

How green have roofs in Berlin become?

Evaluation of green roof subsidy program performance using geodata and deep learning

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MOTIVATION

Green roofs are one of the most widely applied types of Blue-Green Infrastructure (BGI) in urban regions. Their large-scale adoption can enhance resilience against urban hazards and mitigate the impacts of future climate. Currently, the most popular policy format to encourage their roll-out are subsidy programs. However, the lack of proper data and evaluation tools hinders a frequent **monitoring of green roof incentivization policy effectiveness**. New tools for **analysis of green roof distribution and assessment of green roof potentials** are needed to support policymakers in devising sustainable urban management.

Here, we identify an **open-source framework** to evaluate the efficacy of green roofing subsidy programs in Berlin (Germany), using geospatial data and deep learning. The state-of-the-art deep learning algorithm "Roofpedia" (Wu and Biljecki, 2021) is applied to identify green roofs and further analyse their urban coverage before and after a subsidy program, called "GründachPlus", which started in 2019.

RESEARCH QUESTION

How to efficiently and systematically track the **spatial** and **temporal** development of **green roofs** to **evaluate the efficacy of green roof subsidy programs**?

METHODOLOGY & TOOLS

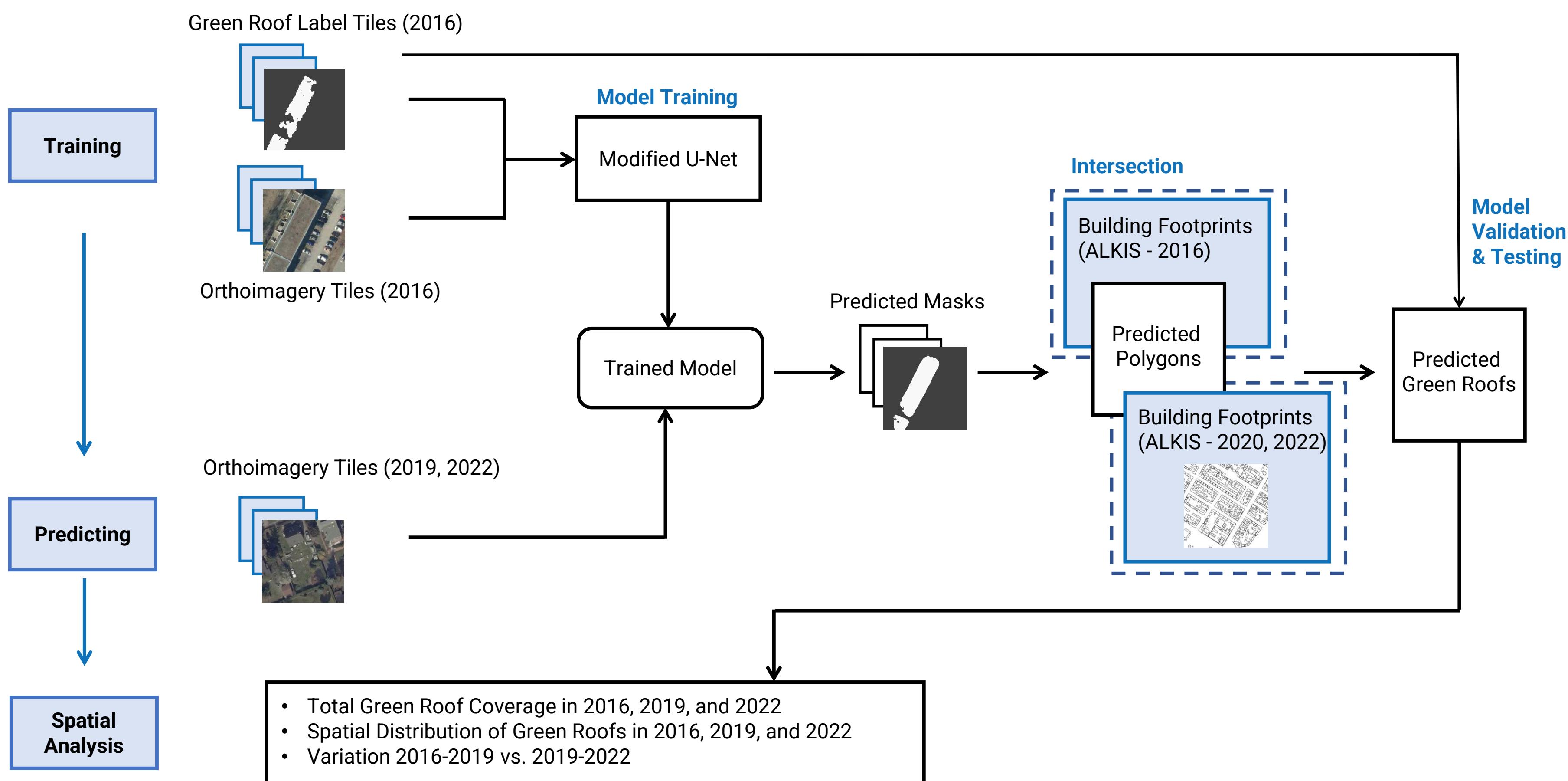


Fig. 1: Methodology flowchart (partially adapted from Wu & Biljecki, 2021)

References

1. Coenradie, B., Haag, L., Streng, B., Schiffrer, S., & Müller, K. (2016). Erhebung und Aufbereitung von Informationen zum Gründachbestand in Berlin (in German). Senate Department for Urban Development and the Environment of Berlin. Retrieved from https://www.berlin.de/umweltatlas/_assets/literatur/ab_versiegelung_2016.pdf. Accessed on 15.03.2023.
 2. Pauligk, A., Stöckigt, B., & Streng, B. (2022). Erhebung und Aufbereitung von Informationen zum Gründachbestand in Berlin 2020 (in German). Senate Department for Urban Development, Building and Housing. Retrieved from https://www.berlin.de/umweltatlas/_assets/literatur/ab_gruendach_2020.pdf?ts=1678733793. Accessed on 15.03.2023.
 3. Wu, A. N., & Biljecki, F. (2021). Roofpedia: Automatic mapping of green and solar roofs for an open roofscape registry and evaluation of urban sustainability. Landscape and Urban Planning, 214, 104167.

