RESEARCH PROGRAMME FOR EARTH OBSERVATION 'STEREO III'
THEMATIC PROJECT PROPOSALS CALL 2013

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vito vision on technology

ULB UNIVERSITÉ LIBRE DE BRUXELLES

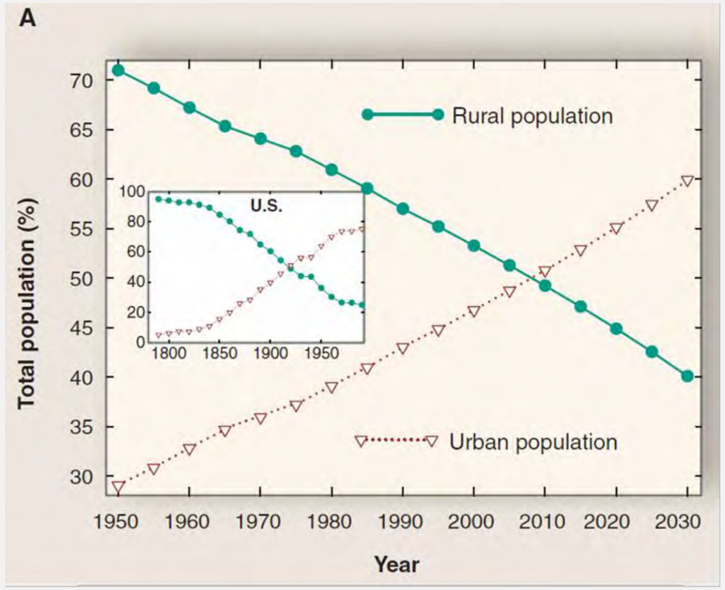
# UrbanEARS

## URBAN ECOSYSTEM ANALYSIS SUPPORTED BY REMOTE SENSING

BELGIAN EARTH OBSERVATION DAY 2019

28 NOVEMBER 2019

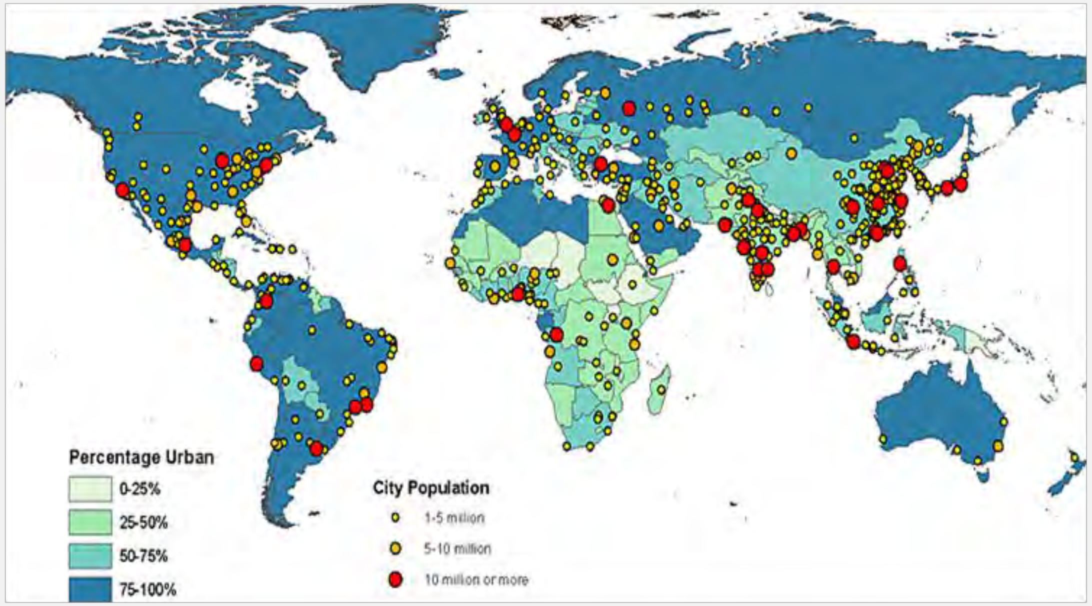
# WELCOME TO THE ANTHROPOCENE AND AN URBANIZING WORLD




- Fig. 1. (A) Change in world urban and rural population (%) from 1950 to 2030 (projected); plotted from data in (1). Inset shows comparable data for the United States from 1790 to 1990; plotted from data in (73). (B) Change in population of the 10 largest urban agglomerations from 1950 to 2010 (projected), ranked from left (largest) to right by their projected population size in 2010: Tokyo, Japan; Ciudad de México, Mexico; Mumbai, India; Sáo Paulo, Brazil; New York– Newark, USA; Delhi, India; Shanghai, China; Kolkata, India; Jakarta, Indonesia; Dhaka, Bangladesh.

United Nations Department of Economic and Social Affairs
Population Division
*World Urbanization Prospects, the 2014 revision*
Monitoring Global population Trends

## % URBAN POPULATION (UN ESTIMATION)




Source: UN Environment Program 2009

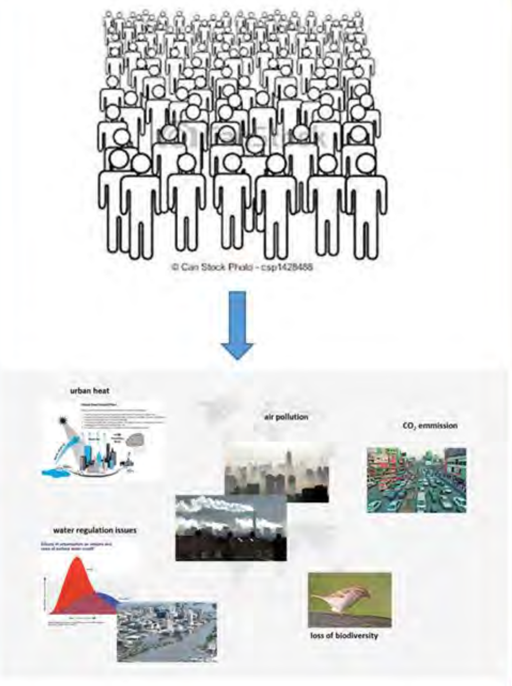
http://www.youtube.com/watch?v=mPi4zwEpswE&feature=player_embedded

# WELCOME TO THE ANTHROPOCENE AND AN URBANIZING WORLD

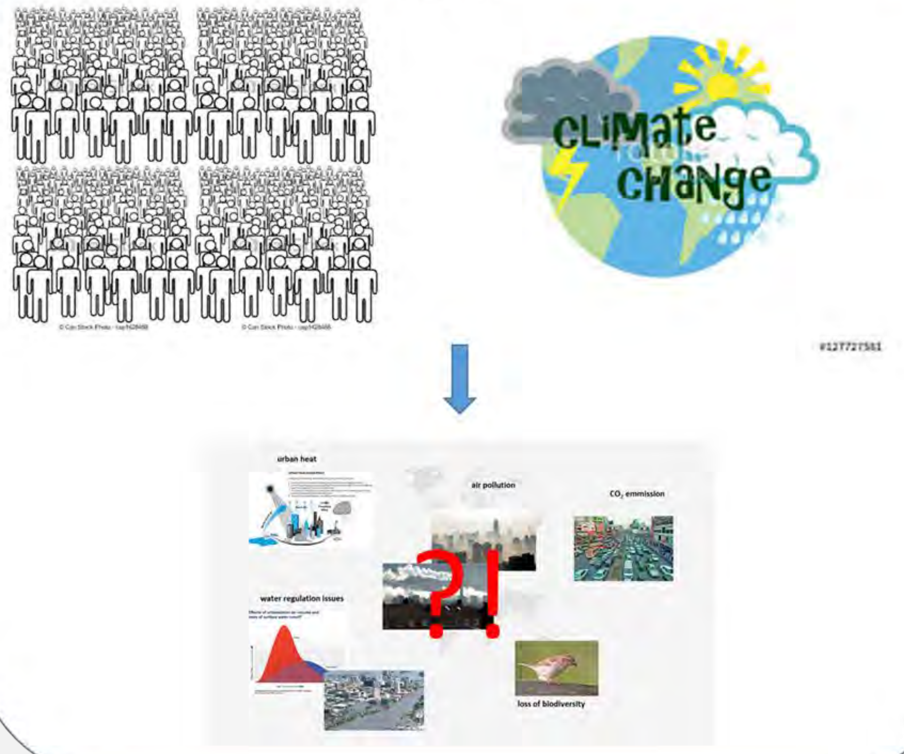
**Urban areas ~ living environment of the people!!!**

# WELCOME TO THE ANTHROPOCENE AND AN URBANIZING WORLD

2018



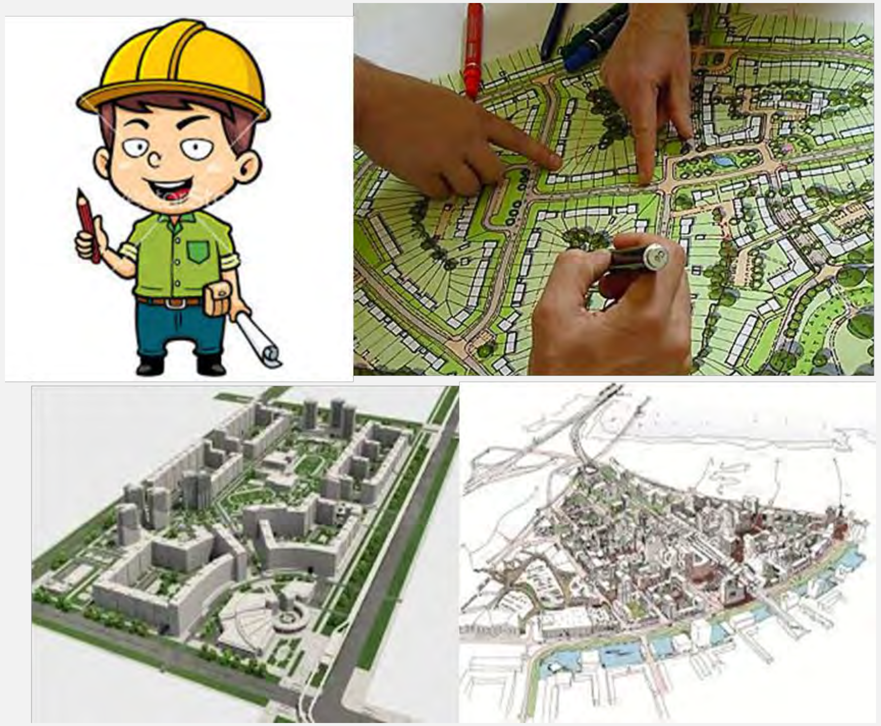

2040 - ...

