Evaluation of an OBIA approach to extract basic urban LC information from high-resolution optical and LiDAR data

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Outline

Introduction

Background & Study Objectives

- ENVILAND 2/urban WP

  - develop a method to extract urban LC from high-res data

  - six basic target classes

  - data fusion to exploit multi-sensoral EO datasets

  - state-of-the-art algorithms for practical problems

  - demonstration of spatio-temporal transferability

E2 project concept & project partners.

Urban Density based on LC & height infos.

Materials & Methods

2 Materials & Methods
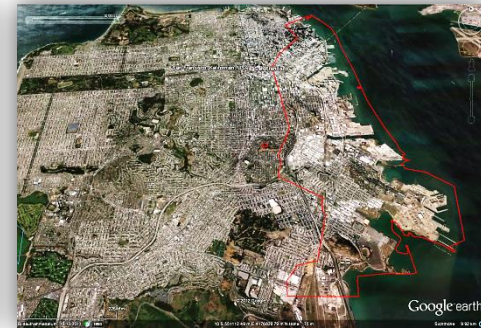
Study Areas & Data Basis

☐ urban LC maps were produced for three (entire) cities

Rostock, MV, GER.   Erfurt, TH, GER.   San Francisco, CA, USA.

☐ different sets of MS imagery and LiDAR data were used

Study Area	Multi-Spectral Imagery				LiDAR Data			
	Sensor	Date	Spectral Bands	GSD	Sensor	Date	Products	GSD
Rostock, MV, Germany	QuickBird	2009-09-19, 12:25 CEST	Blue, Green, Red, NIR, Pan	2.4 m (MS), 0.6 m (Pan)	Optech ALTM 3100	2007-04	DEM, DSM	2.0 m
	RapidEye	2010-07-09, 13:12 CEST	Blue, Green, Red, Red Edge, NIR	5.0 m (MS)	Optech ALTM 3100	2007-04	DEM, DSM	2.0 m
Erfurt, TH, Germany	WorldView-2	2011-09-26, 12:48 CEST	Coastal Blue, Blue, Green, Yellow, Red, Red Edge, NIR-1, NIR-2, Pan	2.0 m (MS), 0.5 m (Pan)	Optech ALTM 1225	2003-03	DEM, DSM	2.0 m
San Francisco, CA, USA	WorldView-2	2011-10-09, 12:36 PDT	Coastal Blue, Blue, Green, Yellow, Red, Red Edge, NIR-1, NIR-2, Pan	2.0 m (MS), 0.5 m (Pan)	Optech ALTM 3100	2010-06	DEM, DSM	0.5 m

Data basis of this study.

