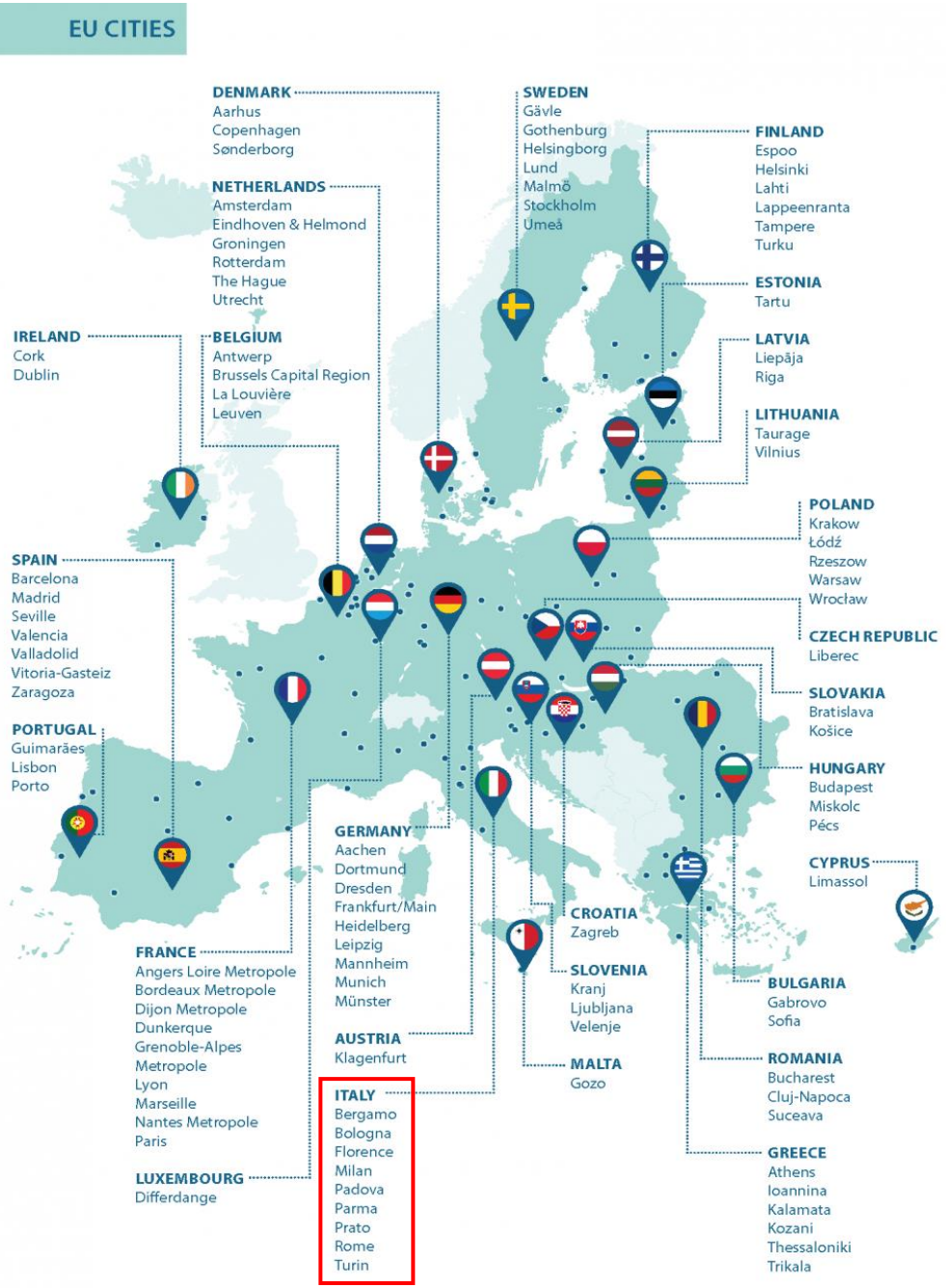
Session:
Integrazione tra osservazioni in-situ, remote sensing e modelli

Urban eddy covariance sites as tools to assess trajectories towards C-neutrality –Firenze-Prato case studies

Lorenzo Brilli, Beniamino Gioli

Consiglio Nazionale delle Ricerche, Istituto per la BioEconomia (CNR-IBE),
Via Madonna del Piano 10, 50019, Firenze, Italia
Contact: lorenzo.brilli@ibe.cnr.it

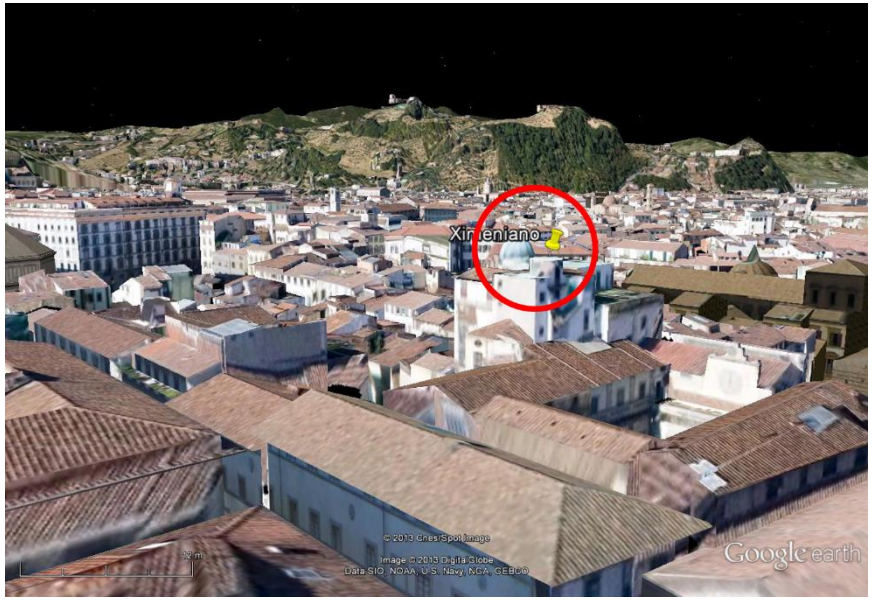


The EU mission for climate-neutral and smart cities was proposed to select 100 climate neutral cities by 2030 (developing decarbonization strategies involving energy, transport, buildings, industry, and agriculture).

