BELAIR – SONIA site

Boud Verbeiren (coordinator), Hydrology and Hydraulic Engineering, VUB
Frederik Priem, Cartography and GIS Research Group, VUB
Jeroen Degeryckx, Division of Forest, Nature and Landscape, KUL

Brugge, 8th of November 2016

BELAIR – SONIA

- Introduction
  - Study site & thematic interest
  - SONIA Team: Urban & Forest
  - Data use & Links
- BELAIR 2015 Campaign – SONIA
  - Airborne acquisition
  - Ground truthing
- Analysis and Preliminary results
- Feedback & Outlook

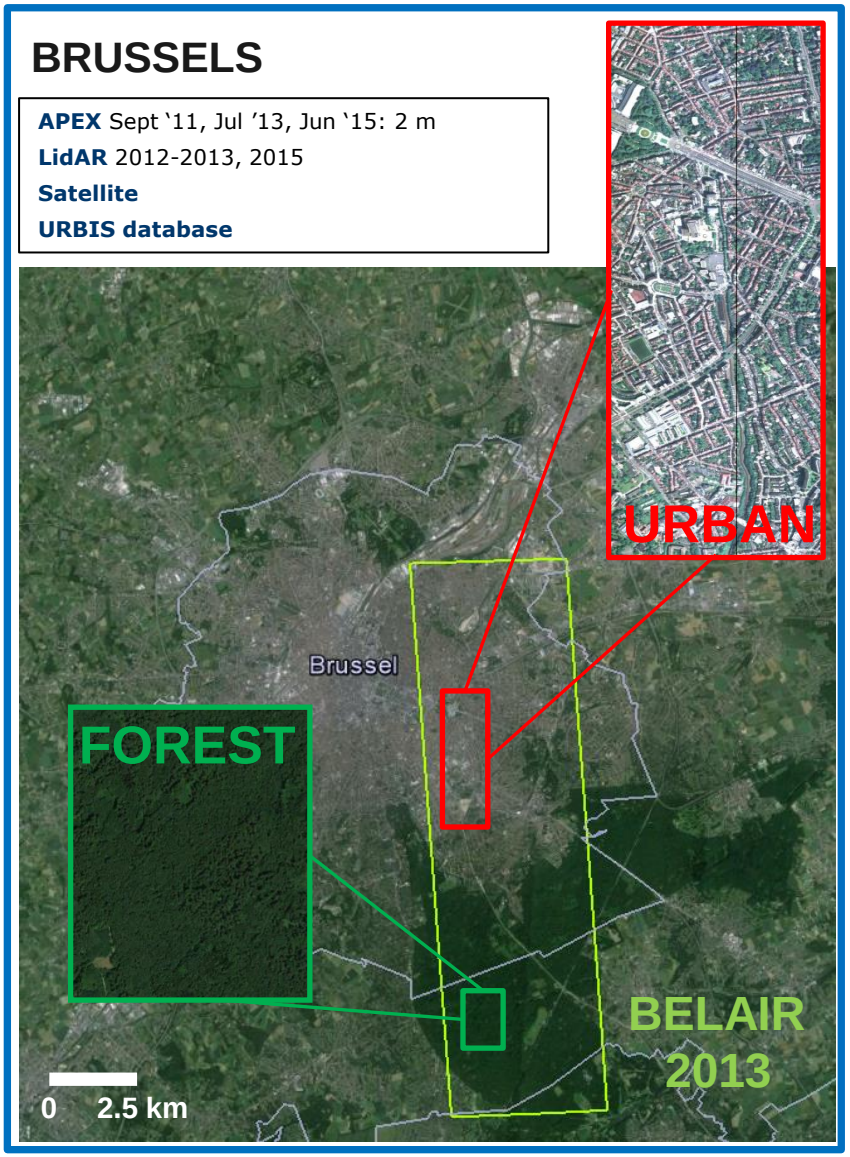
SONIA study site

Brussels

- Urban diversity
- Sonian Forest
- Upper Woluwe basin

Focus

Spatiotemporal characterization and **monitoring** of **water and energy fluxes** in urban and forest environment



SONIA team

URBAN

VUB

KU LEUVEN

UNIVERSITEIT GENT

Hydrology
Geography

Earth & Environmental Sciences

Forest Management and Spatial Information techniques

FOREST

bruxelles environnement leefmilieu brussel .brussels

Agentschap voor Natuur en Bos

inbo

UNIVERSITEIT GENT

Université de Liège

Data use & Links

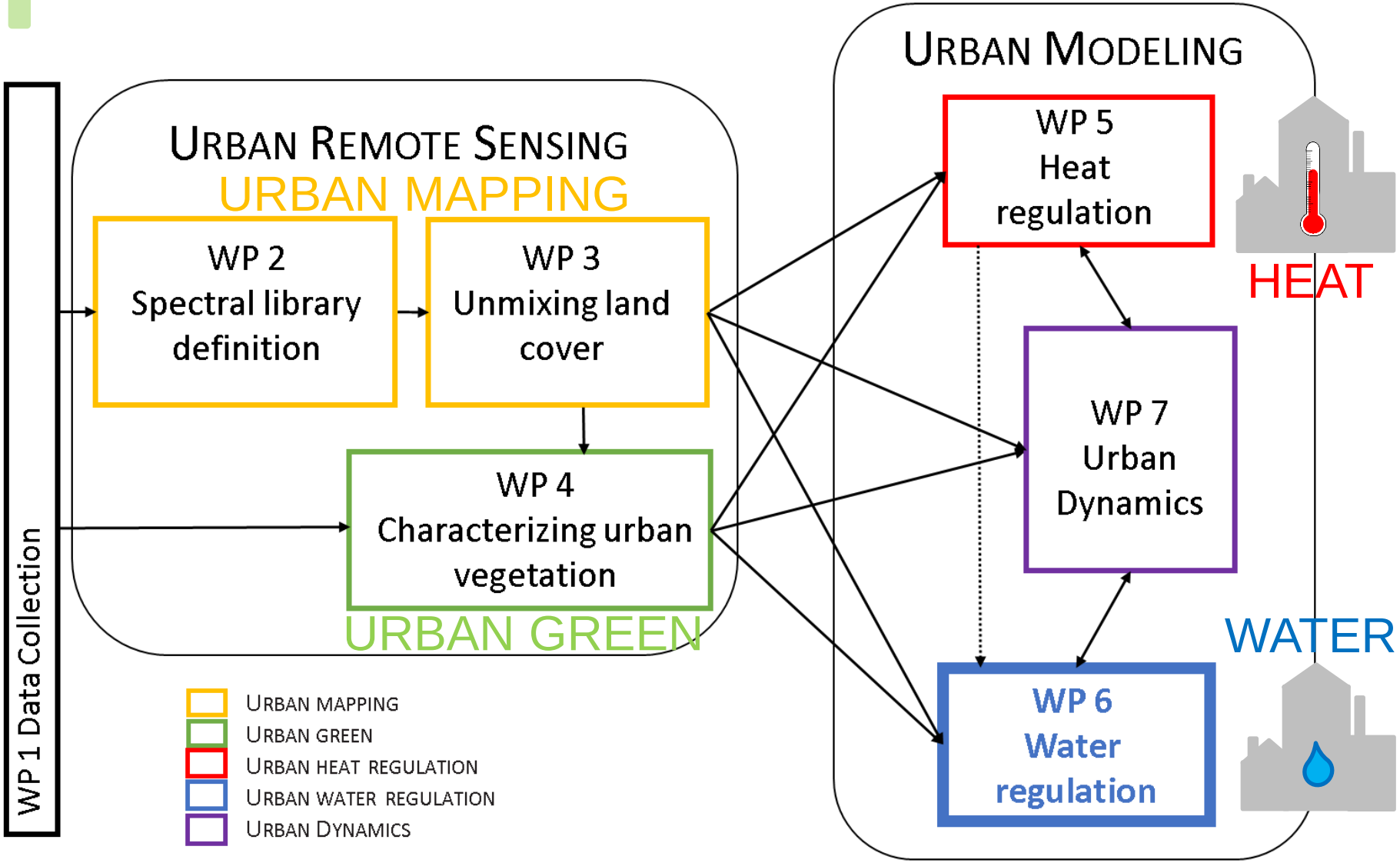
- BELSPO STEREO III Thematic project
  - UrbanEARS > 4 PhD's + related work
- Innoviris project
  - Water budgeting
- BELIRIS project
  - Urban tree health
- PhD Theses (8)
- MSc Theses (7)