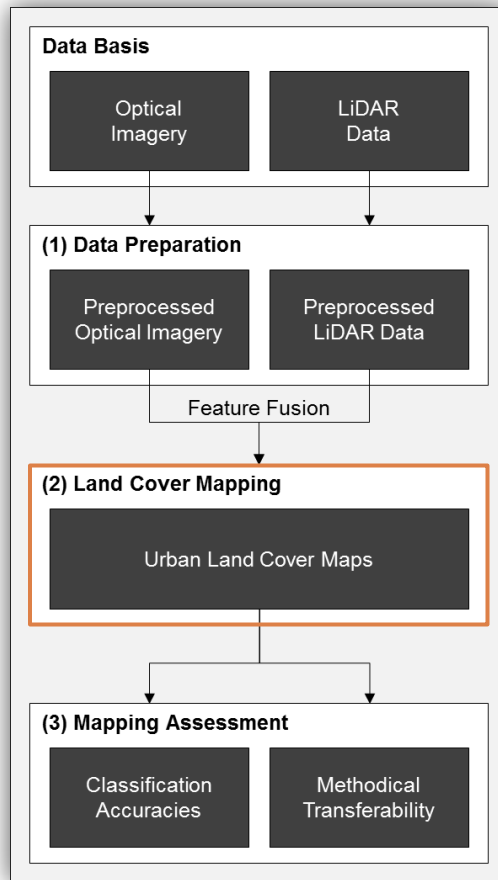# 2 Materials & Methods

Overall Workflow
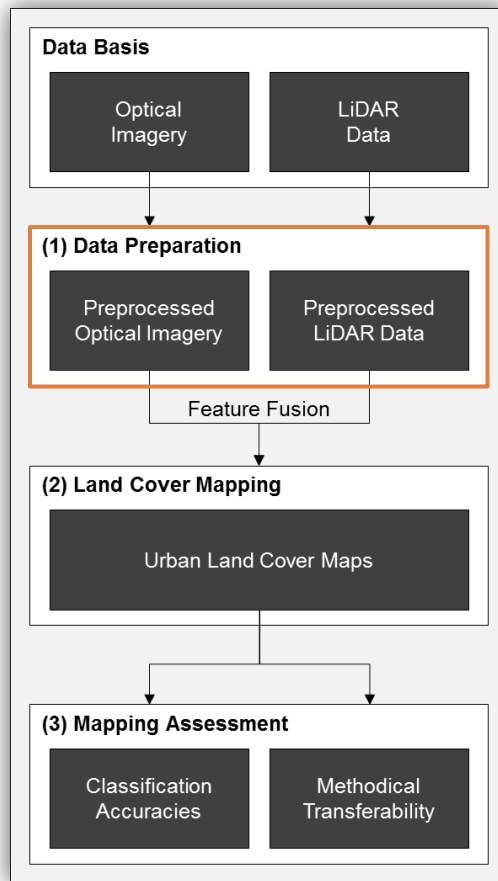
Workflow of this study.

- ☐ data preprocessing
  - ◼ ATCOR, panfusion, coregistration
  - ◼ derivation of DEMs/DSMs/nDSMs
- ☐ generation of additional information layers
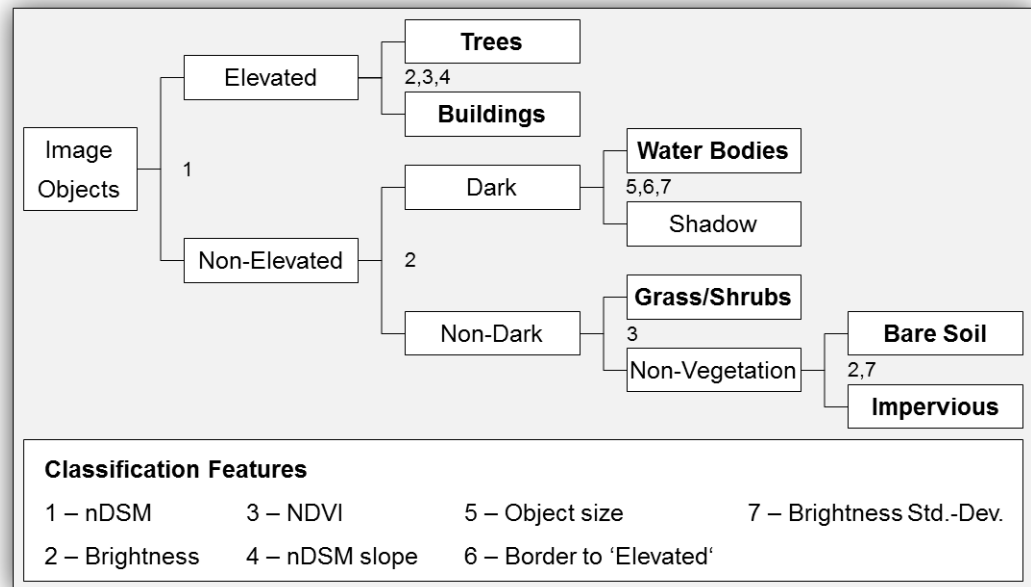 - ◼ image brightness, NDVI, nDSM slope

