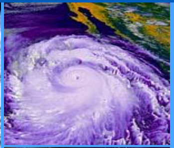




Characterization of Land cover Composition and Changes using Hyper-temporal Remote Sensing

Dr. Amjad Ali

SUPARCO

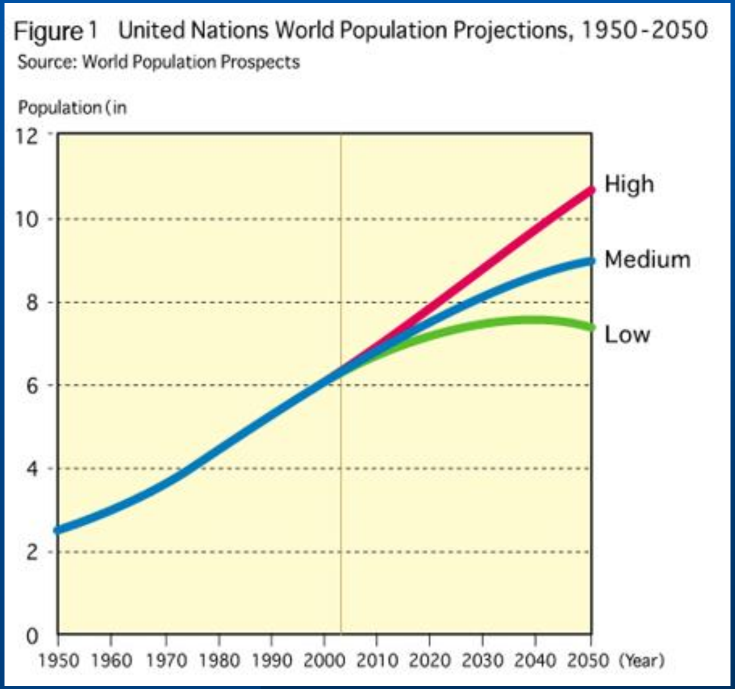
Contents

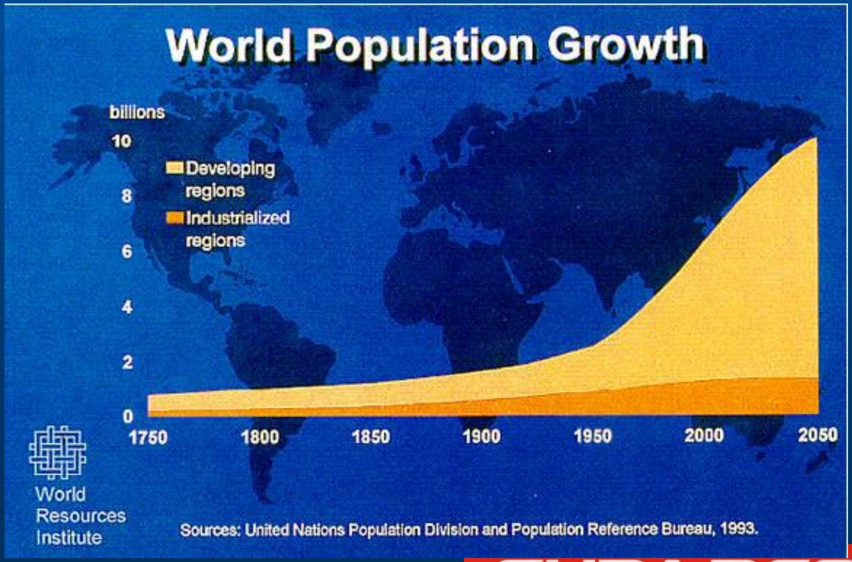
- Introduction
- Hyper-temporal RS
- Land cover composition and change detection method
- Results
- Conclusion

Introduction

Today's problems:

- Population growth.





SUPARCO

Introduction

Today’s problems:

- Population growth.
- Increasing demand for natural resources.

Introduction

Today's problems:

- Population growth.
- Increasing demand for natural resources.
- Expansion into marginal lands, land degradation and ecosystem destruction.

SUPARCO

Introduction

Today’s problems:

- Population growth.
- Increasing demand for natural resources.
- Expansion into marginal lands, land degradation and ecosystem destruction.
- Pollution, global change.

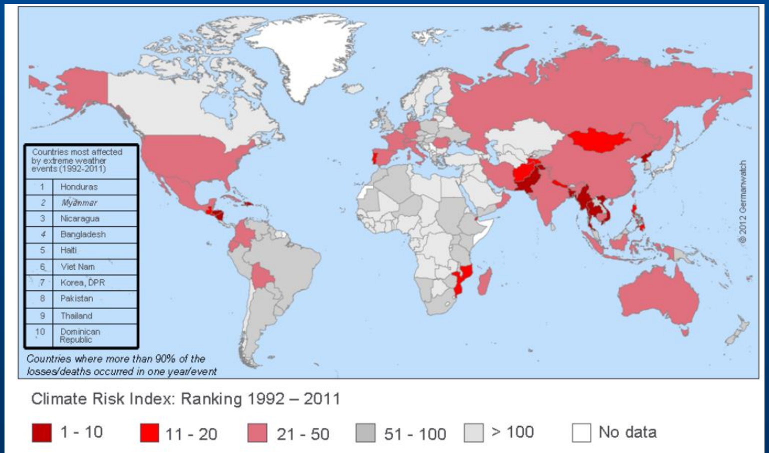


Figure 2: World Map of the Global Climate Risk Index 1992-2011

Source: Germanwatch and Munich Re NatCatSERVICE

SUPARCO

Introduction

Today's problems:

- Population growth.
- Increasing demand for natural resources.
- Expansion into marginal lands, land degradation and ecosystem destruction.
- Pollution, global change.
- Food shortage
- Biodiversity loss

SUPARCO

Today's challenges:

Timely and quality information about Land use and Land cover and its Change

- Base of all important RS models
- Second most important statistics
- Climate change proxy
- Important for mitigation
- Ecosystem services relevance
- Biodiversity and food security indicator
- Policy formulation

SUPARCO

Existing LULC(C)C detection methods

- Image differencing (Ingram and Dawson, 2005…………………)
- Image rationing (Nelson, 1983……………….)
- Post-classification comparison (Chen and Wang, 2010…….)
- Principal component analysis(PCA) (Young and Wang, 2001………)
- Regression models (Fraser and Latifovic, 2005………..)
- Change vector analysis (Bayarjargal et al., 2006………)
- Neural networks (Woodcock et al., 2001………….)
- Correspondence analysis (Cakir et al., 2006………….)
- Object oriented methods (Zhou et al., 2008…………).
- Time profiles statistic's (Borak et al., 2000………….)
- Change vector analysis (He et al., 2011………………..)
- Change in phenological cycles(Beurs and Henebry, 2005………………)
- Change metrics (Lupo et al., 2007…………………..)
- Temporal trajectory analysis (Lunetta et al., 2006…………………)

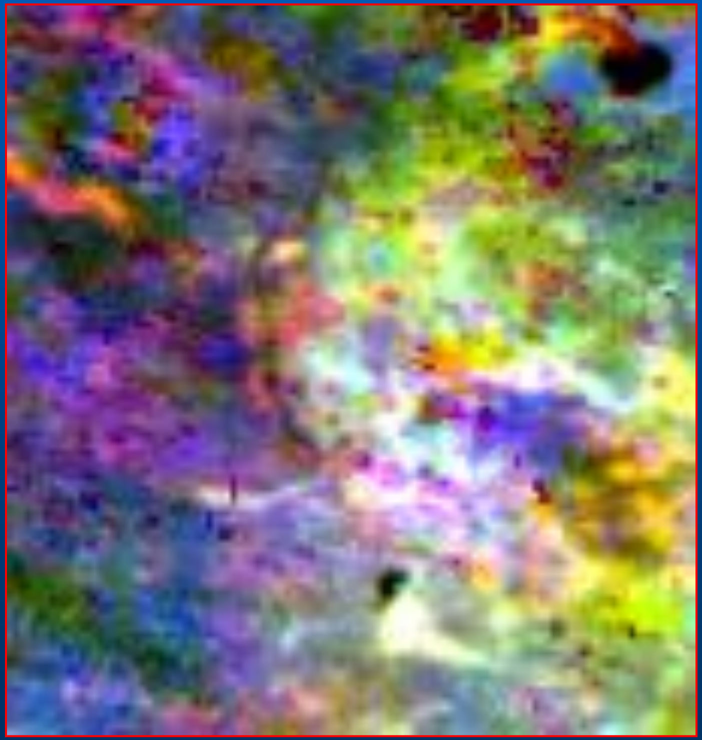
Concerns ?

