

Exploring High-Resolution Building Material Stocks to Reveal Urban Sustainability Potential

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Abstract

Urbanization since the Industrial Revolution has led to increased material stocks within the built environment, which contain valuable secondary materials for urban mining. However, existing assessment methods often lack the high-resolution data necessary for effective evaluation, thereby hindering resource recovery. This PhD thesis addresses these gaps by mapping building material stocks at the component level across Europe and enhancing the extraction of both internal and external building information through the integration of diverse data sources. This study is significant as it advances the understanding of material stocks, facilitating improved resource management. By establishing a comprehensive database, the findings will support sustainable urban development and provide policymakers with critical insights for resource recovery and environmental impact assessment.

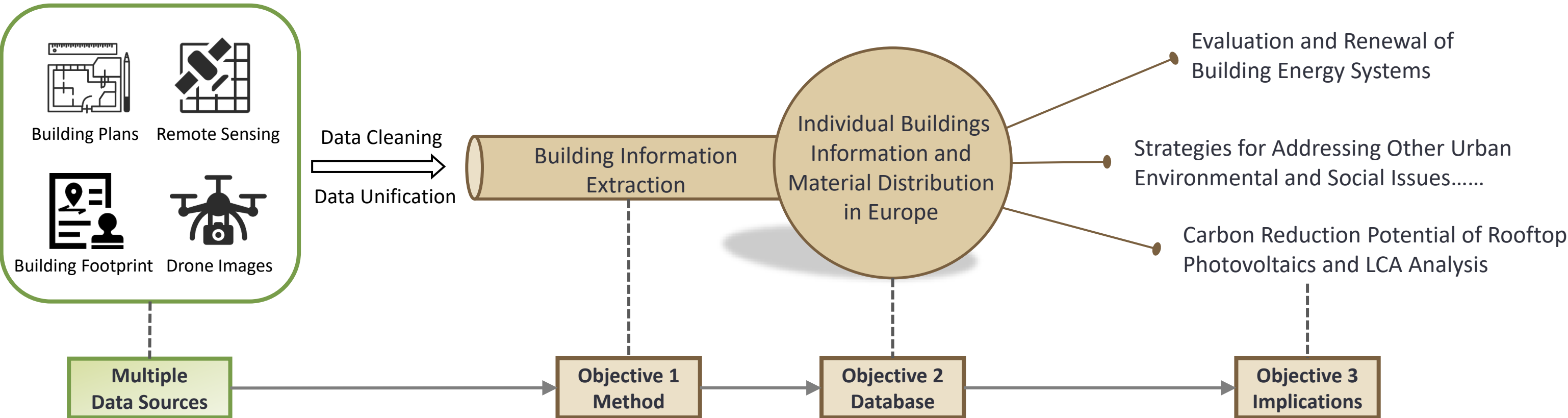


Fig 1. PhD Thesis Workflow Overview

Background

The built environment serves as a backstone for modern societies, acting as a significant reservoir of secondary raw materials. Analyzing material stocks is essential for enhancing urban sustainability and mitigating climate change (Krausmann et al. 2017; Lanau et al. 2019). Effective management of these resources can lead to reduced waste and improved resource efficiency in urban areas.

However, current methodologies mainly rely on remote sensing for external data, while research on internal components, such as structural elements and HVAC systems, is limited (Müller et al. 2014; Dai et al. 2024). Additionally, the lack of integrated high-resolution material databases across Europe hampers effective sustainability planning (Frantz et al. 2023; Arbabi et al. 2022). This fragmentation of data makes it challenging to realize the opportunities for urban sustainability.

Research Objectives

1. Method innovation
 - Improve extracting accuracy of both external and internal building information. Focus on automating the extraction processes to enhance applicability across various contexts.
2. Database development
 - Develop a database for individual buildings in Europe, providing detailed information on the quantities and distributions of secondary resources throughout the region.
3. Sustainability Implication Assessment
 - Utilize the high-resolution database to evaluate sustainability impacts. Examine how the building sector can effectively tackle urban environmental challenges and address social issues.