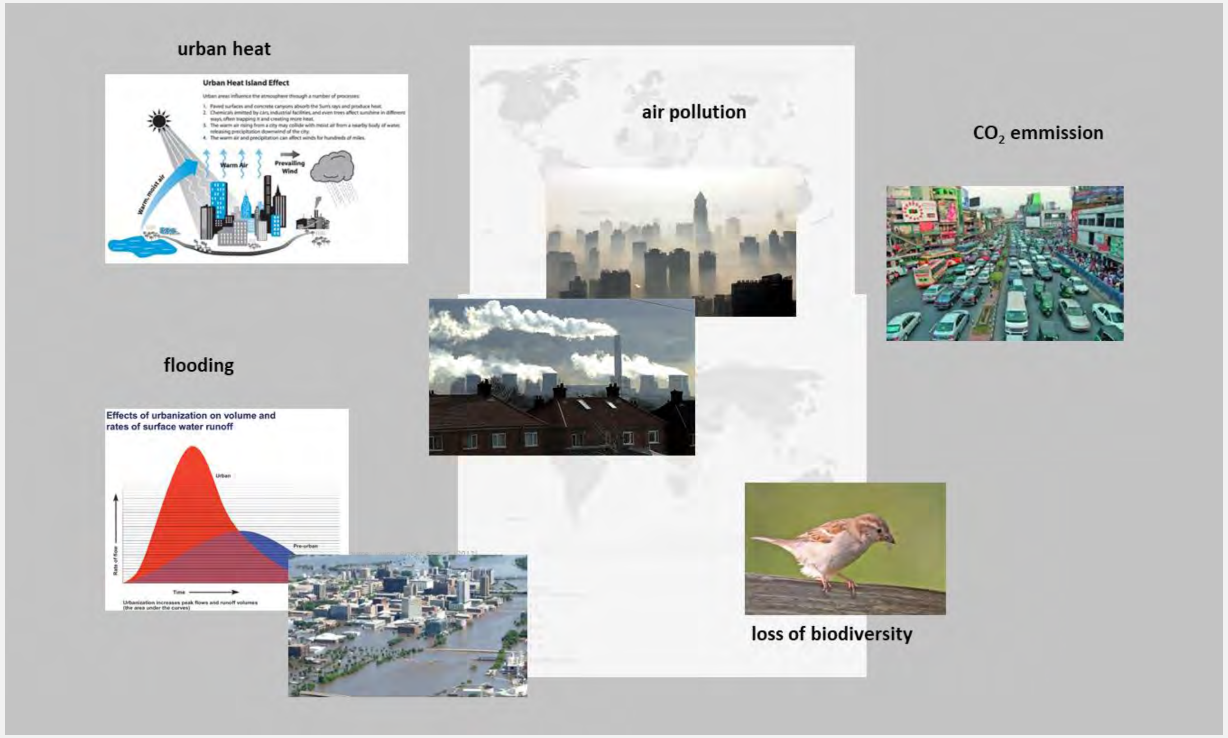



**HOW CAN WE ENSURE THE QUALITY OF LIFE IN OUR CURRENT AND FUTURE CITIES?!**

# Sustainable Urban Planning/Development/Management?

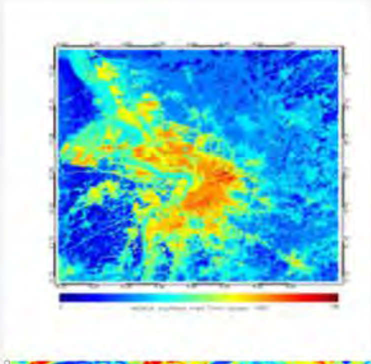
This urbanization and globalization context **forces us to think of alternative solutions to coop with our living environment. It is clear that we urgently need additional environmental policy measures and smart urban planning schemes to secure our quality of life in this changing environment.**

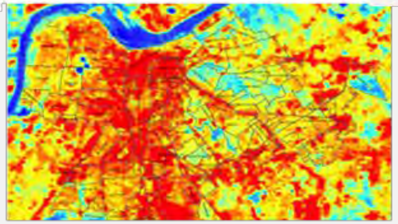


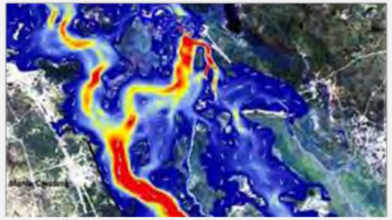


# SUSTAINABLE URBAN PLANNING/DEVELOPMENT/MANAGEMENT?

## URBAN BIOPHYSICAL MODELS







## SUSTAINABLE URBAN PLANNING

# Sustainable Urban Planning/Development/Management?

## Urban biophysical Models

## Sustainable Urban Planning

**Urban Infrastructure**

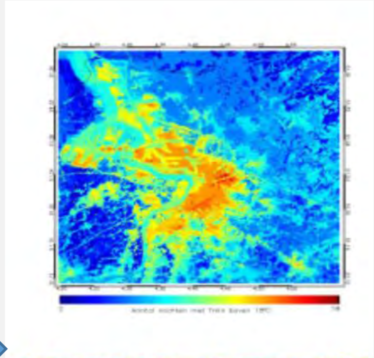
type of material

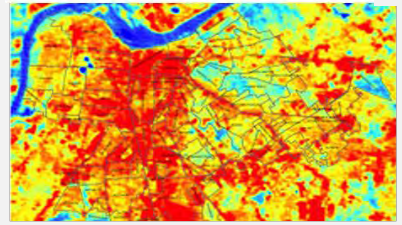
height of buildings

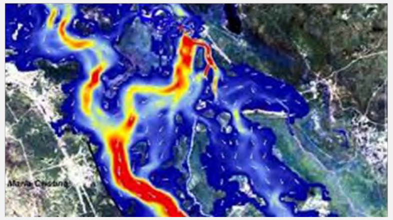
roof exposition

etc,

?







**Plant & Ecosystem Properties**

moisture content

chl-a concentration

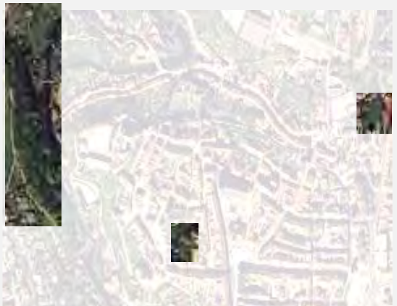
species diversirty

habitat Quality

vegetation Height

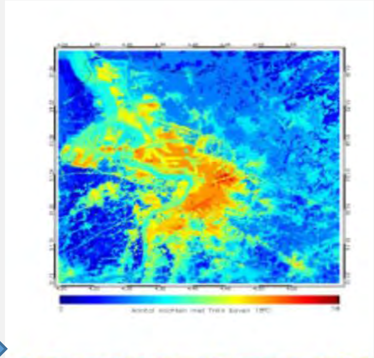
etc.

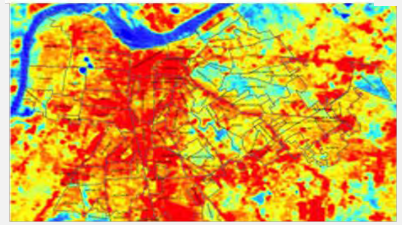
# SUSTAINABLE URBAN PLANNING/DEVELOPMENT/MANAGEMENT?

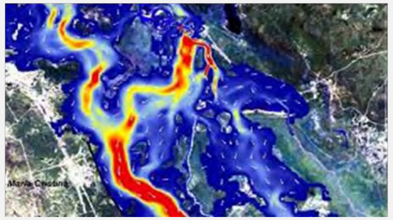


?

