Estimating building heights from global Digital Elevation Models

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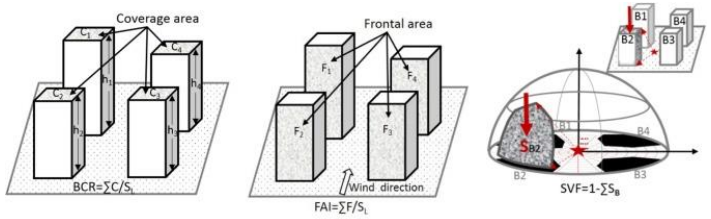
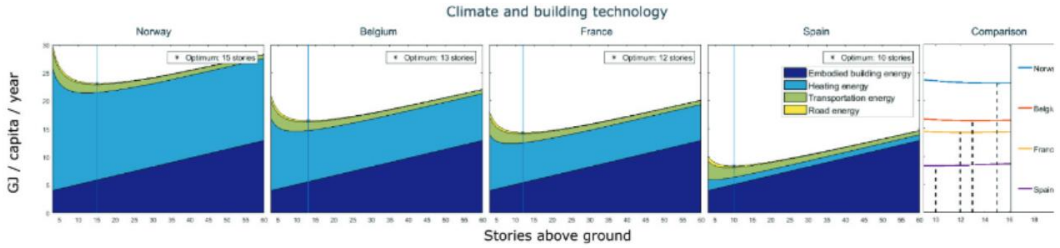
Large scale estimations of height of built-up areas have multiple applications in urban-related studies

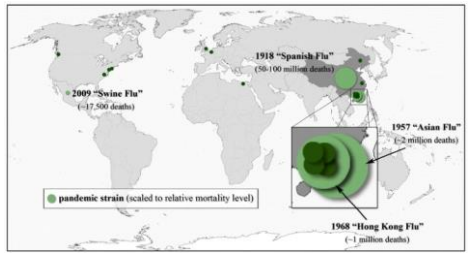
URBAN PLANNING | POPULATION DISTRIBUTION | CLIMATE STUDIES | ENERGY CONSUMPTION | URBAN AGRICULTURE | RISK MANAGEMENT



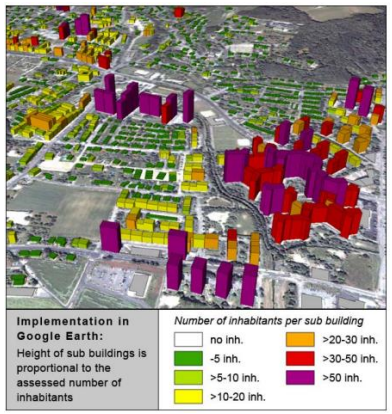
Urban morphology indicators [1]



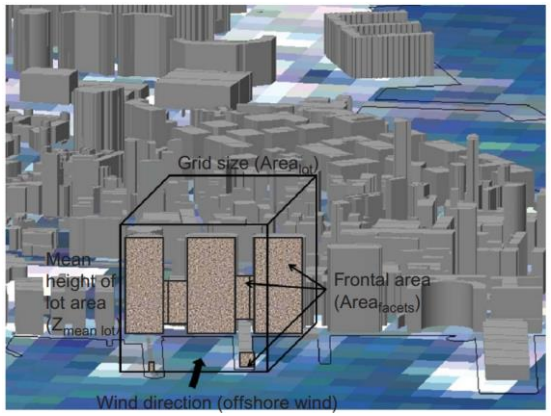
Variations in energy consumption [4]



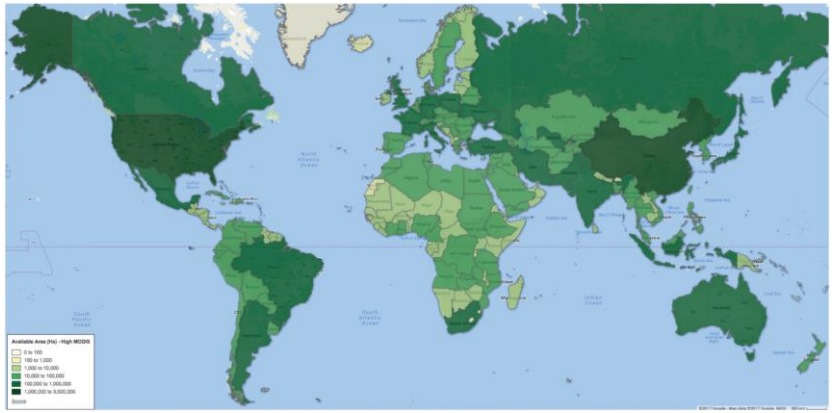
Spreading infectious diseases [6]



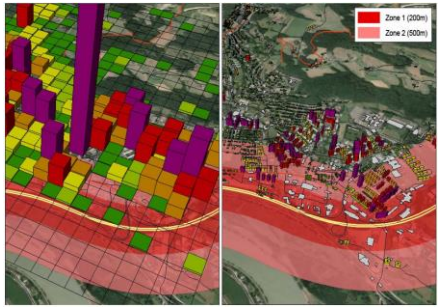
Allocation of population [2]



Wind ventilation [3]



Available urban area for agriculture [5]



Exposure to noise [2]

