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Urban densification potentials and energy impacts in Switzerland

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Densification: Global context

Densification: Global context

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- 68% of world population projected to live in urban areas by 2050
- In many cities green spaces are being reduced
- High density living results in a wide range of environmental problems
- Paradox of densification
- UN Sustainable development Goal Nr 11: Building sustainable cities
- Debate on dis/advantages of high density: optimal density?

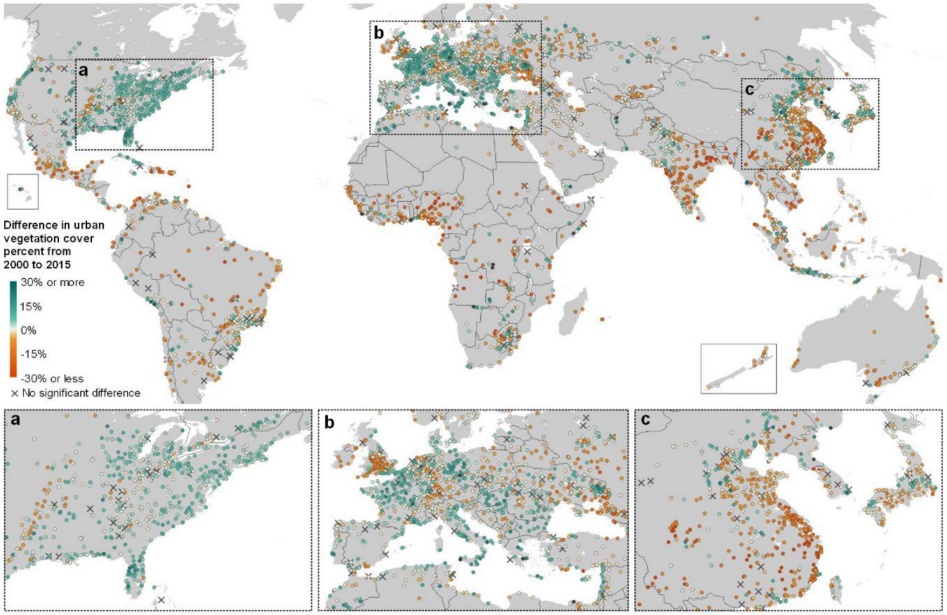
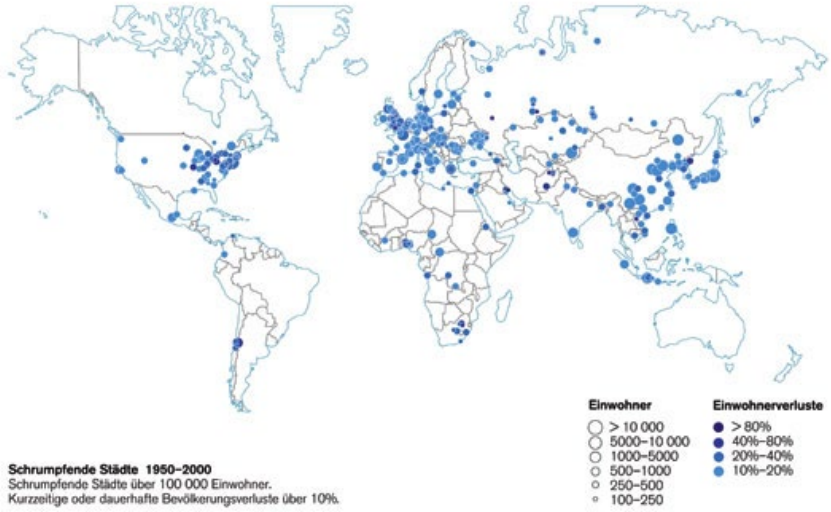


Figure 4. Net difference in vegetation cover percentage between 2000 and 2015, in all urban areas larger than 15 km^2 that existed in both these years. Inset subfigures show more detail for regions with large numbers of urban areas; (**a**) eastern North America, (**b**) Europe, and (**c**) East Asia. Significant vegetation cover change shown for 4,093 urban areas and no significant change shown for 163 urban areas.

Richards & Belcher 2020: https://doi.org/10.3390/rs12010023



http://www.cluster.eu/shrinking-citiescitta-che-si-spopolon

Densification: Swiss context

Source: https://www.nzz.ch/schweiz/schoene-neue-raumordnung-ld.1453214, Image: ETH-Bildarchiv / Stiftung Luftbild Schweiz / Swissair Photo / CC BY-SA 4.0

Densification: Swiss context

Source: https://www.nzz.ch/schweiz/schoene-neue-raumordnung-ld.1453214, Image: ETH-Bildarchiv / Stiftung Luftbild Schweiz / Swissair Photo / CC BY-SA 4.0

