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Building typologies for Norway: a case study for Oslo using machine learning

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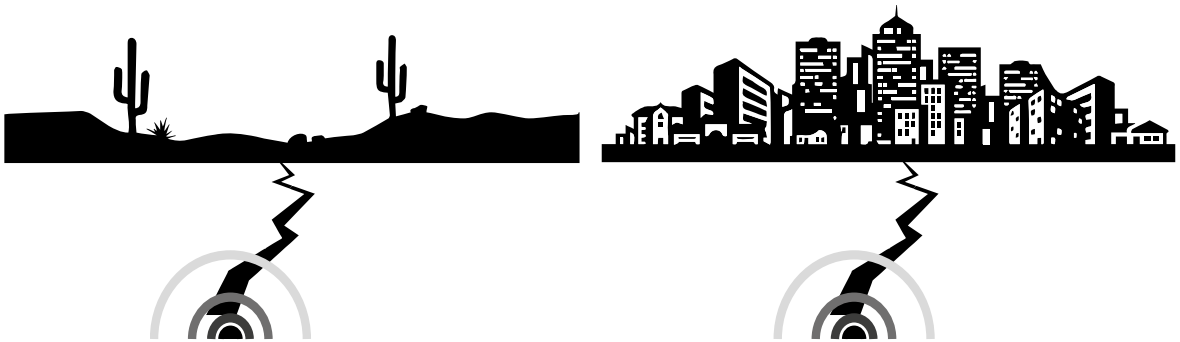
NORSAR Exploring the Earth

Background

Seismic risk is the probability of losses occurring due to earthquakes at a specific place within a given time period. These losses can include human lives, social and economic disruption as well as material damage.



≠ Risk

= Hazard

Risk
=
Hazard
x
Vulnerability
x
Exposure

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Study area and Methodology

Steps to develop a Model Building Typology (MBT):

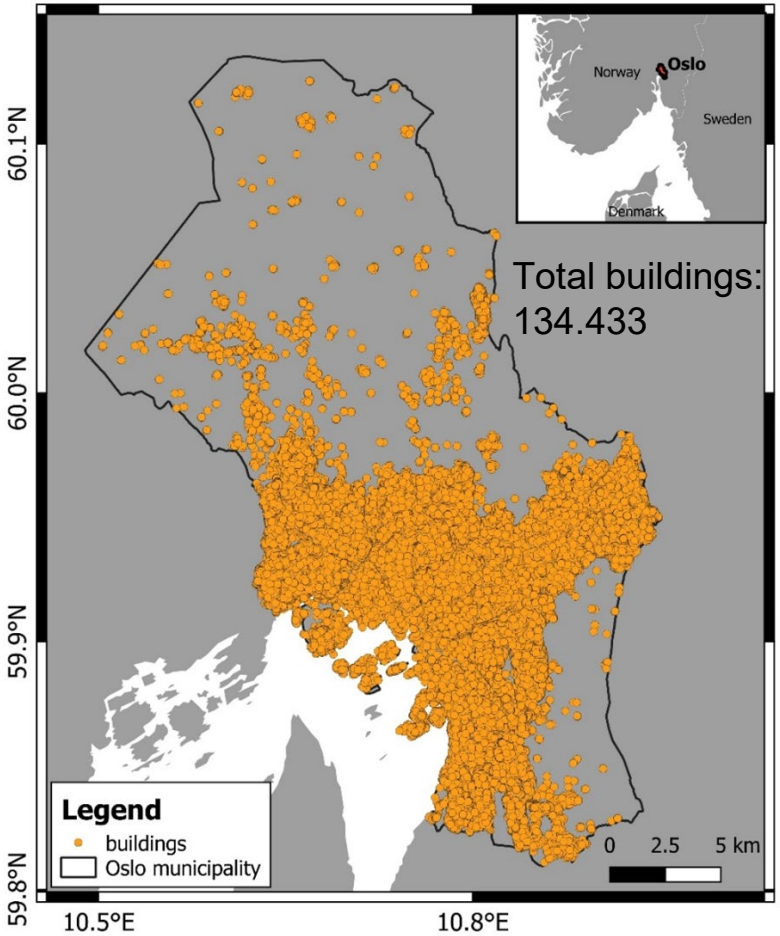
1. First overview from Google Earth

2. Detailed in-situ fieldwork:
   - ~500 pictures taken manually
   - Info about structural system and material data

3. Initial definition of 5 typologies

4. To confirm initial evaluation, survey questionnaire

5. Final MBT



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Building typologies for Oslo (Norway)

Timber (T)

Unreinforced Masonry (MUR)

Reinforced Concrete (CR)

Composite (SRC)

Steel (S)

Other

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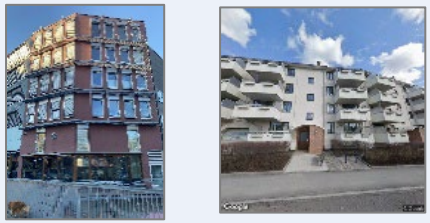
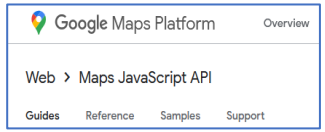
Workflow

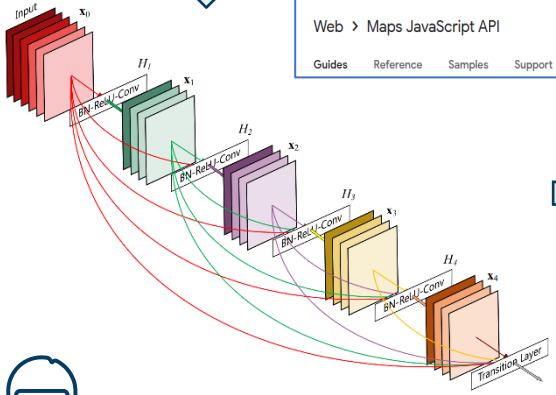
Collect images in area of interest



Camera and/or Streetview

Get images to be classified





Train a classifier

Manually label a representative set
(5074 images labelled)

Automatically label batches of building images

Timber

Reinforced Concrete

Steel

...