RESULTS & DISCUSSION

1. Evaluation of the Green Roof Identification Algorithm (Roofpedia; Wu & Biljecki, 2021)

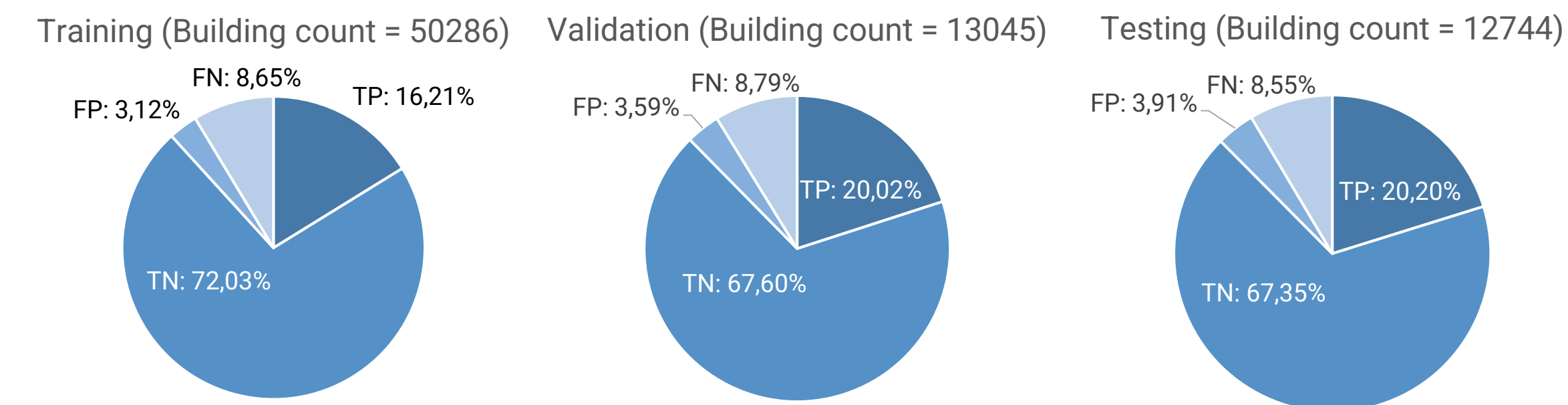


Fig. 2: Bar charts illustrating ratios of TP, TN, FP, FN counts to total building counts in algorithm training, validation, and testing

- Stable model performance (Fig. 2 & 3)
- #### 2. Spatial Distribution of Green Roofs in 2016 & Development (2016-2019, 2019-2022)
- Larger increase of green roofs since the subsidy program in 2019 (Fig. 4 & 5)