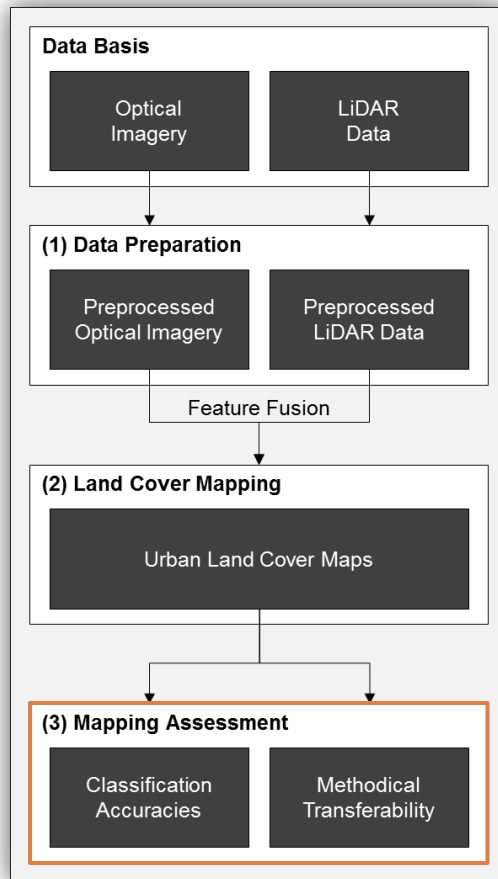## Overall Workflow

Workflow of this study.

- extraction of urban LC information
  - using OBIA and feature fusion
  - compilation of simple class descriptions

The urban LC classification scheme proposed in this study.

Overall Workflow

Workflow of this study.

- ☐ accuracy assessment

    - ◻ 50 random points per class

    - ◻ standard accuracy measures

    - ◻ reference: DOPs & GIS data

- ☐ transferability assessment

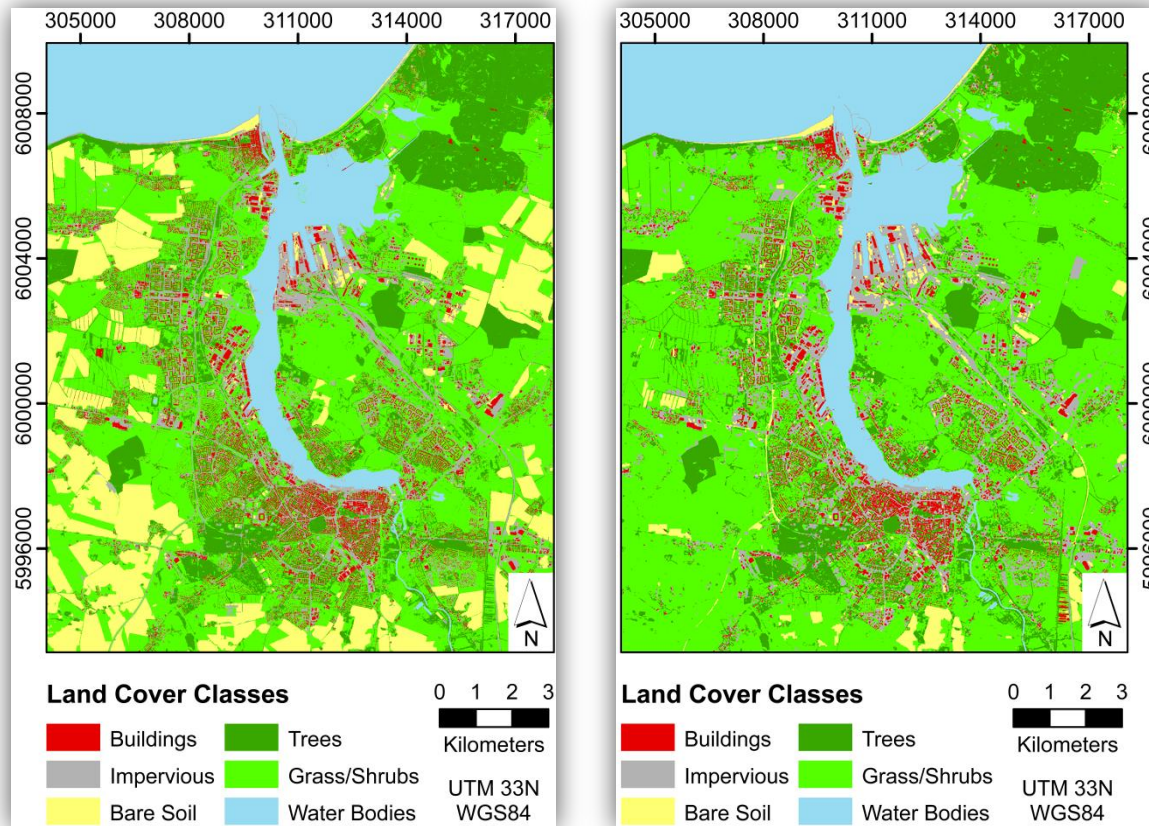   - ◻ discussion on strenghts and limitations of the approach