RESEARCH PROGRAMME FOR EARTH OBSERVATION 'STEREO III'
THEMATIC PROJECT 2014-2018

URBANEARS

URBAN ECOSYSTEM ANALYSIS SUPPORTED BY REMOTE SENSING

URBANEARS - WORK PLAN



Interdisciplinarity & International

KU LEUVEN

Urban Vegetation

Vrije Universiteit Brussel

Remote Sensing
Urban Modelling
Urban Hydrology

UNIVERSITEIT GENT

Urban Climate

HUMBOLDT-UNIVERSITÄT ZU BERLIN

Remote Sensing

UrbanEARS Partnership

UCSB

Remote Sensing

BATir

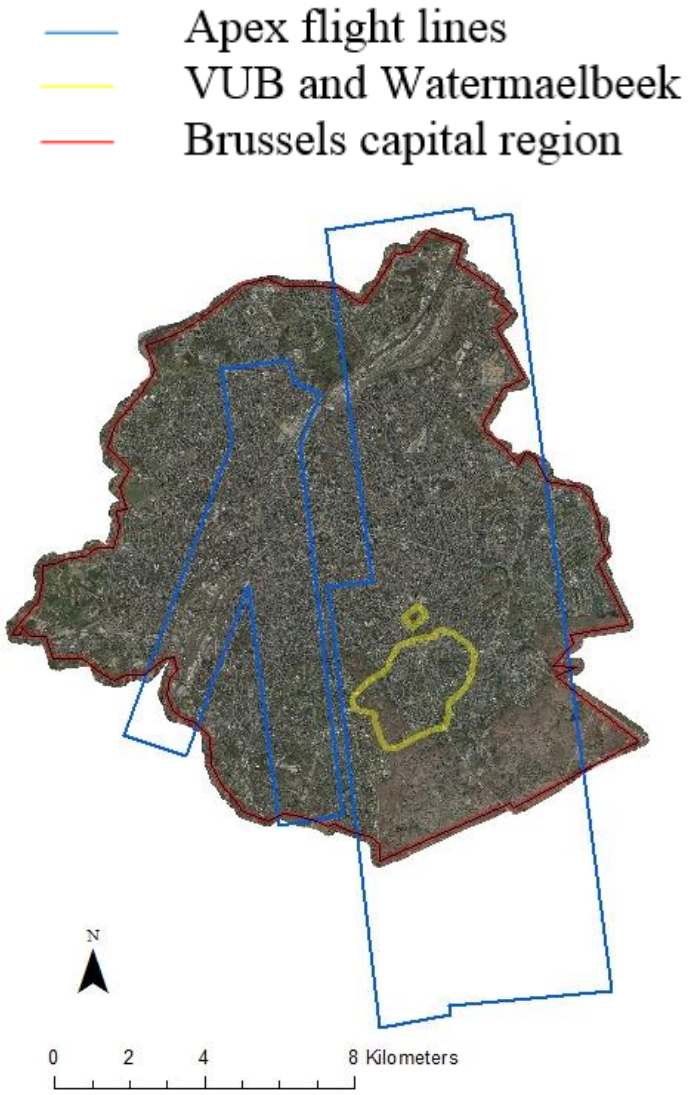
Urban Planning
& Architecture

vito
vision on technology

Urban Climate

BELAIR 2015 campaign – SONIA

- Airborne acquisition
  - Hyperspectral APEX
  - 30th of June 2015
  - 7 flight lines
- Pre-processing (VITO)
  - Radiometric
  - Geometric
  - Atmospheric
- Image: 2m resolution

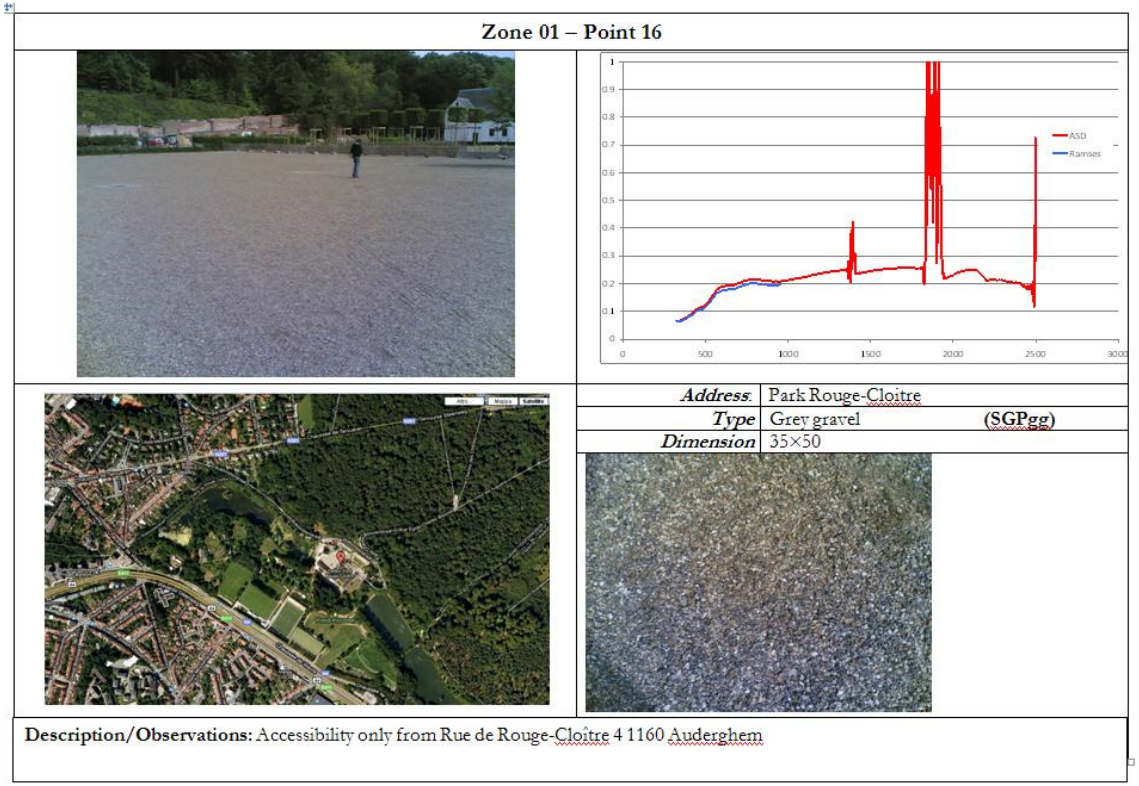


BELAIR 2015 campaign – SONIA

- In-situ Ground truthing
  - **REFERENCE**
  - URBAN

Reference measurements

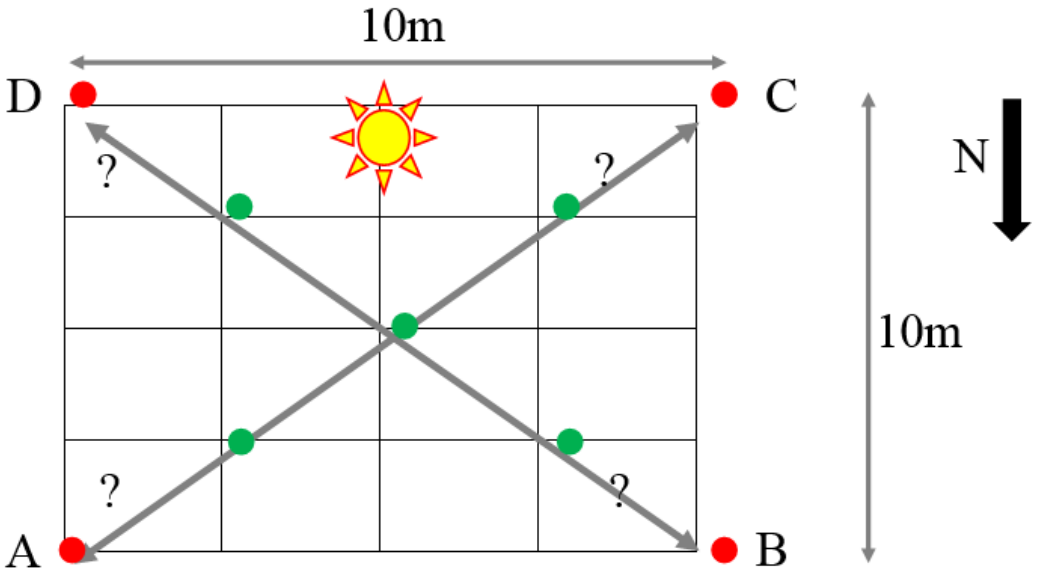
- Spectral measurements reference targets
  - VUB – CGIS
  - ASD spectro
  - 30 June 2015
  - 10 July 2015
  - Seven targets:
    - Five dark (asphalt, bitumen)
    - Two bright (gravel)



