ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Evaluation of possible Cartographic and Remote Sensing methods for detecting temporal changes in the urban area in the Alpine Region

Yurate Plyushkayvichyute

Geomatic and Planning MSc

Outline

- Goal and Motivation
- Study area
- Methodology
- Results of implementation of the methods
  - Cartographic Approach
  - Remote Sensing approach
- Evaluation of both results
- Conclusions

WUI (Wildland-Urban Interface)-CH project

I-st phase:

- Evaluation of the utility of derived information from spaceborne remote sensing for monitoring and mapping WUI in Alpine region

II-nd phase:

- Processing for more detailed investigations in order to access better characteristics of the spatial and temporal evolution of WUI

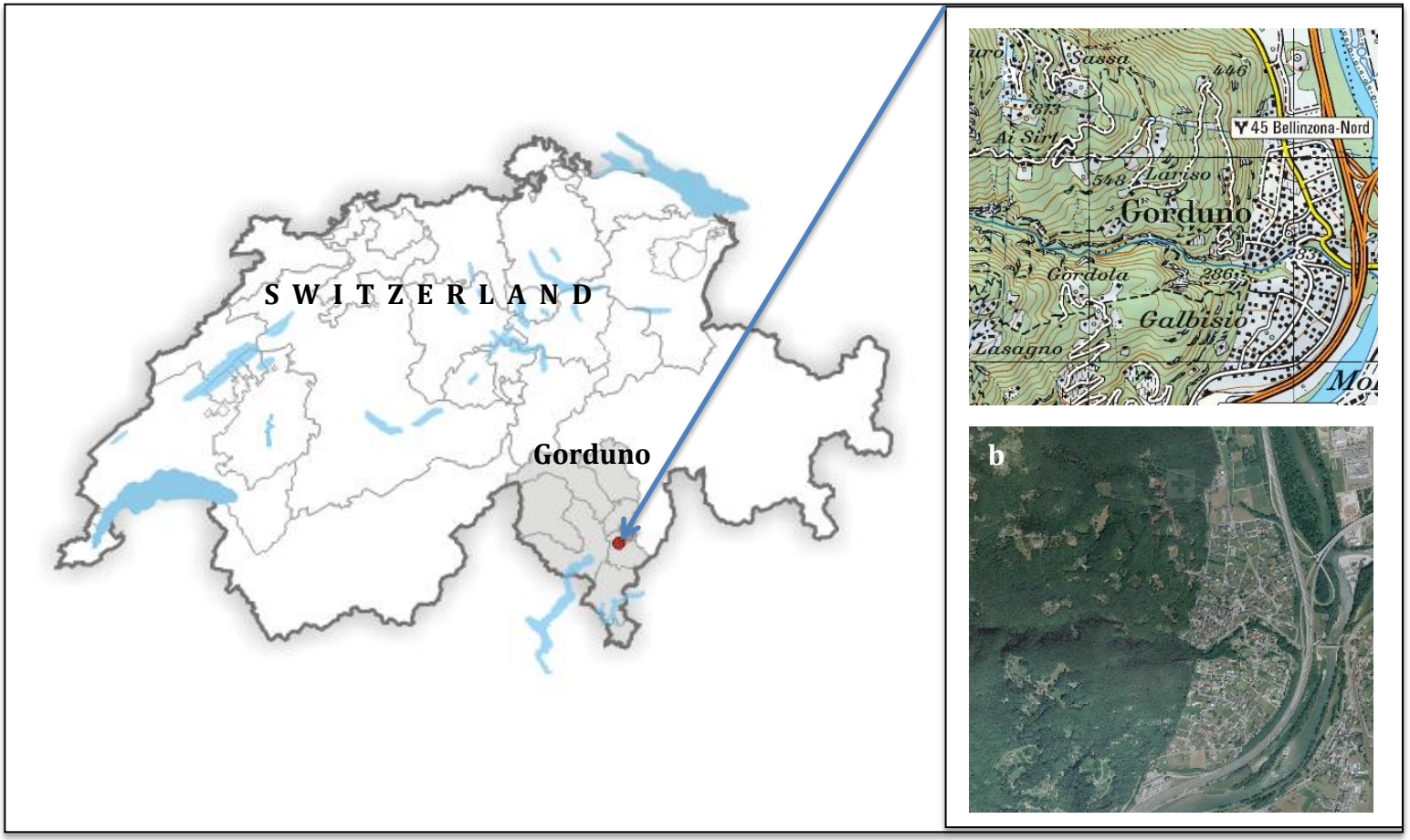
Goal of the master project

- Derive and establish the best method for distinguishing temporal changes by using:
  - Cartographic approach
  - Remote Sensing approach

Motivation

- Due to the lacking functional information content about temporal changes in Alpine region
- Show the potential of using above-mentioned approaches

