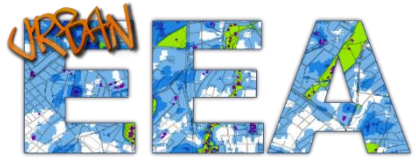
TALL SOM FORTELLER

# Integrating urban ecosystem and condition accounts using a flexible spatial concept.Examples from OSLO

*PER ARILD GARNÅSJORDET, SSB/NINA, MARGRETE STEINNES,SSB, MEGAN NOWELL, NINA, DAVID BARTON ,NINA, IULI ASLAKSEN , SSB*




NINA
Norwegian Institute for Nature Research

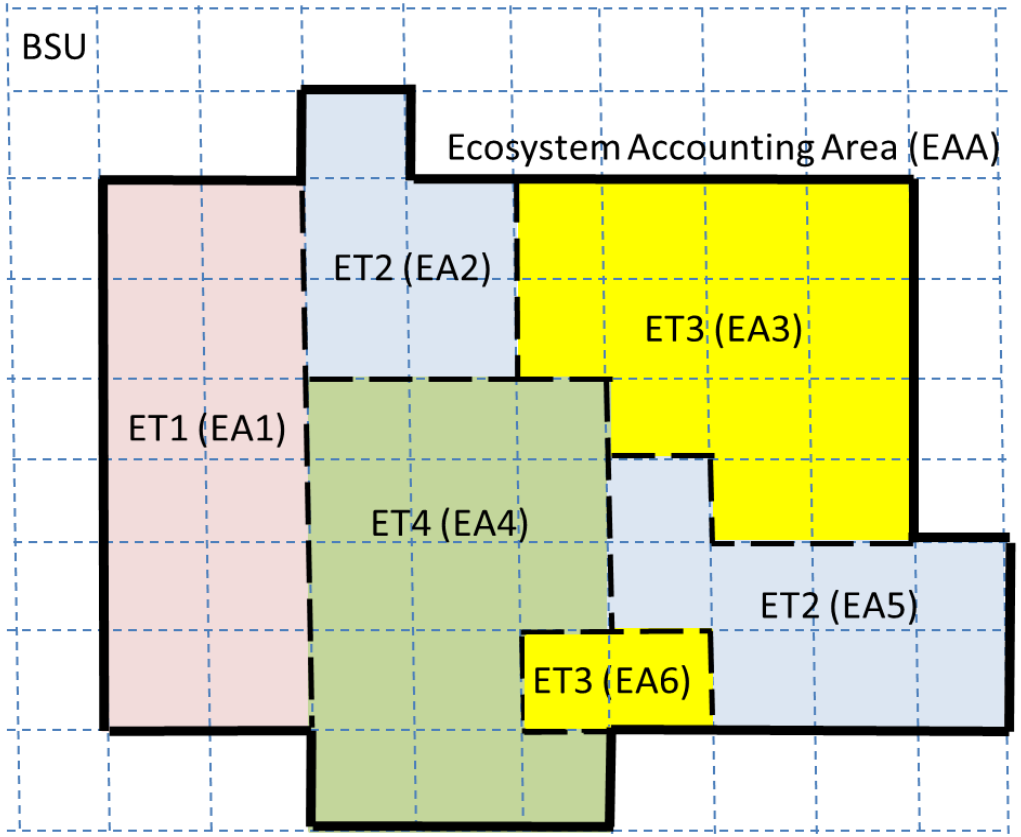
AHO
Arkitektur- og designhøgskolen i Oslo
The Oslo School of Architecture and Design

Statistisk sentralbyrå
Statistics Norway

# Agenda

1. Pro and con about spatial units
2. The potential for ecosystem services
3. Land use statistics and sattellite data
4. Selecting case study areas
5. Presention of maps and stastistics
6. Conclusions- the usefulness of the method.

# Relationships between spatial units for ecosystem accounting in ecosystem extent accounting

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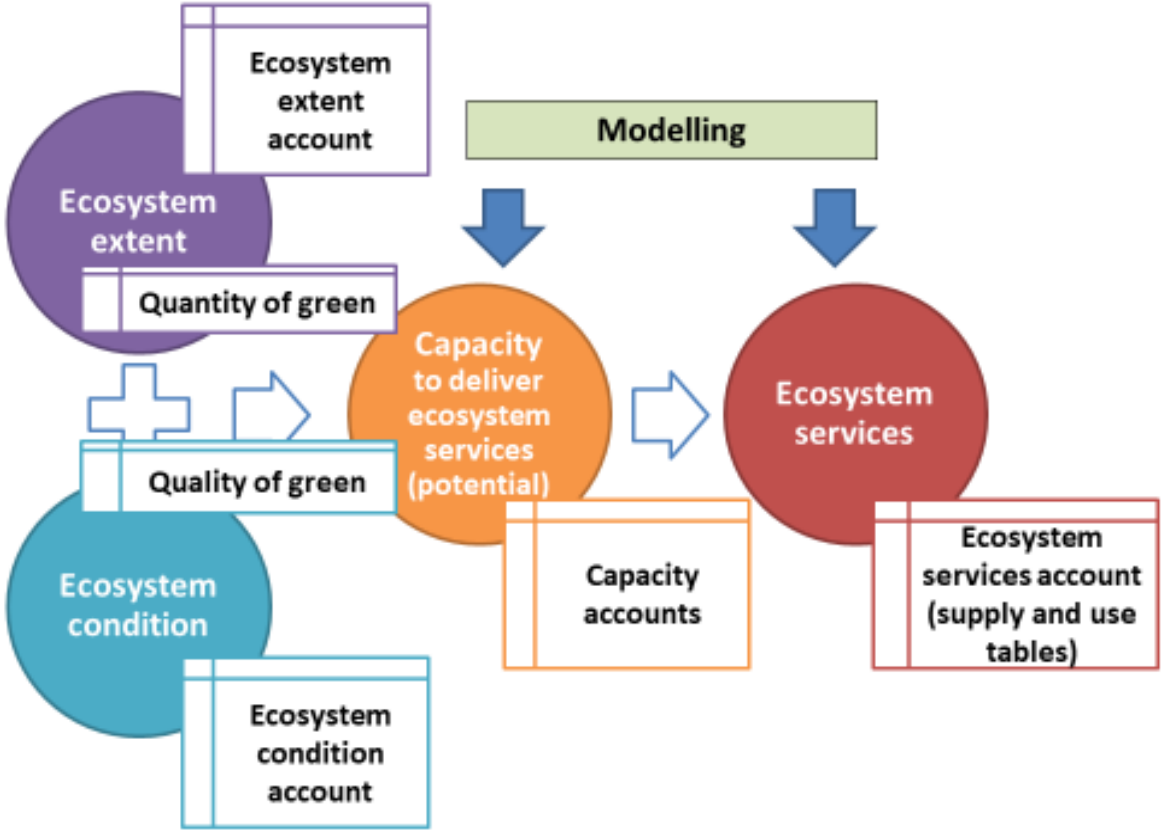
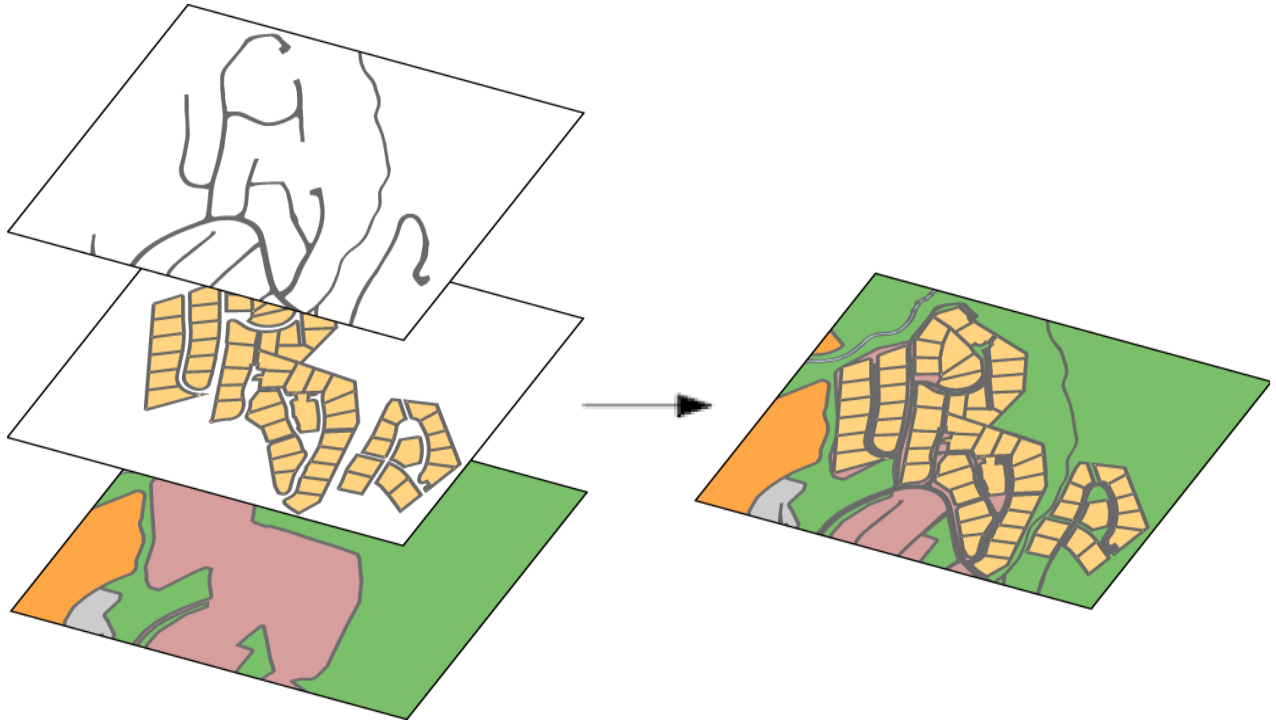
# The extent and condition account can form a basis to analyze the capacity (potential) for different ecosystem services

