

COPERNICUS RESPONDING TO EU CITIES MISSION

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Editorial

by Nektarios Chrysoulakis

It is with great pleasure that we present the second issue of the CLMS-Cities Newsletter. This project brings together leading research institutions, European agencies, commercial partners and city stakeholders to develop innovative ways of monitoring and understanding urban CO₂ emissions. By harnessing the power of the Copernicus Land Monitoring Service (CLMS) and more Earth Observation data, our aim is to equip European cities with actionable data and tools to accelerate their journey toward climate neutrality.

In this issue, you will explore how heterogeneous datasets are processed and aligned into model-ready inputs, using the Vitoria-Gasteiz pilot to bridge technical rigor with real-world application. By analyzing stakeholder requirements from our recent workshop and surveys, we are translating city needs into CLMS action to ensure our tools remain practical, scalable, and interoperable. We invite you to follow our progress, join the dialogue, and in turn help us ensure that CLMS-Cities contributes to a more sustainable urban future.

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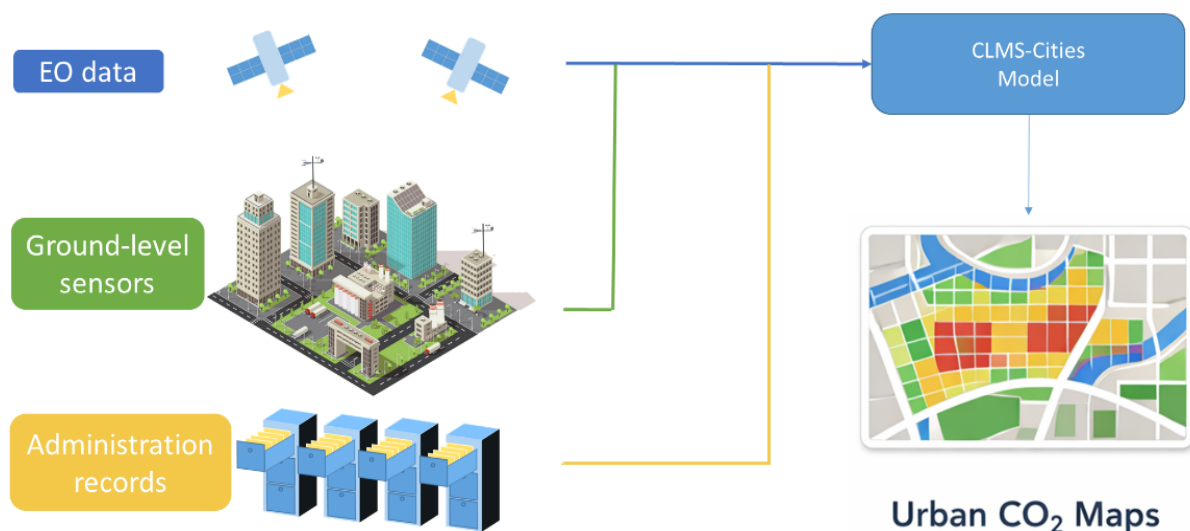
Copernicus and Third Party Data Sources Interfacing

By Mauricia, Alessandra

The CLMS-Cities project brings together satellite-based observations, ground-level sensors and local administration records to build a clear picture of urban CO₂ flows. At the core lies the Copernicus programme, delivering high-resolution imagery, land-cover maps and atmospheric variables. By linking these products to complementary datasets such as ECMWF's ERA5 re-analysis, GPS-based mobility logs, and local building and waste-management registers, we define the necessary steps needed to transform raw data into clean and structured format suitable for the model ingestion. This harmonized flow fuels the model's five sector modules: Buildings, Mobility, Industrial, AFOLU and Human Respiration. The result is a modular system that can ingest and synchronise information on a common 10 × 10 m grid (the Sentinel resolution) while delivering output at a neighbourhood-scale 100 × 100 m resolution or at polygon base, fine enough to see which streets, blocks or parks drive the biggest CO₂ spikes, providing clear and comparable emission estimates to city planners and citizens.

