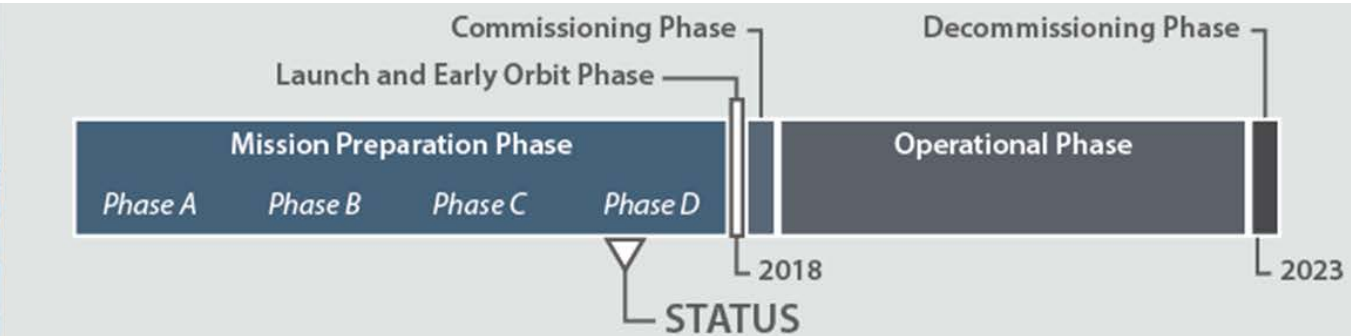
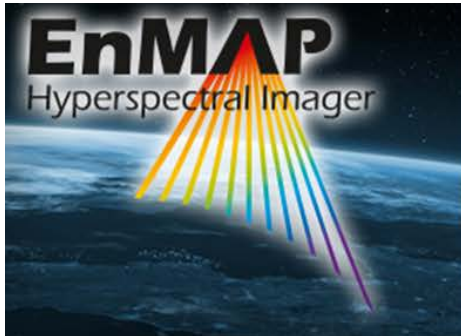


→ MAPPING URBAN AREAS FROM SPACE CONFERENCE

On the use of extended vegetation-
impervious-soil maps from simulated EnMAP
data for characterizing urban functional areas

Akpona Okujeni, Sebastian van der Linden &
Patrick Hostert

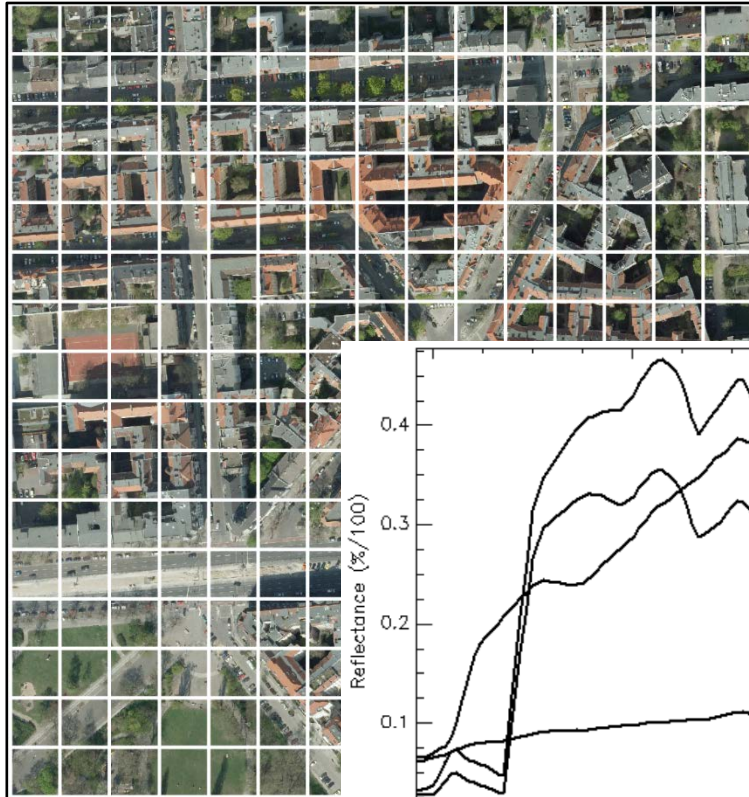
4–5 November 2015 | ESA–Esrin | Frascati, Rome (Italy)



