



Estimating the age of buildings from satellite and morphological features

towards the creation of a pan-EU Digital Building Stock Model (DBSM)

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Motivation

Pan-European map of individual buildings with energy-related features, including building age

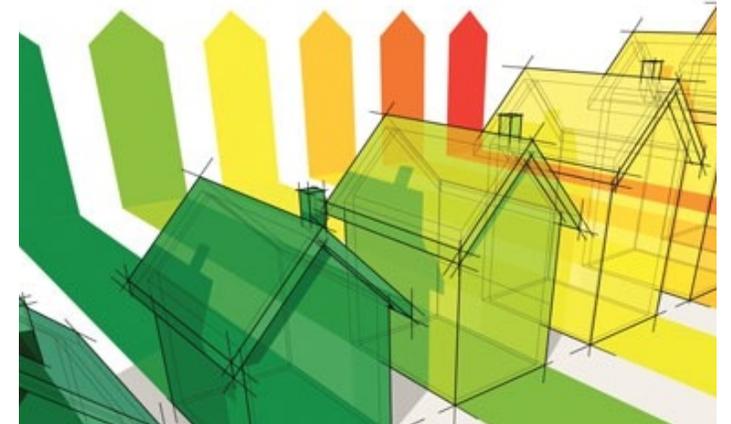
Use of **Machine Learning** and data from **Earth Observation**

Open access to all citizens

Policy support

Energy Renovation Wave

Energy Performance of Buildings Directives



Digital Building Stock Model at EU scale

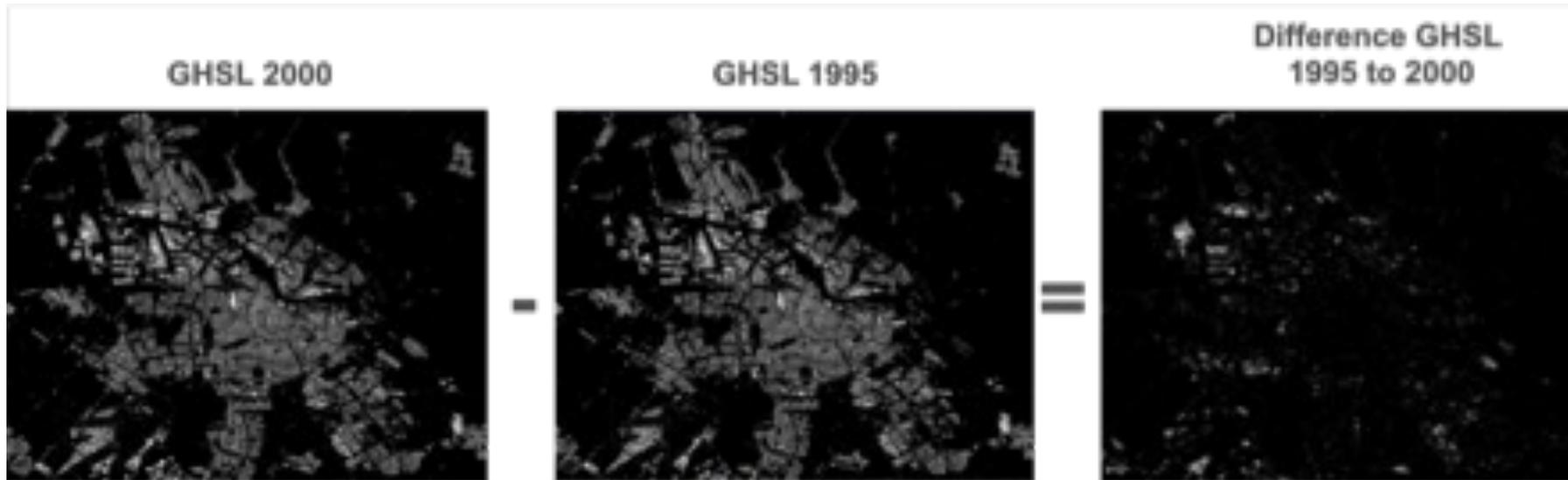
Building attributes

Attributes	Source / Reliability	
Footprint	Conflation of sources (OSM/Microsoft/ESM)	Available DBSM v1
Height	GHSL-based (LoD1)	Coming soon DBSM v2
Compactness	Compactness formula	
Function (res/non-res)	GHSL+	
PV potential	PVGIS+	
Age	Machine Learning	Under research
Rooftop type	Machine Learning	
Energy demand	Simplified physical Model	
RE suitability	JRC Model	



Age prediction: satellite + morphological features

Integrates the multi-temporal built-up surface grid from GHS-BUILT-S and various morphological features from OSM in a Random Forest model.