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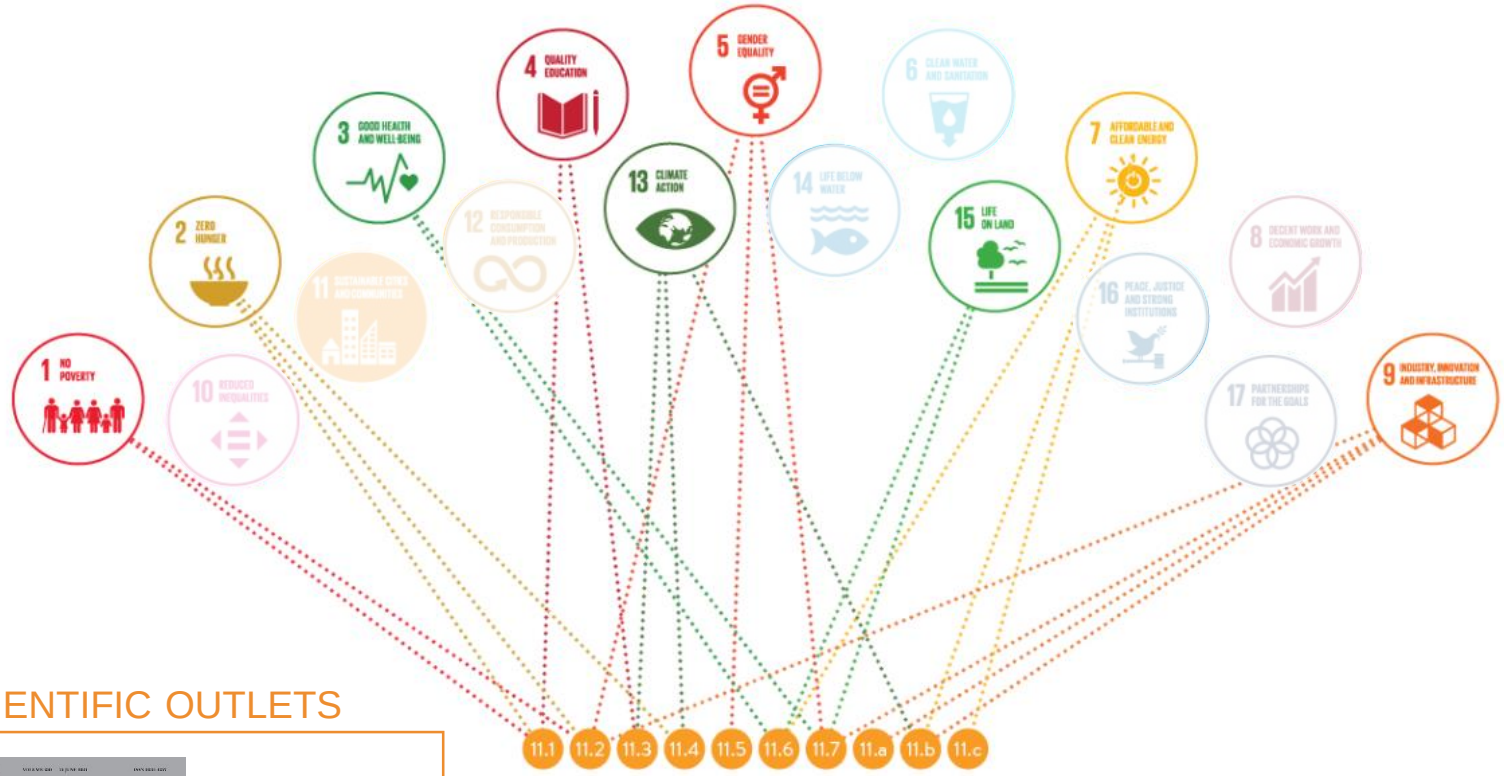
Built-up height estimations can be used by researchers and decision-makers to support the achievement of the SDGs



DECISION-SUPPORT

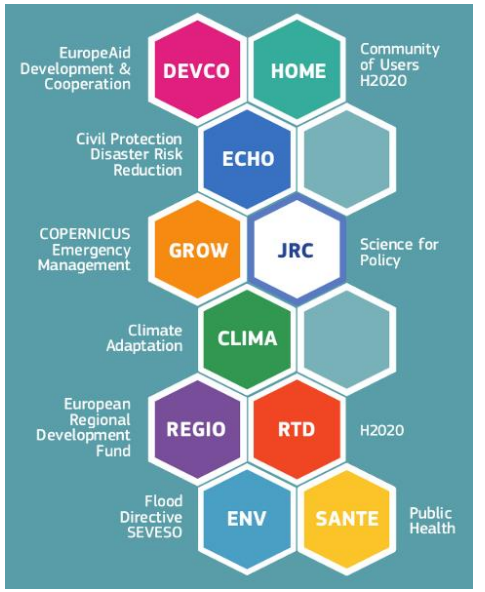
WORLD RESOURCES INSTITUTE

EU Adaptation Strategy

UNITED NATIONS

WORLD BANK GROUP

ipcc INTERGOVERNMENTAL PANEL ON climate change



Science-policy interface in DRM [8]

SCIENTIFIC OUTLETS

Remote Sensing of Environment

PLOS ONE

IEEE GRSS Geoscience and Remote Sensing Society

11 SUSTAINABLE CITIES AND COMMUNITIES

Indicator 11.3.1: Ratio of land consumption rate to population growth rate

Interrelated connections between built-up environment and SDGs [7]