- Lack of gradient representation
- Use of the limited time imagery (2-3 times imagery) of irregular time period and or long term but seasonality is not adjusted
- LULC change must be assessed after seasonal aspects (weather, phenology, crop calendars) are removed! And they are represented in realistic manner (gradient representation (Whittaker 1978)

SUPARCO

Gradient Representation

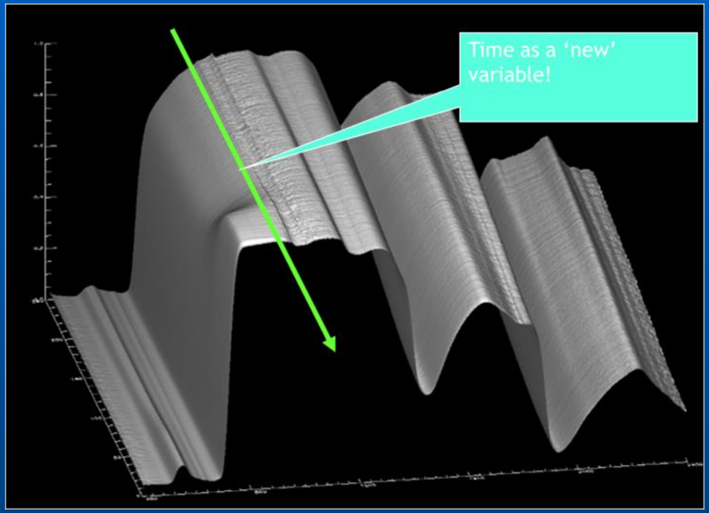
- Agriculture and natural and semi natural landscape exhibit gradients
- Help to understand structure and functions of a landscape
- Important for accurate areas estimation and to analyze spatial patterns
- Give indication of spatial and temporal variations
- Realistic representation



Hyper-temporal Remote sensing

Hyper-temporal RS combines time, vegetation properties, and space…for mapping and monitoring

- Continuous time series instead of a number of “snap shots” over the years
- Phenological differences of the land cover within and between years are visualized and ready for analysis
- Problem of cloud cover is reduced (MVC-approach).



“long-term, extensively repeated (daily) time series datasets of an area (Piwowar and LeDrew, 1995; Piwowar et al., 1998; McCloy, 2006; de Bie et al., 2008).

Objective

Develop and test methods to improve land cover mapping and monitoring in terms of gradient representation and the use of hyper-temporal remote sensing.

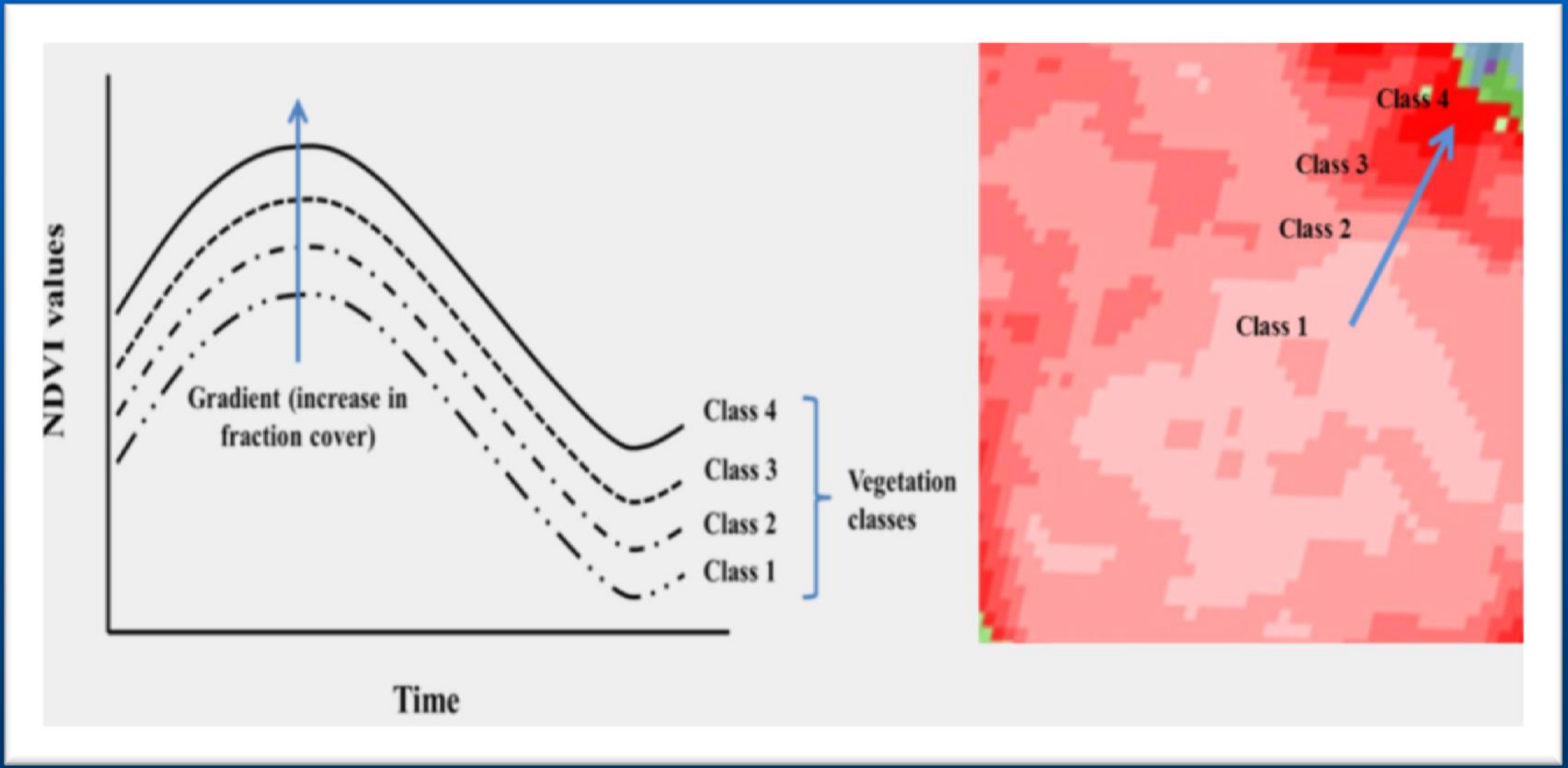
Specific Objectives

- Map Hyper-temporal imagery based land cover gradient
- To develop a spatiotemporally explicit and gradient based land cover composition change assessment method

Specific objective 1

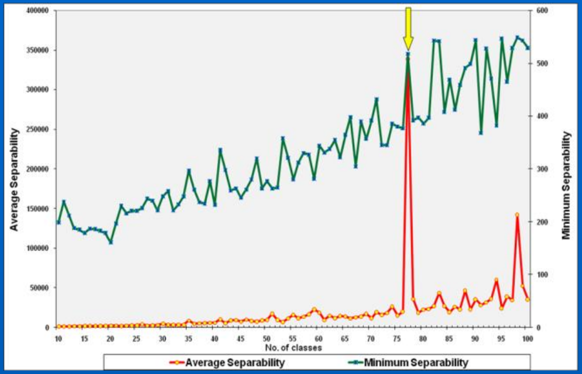
Mapping land cover gradients

Mapping land cover gradients through analysis of hyper-temporal NDVI imagery (Concept)