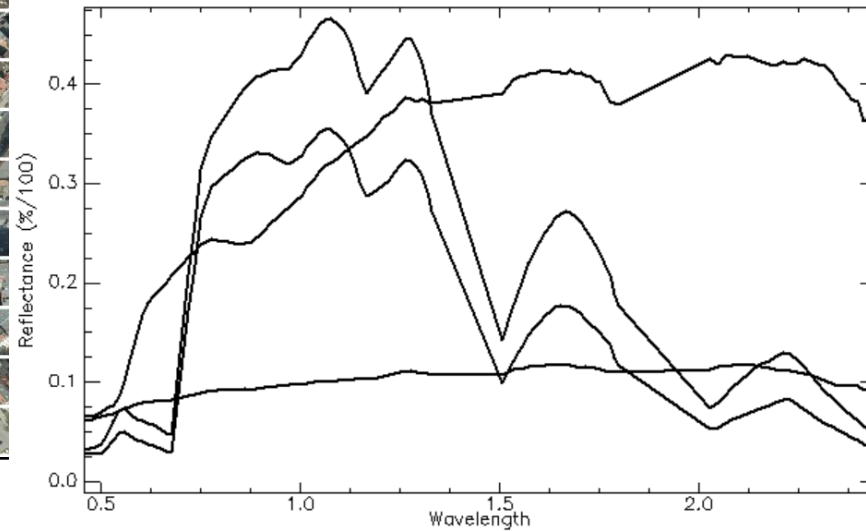
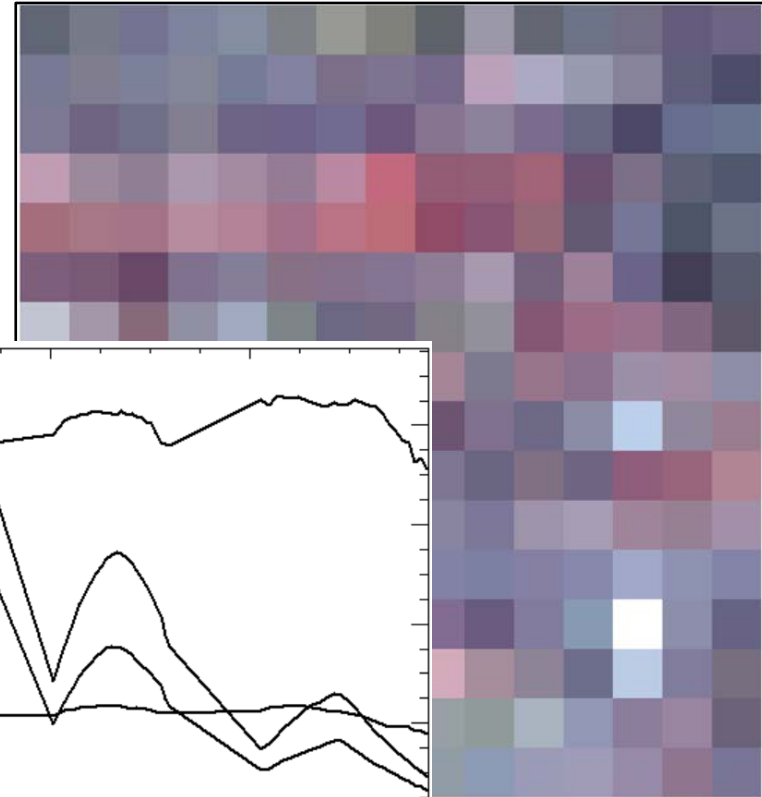
EnMAP (Environmental Mapping and Analysis Program)	
Spectral range	420 – 2450 nm
Spectral sample distance	6.5 nm (VNIR), 10 nm (SWIR)
Spectral bands	> 200
Geometric resolution	30 x 30 m
Swath width	30 km
Swath length	5000 km per day
Revisit	27 days ($\pm 5^\circ$ off-nadir tilt) 4 days ($\pm 30^\circ$ off-nadir tilt)

www.enmap.org

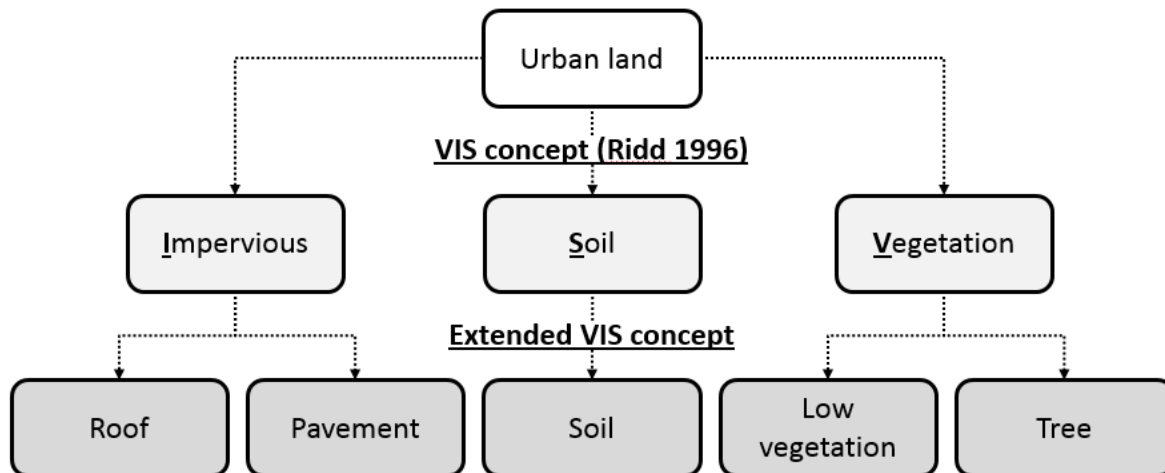
Aerial image & EnMAP grid (30 m)



