Mapping Deforestation in Riau, Indonesia by using 50m ALOS PALSAR MOSAIC Based on Amplitude and Texture Characteristic

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JAXA EORC, WWF

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Background

- Riau province, in central Sumatra, is covered by vast peatlands estimated to hold Indonesia's largest store of carbon.
- Riau has had one of the highest deforestation rates in recent years which are largely driven by industrial plantation companies.
- Remote Sensing data can provide deforestation information. Especially, Microwave remote sensing is insensitive to cloud coverage.
- We examine the possibilities of the 50m ALOS PALSAR mosaic in mapping land cover and deforestation in Riau, Indonesia and to compare the effectiveness of classification algorithms.

Methodology - Data

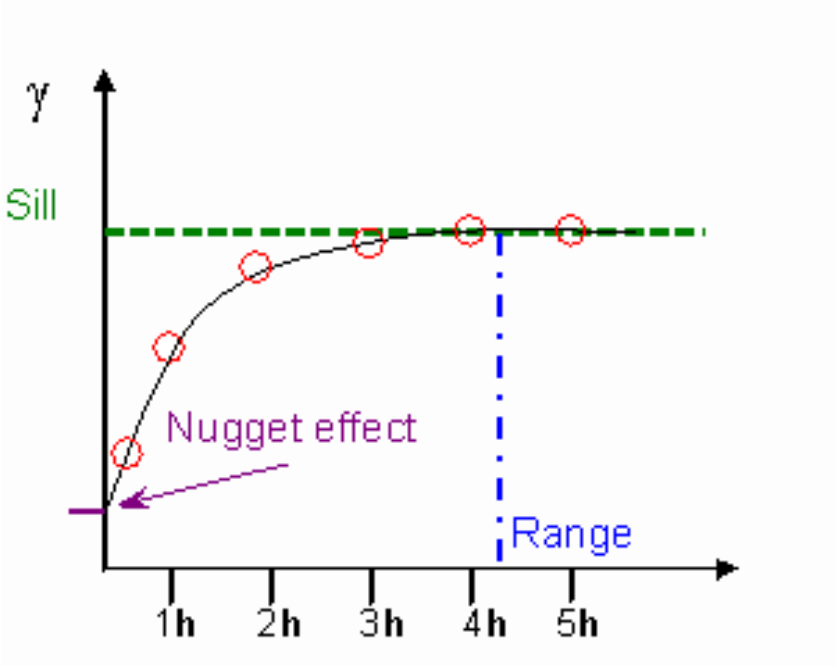
- The following datasets were obtained for the study:
  - 50-m ALOS PALSAR mosaic data from June to November 2007
  - WWF Land cover map in 2007

WWF Land cover map using Landsat ETM	Aug 3 2006, Aug 26 2006, Aug 1 2006, Apr 7 2007, Apr 16 2007, Apr 23 2007, May 23 2007, Jul 3 2007
50-m ALOS PALSAR mosaic data	Jun 23 2007, Jun 28 2007, Jul 3 2007, Jul 20 2007, Sep 11 2007, Nov 1 2007 , Nov 25 2007, Nov 30 2007

Semivariance Statistic

$$\gamma(h) = \frac{1}{2n} \sum_{i=1}^{n} [z(x_i) - z(x_i + h)]^2$$

- **A semivariogram describes the relationship between measurements taken some distance apart. Semivariograms define the range or distance over which spatial dependence exists.**
- **All samples *z(x)* and *z(x+h)*, located a distance *h* from *z(x)* called the *separation distance* or *lag distance*, are used to calculate the semivariance statistic $\gamma(h)$.**
- ***n* is the number of sample pairs**



- Range – the extent of spatial trends, distance beyond which sampling is random
- Nugget – variability at zero distance, represents analytical, or theoretical errors
- Sill – variability of spatially independent samples

Texture filter

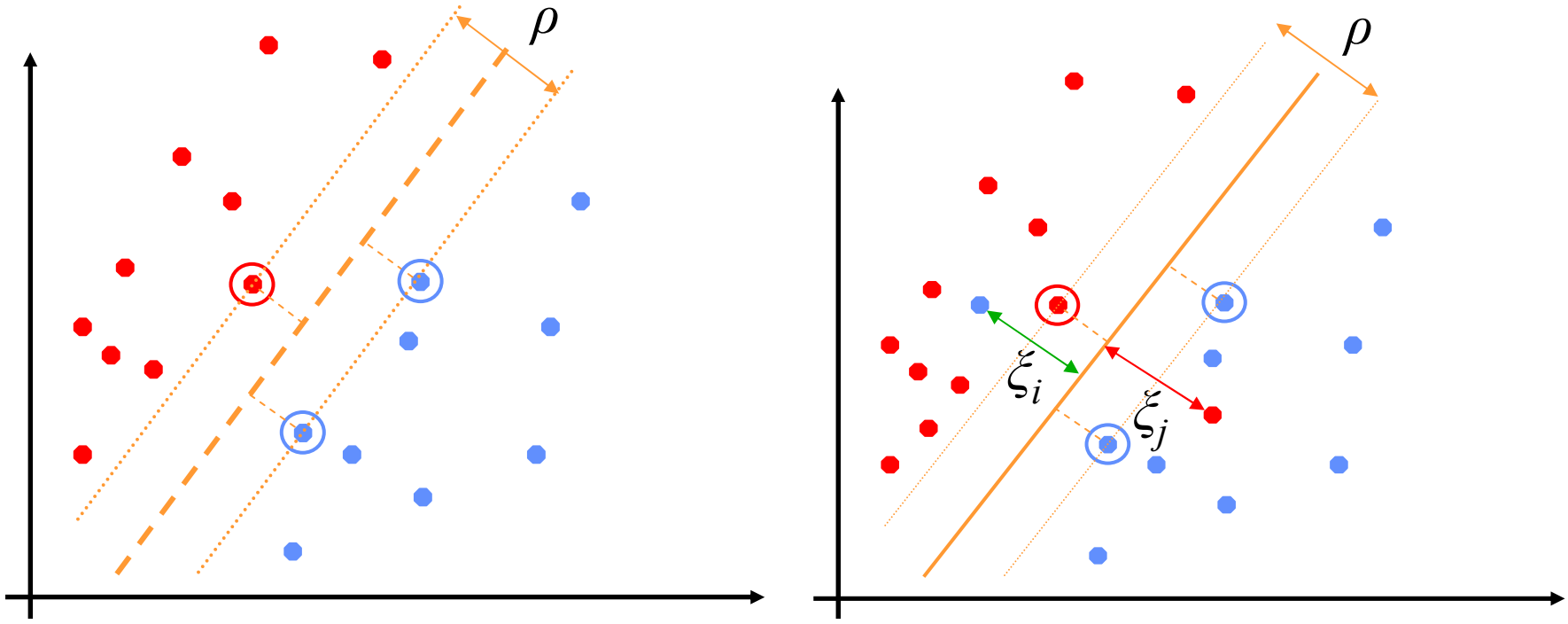
- **First order**
  - **Mean** $S_M = \sum_{i=0}^{k-1} iP(i)$
  - **Variance** $S_D^2 = \sum_{i=0}^{k-1} (1 - S_M)^2 P(i)$
  - **Entropy** $entropy = -\sum_{i=0}^{k-1} P(i)\log[P(i)]$

