A Stakeholder-Driven Needs Assessment: Identifying Urban Challenges and Requirements for Satellite-Based Services Supporting Climate-Resilient Austrian Cities

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1 ABSTRACT

Cities and municipalities face major challenges in times of climate change. As key actors in the transition towards climate neutrality, they require analysis, planning, decision-making processes and services to help them prioritise and justify the necessary measures and activities.

One option for data-based decision-making is the use of satellite-based services. The Urban Sky research project is therefore collaborating with representatives from Austrian cities of various sizes and structures to identify challenges and needs. This information will be used to develop satellite-based services concepts for urban planning, neighbourhood development, natural hazards, and urban mobility, while taking into account the relevant legal and normative framework conditions.

The project focuses on using freely available data such as that from the Copernicus programme. The aim is to explore the potential of the satellite data, review its feasibility and combine it to create useful services. The project also assesses the added value for cities, the market potential and the research requirements, and categorises and prioritises the services, resulting in actionable recommendations. To achieve this, the following research questions are answered: (1) What challenges do Austrian cities face regarding urban and neighbourhood planning? (2) How can satellite data help to solve these challenges? (3) Taking into account spatial and temporal resolution, what additional data and information is required to use satellite data effectively to overcome these challenges?

Following a literature review, the topics were narrowed down to the following areas: buildings; green spaces and biodiversity; infrastructure; mobility; natural hazards; urban planning; and spatial planning. These areas were further discussed and specified during the first Stakeholderworkshop, which was attended by representatives of several Austrian cities varying in population and structure. Particularly urgent needs were identified focussing e.g. on buildings and potential renovation, solutions to reduce heat energy losses and the potential for redensification. In the field of natural hazards, key topics included small-scale air temperature monitoring and the development of early warning systems for floods or agriculture. In the context of infrastructure, the focus was on the detection of damage after extreme weather events and the analysis of photovoltaic (PV) potential in car parks. In addition, priorities were identified in the following areas: recording of traffic movements and parking space usage (mobility); calculating the degree of greening and tree canopy cover to comply with the EU Nature Restoration Regulation; and smart irrigation management (green spaces). Other priorities included urban heat island monitoring and climate risk analysis (urban planning).

The applications are primarily based on time-series data from optical satellite missions, such as Sentinel-2 and commercial very high-resolution satellites like Pléiades, Synthetic Aperture Radar (SAR) missions (such as Sentinel-1, NISAR, and future ROSE-L), and thermal missions, e.g. TRISHNA, ECOSTRESS, and the upcoming Land Surface Temperature Mission (LSTM) from the European Space Agency (ESA). A key outcome of the Urban Sky project is a structured study on the potential of satellite technology for urban and neighborhood planning. The study identifies and analyses existing satellite applications in cities (both nationally and internationally), and assesses their compatibility with current geodata sources. Based on the stakeholders' requirements, the study proposes ten potential applications to serve as a foundation for further RTI (research, technology, and innovation) initiatives.

Keywords: satellite data, services, stakeholder-driven, urban planning, climate resilience

2 INTRODUCTION

Climate change poses multiple challenges for Austrian cities and municipalities. As the main contributors to greenhouse gas emissions, they are required to implement climate mitigation measures in order to meet both national and international climate goals. However, urgent action is not only required due to legislative requirements; cities are also the most severely affected by the consequences of climate change such as urban heat islands (UHI), heavy rainfall events and biodiversity loss. Therefore, they must develop comprehensive adaptation strategies. This pressure has been further intensified by the European policy framework. While the European Green Deal (European Commission, 2019) established the ambitious ecological targets, its successor, the Clean Industrial Deal, introduced in February 2025 (European Commission, 2024), has shifted the focus towards competitiveness and efficient implementation. Within this new framework, local authorities are not only required to prove ecological compliance (e.g., under the Nature Restoration Regulation (Regulation (EU) 2024/1991)) but are also urged to accelerate planning and permitting processes to foster economic resilience. Recent policy analyses emphasise this pivotal role, arguing that cities act as the 'central architects' of the Clean Industrial Deal, because they directly control critical levers such as land use, transport, and energy systems (C40 Cities, 2025). To fulfil this role and tackle these challenges of 'greening' and 'speeding up,' administrations urgently need scalable, evidence-based decision support systems.