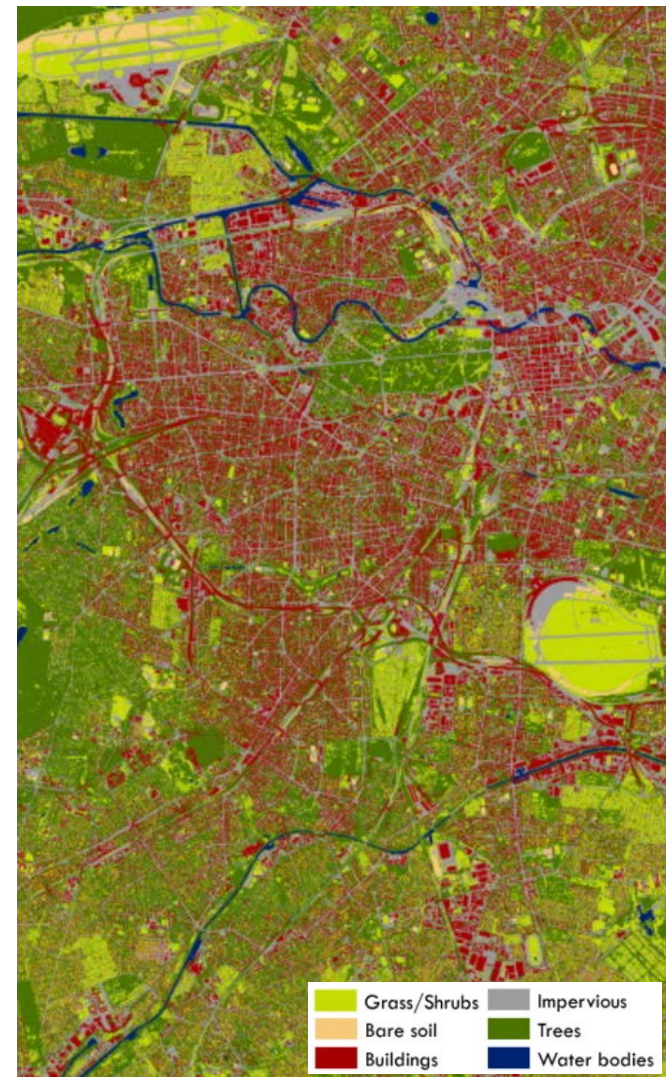
simulated EnMAP



Bio-physical mapping of urban areas



Voltersen, M., et al. (2014)



Functional mapping of urban areas (e.g. European Urban Atlas)

Continuous urban fabric



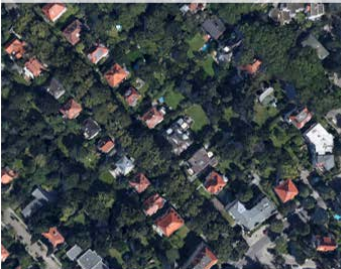
Industrial units



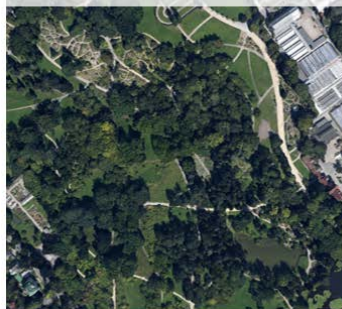
Sports & leisure facilities



Discontinuous urban fabric
(med. density)