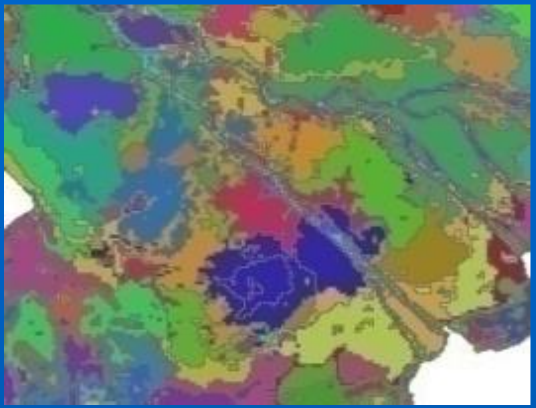


Hyper-temporal NDVI analysis approach

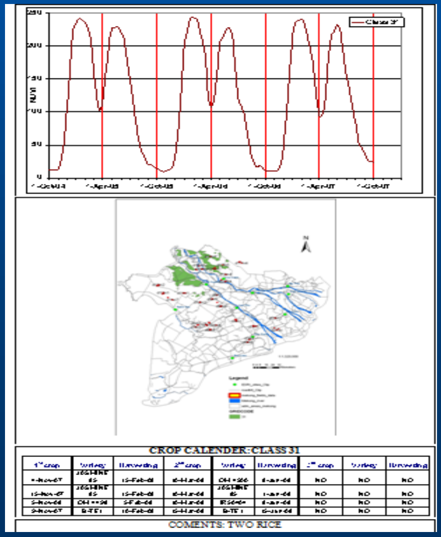
Stacked NDVI image



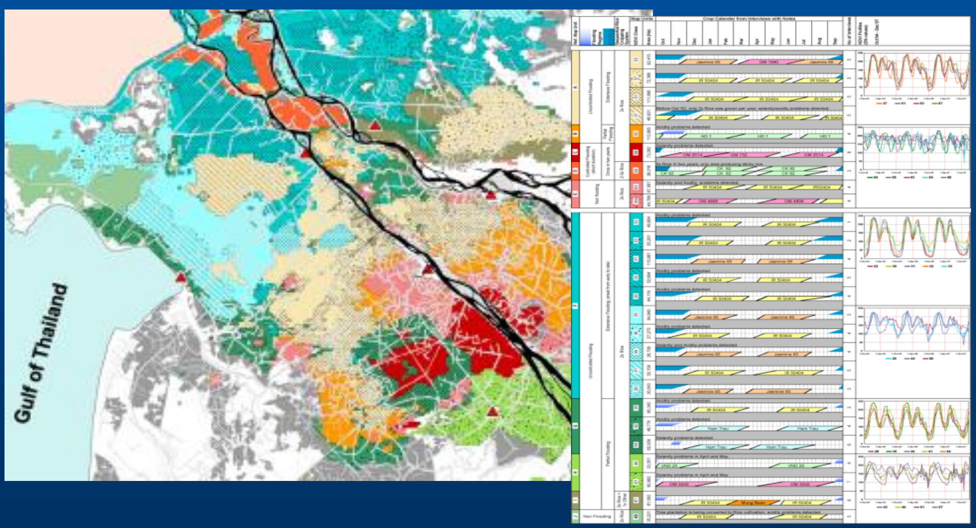
Divergence statistics



NDVI classes map

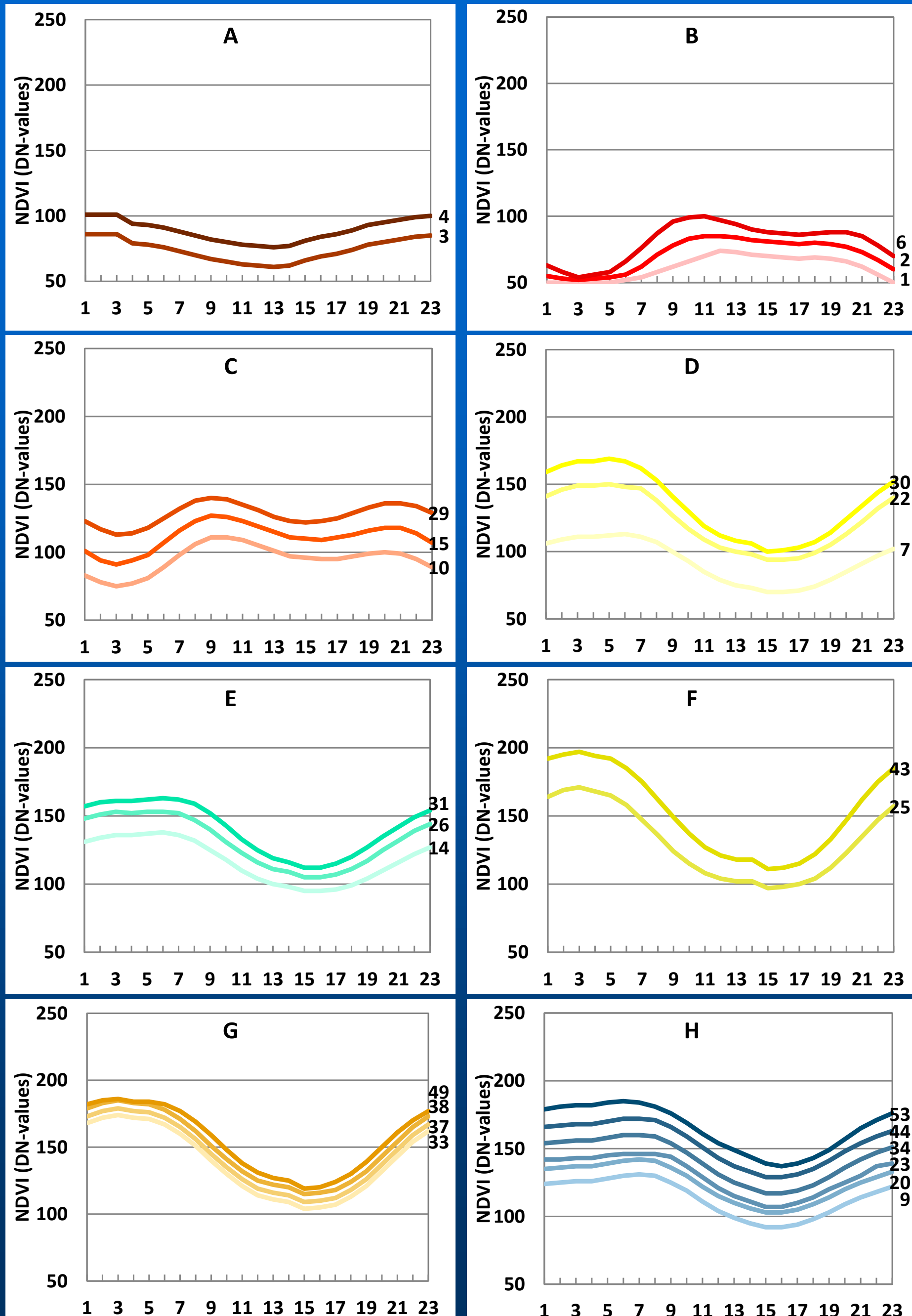


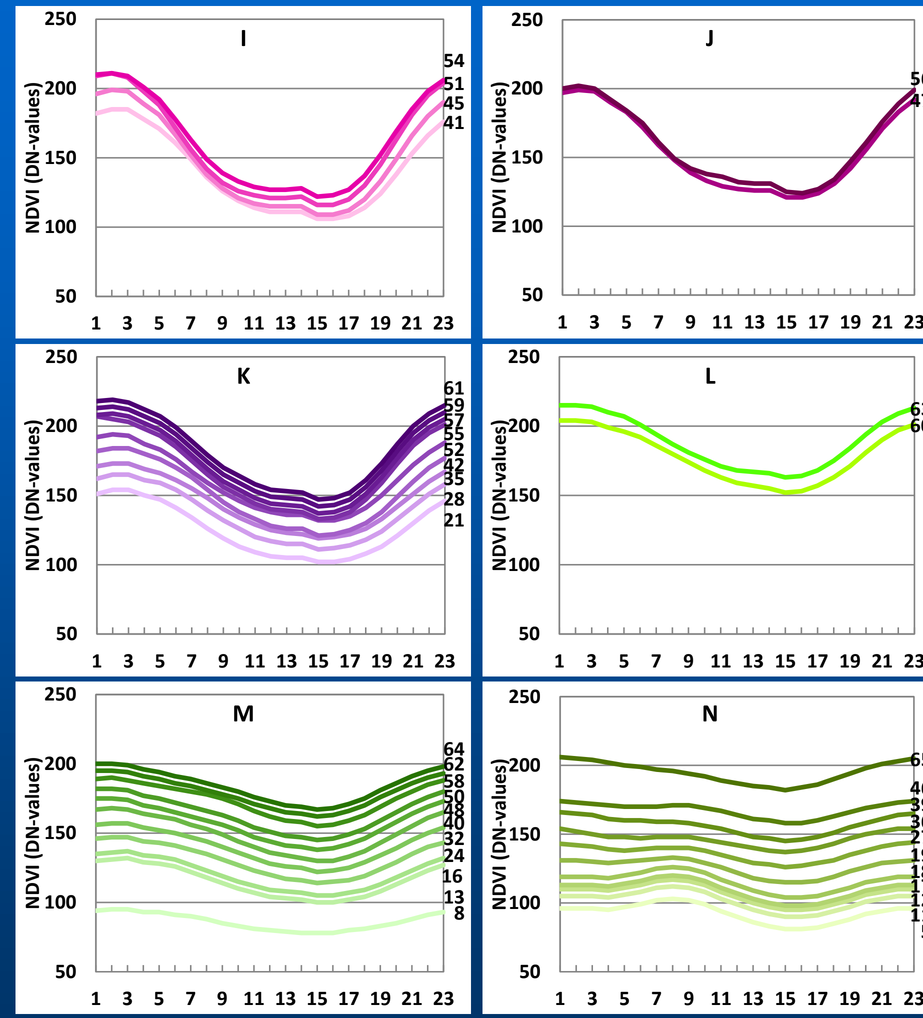
Spatial + Temporal + Field data analysis



