Forest Monitoring in Tropical Regions

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Content:

1. Background

Project in the frame of REDD

Reducing
Emissions from
Deforestation and Forest
Degradation

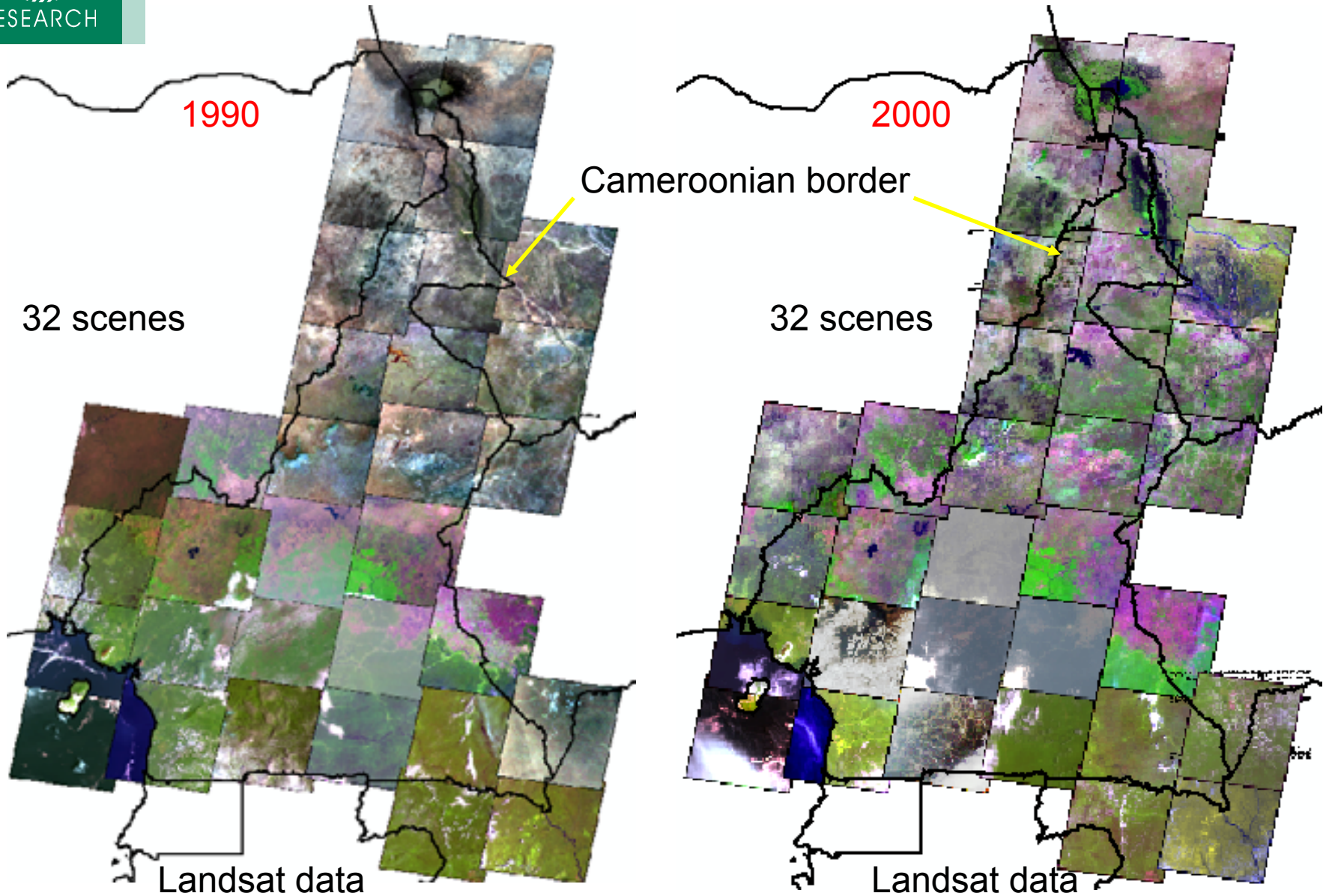
→ **post-Kyoto reporting**
→ **reducing green house gas (GHG) emissions**

Pilote project under the auspices of ESA and GMES Service Element Forest Monitoring (GSE-FM), performed together with GAF AG

Aim:
Develop a methodology for country-wide mapping of deforestation, classification of the deforested areas and classification of forest degradation