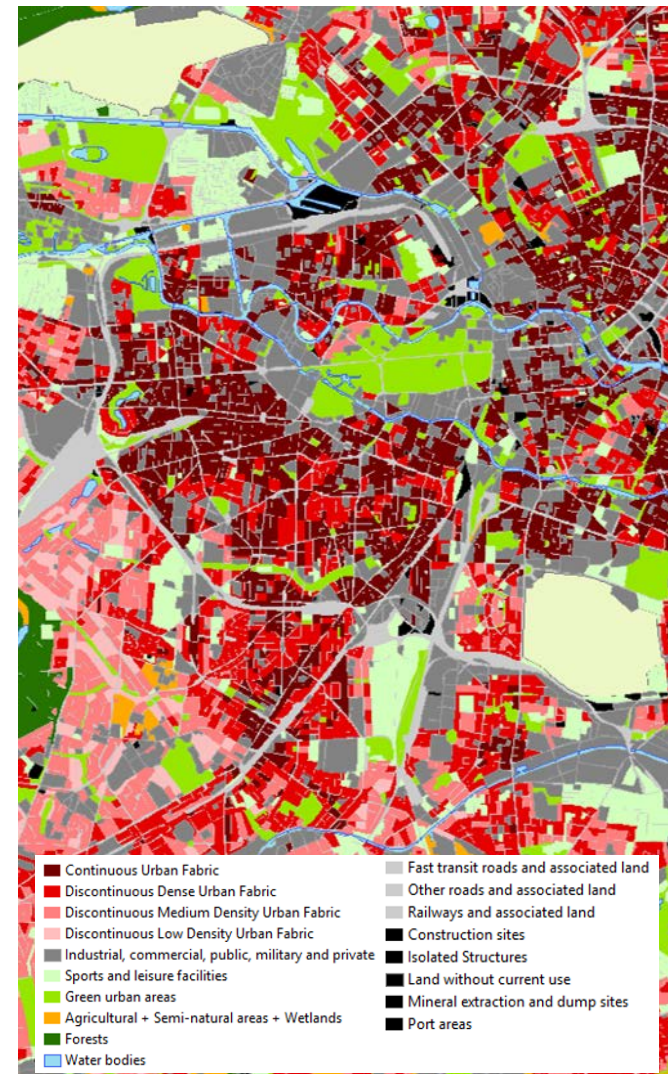
Green urban areas



Forest



www.google.com/earth/

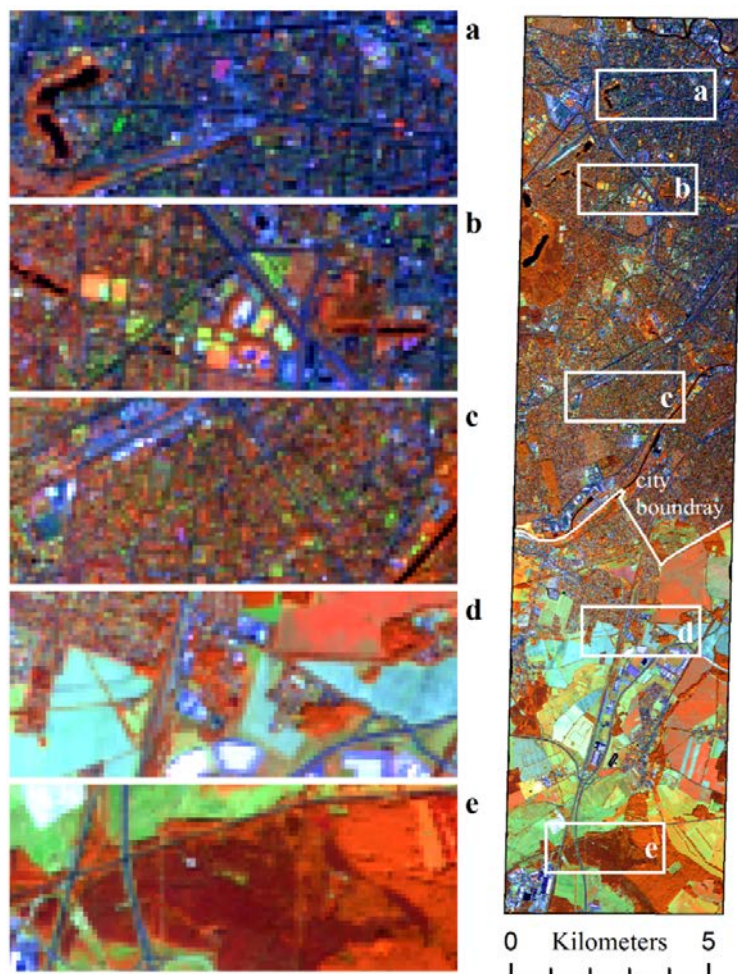


www.eea.europa.eu

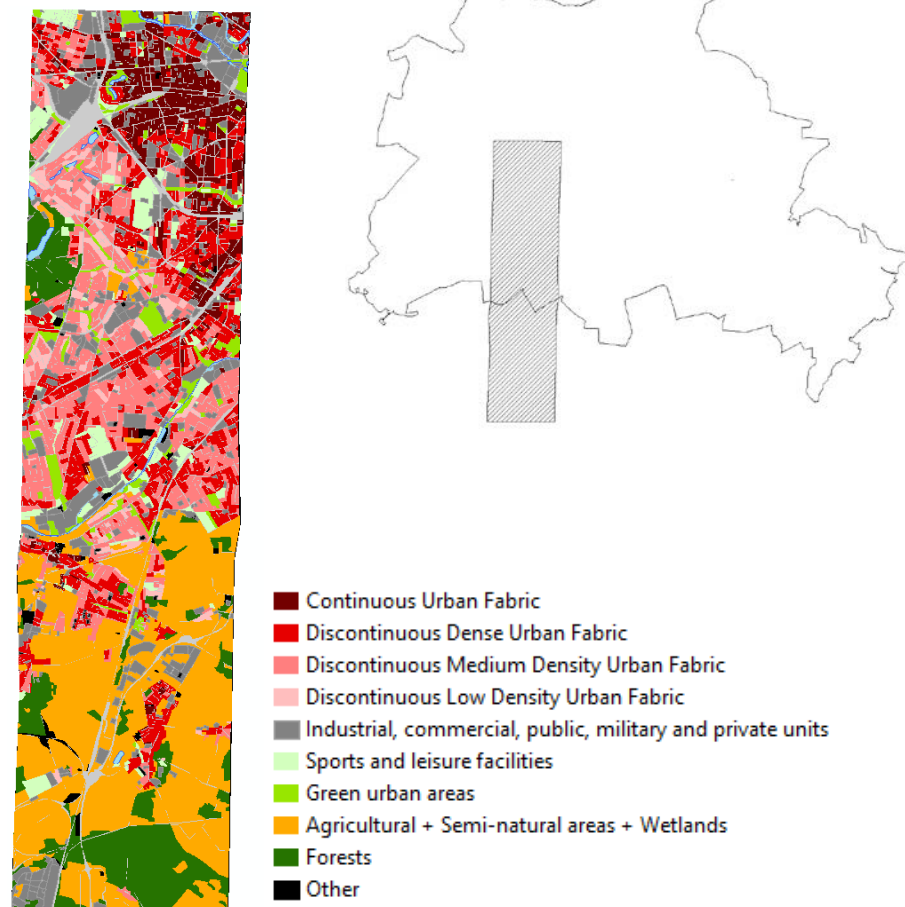
- 1) Demonstrate the value of EnMAP data for VIS and extended VIS mapping.
- 2) Demonstrate the use of VIS and extended VIS maps for characterizing urban functional areas.