From raw to ready to run data

Robust data harmonisation, spatio/temporal alignment, and semantic standardisation is necessary for turning heterogeneous raw data into a structured model input. The CLMS-Cities model ties the “big picture” view of Copernicus-derived land-use and land-cover to the “microscopic” details supplied by local administrations and third parties. Before the model can crunch numbers, every dataset must be cleaned, standardised and stored in a reproducible structure. Each sector undergoes its own preprocessing – converting satellite rasters, vector layers, and CSV logs into consistent GeoPackages, GeoTIFFs or NetCDF files. To ensure reproducibility, the repository follows a modular structure to separate model logic, data exploration workflows, and organized datasets segmented by thematic layers such as climate, buildings, and mobility, complemented by documentation and environment specifications to ensure reproducibility. Hourly resolution is achieved by down-scaling yearly activity data (EDGAR, literature) or ERA5 to match the model's time step. Each sector processes data in its native format and outputs results accordingly at hourly resolution, while typically providing a GeoPackage aligned with Urban Atlas polygons for fast aggregation and spatial consistency.



Quality, Sectors & What Comes Next

Data quality varies across sources: free CLMS Normalized Difference Vegetation Index (NDVI) products give useful vegetation signals, while partner-provided LAT40 imagery adds metre-level detail for land-use change; municipal building registers often contain richer information on heating type and occupancy than the generic Urban Atlas layers. The model therefore flags each input by its confidence level, allowing users to weigh high-resolution vectors more heavily when available. Once the pilot in Vitoria-Gasteiz passes the 15 % agreement test against flux-tower measurements, the same pipeline will be rolled out to other cities, leveraging the same workflow. As new Urban Atlas releases and higher-resolution building or vegetation data become available, the system will simply ingest the fresh inputs, keeping the model up-to-date. In short, robust preprocessing, modular repository design, solid quality checks turn heterogeneous satellite and ground data into a reliable, city-wide CO₂ accounting ready to inform climate policies, urban planning, and public awareness across Europe.

Stakeholder Requirements

by Zaheer, Ahsan, Katy

2nd Stakeholder Workshop – Vitoria-Gasteiz

While the technical pipeline provides a strong foundation, the project's ultimate success depends on its practical utility for urban decision-makers. To ensure the model's outputs are truly applicable, the project facilitates direct dialogue with the end-users responsible for their implementation. As part of the CLMS-Cities co-creation strategy, the project hosted its second Stakeholder Workshop on 11 September 2025 in Vitoria-Gasteiz, Spain, bringing together representatives from seven European cities and project partners. The event showcased progress in CO₂ emission modelling and explored innovative approaches to integrate new data sources into city inventories, unlocking co-benefits for sustainable urban development.



A working prototype for Vitoria-Gasteiz was demonstrated to spark discussion. Participants collaborated to define priorities for making project tools more practical, interoperable, and scalable - key steps to accelerate Mission Cities' transition to climate neutrality by 2030. Identified requirements included resolution scale, reporting needs, co-benefits, planning scenarios, inventory frequency, methodological harmonization, validation, benchmarking, usability, training, integration with local data, and long-term availability. These insights are shaping CLMS-Cities model design and are being documented in Deliverable D1.1, ensuring stakeholder needs remain central to the project.

Survey with Mission Cities

A survey conducted in November-December 2025, under the CLMS-Cities initiative. It gathered responses from 52 EU Mission cities, offering a valuable snapshot of current practices, challenges, and future needs in monitoring and reducing CO₂ emissions. 90% respondents were from municipal authorities, with most cities actively pursuing climate neutrality through integrated measures spanning transport, energy, and urban planning.

Key Findings:

Awareness Gap: Familiarity with Copernicus Land Monitoring Service (CLMS) products remains low, with over 38% rating their knowledge at 0–2 on a 10-point scale.

Inventory Practices: Nearly 88% of cities collect GHG CO₂ inventories, and 78% apply quality checks using standards like ISO 14064-1 and GPC. However, resource constraints and complexity hinder broader adoption.

Data Sources & Coverage: Inventories primarily draw on transport and building data, with most cities covering all three emission scopes (58%). Uncertainty levels vary widely (10–30% typical), highlighting the need for methodological consistency.

Applications: CO₂ data is central to urban planning, informing zoning, energy retrofits, and mobility strategies. Around 80% of respondents use inventories for public communication, emphasizing transparency and citizen engagement.

Future Needs: Respondents call for harmonized EU-wide standards, high-resolution datasets (100 m grids) as well as coarser resolution, and flexible formats such as polygon-based spatial layers for GIS integration as well as raw tabular data. Digital platforms enabling citizen participation and gamification emerged as a priority for fostering behavioral change.