Methodology

This thesis will primarily use a bottom-up approach to estimate material stocks in buildings. It will incorporate methods from various disciplines, including geographic information systems, architecture, civil engineering, machine learning, and industrial ecology. These methods will provide a robust framework for accurately assessing material stocks and understanding their implications for sustainability in urban contexts.

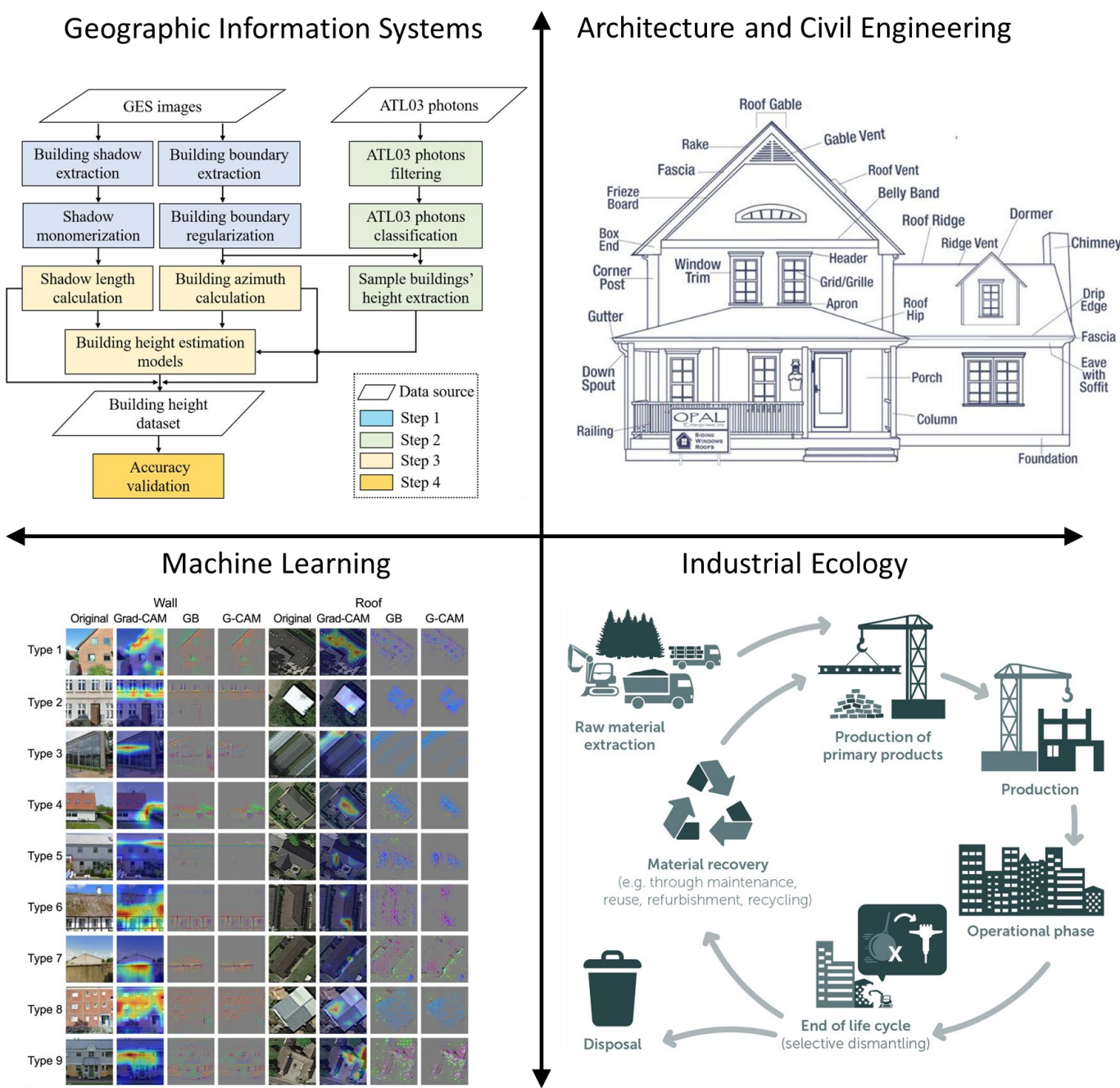


Fig 2. Multidisciplinary Research Methodologies

Reference

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