## URBAN BIOPHYSICAL MODELS



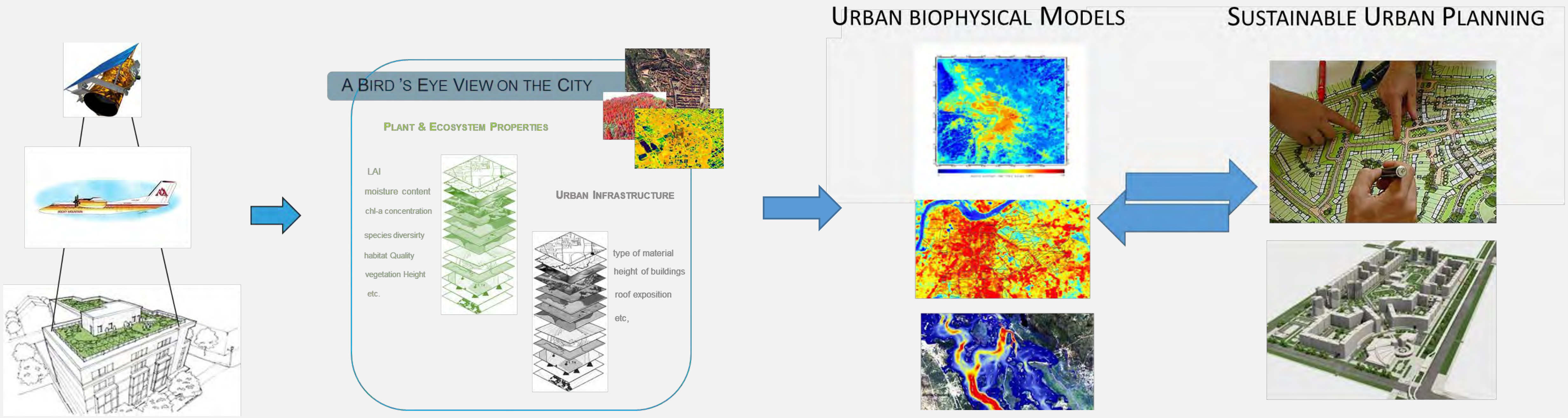




## SUSTAINABLE URBAN PLANNING

# Urban Remote Sensing

## the Starting Point of Sustainable Urban Planning/Development/Management?



# OBJECTIVES

## URBAN REMOTE SENSING

Explore **the potential of the combined use of recent multi- and hyperspectral sensors,** in combination with structural information derived by LiDAR, for detailed, characterization of morphological and (bio)physical properties of the urban environment.

## URBAN FLUX MODELING

**Incorporating remote sensing** derived information on the urban environment **into modeling of water and heat fluxes**

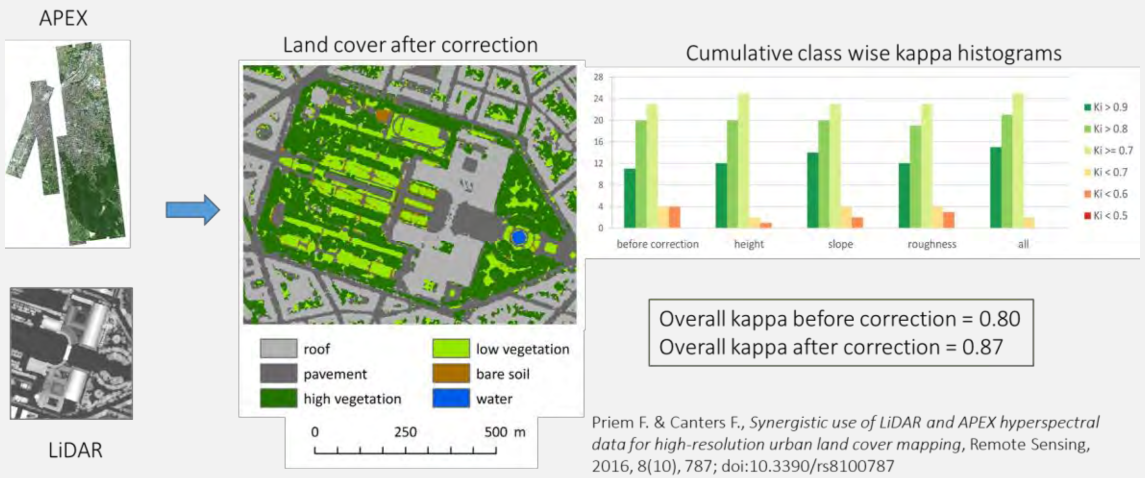
## URBAN PLANNING

The **dynamics of the urban environment** will be accounted for by coupling biophysical modeling approaches (urban climate, hydrology) to urban growth simulation

# URBAN MAPPING

**THE SYNERGENIC USE OF LIDAR AND IMAGING SPECTROSCOPY**
RESULTED IN SIGNIFICANT IMPROVEMENTS IN URBAN LAND COVER MAPPING

A detailed urban material map was made for Brussels using **Support Vector Classification of APEX data** in combination with post-classification correction based on LiDAR derived geometric features




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

The performance of **Spectral Unmixing via MESMA** for urban land cover mapping was signifincantly improved using height information derived from LiDAR data.

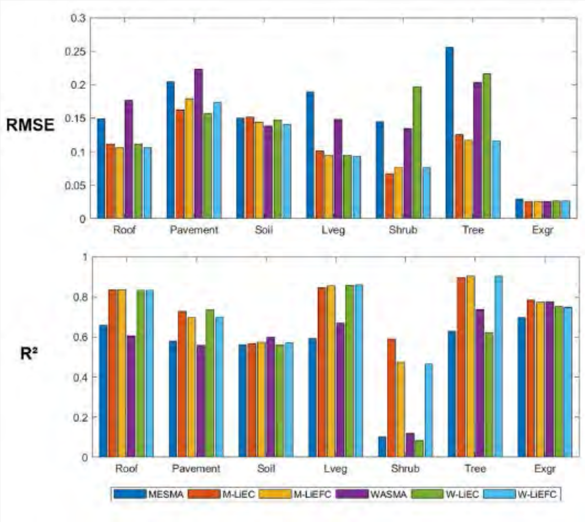


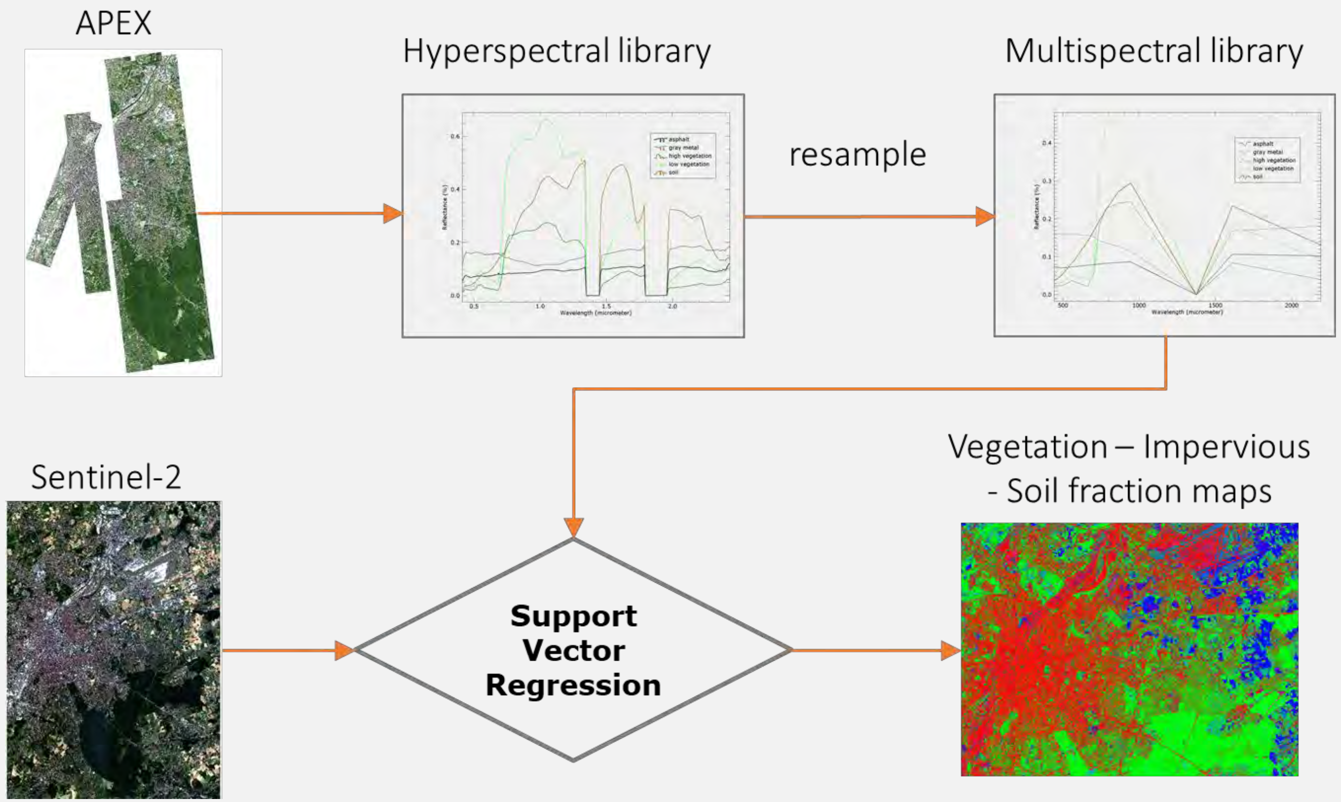

**Fig. 7.** Accuracy in estimating subpixel fractions attained by the six different unmixing algorithms (different colors) tested on real APEX data for each land cover class separately. The graphs show the Root Mean Square Error (RMSE) and $R^2$ of the relation between reference and modelled fractions calculated for blocks of 12 × 12 APEX pixels (hence, the results are not directly comparable to those in Fig. 5, where evaluation was done on individual pixel level).