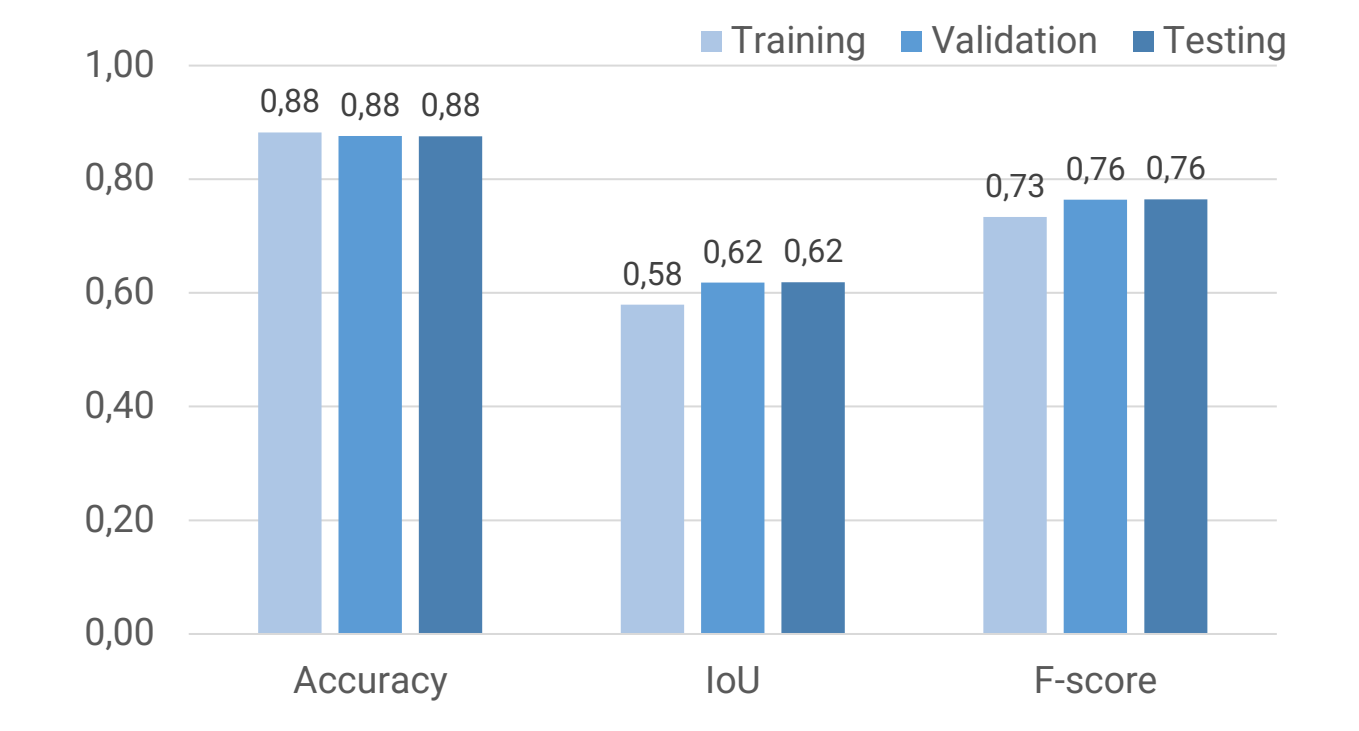


Fig. 3: Diagram of evaluation metrics

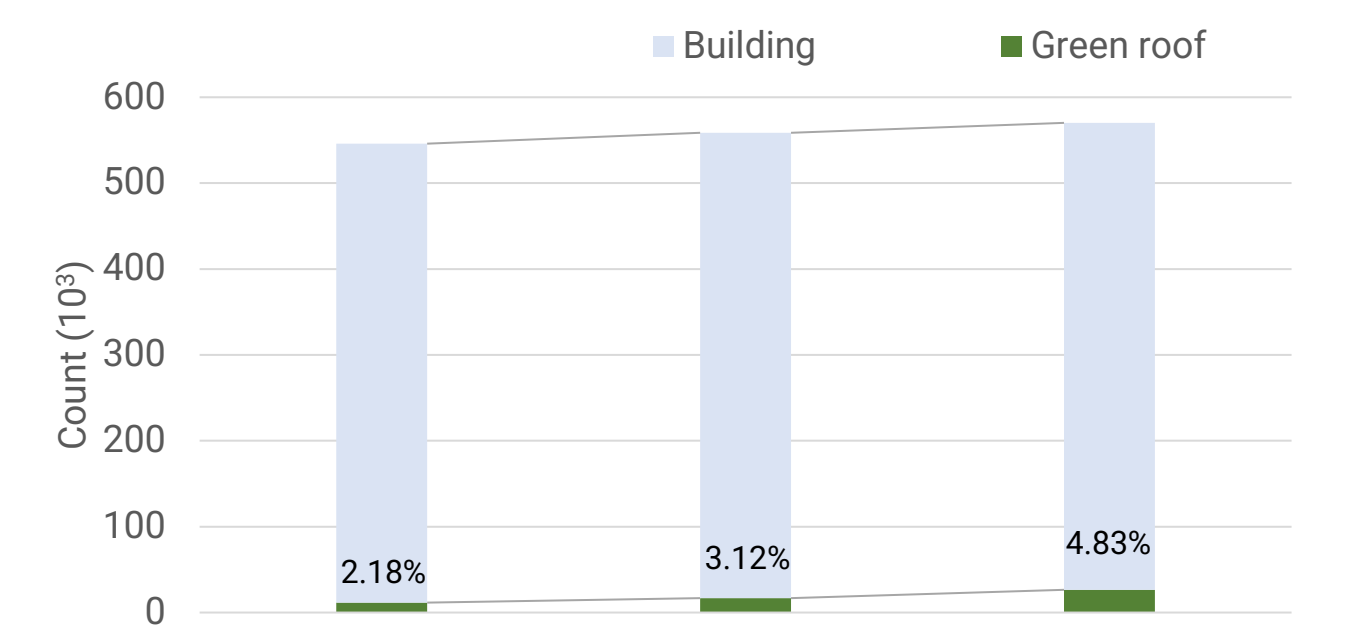


Fig. 4: Diagram of building and green roof counts, labelled with percentages of green roofs