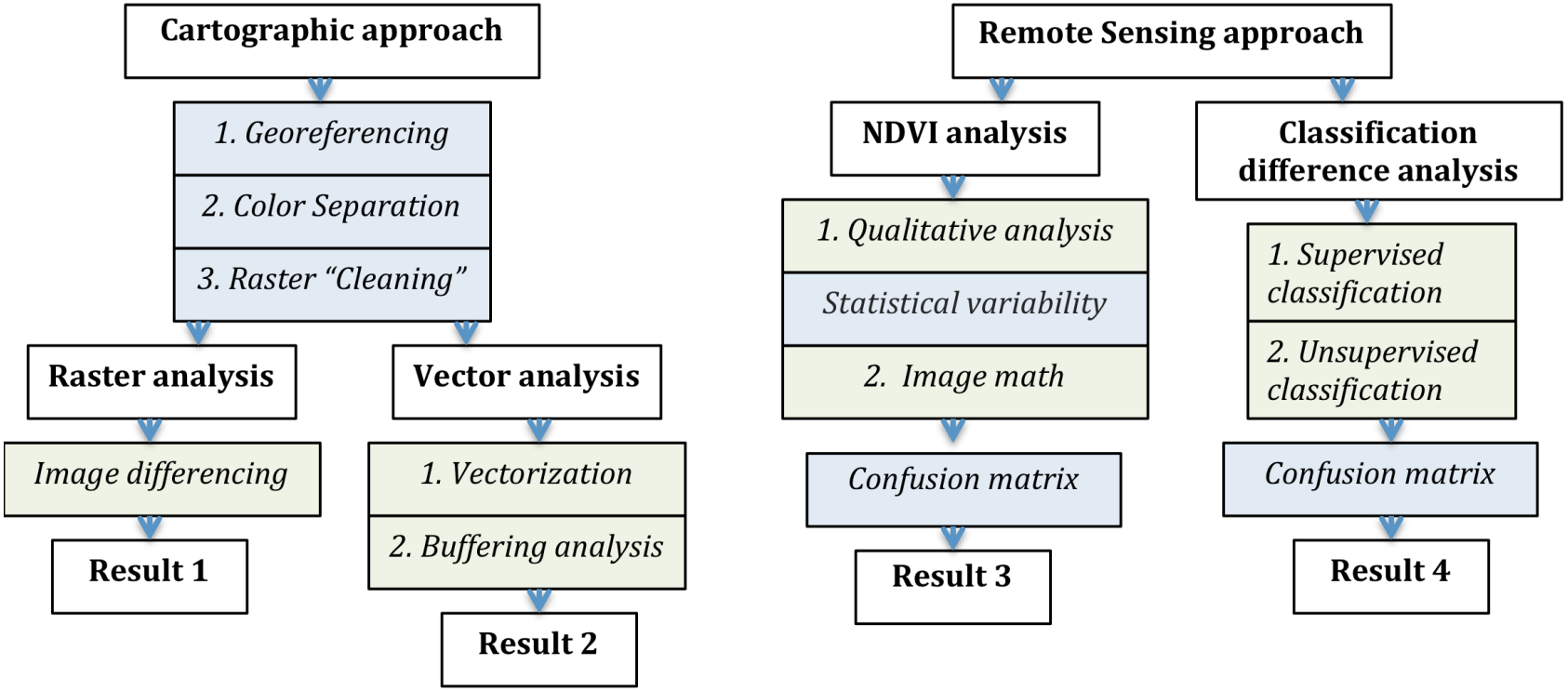
Study area



Gorduno municipality region, Canton Ticino, Switzerland
(a- fragment from the map, b-fragment from satellite image)

References: www.swisstopo.ch

Methodology



Cartographic approach

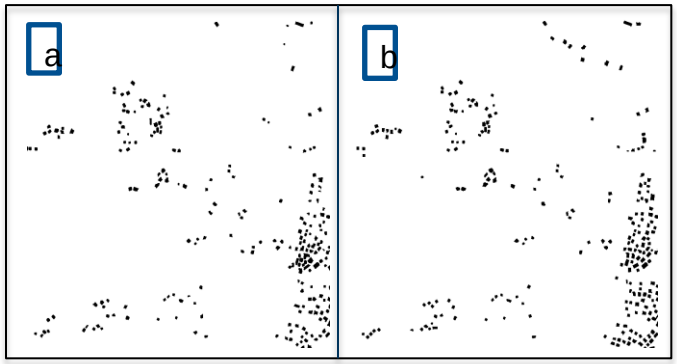
- Georeferencing
- Color separation

Fragment of the map (scale 1: 50 000) by the year **1995**
a- without color separation
b- with color separation
visible temporal changes

Fragment of the map (scale 1: 50 000) by the year **2006**
a- without color separation
b- with color separation
visible temporal changes

- Raster Cleaning

Representation of two raster images for the study area for further analysis:
a- for the year 1995
b- for the year 2006



Reduced size of the image, original scale 1: 50 000

Cartographic Approach

Vector Analysis (Buffering method)

Approach A:

- evaluate the distance, where new buildings have been built form the already existing

Approach B:

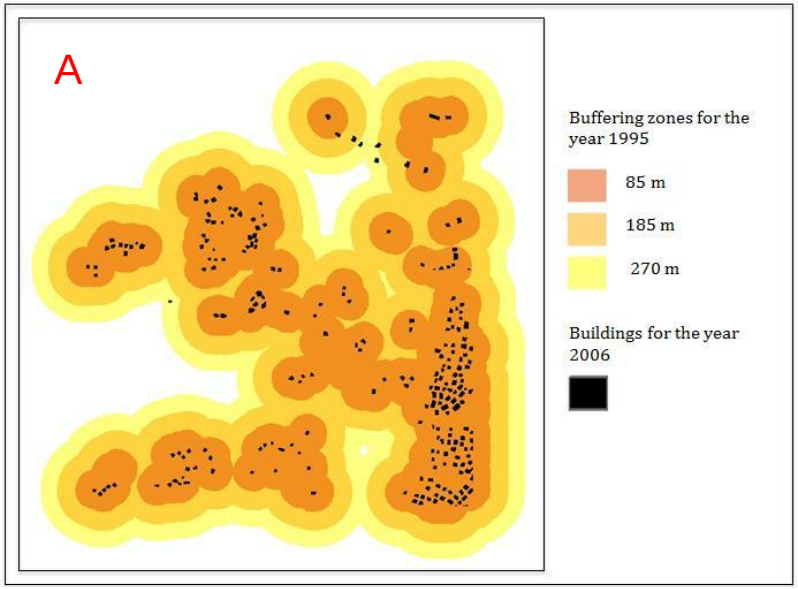
- establish new build-up buildings
- evaluate distance of the buildings, which are not existing anymore

Cartographic Approach

Vector Analysis

Result approach A:

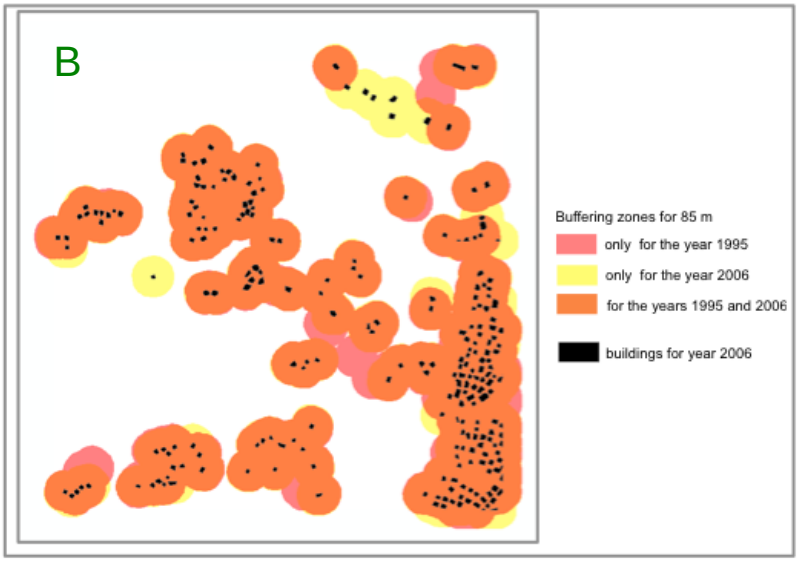
- most of the new buildings were built within the distance 270 m



Reduced size of the image, original scale 1: 50 000

Result approach B:

- established new buildings
- established area of the buildings, which are not existing anymore



Reduced size of the image, original scale 1: 50 000

Evaluation of Cartographic Vector Approach

Results:

- possibility distinguishing the changes in build-up area
- detection of areas of the buildings, which are not existing anymore
- ability of further analysis

Possible challenges:

- vectorization process
  - time-consuming
- control of raster cleaning step (ground truth data)

Remote Sensing Approach

NDVI Analysis

(Normalized Difference Vegetation Index)- it is a simple quantitative measure of photosynthetically active biomass.

NDVI = (NIR-RED)/(NIR+RED)

NIR- reflection in Near Infrared Band
RED- reflection on the Red Band

Two approaches, based on NDVI analysis:

- **Qualitative analysis (FCC)**
- **Image math**

Remote Sensing Approach

NDVI analysis

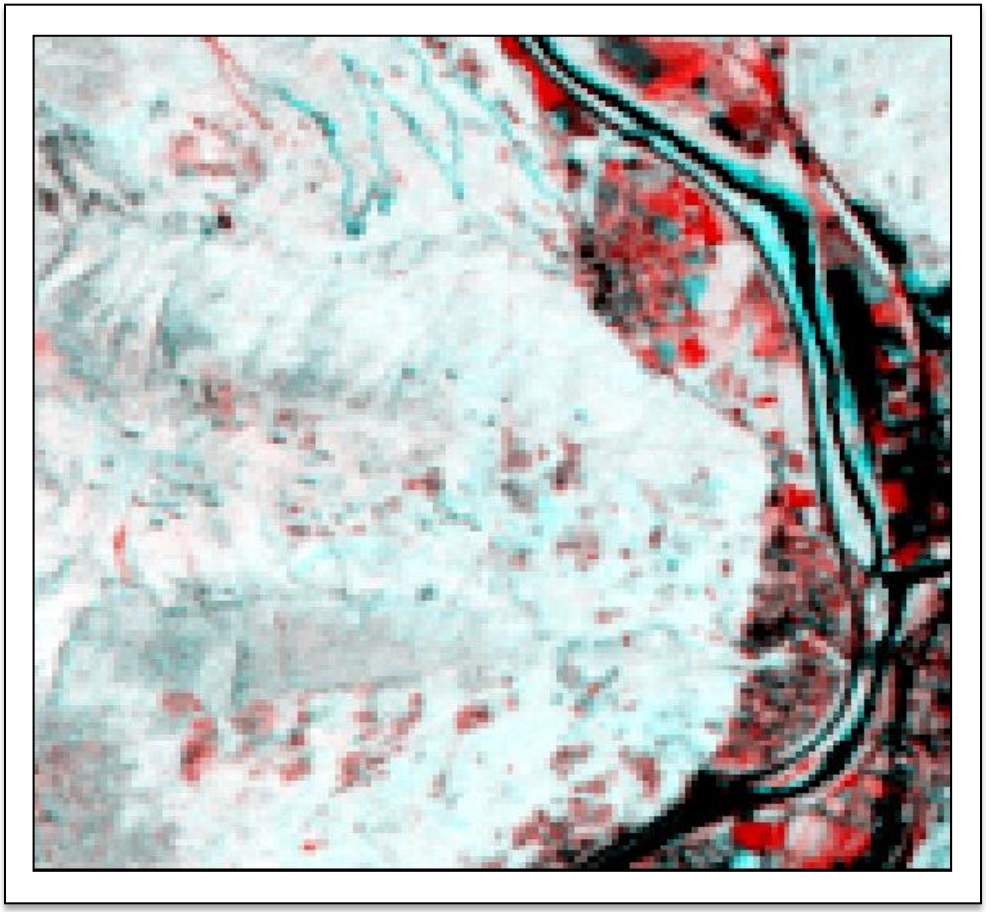
Qualitative visualization (False Color Composite):

Principle of approach:

- 1 channel (R)- NDVI for 1990
- 2 channel (G)- NDVI for 2003
- 3 channel (B)- NDVI for 2003

Results of approach:

- representation of changed and non-changed areas
- no statistical information



Fragment of composite: Landsat TM, 30 m, 09.07.1990 and 05.07.2003

Remote Sensing Approach
NDVI analysis

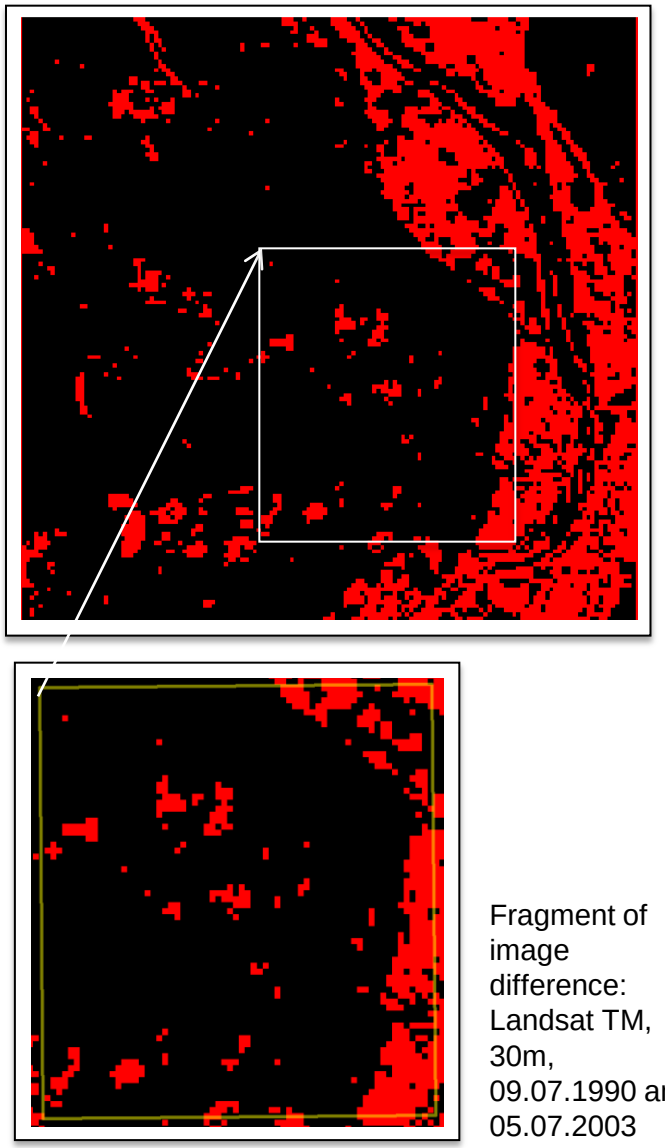
Image math approach:

Principle of approach:
Computation of differences in ratios between image bands.

DNDVI = (NIR-R)/(NIR+R) t1 – (NIR-R)/(NIR+R) t2

Results of approach:
- possibility distinguishing the changes in build-up area
- statistical information about changed areas:
  - Changes in total for build up area (*303,18 ha*)
  - Changed study area (*35,7 ha*)

Possible challenges:
- modification of threshold with ground truth data



Fragment of image difference: Landsat TM, 30m, 09.07.1990 and 05.07.2003

Remote Sensing approach
Classification Difference analysis

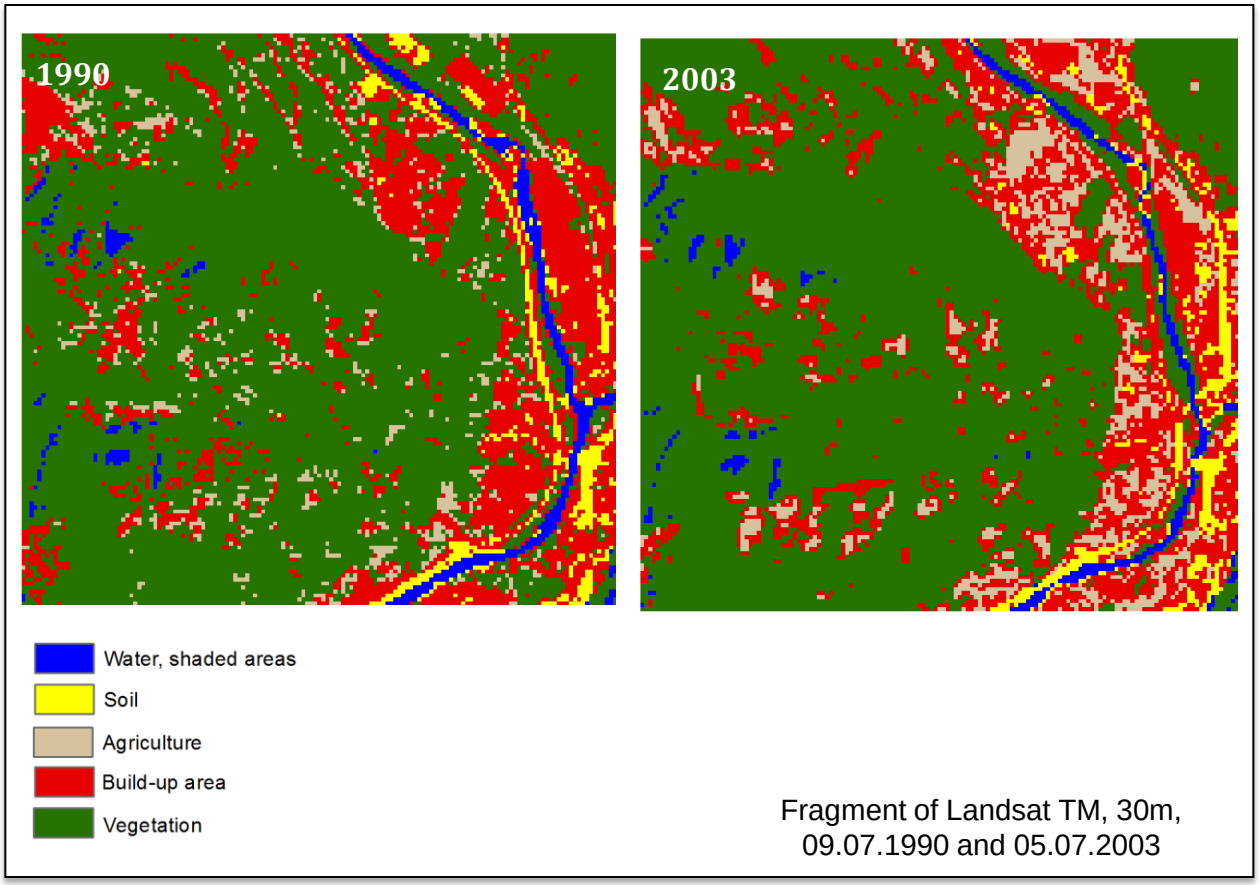
Supervised Classification

Results:

- possibility distinguishing the changes in build-up area
- statistical information about changed areas

Possible challenges:

- investigation of signature plots

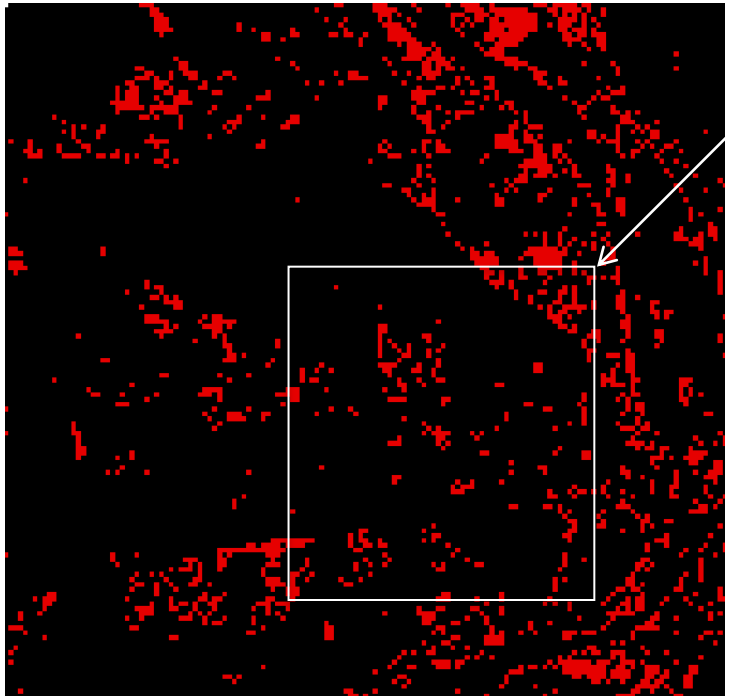


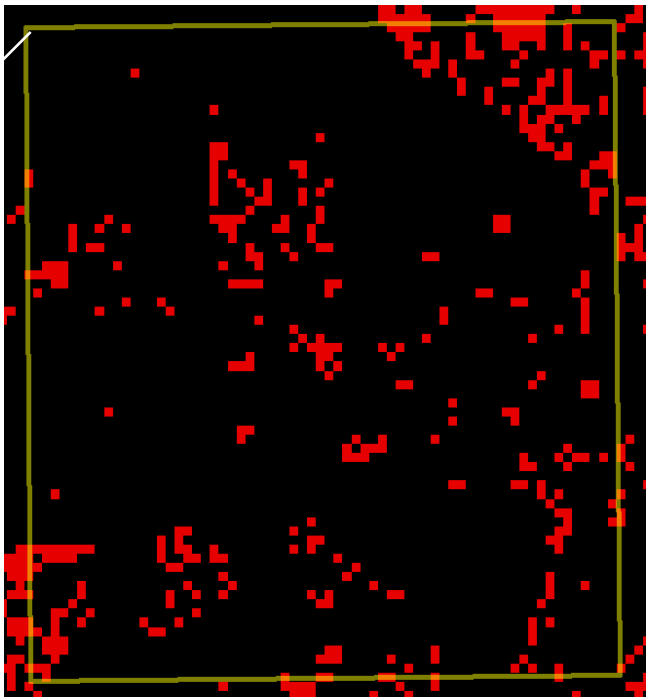
Fragment of Landsat TM, 30m, 09.07.1990 and 05.07.2003

Remote Sensing approach
Classification Difference analysis

Supervised Classification

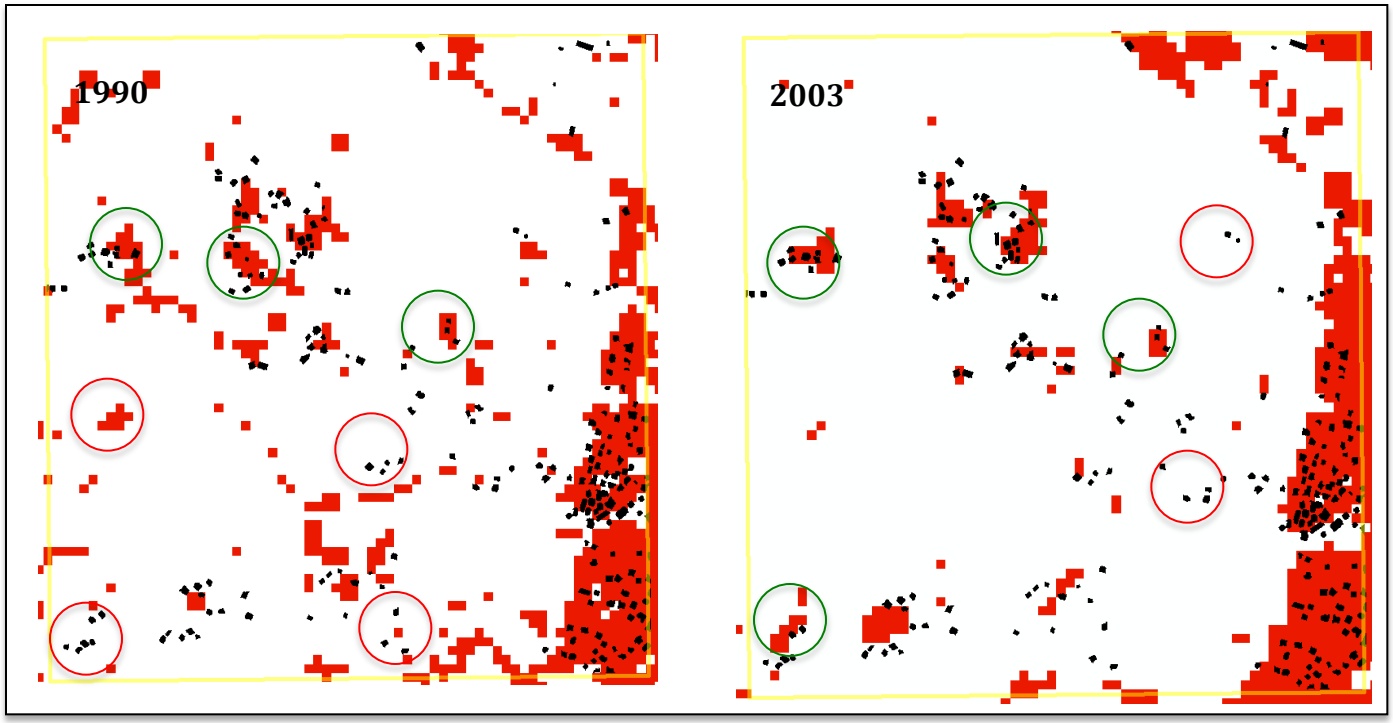
Changes in total for build up area (*193,05 ha*)
Changes in study area (*32,76 ha*)