BELAIR 2015 campaign – SONIA

- In-situ Ground truthing
  - REFERENCE
  - **URBAN → WATER & ENERGY FLUXES**

    Grass & top soil characteristics

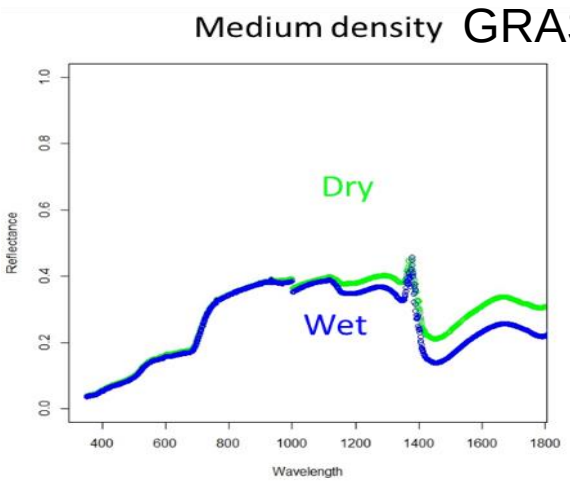


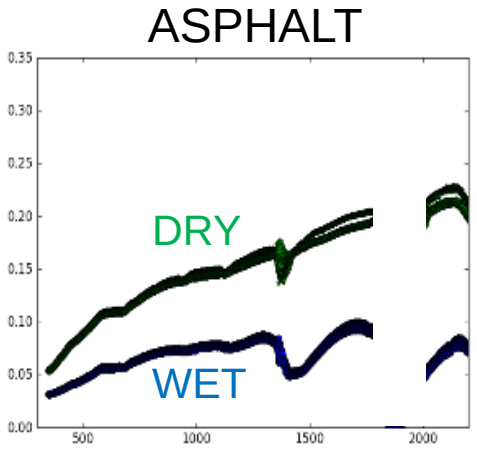
BELAIR 2015 campaign – SONIA

- In-situ Ground truthing
  - REFERENCE
  - **URBAN → WATER & ENERGY FLUXES**

    Grass & top soil characteristics

    Spectral characterization grass & urban surfaces





BELAIR 2015 campaign – SONIA

- In-situ Ground truthing
  - REFERENCE
  - **URBAN → WATER & ENERGY FLUXES**

    Grass & top soil characteristics

    Spectral characterization grass & urban surfaces

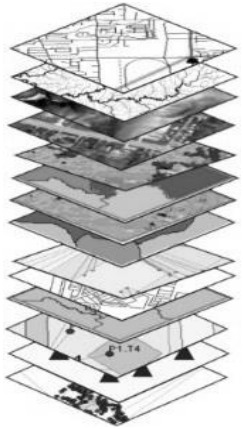
    Tree characteristics

    > LAI timeseries

    > Sap flow

Urban water/heat regulation

URBAN INFRASTRUCTURE



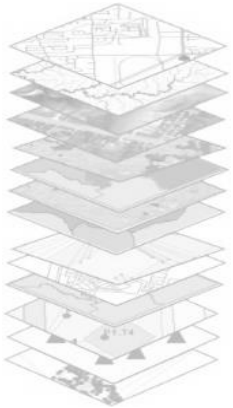
type of material

height of buildings

roof exposition

etc,

URBAN GREEN



LAI

moisture content

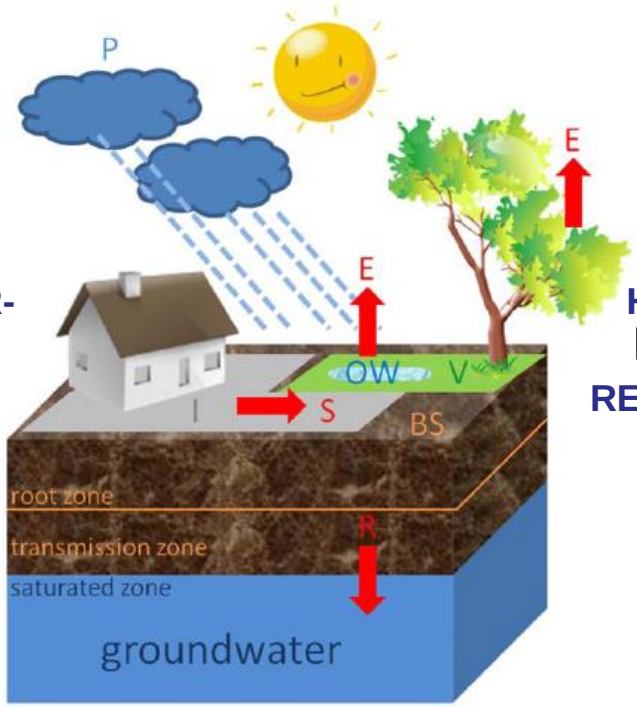
chl-a concentration

species diversirty

vegetation Height

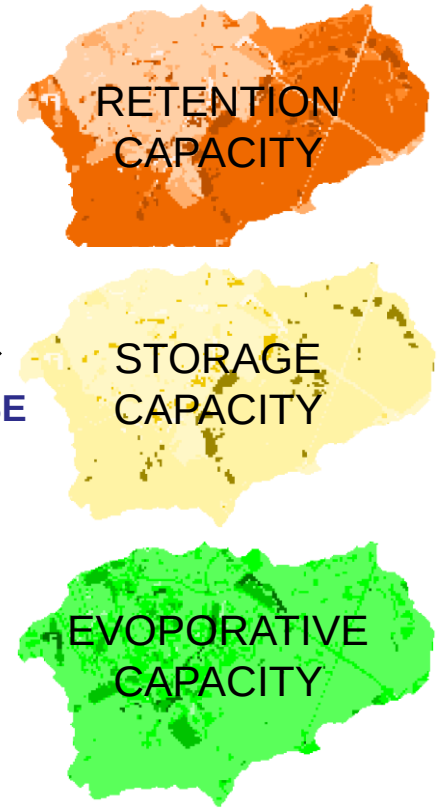
etc.

PARAMETER-ISATION



WATER BALANCE MODEL

HYDRO RESPONSE



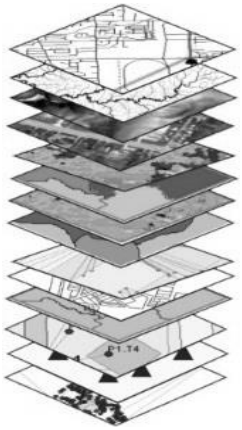
ECOSYSTEM SERVICE INDICATOR MAPS

Preliminary results

- Linked to UrbanEARS project

Mapping urban surfaces

URBAN INFRASTRUCTURE



type of material

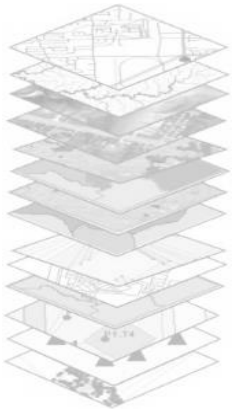
height of buildings

roof exposition

etc,

Urban green characterisation

URBAN GREEN



LAI

moisture content

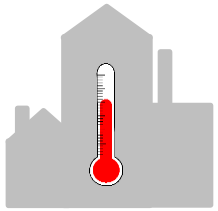
chl-a concentration

species diversirty

vegetation Height

etc.

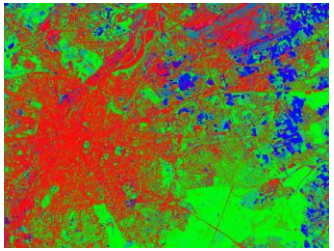
Urban mapping
(Frederik Priem - VUB)



Urban ecosystem services

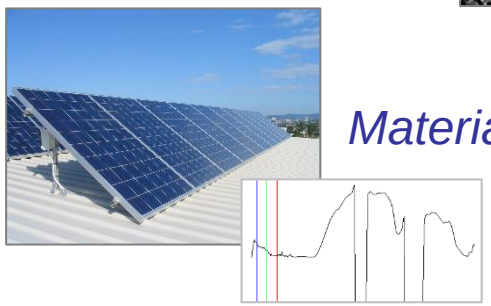
Material characteristics

Urban composition



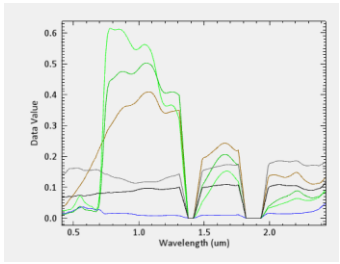
Including LiDAR height information

Satellite imagery



Material mapping

Spectral library



Urban land cover

Urban mapping
(Frederik Priem - VUB)