2. Data

Satellite data covering the whole country of Cameroon



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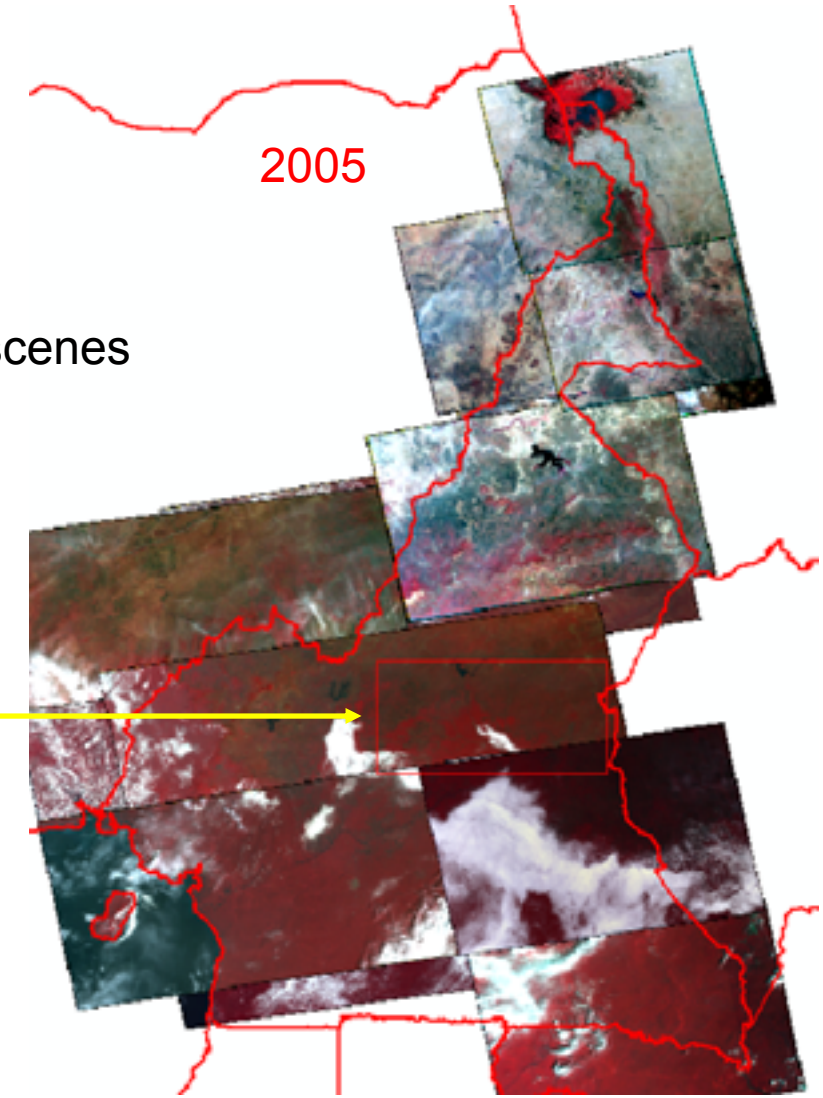
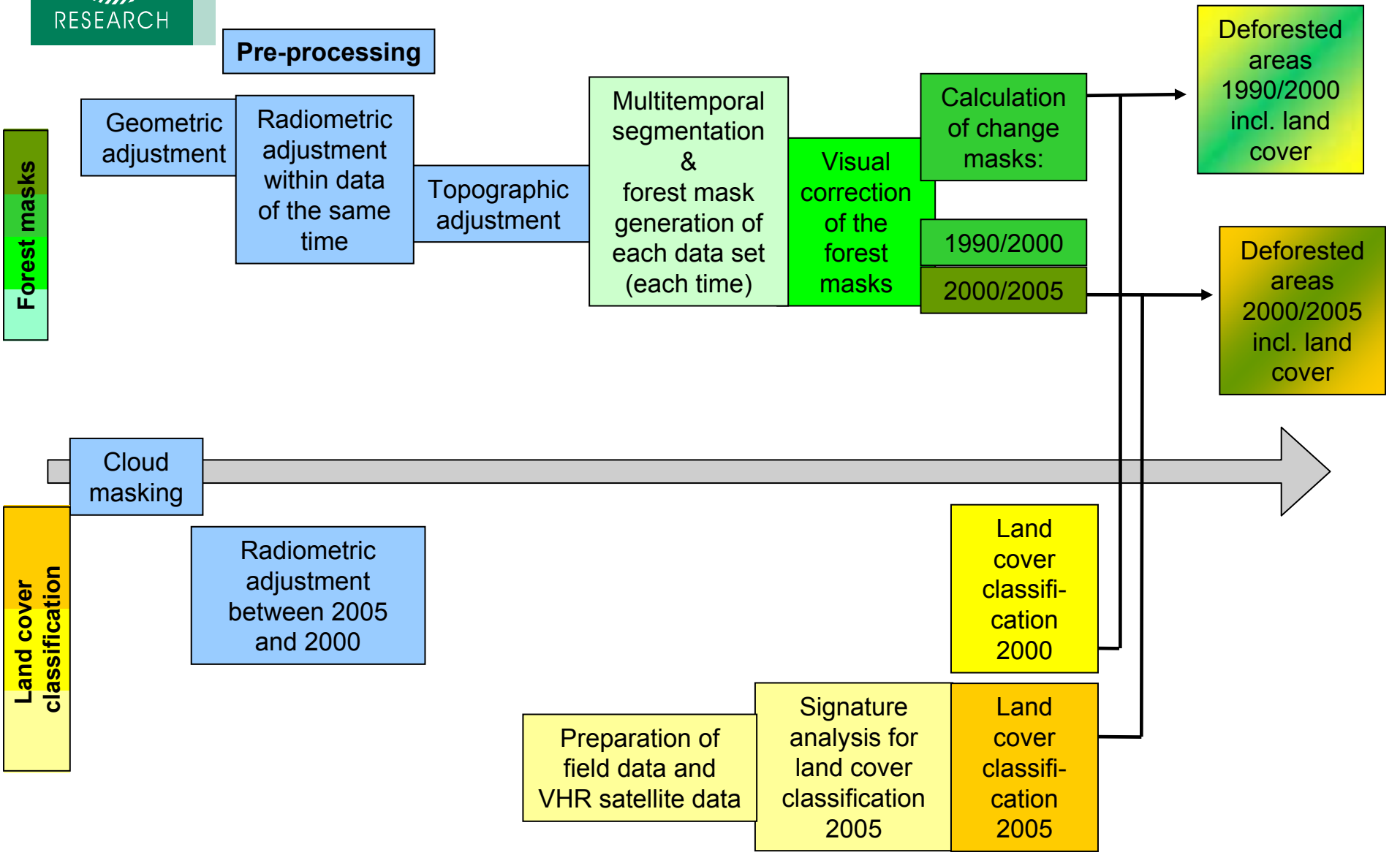