Study Area & Data

simulated EnMAP

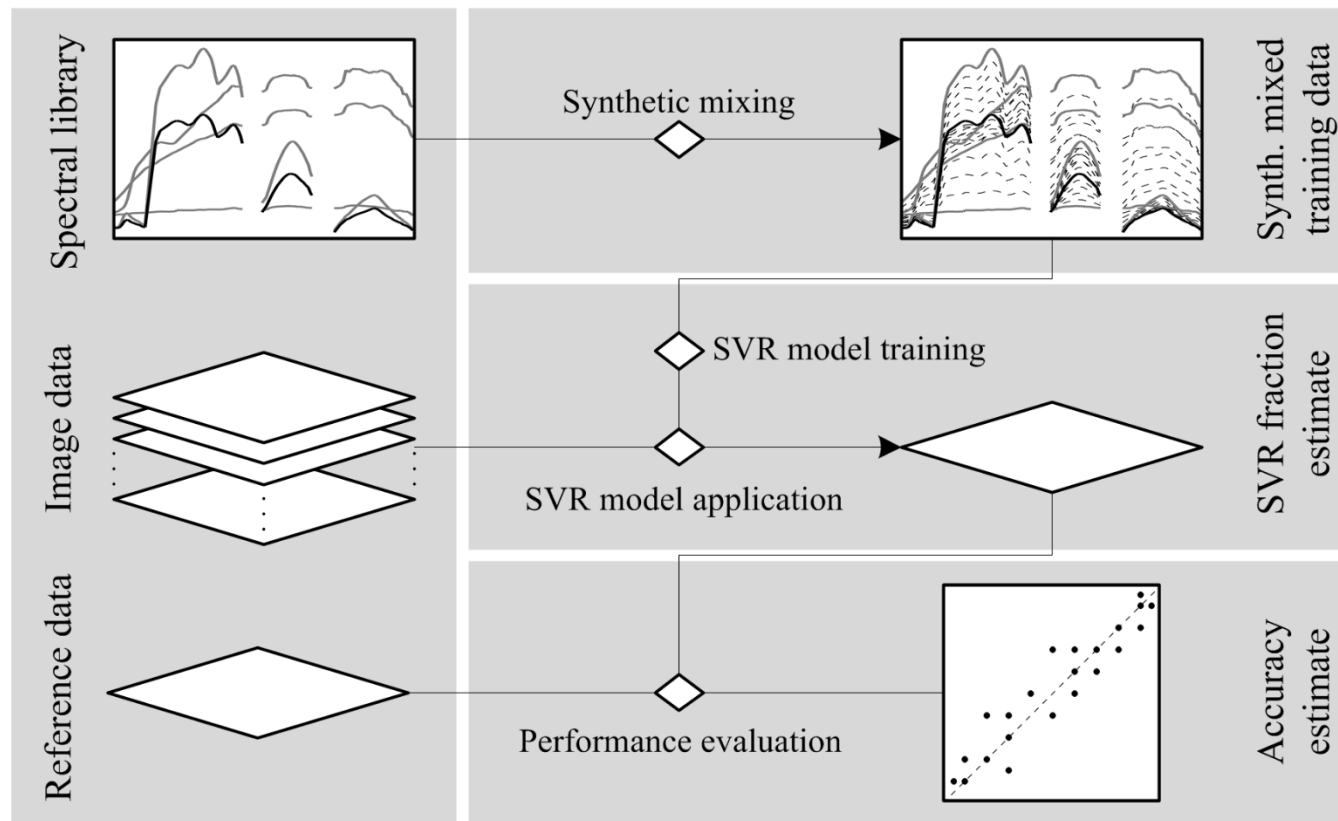


Urban Atlas



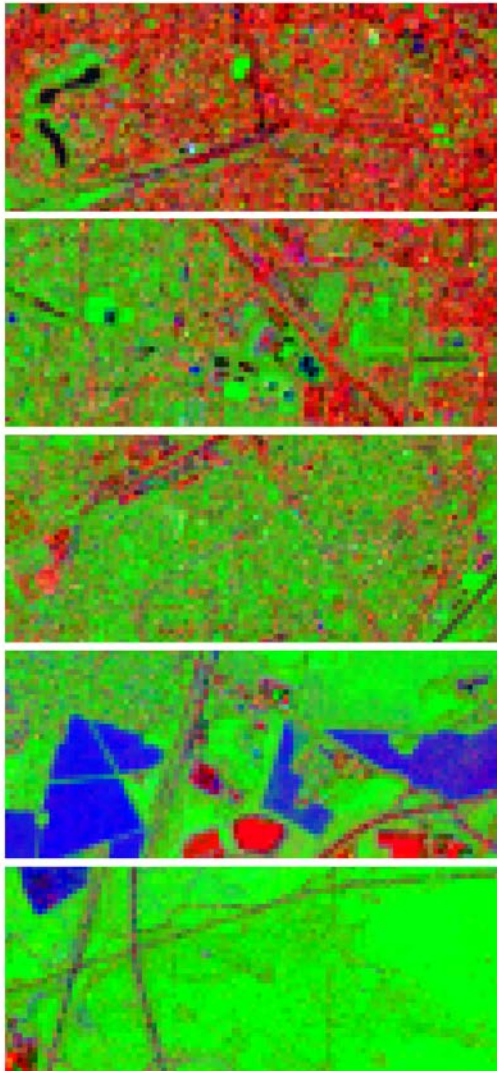
VIS & extended VIS mapping

Support vector regression and synthetically mixed training data for VIS and extended VIS fraction mapping



Okujeni, A., et al. (2013)