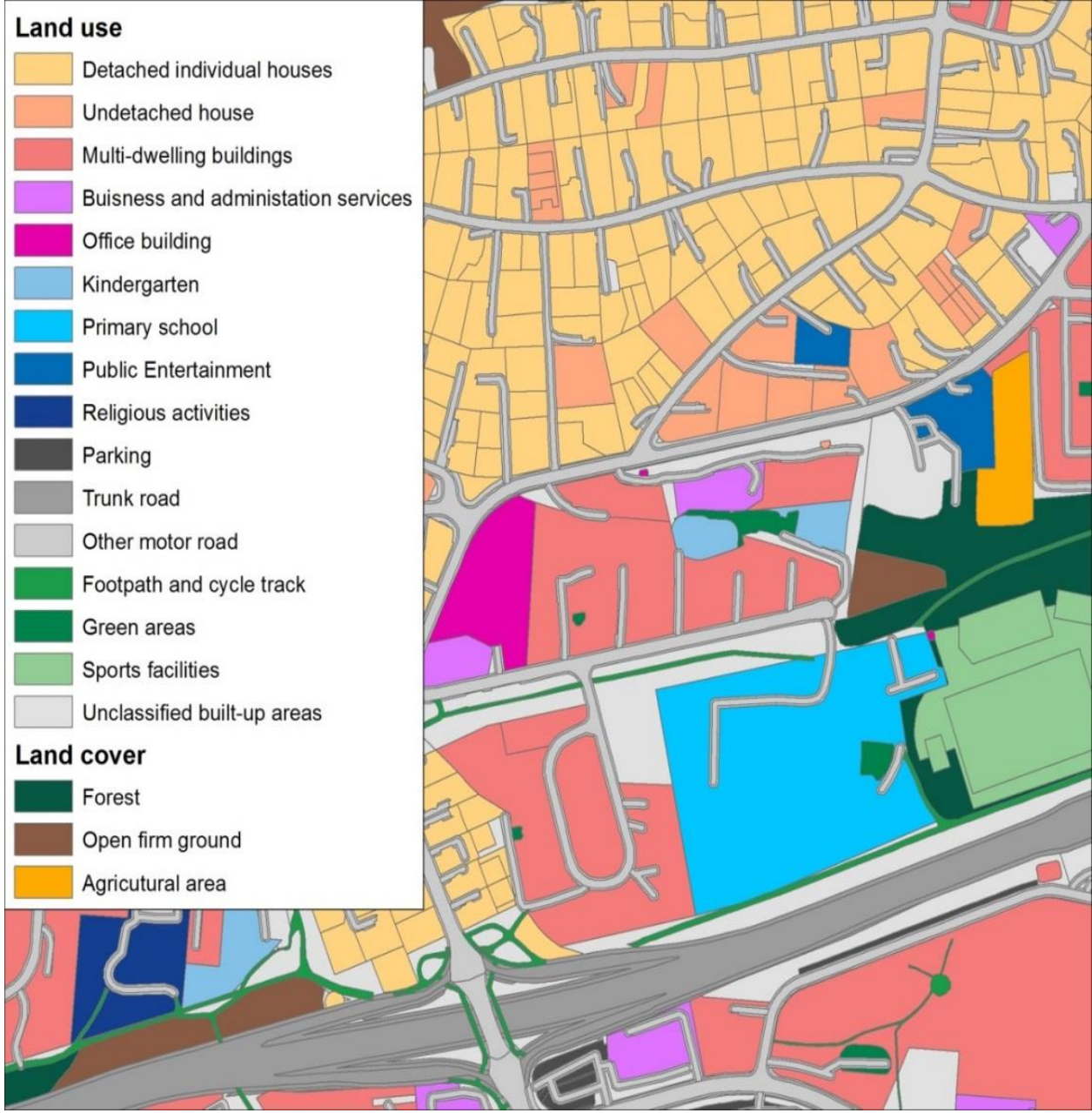


# Statistics Norways land use map

- Principle of overlaying different maps



- The result of combining maps from different sources, an example of a land use/land cover map from Statistics Norway

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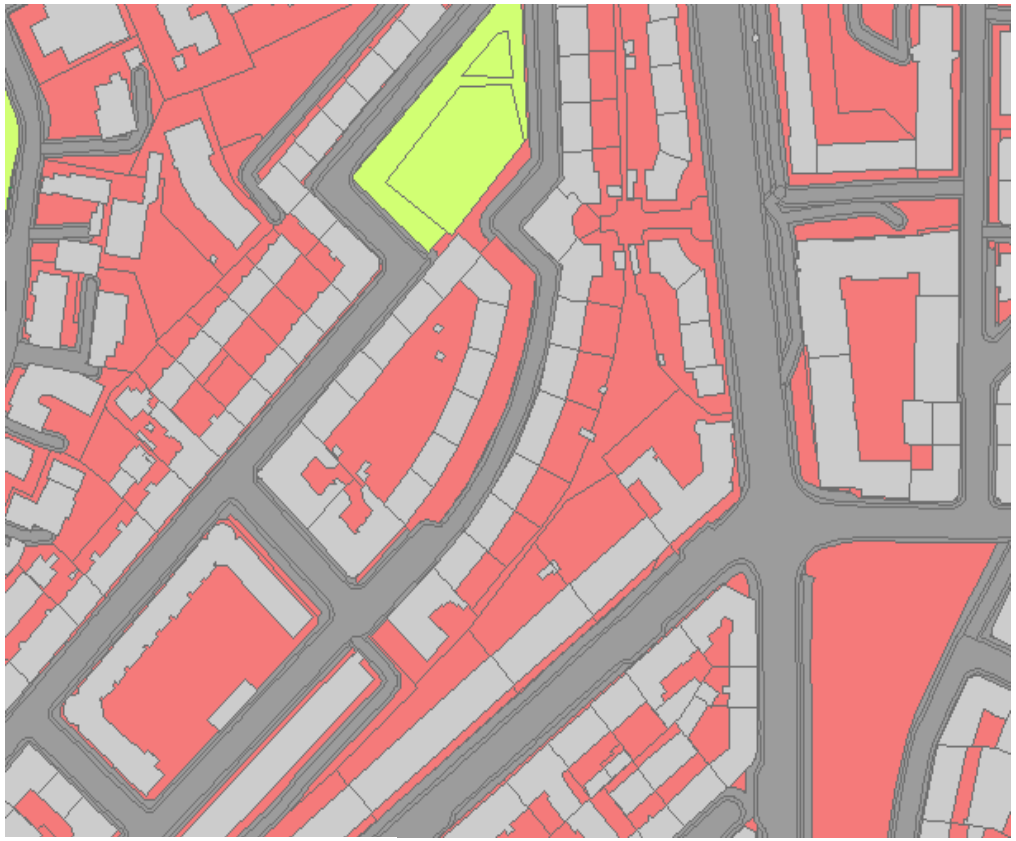
Statistics Norway

# Intersection of SSB land use maps and Sentinel-2 land cover classification. Example



Built-up, buildings

Built-up, infrastructure

Grass

Developed, known land use, unknown land cover

In the area with a red circle there is an asphalted school yard and a back yard used for parking space.

The green circle is an area for housing with a back yard with trees.