Final NDVI map and legend

Results

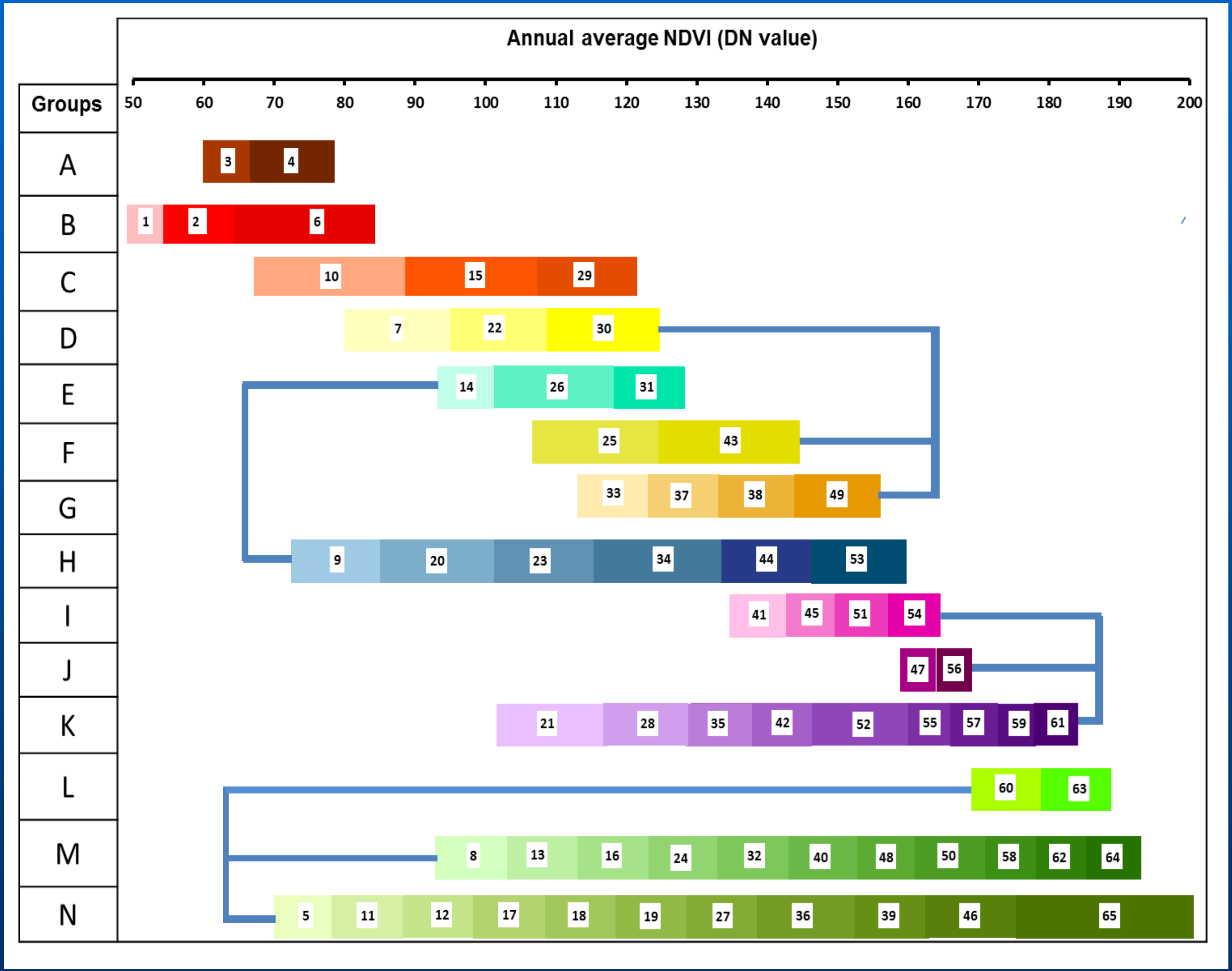




MODIS 16-day time series

MODIS 16-day time series

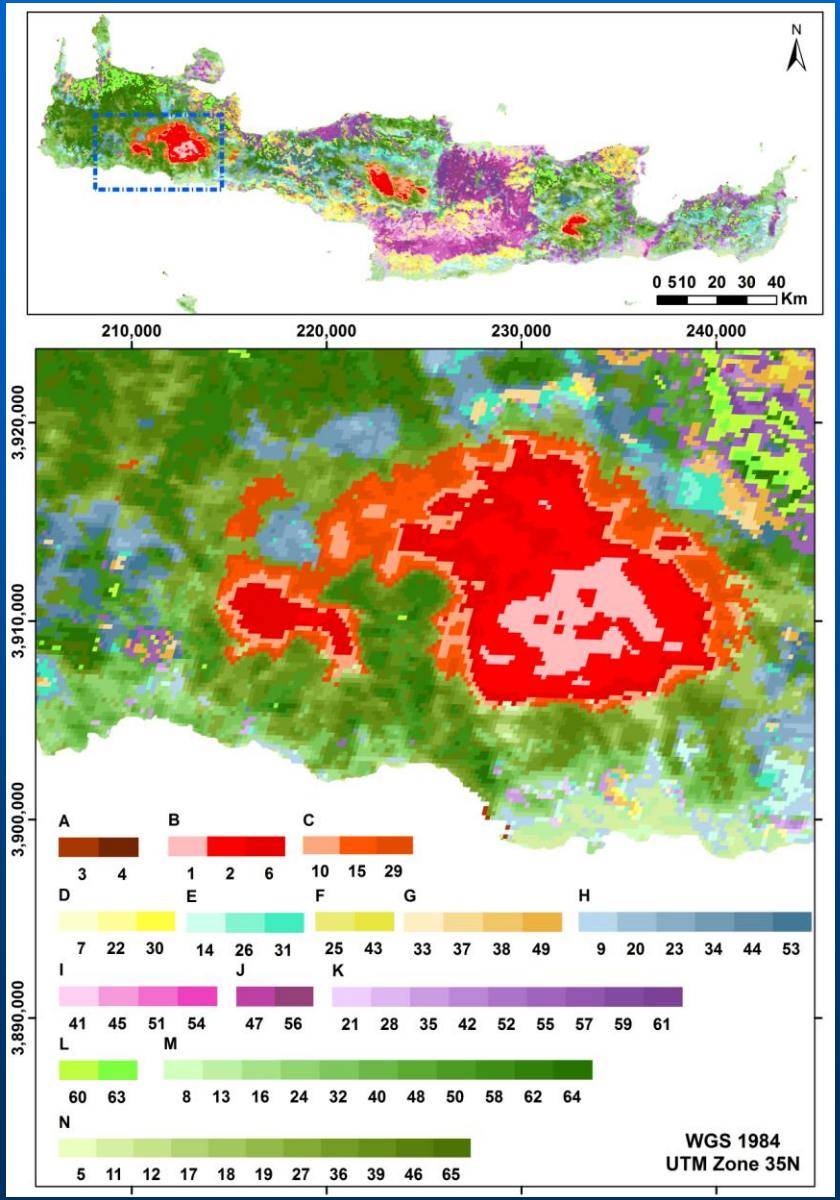
Results

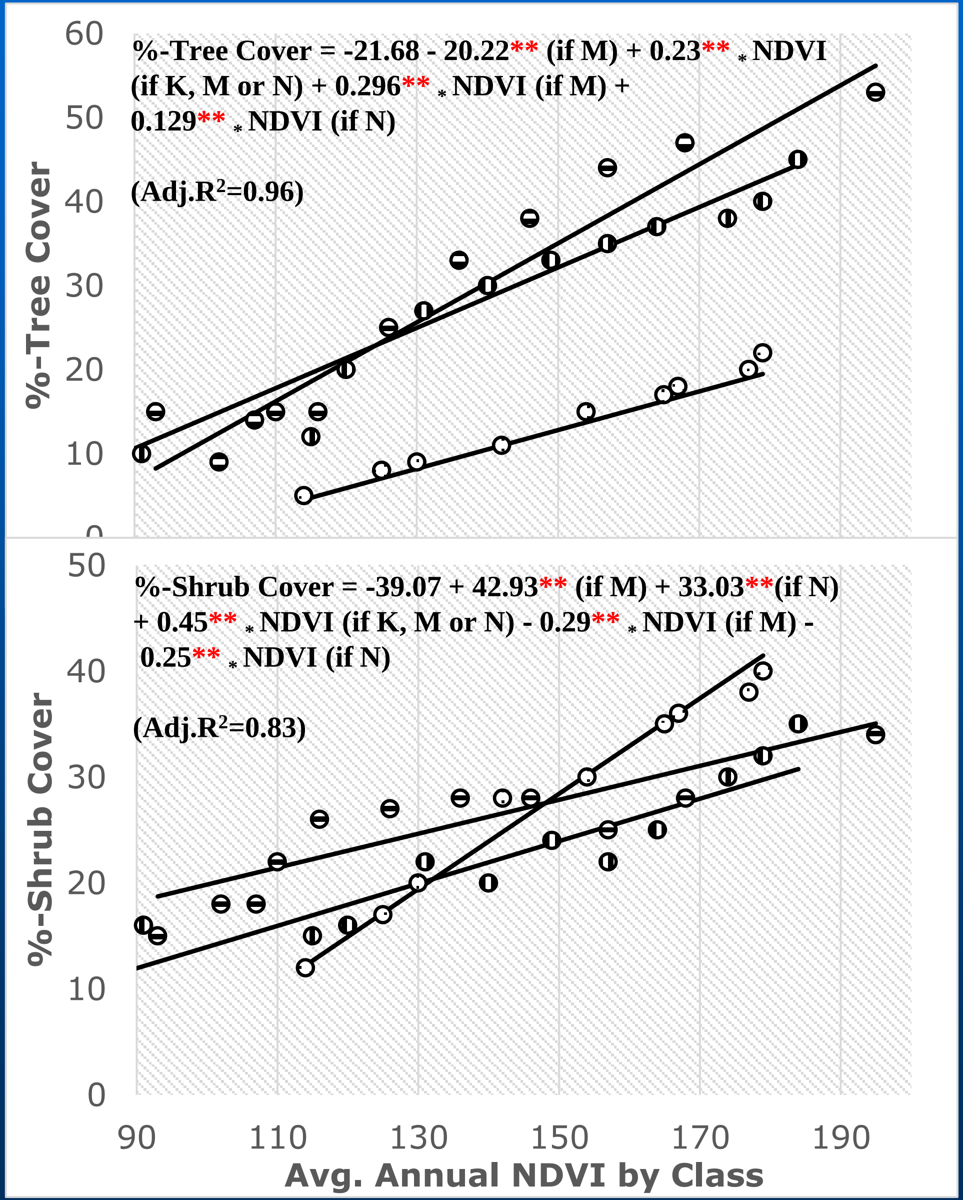


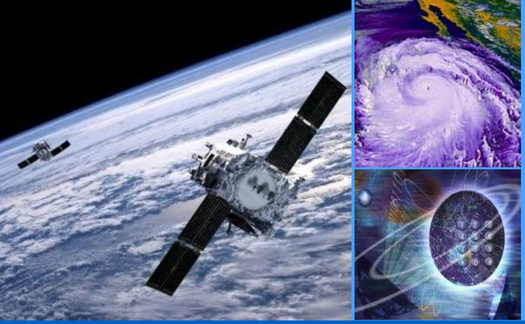
Annual average NDVI (DN value)
Groups
50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
A
B
C
D
E
F
G
H
I
J
K
L
M
N
3 4
1 2 6
10 15 29
7 22 30
14 26 31
25 43
33 37 38 49
9 20 23 34 44 53
41 45 51 54
47 56
21 28 35 42 52 55 57 59 61
60 63
8 13 16 24 32 40 48 50 58 62 64
5 11 12 17 18 19 27 36 39 46 65