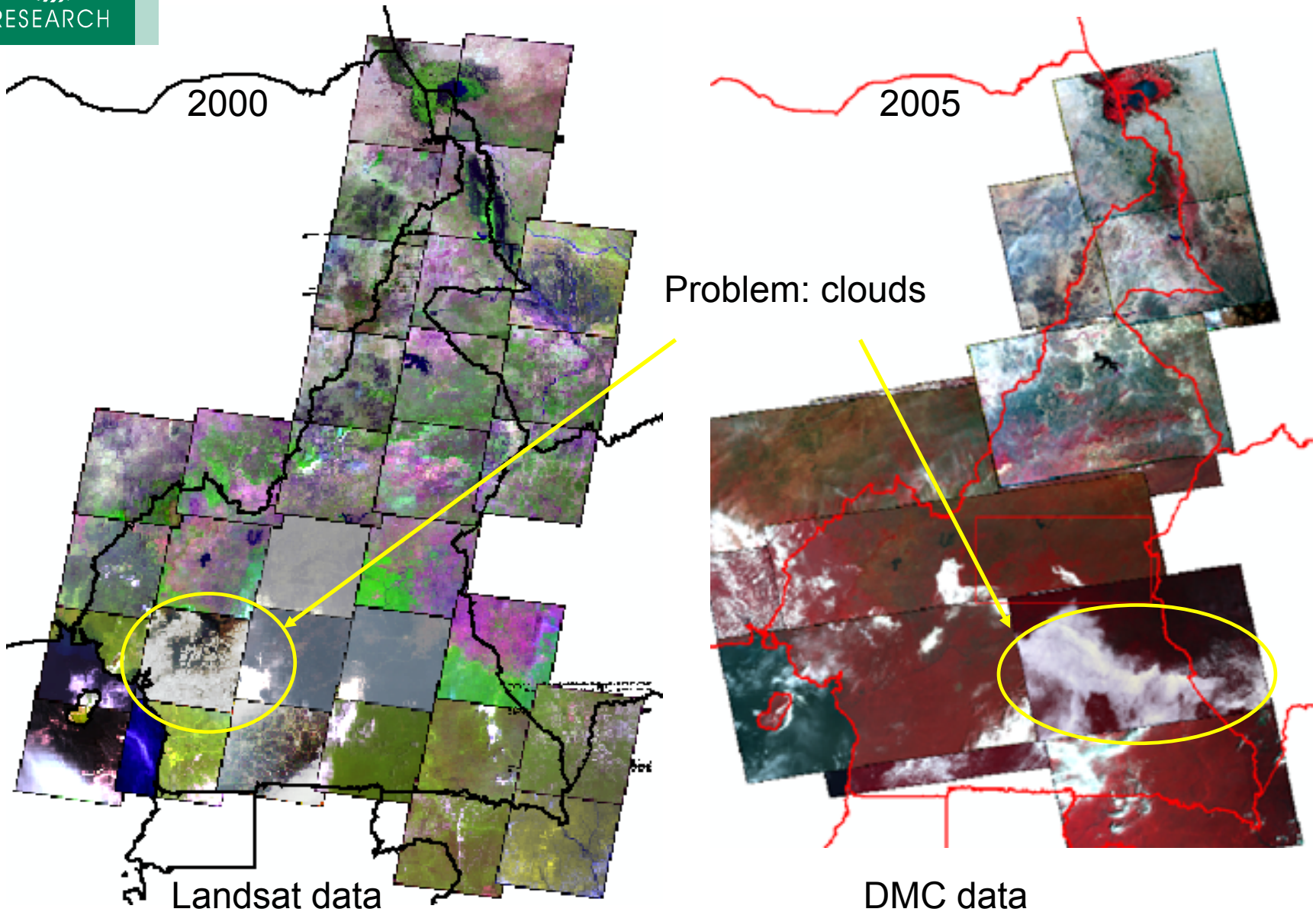
DMC data

3. Methods

Processing chain deforestation and land cover classification



3. Methods



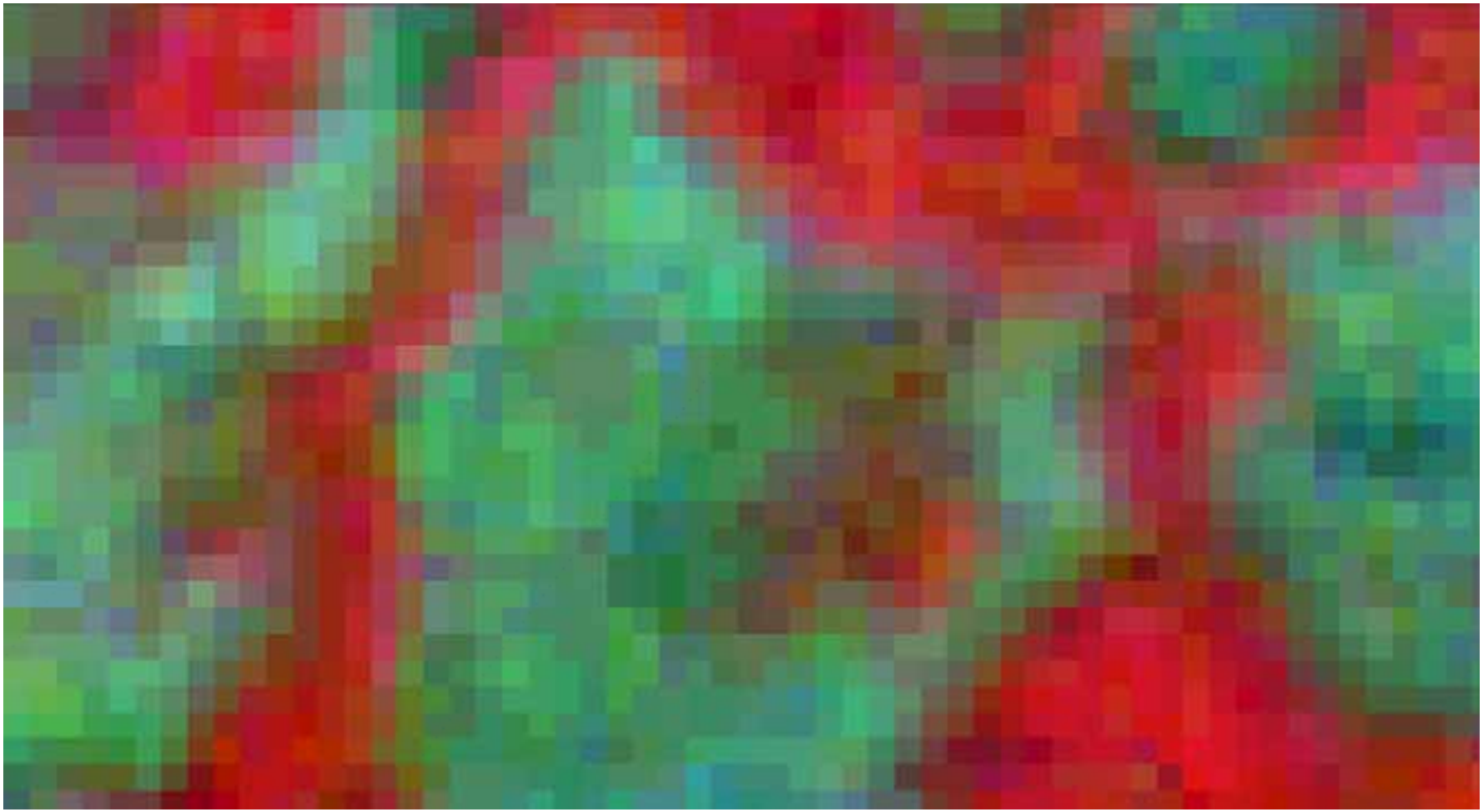
Cloud and cloud shadow masking

Cloud shadow masking – semiautomatically
(morphological operation & manual correction)

3. 1. Pre-processing

Geometric adjustment with „Fine registration“ = fully automatical local adjustment based on image matching

Adjusted data from 2005



Radiometric adjustment

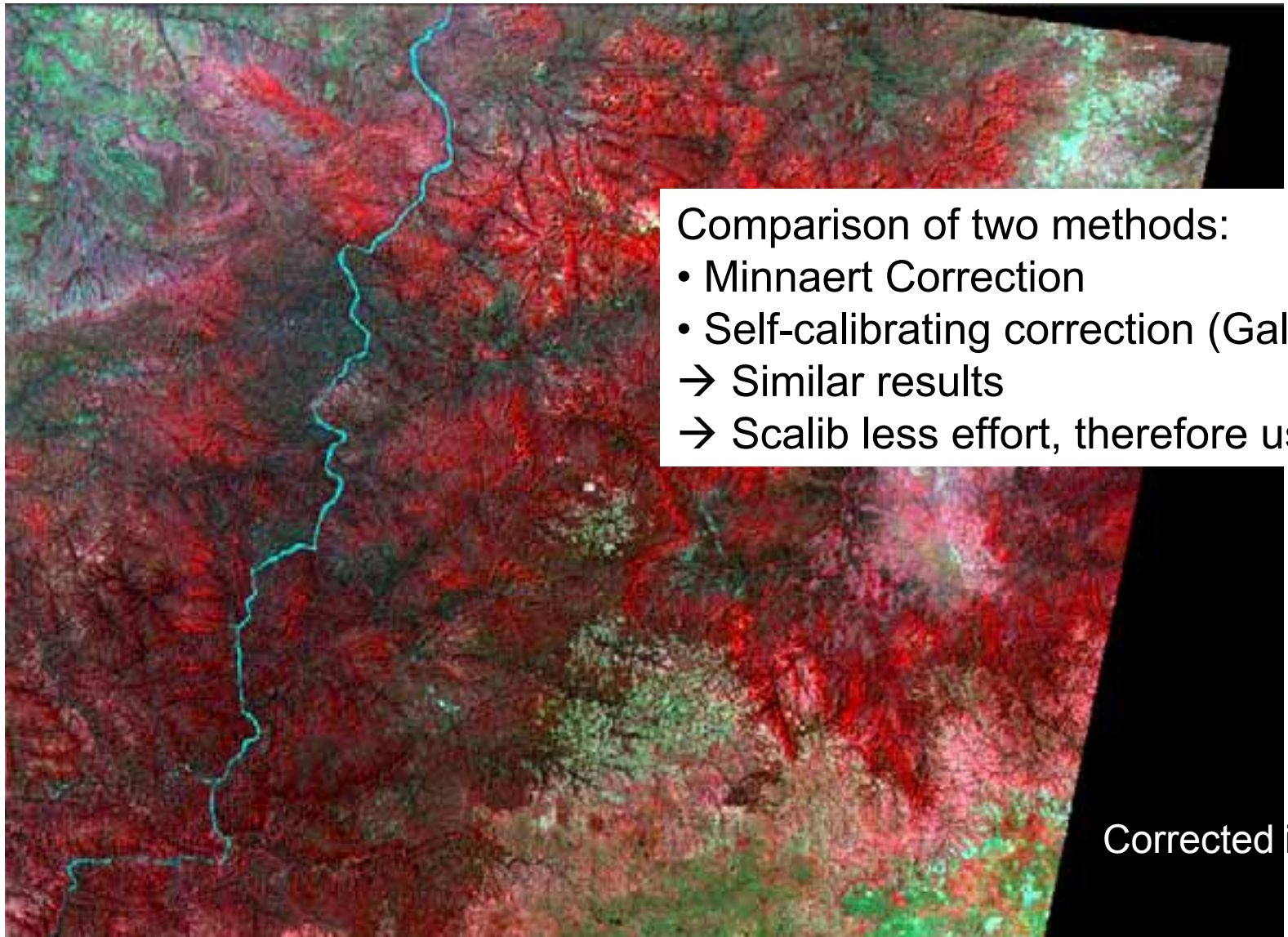
Neighboring images after radiometric adjustment