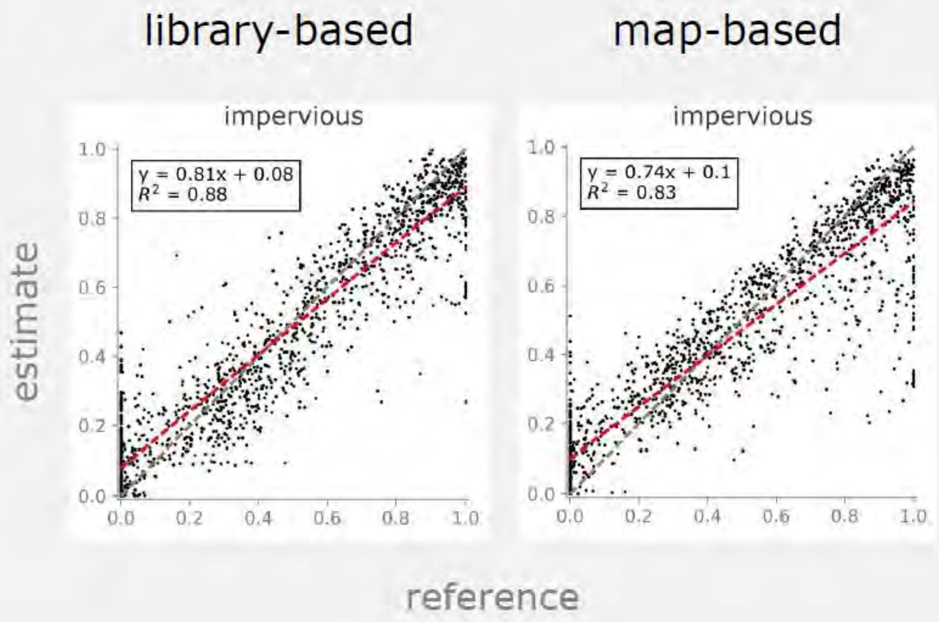
Tested on both airborne hyperspectral (APEX) data and satellite multispectral (Sentinel-2) data and was found to **increase the accuracy of subpixel fraction estimation by roughly 60%** in both cases.

*Degerickx, J. Roberts, D., Somers, B. (2019). Enhancing the performance of Multiple Endmember Spectral Mixture Analysis (MESMA) for urban land cover mapping using airborne lidar data and band selection. Remote Sensing of Environment, 221, 260-273*

# URBAN MAPPING

THE SYNERGENIC USE OF **HYPERSPECTRAL DATA AND SENTINEL2**
RESULTED IN SIGNIFICANT IMPROVEMENTS IN URBAN LAND COVER MAPPING



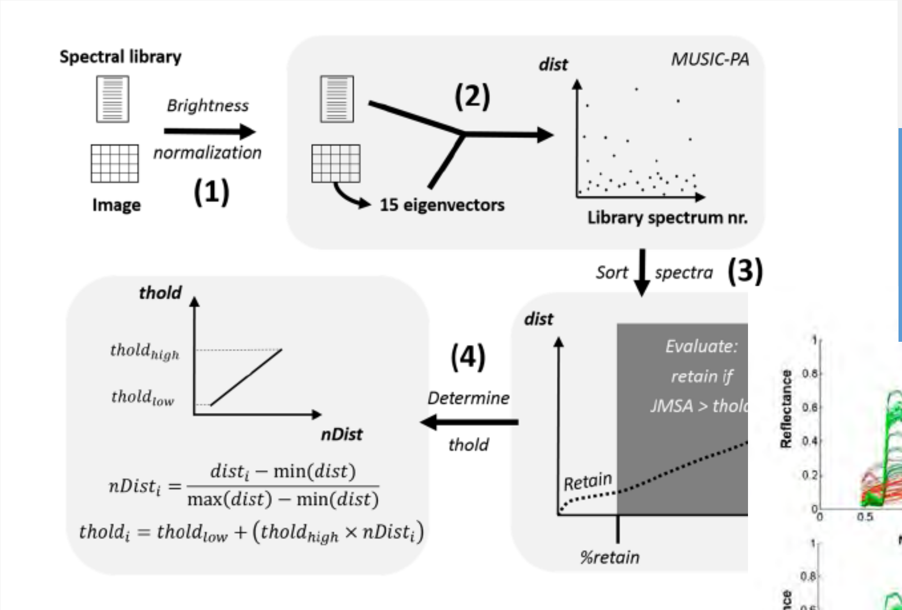



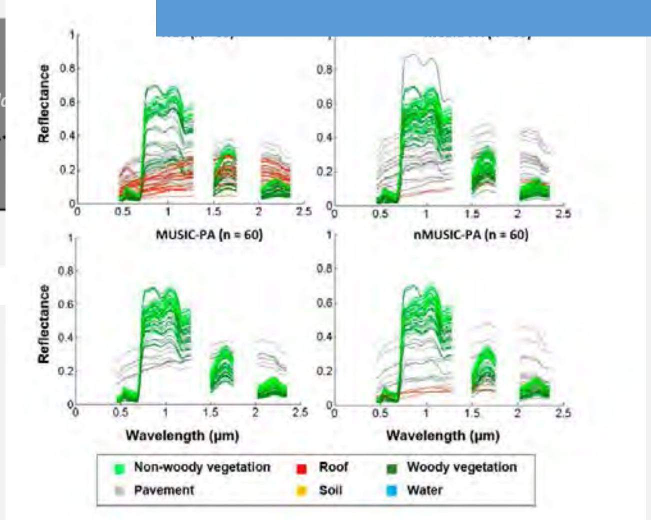

*Priem, F., Okujeni, A., Van der Linden, S., Canters, F. (2019). Comparing map-based and library-based training approaches for urban land-cover fraction mapping from Sentinel-2 imagery. Int J Appl Earth Obs Geoinformation, 78, 295-305. https://doi.org/10.1016/j.jag.2019.02.003*

# URBAN MAPPING

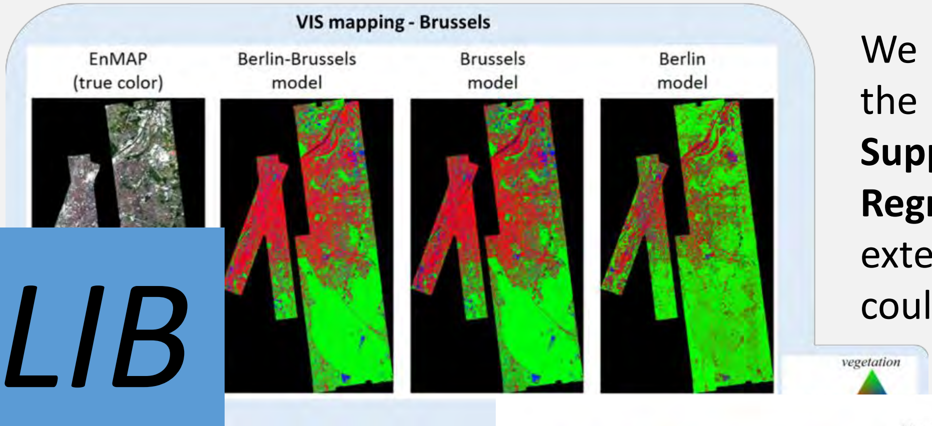
**THE SYNERGENIC USE OF AN (EXTERNAL) SPECTRAL LIBRARY AND IMAGE DATA**
**RESULTED IN SIGNIFICANT IMPROVEMENTS IN URBAN LAND COVER MAPPING**

MESMA was used in combination with **a new library optimization technique** to show its potential for urban land cover mapping based on generic spectral libraries

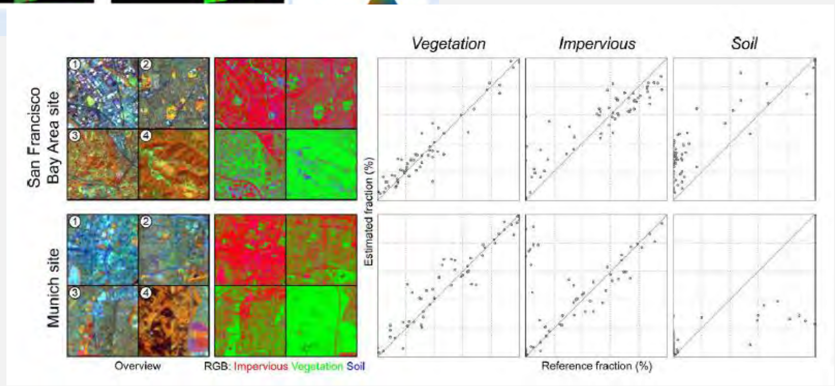



# GENLIB




We could illustrate that the **transferability of Support Vector Regression models** using external spectral libraries could work.