  ***P(i) = N(i)/M*, *N(i)* = number of pixels of same grey level in window, *M* = number of classes, *i* = pixel grey level, *k* = max possible grey level**

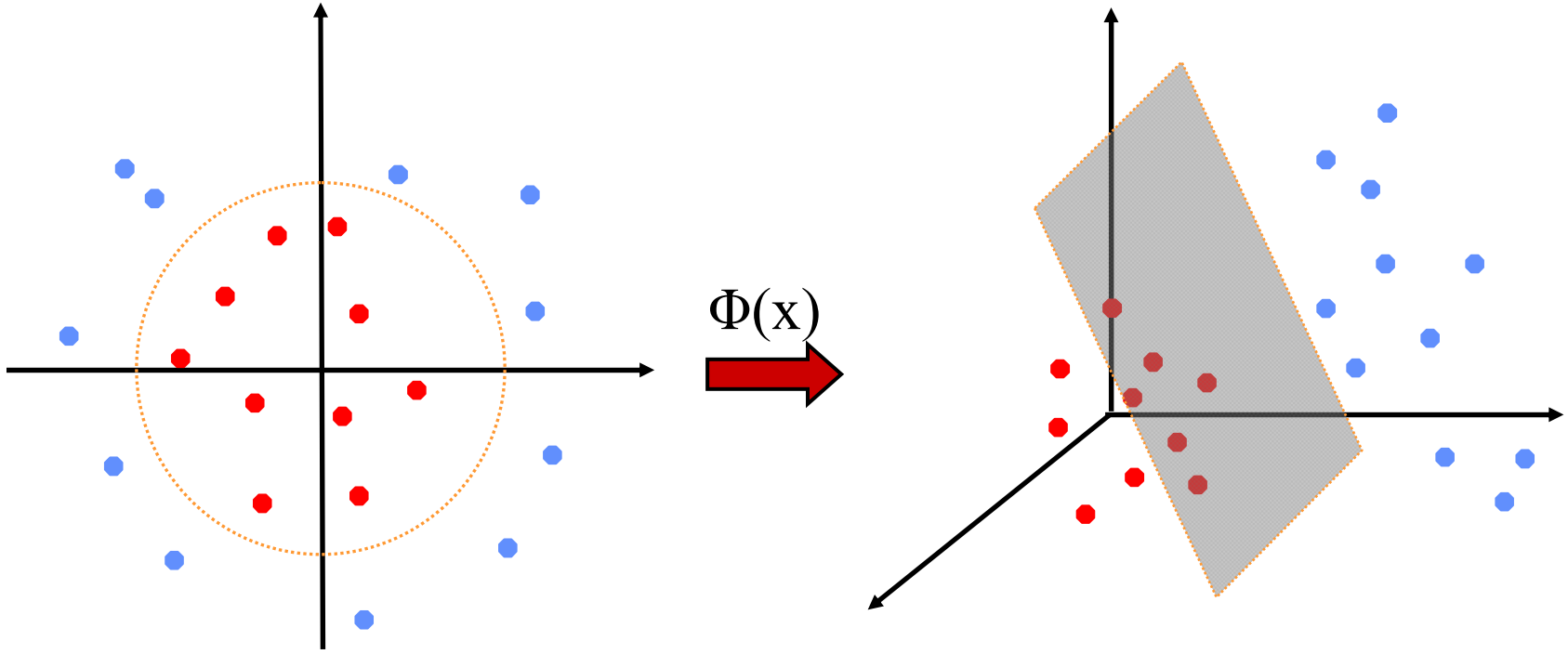
- **Window size = 9**

Support Vector Machine (SVM) Classifiers

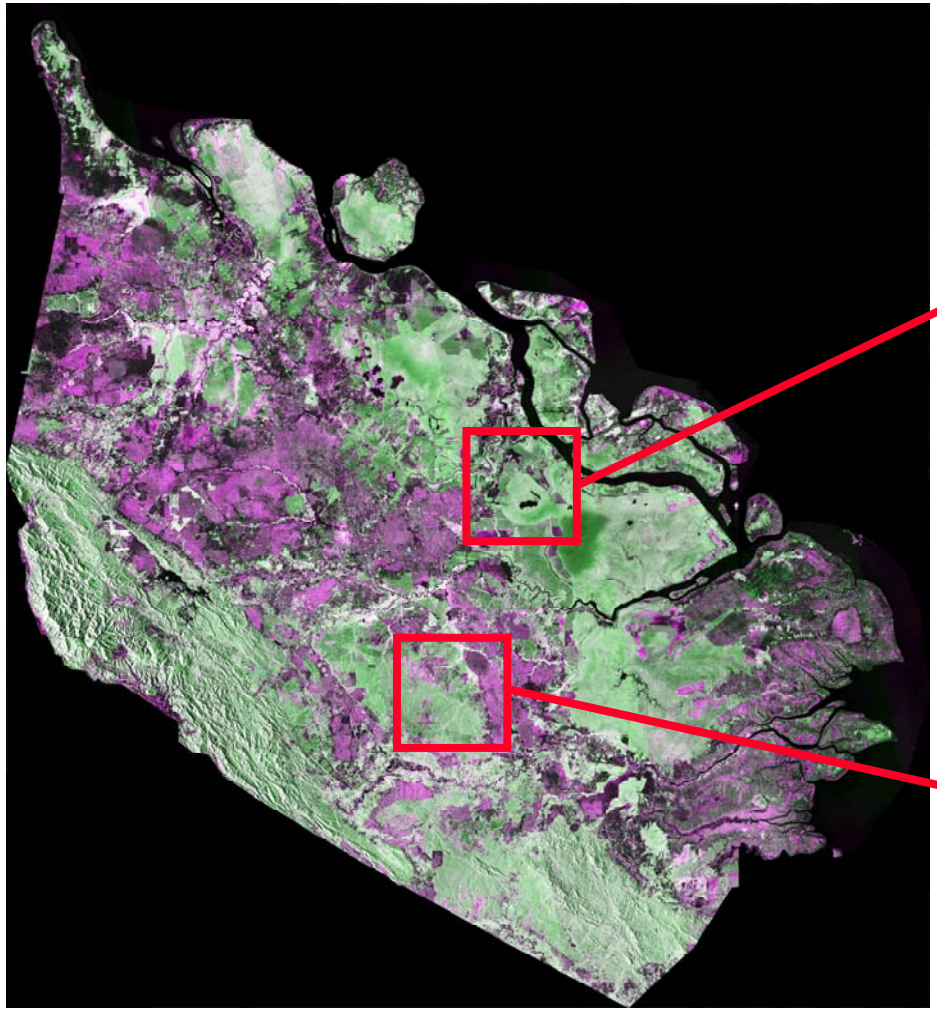
- **Linear Cases: find the optimal linear separating boundary with (a) maximum margin ρ (b) best trade-off between maximum margin ρ and minimum classification errors ξ**