Results & Discussion

3 Results & Discussion

Urban LC Maps

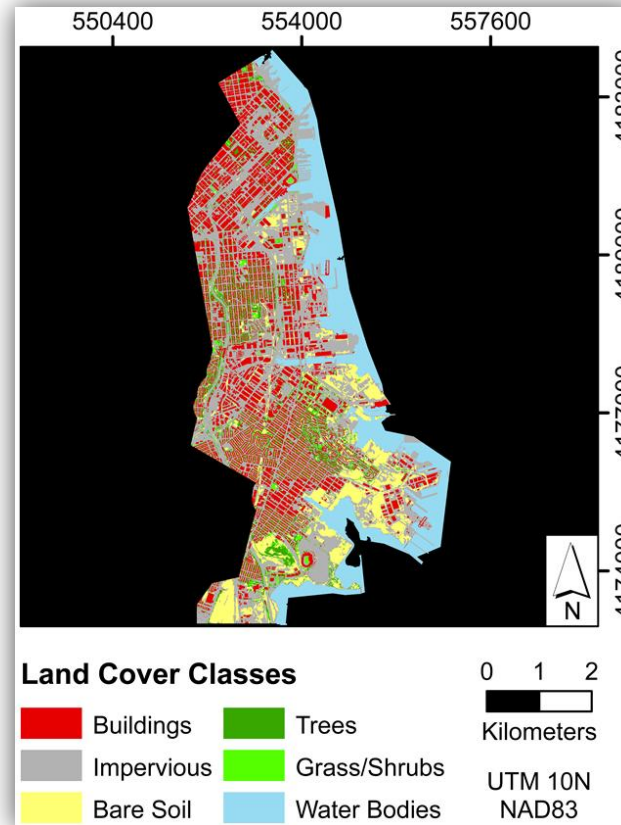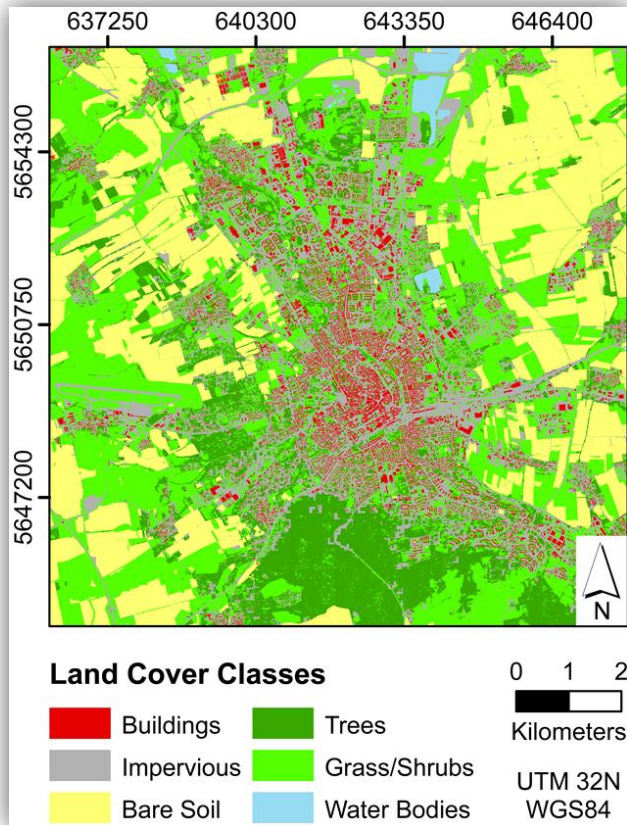☐ an overall area of almost 700 km² was classified

The urban LC maps of Rostock: QuickBird (left) and RapidEye (right).