VIS & extended VIS mapping

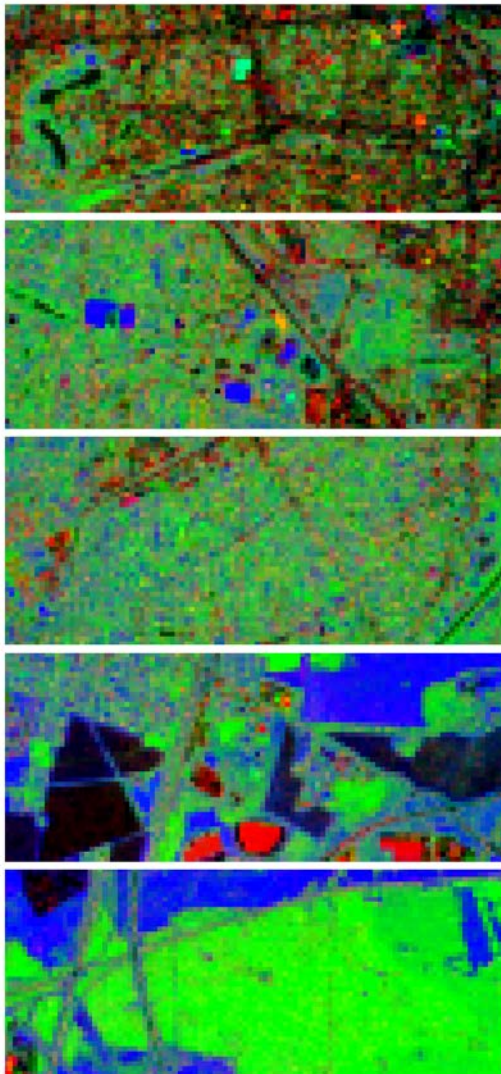


VIS fraction map

(R) Impervious (G) Vegetation (B) Soil

	EnMAP (MAE%)	Landsat (MAE%)	Δ (MAE%)
Impervious	10.9	15.5	-4.6
Vegetation	11.9	11.5	0.4
Soil	10.5	11.4	-0.9

Okujeni, A., et al. (2015)



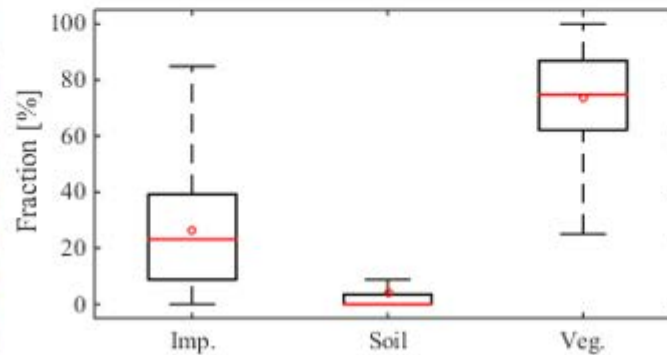
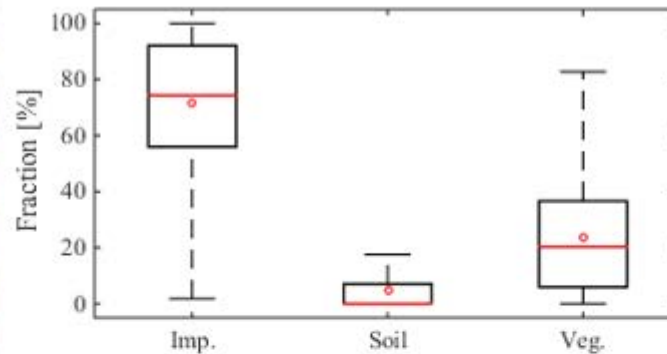
Extended VIS fraction map
(R) Roof (G) Tree (B) Low vegetation

	EnMAP (MAE%)	Landsat (MAE%)	Δ (MAE%)
Roof	12.4	21.7	-9.3
Pavement	21.0	24.0	-3.0
Low vegetation	7.3	12.2	-4.9
Tree	16.6	21.8	-5.2

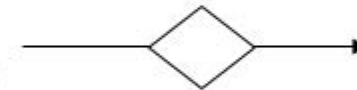
Okujeni, A., et al. (2015)

Characterizing Urban Functional Areas

Random forest based urban functional area mapping using block-wise statistical metrics



Random forest classification



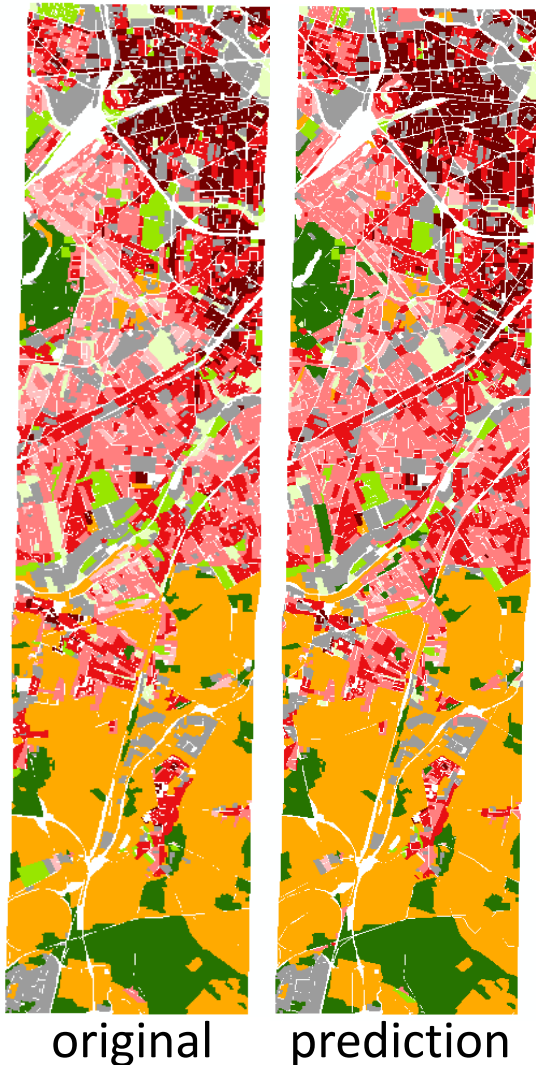
Accuracies of urban functional area maps