BERGAMO
BOLOGNA
FIRENZE
MILANO
PADOVA
PARMA
PRATO
ROMA
TORINO

The quantification and partitioning of the urban CO_2 emissions, and the CO_2 sequestration capacity that may be provided by urban green areas to impact the city-level C-balance and offset anthropogenic emissions is a complex issue.

1. STUDY AREA: Experimental site 1 – Florence, Osservatorio Ximeniano



ICOS association: ongoing

Measurement mast:

Height above ground: 33 m

Mean building height: 19 m

Roughness length ~ 1.0 m

1. STUDY AREA: Experimental site 1 – Florence, Osservatorio Ximeniano

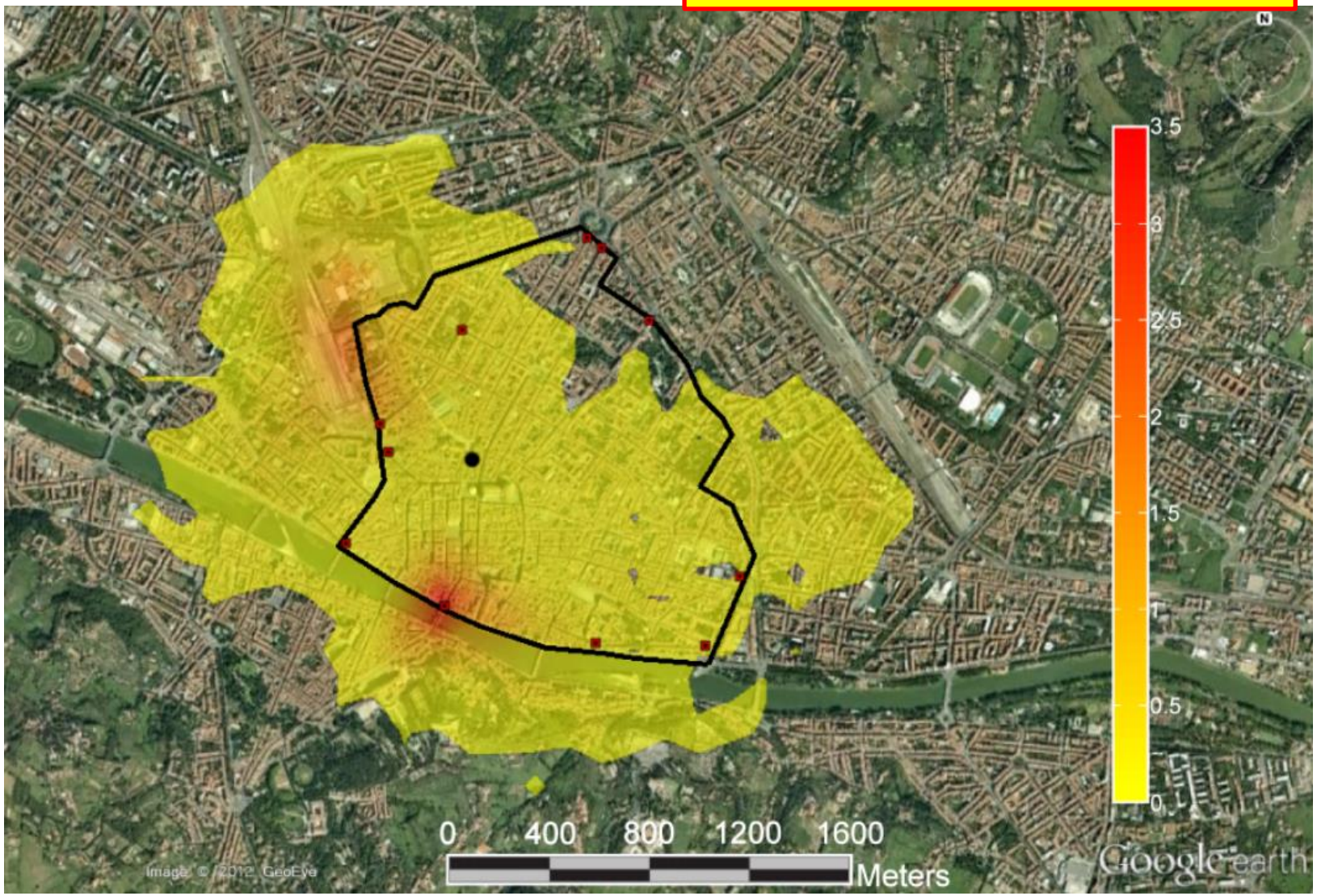
ICOS association: ongoing

Measurement periods:

- CO_2: Long-term**, 2005 – ongoing**
- CH_4: Short-term campaigns
- PM: Short-term campaigns

Footprint area :

> 90% urbanized land



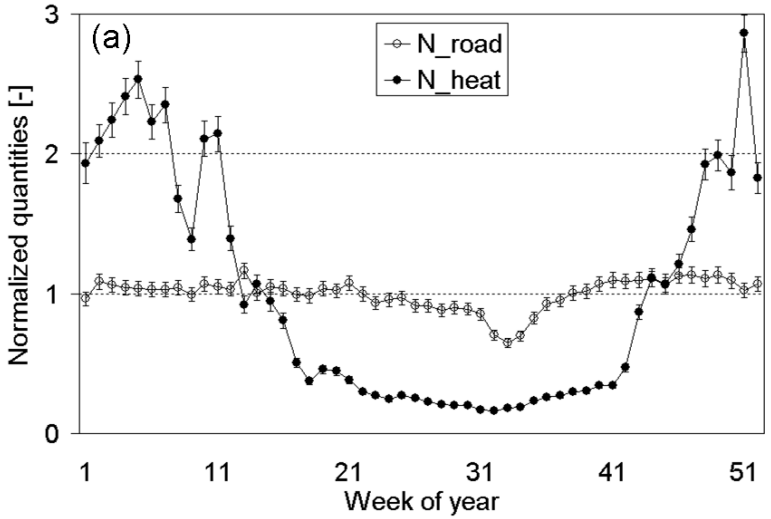
1. **STUDY AREA:** Experimental site 2 – Prato, Palazzo Pretorio