Densification: Swiss context

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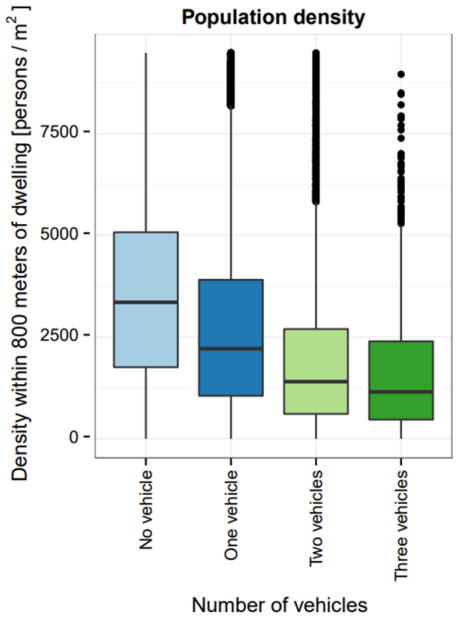
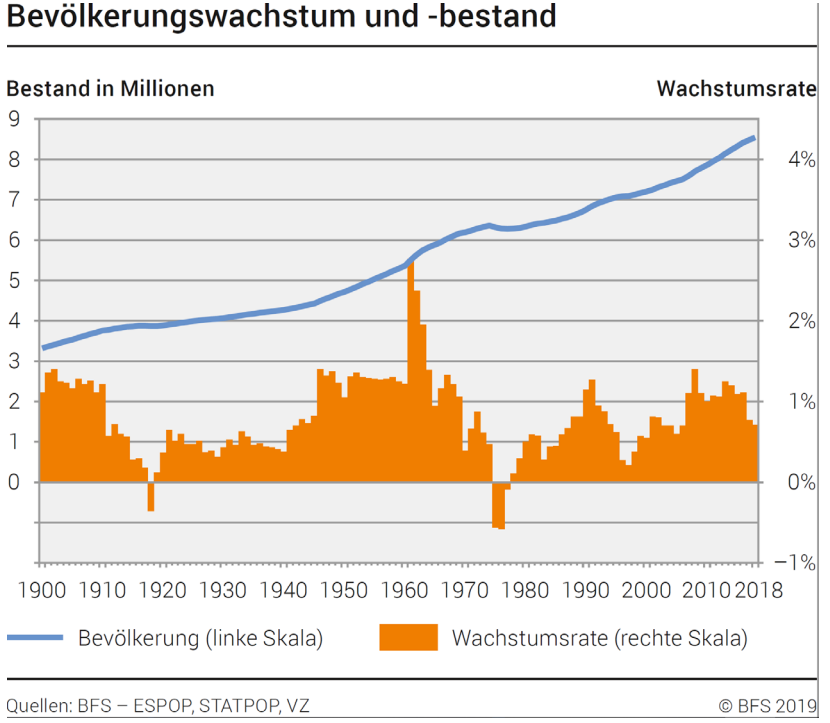
- Increase in population, urban sprawl
- High rate of new development sites, reduction of high-quality agricultural land
- Swiss regulations promote intra-urban densification, creation of compact development
- Densification as a sustainable urbanization strategy to reduce per capita environmental impacts
- Research Questions: re-densification potentials, impacts (energy, transport…)

→ Densification needs to be sustainable



https://www.research-collection.ethz.ch/bitstream/handle/20.500.11850/102903/ab1093.pdf?sequence=4&isAllowed=y



Methodology

Geospatial Analysis

- Densification (also urban consolidation or redensification)
- Focus on neighborhoods in urban Switzerland
- Post-war time-period (1945-1985)
  - Poor energy performance
  - Large post-war building stock
  - Large densification potential due to modernistic typological arrangement