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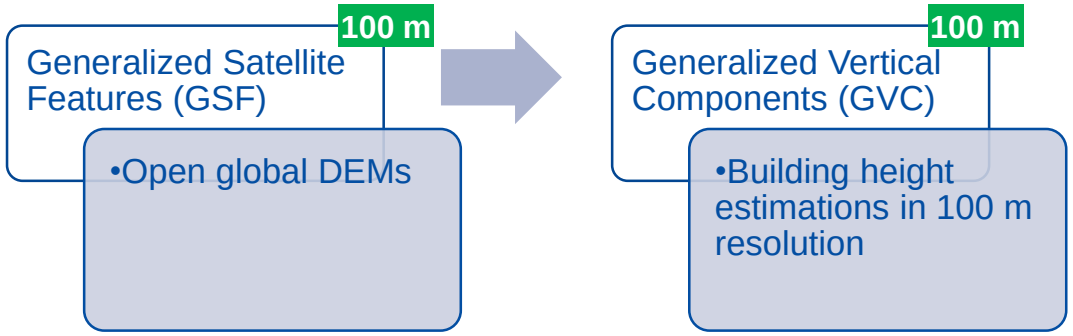
Estimating vertical components of built-up areas from open global Digital Elevation Models in 100 m resolution



6 test sites:

1. Albuquerque (New Mexico, US)
2. Beirut (Lebanon)
3. London (UK)
4. Philadelphia (Pennsylvania, US)
5. San Francisco (California, US)
6. Toronto (Ontario, Canada)

250 m

PLOS ONE

OPEN ACCESS PEER-REVIEWED

RESEARCH ARTICLE

Generalized Vertical Components of built-up areas from global Digital Elevation Models by multi-scale linear regression modelling

Martino Pesaresi, Christina Corbane, Chao Ren, Ng Edward

Published: February 10, 2021 • https://doi.org/10.1371/journal.pone.0244478

100 m

Conferences > 2023 Joint Urban Remote Sensi...

Multiple regression model for estimating vertical characteristics of built-up areas at 100 m resolution from open and global Digital Elevation Models

Publisher: IEEE Cite This PDF

Katarzyna Goch ; Martino Pesaresi ; Christina Corbane ; Panagiotis Politis ; Thomas Kemper All Authors

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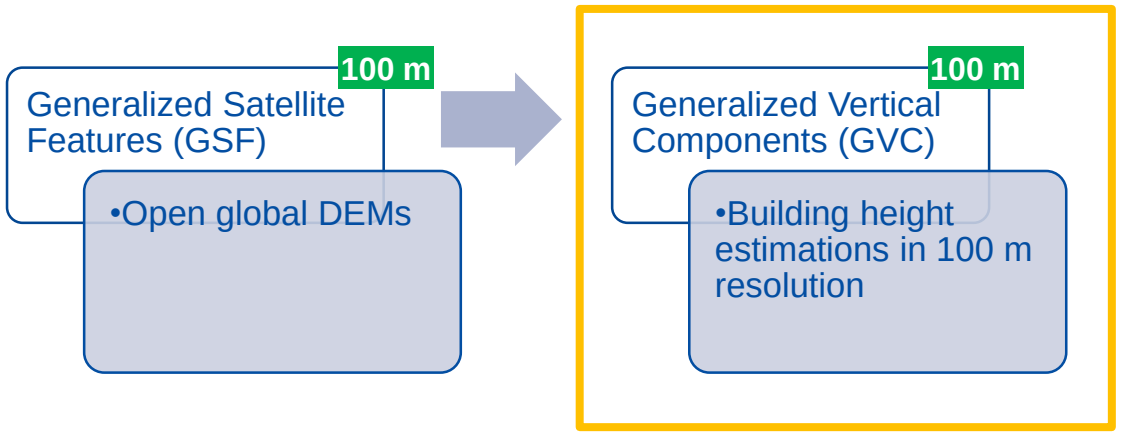
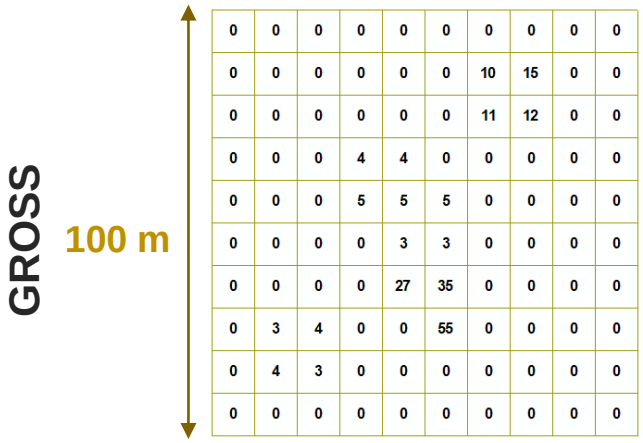
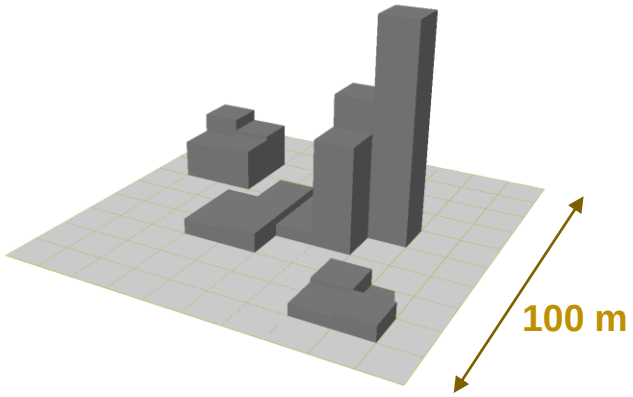
Estimating vertical components of built-up areas from open global Digital Elevation Models in 100 m resolution