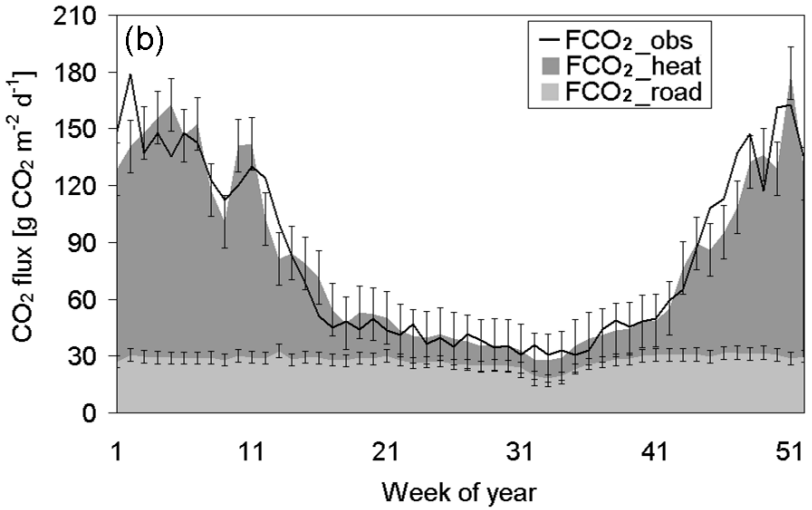
Measurement periods:

- CO_2: **2021 – ongoing**

2. DATA ANALYSIS: Anthropogenic drivers of CO_2 & CH_4 fluxes

Flux source partition: CO_2

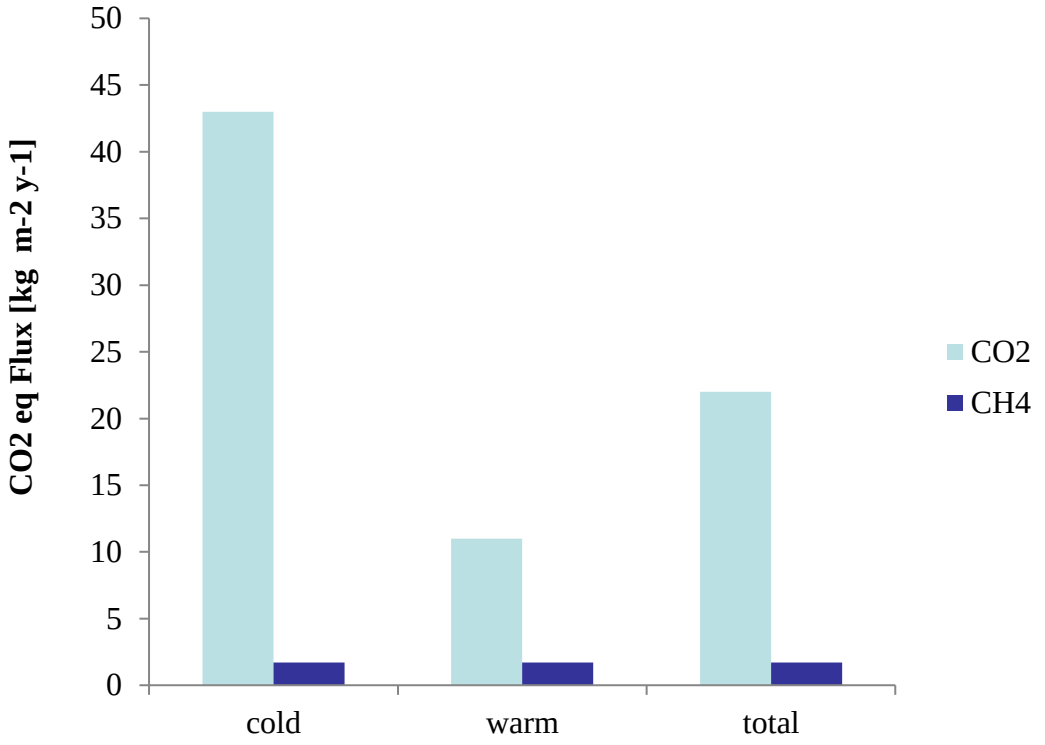




Partition factors.
Derived from emission factors and inventorial normalized proxies (road traffic amounts & gas network flow-rates) through multi-regressive approach.

Road traffic → 32%
Domestic heating → 68%

GHG balance (CO_2 equivalent)