Level 1	Level 2
roof	1. red ceramic tile
	2. dark ceramic tile
	3. dark shingle
	4. bitumen
	5. fiber cement
	6. bright roof material
	7. hydrocarbon roofing
	8. gray metal
	9. green metal
	10. paved roof
	11. glass
	12. gravel roofing
	13. green roof
	14. solar panel
pavement	15. asphalt
	16. concrete
	17. red concrete pavers
	18. railroad track
	19. cobblestone
	20. bright gravel
	21. red gravel
	22. tartan
	23. artificial turf
	24. green surface
high vegetation	25. high vegetation
low vegetation	26. low vegetation
bare soil	27. bare soil
water°	28. water°

27 material classes trained for mapping

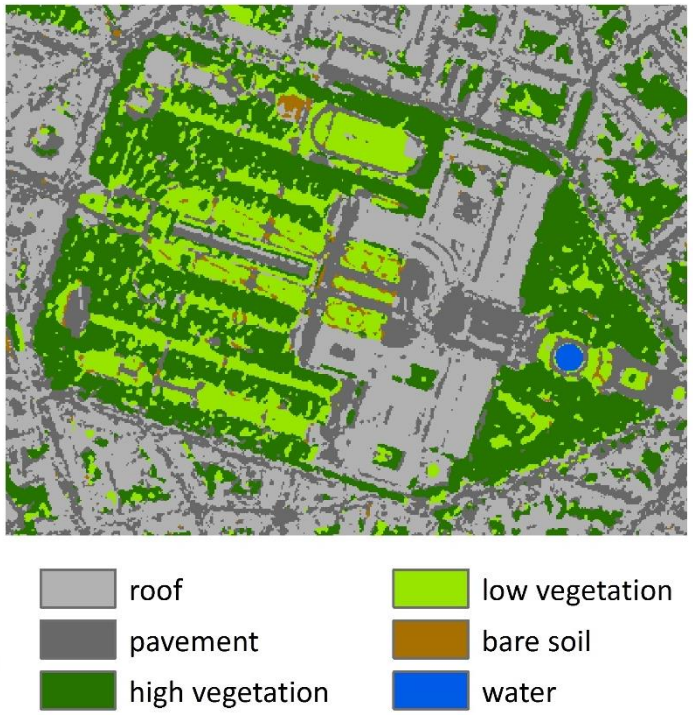
sunlit + shaded spectra included

Urban mapping
(Frederik Priem - VUB)

APEX SONIA

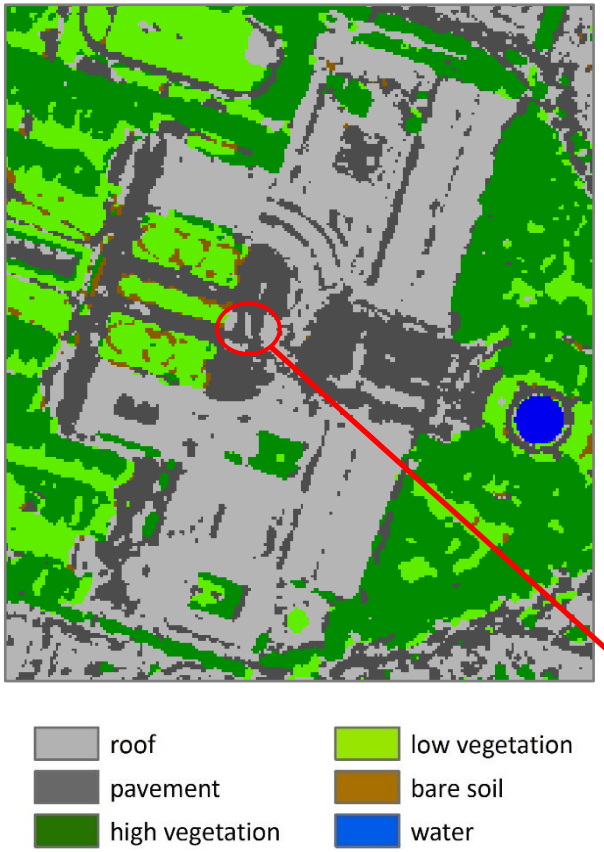
Support Vector Classification

Land cover + class probabilities



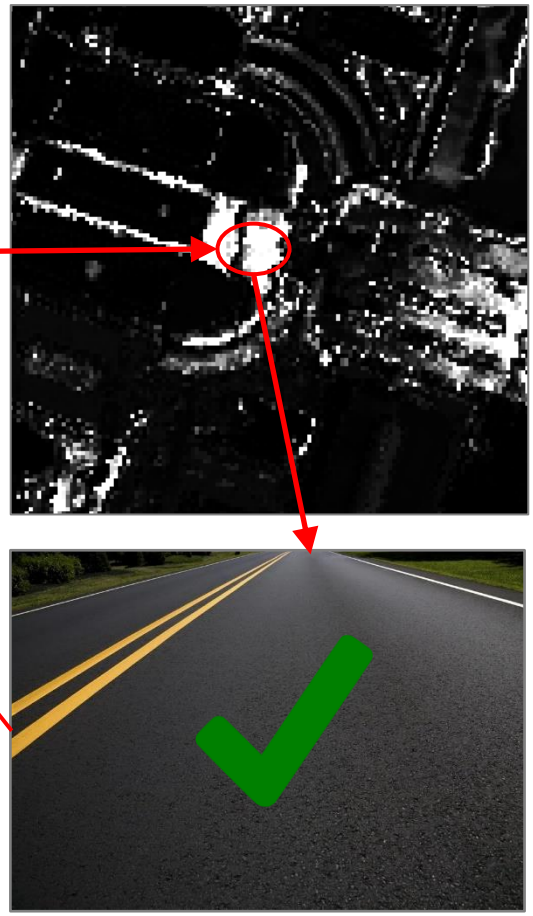
Urban mapping
(Frederik Priem - VUB)

Land cover



Geometry check

If wrong: next best class
(SVC class probabilities)



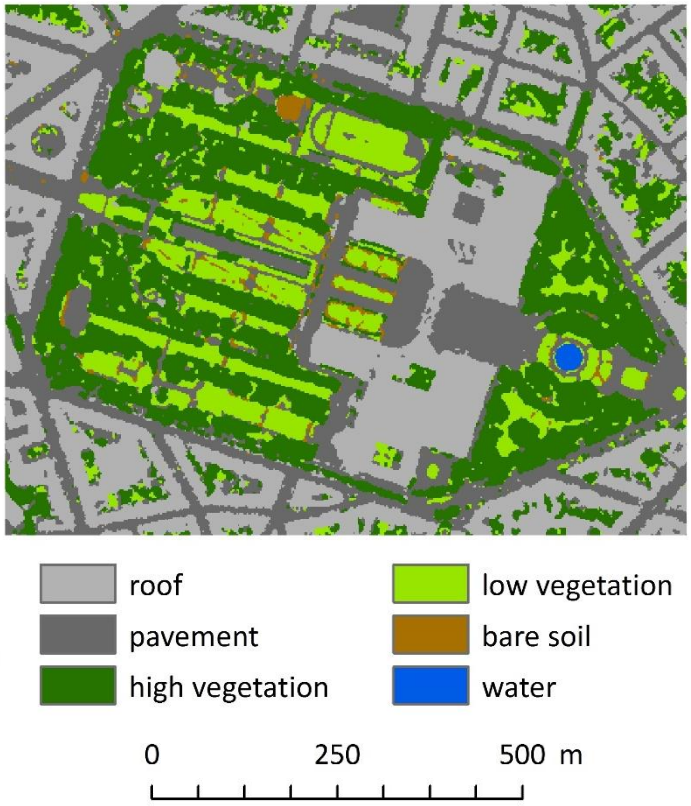
Bitumen

Repeat!