AVERAGE HEIGHT

- Average Gross Building Height (**AGBH**)
- Average Net Building Height (**ANBH**)

VARIATION

- Standard Deviation of Gross Building Height (**SGBH**)
- Standard Deviation of Net Building Height (**SNBH**)

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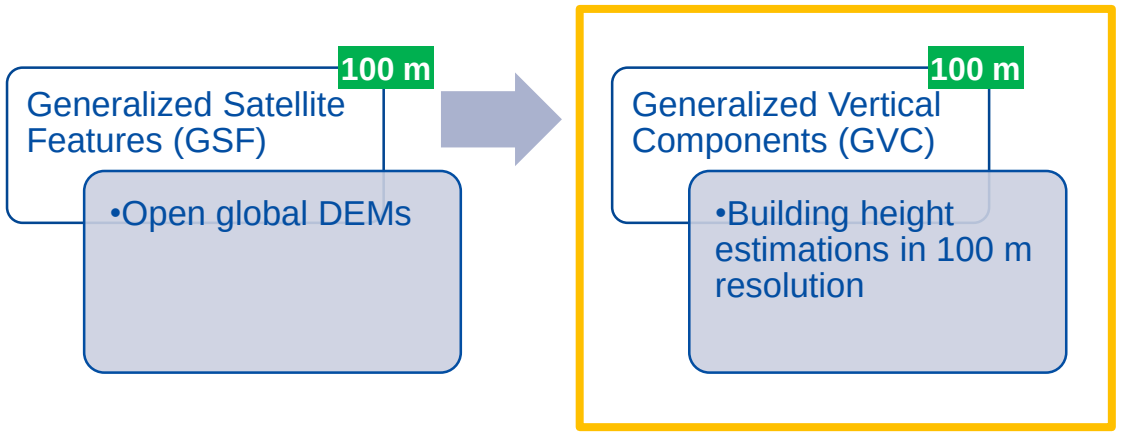
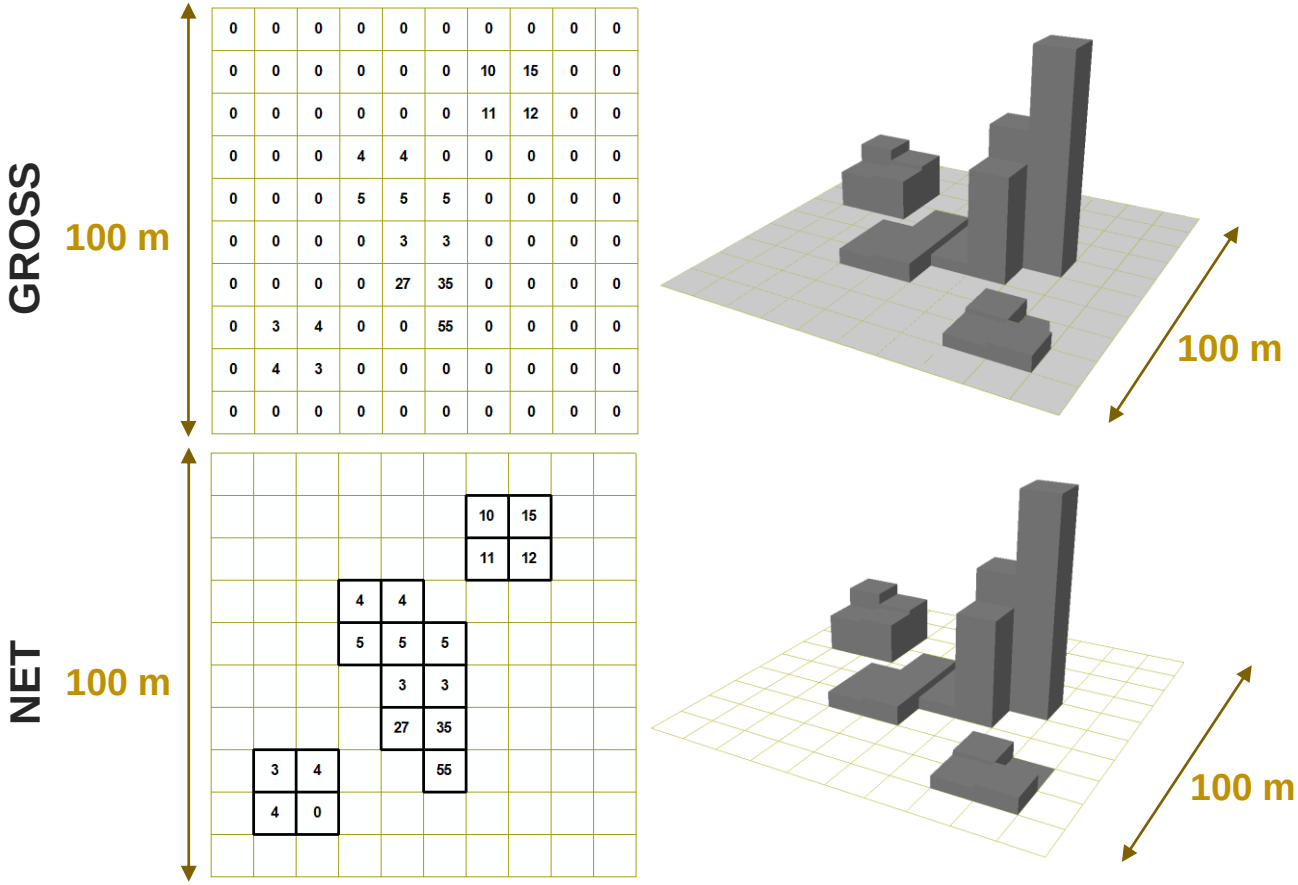
Estimating vertical components of built-up areas from open global Digital Elevation Models in 100 m resolution





