Main URBANFLUXES achievements

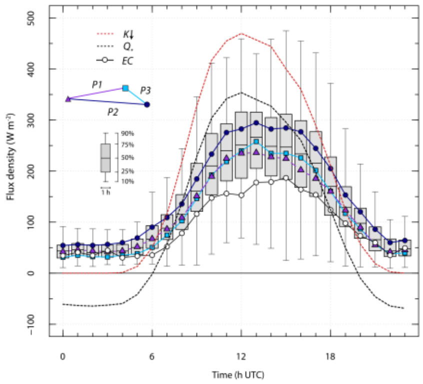
During the three years of URBANFLUXES project, the team advanced significantly the current knowledge of the UEB components estimation methods and assess their behaviour in space and time, as well as their impacts on the Urban Heat Island (UHI) and hence on urban climate and energy consumption.

Extended analyses of various methodologies and a vast amount of meteorological, micro-meteorological and geospatial (mainly EO-based) data took place in London, Basel and Heraklion. Sophisticated models were developed to derive the different urban energy fluxes. The final methodology for EO-based estimation of all UEB fluxes through the exploitation of Copernicus Sentinels is a valuable tool for Earth System Science and urban planning communities.

Online monitoring of in-situ meteorological and Eddy Covariance data of each case study through the URBANFLUXES web tools.

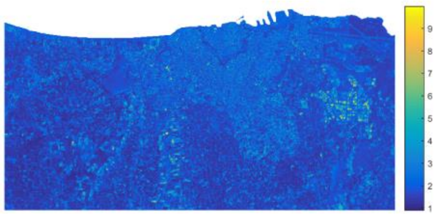
The URBANFLUXES tools are capable of supporting strategies to mitigate UHI effects, improving thermal comfort and energy efficiency in cities. Furthermore, the developed tools can be used for monitoring and evaluation of the implementation of climate change mitigation technologies, including Nature Based Solutions (NBS).

The method for deriving Q* using the DART model proved to work efficiently for Sentinels and can now be applied in any city, provided the necessary data (3D urban models & atmosphere data). The Element Surface Temperature Method (ESTM) is a dynamic and the most appropriate method when utilizing EO and geodata for deriving ΔQ_S. The Aerodynamic Resistance Method (ARM) is also a valuable technique for deriving turbulent heat fluxes using EO data combined with morphology and in-situ meteorology.



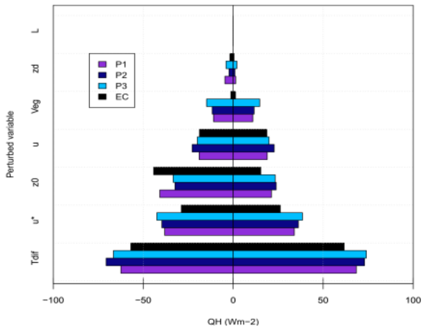
Diurnal patterns of in-situ measured energy fluxes for the centre of London using net radiometers, scintillometry and Eddy Covariance.

The challenges that have been recognized in the estimation of each UEB term are also very important for the future research. The sensitivity/accuracy of input parameters in each model have been proved crucial for the output accuracy. The temperature of surfaces not seen by the satellites, combined with the thermal anisotropy of the urban environments are factors that may introduce uncertainty in the flux models.



Uncertainty (K) map of downscaled LST product in Heraklion.

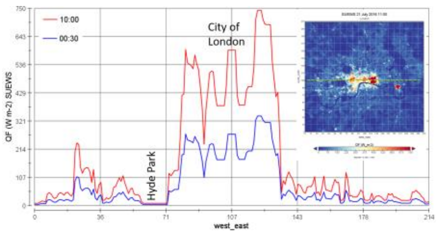
Sensible heat flux (Q_H) is a key component of the UEB and URBANFLUXES proved that the uncertainty imposed in its estimation is crucial for closing the energy balance and estimating Q_F from a residual approach. Uncertainties in the calculation of aerodynamic resistance and excess resistance due to extrapolation of measured air temperature, humidity and wind speed to the full area of interest can affect the Q_H estimation. However, the most important parameter is the difference between air temperature and surface temperature. ± 2 K perturbation in LST can impose ± 50 W m^{-2} variance on modeled Q_H.



Sensitivity of Q_H estimation to various input variables. The difference between surface and air temperature is the most important parameter in the model.

The anthropogenic heat flux has been estimated in URBANFLUXES using a variety of approaches. Bottom-up, top-down, simple parameterization and combined models have been integrated with in-situ UEB flux measurements and compared with the developed EO-based methodology. All of the techniques have uncertainties and most are data intensive. Attention is needed when comparing compatible spatial information. Areas with most intense anthropogenic heat emissions may be missed by a simple model, while emissions estimates are improved with more detailed information.

Anthropogenic heat emissions vary with human activity and population shifts during workdays lead to changes in the spatial structure of emissions. During URBANFLUXES, a variety of methods have been developed and are available for others to use through the integrated UMEP tool that is offered as an open source plugin in QGIS.



Spatial variations of Q_F in London during day and night of a summer day, estimated using SUEWS model.