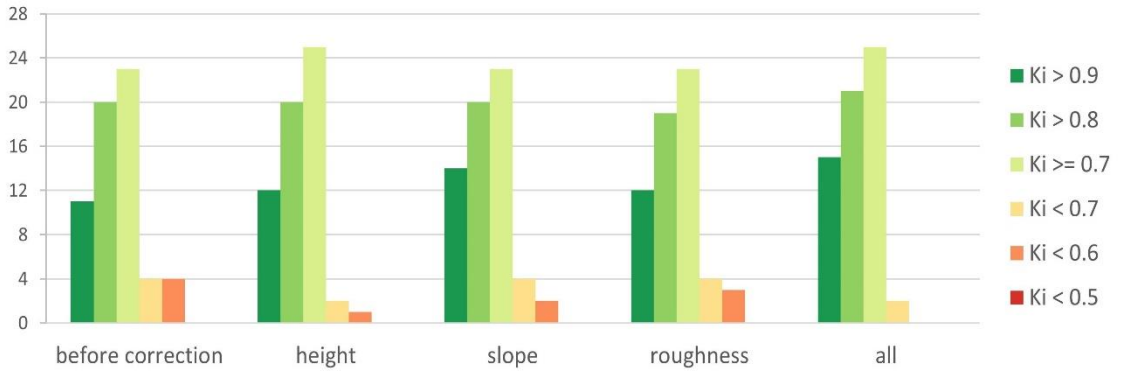
Asphalt

Urban mapping
(Frederik Priem - VUB)

Land cover after correction



Cumulative level 2 class wise kappa histograms



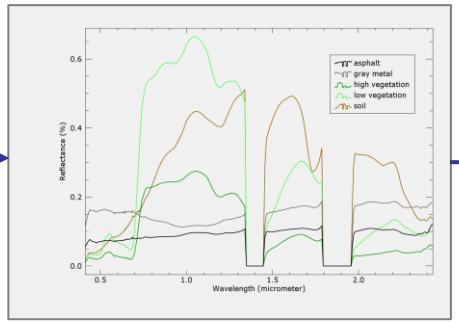
Overall level 2 kappa before correction = 0.80
Overall level 2 kappa after correction = 0.87

Priem F. & Canters F., *Synergistic use of LiDAR and APEX hyperspectral data for high-resolution urban land cover mapping*, Remote Sensing, **2016**, 8(10), 787; doi:10.3390/rs8100787

Urban mapping
(Frederik Priem - VUB)

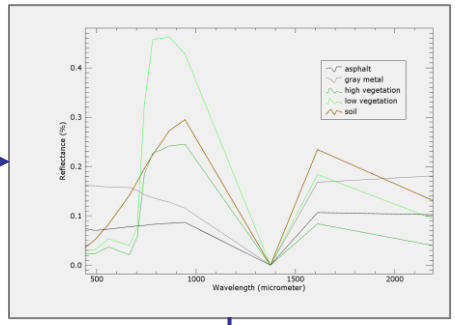
APEX SONIA (2015)

Hyperspectral library



resample

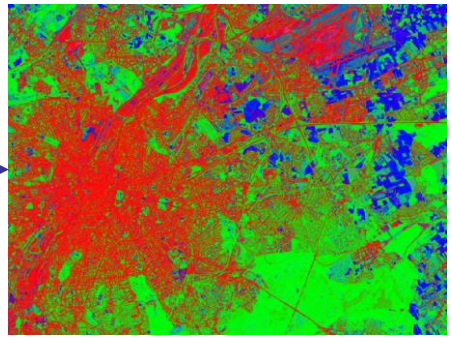
Multispectral library



Sentinel-2 (2015)

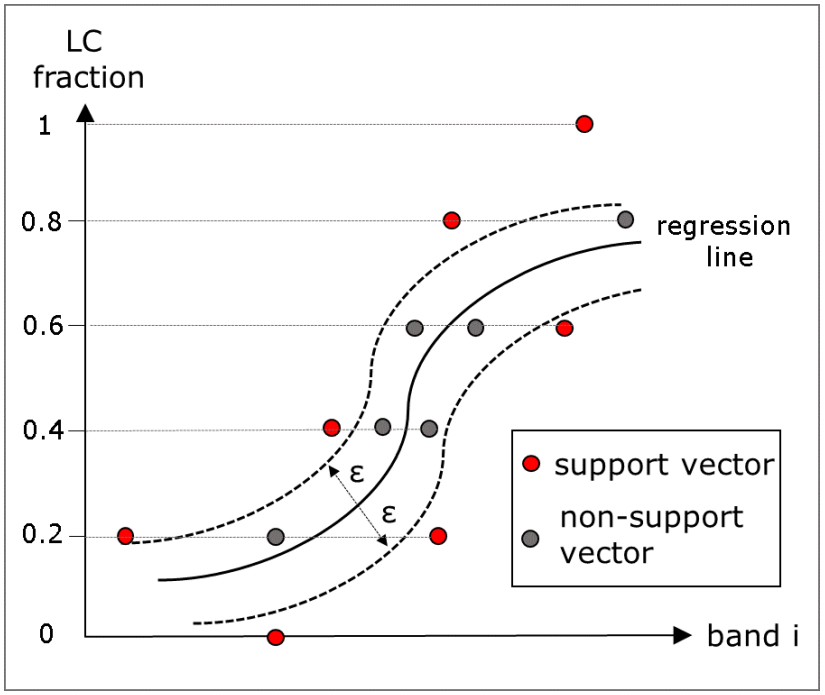
Support Vector Regression

Vegetation – Impervious - Soil fraction maps

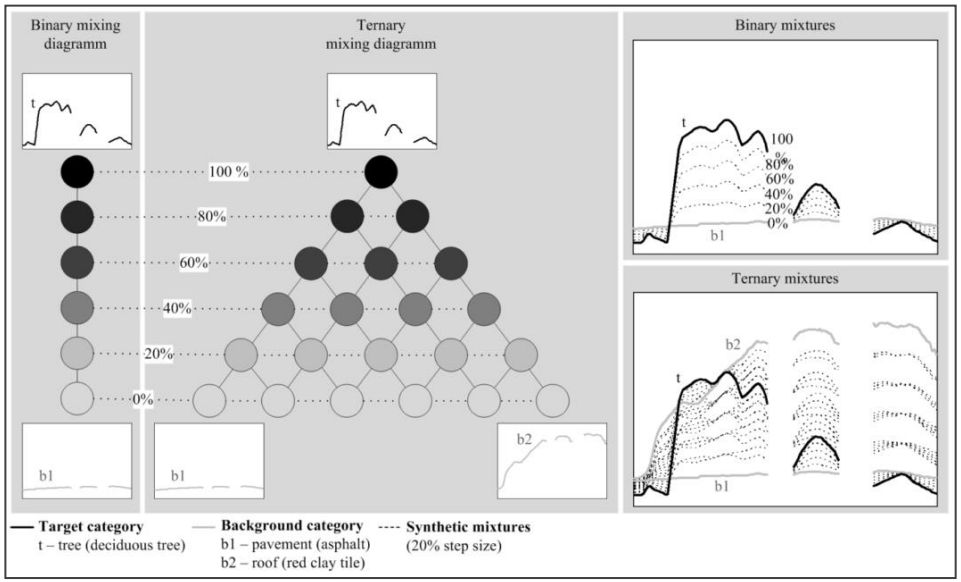


Urban mapping
(Frederik Priem - VUB)

SVR needs quantitative training data → Synthetic mixing



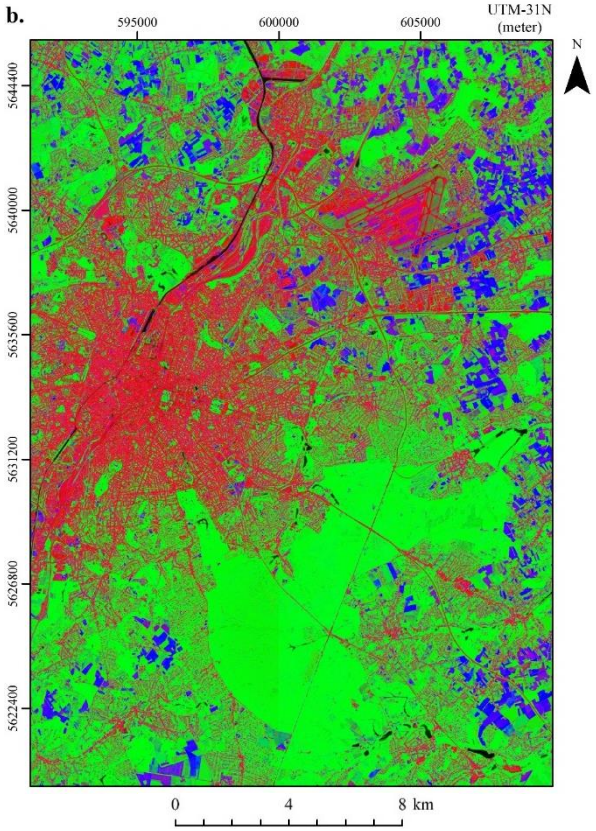
70 EM spectra yield > 300000 mixed spectra



Okujeni et al., *A Comparison of Advanced Regression Algorithms for Quantifying Urban Land Cover*, Remote Sensing, **2014**, 6, 6324-6346, doi:10.3390/rs6076324