AVERAGE HEIGHT

- Average Gross Building Height (**AGBH**)
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AGBH < ANBH
SGBH > SNBH

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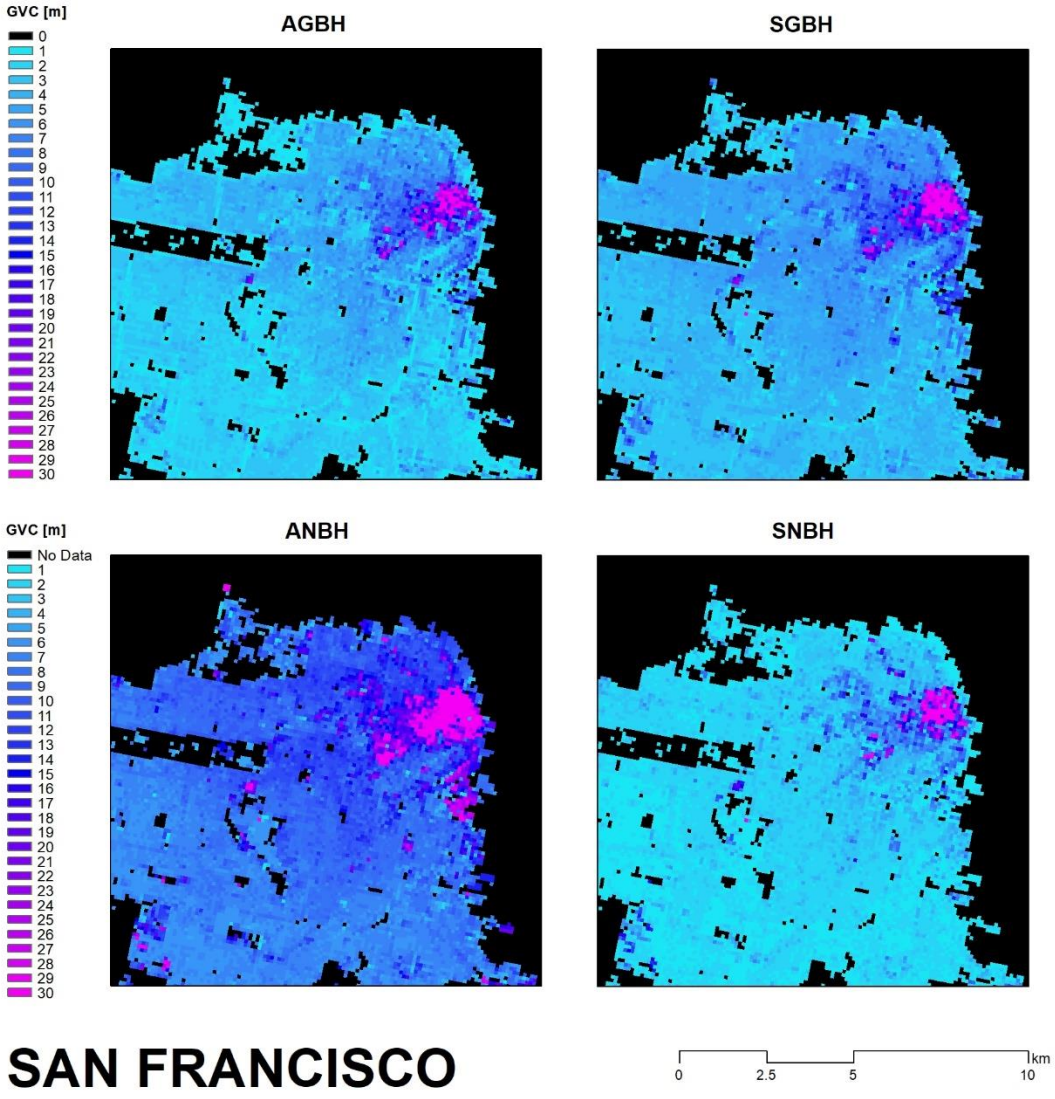
Estimating vertical components of built-up areas from open global Digital Elevation Models in 100 m resolution

Example:



AGBH: Average Gross Building Height

SGBH: Standard Deviation of Gross Building Height

ANBH: Average Net Building Height

SNBH: Standard Deviation of Net Building Height

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Estimating vertical components of built-up areas from open global Digital Elevation Models in 100 m resolution

Generalized Satellite Features (GSF) — 100 m
- Open global DEMs

→

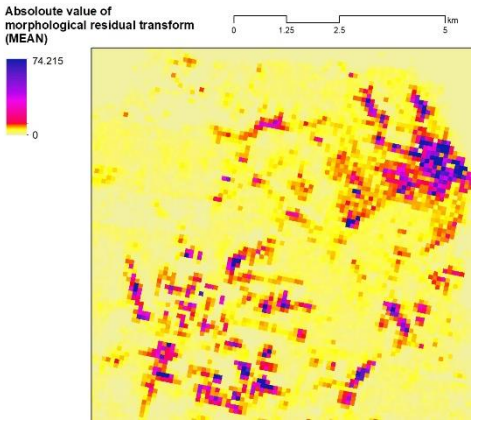
Generalized Vertical Components (GVC) — 100 m
- Building height estimations in 100 m resolution