Comparison of two methods: Linear regression and Histogram matching

Band	Difference between A_{orig} and B_{orig}	Difference between A_{orig} and B_{linreg}	Difference between A_{orig} and $B_{histmatch}$
1	4,04	3,17	1,21
2	1,94	1,62	0,84
3	3,54	3,79	1,49
4	7,75	5,77	4,42
5	11,71	5,67	7,52
6	4,15	2,75	1,58

3. 1. Pre-processing

Topographic Normalization to generate similar signatures on the south- and north-facing slopes



Comparison of two methods:
- Minnaert Correction
- Self-calibrating correction (Gallaun)

→ Similar results
→ Scalib less effort, therefore used

Corrected image

3. 2. Segmentation

Multitemporal segmentation vs. pixel-based analysis

Multitemporal segmentation

- filtering and segmentation effort
- only 1 information per segment

+ robust to slight geometric in-consistencies
+ radiometrically more robust
+ targeted elimination of segments with certain properties (size, shape)
+ easier manual interaction

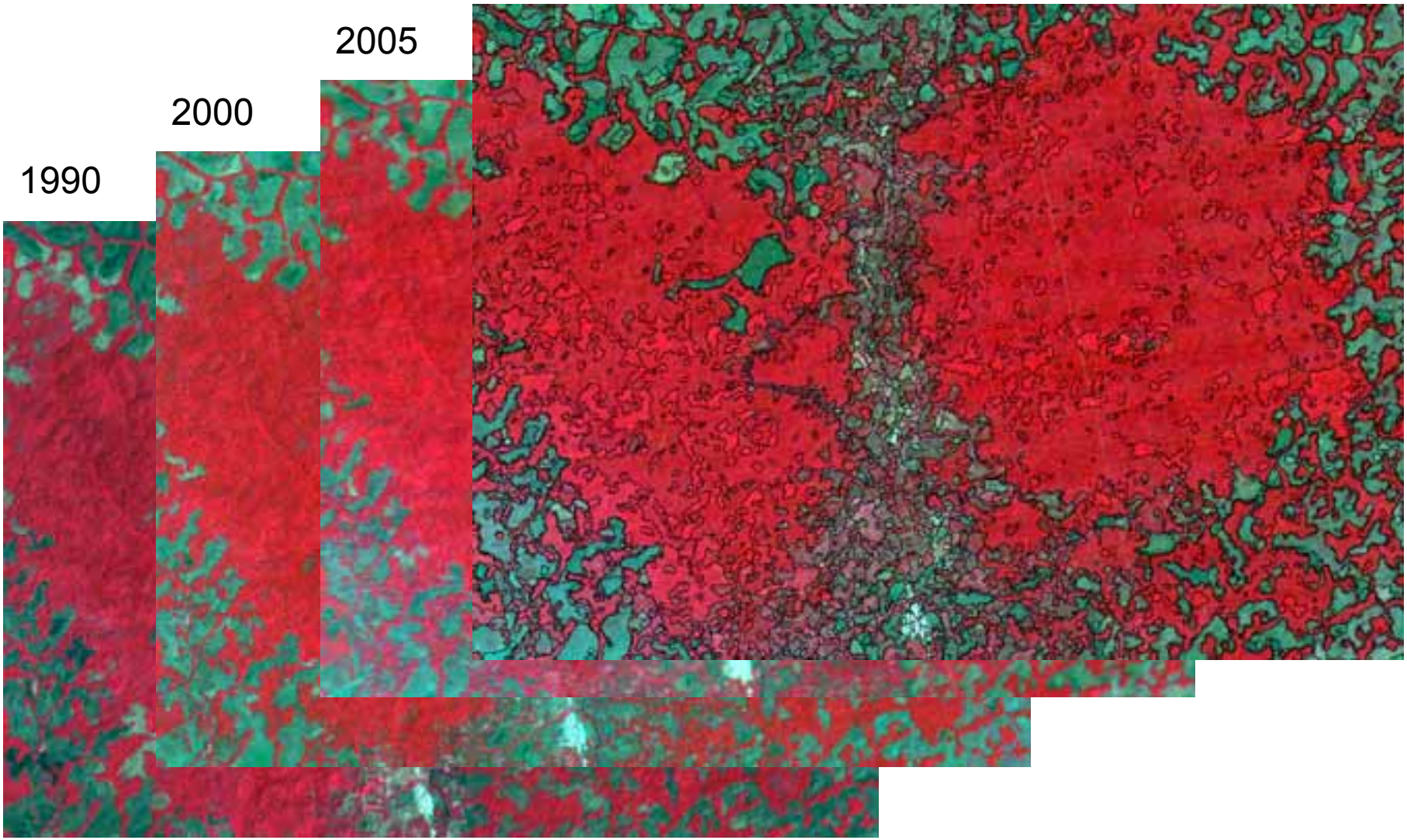
Pixel-based analysis

+ fast
(+) more details (MMU = 1 Pixel)

- errors due to geometric inconsistencies
- „Salt and Pepper“ effect
- manual interaction difficult

Multitemporal segmentation

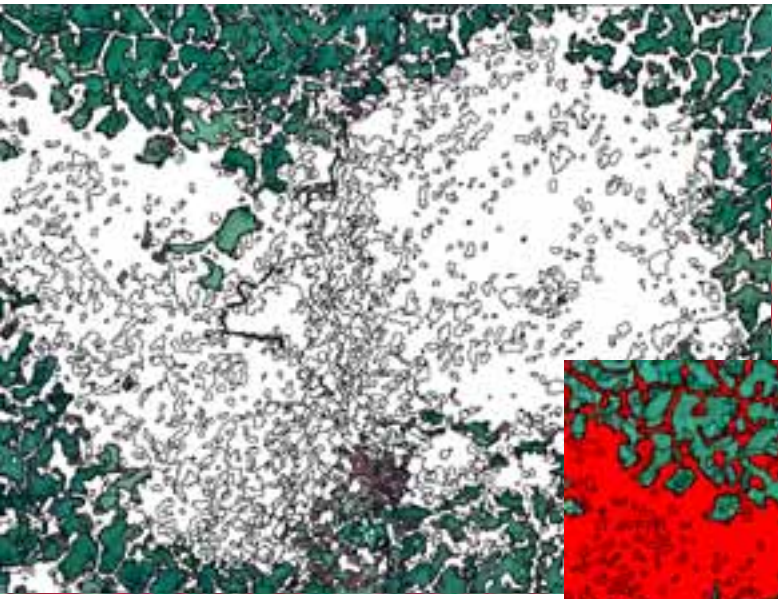
Layerstack, filtering and region growing segmentation