To meet these requirements, urban planning authorities and decision-makers need accurate, up-to-date and comprehensive data. Traditional survey methods (terrestrial surveying, aerial surveys, local sensors) are often costly and updated at intervals that are too long to monitor dynamic changes. Satellite-based services (Earth observation – EO), in particular cost-free data, e.g. as provided by the European Copernicus programme, offer enormous potential in this regard. They provide continuous time series on parameters such as surface temperature, soil moisture and vegetation density. Nevertheless, practical experience shows that this potential has not yet been sufficiently exploited in municipal administration (Murgante et al 2024, Gulyás et al. 2025, Strand et al 2025).

A major obstacle to the integration of EO data is the discrepancy between large urban agglomerations and smaller municipalities. Large cities often have specialised GIS departments and budgets for commercial data, but face the challenge of complex inner-city structures and extreme pressure on land use. Small and medium-sized towns – the majority of Austrian municipalities – are often confronted with limited human resources and municipal finances, resulting in a lack of expertise to process raw data and budget for expensive software solutions. Therefore, the solution must not consist of providing even more raw data, but must lie in the development of tailor-made, cost-efficient services that can be directly integrated into existing administrative processes.

The Urban Sky research project addresses this topic. The aim is to identify the specific needs of stakeholders using a demand-driven approach in order to develop concepts for services supporting their urban challenges. The focus is on freely available data (open data) in order to lower the financial hurdle for local authorities.

This paper presents the results of the stakeholder process and the needs analysis. In order to derive recommendations relevant to action, this article addresses the following research questions:

(1) What challenges do Austrian cities face regarding urban and neighbourhood planning?

(2) How can satellite data help to solve these challenges?

(3) Taking into account spatial and temporal resolution, what additional data and information are required to effectively use satellite data to overcome these challenges?

3 METHODS

An initial literature research and review was conducted to gain an understanding of the field of satellite data and Earth observation for urban planning. The results were used to set up a first online Stakeholderworkshop, which aimed to gather information on the needs of cities´ representatives regarding their goal to become climate neutral cities. During the workshop, the participants were asked to consider their daily challenges and what they would like to change. The impressive variety of anwers enabled us in various internal workshops to come up with over 15 service concepts which have been prepared with descriptive texts and graphical abstracts and are currently being evaluated by our stakeholders in a comprehensive online survey. Based on the results, the best ranked ideas will be detailed in a second Stakeholderworkshop. For the prioritised ten final results, a roadmap will be developed including an assessment of added value, market potential, future research needs, and feasibility.

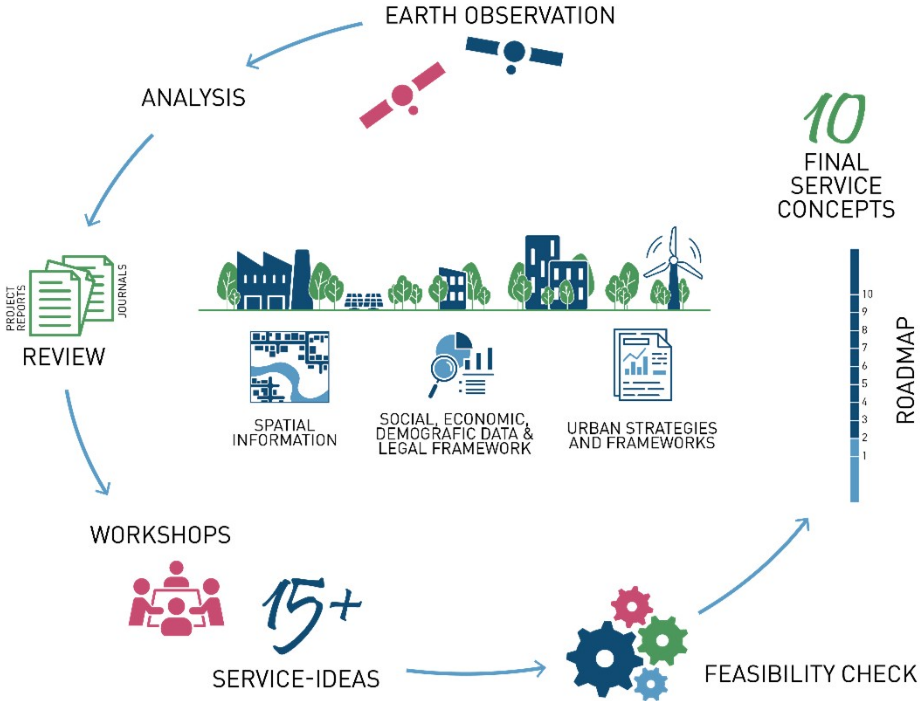

Figure 1: Urban Sky Project Plan © AIT

4 URBAN REQUIREMENTS AND PRIORITY FIELDS IN AUSTRIAN CITIES

Based on the literature review, the topics were clustered in priority fields that were used throughout the stakeholder process. Although there are overlapping areas, the priority fields help to classify and get an overview of most important topics for the cities: Urban Planning & Urban Climate, Buildings & Energy, Green Spaces & Biodiversity & Water management, Natural Hazards, Mobility & Infrastructure. The following section summarises the stakeholder inputs.