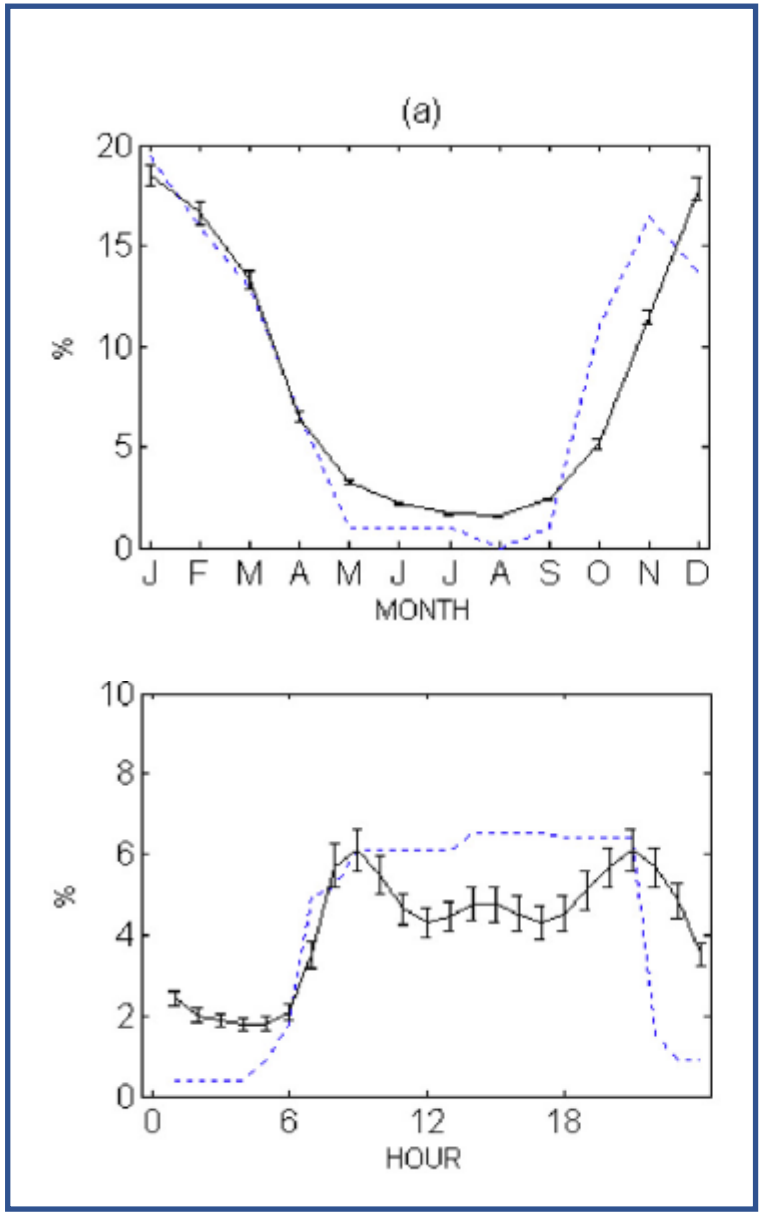


CH_4 GWP = 8% CO_2 GWP

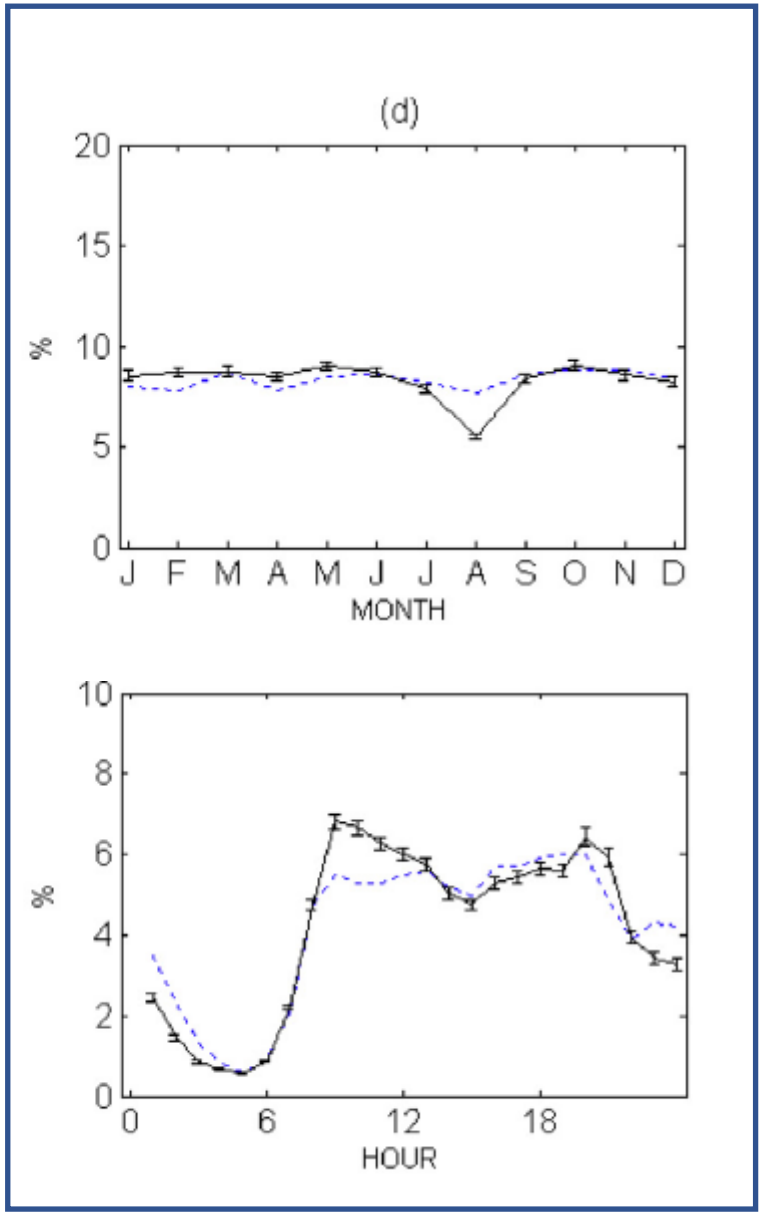
(Matese et al 2009)
(Gioli et al 2012)

3. Measured Data vs Inventory

NATURAL GAS



ROAD TRAFFIC



Mmonthly and hourly ffCO2 fluxes (Florence):

- official city scale inventories (blu dots)
- measured by eddy covariance (black line)

When assimilating eddy covariance temporal variability, fCO2 emission inventories are improved 26 to 47%

(Gioli et al, 2015)

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

Improving high resolution emission inventories with local proxies and urban eddy covariance flux measurements

Beniamino Gioli [a, *], Giovanni Gualtieri [a], Caterina Busillo [b], Francesca Calastrini [a], Alessandro Zaldei [a], Piero Toscano [a]

[a] Institute of Biometeorology (CNR–IBIMET), Via Caproni 8, 50145 Firenze, Italy
[b] LaMMA Consortium, Via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy

3. City scale C-balance (Firenze, 2013)

Landscape and Urban Planning 120 (2013) 138–146

Contents lists available at ScienceDirect

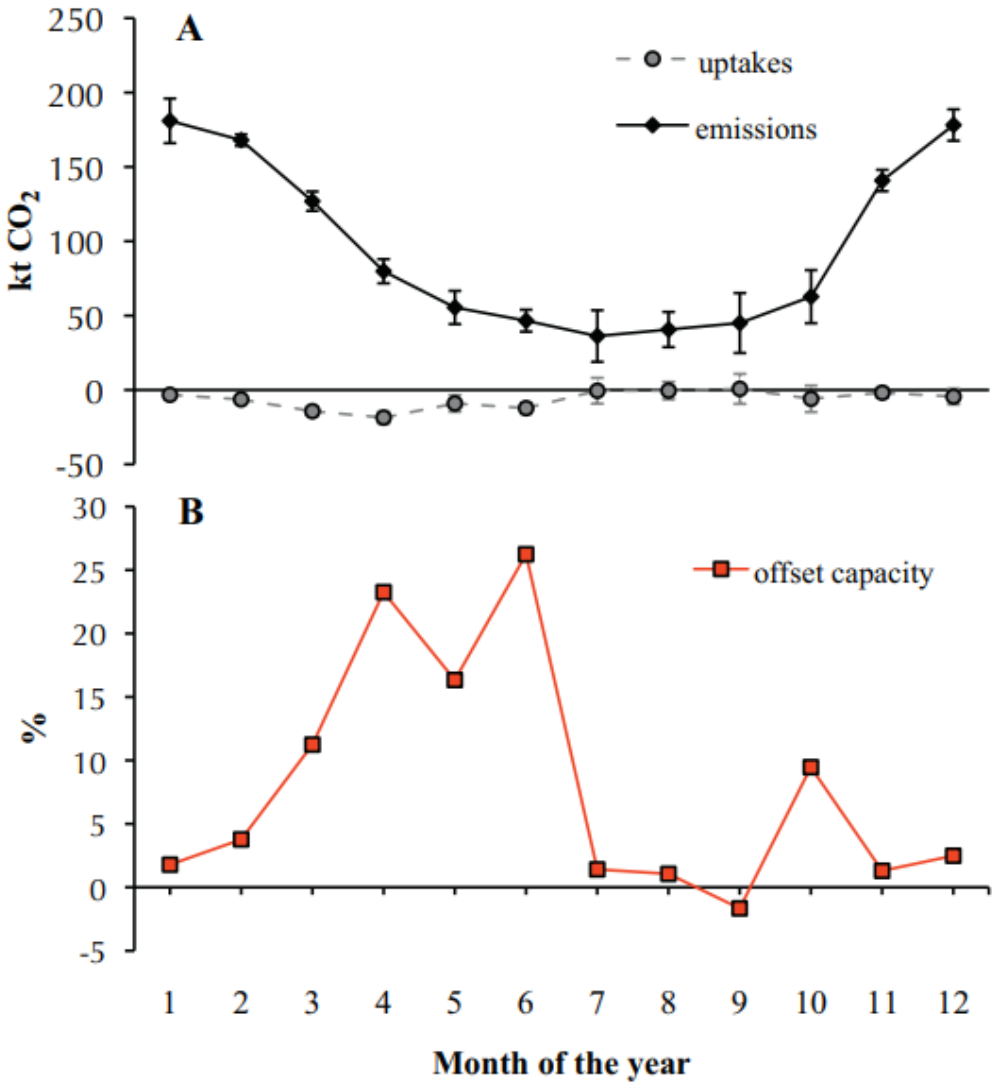
Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Carbon dioxide balance assessment of the city of Florence (Italy), and implications for urban planning

Francesco Primo Vaccari[a,*], Beniamino Gioli[a], Piero Toscano[a,c], Camilla Perrone[b]

[a] Institute of Biometeorology (IBIMET), National Research Council (CNR), Via G. Caproni, 8, 50145 Florence, Italy
[b] Department of Urban and Regional Planning (DUPT), University of Florence, Via P.A. Micheli, 2, 50121 Florence, Italy
[c] Department of Agricultural and Environmental Sciences, University of Udine, Via delle Scienze, 206, 33100 Udine, Italy



(Vaccari et al 2013)

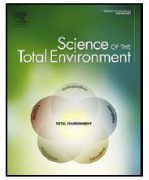
4. City scale C-balance (Prato, 2022)

Science of the Total Environment 842 (2022) 156843

Contents lists available at ScienceDirect

Science of the Total Environment

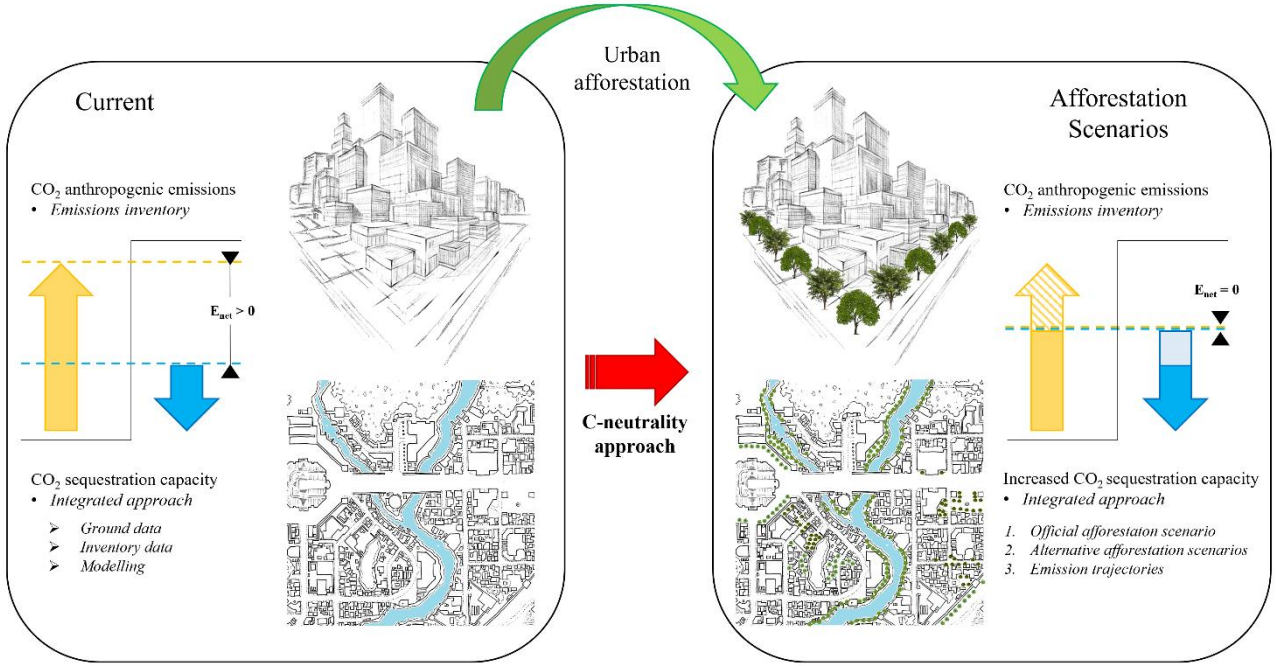
journal homepage: www.elsevier.com/locate/scitotenv