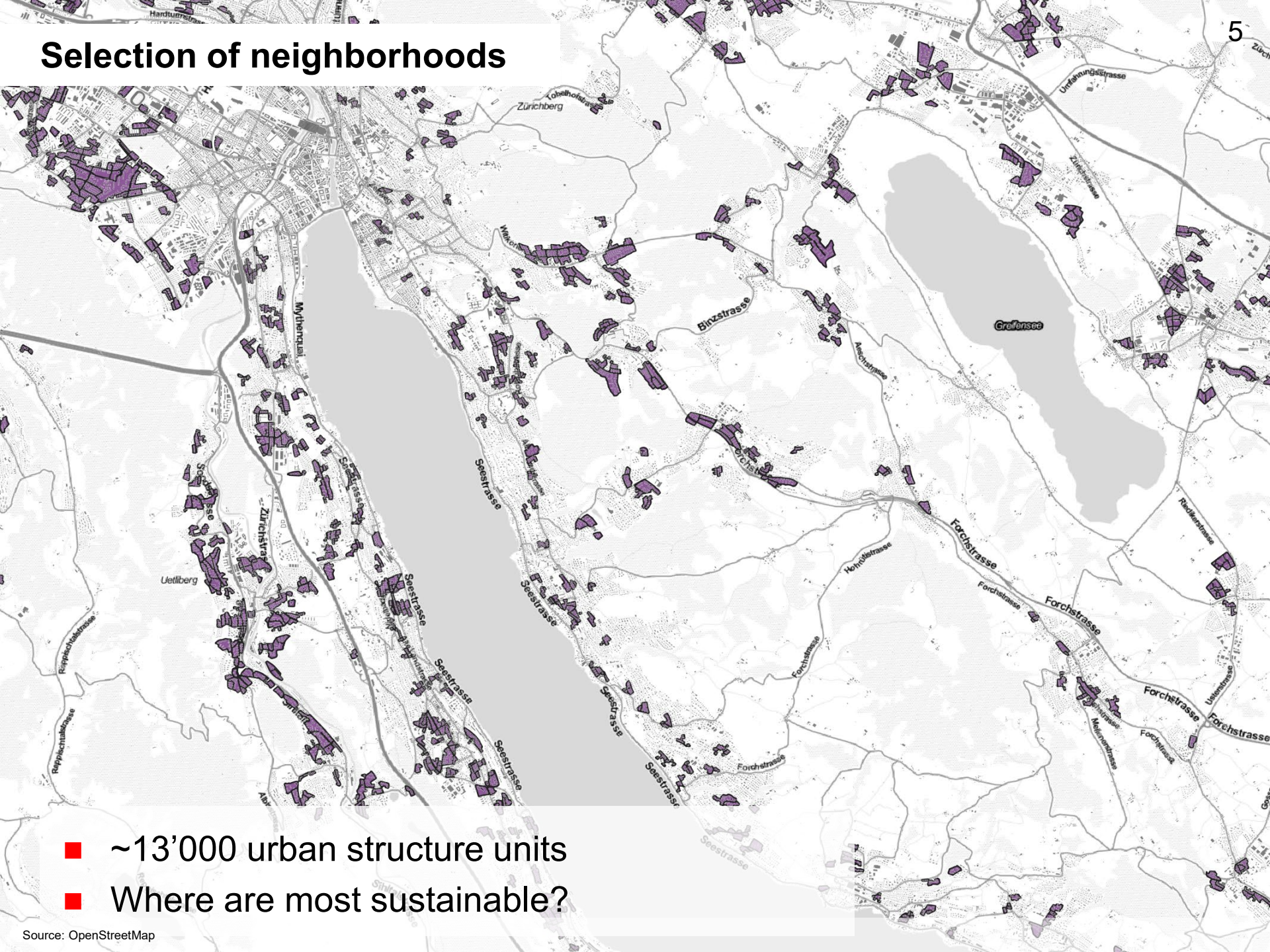
Source: OpenStreetMap

Selection of neighborhoods

- No single family homes
- No industry
- Only post-postwar building
- Neighbourhood definition