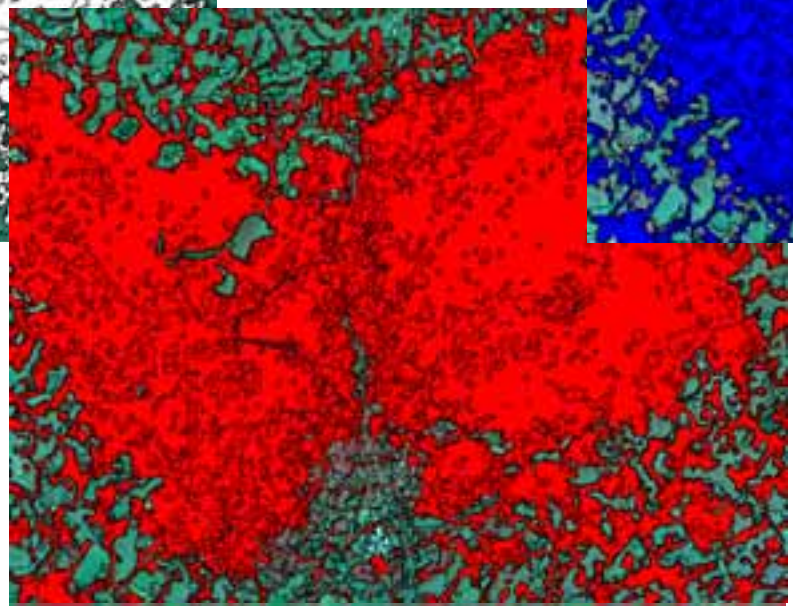
3. 3. Classification I

Semi-automatic **forest/non-forest** classification for each time based on the segments

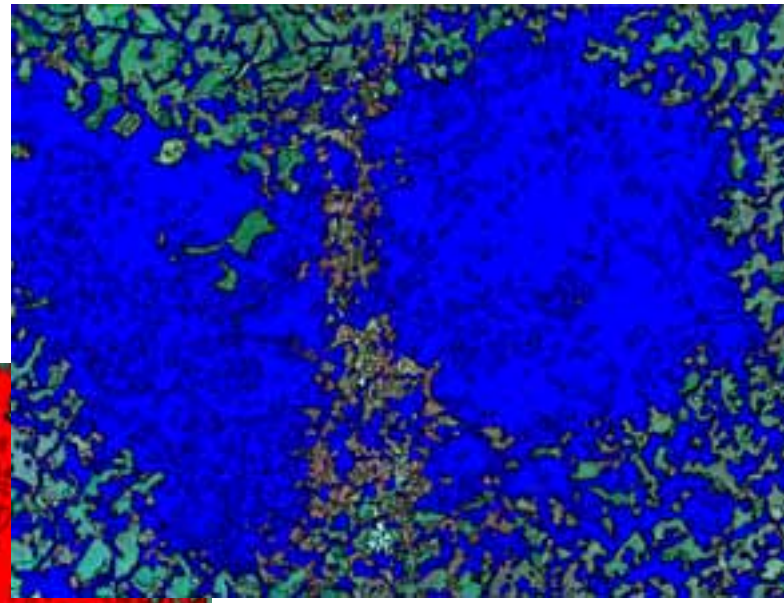
forest mask 1990



forest mask 2000



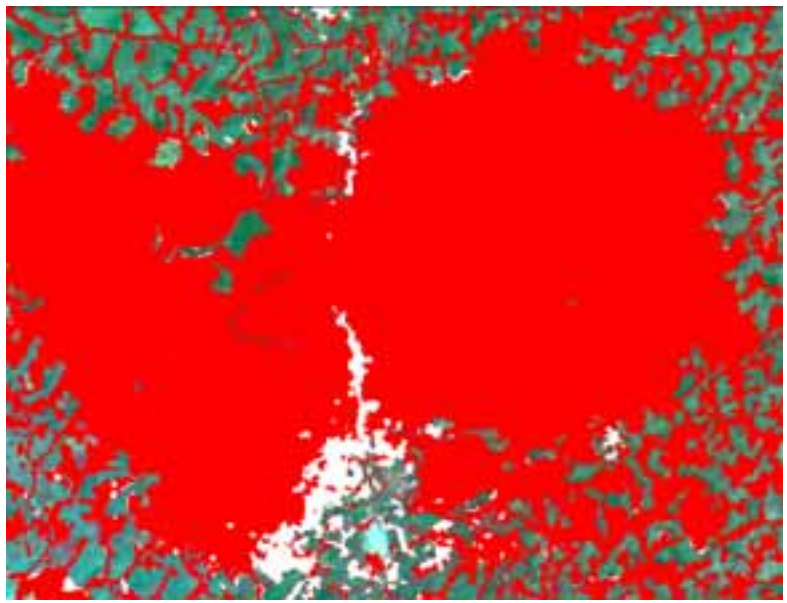
forest mask 2005



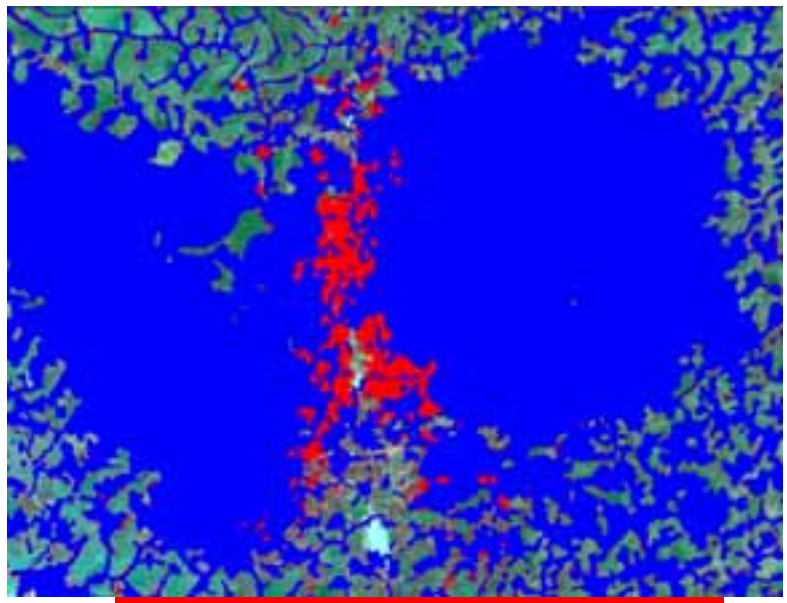
3. 2. Classification I

Selection of **deforested areas** for both epochs
→ Calculation of areas for each combination (90-00, 00-05, 90-05)

forest mask 1990 **forest mask 2000** **forest mask 2005**



change mask 1990/2000 (white)



change mask 2000/2005 (red)

Land cover classification – preparation of training data

Two sources:

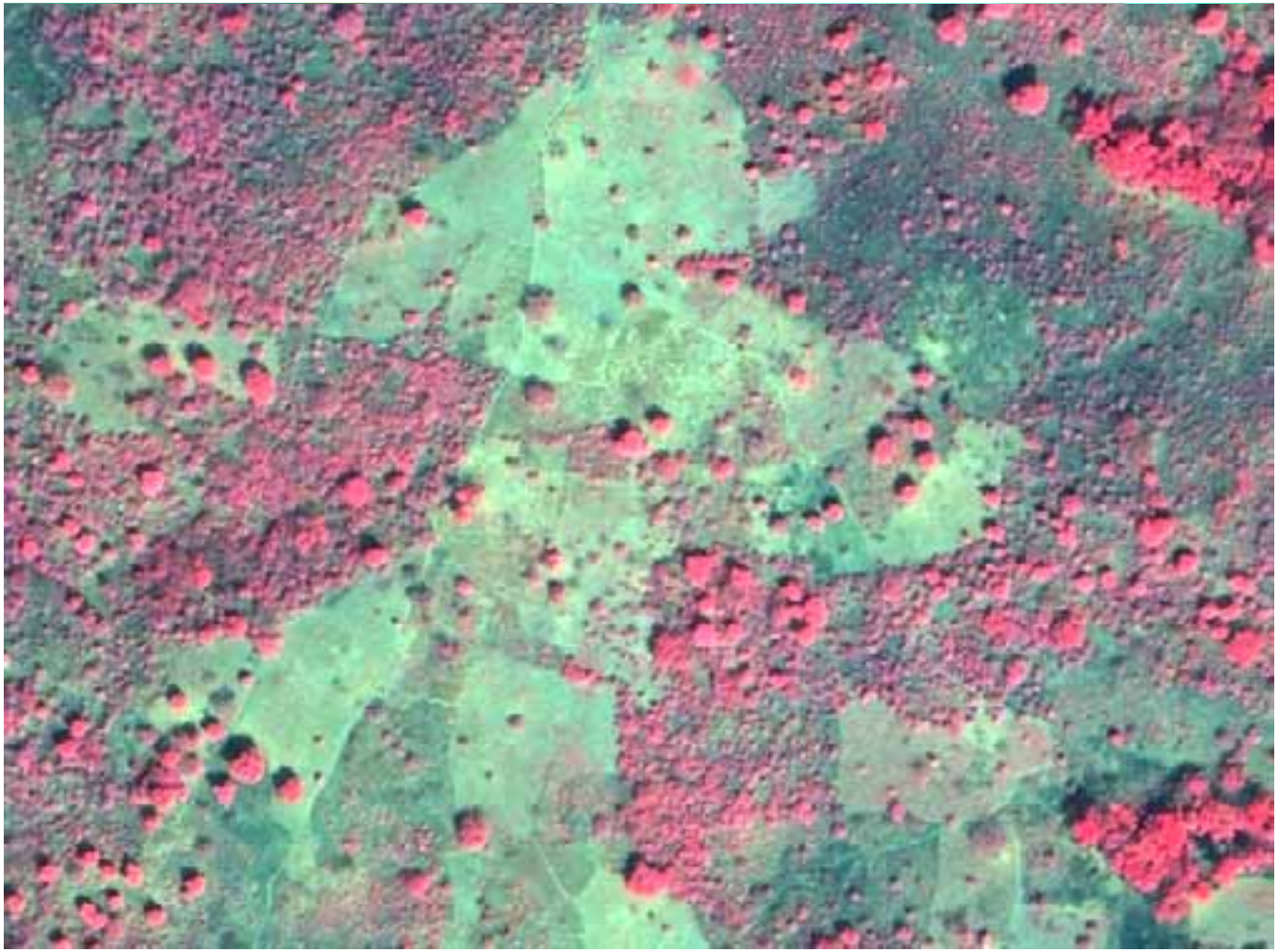
A) Very high resolution satellite data

B) Field work

Land cover classification – preparation of training data

A) Very high resolution satellite data – e.g. Quickbird

Quickbird data



Land cover classification – preparation of training data

B) Field work

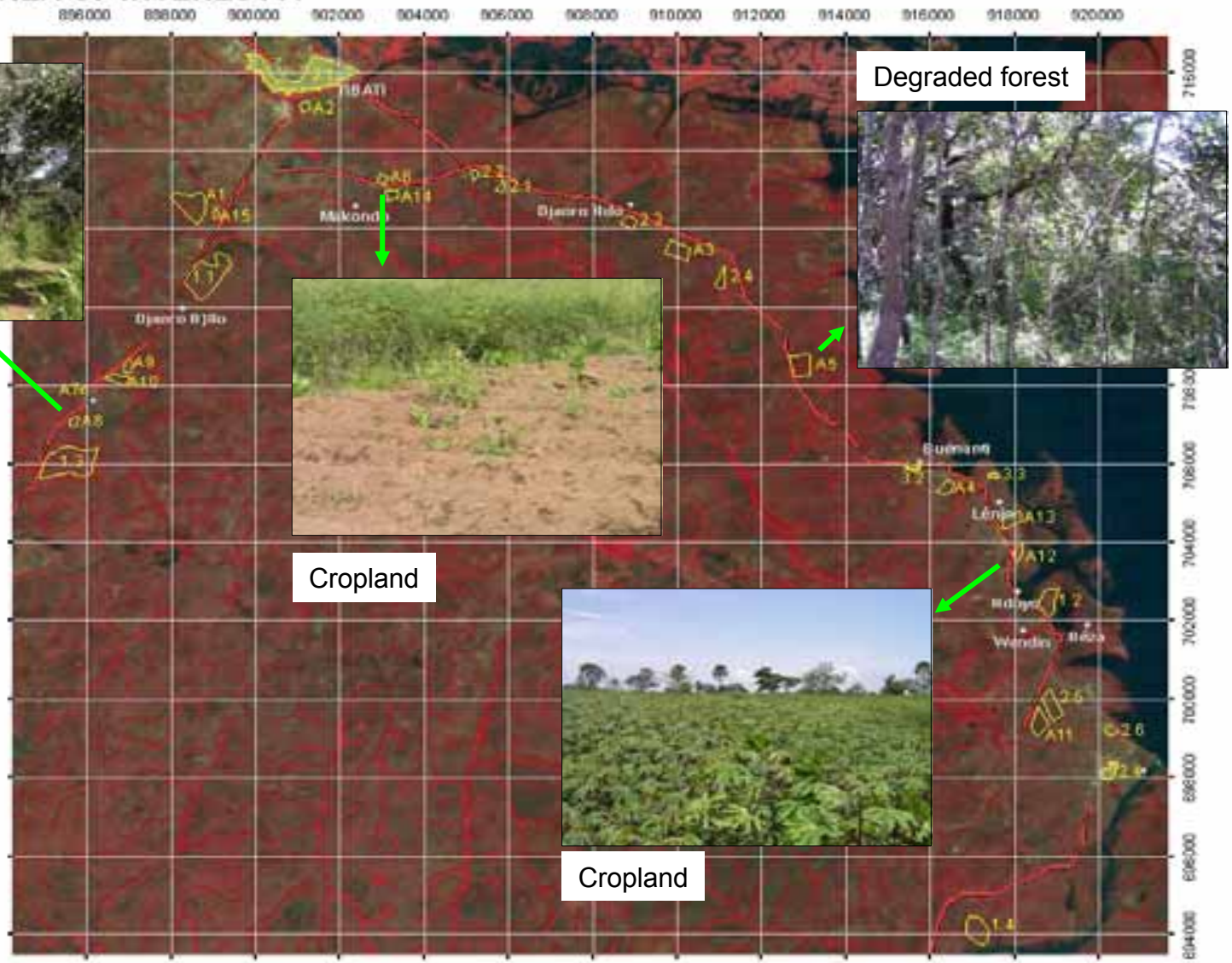
2a

Shrubby savanna

Degraded forest

Cropland

Cropland

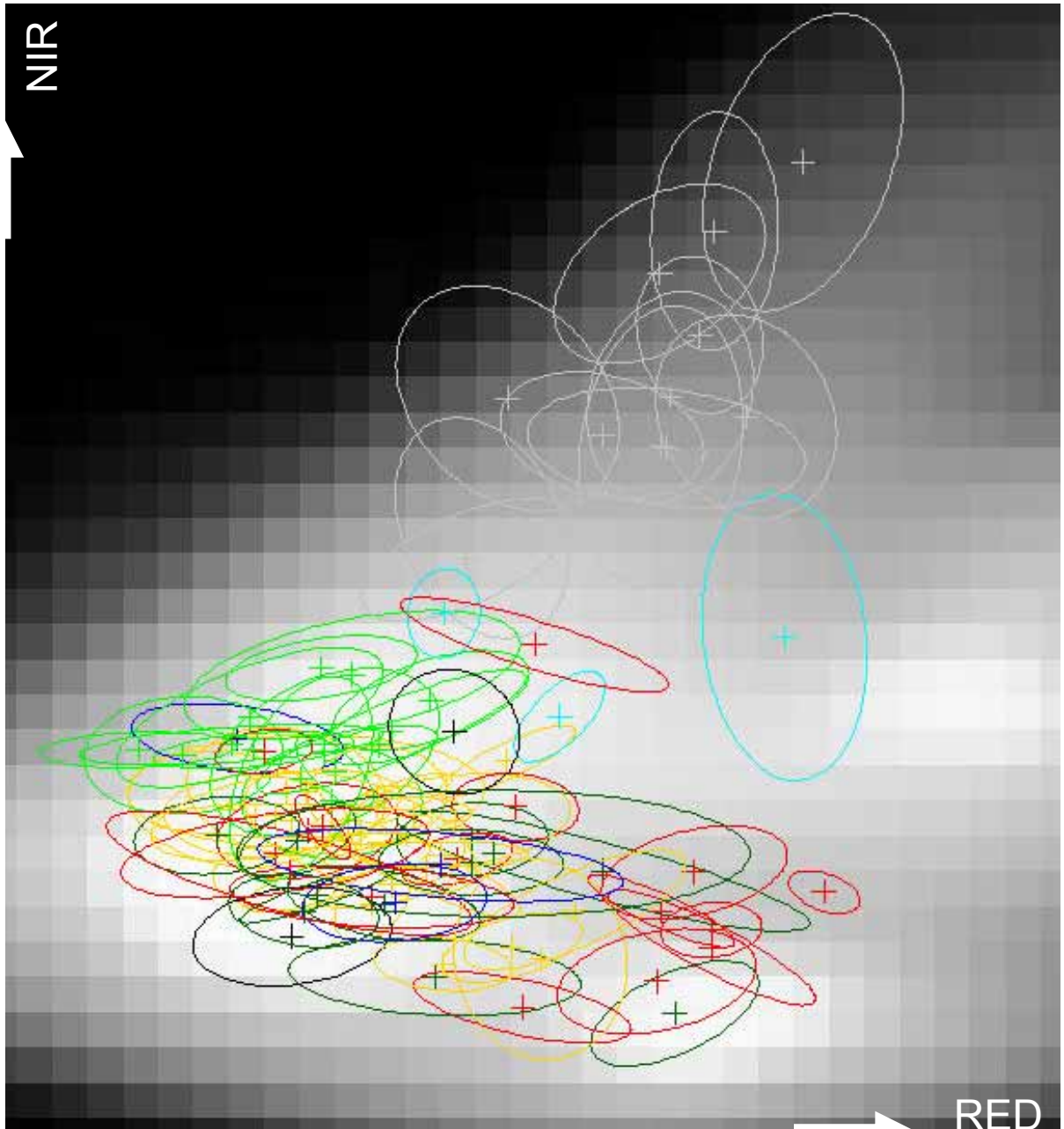


3. 2. Classification II

Original field data →

