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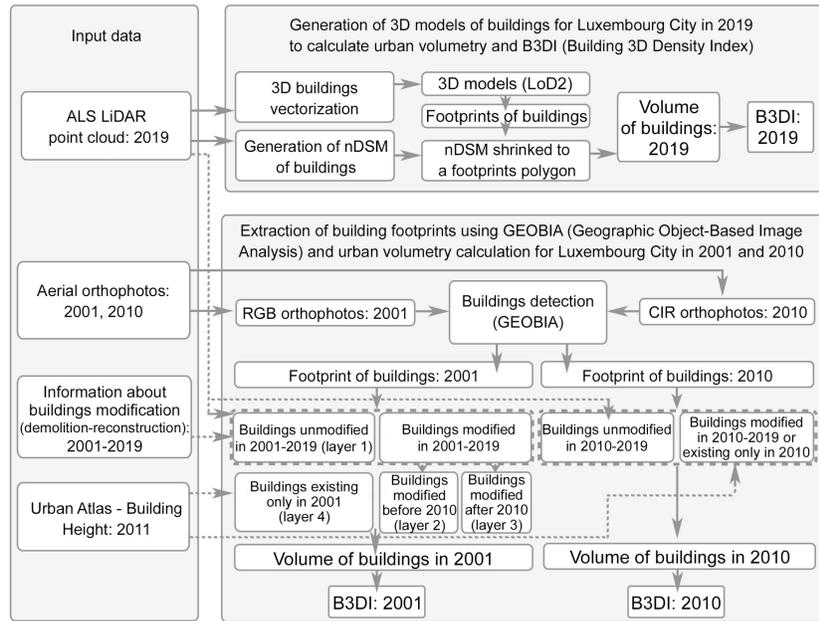
1. INTRODUCTION

Understanding how, where, and when a city is expanding can inform better ways to make our cities more resilient, sustainable, and equitable.

We explore urban volumetry in Luxembourg City using new **Building 3D Density Index (B3DI)** in **2001, 2010, 2019**, and quantifie changes in the volume of buildings and urban expansion in Luxembourg City over the last two decades.

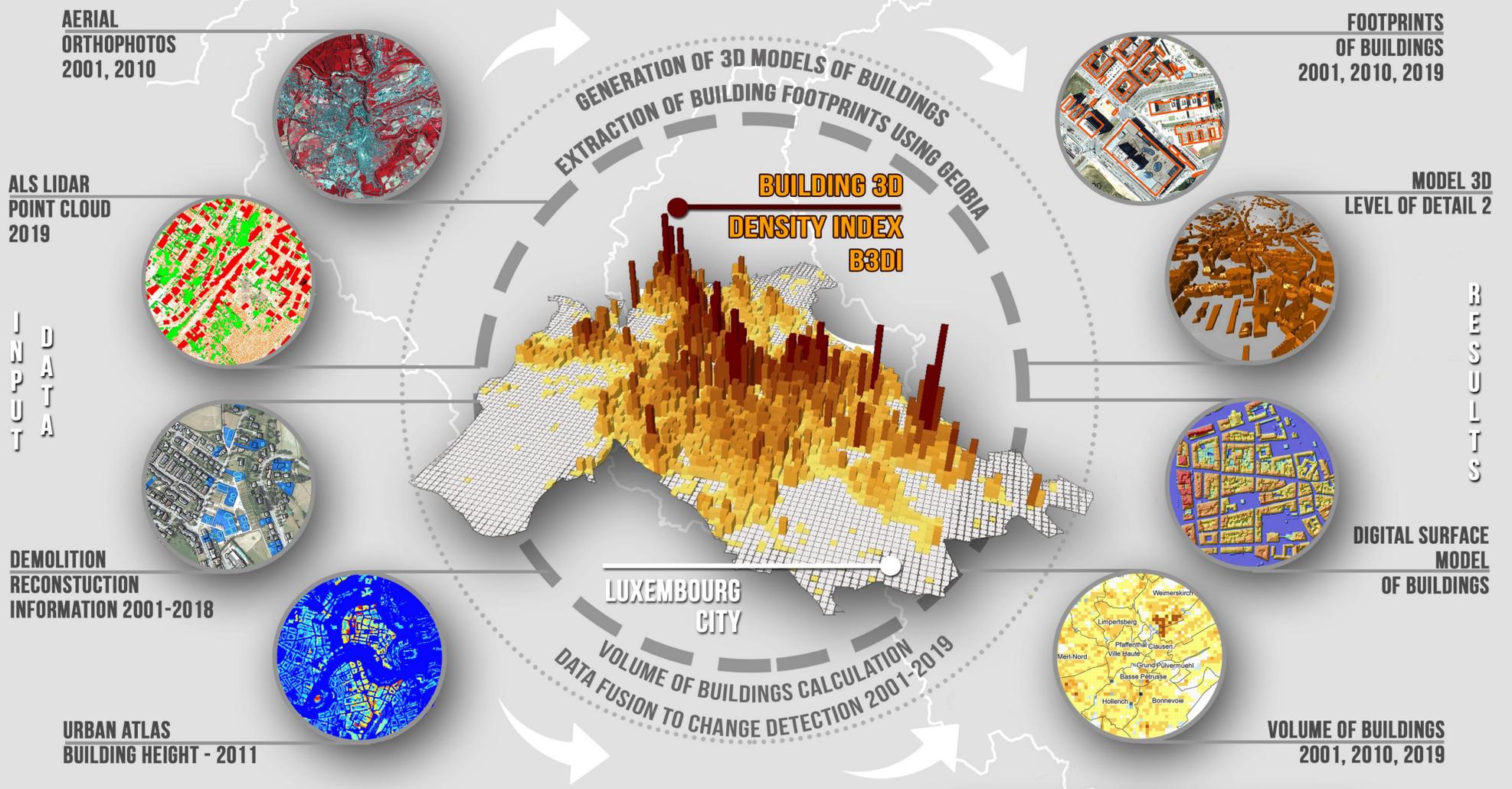
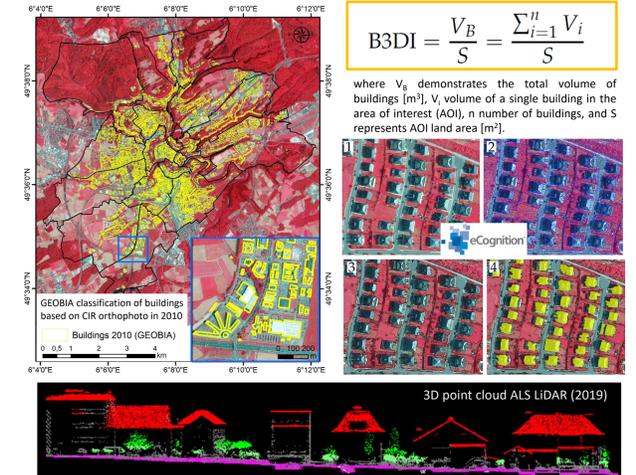
2. DATA PROCESSING