Land cover gradients map

Validation Analysis





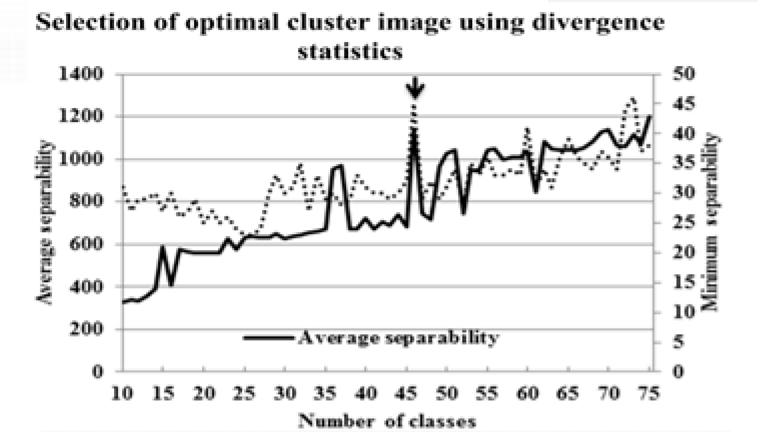


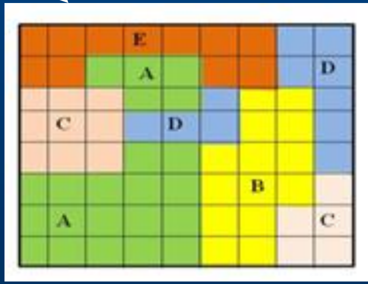
Specific objective 2

Land cover composition change detection method

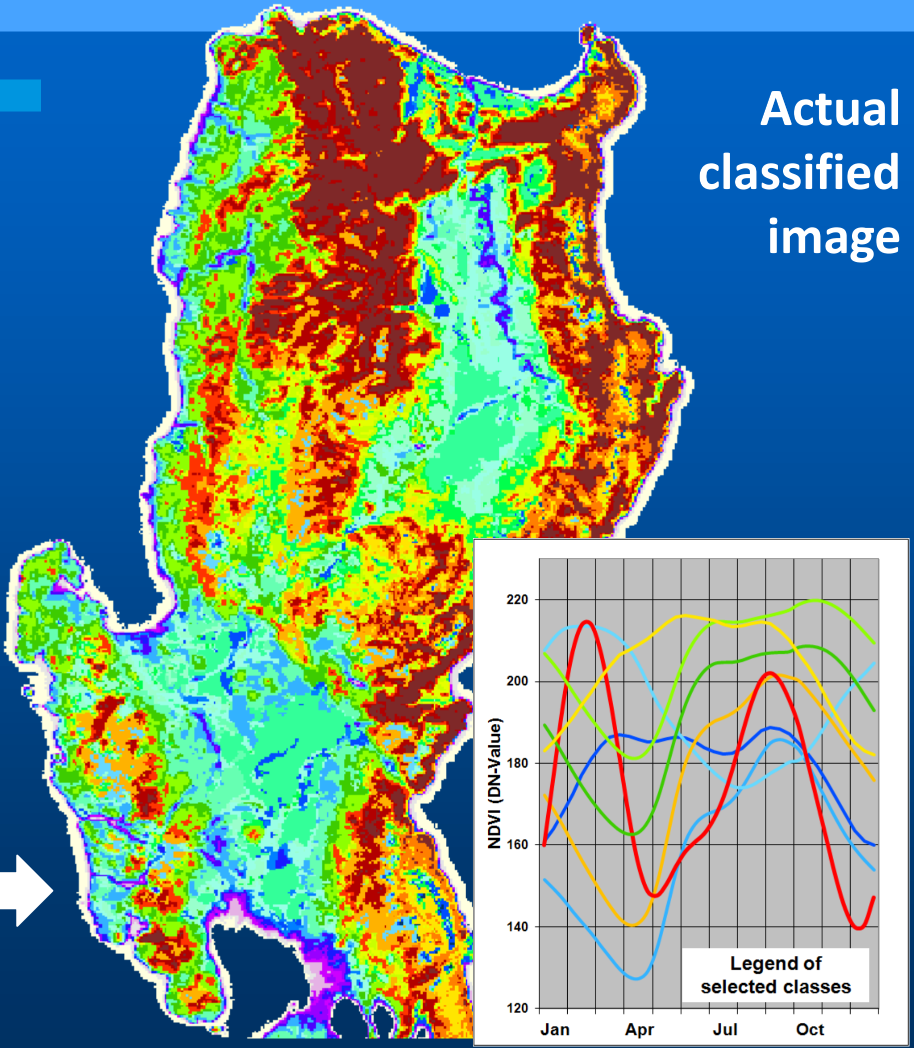
Step-1: Classify NDVI imagery of the reference time period

Processing SPOT NDVI (2000-2004) using Iterative Self Organizing Data Analysis (ISODATA) Technique





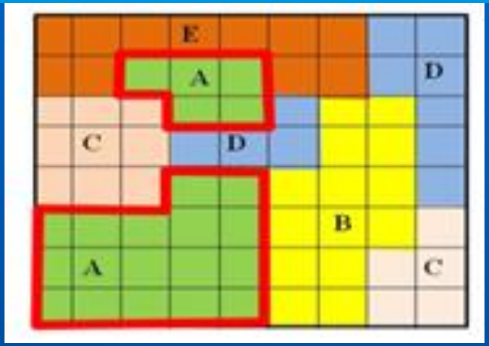
Graphical representation of classified image (each grid represent pixel of the actual classified image)



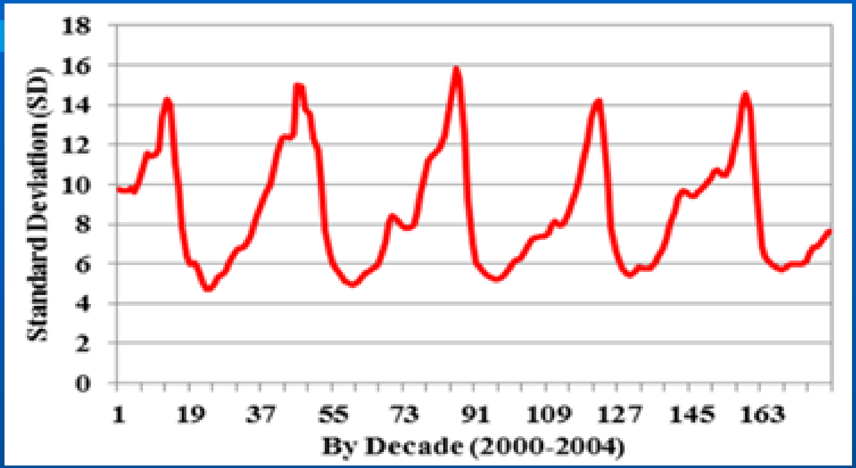
Actual classified image

SUPARCO

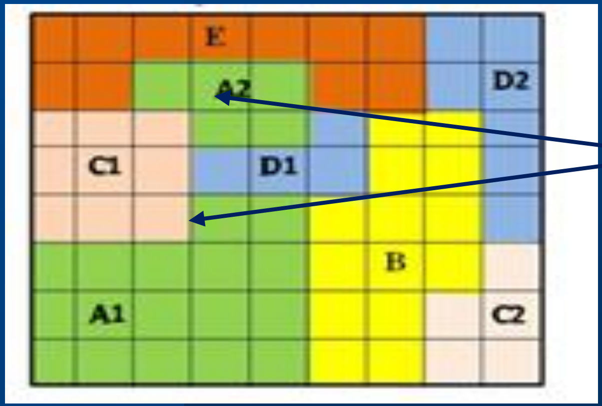
Step 2: Calculate by NDVI-class pooled-SD* values