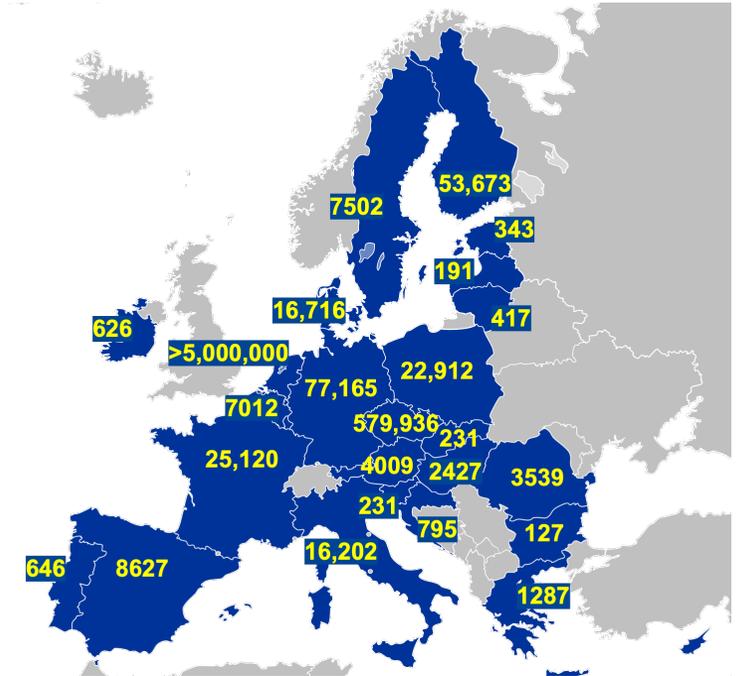
Building features	Neighbourhood features
Shape Complexity	Distance to closest neighbour
House element count	Number of adjoining buildings
House area	Distances to closest street and intersection
	Building count in 20m, 100m and 500 range

Predictive model with Random forest

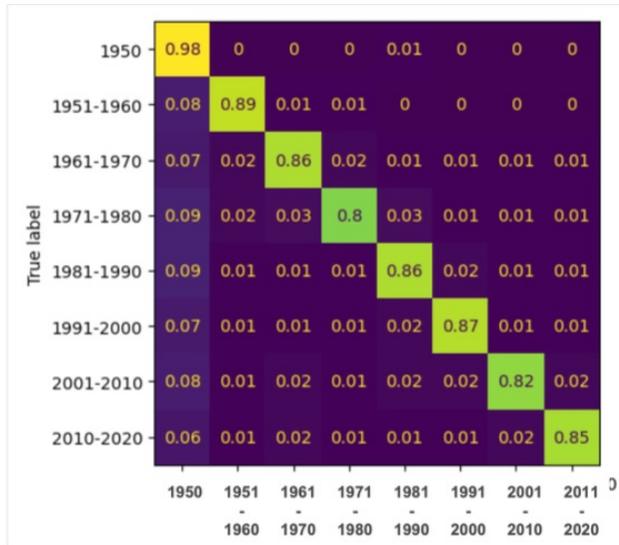
Number of buildings per Age Category for Amsterdam

Pre 1950	1951-1960	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010	2011-2020
95,693	29,073	18,871	13,992	29,821	27,872	17,301	16,923

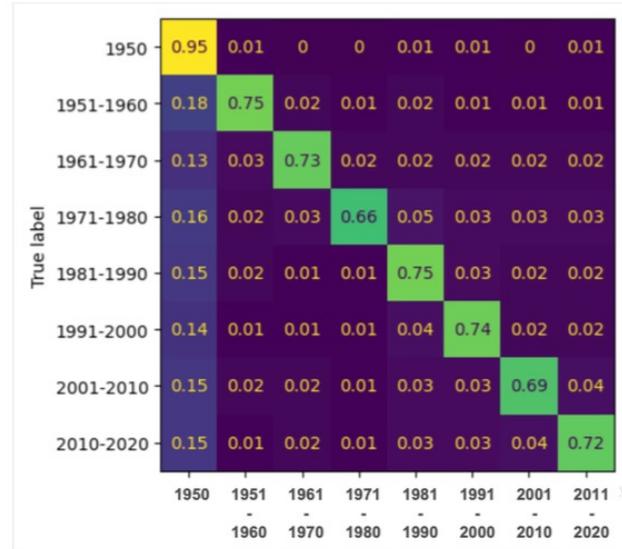
- Amsterdam and Rotterdam are considered as test cities (with balanced class labels)
 - Train model on 80% of the available data for Amsterdam and test on remaining 20%
 - Assess model when only either satellite-base or morphological features are considered
 - Train model on 80% of the available data for Rotterdam and include some of the samples from Amsterdam