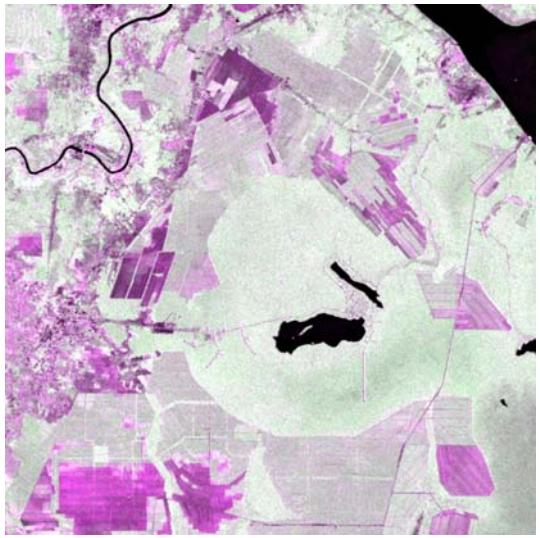


- **Non-Linear Cases: find the optimal linear separating boundary in a transformed higher dimensional feature space**

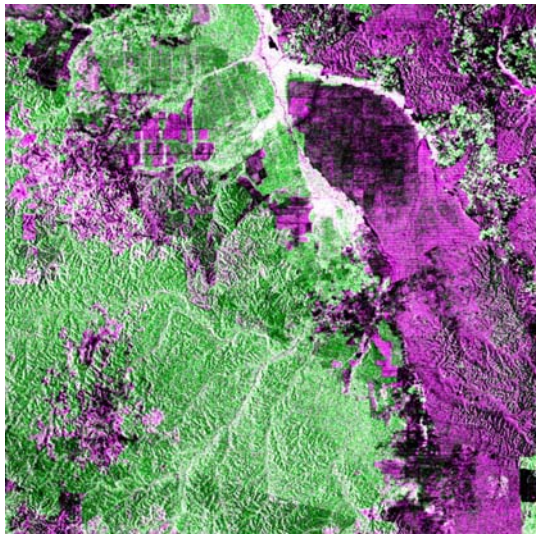


Study area

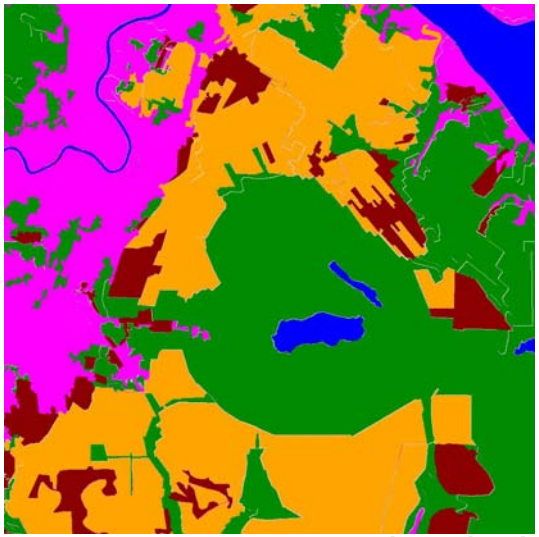




subset1

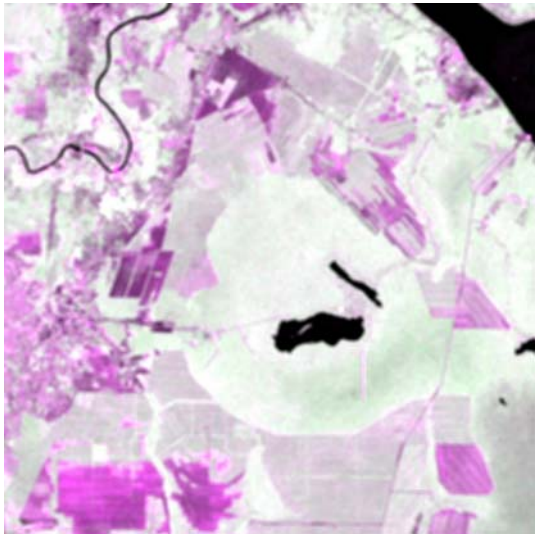


subset2



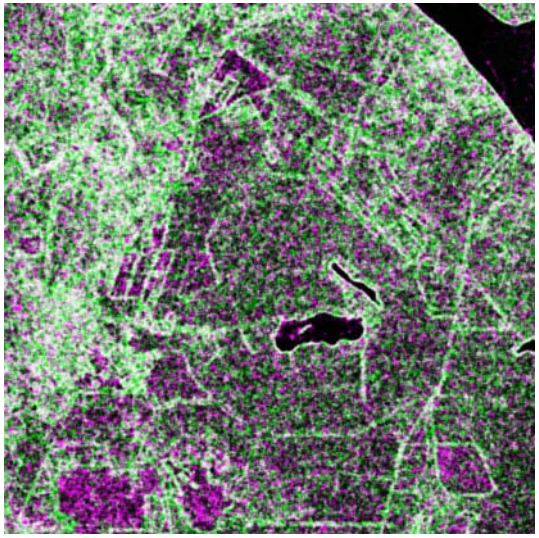
Darkgreen = swamp, orange = acacia , red = clear, blue = water, purple = other