Fragments of composite difference image: Landsat TM, 30m, 09.07.1990 and 05.07.2003

Evaluation NDVI analysis

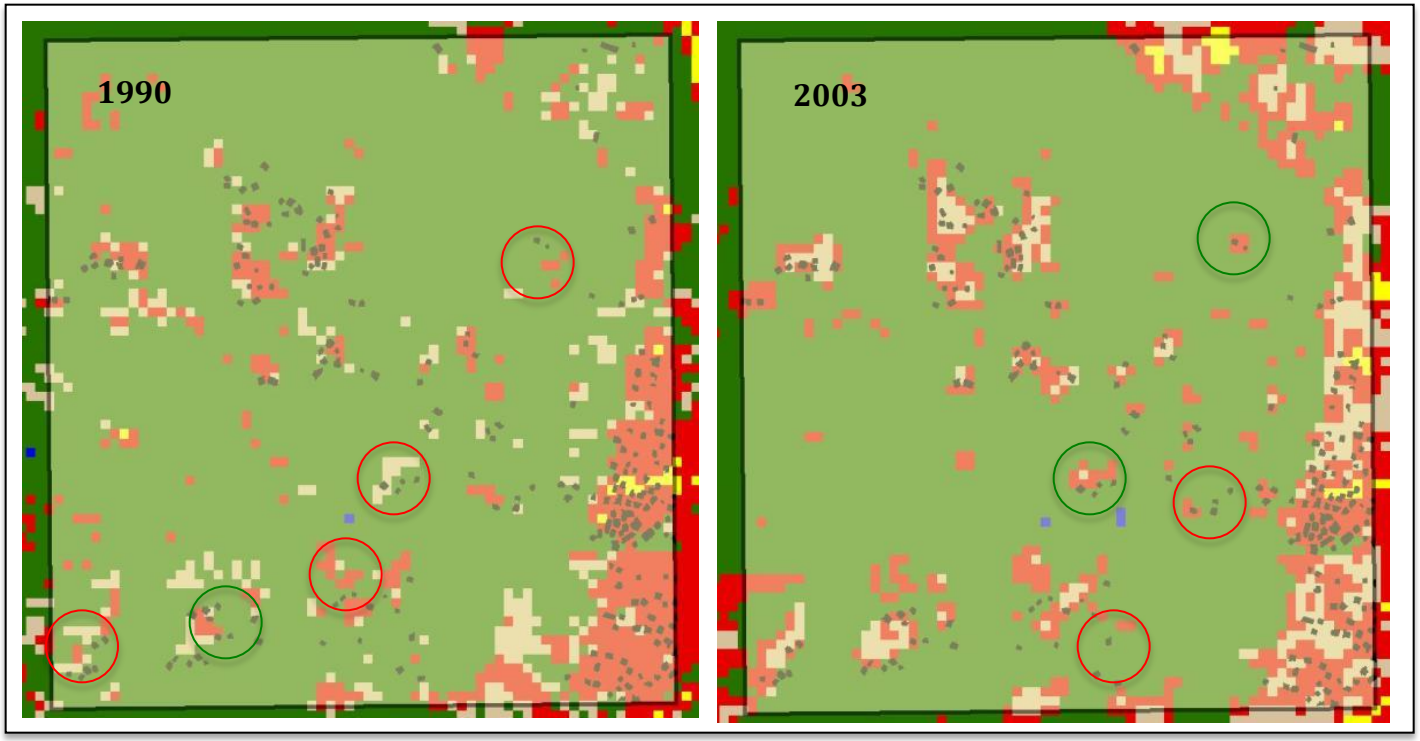


Fragments of NDVI difference image: Landsat TM, 30m 09.07.1990 and 05.07.2003; and topographic map, original scale 1: 50 000

Result:

- was possible to distinguish correctly the changes
- the threshold was evaluated correctly

Evaluation Classification Difference analysis



Fragments of NDVI difference image: Landsat TM, 30m 09.07.1990 and 05.07.2003; and topographic map, original scale 1: 50 000

Result:

- possible to distinguish changes,
- build-up class was evaluated with the high accuracy

Comparison of both Remote Sensing approaches

NDVI approach

Results:
- possible to distinguish changes in build-up area
- fast qualitative analysis
- statistical information about changed areas
- useful for big area

Possible challenges:
- threshold evaluation

Possible improvements:
- ground truth data
- analysis for more images within summer season period

Classification Difference

Results:
- possible to distinguish build-up area
- statistical information about changed areas
- time-consuming while choosing signatures
- useful for big areas
- high accuracy results

Possible challenges:
- signatures for supervised classification

Possible improvements:
- ground truth data

Conclusions

- Both approaches give relevant result about temporal changes for urban zones in Alpine region

- Cartographic approach (vector) gives more detailed information about the changes (up to the single building). At the same time it is a time-consuming approach, therefore might be hard to implement for the big areas

- Both Remote Sensing approaches are fast in implementation, but at the same time need a lot of additional corrections in terms of controlling the accuracy of the results on each step

Thank you for your attention!