3   Results & Discussion

Urban LC Maps

☐   an overall area of almost 700 km² was classified

The urban LC maps of Erfurt and San Francisco.

Validation Results

The classification accuracies obtained for the urban LC maps.

Map	User's/Producer's Accuracy						Overall/Kappa
	Buildings	Impervious	Bare Soil	Trees	Grass/Shrubs	Water Bodies	
Rostock (QuickBird)	0.90/0.90	0.82/0.89	0.96/0.86	0.96/0.98	0.84/0.89	1.00/0.96	0.91/0.89
Rostock (RapidEye)	0.90/0.96	0.92/0.78	0.84/0.86	0.94/0.96	0.84/0.88	0.96/1.00	0.90/0.88
Erfurt (WorldView-2)	0.94/0.85	0.82/0.82	0.88/0.80	0.74/0.90	0.72/0.68	0.92/1.00	0.83/0.80
San Francisco (WorldView-2)	0.92/0.81	0.86/0.74	0.90/0.90	0.82/0.98	0.80/0.93	1.00/1.00	0.88/0.86
Median Accuracies	0.91/0.88	0.84/0.80	0.89/0.86	0.88/0.97	0.82/0.88	0.98/1.00	0.89/0.87

- high overall degree of accuracy across all maps

- method performs better for Rostock & San Francisco

- UA: 72–100%; PA: 68–100%; OA: 83–91%; Kappa: 0.80–0.89

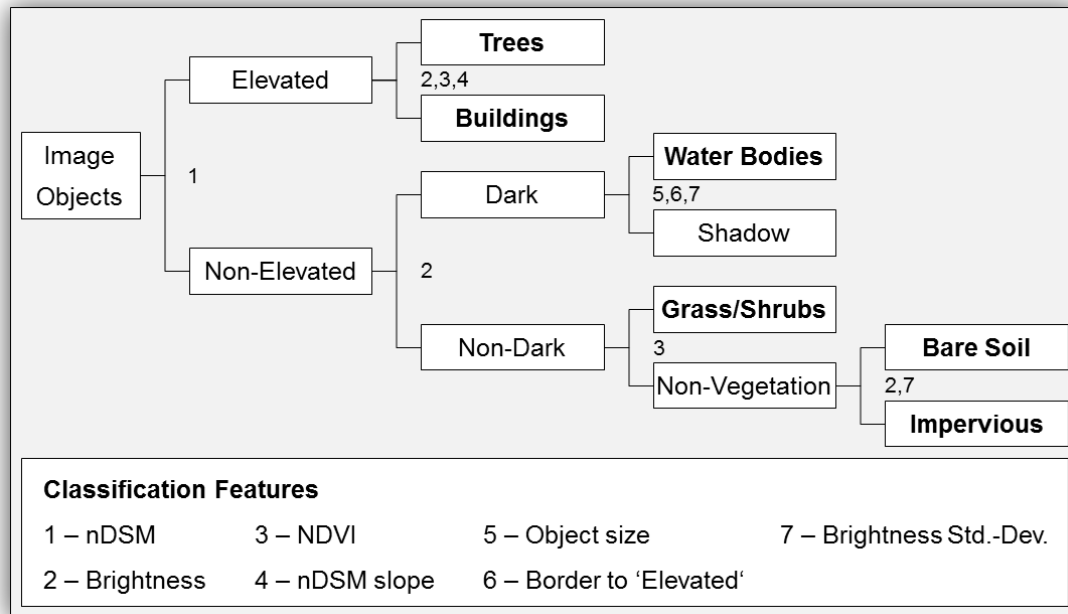# 3 Results & Discussion

Major Sources of Errors
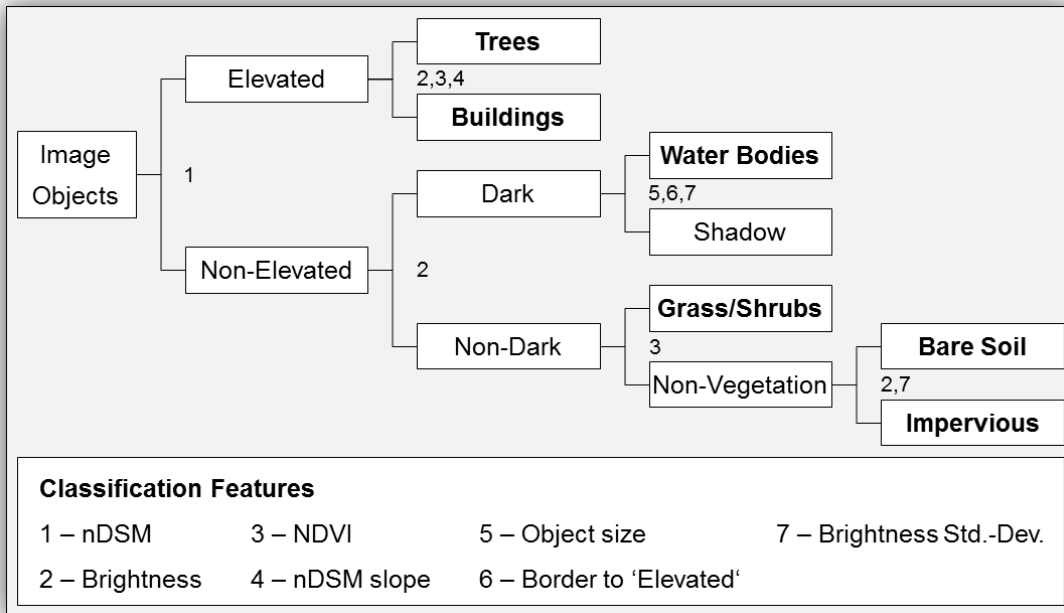
The urban LC classification scheme proposed in this study.

□ ruleset simplicity

  ▪ extensive shadowing from buildings

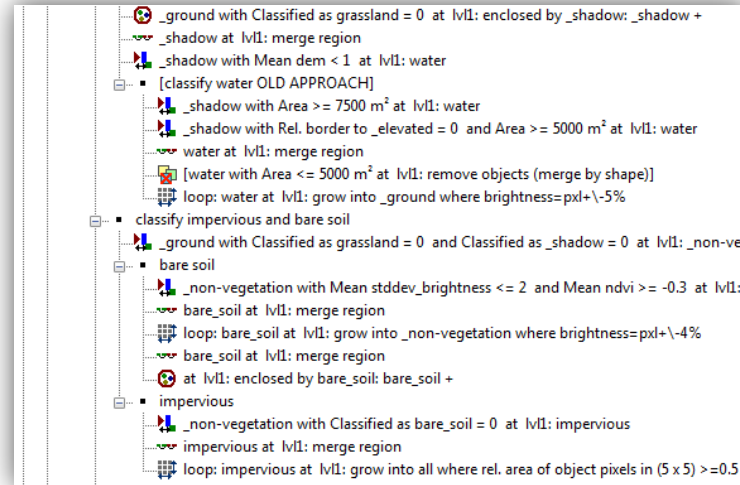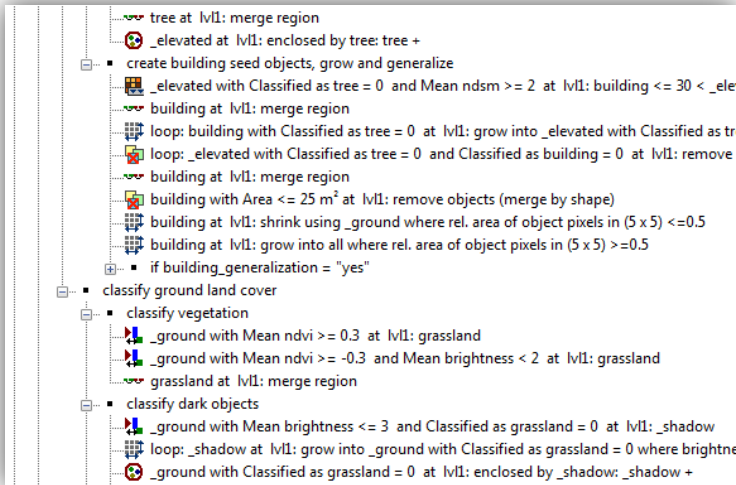 ▪ bare soil areas vs impervious surfaces