R = HH, G = HV ,B = HH



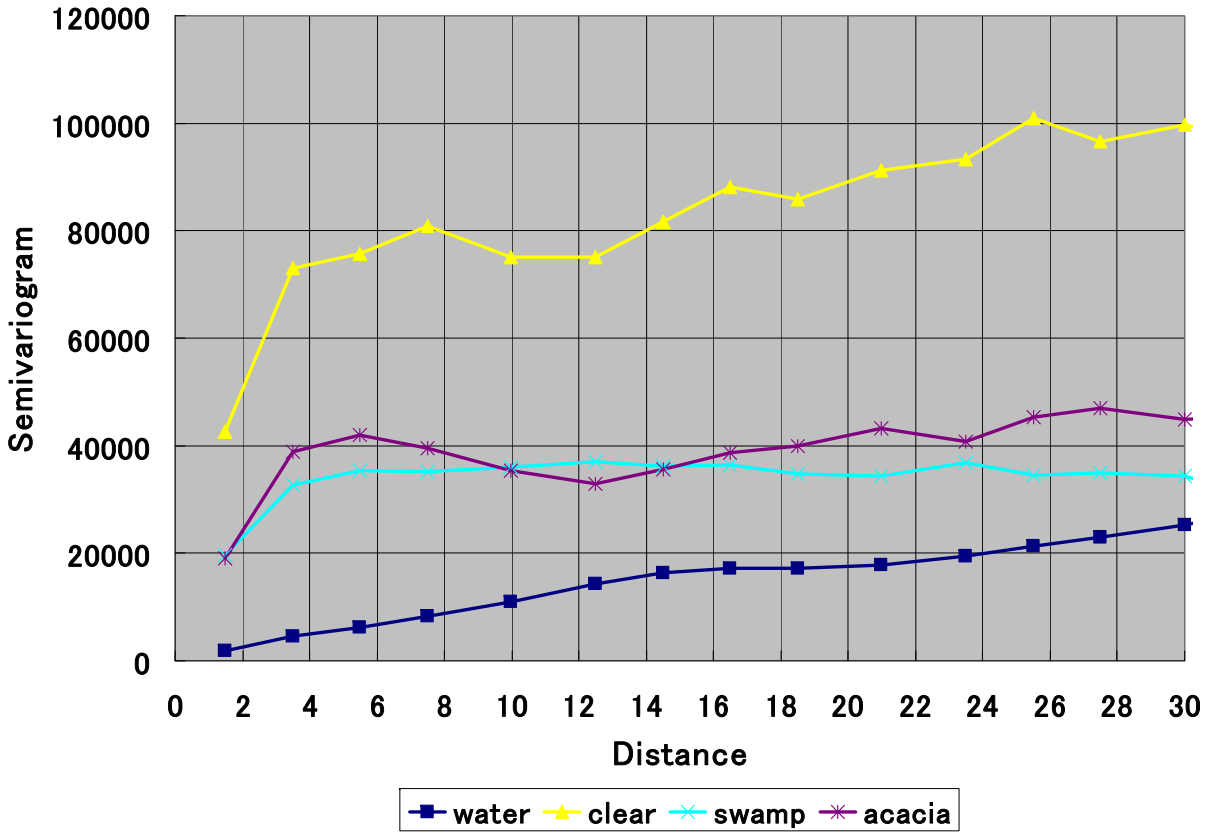
mean

variance

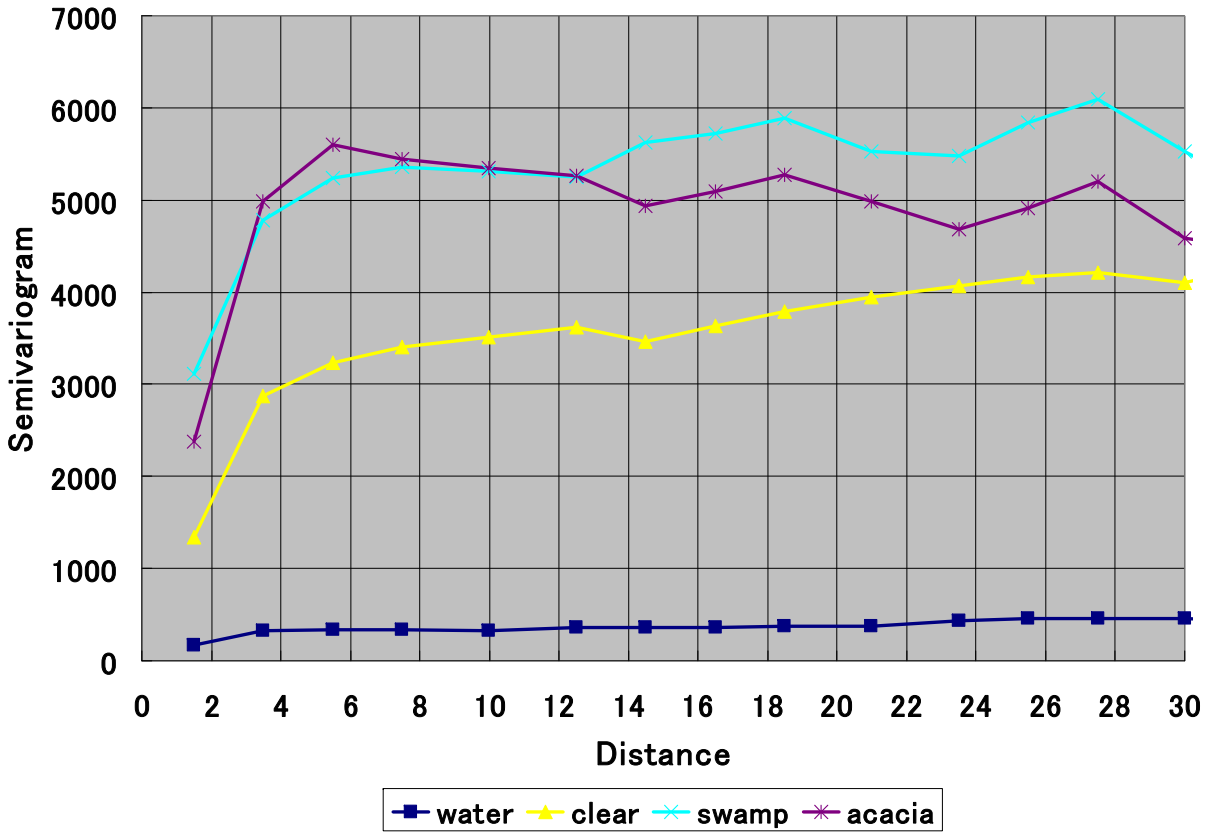


entropy

Subset 1, HH


120000
100000
80000
60000
40000
20000
0
Semivariogram
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Distance
water
clear
swamp
acacia

Subset 1, HV


Semivariogram
7000
6000
5000
4000
3000
2000
1000
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Distance
water
clear
swamp
acacia

ALOS

K&C Initiative

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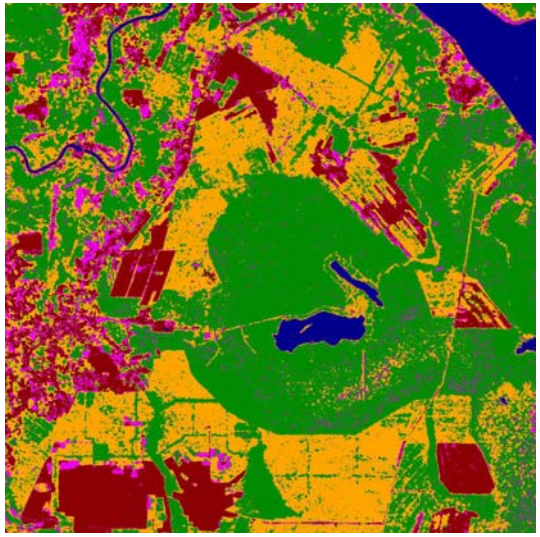
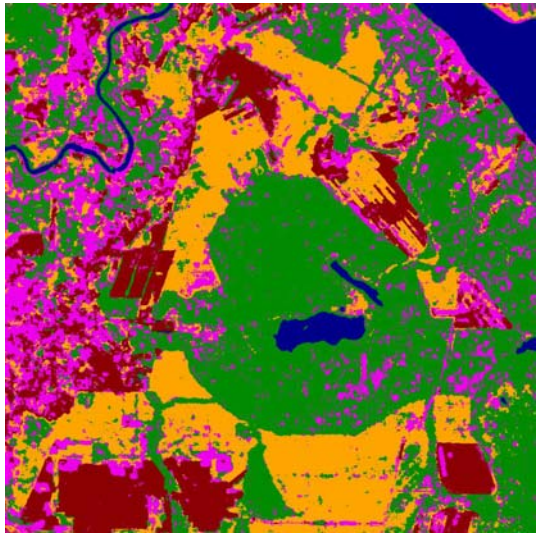
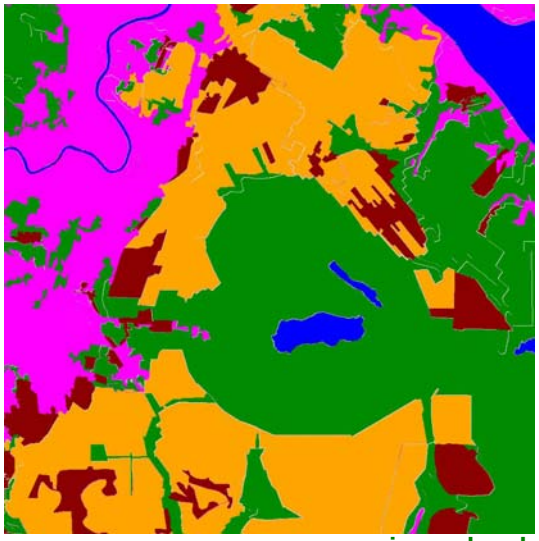
R = HH, G = HV ,B = HH