Questions?

ACKNOWLEDGEMENTS

I would like to thank *Prof. Dr. Lorenz Hurni* and *Lorenzo Oleggini*, for supervising my Master Project, for guidance and support from the initial to the final level, what enabled me to develop an understanding of the subject. I am thankful to staff of the *Institute of Cartography and Geoinformation* for encouragement, help and support. Special thank to *staff of WUI-CH project* for providing the data for the research.

Cartographic approach

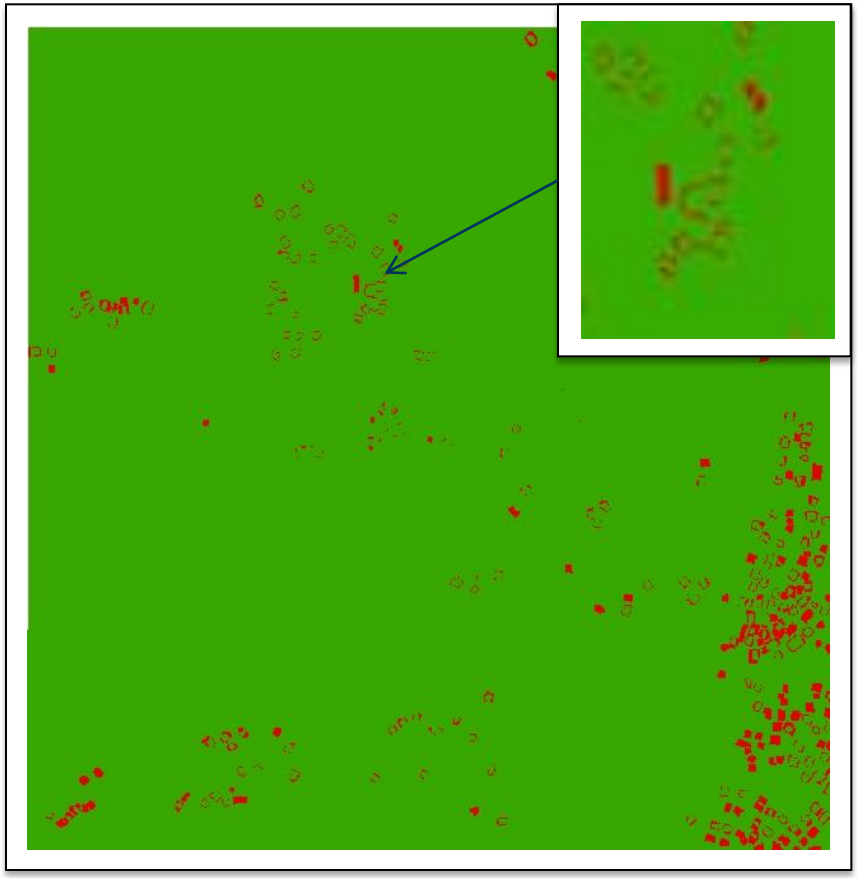
Raster Analysis

Result:

- representation of new build up buildings
- visualization of non-changed areas

Possible challenges:

- obtain comparable input data (same font type)
- improving georeferencing



red- new buildings, green- other areas

Remote Sensing approach

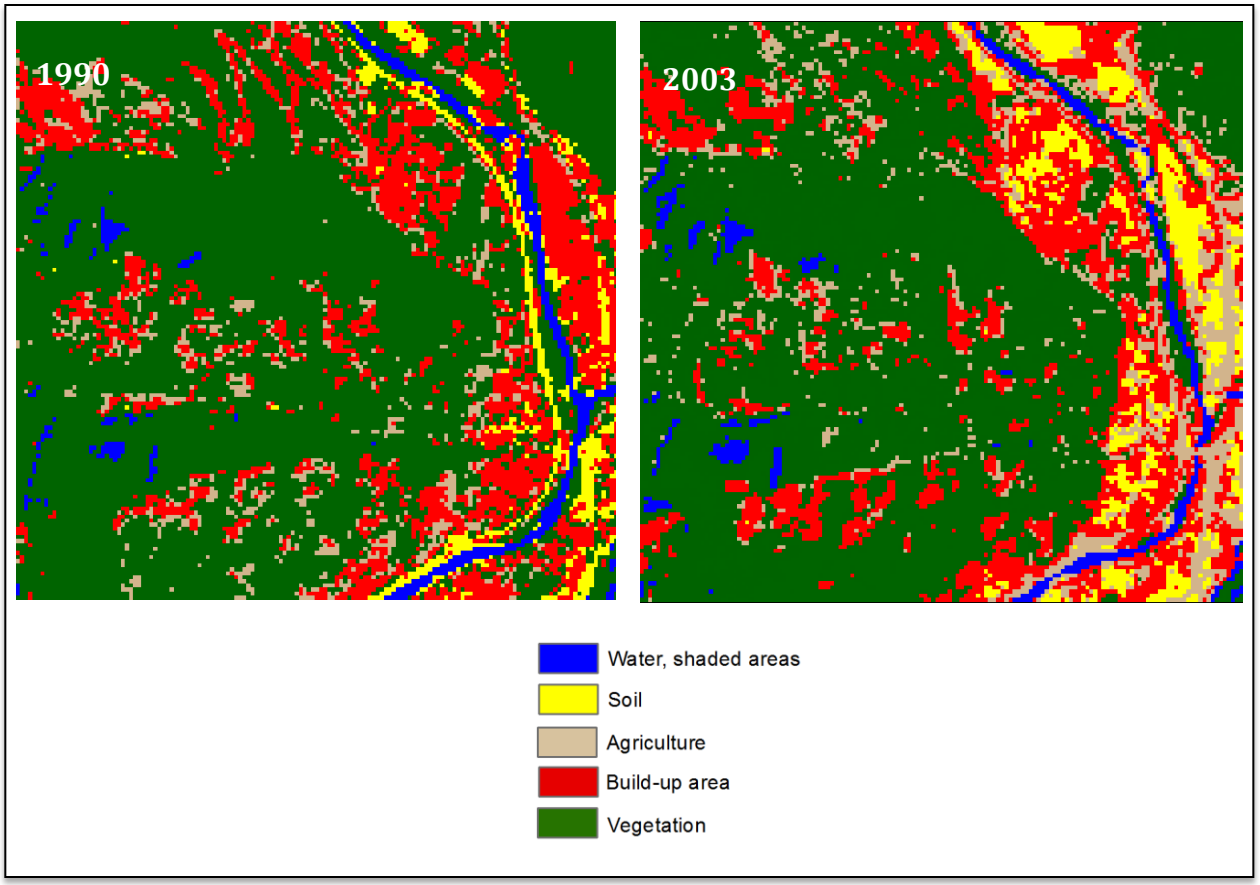
Classification Difference Analysis

Result approach B (Unsupervised Classification):

- possibility distinguishing the changes in build-up area
- statistical information about changed areas

Possible challenges:

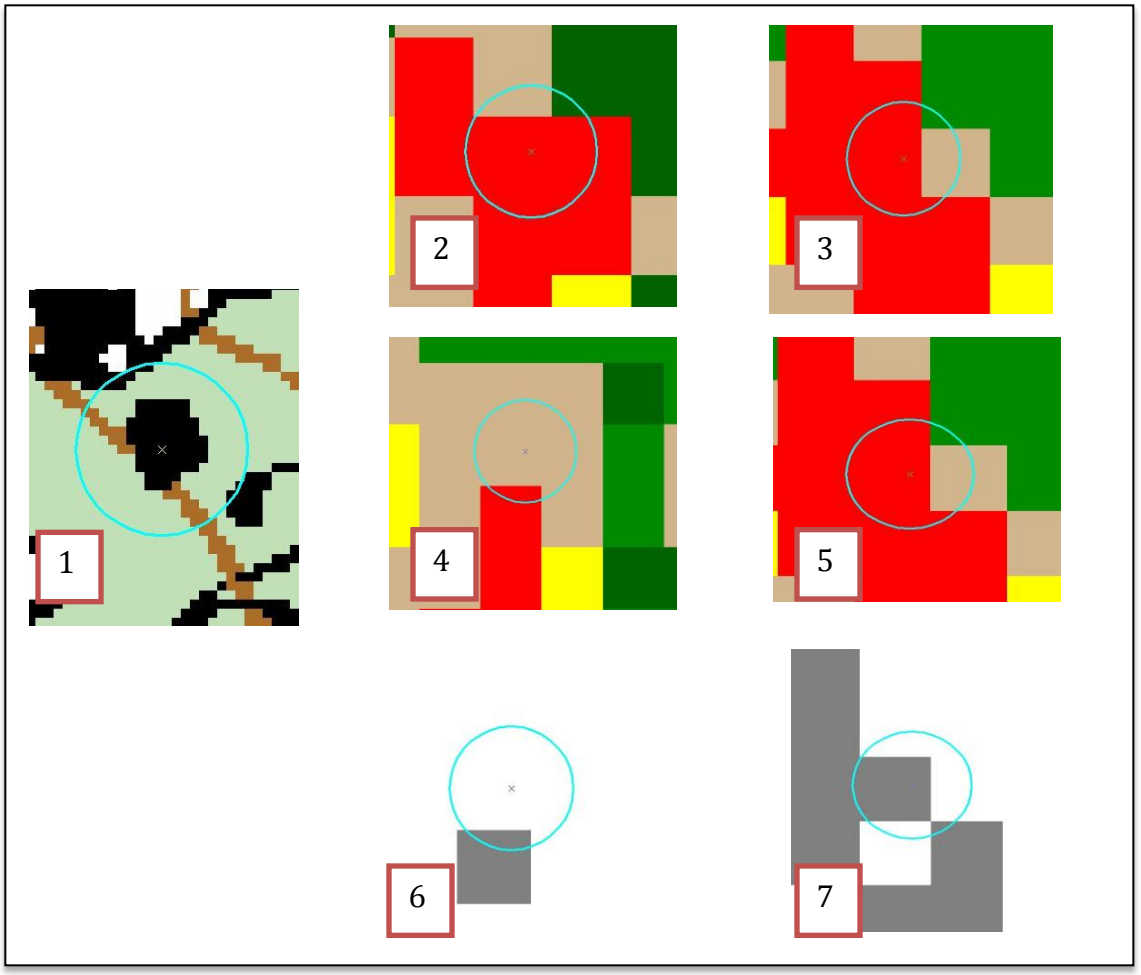
- modification of unsupervised classification method



Evaluation for Remote Sensing approach

Confusion matrixes Analysis (*100 control points*)

- random points
- buffering
- extracting multi values



1- ground truth map for the year 1995;
2- supervised classification 1990;
3- supervised classification 2003;
4- unsupervised classification 1990;
5- unsupervised classification 2003;
6- NDVI for 1990;
7- NDVI for 2003;

Evaluation for Remote Sensing approach

Confusion matrixes Analysis

NDVI

Total accuracy of the *threshold* for build-up area:
Year 1990- 78 %
Year 2003- 97 %

Possible mistakes A:

- not relevant comparison threshold for the year 1990 with the map for the year 1995

Classification difference

Total accuracy of the classification for *build-up class*:

Supervised classification	Unsupervised classification
year 1990- 88%	year 1990- 77 %
year 2003- 87 %	year 2003- 77 %

Possible mistakes B:

- not relevant type analysis within the classification method

Results:

- NDVI can be used with additional improvement of threshold for build-up area
- according to the confusion matrixes supervised one should be chosen for the further analysis