4.1 Results of the needs assessment

4.1.1 Priority Field: Urban Planning & Urban Climate

One of the main topics that were discussed during the stakeholder workshop was the field of "Urban Planning and Urban Climate". Throughout the conversations, climate-related risks emerged as a cross-cutting concern that should not be overlooked.

The following topics were highlighted in the discussions:

- The importance of systematic monitoring and assessment of urban heat islands and surface temperatures, with a particular focus on public spaces. Participants discussed the need for city-wide assessments considering perceived temperatures, shading conditions, cold air corridors and monitoring the quality of stay. This information is essential to identify priority areas for heat mitigation and support climate risk analyses at neighbourhood scale.
- The need to identify and reactivate brownfield sites and vacant urban areas including large, sealed surfaces such as parking lots and increasingly also privately-owned sealed green spaces. Sealed surfaces were highlighted as major heat traps and therefore high-priority targets for cooling-oriented reuse and redesign. For the participants it was important to prioritise adaptation, renovation, and climate-sensitive redevelopment over new greenfield construction, as well as monitoring changes in

land use, vacancy and unused spaces over time. Therefore, change detection was considered one interesting topic to be supported by using satellite time-series data.

- Additionally, monitoring of light pollution was discussed as an important topic as the view from above reveals unnecessary electricity use and shows where light can be reduced and energy saved.

4.1.2 Priority Field: Buildings & Energy

The field of Buildings & Energy was one of the central topics discussed during the stakeholder workshop as it is one of the main levers to reach the goal of climate neutrality and energy efficiency in cities. The following topics were discussed:

- Updating and improving existing building inventories, including the identification of conditioned and non-conditioned building areas was seen as essential to support reporting obligations under the revised Energy Efficiency Directive EED III (Directive (EU) 2023/1791), which requires member States to improve the availability and consistency of data on building energy performance.
- Closely linked to this, stakeholders highlighted the need for the detection of thermal energy losses through the building envelope to identify renovation priorities.
- The assessment of rooftop solar potential including shading was identified as crucial to assess seasonal yields to support the usage of renewable energy and strategic energy planning.
- In addition, the monitoring of green roofs was highlighted as an important climate adaptation measure. From an EO perspective, time-series analyses allow vegetation development and vitality to be monitored in a consistent and city-wide manner. This is relevant not only for building owners/tenants to assess, whether green roofs effectively contribute to heat mitigation, but also for city administrations to verify the performance of (potentially) subsidised measures, ensure the effective use of public funding, and support strategic planning and monitoring of urban climate targets.

4.1.3 Priority Field: Green Spaces & Biodiversity & Water management

The stakeholders ranked the priority field “Green spaces, Biodiversity and Water Management” as very important. This was particularly pertinent given the future tasks arising from the implementation and enforcement of the EU Nature Restoration Regulation (Regulation (EU) 2024/1991), a key element of the EU Biodiversity Strategy (European Commission, 2020). The discussions covered the following topics:

- Quantitative and qualitative mapping of tree populations (including tree species, crown diameter/tree canopy cover and height) and changes therein (such as tree health), with the aim of establishing a baseline in accordance with the EU Nature Restoration Regulation.
- Another closely related topic was efficient and sustainable irrigation management (smart irrigation), with a view to preserving tree health and adapting to changes of vegetation period. This included the question of automation.
- Green spaces, particularly trees, were regarded not only as a means of mitigating urban heat, but also as a steppingstone for establishing resilient biodiversity.

4.1.4 Priority Field: Natural Hazards

The topics discussed in the “Natural Hazards” priority field were diverse and naturally overlapped with those in other priority fields. There were overlaps, particularly in the “Green Spaces” priority field.

- The participants prioritised two topics regarding climate change: the small-scale monitoring of inner-city air temperatures, and the identification of areas where cold air forms.
- The monitoring and management of neophytes and invasive species (as a biological natural hazard) currently was mentioned as a contribution to biodiversity. However, the use of EO was questioned and deemed ineffective.
- Stakeholders also identified the assessment (and monitoring) of stormwater events or flooding in urban areas as essential (for assessing the risk situation, for designing danger zones, and for the

identification of gaps and lack of protective measures). However, it was noted that responsibility actually lies with higher levels of administration. The same applies to the topic of mass movements.