The blue circle is a playground which is asphalted, but with trees around

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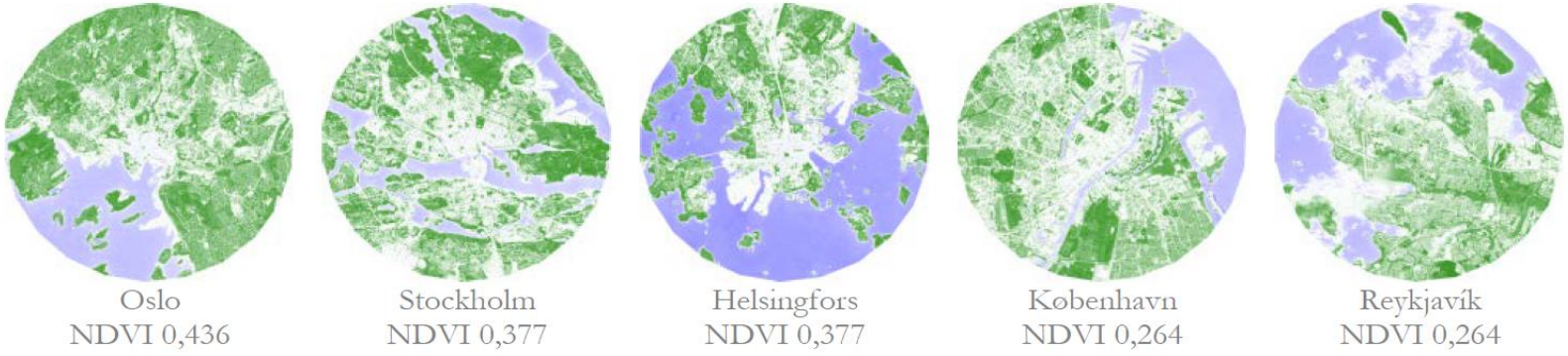
Statistics Norway

# Comparing the capitals of the Nordic countries

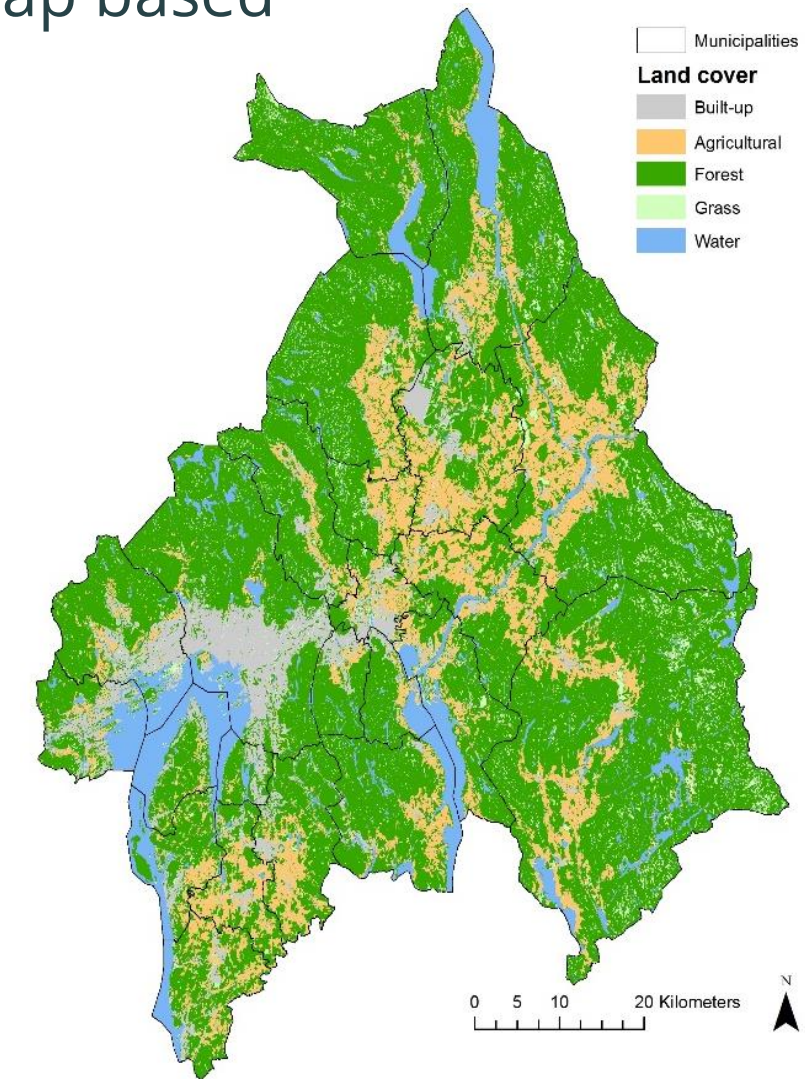
- Comparing the capitals of the Nordic countries in terms of green areas available to their citizens. Greenness measures by normalized vegetation index (NDVI)



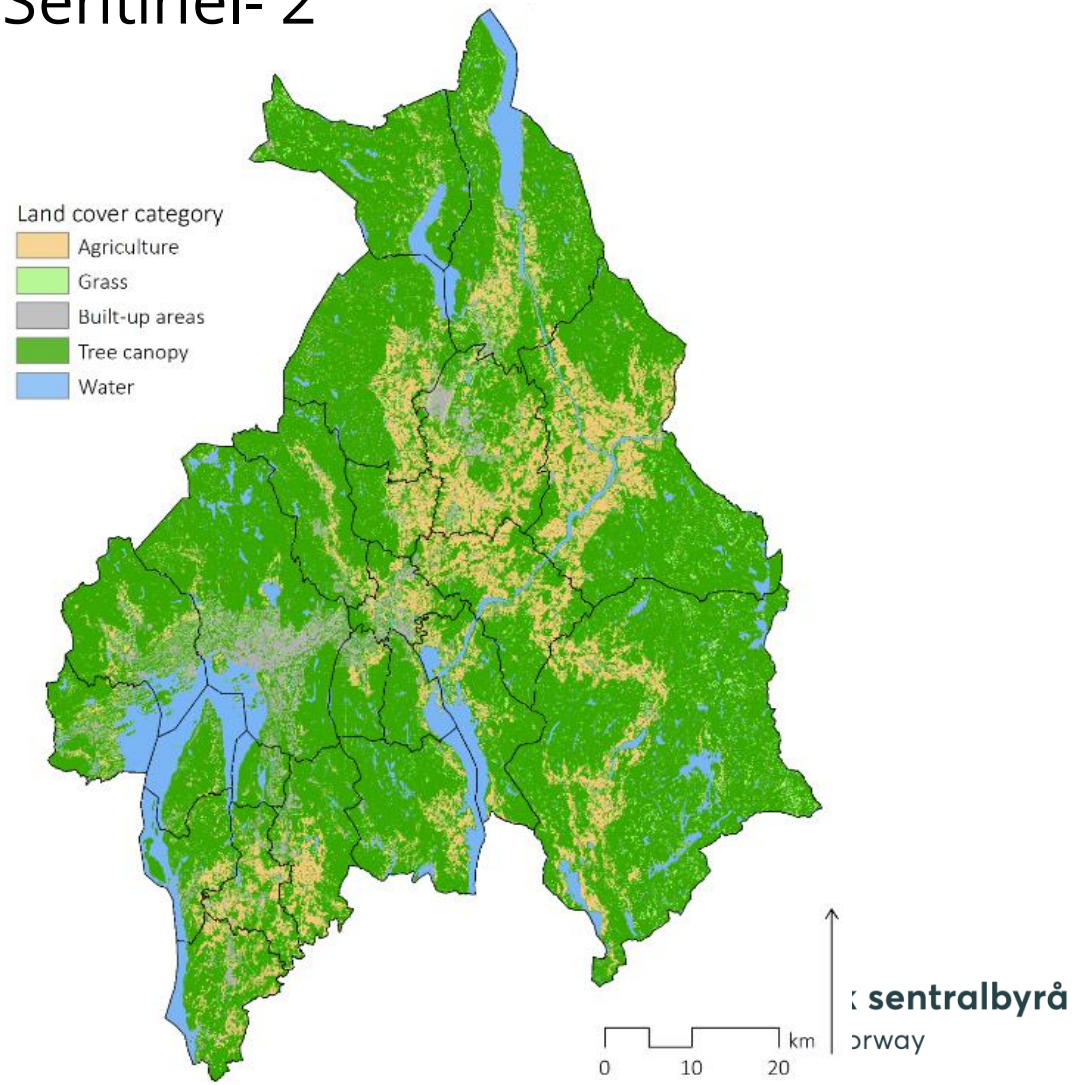

**Figur 1: For å finne ut hvilken europeisk hovedstad som tilbyr mest grøntareal for sine innbyggere har forskere i Tyskland brukt satellittdata til å måle planteliv ved en normalisert vegetasjonsindeks (NDVI). Oslo er rangert som Nordens grønneste hovedstad og blant de grønneste i hele Europa. Kilde: Philipp Gärtner / CC BY-SA 4.0**