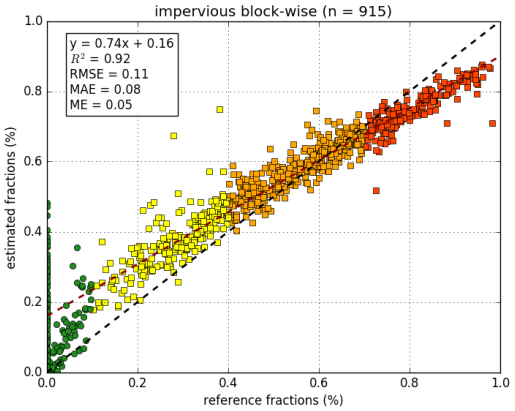
Urban mapping
(Frederik Priem - VUB)

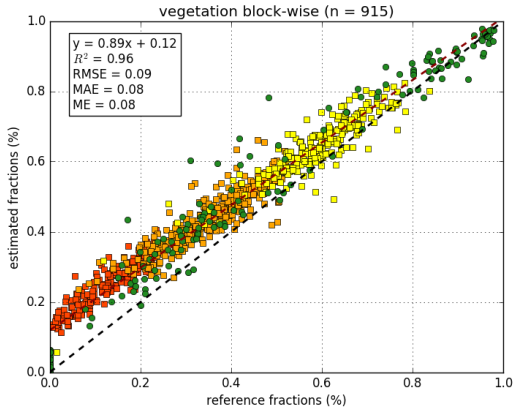
VIS fractions map

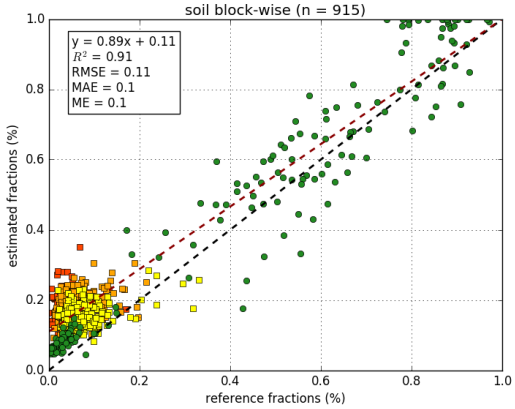


Red = Impervious
Green = Vegetation
Blue = Soil

Validation on block level (± 7 S2-pixels)

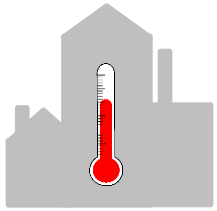






Urban green characterisation

(Jeroen Degerickx - KULeuven)



Urban ecosystem services

Type

Structural properties

Context

Biochemical properties

Urban green

Urban green characterisation

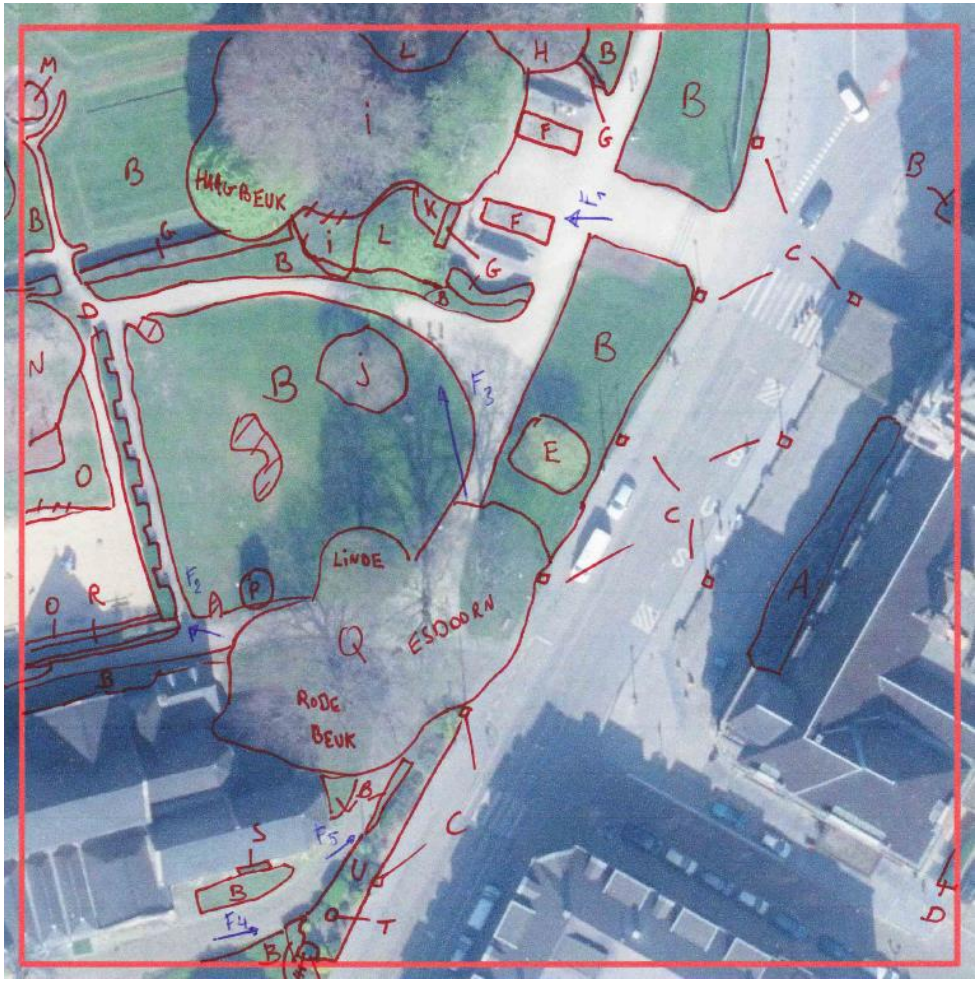
(Jeroen Degerickx - KULeuven)

Functional urban green typology

Urban green characterisation

(Jeroen Degerickx - KULeuven)

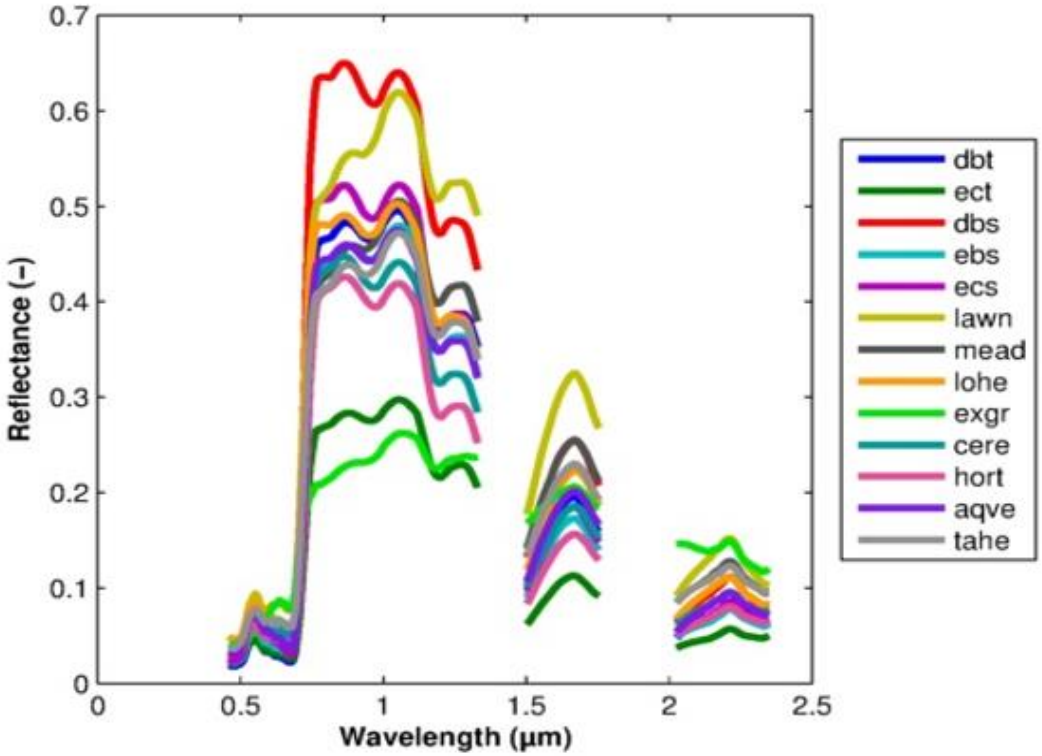
Validation data



Urban green characterisation

(Jeroen Degerickx - KULeuven)