We use Airborne Laser Scanning (ALS) point cloud (2019) and Geographic Object-Based Image Analysis (GEOBIA) of CIR/RGB aerial orthophotos (2001, 2010) to extract 3D models, footprints of buildings and calculate the volume of individual buildings and B3DI in the frame of a 100 x 100 m grid, at the level of parcels, districts, and city scale.



3. METHODS

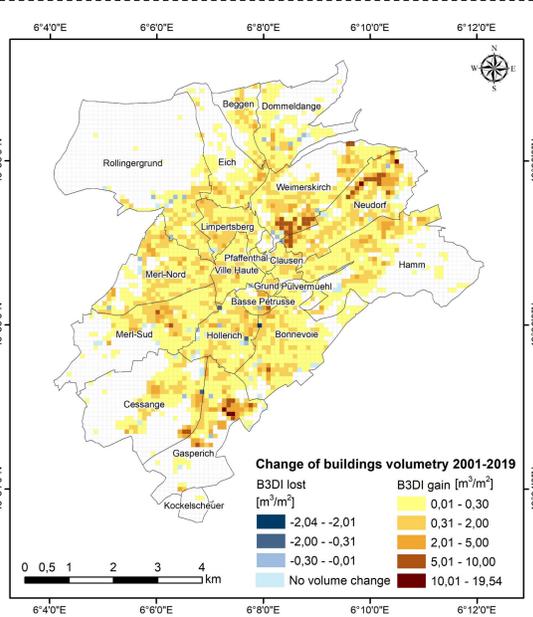
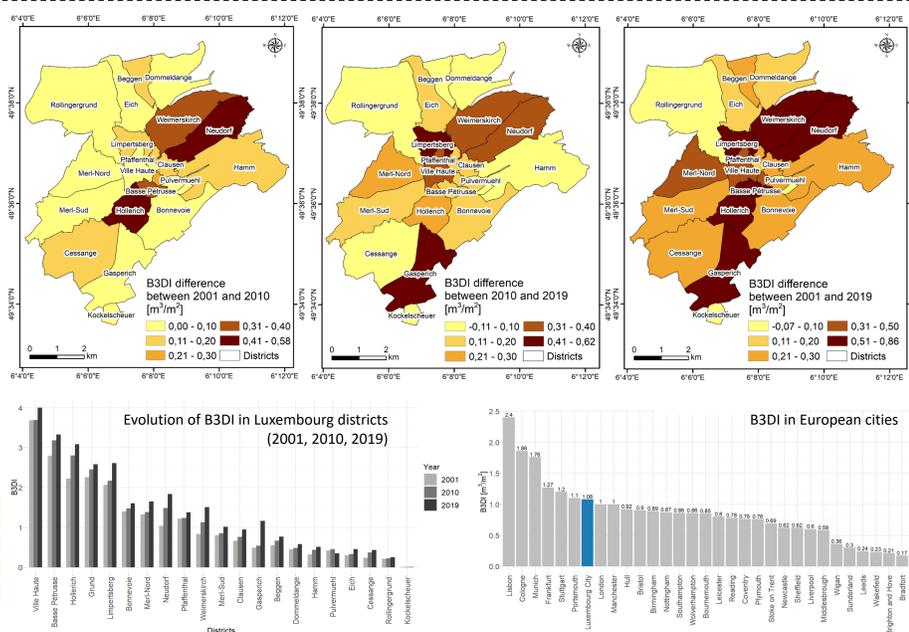
- Extraction of building footprints using GEOBIA.
- Generation of 3D models of buildings.
- Data fusion to calculate **Building 3D Density Index**.



4. RESULTS

- The B3DI has notably increased in the past 20 years from 0.77 m³/m² (2001) to 0.9 m³/m² (2010) to 1.09 m³/m² (2019).
- The increase in the volume of buildings between 2001-2019 was +16 million m³.
- The general trend of changes in the cubic capacity of buildings per resident shows a decrease from 522 m³/resident in 2001, to 460 m³/resident in 2019, which, with the simultaneous appearance of new buildings and fast population growth, suggests the dynamic development of the city (Zięba-Kulawik et al. 2020).

Zięba-Kulawik, K., Skoczylas, K., Mustafa, A., Weżyk, P., Gerber, P., Teller, J., & Omrani, H. (2020). Spatiotemporal Changes in 3D Building Density with LiDAR and GEOBIA: A City-Level Analysis. *Remote Sensing*, 12(3668).



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