# Land use/land cover and Sentinel-2 land cover classification in the Oslo region in 2017

Map based




Sentinel- 2

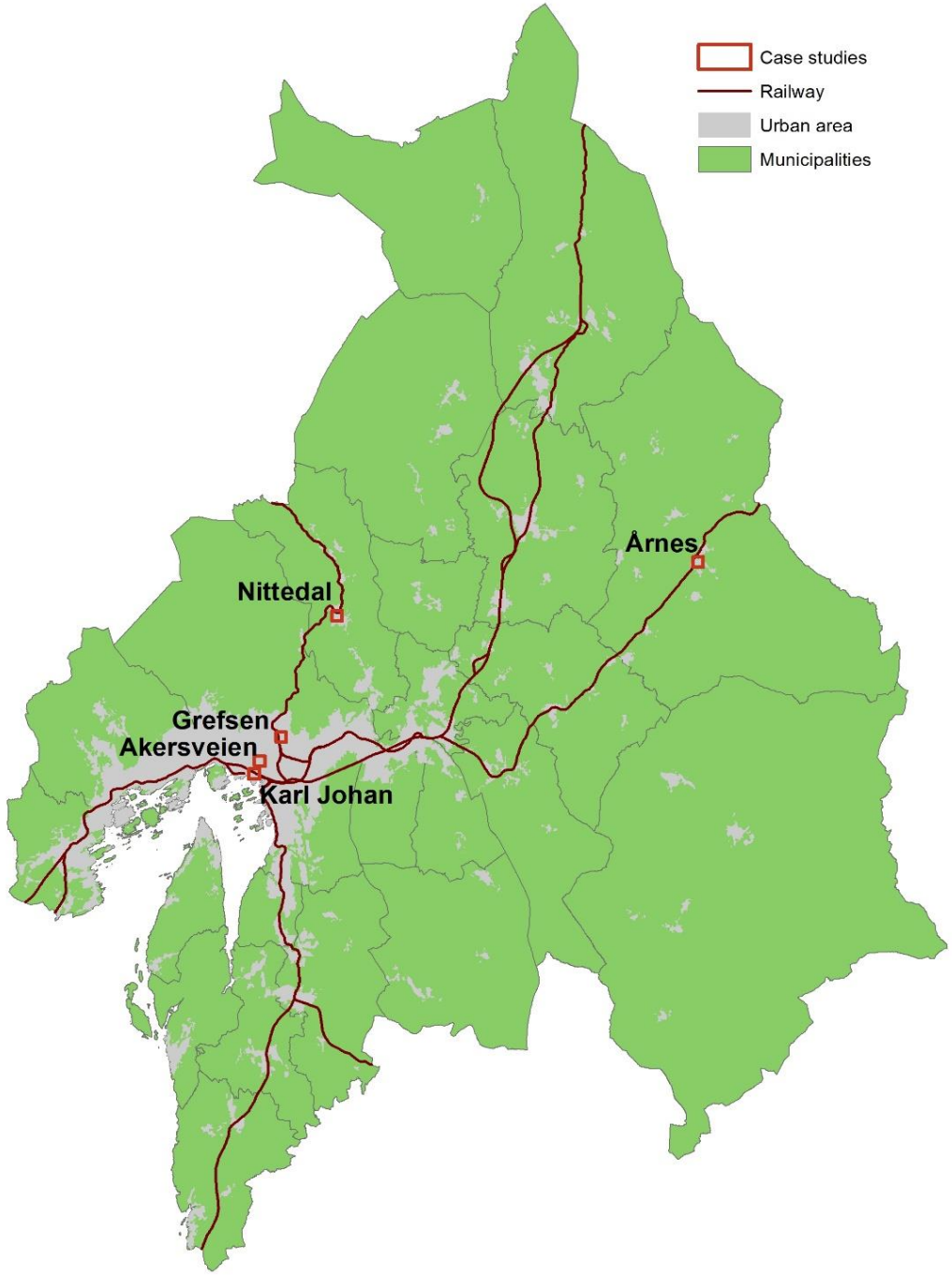


# Selected case study areas in the Oslo region

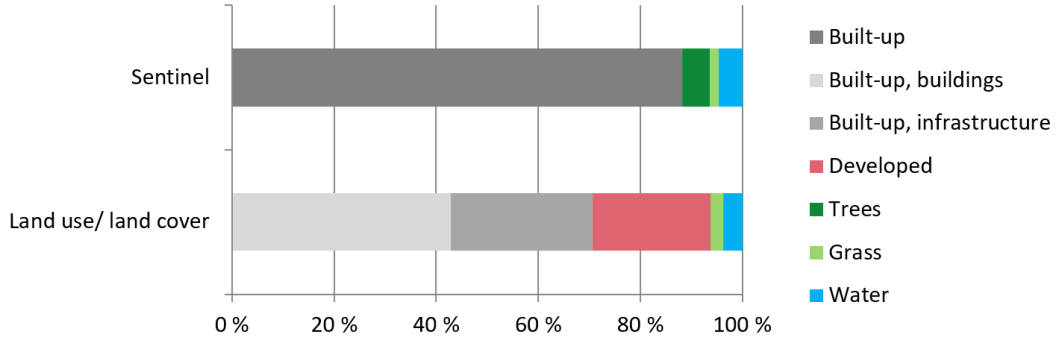
| Name, Municipality | Distance from city center, km | Population per km2 | Jobs per km2 | Characterization |
|---|---|---|---|---|
| **Old city center, Oslo** | 0 | 6 674 | 62 419 | Central, railway station |
| **Akersvegen, Oslo** | 1 | 16 374 | 11 181 | Urbanized |
| **Grefsen, Oslo** | 8 | 6 296 | 4 078 | Dense single-housing |
| **Nittedal** | 16 | 2 223 | 245 | Commuter distance , 30 minutes by train |
| **Årnes** | 80 | 1 404 | 2 365 | Rural, 50 minutes by train |

# Case studies in the Oslo-region

- Comparing areas from the city center and northeastwards. Map of the Oslo region



# Case study: The old city center




A- Land use/land cover maps

Karl Johans gate
Case study
Built-up, buildings
Built-up, infrastructure
Developed, known land use, unknown land cover
Agricultural
Grass
Water