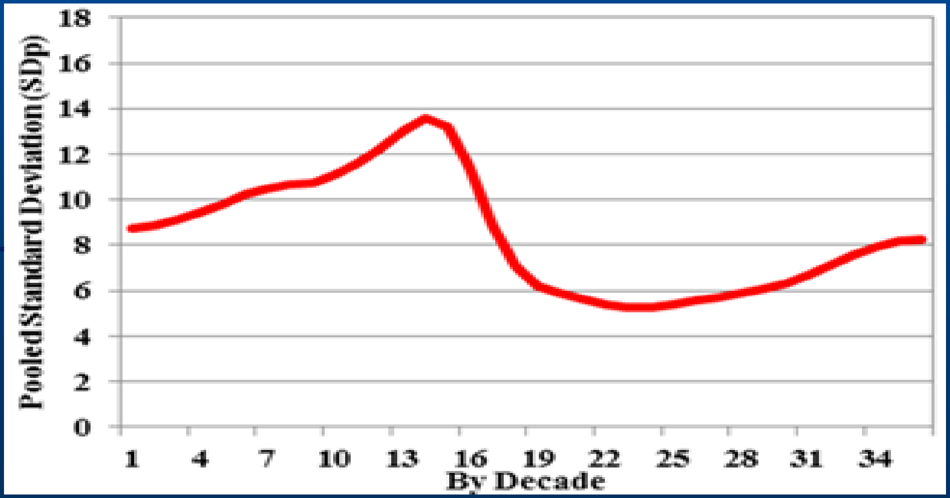


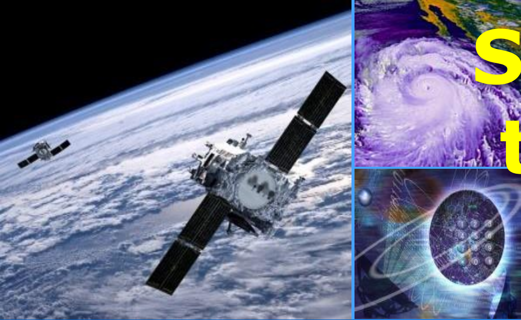
NDVI-Classes map



Apply the Pooled-SD values to individual map units



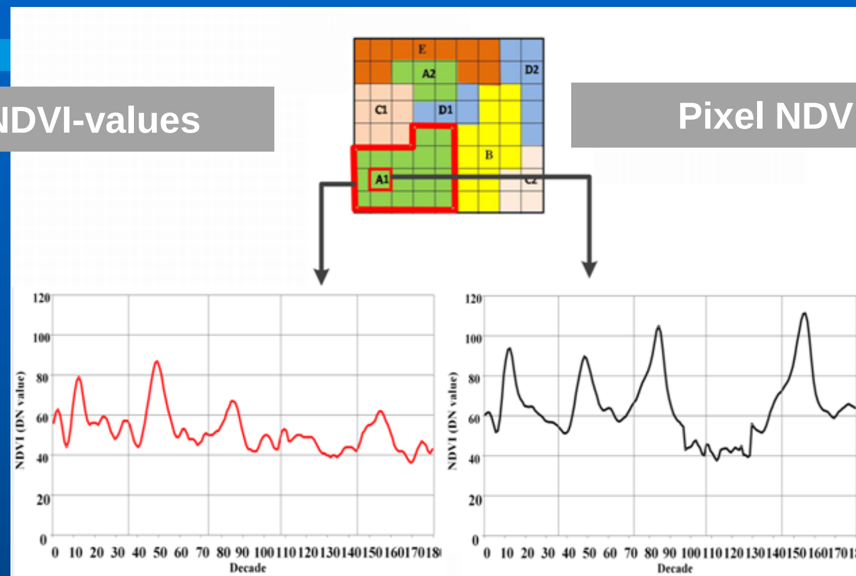




Step 3:Generate for each image of the "Change Assessment Period" a map of LULCCC-probability

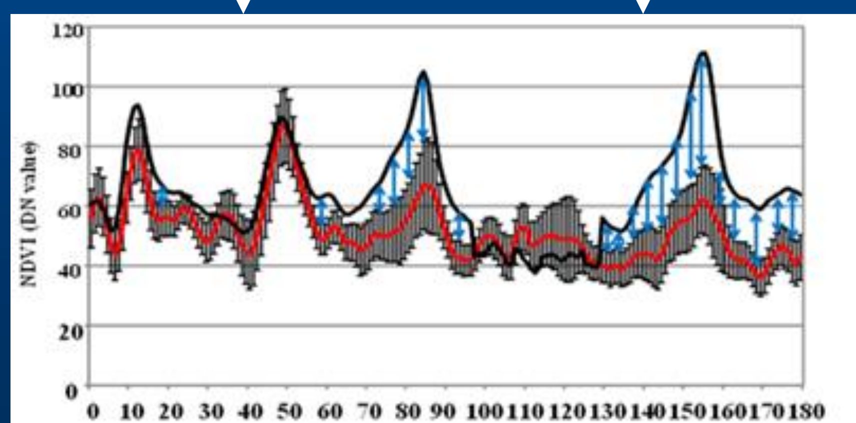
Map unit NDVI-values

Pixel NDVI-values



Now, seasonal aspects are removed !

± Pooled-SD

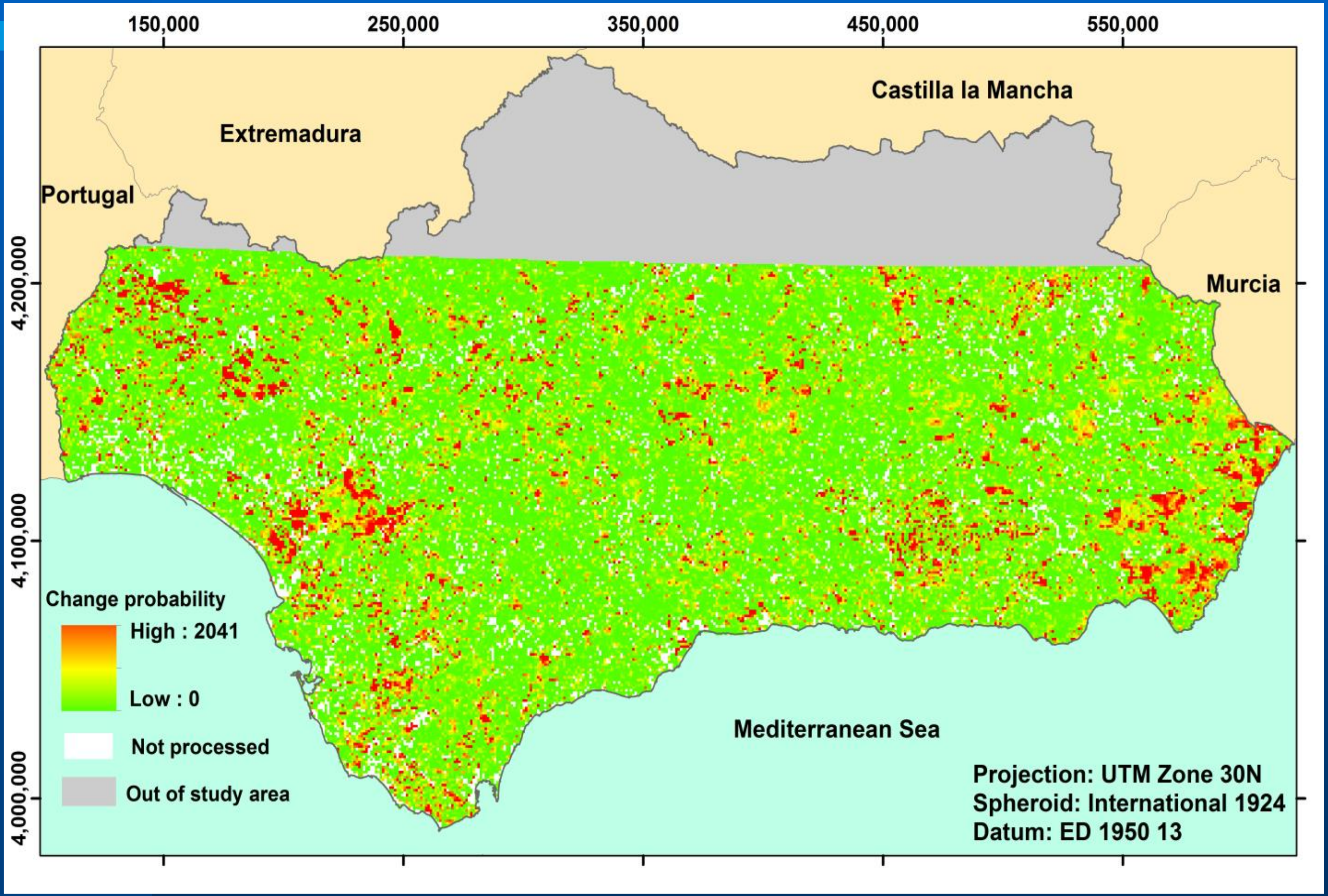


Decades where the pixel has LCCC probabilities

(more distance: higher probability)