*Degerickx, J., Okujeni, A., Iordache, M.-D., Hermy, M., Van Der Linden, S., Somers, B. (2017). A novel spectral library pruning technique for spectral unmixing of urban land cover. Remote Sensing, 9, art nr 565.*

*Okujeni et al. (2018). Generalizing machine learning regression models using multi-site spectral libraries for mapping vegetation-impervious-soil fractions across multiple cities. Remote Sensing of Environment, 216, 482-496*

# Urban Heat Monitoring

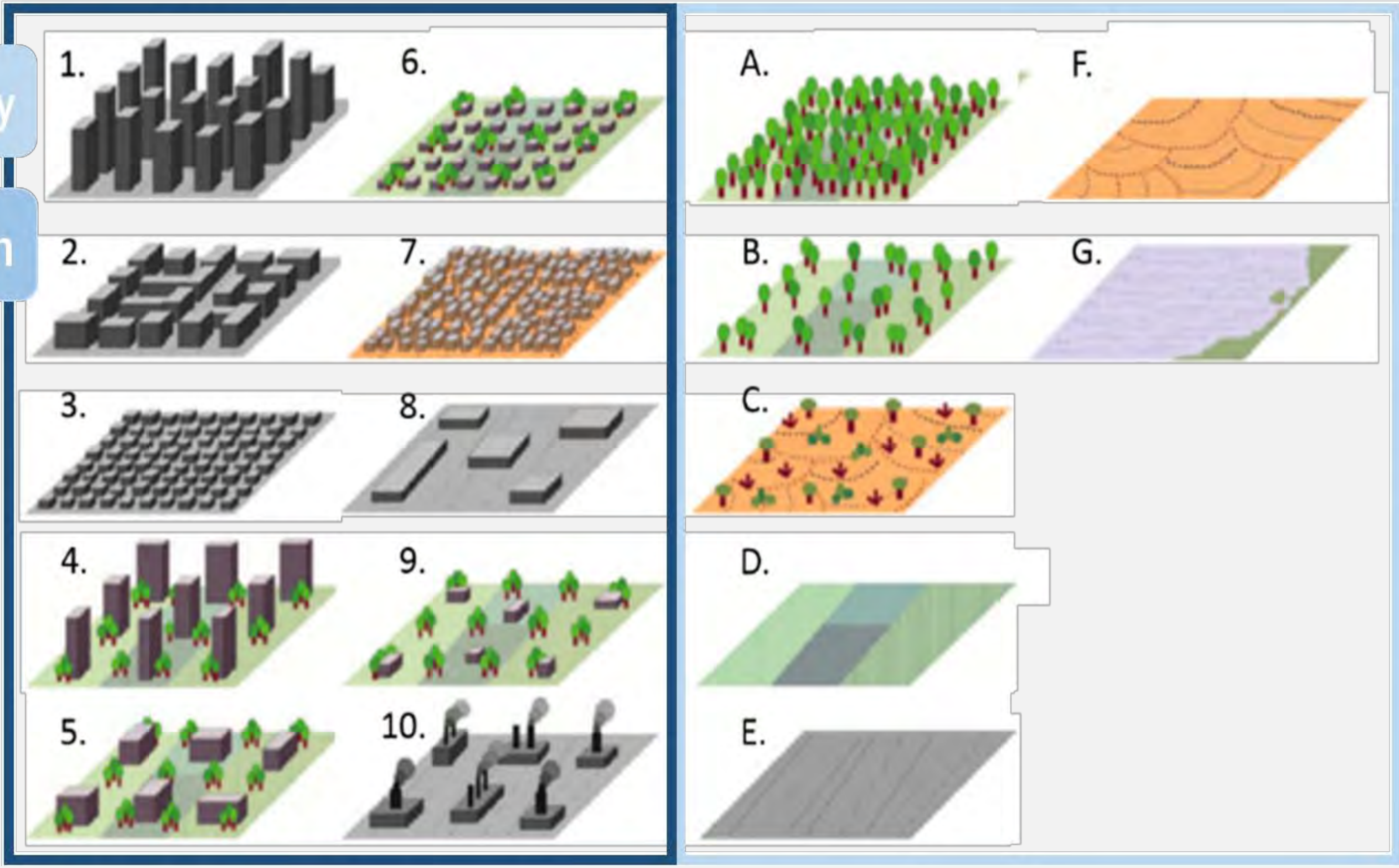
## Remote Sensing as a heat assessment tool? The **Local Climate zone** concept

### Local Climate Zones

After Stewart and Oke (2012)

Morphology

Lack of vegetation

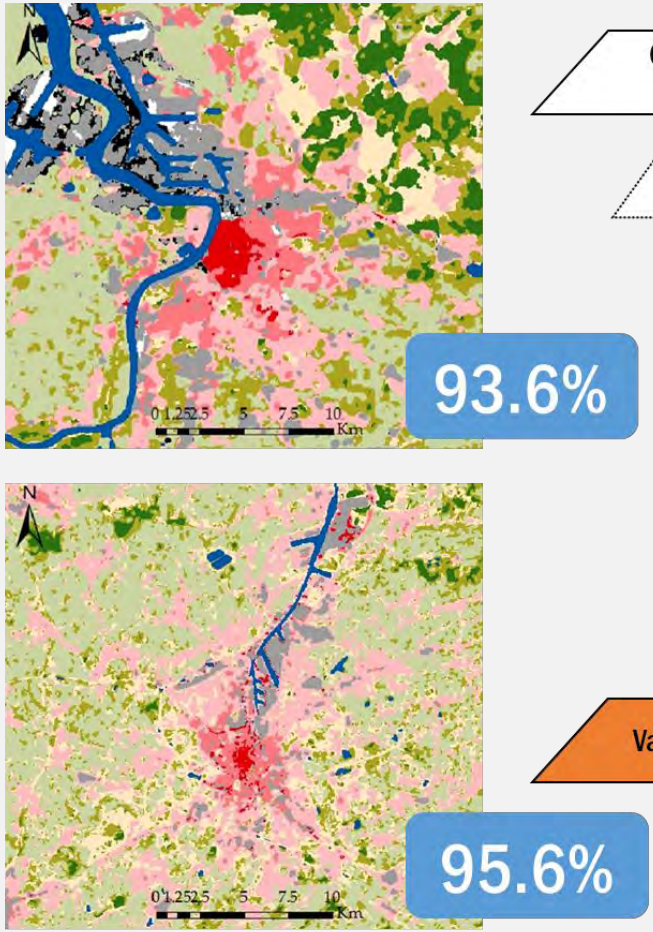


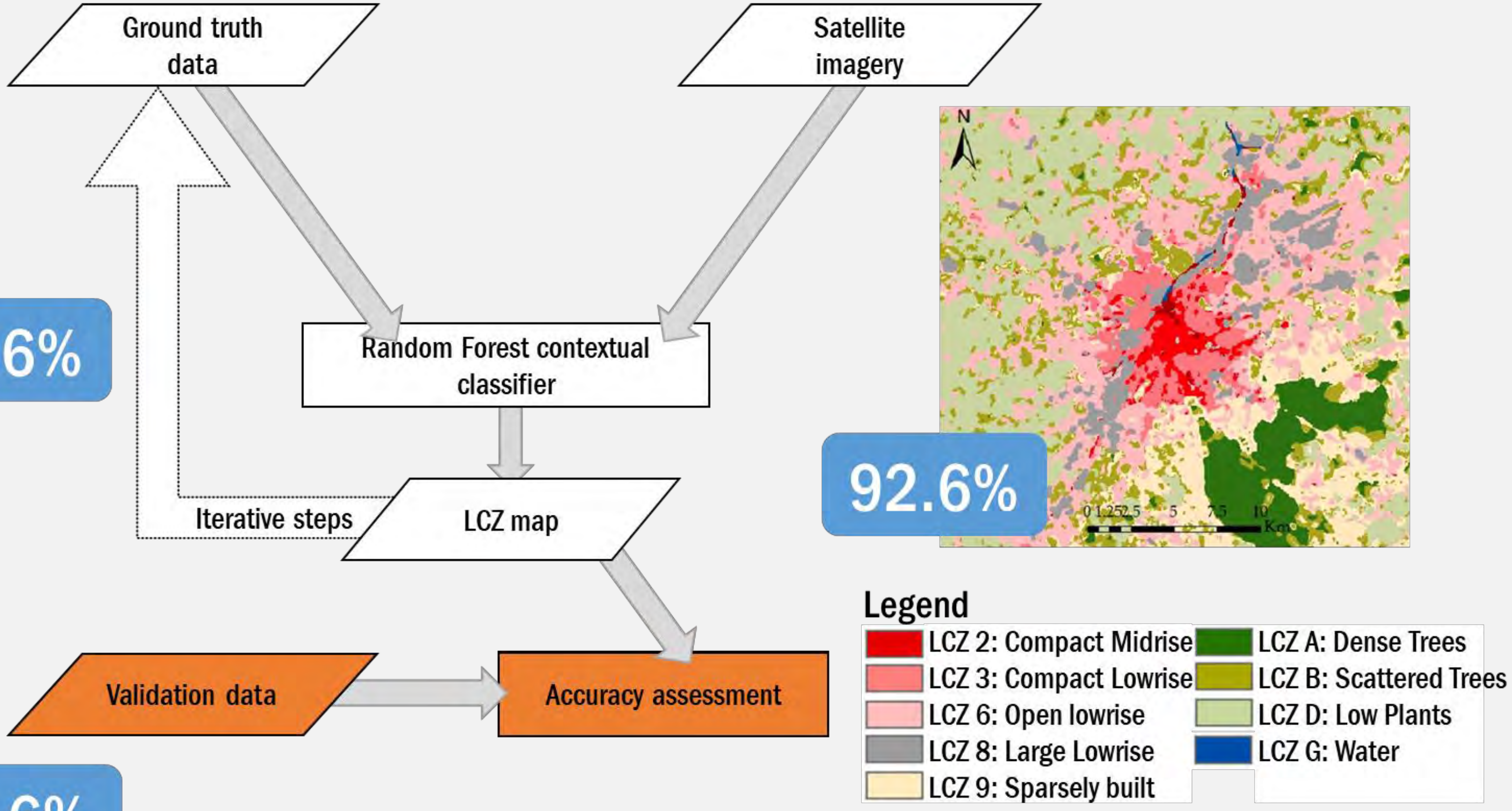

1. Compact highrise
2. Compact midrise
3. Compact lowrise
4. Open highrise
5. Open midrise
6. Open lowrise
7. Lightweight lowrise
8. Large lowrise
9. Sparsely built
10. Heavy industry