B- Buildings, year of construction

Case study

**Buildings**

**Year of construction**

1976 or earlier
1977 - 1986
1987 - 1996
1997 - 2006
2007 - 2016

C- Sentinel-2, NDVI and orthophoto

Case study

**Sentinel 2**

**Land cover category**

Agricultural
Grass
Built-up
Trees
Water

D- Private and public green

Case study

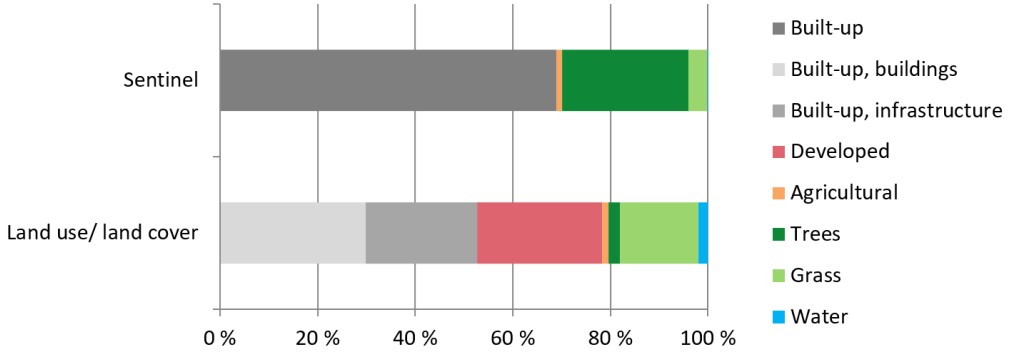
**Sentinel 2 and maps**

Green, private
Green, public access
Grey, private
Grey, public access

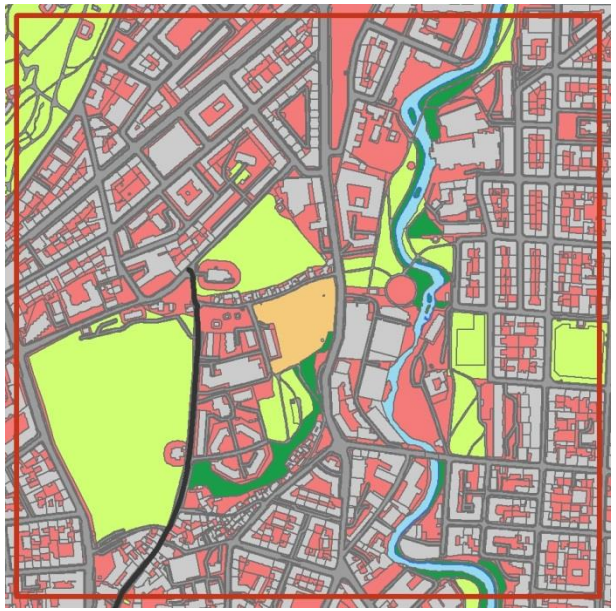
**Maps**

Water

# Case study: Akersveien

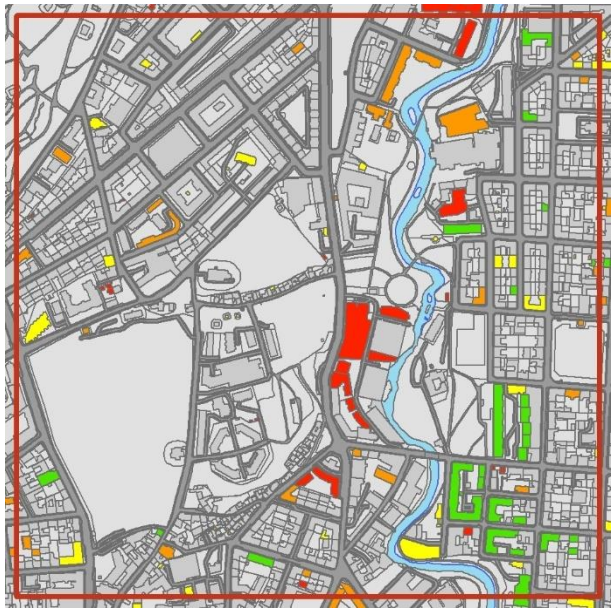



A- Land use/land cover maps



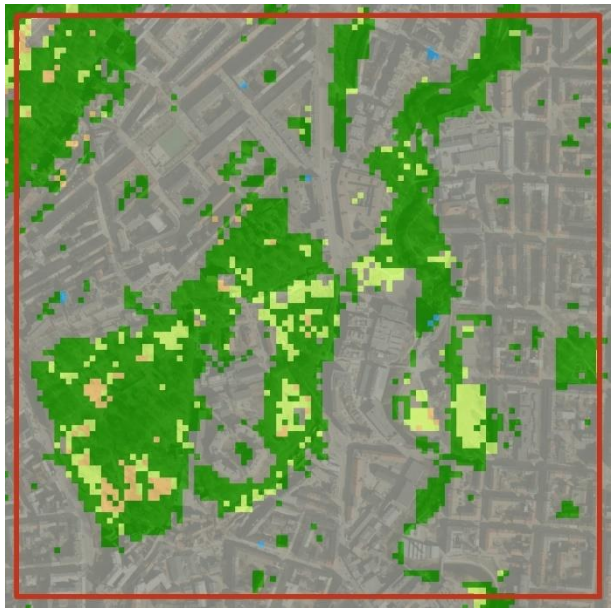
Akersveien
Case study
Built-up, buildings
Built-up, infrastructure
Developed, known land use, unknown land cover
Agricultural
Grass
Water

B- Buildings, year of construction



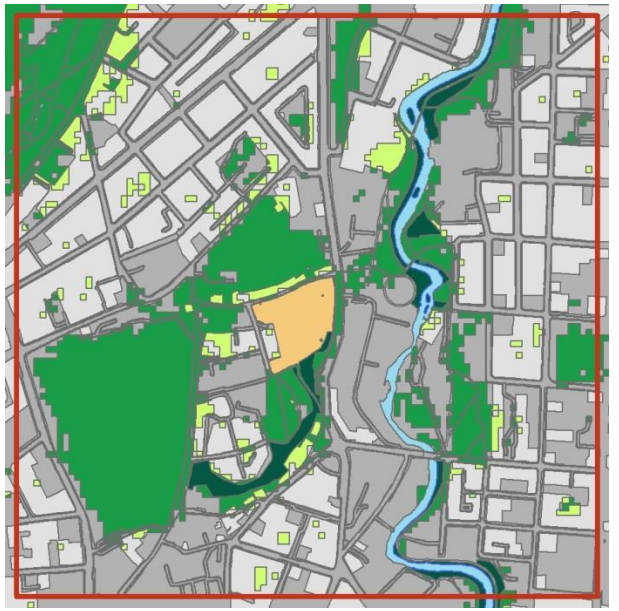
Case study
**Buildings**
**Year of construction**
1976 or earlier
1977 - 1986
1987 - 1996
1997 - 2006
2007 - 2016

C- Sentinel-2, NDVI and orthophoto



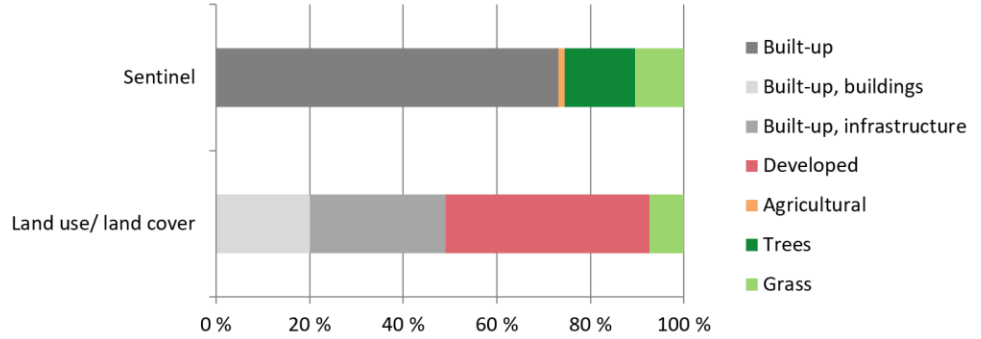
Case study
**Sentinel 2**
**Land cover category**
Agricultural
Grass
Built-up
Trees
Water

D- Private and public green

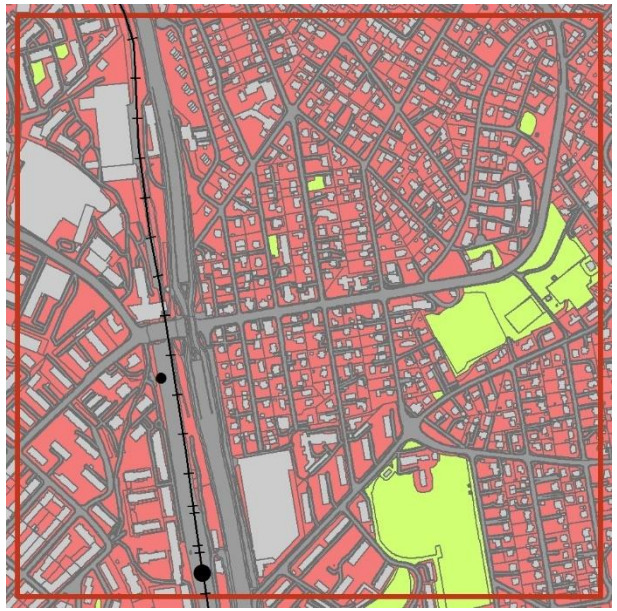


Case study
**Sentinel 2 and maps**
Green, private
Green, public access
Grey, private
Grey, public access
**Maps**
Agricultural
Forest
Water

# Case study: Grefsen




A- Land use/land cover maps



- Metro station
- Railway station
- Railway
- Case study
- Built-up, buildings
- Built-up, infrastructure
- Developed, known land use, unknown land cover
- Agricultural
- Forest
- Grass
- Water