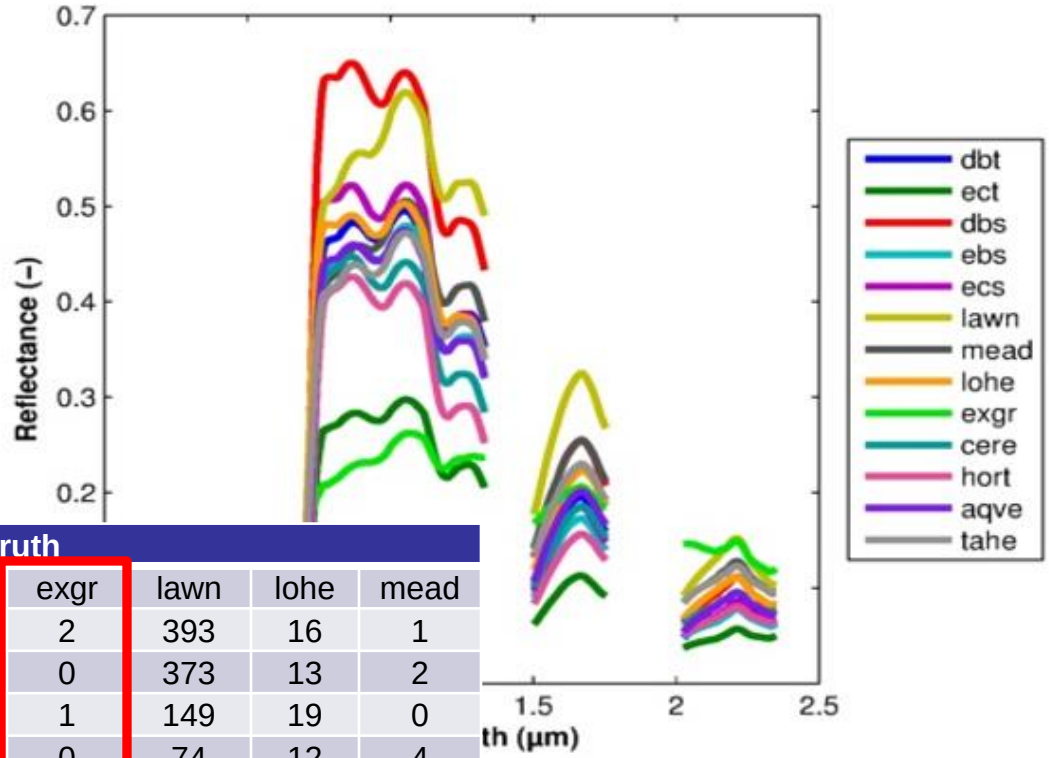
Preliminary results



Urban green characterisation

(Jeroen Degerickx - KULeuven)

Preliminary results

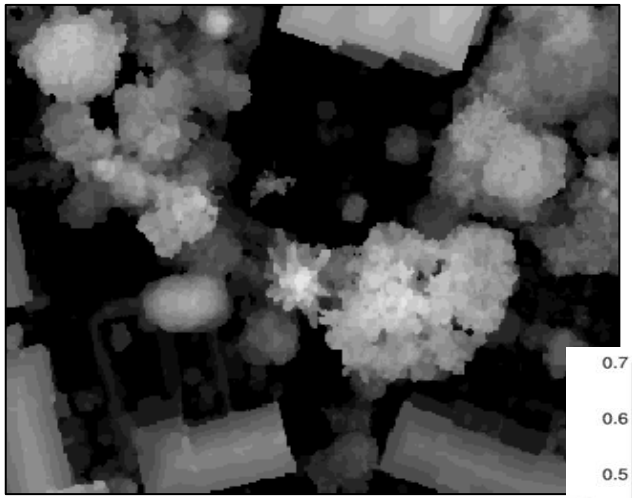


		Ground truth								
		dbs	dbt	ebs	ecs	ect	exgr	lawn	lohe	mead
Classification result	dbs	344	674	85	39	35	2	393	16	1
	dbt	428	4078	56	60	54	0	373	13	2
	ebs	124	374	37	28	24	1	149	19	0
	ecs	119	319	39	25	26	0	74	12	4
	ect	282	1155	171	83	165	51	700	59	4
	exgr	205	277	107	34	14	1382	304	41	4
	lawn	252	781	68	19	25	0	2792	32	11
	lohe	7	48	1	2	1	0	9	0	0
	mead	263	543	63	36	30	12	1077	42	102

Urban green characterisation

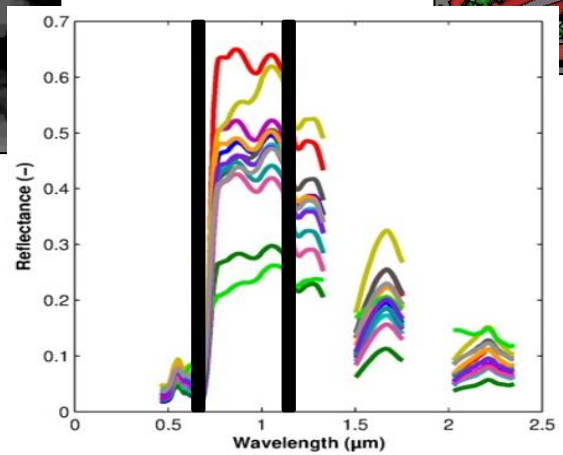
(Jeroen Degerickx - KULeuven)

Outlook



Integration with LiDAR

Object-based classification



Spectral feature selection

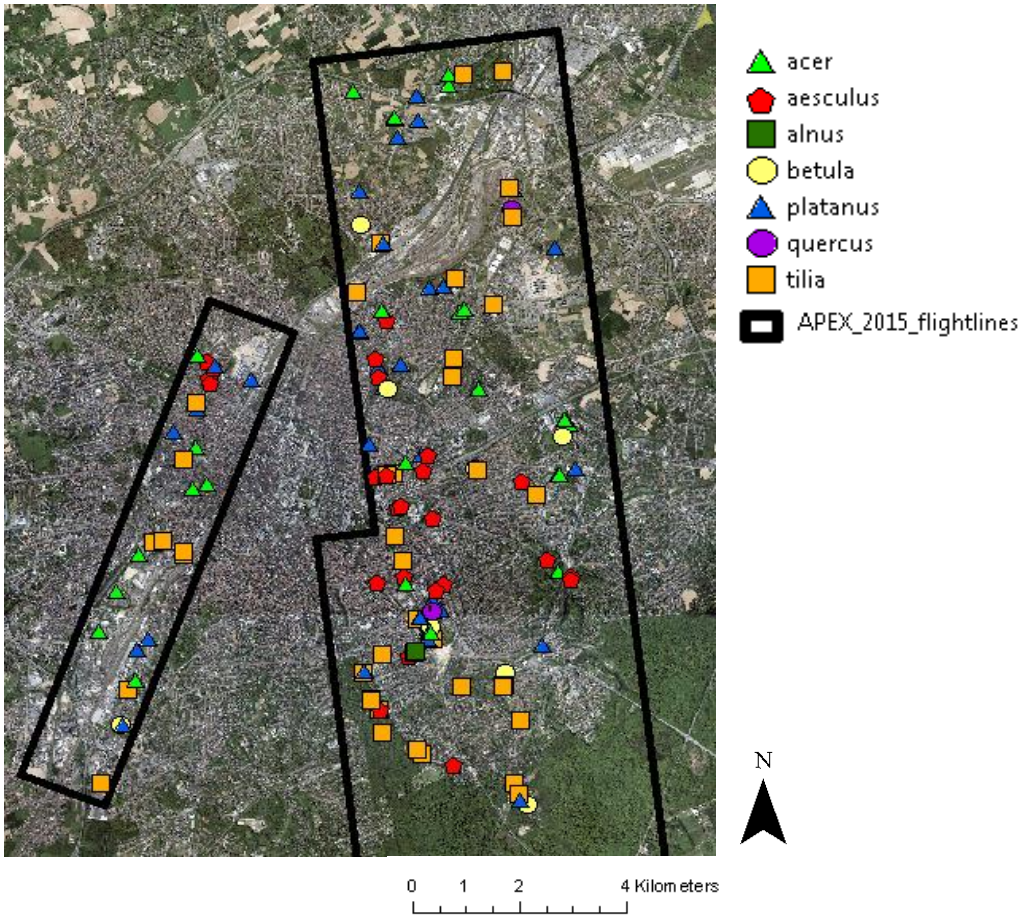
Urban green characterisation

(Jeroen Degerickx - KULeuven)