Source: OpenStreetMap

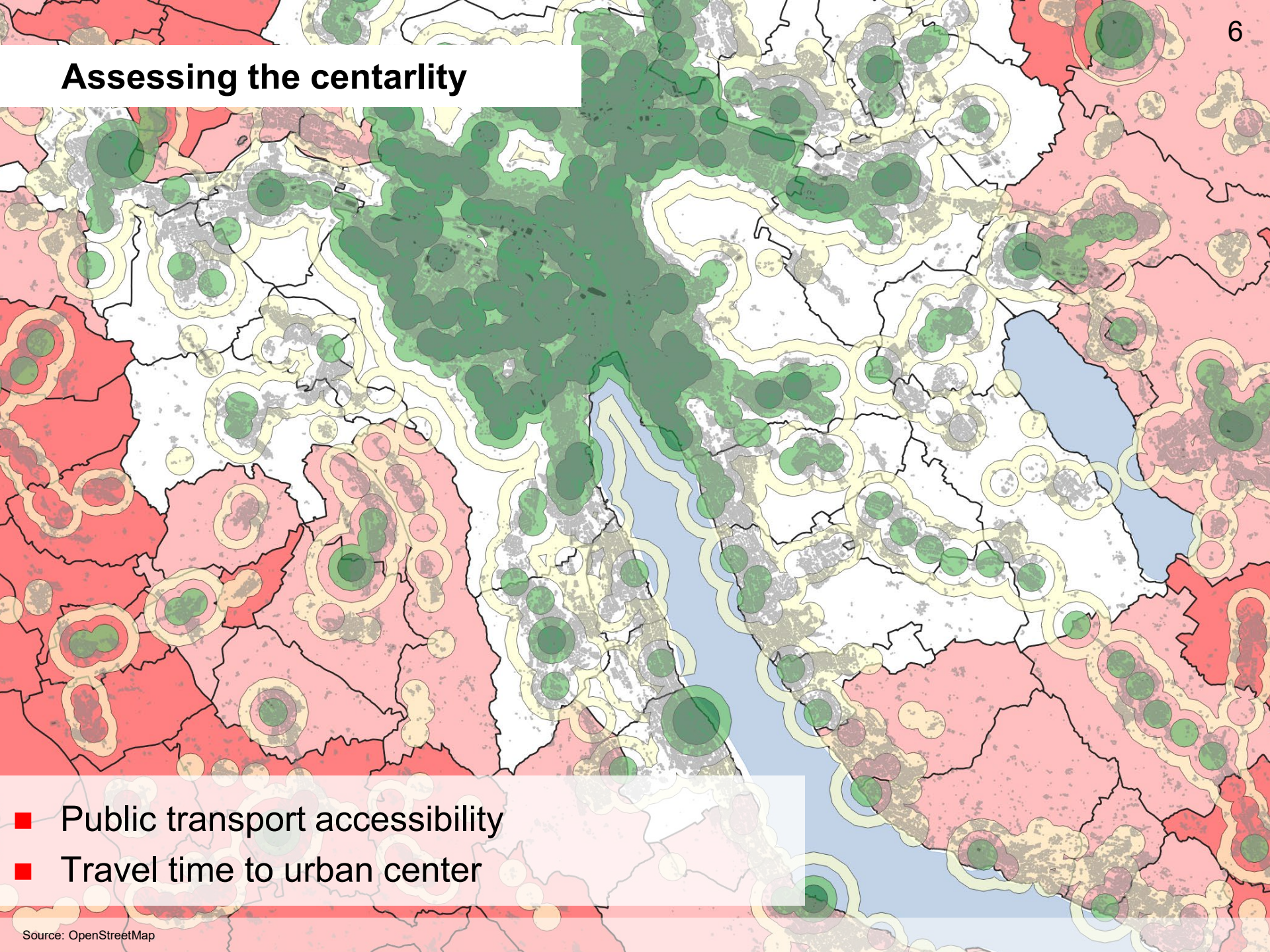
Selection of neighborhoods



- ~13’000 urban structure units
- Where are most sustainable?