Major Sources of Errors

The urban LC classification scheme proposed in this study.

☐ nDSM properties (Erfurt)

▫ forests and forested areas

▫ allotment garden cottages
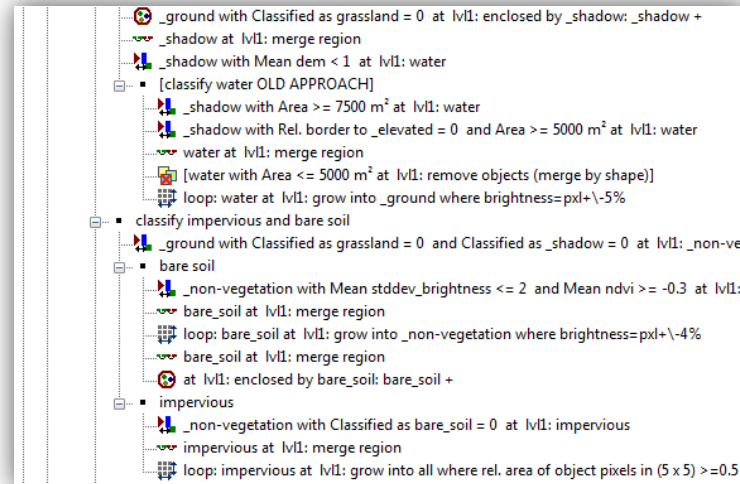
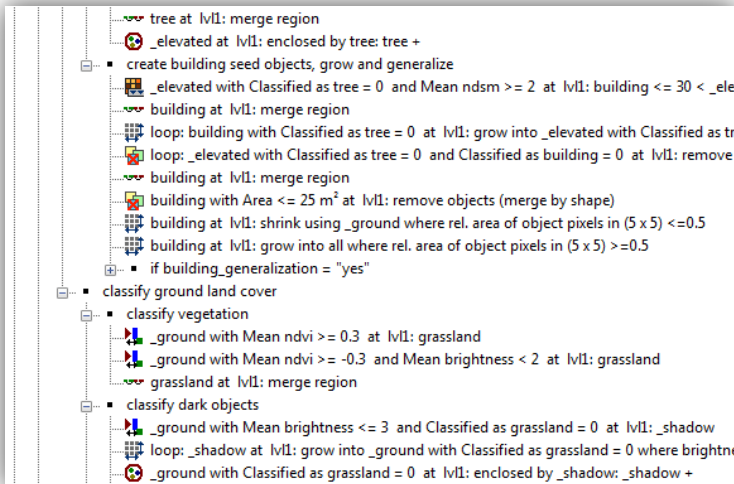## Methodical Transferability

Excerpts from the ruleset.

☐ strengths

    ▫ simple class descriptions; (re)use of basic features

    ▫ utilization of the four most common spectral bands

    ▫ modular ruleset structure; no training data required

Methodical Transferability

Excerpts from the ruleset.

☐ limitations

  ◻ some ruleset adaptations are necessary

  ◻ initial setup of variables (MMU, thresholds)

  ◻ compensating for data properties (nDSM)

Methodical Transferability

The percentage differences in accuracy ("reference map": Rostock (QuickBird)).