SUPARCO

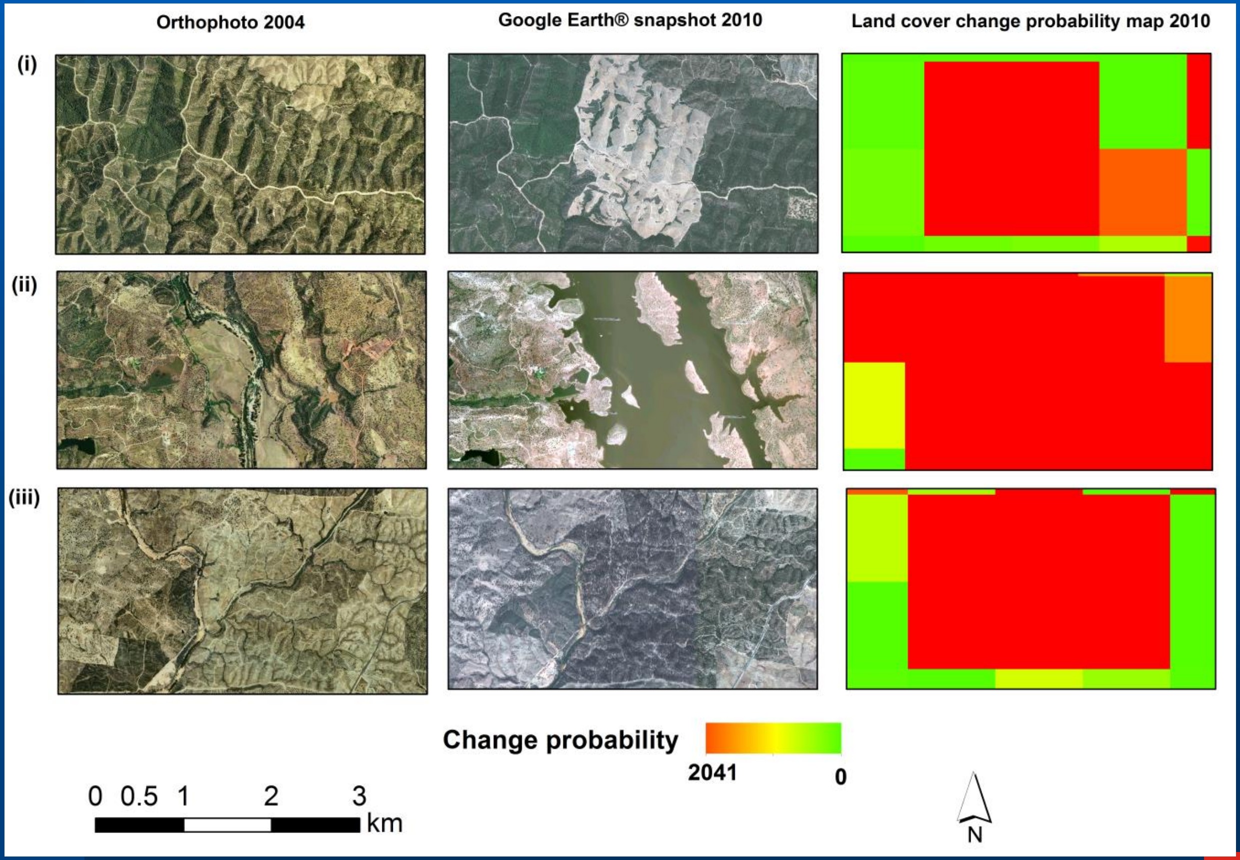
Step 4: Generalize step-3 results to periods



LULCCC-probability values map (sum of 36 decades)

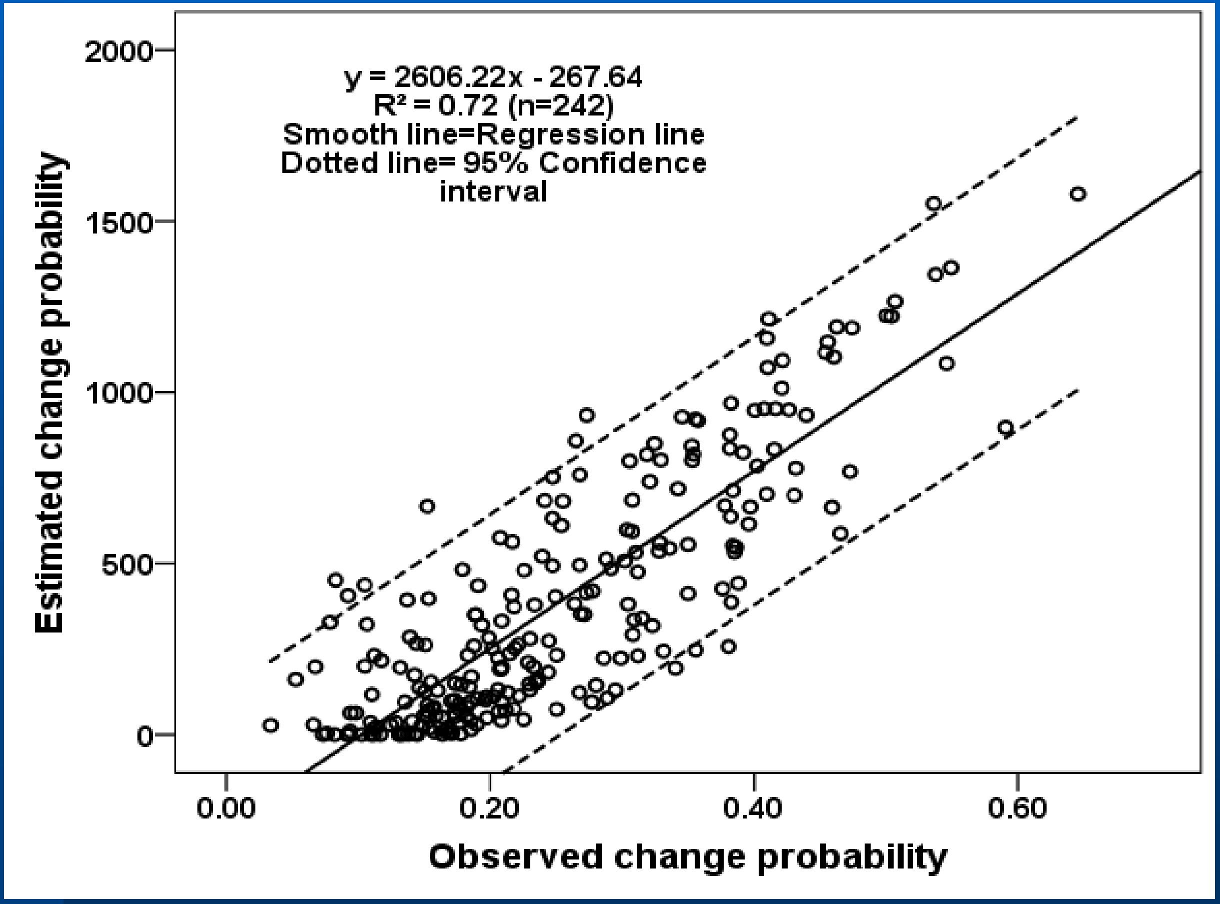
Case study ‘Andalucía’

Examples of land use/land cover composition change detection



SUPARCO

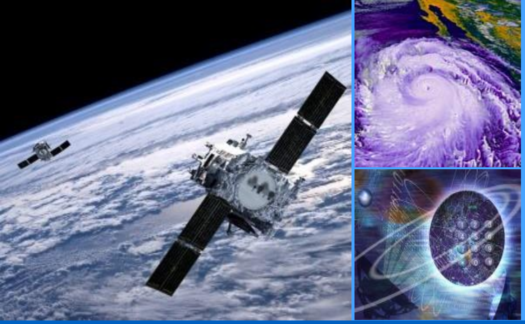
Case study ‘Andalucía’



SUPARCO

Conclusion

Through the use of hyper-temporal remotely sensed imagery the study succeeded to develop and test methods that support, complement and improve accuracies of land cover mapping and monitoring techniques.



Thanks