B- Buildings, year of construction

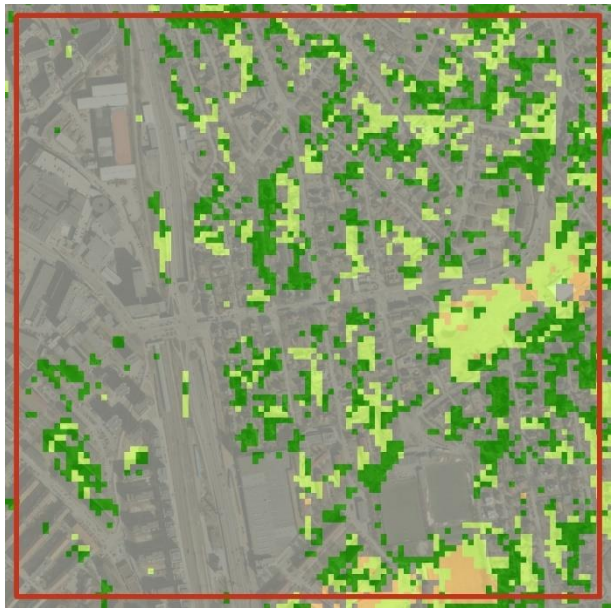
- Case study
- Densification zone

**Buildings**

**Year of construction**

- 1976 or earlier
- 1977 - 1986
- 1987 - 1996
- 1997 - 2006
- 2007 - 2016

C- Sentinel-2, NDVI and orthophoto



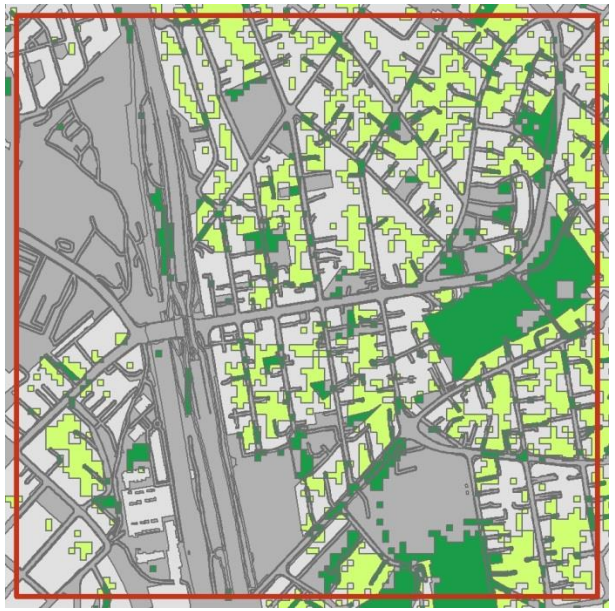
- Case study

**Sentinel 2**

**Land cover category**

- Agricultural
- Grass
- Built-up
- Trees
- Water

D- Private and public green

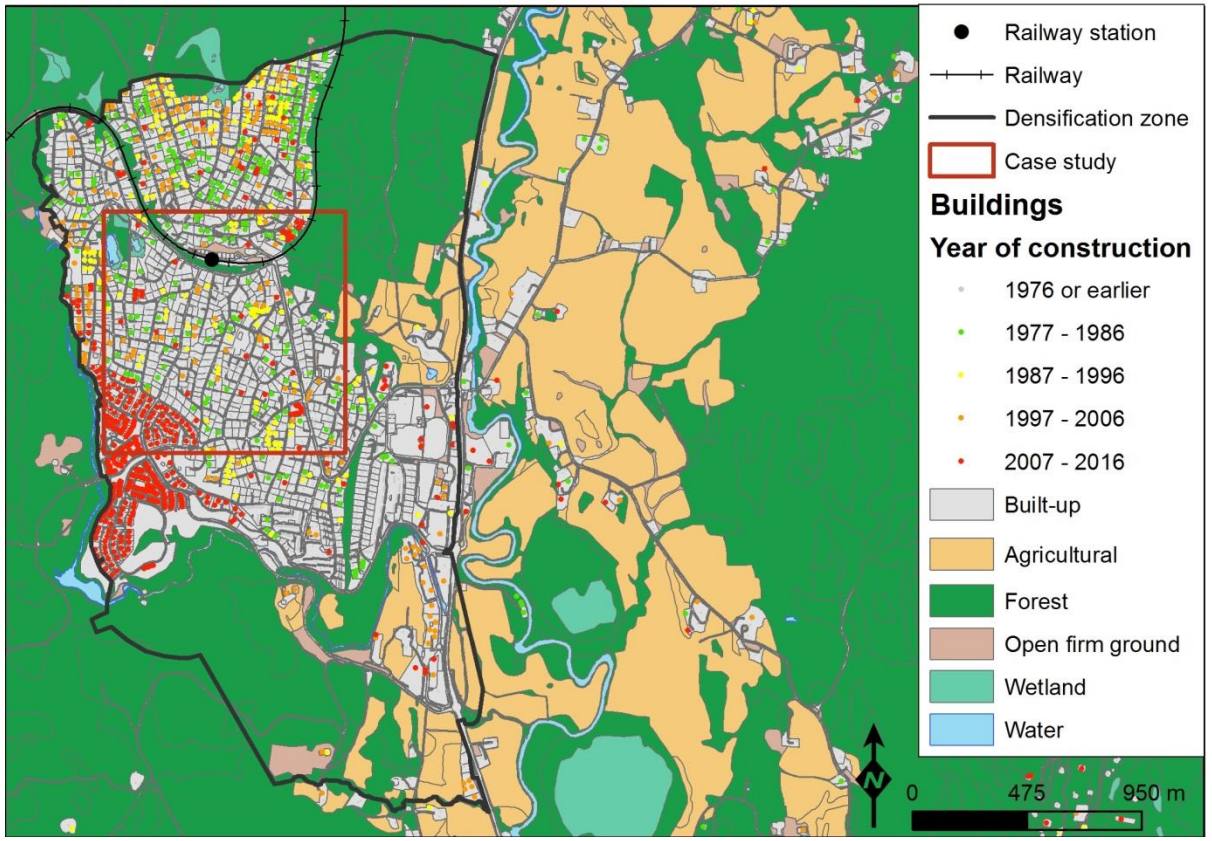


- Case study

**Sentinel 2 and maps**

- Green, private
- Green, public access
- Grey, private
- Grey, public access

# Densification area in the central area of Nittedal

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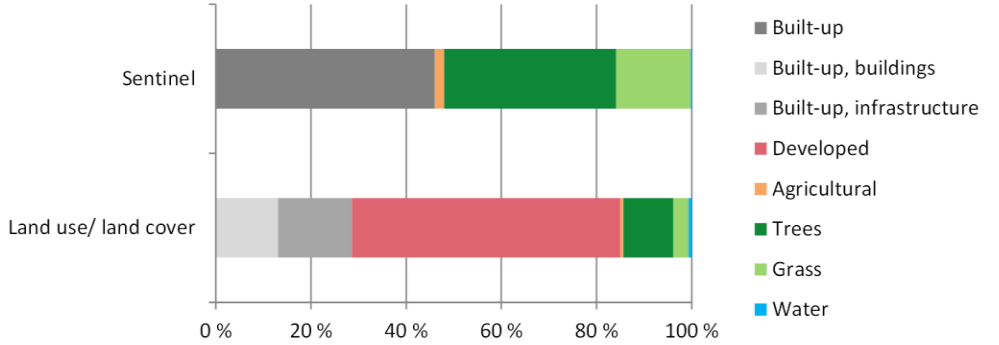
Statistics Norway

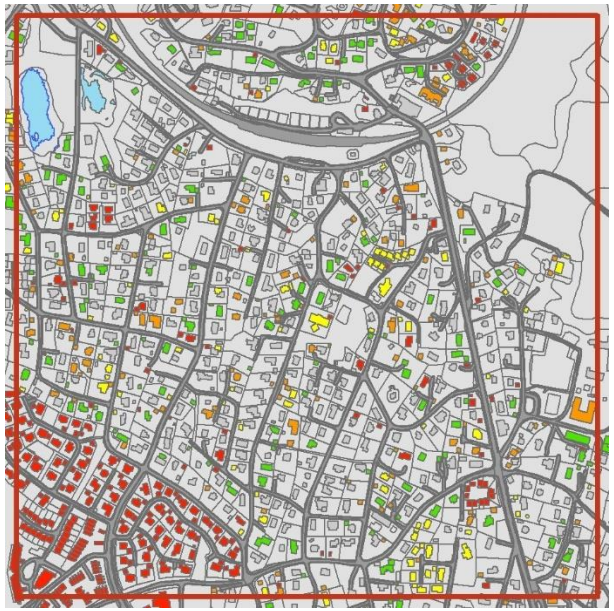
# Case study: Nittedal




A- Land use/land cover maps

Case study
Built-up, buildings
Built-up, infrastructure
Developed, known land use, unknown land cover
Agricultural
Forest
Grass
Water