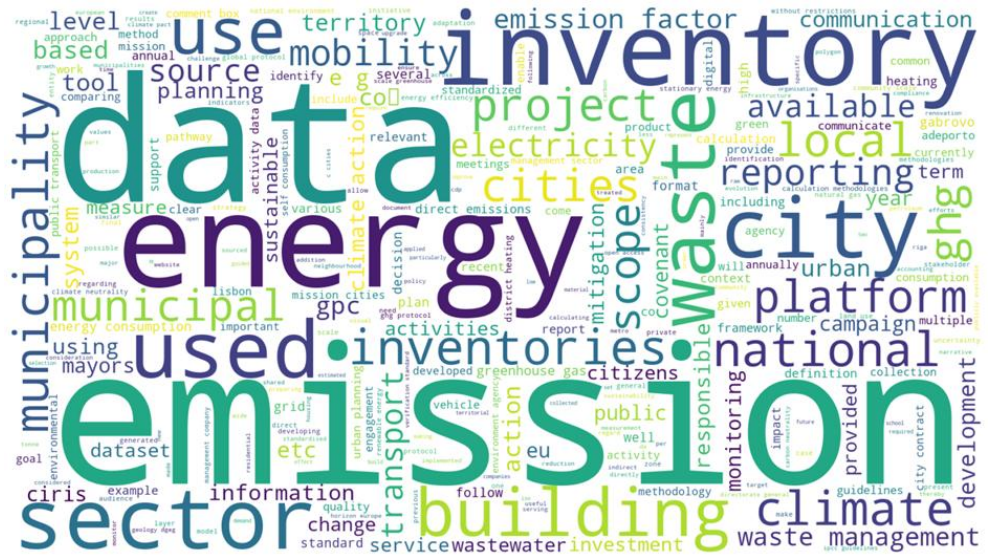
What's Next? The findings underscore the urgency of improving data quality, interoperability, and usability to accelerate climate-neutral pathways. By addressing gaps in awareness, standardization, and communication, CLMS-Cities can empower municipalities to make informed, impactful decisions, turning data into action for a sustainable urban future.

Consolidated Requirements:

Stakeholders demand harmonized, user-friendly emissions data integrated with existing workflows, high spatial and temporal resolution, and flexible local relevance. Tools should support planning, scenario modeling, and impact tracking, cover all sectors, and provide clear visualizations and narratives for diverse audiences, ensuring transparency, compliance to reporting platforms, interoperability, and continuous monitoring.

Wordcloud representing the most frequently used terms in the open-text responses of the survey.

Larger words indicate higher frequency, meaning these words were mentioned repeatedly by participants.



Turning City Needs into CLMS Action

By Konstantinos Politakos

Building on stakeholder feedback and a review of existing Copernicus Land Monitoring Service (CLMS) capabilities, the CLMS-Cities project has identified several areas where future developments can further strengthen support for city-level climate action. CLMS already provides high-quality and widely used land monitoring data; however, cities have highlighted opportunities to enhance its relevance for neighbourhood-scale planning and for capturing short-term changes linked to local interventions, such as mobility measures or building retrofits.

There is also strong interest in expanding how CLMS data can contribute to the development cities' emissions inventories. While current products cover a wide range of land-use themes, cities would ask for further development to better represent key urban sectors such as transport, industry, waste, and agriculture, supporting more direct use in mitigation planning and scenario analysis. In parallel, stakeholders have expressed a need for improved integration between CLMS outputs and local inventories, reporting frameworks, and planning tools, to facilitate smoother data exchange and more efficient workflows.

Finally, cities emphasise the value of continued progress in usability and operational support. Enhancements such as more intuitive visualisations, greater automation, and targeted guidance or training would help a wider range of users translate CLMS data into actionable insights. Together, these opportunities highlight how CLMS-Cities can build on existing strengths to deliver scalable, practical solutions that support cities in advancing towards climate neutrality.

City Emissions Inventories: Key Observations

Further analysis highlights several methodological and data-related areas where city-level emissions inventories can be further strengthened to support consistent, transparent, and comparable climate action across cities. While Climate City Contracts offer high-level direction practical experience shows that in a number of cases, documentation is limited and inventories rely on multiple assumptions that are not always clearly recorded. As a result, levels of transparency, verification, and replicability differ between cities, making it more challenging to monitor progress within the EU Cities Mission framework.

Beyond documentation, cities also face practical challenges when assembling inventories from multiple strategies, datasets, and analytical tools developed at different times and for different purposes. Although these sources are often valid within their original contexts, combining them across sectors, years, and frameworks can introduce internal inconsistencies that affect the overall coherence of reported emissions. In the same way, the use of different reporting protocols—such as SECAPs, GPC, and other EU Cities Mission-aligned approaches—is widely supported and beneficial at the city level, yet differences in underlying accounting foundations can limit comparability when results are viewed collectively.