An integrated approach to estimate how much urban afforestation can contribute to move towards carbon neutrality

L. Brilli *, F. Carotenuto, M. Chiesi, E. Fiorillo, L. Genesio, R. Magno, M. Morabito, M. Nardino, A. Zaldei, B. Gioli

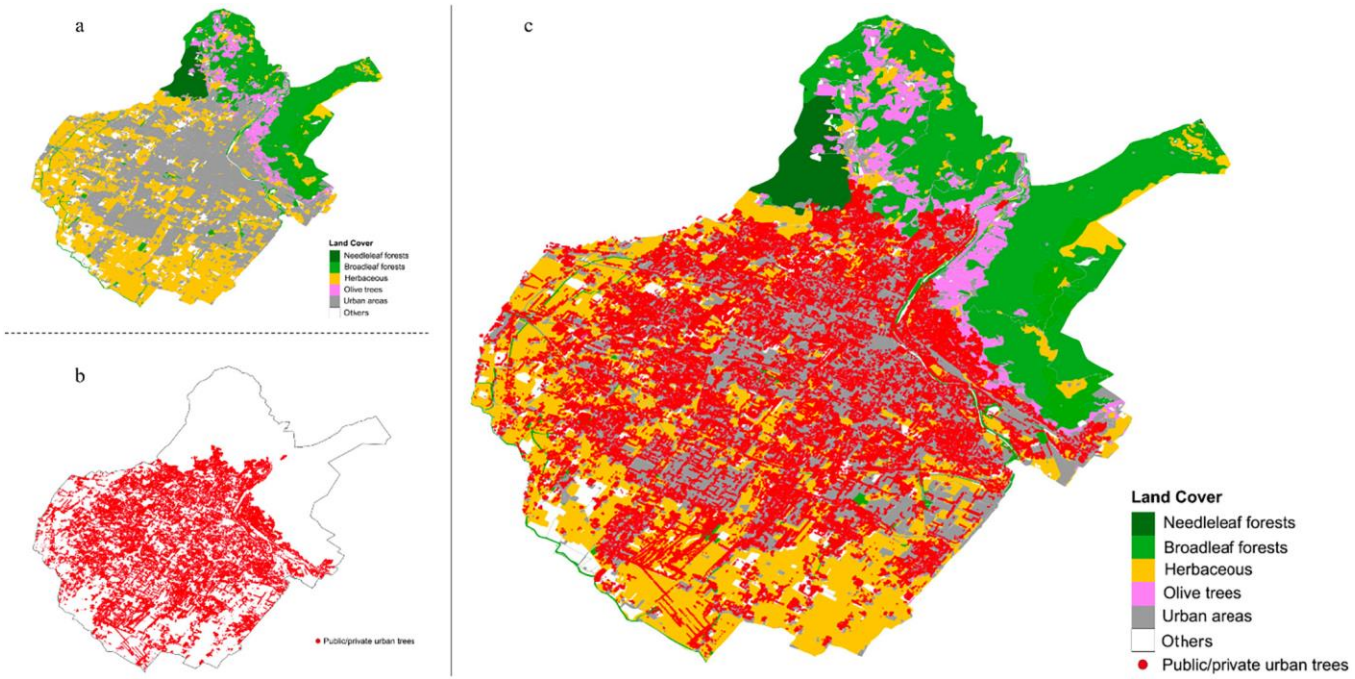
CNR-IBE, National Research Council of Italy, Institute of Bioeconomy, Via Madonna del Piano 10, 50145 Sesto Fiorentino, Italy

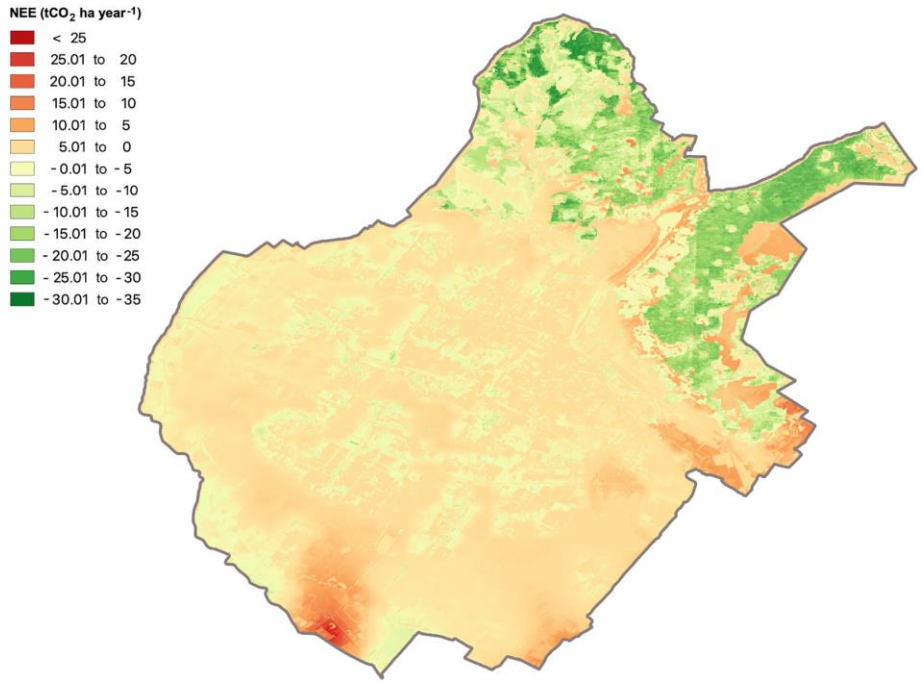


- **Land use and tree cover analysis:** To identify type and extent of the forest areas falling within the municipality.
- **Tree volumes and urban forest area:** The tree volumes and C-stock were calculated for all urban trees to improve modelling estimates of the net carbon fluxes.
- **Emission inventory (IRSE):** provides regional estimates of pollutants emissions from industrial, civil, and natural sources at different spatial resolutions (1-km to municipal level).
- **Modelling approach:** The CO_2 sequestration capacity was estimated based on the use of two models, C-Fix and BIOME-BGC, as proposed by Maselli et al. (2009a, 2009b) and Chirici et al. (2022).