B- Buildings, year of construction



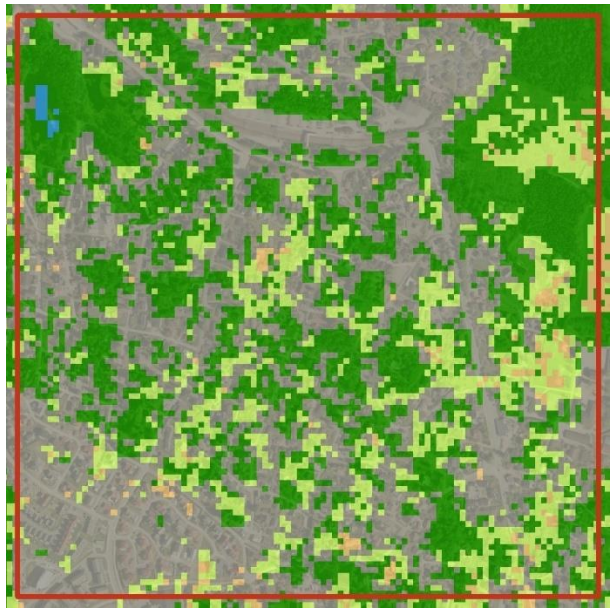
Case study

**Sentinel 2**

**Land cover category**

Agricultural
Grass
Built-up
Trees
Water

C- Sentinel-2, NDVI and orthophoto



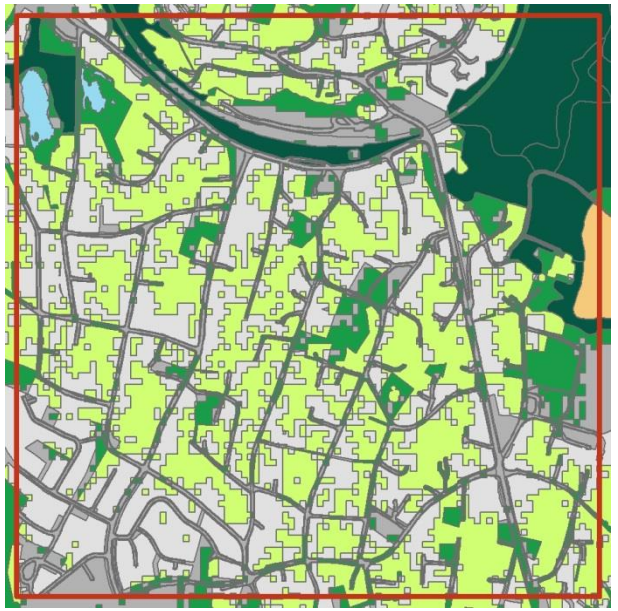
Case study

**Buildings**

**Year of construction**

1976 or earlier
1977 - 1986
1987 - 1996
1997 - 2006
2007 - 2016

D- Private and public green



Case study

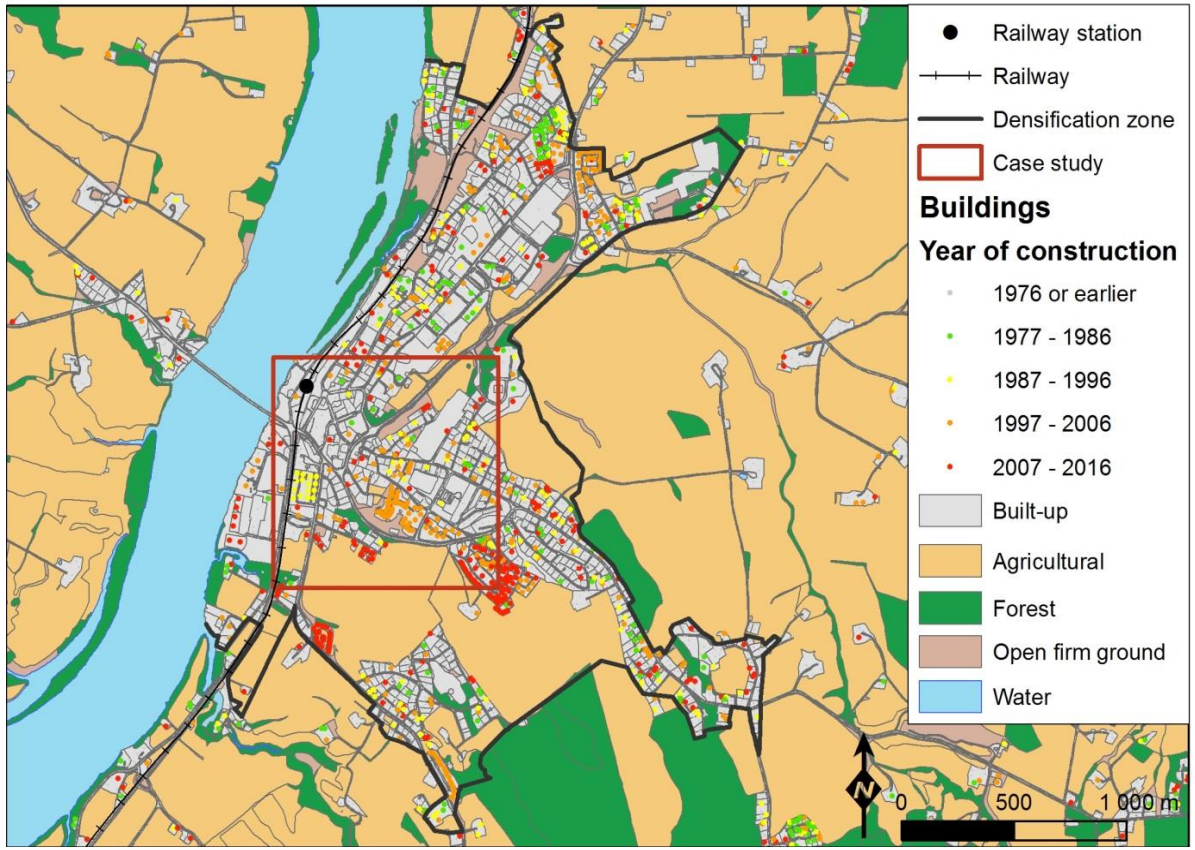
**Sentinel 2 and maps**

Green, private
Green, public access
Grey, private
Grey, public access

**Maps**

Agricultural
Forest
Water

# Årnes. Densification zone and recent development

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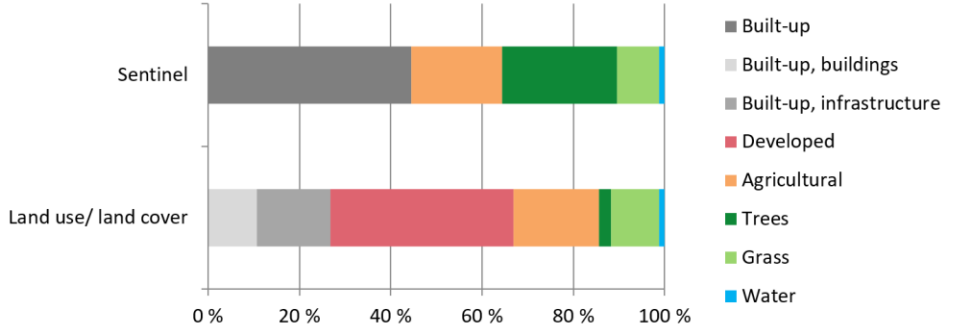
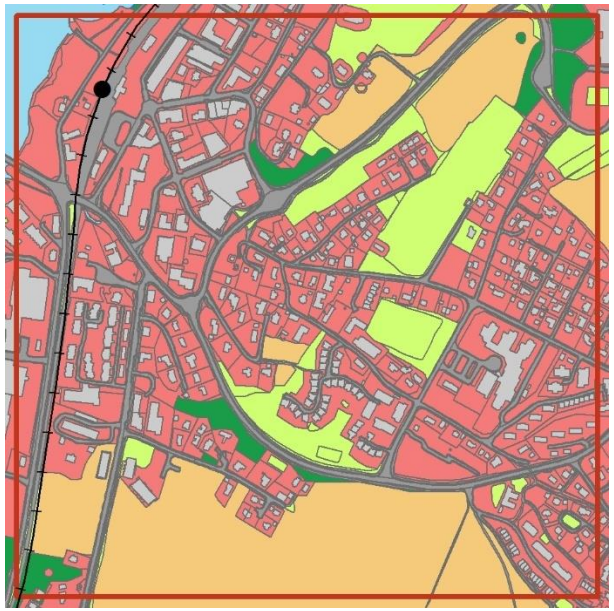
Statistics Norway

# Case study: Årnes




A- Land use/land cover maps



- Railway station
- Railway
- Case study
- Built-up, buildings
- Built-up, infrastructure
- Developed, known land use, unknown land cover
- Agricultural
- Forest
- Grass
- Water

B- Buildings, year of construction

- Case study

**Buildings**

**Year of construction**

- 1976 or earlier
- 1977 - 1986
- 1987 - 1996
- 1997 - 2006
- 2007 - 2016

C- Sentinel-2, NDVI and orthophoto

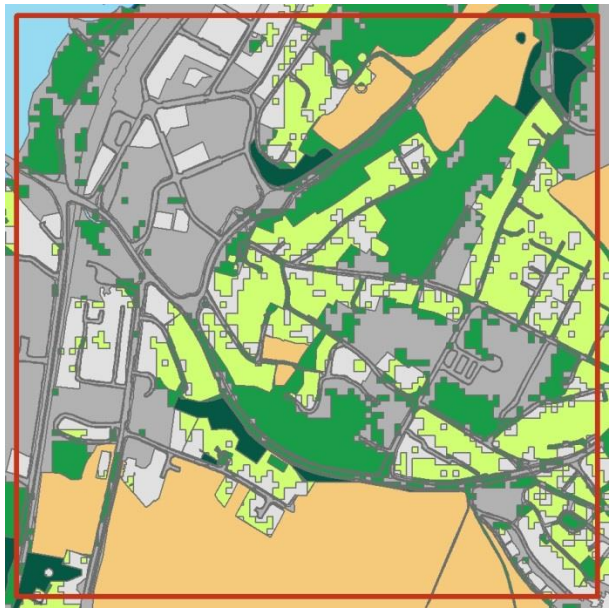
- Case study

**Sentinel 2**

**Land cover category**

- Agricultural
- Grass
- Built-up
- Trees
- Water

D- Private and public green



- Case study

**Sentinel 2 and maps**

- Green, private
- Green, public access
- Grey, private
- Grey, public access

**Maps**

- Agricultural
- Forest
- Water

# Decision rules based on the case studies

| Case Study | Land use/land cover | Sentinel-2 |
|---|---|---|
| **City Center** | Streets,public places, markets and buildings, Some large plots of grasslands as public parks | Trees and green Shadows as water. The data sources allow us to separate private green from public. Here it is no private green areas. |
| **Akersveien** | Public parks and graveyards, Water, Allotments | Lot of trees and green, No Water Agriculture misclassified |
| **Grefsen** | No green except sports areas and public institutions | No streets, Lots of trees and green space in private gardens. Misclassification of agriculture |
| **Nittedal** | Buildings and infrastructure Forest, water and agriculture as map based land use. | Private green and trees, Not so much green in the new developed area, Agriculture misclassified |
| **Årnes** | Little green in the old part of the city. Some new expansion on agricultural land | Private green dominates in the villa-areas, Large public green areas which could be developed. |