Source: OpenStreetMap

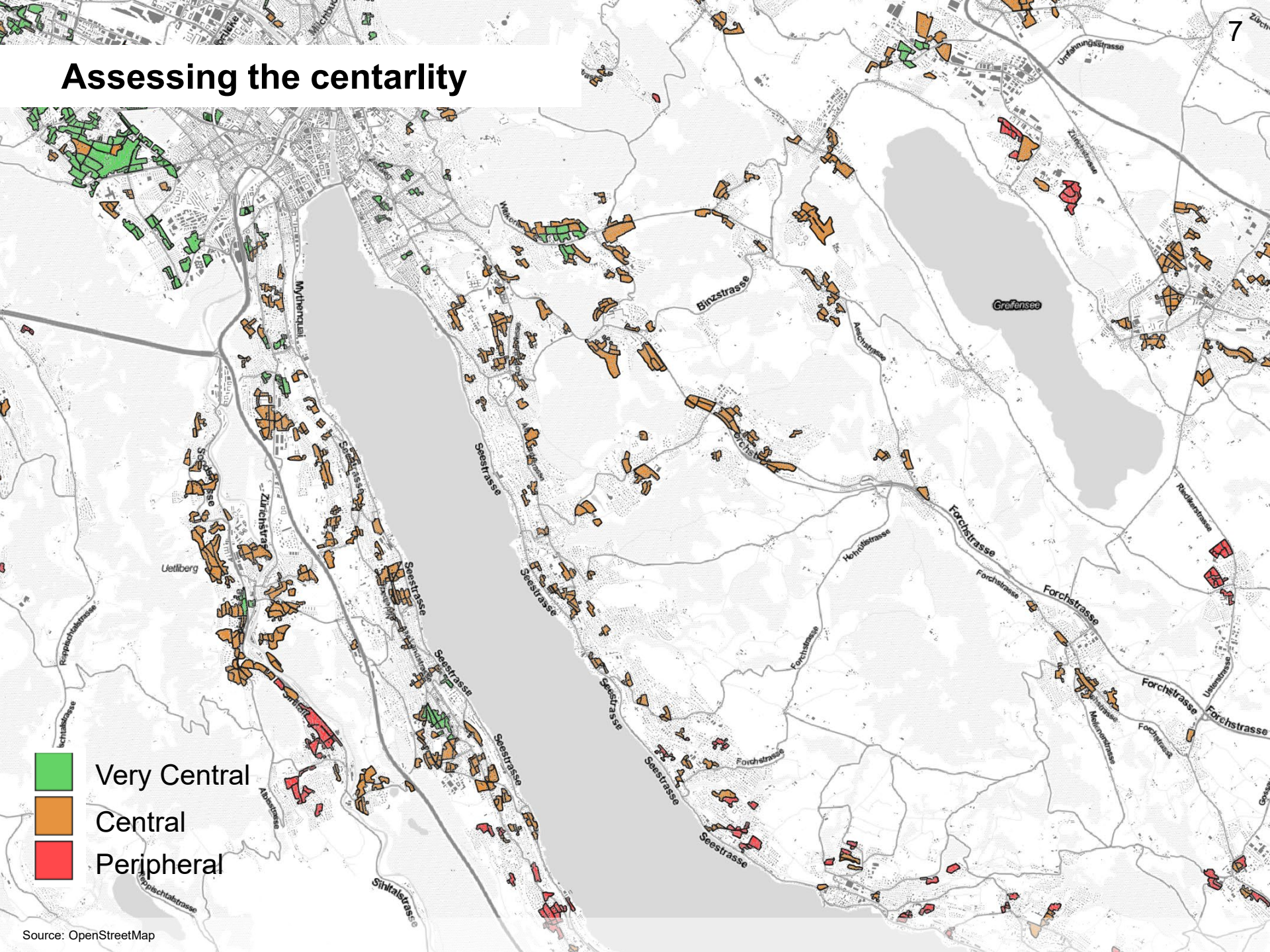
Assessing the centarlity



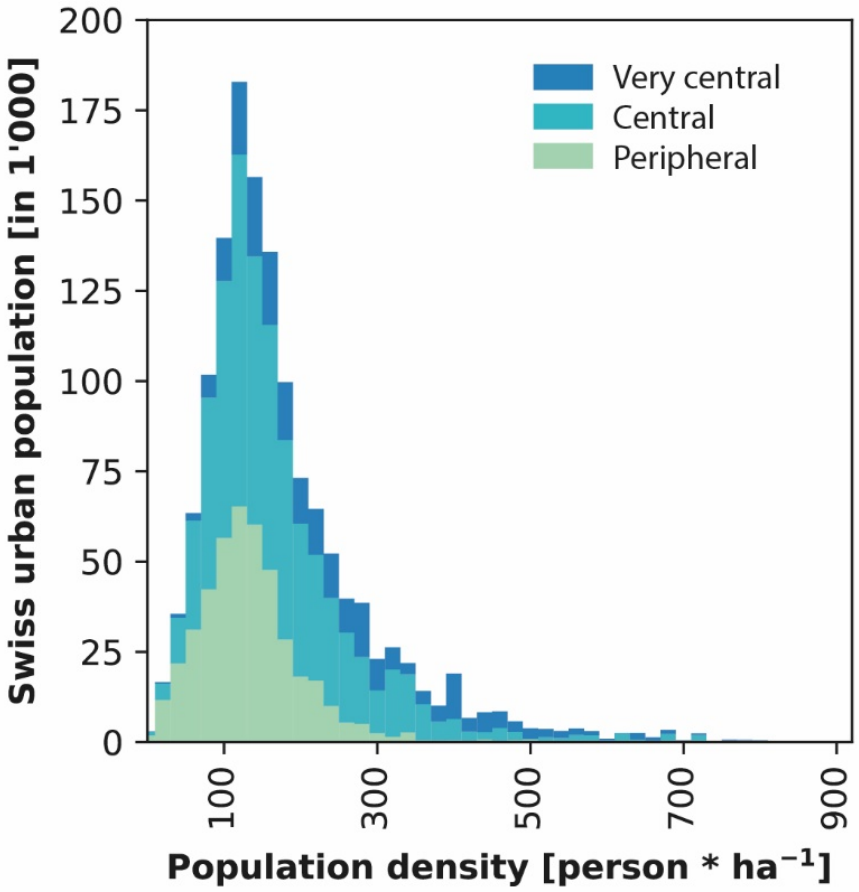
- Public transport accessibility
- Travel time to urban center

Source: OpenStreetMap

Assessing the centarlity



Assessing Swiss post-war neigbhorhoods



- Central neighborhoods have already high densities
- Many post-war neighborhoods with central or peripheral locations

Generic Densification potentials

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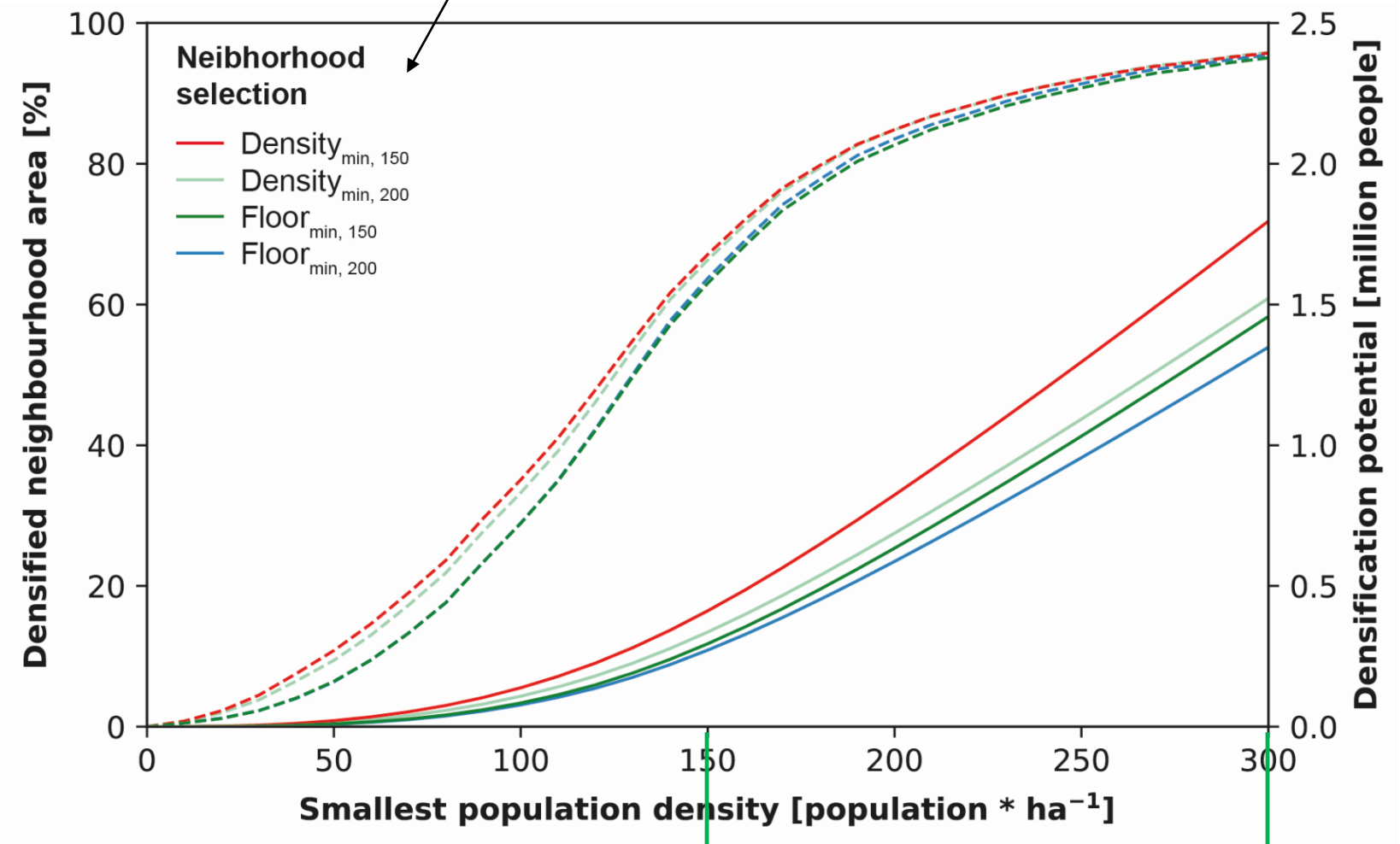
Different methods to define and select neighborhoods