Map	User's/Producer's Accuracy						Overall/Kappa
	Buildings	Impervious	Bare Soil	Trees	Grass/Shrubs	Water Bodies	
Rostock (RapidEye)	±0.00/+0.06	+0.12/−0.13	−0.13/±0.00	−0.02/−0.02	±0.00/−0.02	−0.04/+0.04	−0.01/−0.01
Erfurt (WorldView-2)	+0.04/−0.05	±0.00/−0.08	−0.08/−0.07	−0.23/−0.06	−0.14/−0.24	−0.08/+0.04	−0.08/−0.09
San Francisco (WorldView-2)	+0.02/−0.10	+0.05/−0.17	−0.06/+0.05	−0.15/±0.00	−0.05/+0.04	±0.00/+0.04	−0.04/−0.03
Median Differences	+0.02/−0.05	+0.05/−0.13	−0.08/±0.00	−0.15/−0.02	−0.05/−0.02	−0.04/+0.04	−0.04/−0.03

- ☐ the presented approach seems promising for…
  - ☐ capturing urban areas with different physical structures
  - ☐ integrating various sets of optical & LiDAR inputs
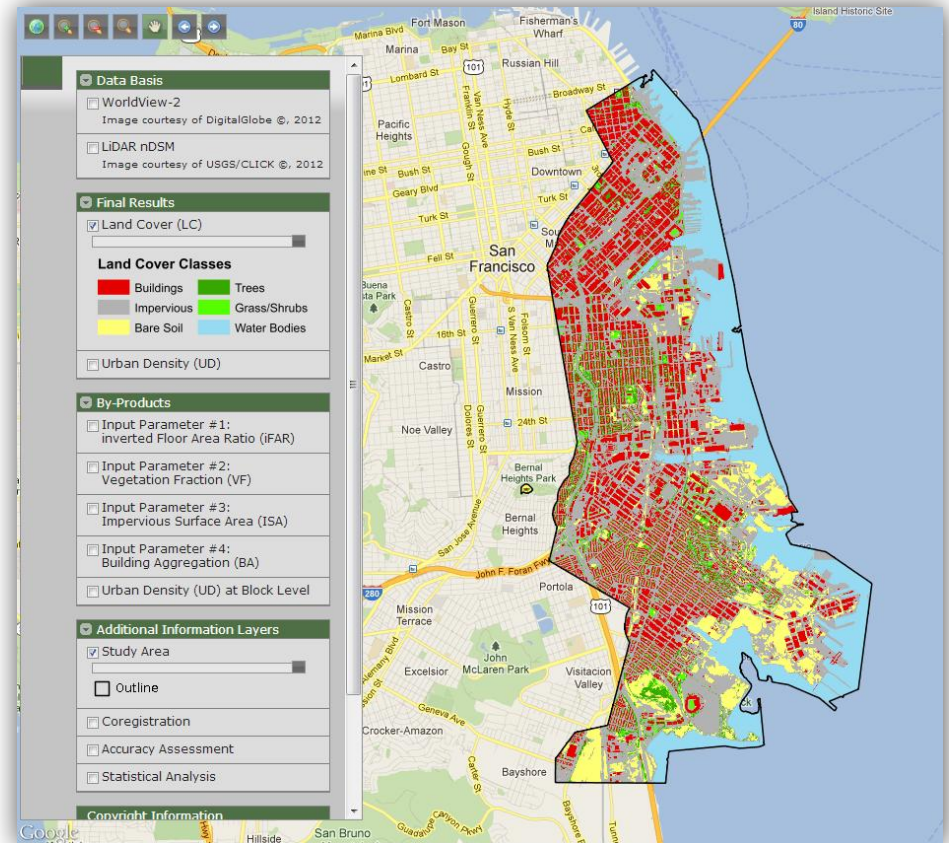 - ☐ dealing with changes in illumination and phenology

Summary

4   Summary

Wrap-Up

- a simple OBIA approach for basic urban LC mapping

- application to HR data acquired over 3 urban areas

- user's/producer's accuracies are mainly above 80/90 %

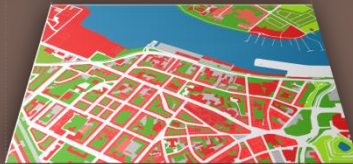- approach can be used as template or starting point

Geoportal

- sf.maps.essi-blog.org

The urban LC mapping result for SF online (J. Eberle).

Thank you!

Contact

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