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Performance

- Tested 11 architectures
- Using a *DenseNet201* model pretrained on the *ImageNet* dataset (*transfer learning)*

		Predicted					
		CR	MUR	S	SRC	T	Other
True	CR	**0.73 (86)**	0.03 (4)	0.03 (3)	0.02 (2)	0.09 (11)	0.10 (12)
	MUR	0.05 (5)	**0.71 (76)**	0.00 (0)	0.00 (0)	0.20 (21)	0.05 (5)
	S	0.18 (5)	0.00 (0)	**0.57 (16)**	0.00 (0)	0.11 (3)	0.14 (4)
	SRC	0.60 (12)	0.00 (0)	0.05 (1)	**0.35 (7)**	0.00 (0)	0.00 (0)
	T	0.01 (3)	0.01 (6)	0.00 (0)	0.00 (0)	**0.89 (424)**	0.09 (42)
	Other	0.02 (4)	0.00 (1)	0.01 (2)	0.00 (0)	0.12 (32)	**0.87 (232)**

- **5074 images labelled** used for training and validating CNN model
  - 20% (1019 images) for test dataset
  - 4055 images to use for training

true: T, predicted: T

true: SRC, predicted: CR

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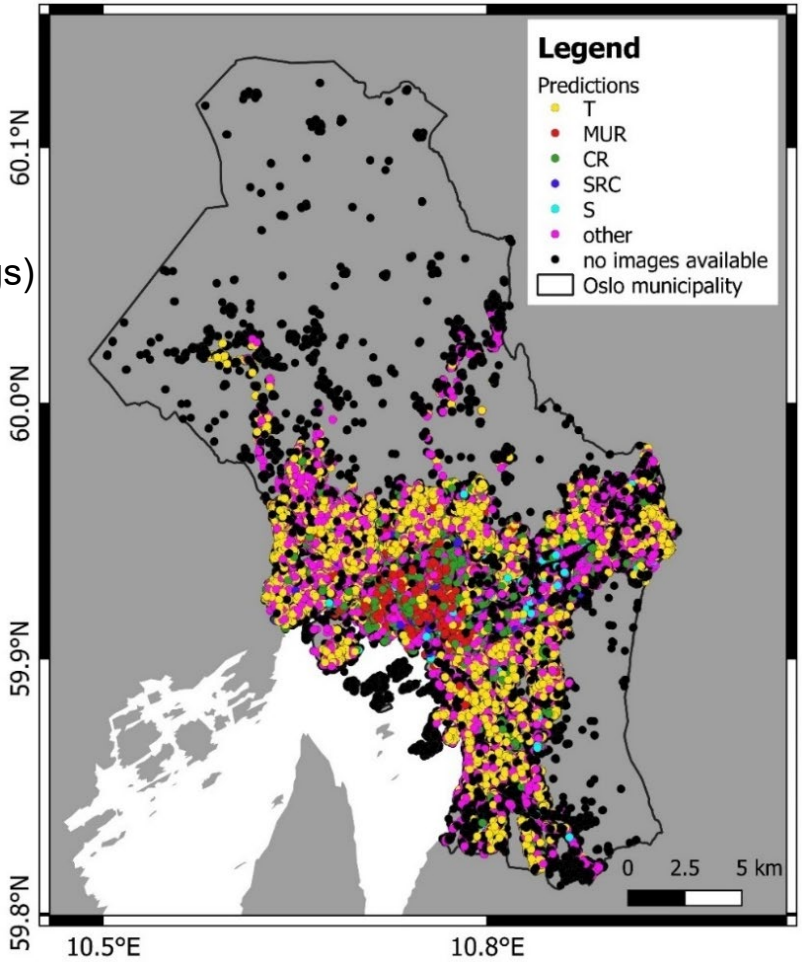
Results

Total buildings:134.432

No GSV images available: 35.093 (26% of total number of buildings)

Typologies	Number of buildings	%
T	56,305	56.7
MUR	7,979	8.0
CR	7,536	7.6
SRC	399	0.4
S	515	0.5
other	26,605	26.8



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Conclusions

- Development of the **first Norwegian Model Building Typologies** using Oslo as a case study.
- Combining Convolutional Neural Network (CNNs) and publicly available street-level imagery can significantly contribute in terms of developing a **cost-effective building stock model** for a seismic risk assessment.
- Potential to apply same method to **other Nordic cities**, with or without additional re-training.
- https://github.com/NorwegianSeismicArray/ML-for-building-typologies

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Paper (waiting for editor's final decision)

"Building stock classification using machine learning: a case study for Oslo, Norway"

Frontiers in Earth Science in Geohazards and Georisks

Research Topic: New Challenges for Seismic Risk Mitigation in Urban Areas

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UiO : University of Oslo

PhD part of the GEO by IT

Geodata-based Machine Learning for real-time urban risk reduction systems

Thank you for your attention

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