Urban Atlas Level	OA Input: VIS	OA Input: VIS + ext. VIS
Level 1 (3 classes)	94.9	95.8
Level 2 (5 classes)	77.4	79.1
Level 3 (9 classes)	55.7	59.6

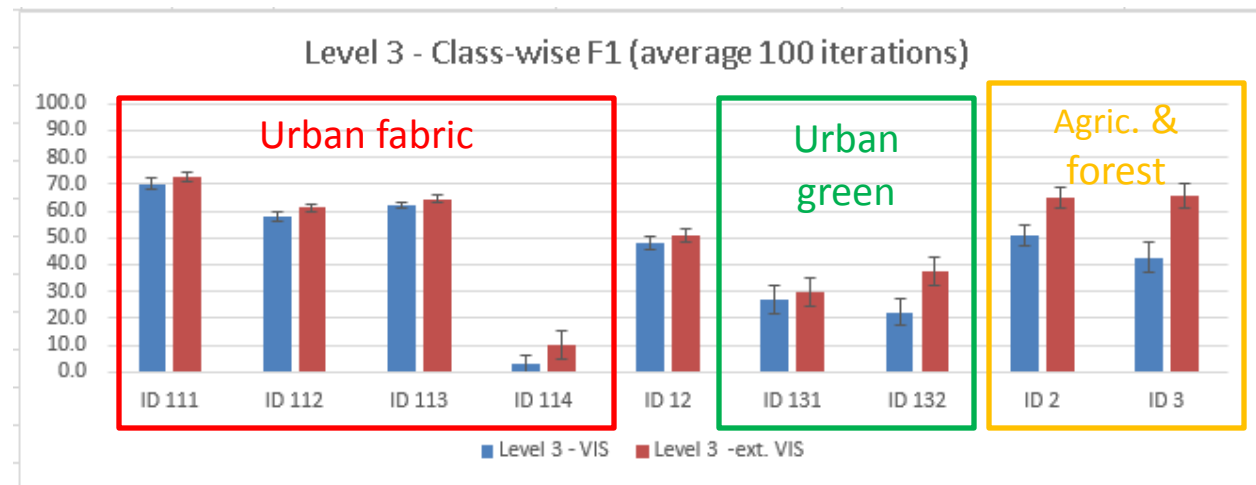
Classification results (100 iterations, stratified random sampling)

Level 1	Level 2	Level 3
Artificial surfaces	Urban fabric	Continuous Urban fabric
		Discontinuous Dense Urban Fabric
		Discontinuous Medium Density Urban Fabric
		Discontinuous Low Density Urban Fabric
	Industrial, commercial, public, military and private units	Industrial, commercial, public, military and private units
	Artificial non-agricultural vegetated areas	Green urban areas
		Sports and leisure facilities
Agricultural areas, semi-natural areas and wetlands	Agricultural Areas, semi-natural areas and wetlands	Agricultural Areas, semi-natural areas and wetlands
Forests	Forests	Forests

Characterizing Urban Functional Areas



Accuracy of Level 3 urban functional area map



- Continuous Urban Fabric
- Discontinuous Dense Urban Fabric
- Discontinuous Medium Density Urban Fabric
- Discontinuous Low Density Urban Fabric
- Industrial, commercial, public, military and private
- Sports and leisure facilities
- Green urban areas
- Agricultural + Semi-natural areas + Wetlands
- Forests

EnMAP data will be useful to improve and extend VIS mapping in urban environments.

VIS and extended VIS maps from EnMAP data will be useful to infer information on urban functional areas.

Error sources are reduced (e.g. in comparison to multispectral data) and remaining uncertainties relate to class similarities.

EnMAP will introduce new quality into urban remote sensing.



Thank you for your attention!

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UrbanEARS

Belgian Science Policy Office



belspo

EnMAP

Hyperspectral Imager



Voltersen, M., et al. (2014): Object-based land cover mapping and comprehensive feature calculation for an automated derivation of urban structure types at block level. Remote Sensing of Environment.

Okujeni, A., et al. (2013): Support vector regression and synthetically mixed training data for quantifying urban land-cover, Remote Sensing of Environment

Okujeni, A., et al. (2013): Extending the vegetation-impervious-soil model using simulated EnMAP data and machine learning.