A. Dense trees
B. Scattered trees
C. Bush, scrub
D. Low plants
E. Bare rock or paved
F. Bare soil or sand
G. Water

# URBAN HEAT MONITORING

REMOTE SENSING AS A HEAT ASSESSMENT TOOL? THE **LOCAL CLIMATE ZONE** CONCEPT



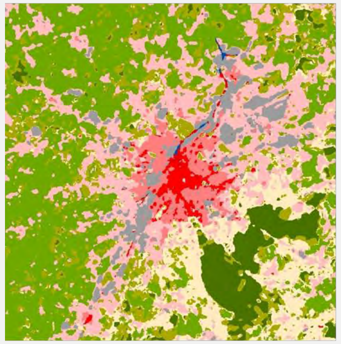




*Verdonck, M.-L., Okujeni, A., van der Linden, S., Demuzere, M., De Wulf, R., & Van Coillie, F. (2017). Influence of neighbourhood on Local Climate Zone mapping in heterogeneous cities. Int J Appl Earth Obs Geoinformation, 62, 102–113.https://doi.org/10.1016/j.jag.2017.05.017*

# Urban Heat Monitoring

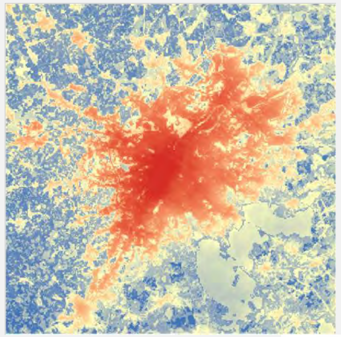
Remote Sensing as a heat assessment tool? the **Local Climate zone** concept

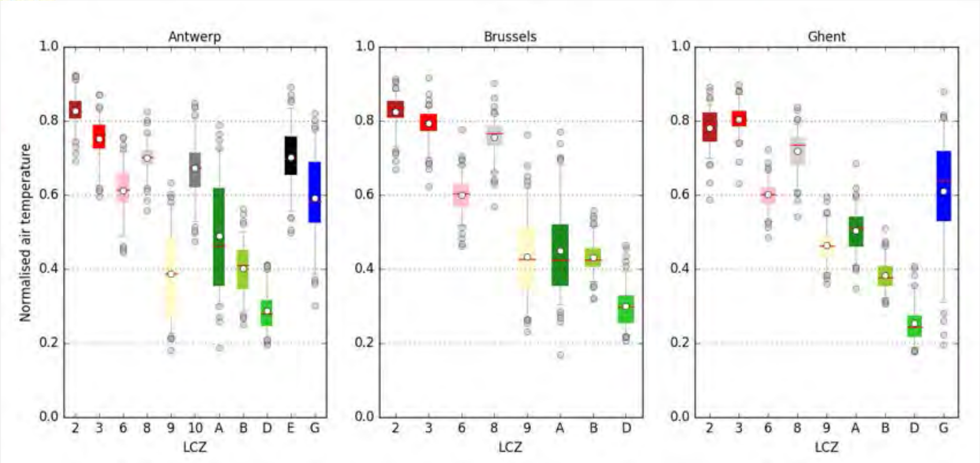
**LCZ map**



**Urban Climate model**

**Temperature map**

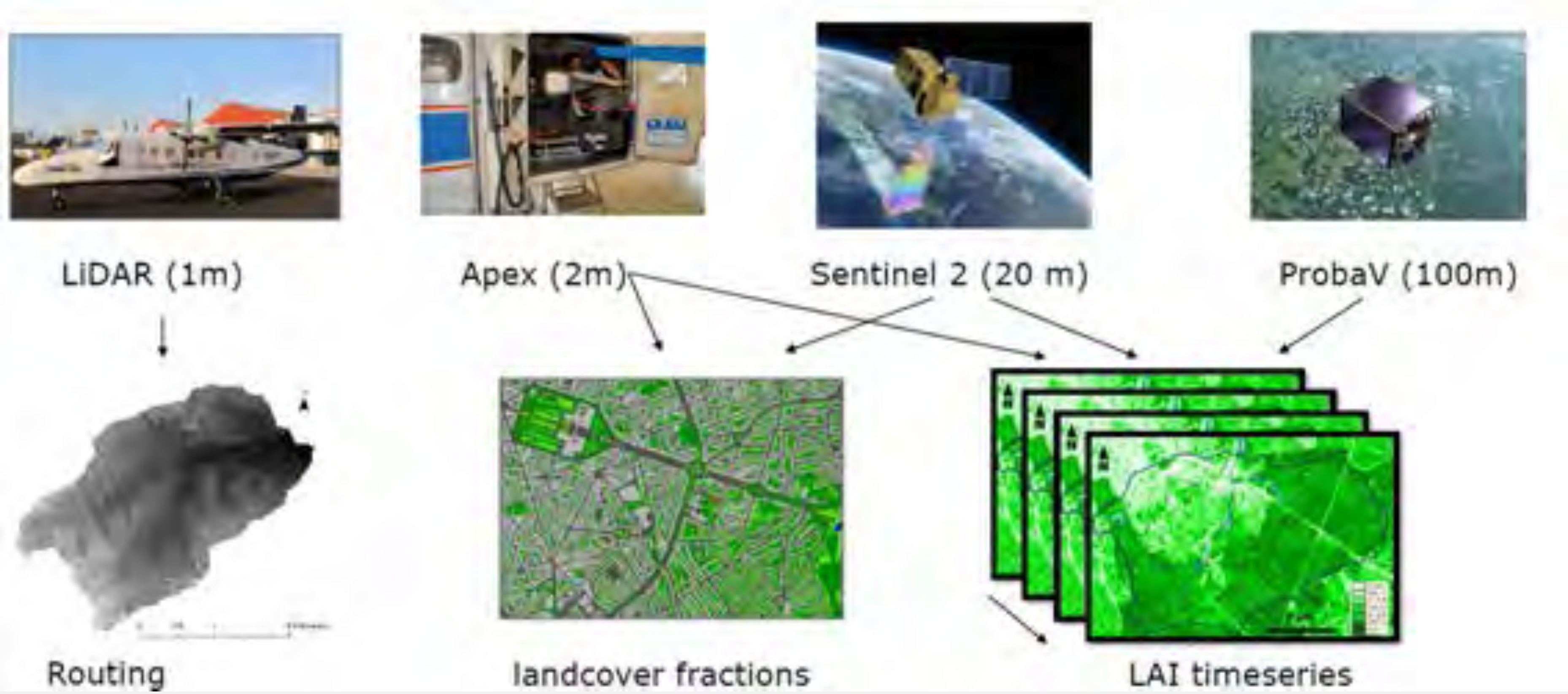





*Verdonck, M-L., Demuzere, M., Hooyberghs, H., Beck, C., Cyrys, J., Schneider, A., Dewulf, R., Van Coillie, F. (2018). The potential of local climate zones maps as a heat stress assessment tool, supported by simulated air temperature data. Landscape and Urban Planning, 178, 183-197.*[https://doi.org/10.1016/j.landurbplan.2018.06.004](https://doi.org/10.1016/j.landurbplan.2018.06.004)

# Urban Water Monitoring

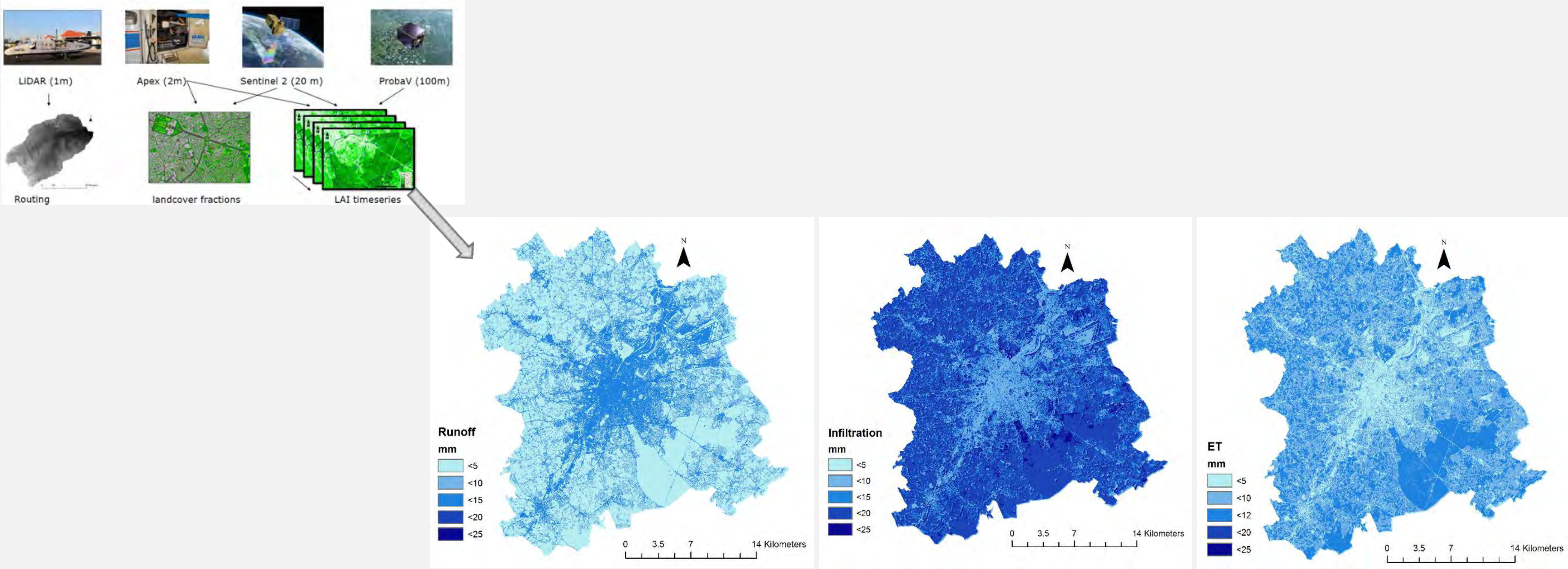
Remote Sensing for Improved water management?
Integration of remote sensing in hydrological models