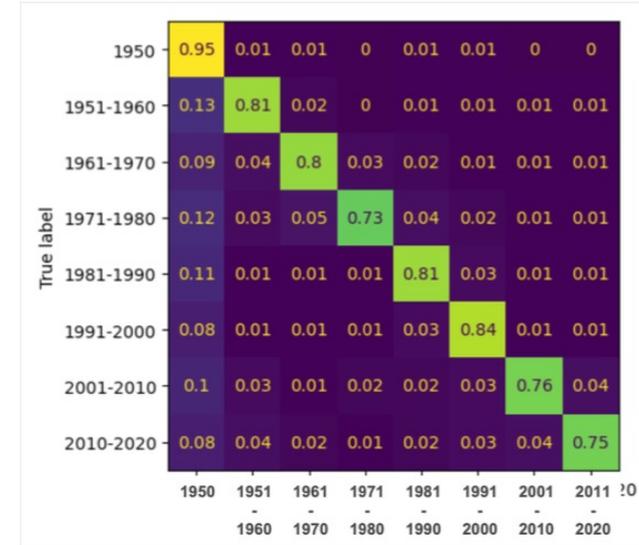
How it performs?



(a) Includes GHSL and morphological features



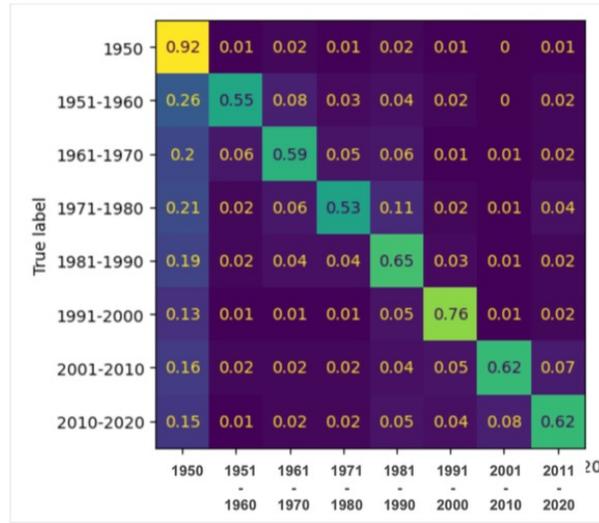
(b) Includes only morphological features



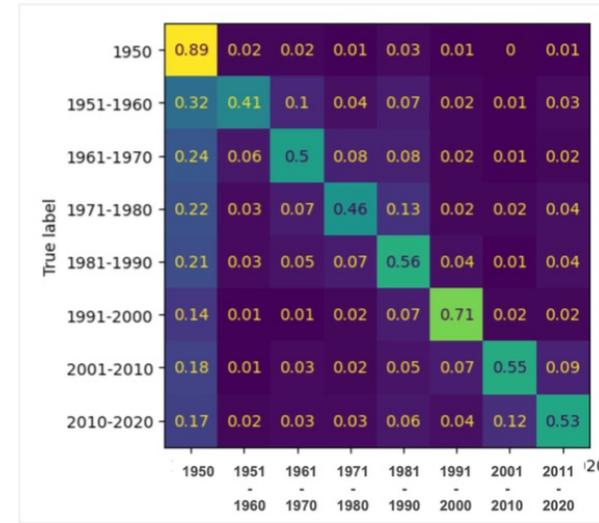
(c) Includes only GHSL features

Best results when combining satellite and morphological features for predicting the age of buildings using Machine Learning.

Does it generalise well to other cities?



(a) Amsterdam predicted using 10% of Amsterdam data on the Rotterdam model



(b) Amsterdam predicted using 5% of Amsterdam data on the Rotterdam model

- As expected, the model exhibited strong **local predictability**, showing sensitivity to the use of local data, particularly from different cities within the same country.
- **Incorporating a small amount of local information** could enhance prediction accuracy for a different location.

What's next?

- Test the model's generalization capability to other countries
- Explore the use of other ML algorithms, such as graph neural networks, which consider spatial relations of the data
- Reference data could also be extracted from EUBUCCO and EUSTAT sources
- For energy-related purposes, it is crucial to have information on the age of renovation, if any. Thus, this data should be combined with information from energy performance certificates in the future

Thank you

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