Densification potential in relationship to current Swiss population

~4.5%

~17%

Generic Densification potentials

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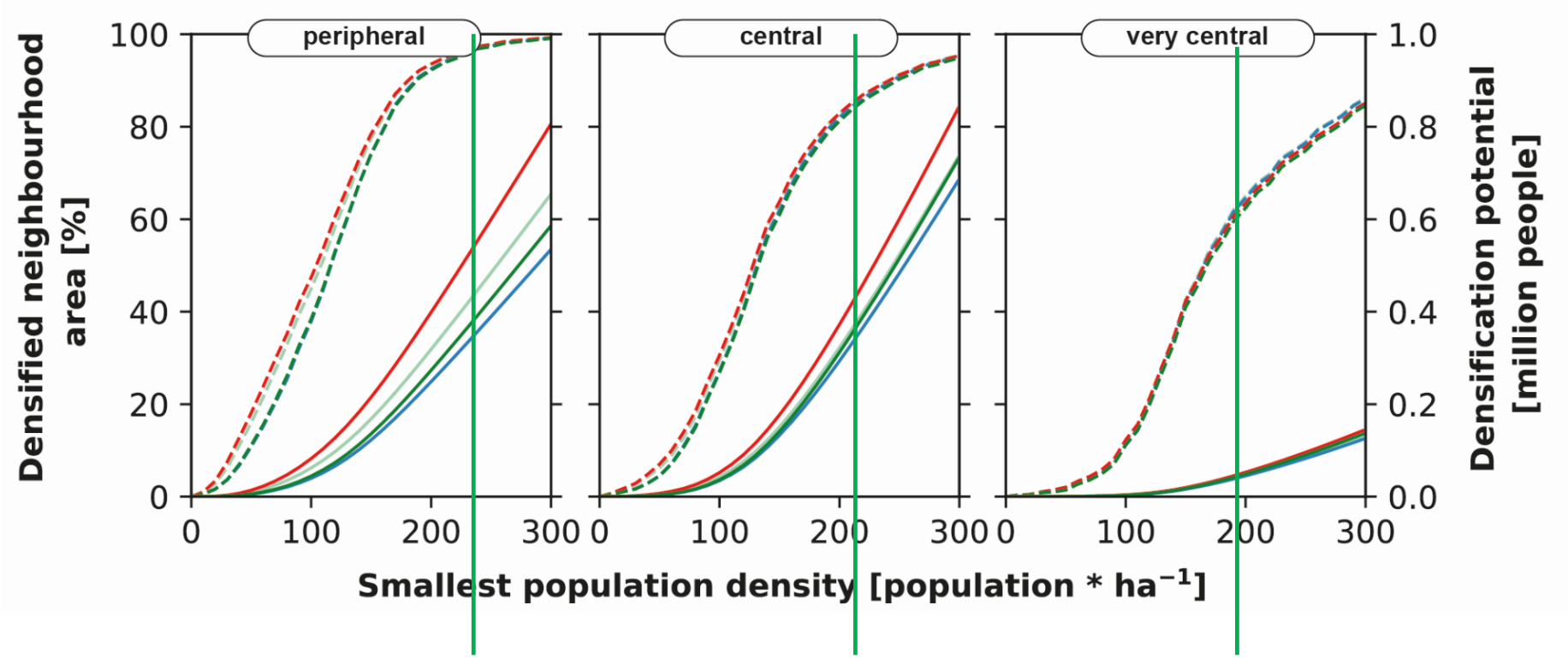