# Land use and public and private green areas in the case study areas, ha and %

Sentinel-2. Corresponds to map C

| | Karl Johan | Akersveien | Grefsen | Nittedal | Årnes |
|---|---|---|---|---|---|
| Built-up | 88,3 | 68,9 | 73,2 | 46,0 | 44,5 |
| Agricultural | | 1,1 | 1,3 | 2,0 | 19,9 |
| Trees | 5,4 | 25,9 | 15,1 | 36,1 | 25,3 |
| Grass | 1,7 | 3,9 | 10,4 | 15,7 | 9,1 |
| Water | 4,6 | 0,1 | | 0,2 | 1,2 |

Land use/ land cover Corresponds to map A

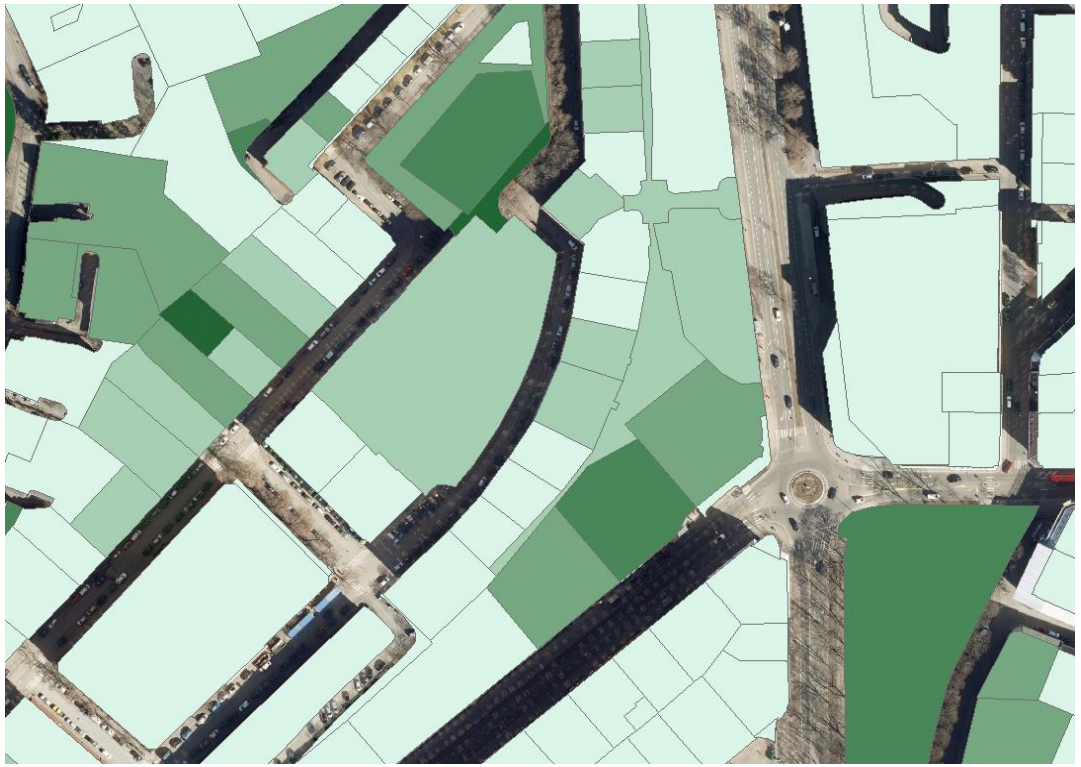
| | Karl Johan | Akersveien | Grefsen | Nittedal | Årnes |
|---|---|---|---|---|---|
| Built-up | 70,7 | 52,7 | 49,0 | 28,5 | 26,8 |
| Developed | 23,0 | 25,6 | 43,5 | 56,5 | 40,1 |
| Agricultural | | 1,4 | | 0,6 | 18,8 |
| Trees | 0,0 | 2,4 | | 10,5 | 2,6 |
| Grass | 2,5 | 16,1 | 7,4 | 3,2 | 10,5 |
| Water | 3,7 | 1,9 | | 0,7 | 1,2 |

# Land use and public and private green areas in the case study areas, ha

Combination, maps and Sentinel. Corresponds to map D

| | Karl Johan | Akersveien | Grefsen | Nittedal | Årnes |
|---|---|---|---|---|---|
| Green, private | 0,0 | 3,5 | 15,7 | 30,7 | 15,8 |
| Green, public access | 7,0 | 23,2 | 11,1 | 12,7 | 20,1 |
| Grey, private | 2,1 | 25,4 | 28,3 | 29,7 | 12,1 |
| Grey, public access | 87,1 | 42,3 | 44,9 | 15,2 | 29,4 |
| Agricultural | | 1,4 | | 0,6 | 18,8 |
| Forest | 0,0 | 2,4 | | 10,5 | 2,6 |
| Water | 3,7 | 1,9 | | 0,7 | 1,2 |

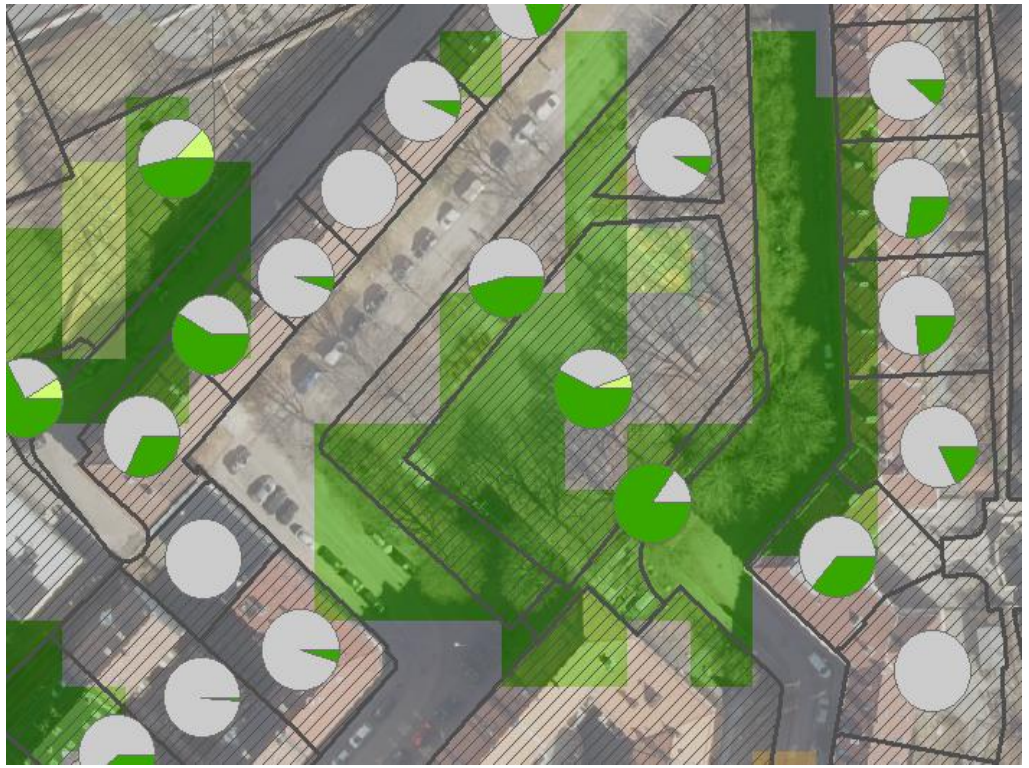
# intersection of Sentinel-2 landcover classification and Statistics Norways land use map



Landuse maps and Sentinel 2

Share of green

- 0 - 20 %
- 21 - 40 %
- 41 - 60 %
- 61 - 80 %
- 81 - 100 %



Landuse maps and Sentinel 2

- Grass
- Trees
- Built_up

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# Thank You!

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