Problems:
- too many mixed pixels
- some classes not covered
- sometimes errors in naming (shrubland / secondary forest / …)

Solution:
- Careful signature analysis
- Sorting out mixed pixels
- Searching for „pure“ areas
- Including additional areas from Quickbird data



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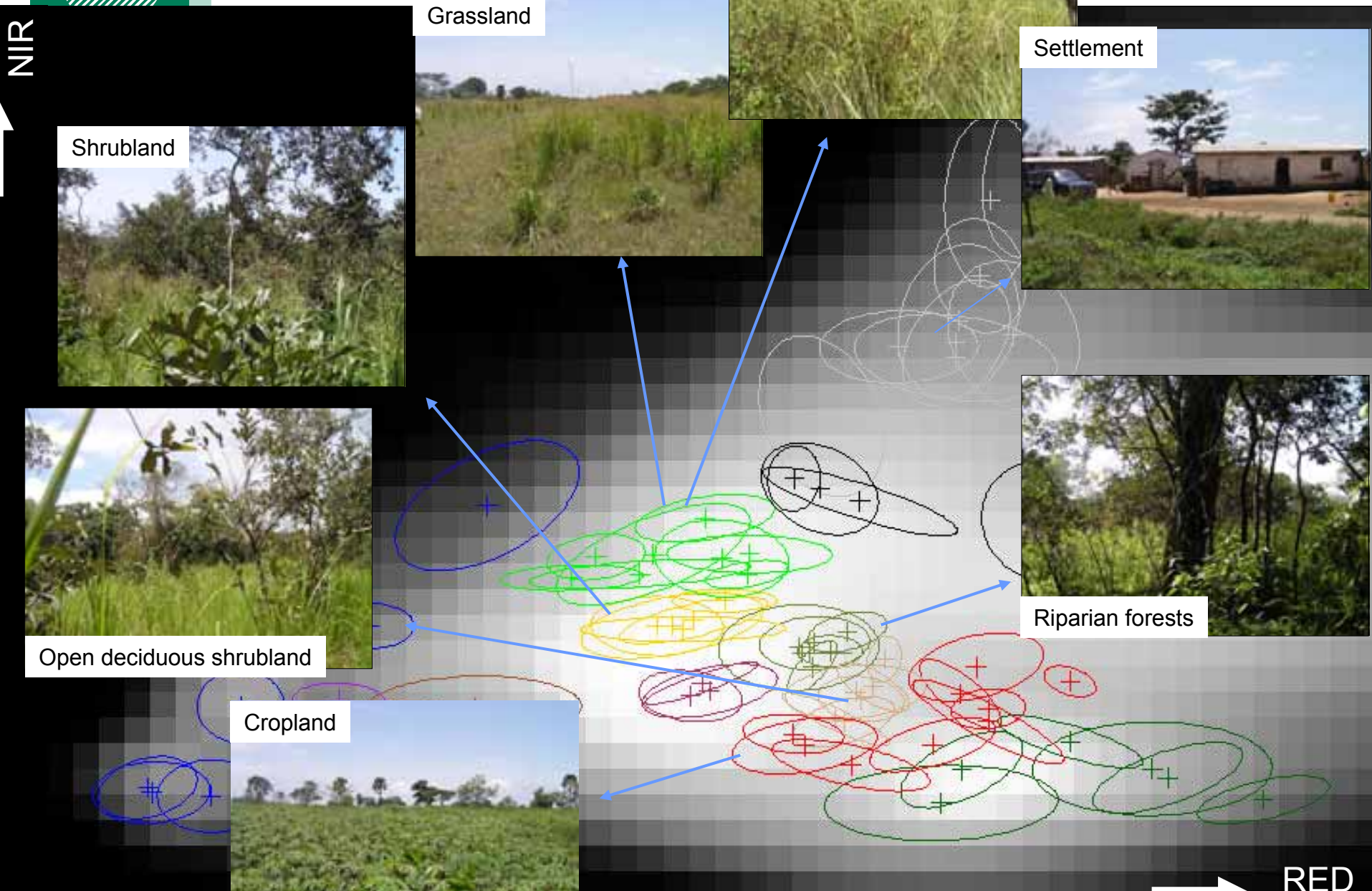
GAF AG



3. 2. Classification II

Challenge: Shifting cultivation
Cropland – Grassland - Scrubland – Forest???