1. Shuttle Radar Topography Mission (SRTM30) ← radar sensor
2. Advanced Land Observing Satellite World 3D (AW3D30) ← optical sensor
3. Copernicus Digital Elevation Model (COP) ← radar sensor

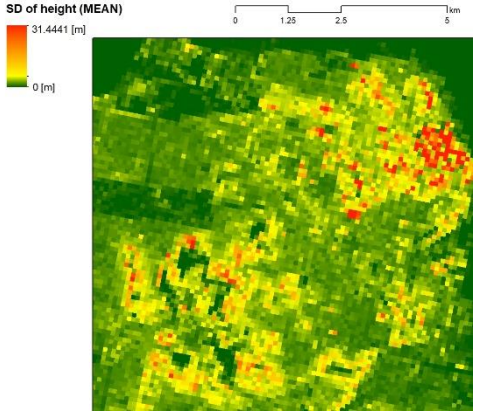
4. SRTM30 and AW3D3 union
5. SRTM30 and AW3D3 intersection
6. AW3D30 and COP union
7. AW3D30 and COP intersection

175 GSF for each DEM and composite.
Examples:

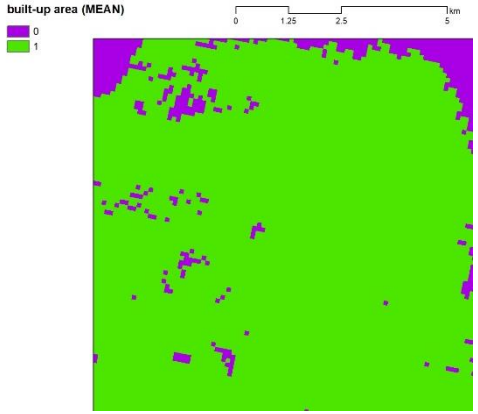
structural GSF



height statistics



ancillary



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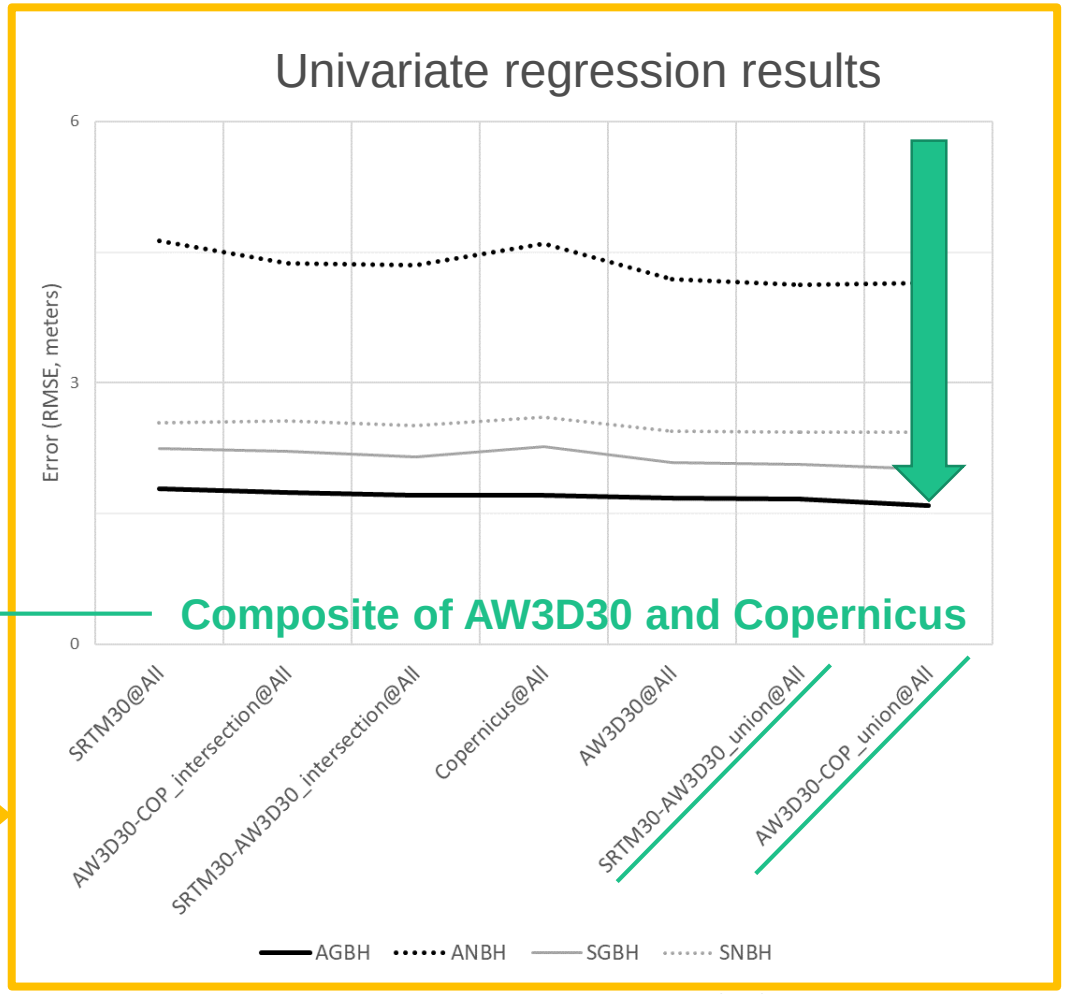
Best performance observed for the composite of an optical and a radar sensor

Generalized Satellite Features (GSF) — 100 m
- Open global DEMs

Generalized Vertical Components (GVC) — 100 m
- Building height estimations in 100 m resolution