*Wirion, C., Bauwens, W., Verbeiren, B. (2017). Location and time specific hydrological simulations with multi-resolution remote sensing data in urban areas. Remote Sensing, 9(7), 645.https://doi.org/10.3390/rs9070645*

# URBAN WATER MONITORING

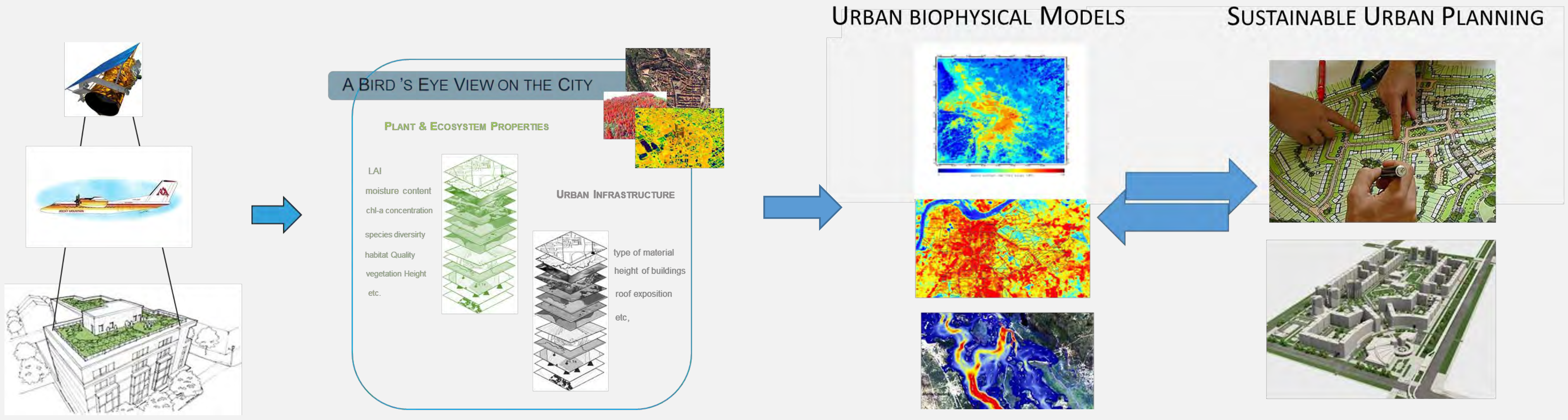
## REMOTE SENSING FOR IMPROVED WATER MANAGEMENT?
## INTEGRATION OF REMOTE SENSING IN HYDROLOGICAL MODELS




*Wirion, C., Bauwens, W., Verbeiren, B. (2017). Location and time specific hydrological simulations with multi-resolution remote sensing data in urban areas. Remote Sensing, 9(7), 645.https://doi.org/10.3390/rs9070645*

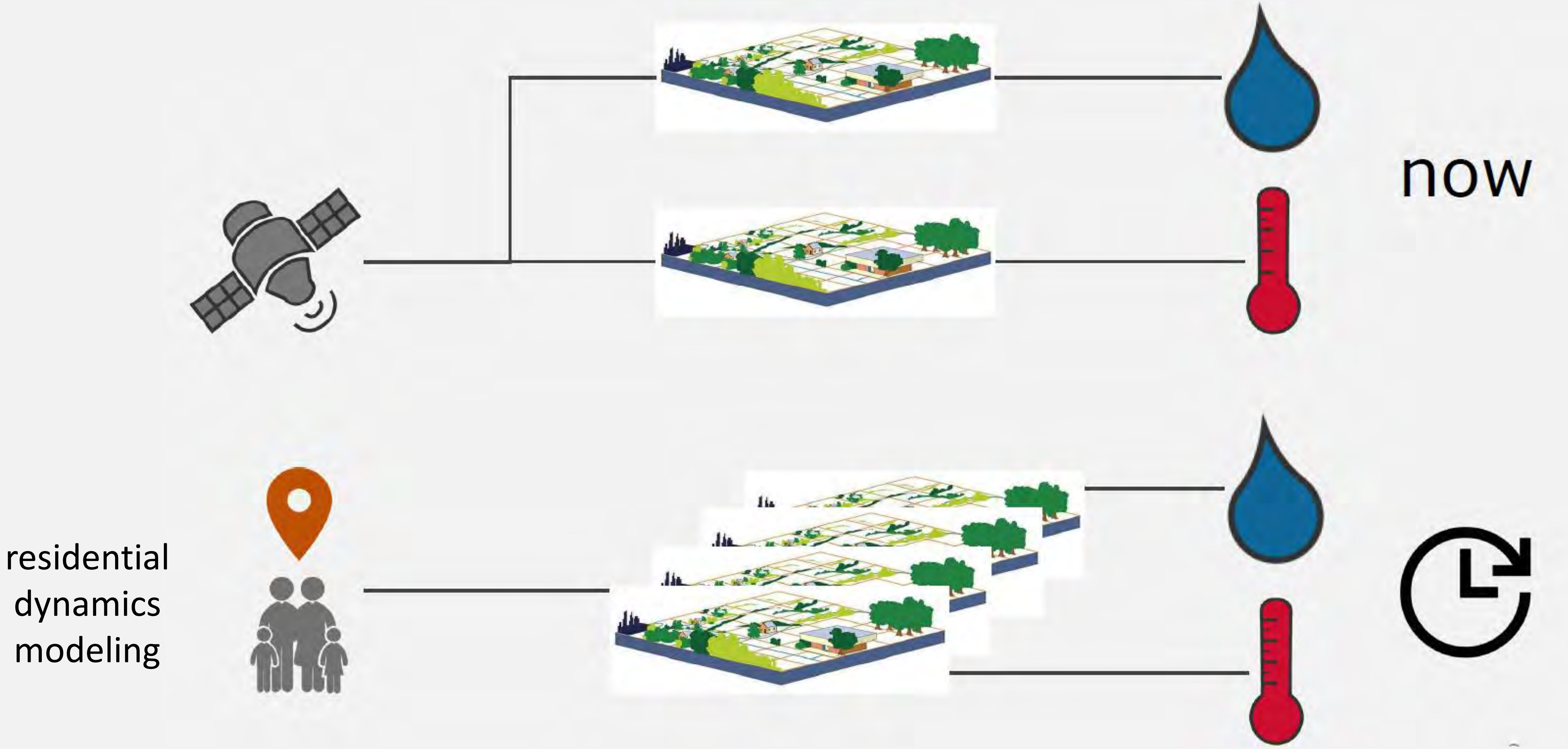
# Urban Planning

We provide a toolset for supporting sustainable urban planning accounting for heat and water flux impacts