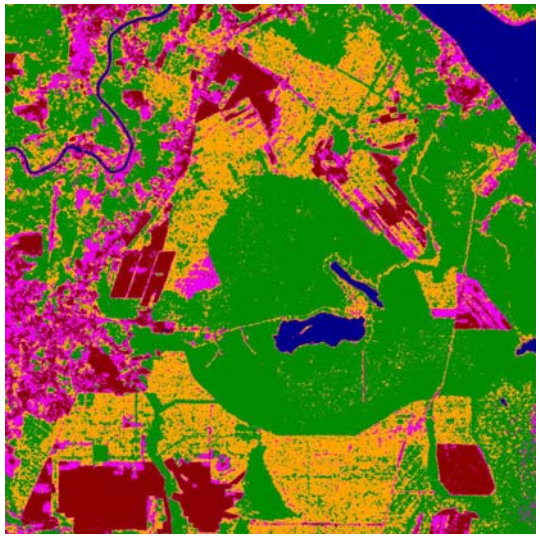
Maximum likelihood



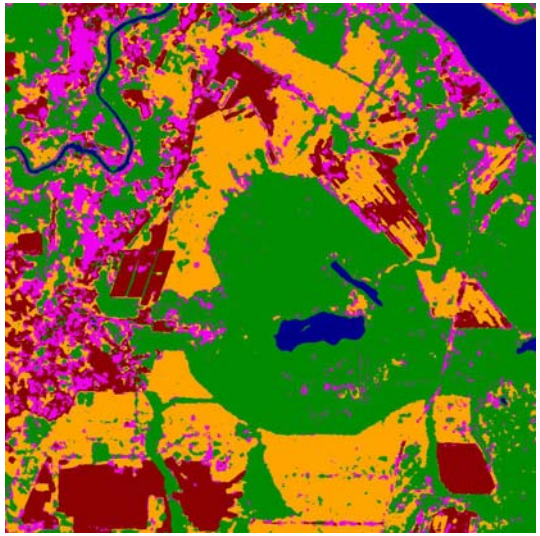
Maximum likelihood with texture



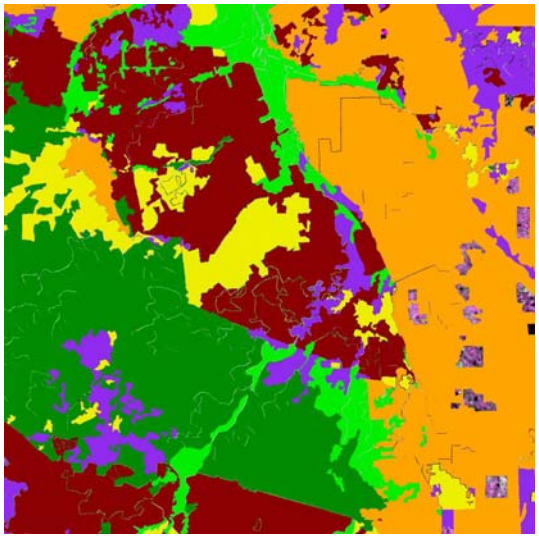
Darkgreen = swamp, orange = acacia , red = clear,
blue = water, purple = other



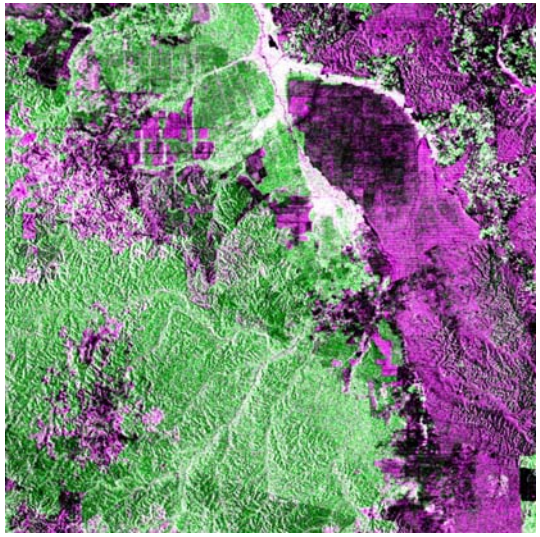
svm



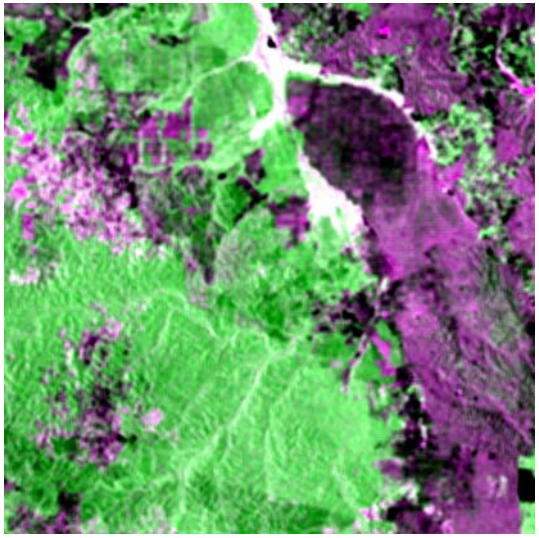
svm with texture



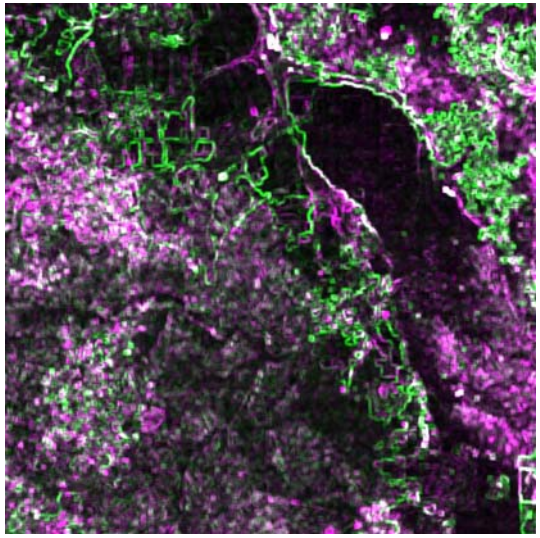
Darkgreen = dry forest, lightgreen=swamp, orange= palm,
red = acacia, yellow = clear, purple = other



