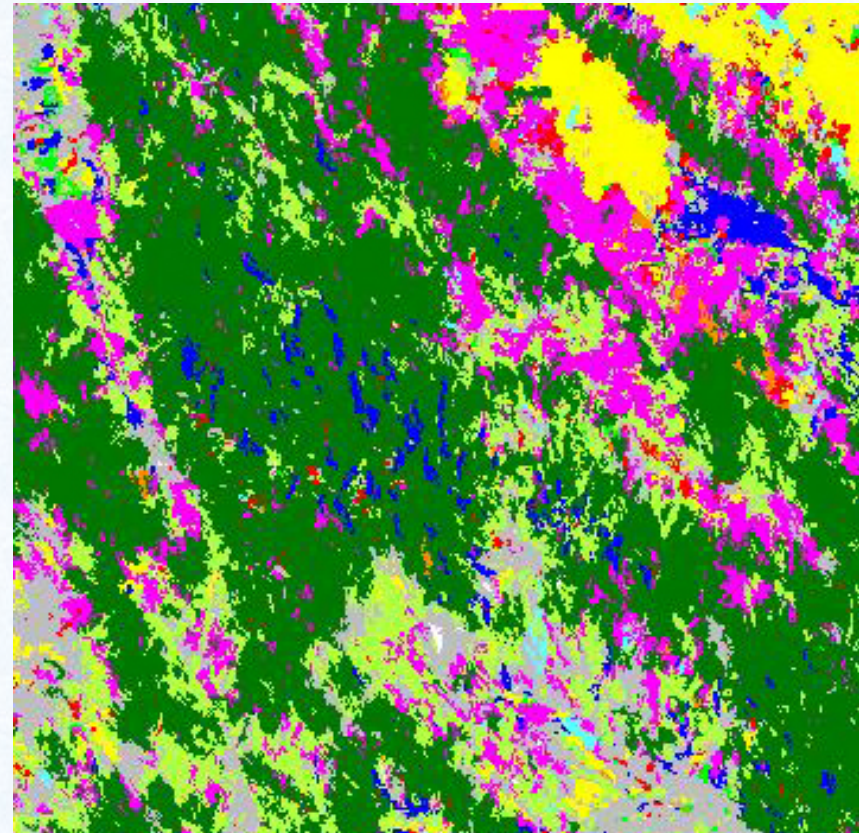
FNF accuracy: 84.84%₂₉
WWF 10 accuracy: 49.84 %

Zoom up of mountaneous area

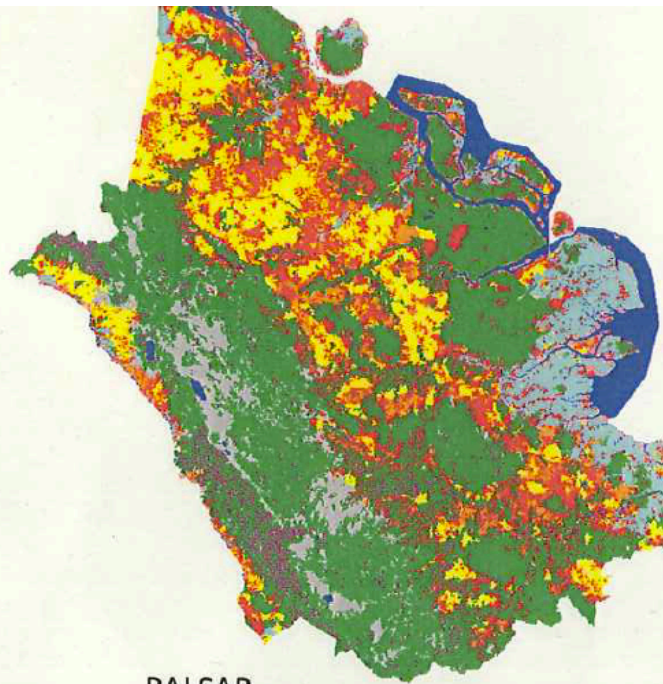
斜面勾配補正あり



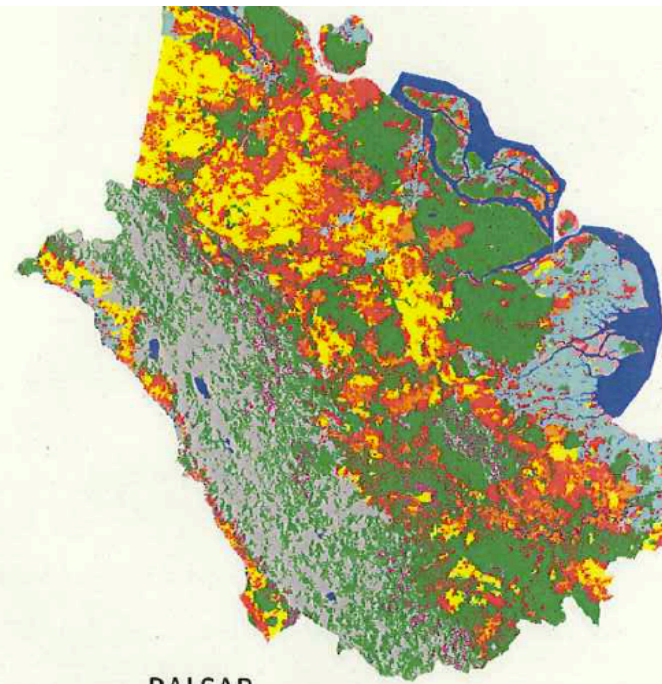
斜面勾配補正なし



Accuracy variation due to slope correction/no-slope correction



PALSAR
(HH + HV, Slope Correctionあり)