These methodological challenges are further reinforced by how emissions are represented across different parts of the city and across sectors. Spatial and sectoral coverage are crucial, as cities consist of diverse neighbourhoods and activities, and inventories that do not reflect this diversity may overlook important emission patterns and mitigation opportunities. At the same time, many cities face practical constraints, including limited access to detailed data and a lack of dedicated personnel or technical resources, which can make it difficult to regularly develop, update, and refine emissions inventories.

City Feedback to CLMS-Cities Design

The development of CLMS-Cities builds on the substantial work already underway in cities across Europe, shaped by extensive feedback from stakeholders and municipal leaders. Cities are actively compiling emissions inventories, piloting climate actions, and reporting progress through Climate City Contracts.

This shared momentum and practical experience provide a strong foundation for defining clear product requirements. By aligning closely with how cities already plan, report, and act on climate mitigation, future CLMS-Cities developments will complement existing efforts and deliver tools that respond directly to cities' real-world needs.

Bridging the Data

A key opportunity identified by cities relates to how emissions data are brought together and presented in inventories. There is also strong interest in better representing sectors that are often underrepresented, such as transport, waste, and land-use-related emissions.

CLMS-Cities aims to support this by promoting harmonised land-use and emissions classifications, making it easier to compare results across cities.

Usable, Scalable, and Inclusive

Beyond technical performance, cities consistently point to challenges related to usability, long-term sustainability, and limited technical capacity. Many municipalities, particularly those with fewer resources, face difficulties in interpreting results, integrating data into existing workflows, and communicating findings to different audiences. In response, CLMS-Cities supports accessible tools for users with varying levels of expertise, complemented by clear documentation, guidance, and training. It also promotes interoperability through common data formats and interfaces, reducing duplication and easing integration with reporting and planning platforms.

Smarter Data, Smoother Workflows

Cities highlighted the need for emissions data that are not only accurate but also practical to work with. CLMS-Cities therefore places emphasis on improving data processing and modelling capabilities, particularly through the use of more detailed energy and activity data. Access to disaggregated information—such as building-level energy use or sector-specific activity patterns—can significantly enhance the quality of emissions estimates and support more targeted analysis.

With many cities constrained by manual, fragmented workflows, CLMS-Cities improves consistency, reduces duplication, and frees staff time, making emissions inventories easier to update, maintain, and use for policy evaluation and climate action.

Citywide Trends to Neighbourhood Insights

Another priority for cities is access to emissions data that reflect how urban systems function across both space and time. Analysis at multiple spatial levels—from city-wide overviews to neighbourhood-scale insights and, where feasible, high-resolution grids—helps cities link emissions patterns to zoning, land-use planning, and local interventions. Temporal detail is equally important, as dynamic profiles such as hourly, daily, or weekly patterns allow cities to understand how emissions vary over time and how specific actions influence short-term trends. CLMS-Cities aims to support this combined spatial and temporal perspective, enabling more targeted, timely, and effective urban climate planning.

Project Activities

Over the past months, the CLMS-Cities team has already been actively engaging with key European events to present and promote the project's vision.

CLMS-Cities in the EuroGEO Workshop, The Hague (13-15 October 2025): The CLMS-Cities project took part in the EuroGEO Workshop 2025 where we shared our way of bringing the Copernicus Land Monitoring Service to European cities reality. Through a poster session we analyzed the potential of Copernicus Missions and Core Services to support EU Cities Mission to meet its ambitious objectives!

CLMS-Cities at the Municipality of Limassol, Cyprus (17 December 2025): The CLMS-Cities project was presented in Limassol, a Tier 2 city, at the Municipality of Limassol. The presentation focused on how Copernicus Land Monitoring Service data can support cities in addressing urban challenges.

1st Progress meeting, Vitoria Gasteiz (11-12 September 2025): Project partners reviewed progress and discussed next steps to support the EU Cities Mission and climate neutrality by 2030.

CLMS-cities and ICLEI overlap, online (29 September 2025): The CLMS-Cities Consortium presented first results from Vitoria-Gasteiz, focusing on high-resolution Scope 1 CO₂ emission modelling based on Copernicus Land Monitoring Service data and Urban Atlas. The exchange highlighted how such city-level CO₂ inventories can support Climate City Contracts and Mission Cities priorities.

All activities of the CLMS-Cities project are available through the project's web-site: <https://clms-cities.eu/news.html>.



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