- Achieveing a minimum density of 200 pop / ha:
  - Peripheral: ~0.4 million people
  - Central: ~0.4 million people
  - Central ~0.1 million people

Neighbourhood archetypes

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A1

A2

A3

A4

A5

Source: GoogleStreetMap

Archetypes

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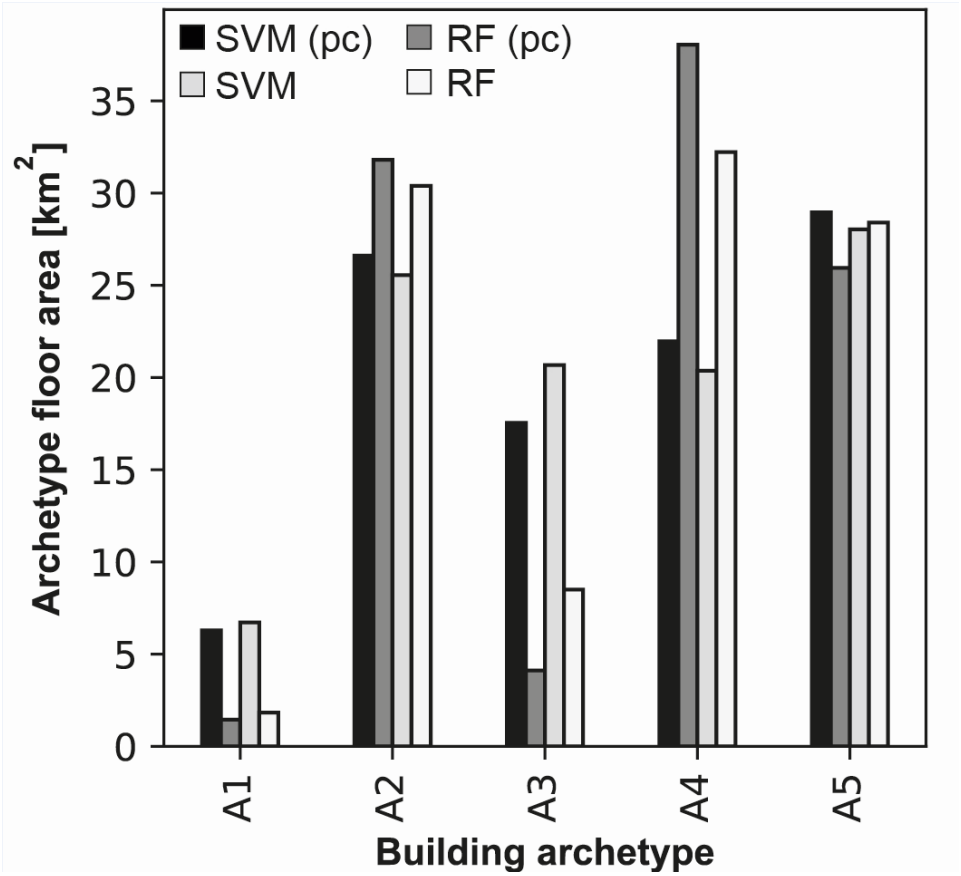
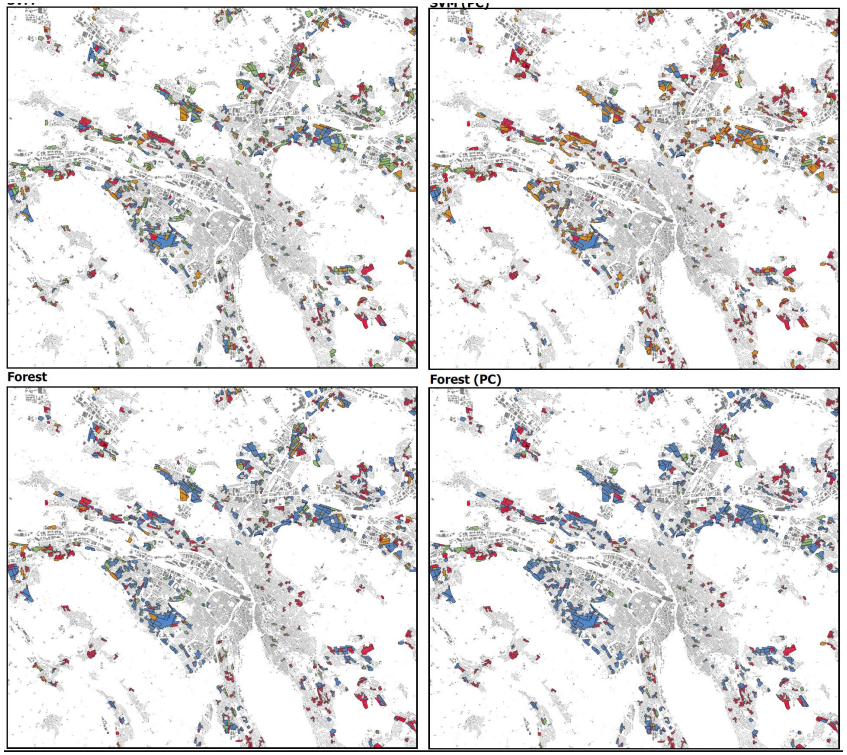
- Characterization of urban form and neighborhood characteristics
- Supervised classification with support vector machine, random forest