(Brilli et al 2022)

4. City scale C-balance (Prato, 2022)





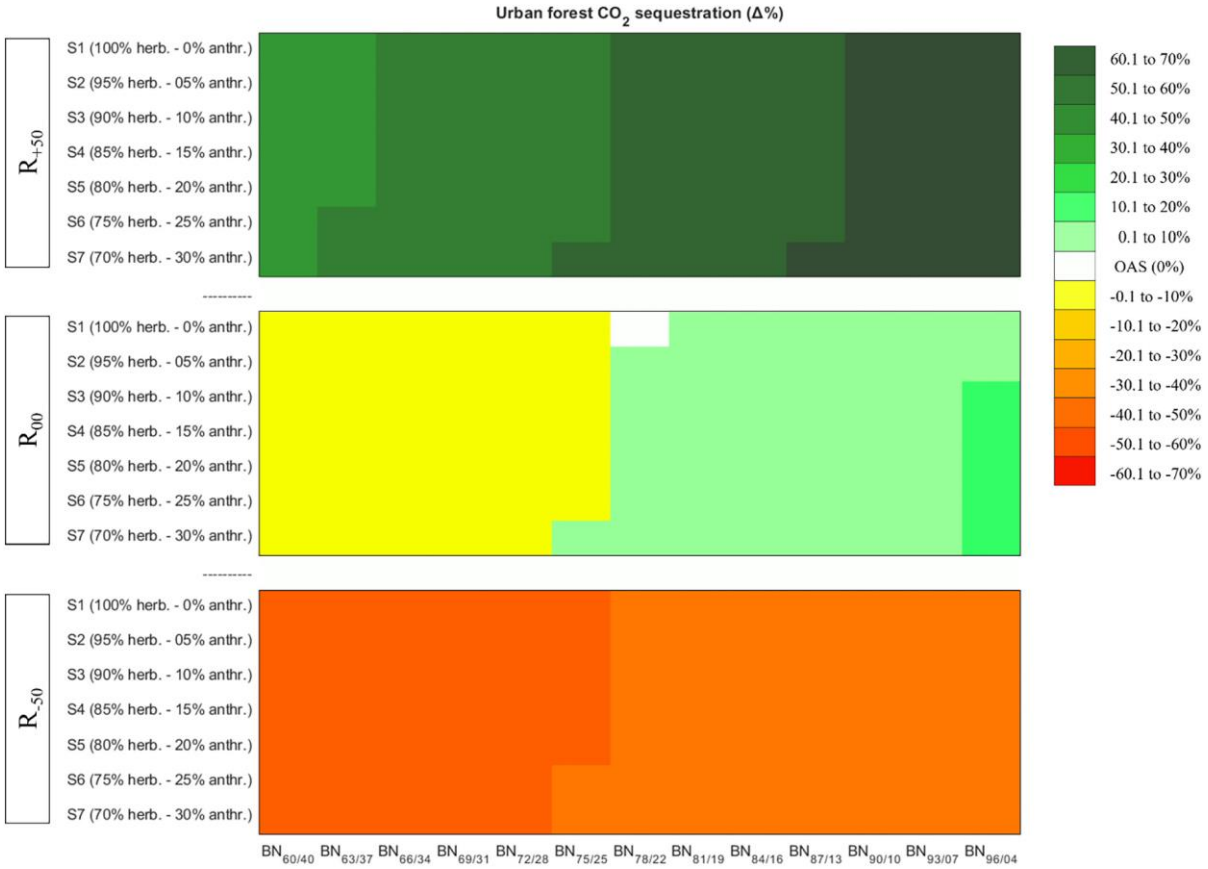
LU classification of the Prato Municipality according to seven classes:

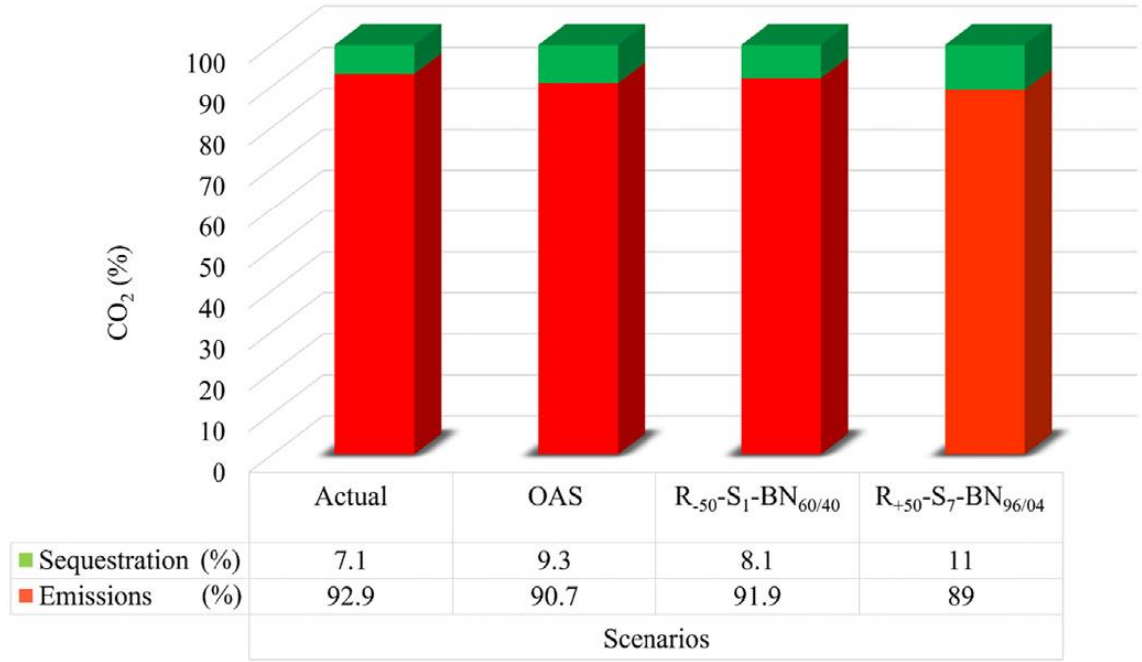
1. *needleleaf forest (light green);*
2. *broadleaf forest (dark green);*
3. *herbaceous areas (yellow);*
4. *Olive trees (pink);*
5. *urban areas (grey);*
6. *Other areas (white)*
7. *Public and private trees (red dots).*