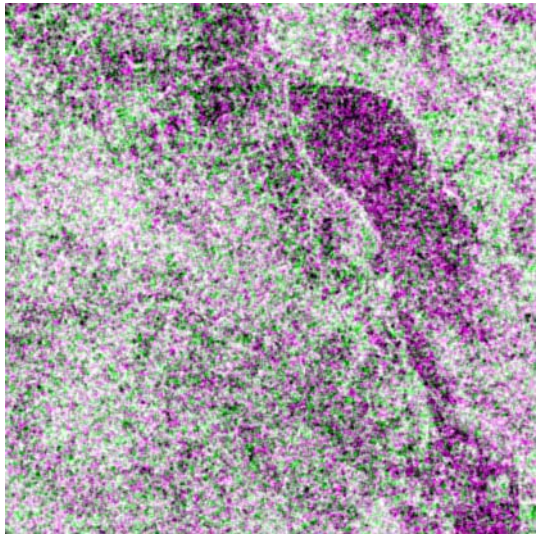
R = HH, G = HV ,B = HH



mean

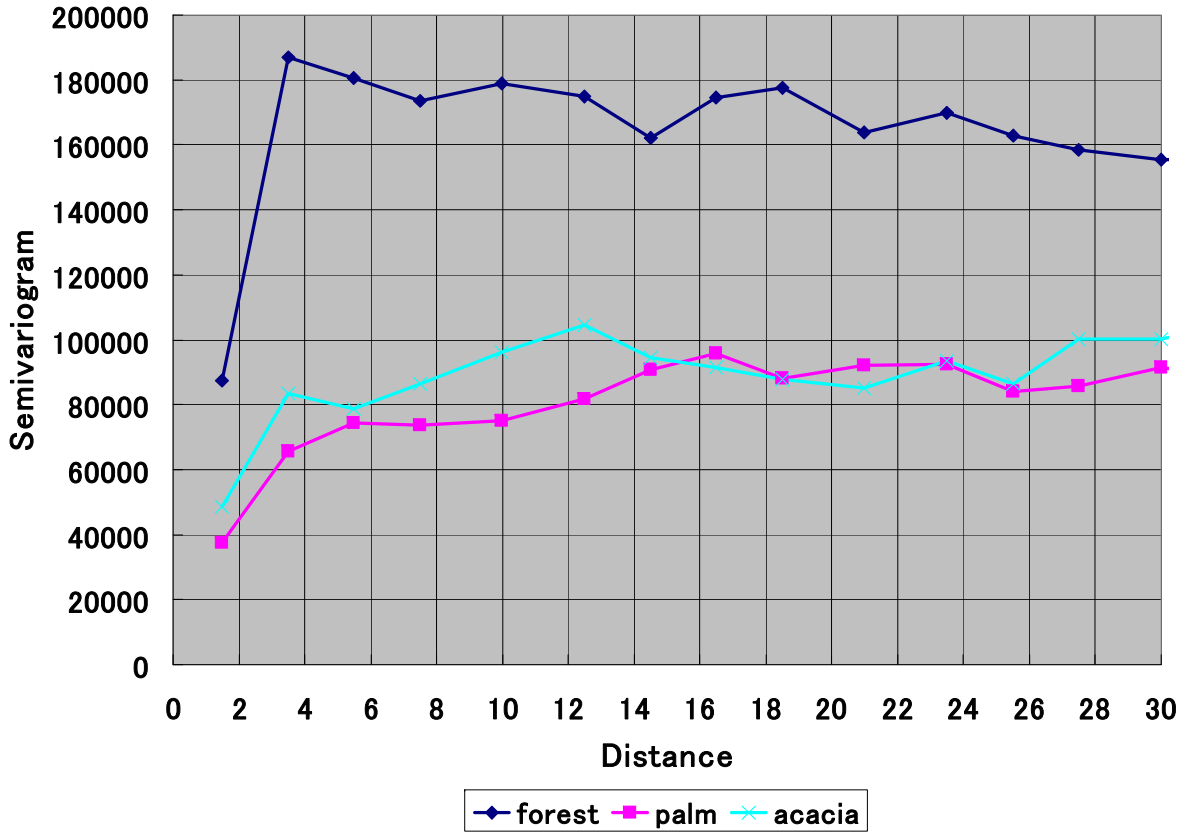


variance

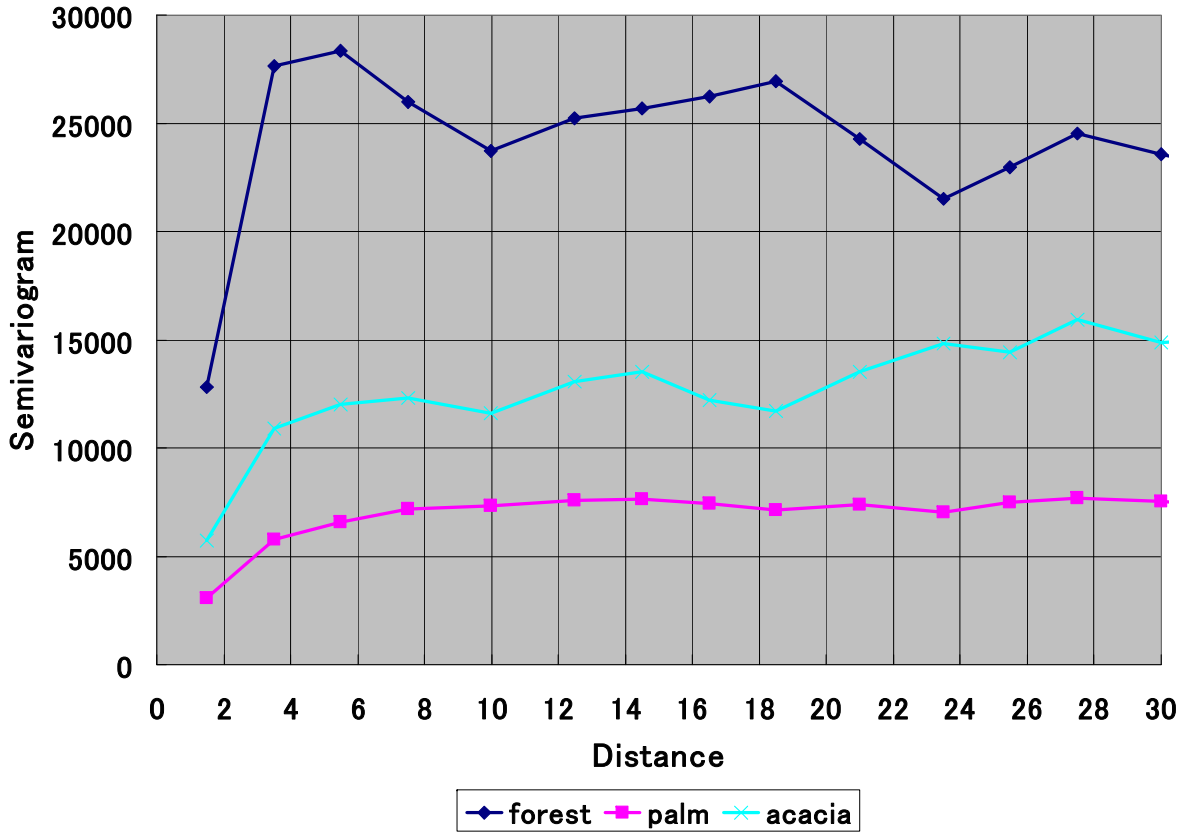


entropy

Subset 2, HH


Semivariogram
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Distance
forest
palm
acacia