# URBAN PLANNING

WE PROVIDE A TOOLSET FOR SUPPORTING SUSTAINABLE URBAN PLANNING ACCOUNTING FOR HEAT AND WATER FLUX IMPACTS

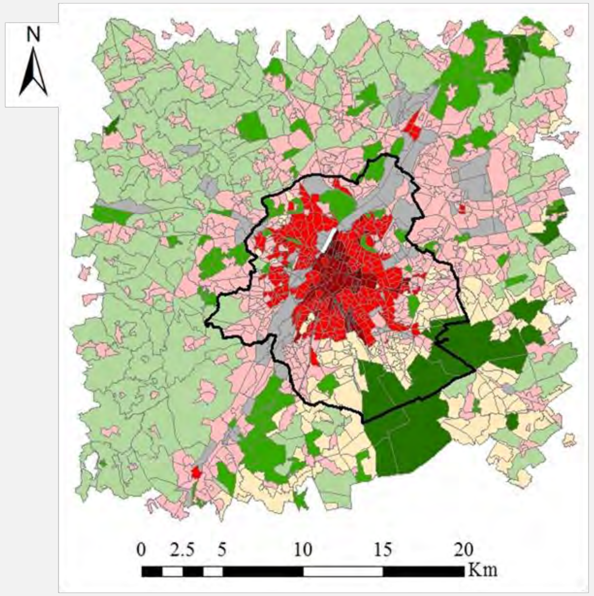


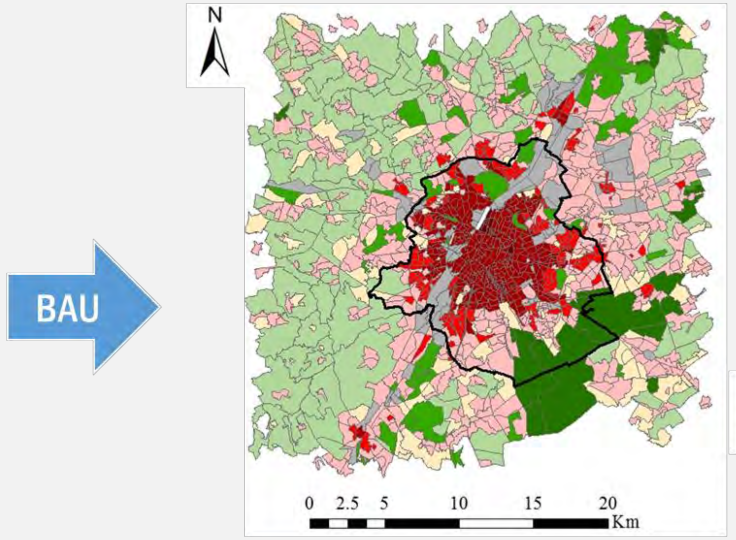
# Urban Planning

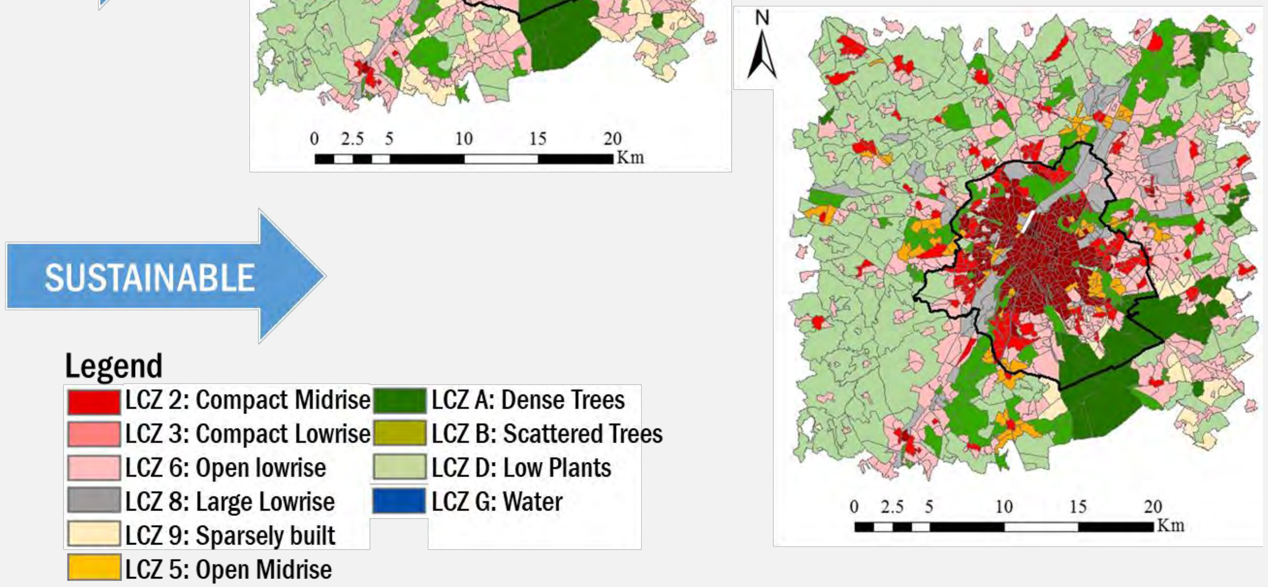
We provide a toolset for supporting sustainable urban planning accounting for heat and water flux impacts

## Thermal evaluation

### Future heat stress



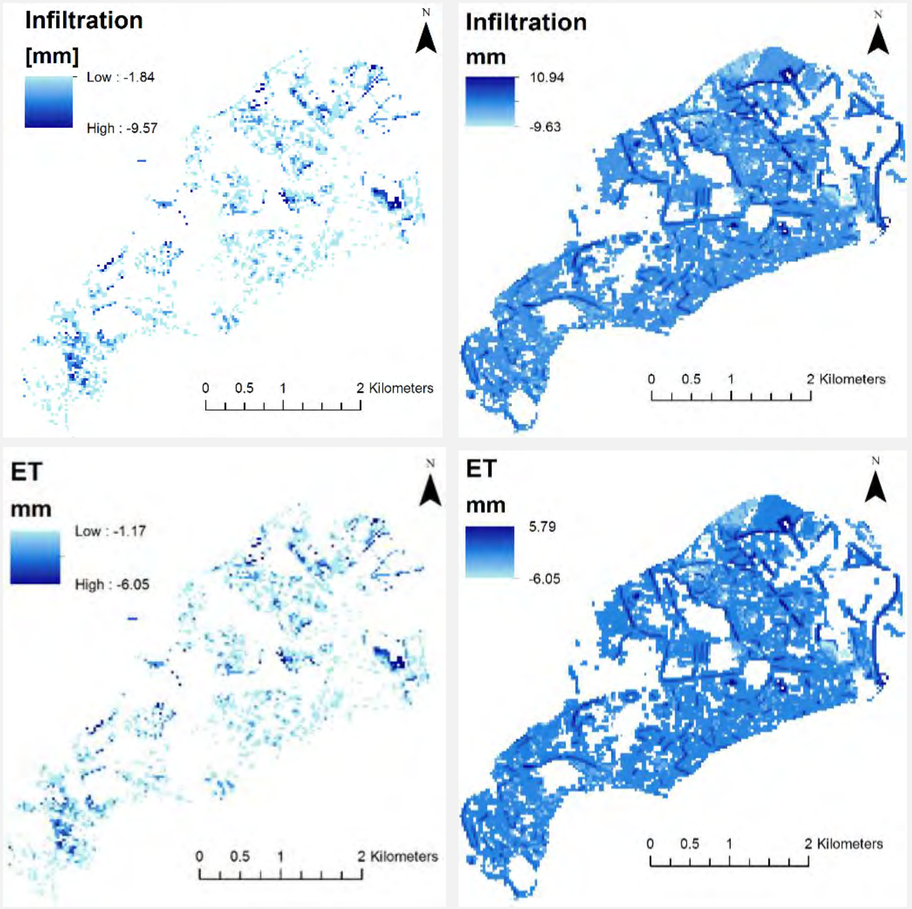




Credits: Frieke Van Coillie, Marie-Leen Verdonck en Matthias Demuzere

# Urban Planning

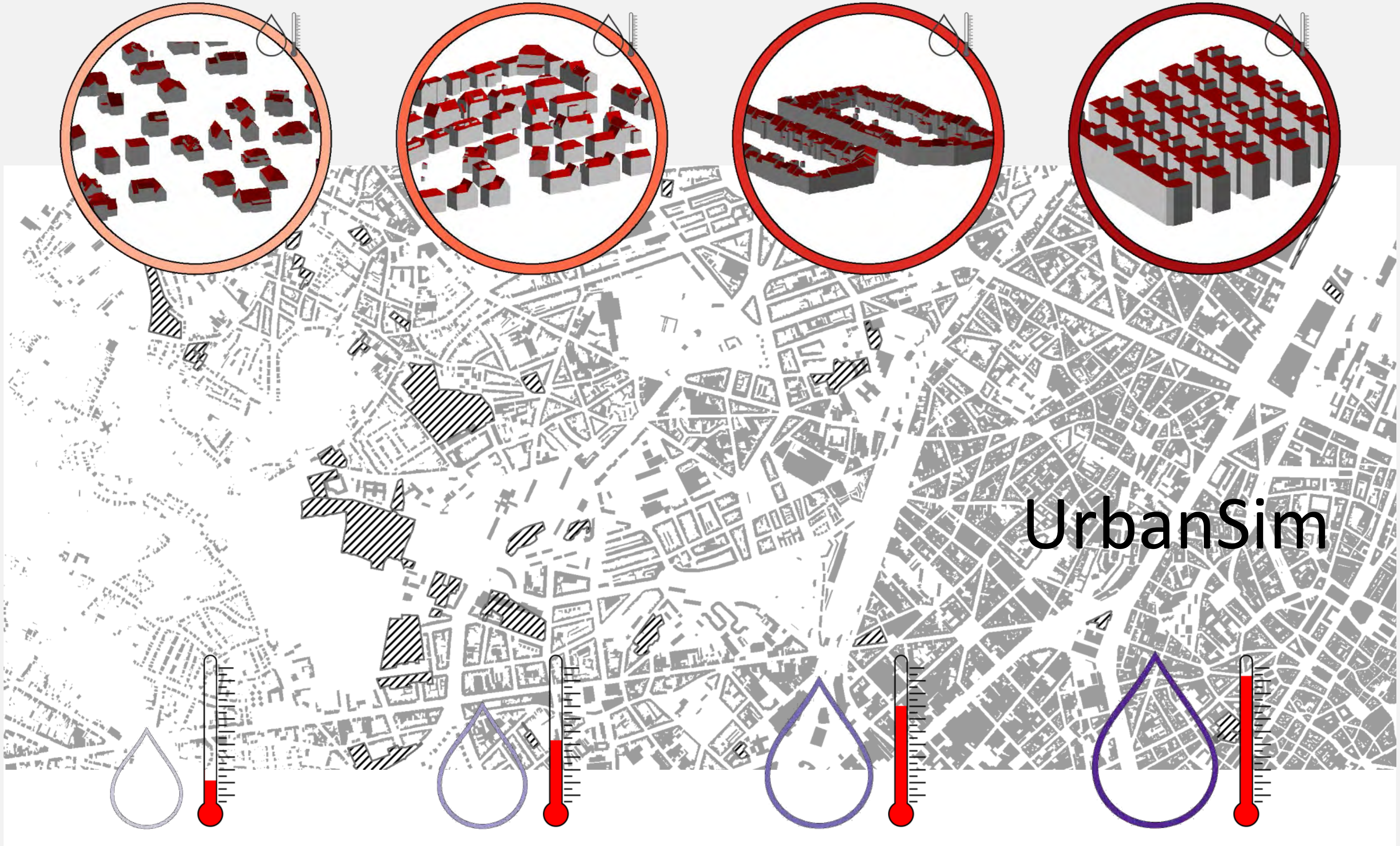
We provide a toolset for supporting sustainable urban planning accounting for heat and water flux impacts

BAU SUS




Credits: Boud Verbeiren & Charlotte Wirion

# SUSTAINABLE URBAN PLANNING/DEVELOPMENT/MANAGEMENT?



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**http://ees.kuleuven.be/urbanears/**


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