PALSAR
(HH + HV, Slope Correctionなし)

		Forest	Mangrove	ReGrowth	Acacia	Oil Palm	Rubber	Coconut	OpenArea	Others
Slope Correction	Producer'S Accuracy [%]	64.03%	33.57%	0.00%	26.66%	55.39%	20.75%	43.17%	17.03%	29.79%
	User'S Accuracy [%]	86.43%	31.81%	0.00%	12.84%	56.92%	4.03%	69.62%	45.61%	19.52%
Slope Correction	Producer'S Accuracy [%]	51.49%	27.24%	0.00%	20.14%	52.22%	14.67%	35.97%	14.89%	14.19%
	User'S Accuracy [%]	60.99%	28.00%	0.00%	13.29%	54.49%	2.18%	73.51%	48.03%	23.20%

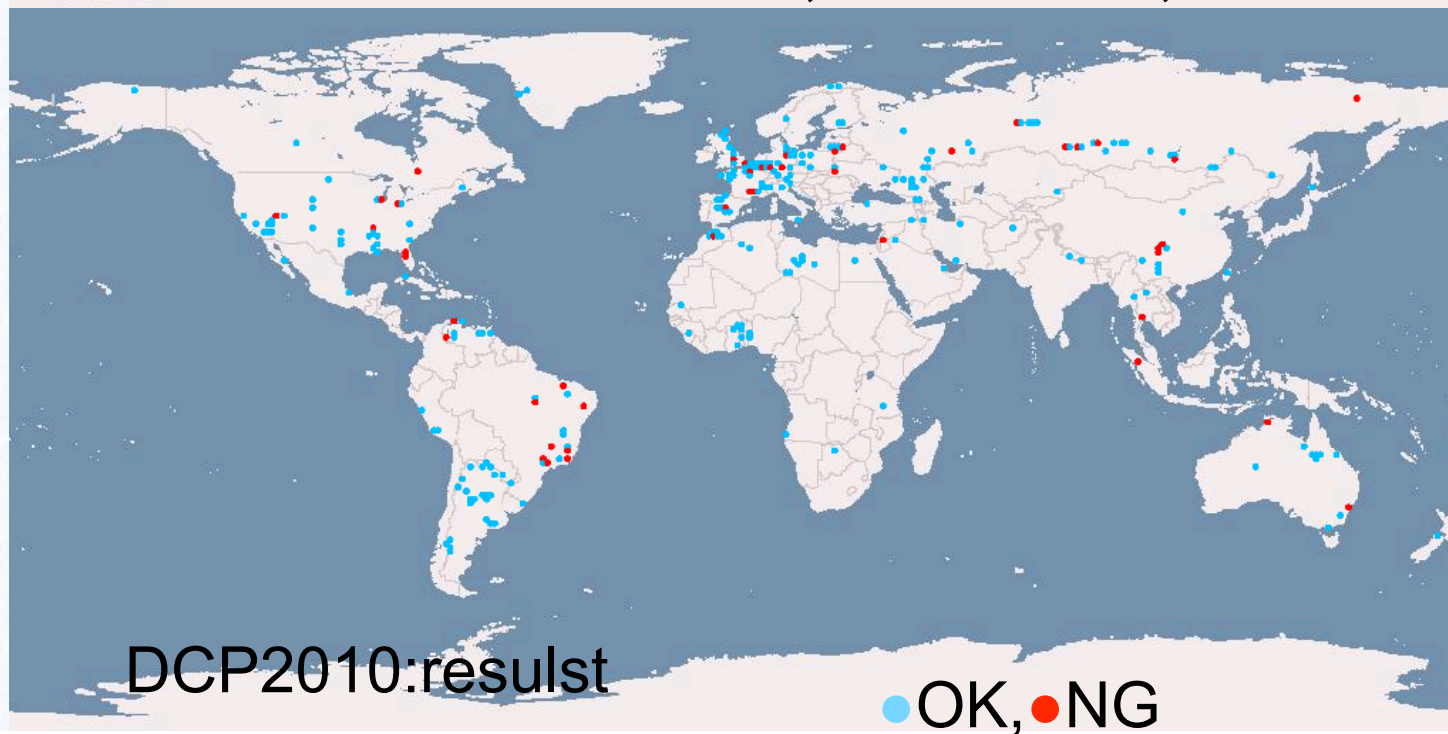
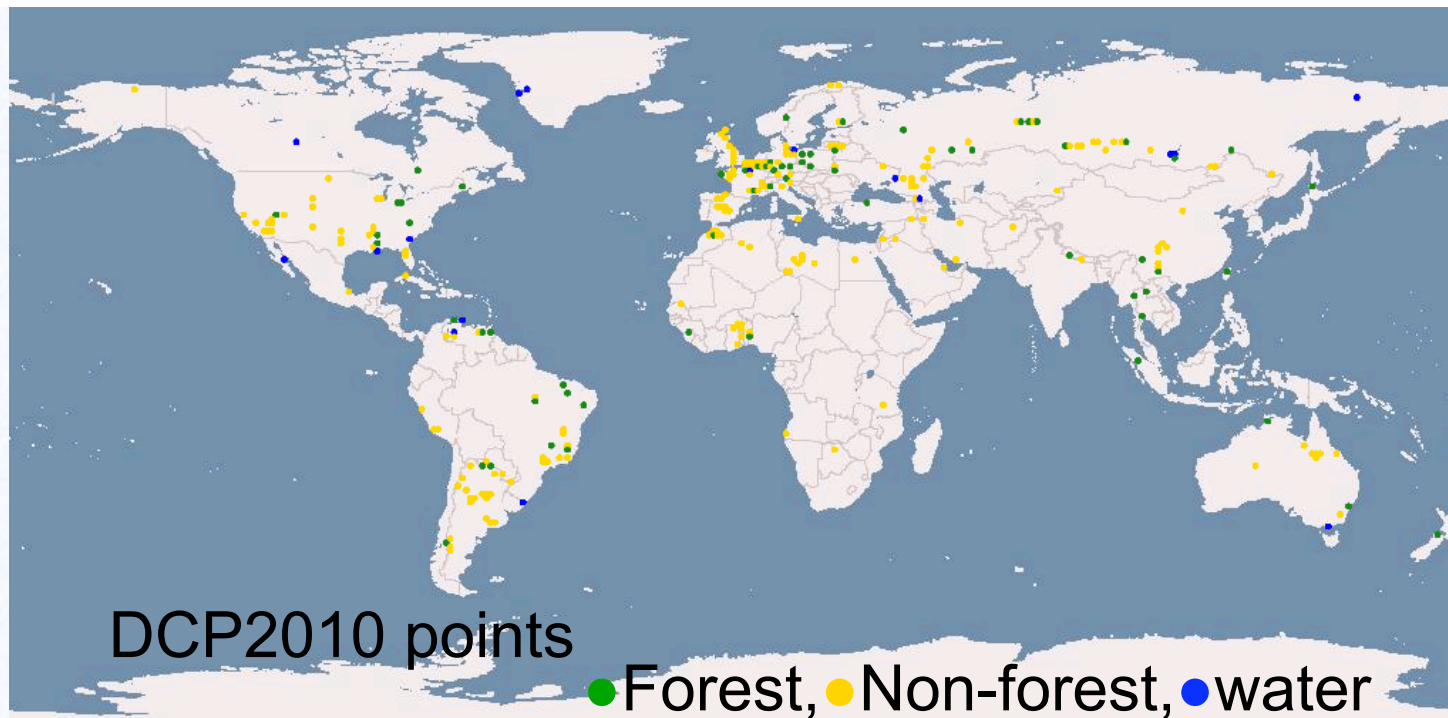
森林・非森林
86%
↓
60%

Slope Correctionされていないデータでは、特に地形の起伏が多い山岳地帯における森林分類の精度が大きく低下した。

Evaluation result of Global FNF using SACLA

- PALSAR FNF 2010, 2009 および2007(25m分解能)について、SACLA(Site-based data for assessing Annual Change of Land cover)(名古屋大学がFLUXNETやDCPの現地データを元に土地被覆判別をしたもの)を用いた精度評価を行った。

Data	Year	Accuracy	No. of Data
FNF	2007	84.5	1152
FNF	2009	84.0	530
FNF	2010	83.0	611



Future activity

- Plotting at Riau (Breat height measurement, height, density, biomass, lidar, Lulucf), error analysis
- Model
 - Gamma-naught vs. biomass
 - Other parameters vs. biomass
- Improve the LULUCF
- 上記モデル精度の向上
- Develop hybrid method to estimate the biomass

7. まとめ

- PALSAR, JERS-1 SARは後方散乱係数の安定性が高く、時系列データの解析から森林減少を把握可能である。
- 3種類の方法を用いて森林減少を把握する方法を開発中である。
- 森林・非森林分類は88%程度まで向上した。
- 今後は地上データ(地上計測、ライダー)との組み合わせを用いて、精度の向上を目指す。

Acknowledgements

- Great Thanks to RESTEC reserchers
- T. Yamanokuchi, T. Itoh, and H. Okumura