Subset 2, HV


30000
25000
20000
15000
10000
5000
0
Semivariogram
0
2
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8
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12
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26
28
30
Distance
forest
palm
acacia

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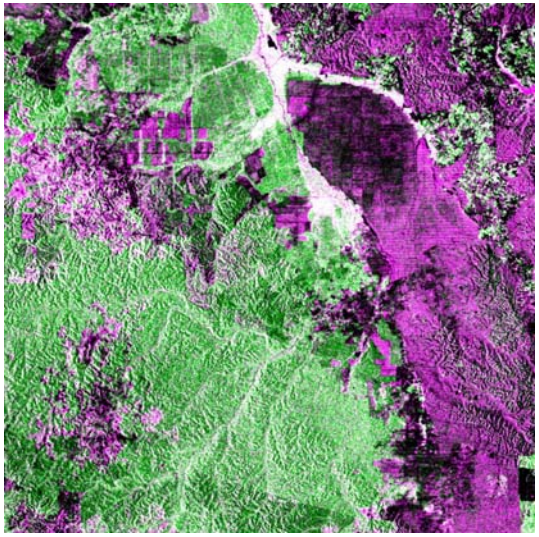
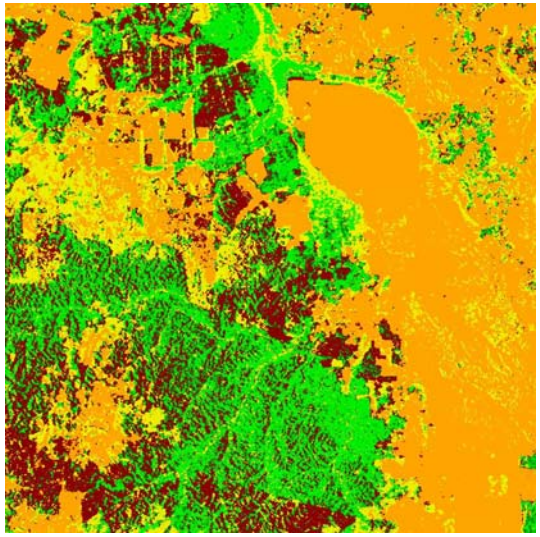
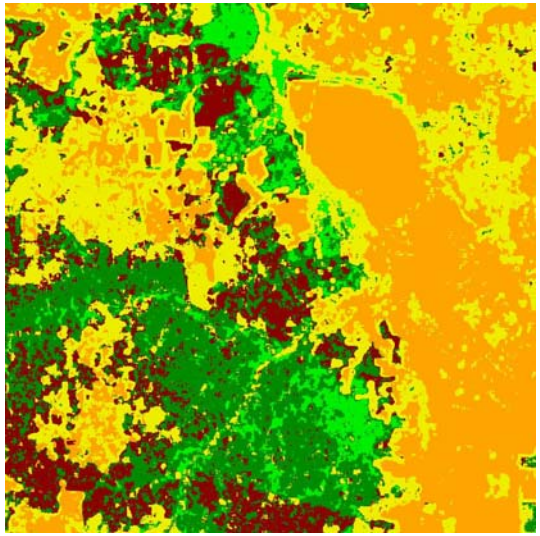


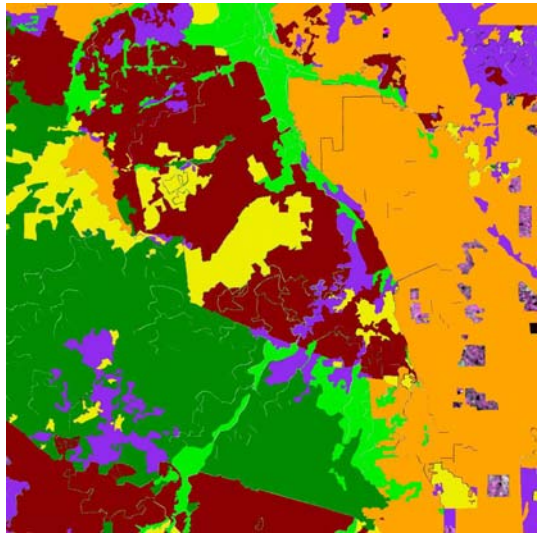
R = HH, G = HV ,B = HH



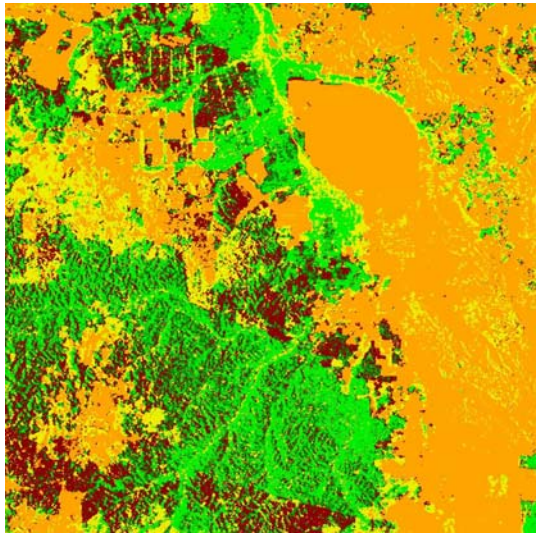
Maximum likelihood



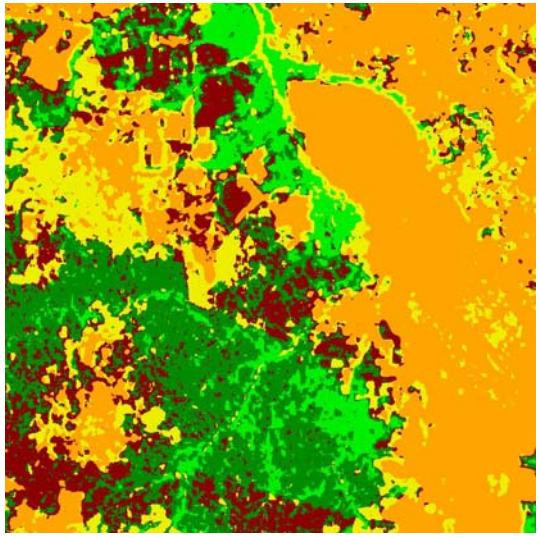
Maximum likelihood with texture



Darkgreen = dry forest, lightgreen=swamp, orange= palm,
red = acacia, yellow = clear, purple = other