Multivariate regression: building a model

Univariate regression: DEM selection



Minimum error in the prediction of the GVC, across 166 input GSFs (without ancillary GSF)

In line with findings [9] combining Sentinel-1 (SAR 10m) and Sentinel-2 (optical)

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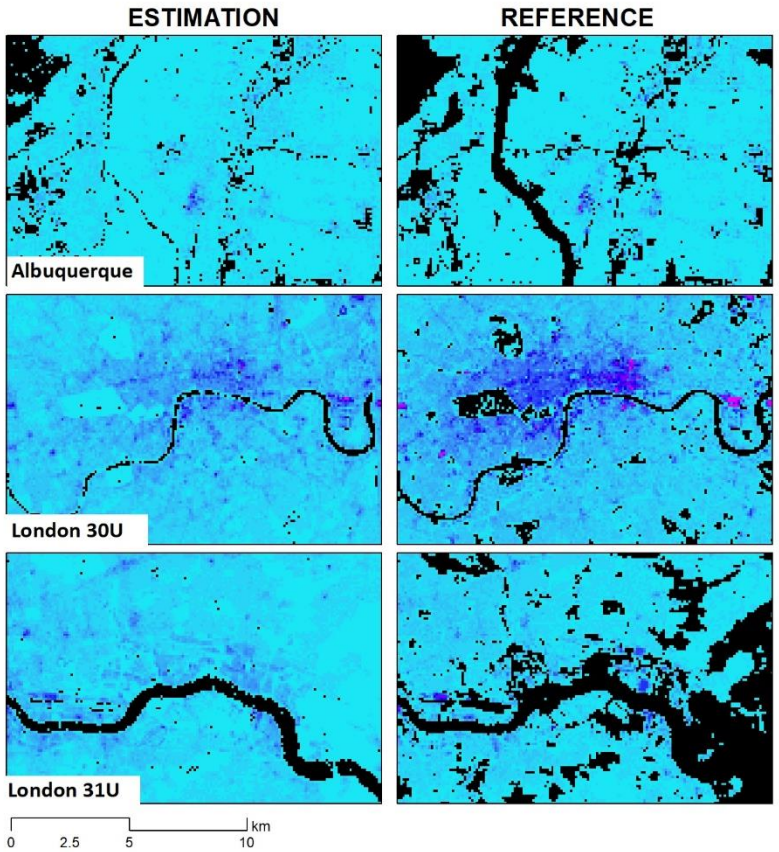
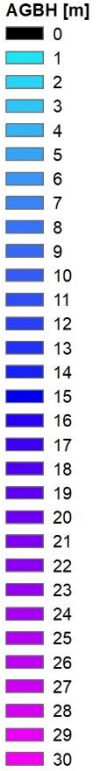
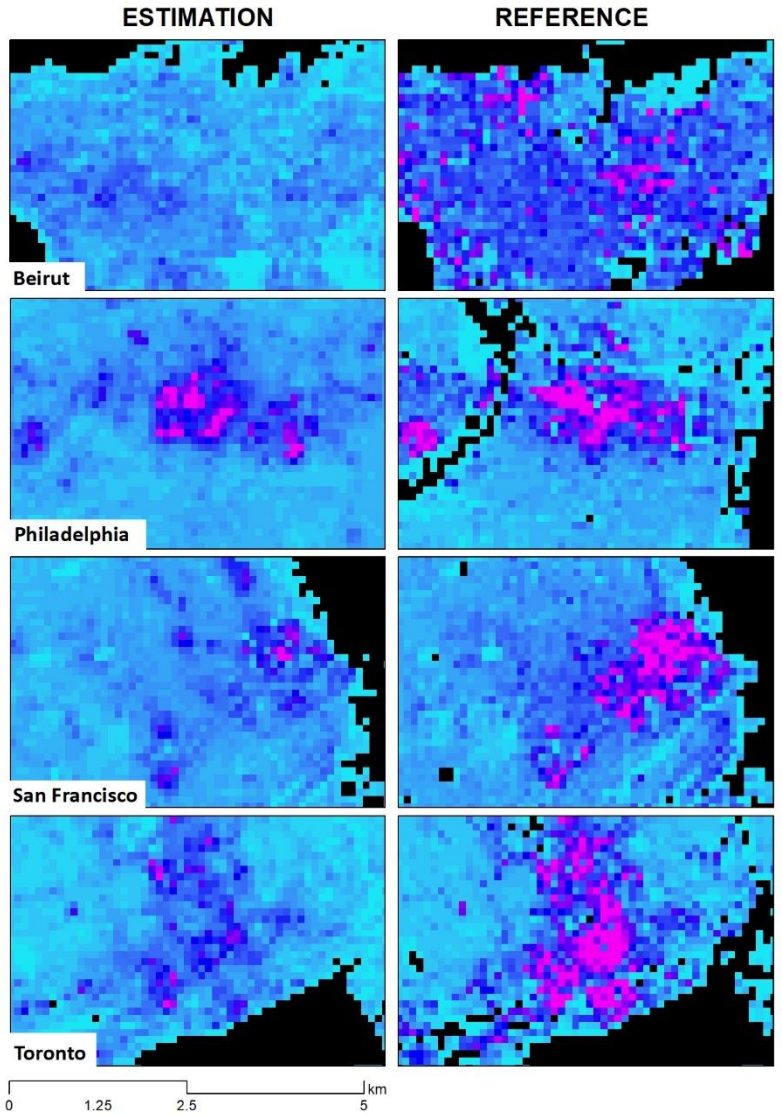
The fitted models show low errors for gross GVCs