Tree properties - validation

- Species
- Dimensions
- LAI
- Spectral measurements

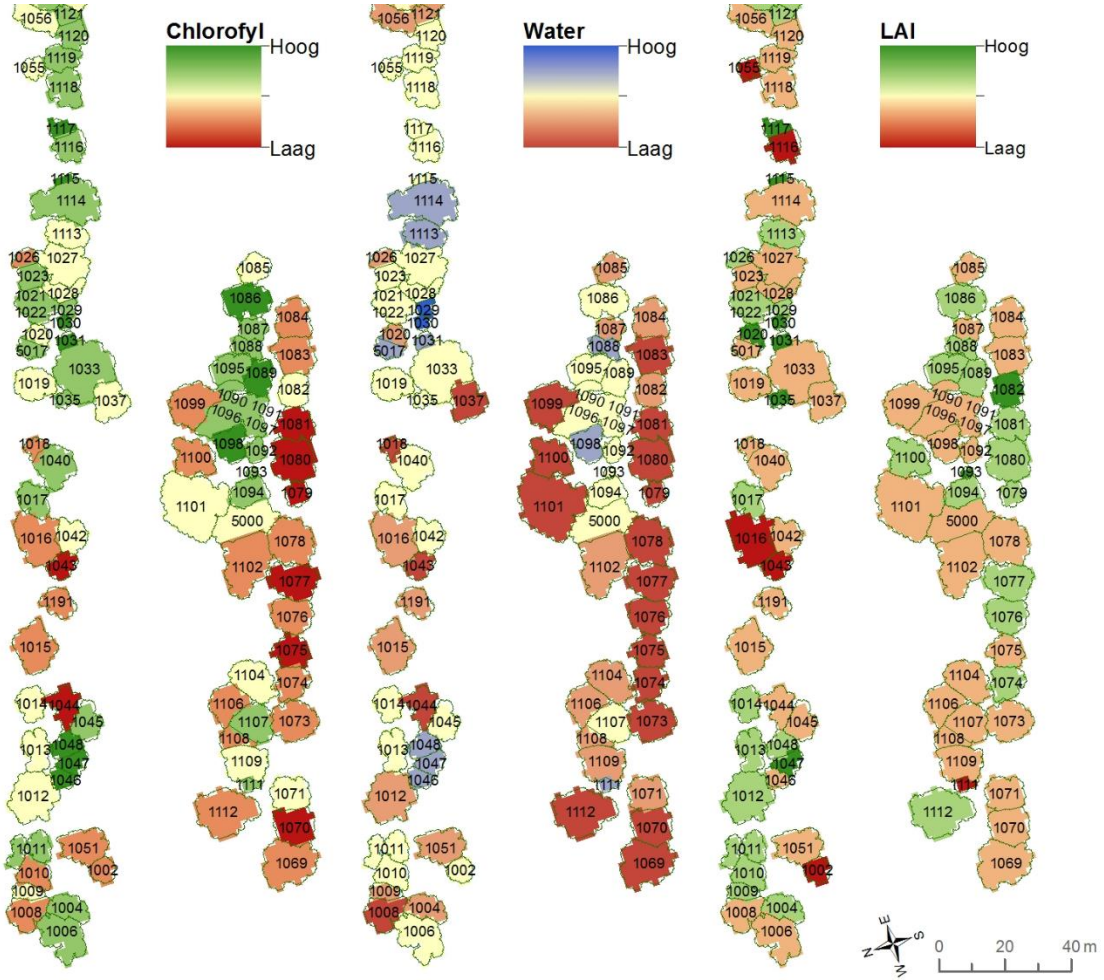
leaves -> chlorophyll, water



Urban green characterisation

(Jeroen Degerickx - KULeuven)

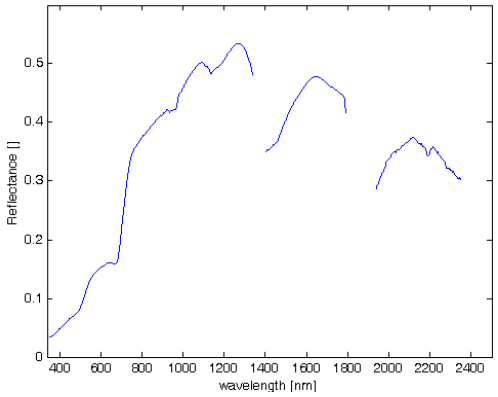
First results



Urban green characterisation

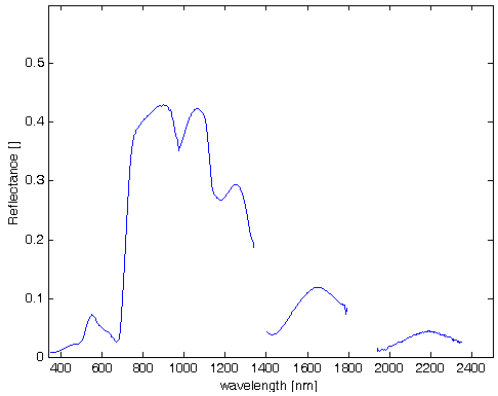
(Jeroen Degerickx - KULeuven)

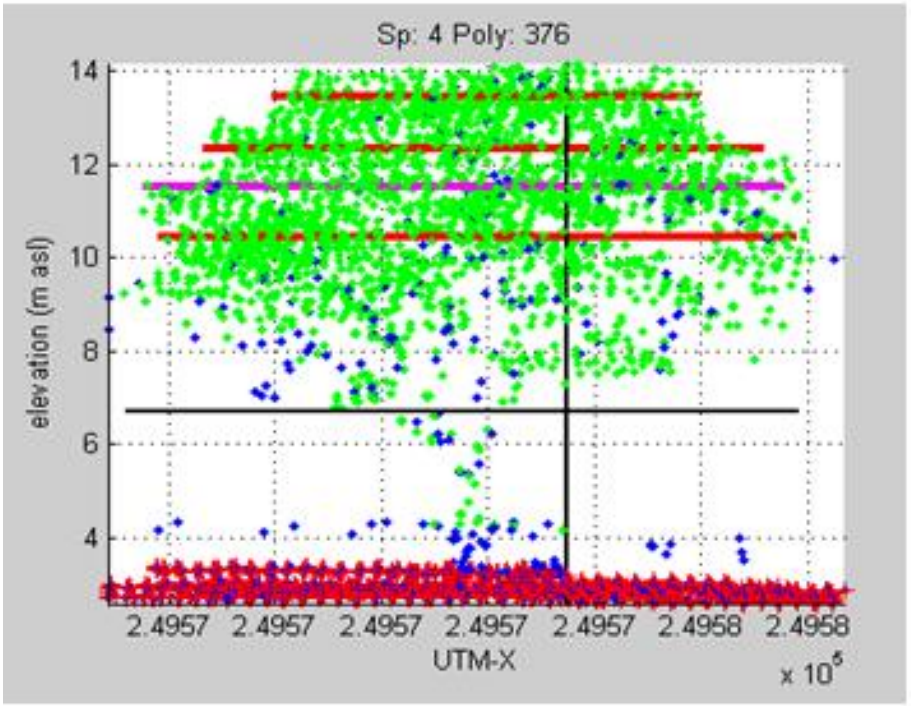
Outlook



Mixed signal

Pure vegetation signal

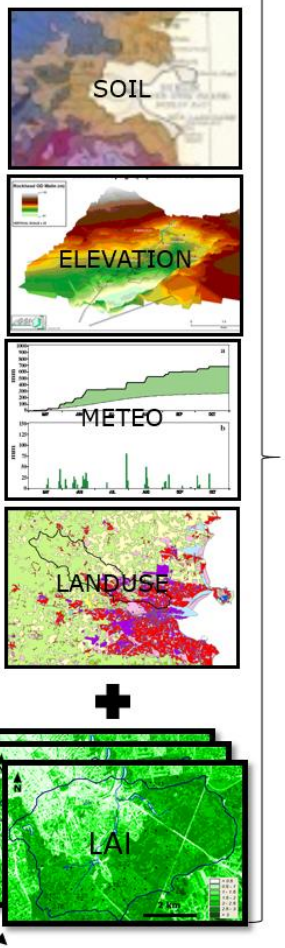




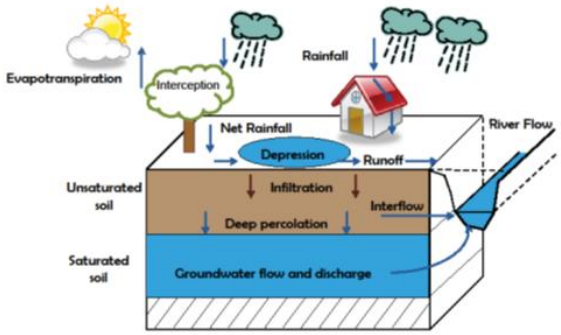
LiDAR point cloud metrics

Improved hydrological parameterisation and simulation

Input



Water Balance Model



Improved simulation hydrological response

SONIA - Outlook

- Outlook
  - Future acquisitions
    - Multiple acquisitions during 1 growing season, advantageous for both urban and forest
      - → NDVI/LAI validation (protocol)
      - → Multi-temporal classification
    - Cover new urban areas with different structure & morphology (other cities?)
  - Ongoing & new projects: BELSPO STEREO III, Innoviris, etc.