svm



svm with texture

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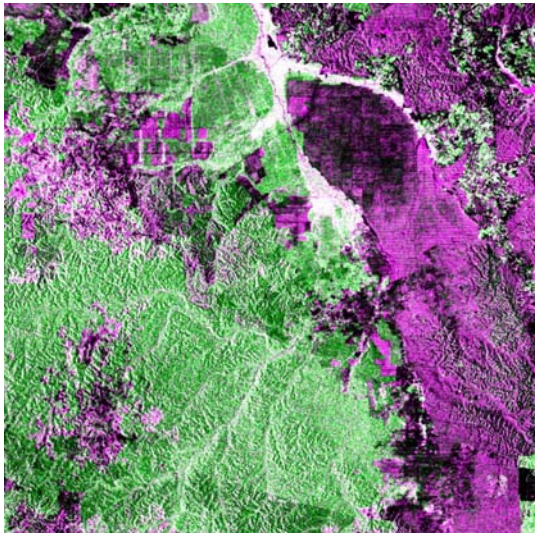
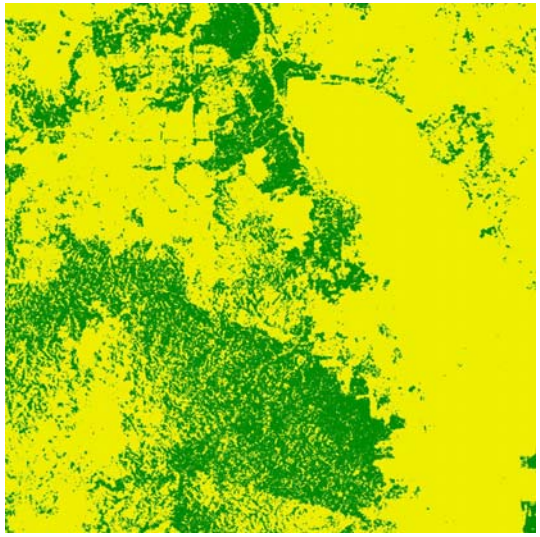
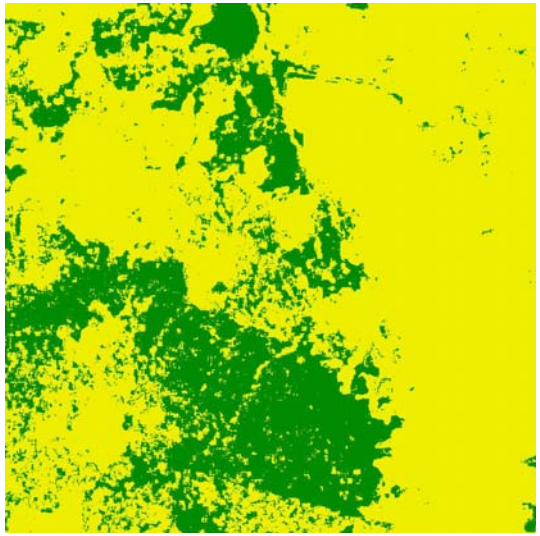


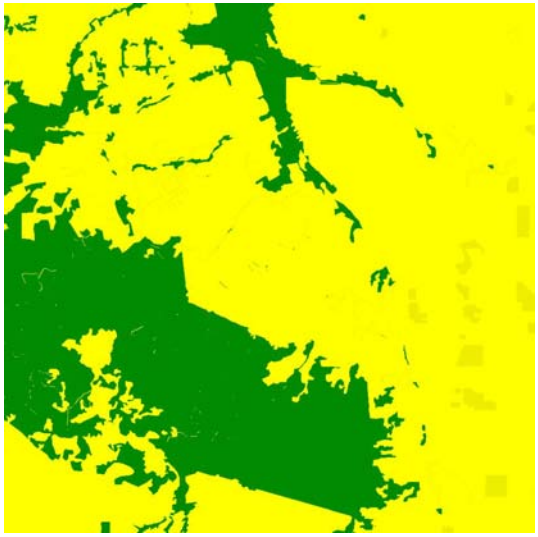
R = HH, G = HV ,B = HH



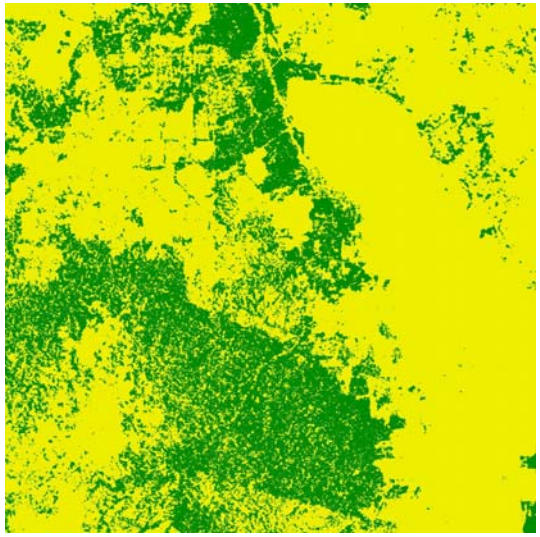
Maximum likelihood



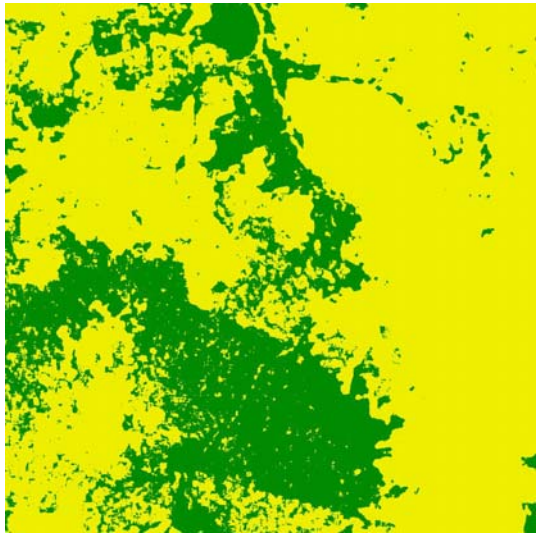
Maximum likelihood with texture



Darkgreen = dry forest, yellow = nonforest



svm



svm with texture

Classification accuracy

	Subset 1	Subset 2
SVM with texture	68.53%	80.92%
ML with texture	66.19%	80.19%
SVM	65.36%	77.90%
ML	63.93%	77.80%

Summary

- From the results, it can be found that SVM algorithm with texture gave better results compared with the other algorithm.
  - Acacia is very difficult to differentiate from dry forest and peat swamp (depended on growth stage)
- AVNIR 2 could be used to be a reference image. (depend on the cloud coverage)
- Grey Level Co-occurrence Matrix (GLCM) will be investigated. (Haralick, R.M. 1979)