Map of NEE for the Municipality of Prato.

(Brilli et al 2022)

4. City scale C-balance (Prato, 2022)



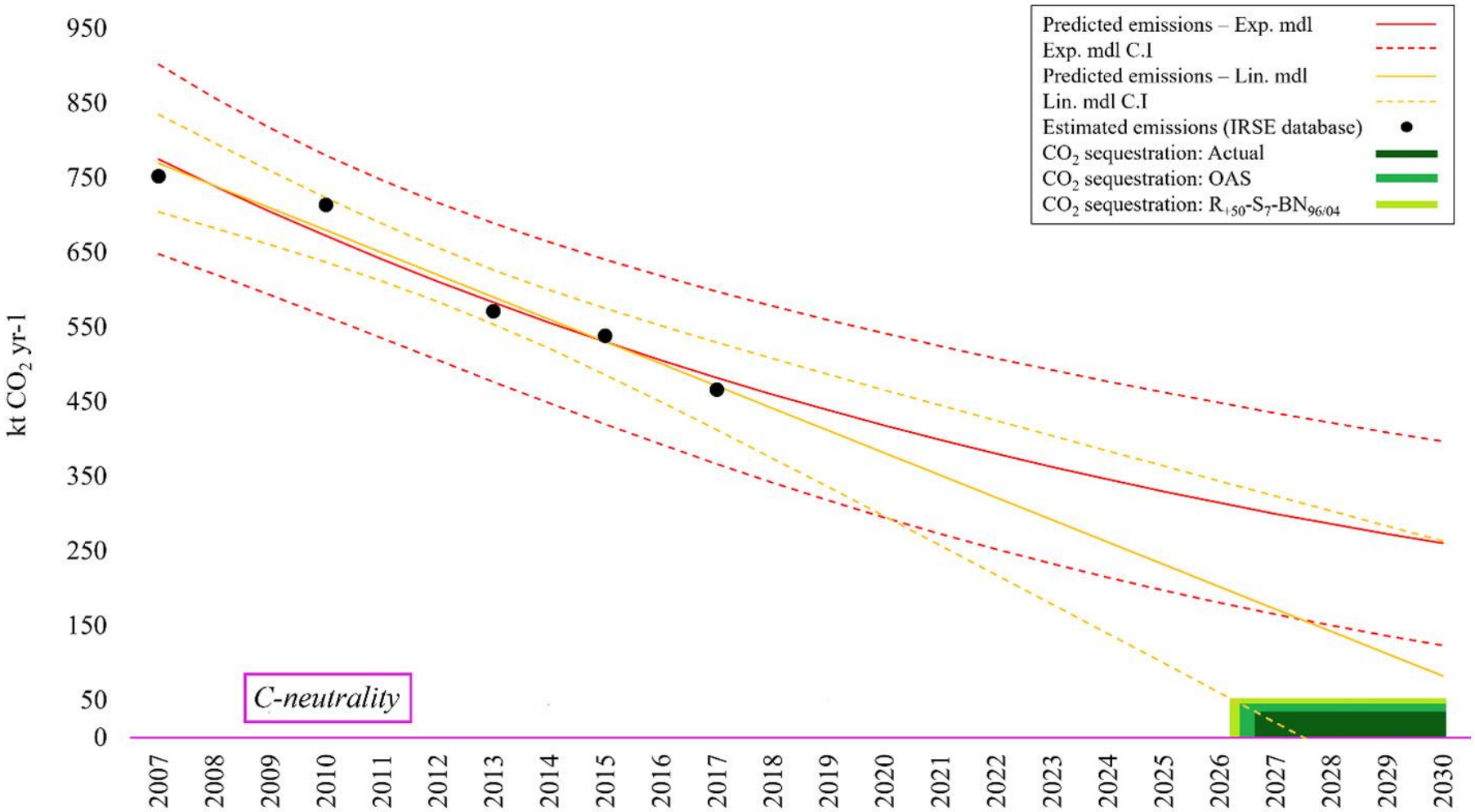


Map of ΔCO2 sequestration between official and 272 (on 1191) alternative afforestation scenarios. The comparison was proposed considering only the reference, the maximum (+50 %) and the minimum (−50 %) surface to be forested included in the analysis and evaluating ΔCO2 sequestration grouping scenarios by 10 % classes.

Emissions offset within the study area according to the Actual, Afforestation scenario, and extremes (minimum and maximum) CO2 sequestration afforestation scenarios

(Brilli et al 2022)

5. City scale trajectories towards C-neutrality (Prato, 2022)



Emissions offset within the study area according to the Actual, Afforestation scenario, and extremes (minimum and maximum) CO2 sequestration afforestation scenarios

5. Conclusions

a) Needs to built infrastructures and networks of eddy covariance sites on urban land-use.

b) Needs to implement and maintain existing eddy covariance sites on urban LU.

c) Eddy covariance infrastructures on urban LU (with and without integrated modelling approach) may provide better estimates of emissions contribution and cities C-balance.

d) Outcomes may be used to plan and develop suitable urban adaptation measures to approach carbon neutrality (Neutral city)