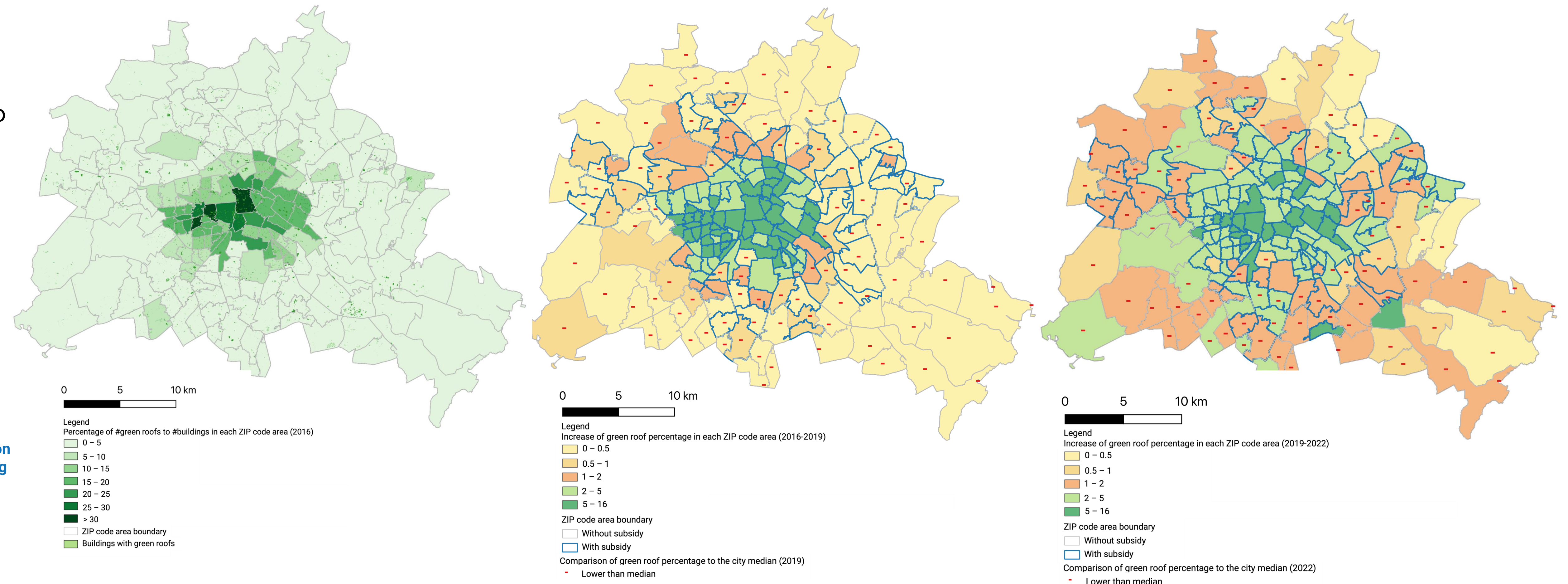


Fig. 5: (a) Spatial distribution and percentage of green roofs in each ZIP code area of Berlin (2016); (b) Increase of green roof coverage [#green roofs/#buildings] in [%] from 2016 to 2019; (c) Increase of green roof coverage [%] from 2019 to 2022

- Main distribution of green roofs is observed in the city centre (Fig. 5)
- Steady increase of green roofs in the city centre, gentle increase in outskirts (Fig. 5 b & c)
- No observable higher increase of green roofs in subsidy funded areas (Fig. 5 b & c) – funded area has a green roof increase rate of 2.28% and 2.54% in 2016-2019 and 2019-2022, whereas non-funded area has a swifter growth from 0.18% to 1.25%.

OUTLOOK

- Further evaluate the results with comparison to institutional analyses from the Berlin Senate (Coenradie et al., 2016; Pauligk et al., 2022)
- Analyse the spatial distribution and development of green roofs considering different building & socio-demographic features
- Formulate a structured assessment of the efficacy of the subsidy program
- Evolve the proposed methodology as a BGI subsidy program evaluation framework

Acknowledgements



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Registered as OSPPP!



QR Code to Abstract