Outlook

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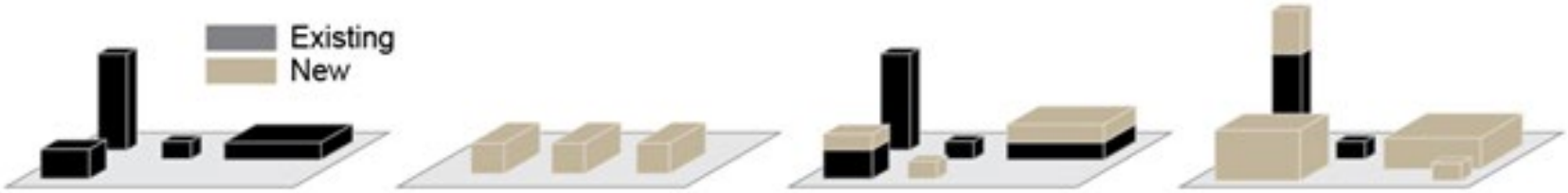
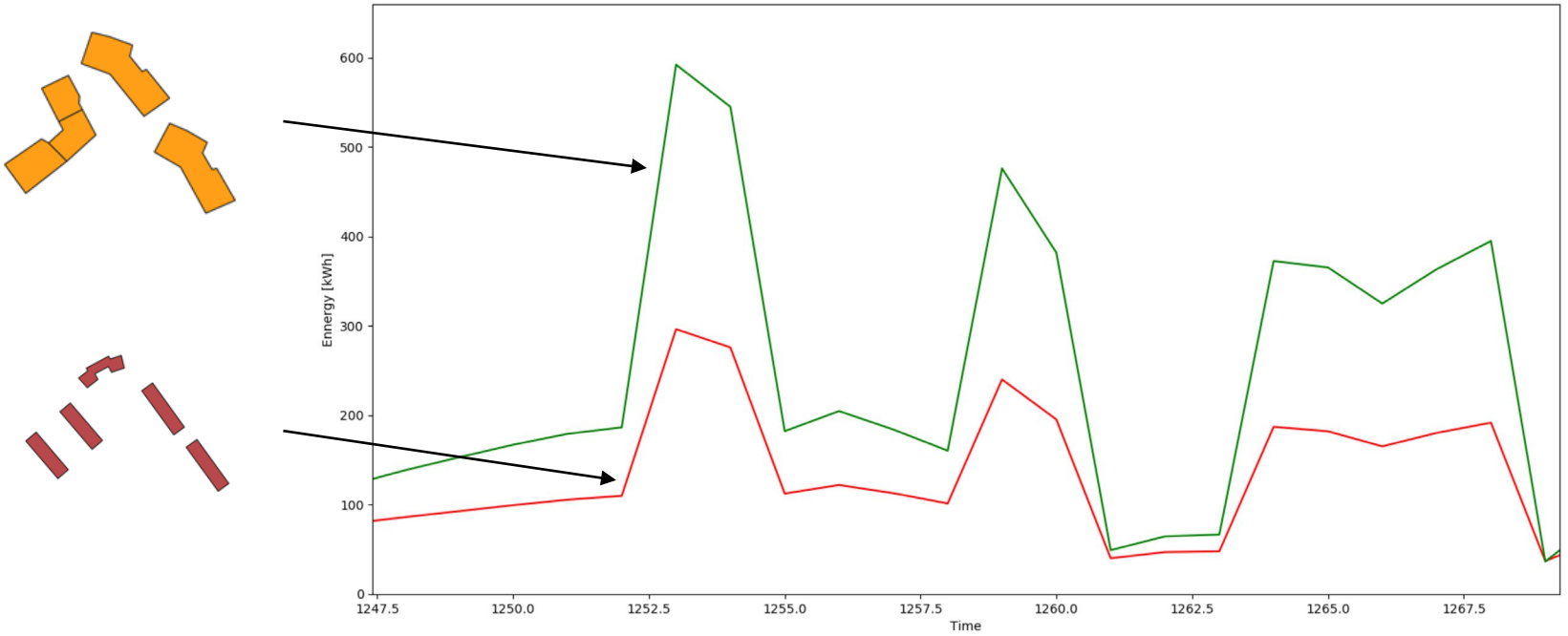
- Develop densification scenarios



- Case-study energy impact assessment



Conclusion

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- Automatic identification of neighborhoods to assess densification potential is challenging (Data availability, Neighborhood definition …)
- Geographical characterization allows to priorize sustainable densification potentials
- Sustianable Swiss densification potentials are mainly in current urban centres such as Zurich or Bern.
- Archetype-based approach is necessary for in-detailed architectural estimations.
- Supervised classification of different neigborhood archetypes is promising to up-scale densification of case-studies