AGBH
Averaged Gross Building Height







Target	AGBH
RMSE	0.91 m
RMSE_CV	0.91 m
adj. R2	0.56

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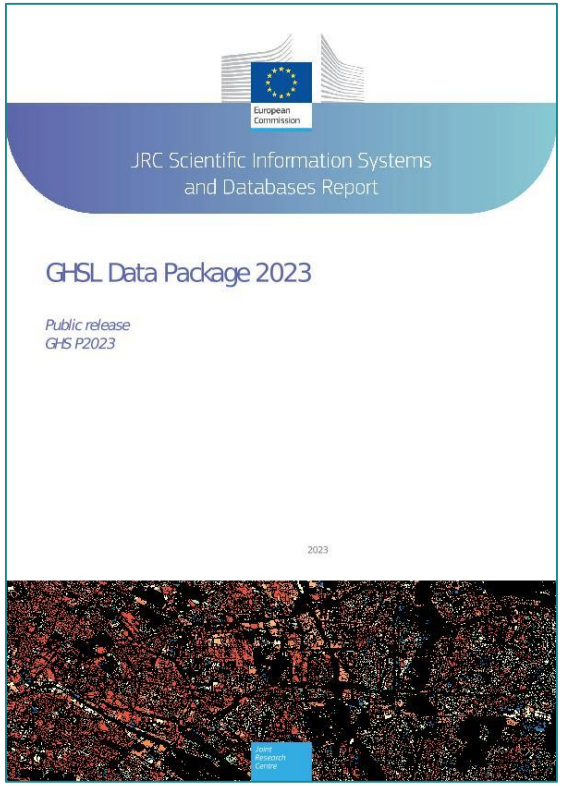
Summary

Strong points

- Open global datasets
- Well established modelling approach
- Promising results in terms of average height estimation
- Workflow ready for global simulation

Limitations

- Improvement of estimating variation in building heights
- Missing input information after 2015



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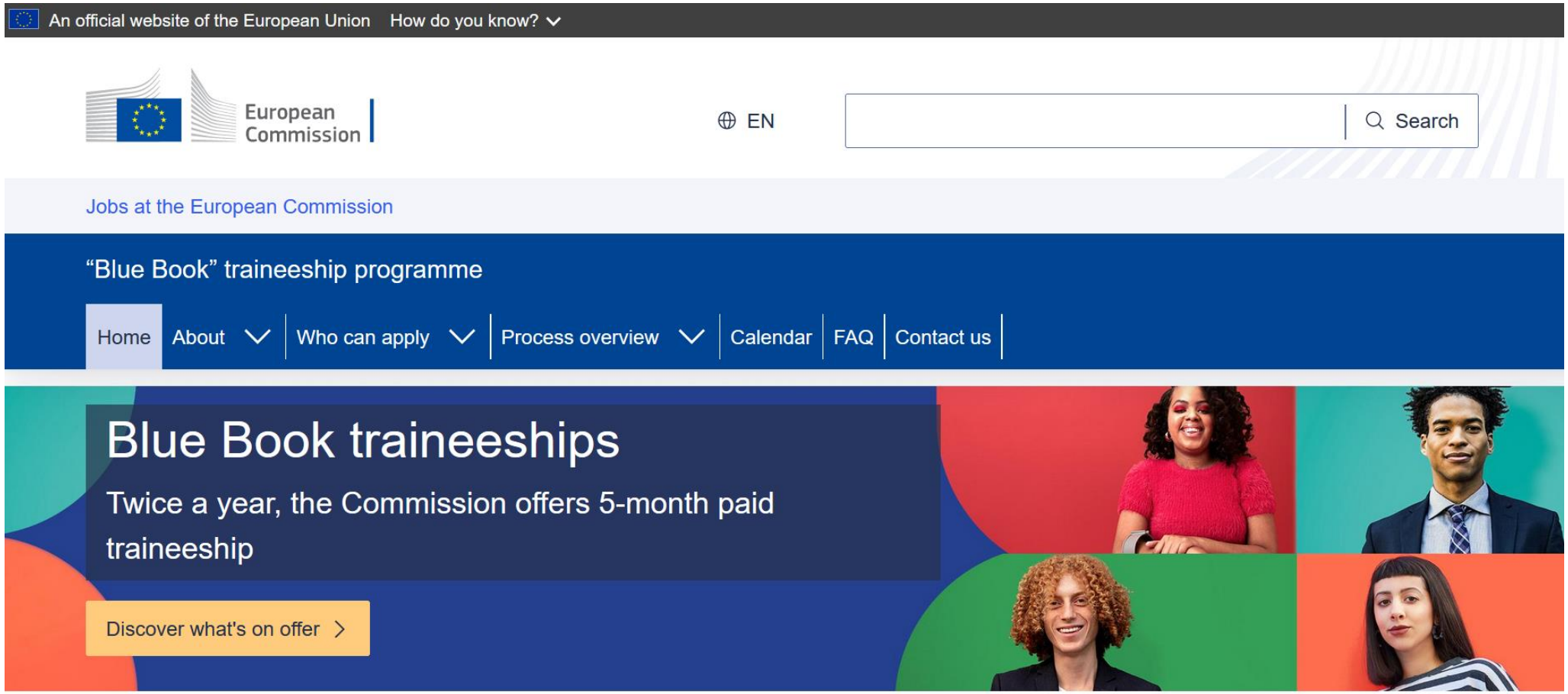
Traineeship at Joint Research Centre



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Thank you

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