Field work: „abandoned farmland“

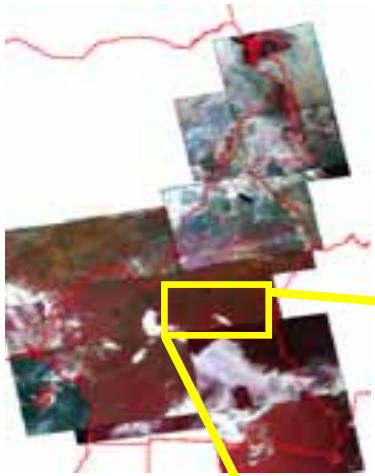
Human usage

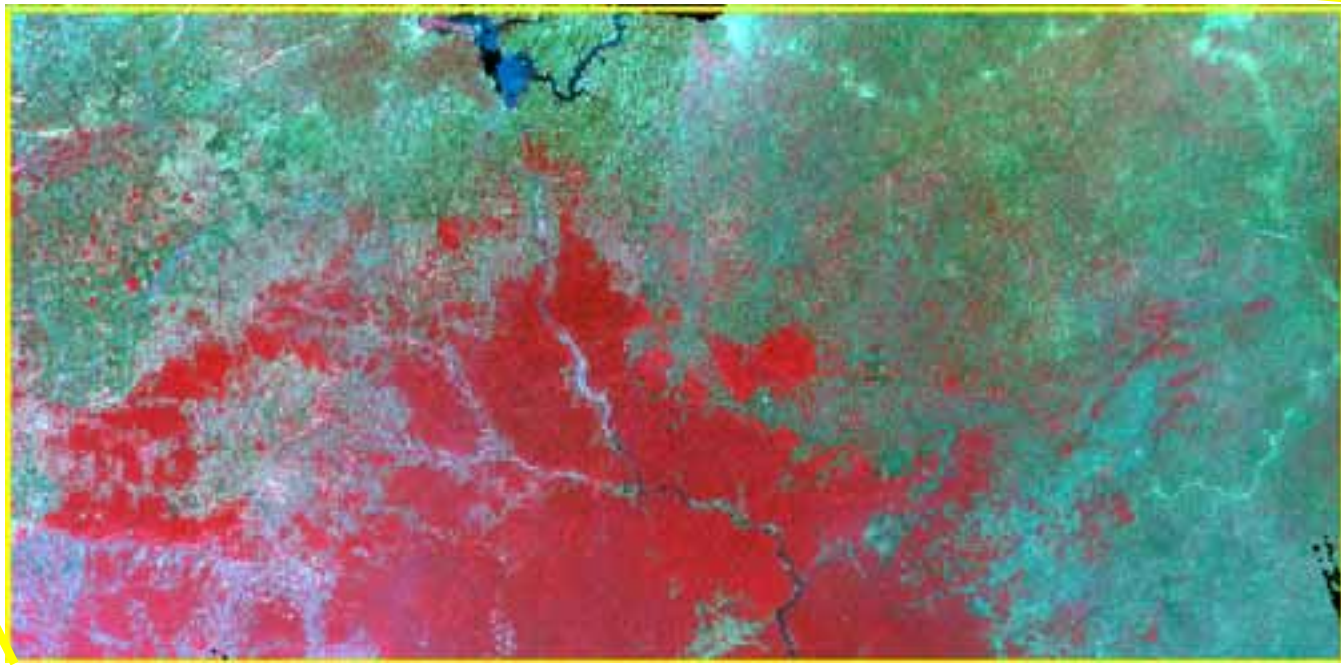
Transition: different succession stages

Secondary forest (partly with signs of abandoned farms)

4. Results

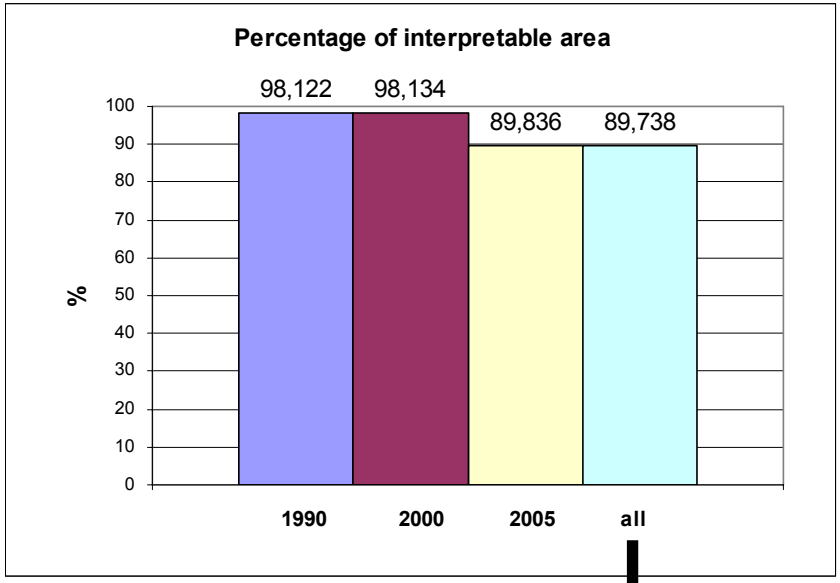
Test site area: 44.691 km^2
Vegetation: transition area between closed evergreen forests and savanna
Data used in the analysis:
- 2 Landsat images from 1990
- 2 Landsat images from 2000
- 1 DMC image from 2005





4. Results

Result of cloud masking and deforestation mapping



→ Moderate Deforestation (Forest definition FAO: 10% crown coverage!)
→ Small net change
→ Degradation more important than deforestation

	sum [km²]	% of interpretable all
Forest 90	15219,826	37,69
Forest 00	15038,647	37,24
Forest 05	15097,321	37,39
Deforestation 90_00	617,853	1,53
Reforestation 90_00	436,675	1,08
Deforestation 00_05	525,307	1,30
Reforestation 00_05	583,981	1,45
net_change90_00	-181,179	-0,45
net_change00_05	58,674	0,15

Conclusions:

→ Methodology successfully implemented

→ Deforestation and land cover classification for testsite completed

Challenges:

→ Clouds and cloud shadow detection

→ Better and automatic radiometric adjustment & mosaicking

→ Classification of transition classes
cropland – grassland – scrubland – secondary forest

Outlook – ongoing work:

→ Degradation studies with additional Quickbird – SAR data

→ Training course for local people to educate them in gathering training- and verification data for both land cover classification and degradation issues

→ Roll-out for whole Cameroon (and ev. other countries of the Congo region)

→ Find alternative data or procedures to cover the clouded areas

Thank you for your attention!

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