4.1.5 Priority Field: Mobility & Infrastructure

The focus area of "Mobility & Infrastructure" was a broadly discussed topic in the stakeholder workshop.

The main topics resulting from the exchange among workshop participants who came from various professional background regarding needs assessment for mobility can be narrowed down:

- Monitoring of commuting and traffic patterns, more specifically a request was to monitor long-term the change rate on the used traffic corridors and streets as well as the frequency of its use and the number and types of vehicles using which road when. This topic was also discussed from the perspective of congestion and traffic frequency, road utilization, peak times, and improvement of traffic flow.
- Monitoring the transit traffic in its amount and main routes used with the aim of developing seasonal deviation roads easing the main routes.
- Monitoring the intensity and frequency of utilization of parking lots by using multi-temporal satellite acquisitions (mornings, middays, evenings and nighttime) over a longer period to detect daily as well as weekly or seasonal patterns.
- Monitoring the traffic of cyclists to raise the share of modal split cyclists. E.g. systems for counting bicycles, traffic flow measurements with smart cameras have been discussed.
- CO_2 and energy accounting of traffic: Especially transport of goods and cargo, but also public transport and general transport of passengers. The assessment of this need focusses on measurement of plausible data instead of a model. The stakeholders mentioned punctual counts of passenger mobility and the use of telecommunication data as well as google analytics, the Google Mobility report or traffic models. The example Vorarlberg was mentioned, where a traffic behavior survey was conducted for the years 2008, 2013, 2017 and 2023 (Herry, 2024).

The focus area "Infrastructure" covered the following topics:

- Detection of infrastructure damages after extreme weather events, including the mapping of economic or monetary damage. Another perspective was the need to detect and prevent damage at an early stage, caused by excessive heat.
- There is a need to gather information on the thickness, density and persistence of snow cover for winter service and snow clearing units. This can be tied to weather and temperature scenarios including the local topography.
- Identification of parking lots which are not covered yet, as possible space for PV installation on roofs.
- Identification of gas leakages or damages along pipelines or power lines that could be caused by landslides, avalanches or storms.
- Mapping and regularly updating construction sites or road closures of each kind. This need includes regular updates on construction progress and compliance with regulations concerning deposit of sewage and construction waste.
- Monitoring the demolition of buildings for reusing its materials, to establish a proper recycling system, interim storage areas would be needed. This poses major difficulties within cities, but remote sensing can help identify brown field/fallow areas.

The following table summarises the five priority fields, and the key urban challenges identified for Austrian cities based on literature and stakeholder input.

Having established the main urban priorities and requirements from Austrian cities, the next step is to examine how current satellite-based applications can address these needs. Chapter 5 presents the key EO application domains identified in literature and international projects, providing a foundation for matching city priorities with usable Earth observation services.

Priority Field	Main Challenges	Typical EO-based use case[1]
Urban Planning & Climate	- Identification and monitoring of urban heat islands and heat stress in public spaces - Assessment of thermal comfort and quality of stay (perceived temperature) - Detection and constant monitoring of vacant areas	- Mapping of surface temperatures using EO data (Landsat, ECOSTRESS) - Identification of potential air corridors using 3D building models in combination with land cover and elevation data (Sentinel-2, LiDAR, DEMs) - Detection of vacant areas through land use classification and time-series analysis of satellite imagery (change detection) - Light pollution
Buildings & Energy	- Updating and improving building inventories - Detection of thermal energy losses to identify renovation needs - Assessment of rooftop solar potential, including shading and energy yield - Monitoring of green roofs	- EO-supported building inventory updates using Sentinel-2 and LiDAR data - Urban heat loss screening with thermal satellites (ECOSTRESS, Landsat) - Roof PV potential assessment combining optical imagery and LiDAR for shading analysis - Green roof monitoring using time-series NDVI (Normalised Difference Vegetation Index) from Sentinel-2
Green Spaces & Biodiversity	- Updating and improving green space/tree inventories - Efficient and sustainable irrigation management (smart irrigation)	- EO-supported green space/tree inventory updates using Sentinel-2 and LiDAR data - Using time-series NDVI for health monitoring of trees for maintenance and irrigation
Natural Hazards	- Small-scale monitoring of inner-city air temperatures - Identification of areas where cold air forms - Mass movement	- Validation with satellite data: ECOSTRESS (daily cycle), Landsat (long-term dynamics) or by future missions e.g. TRISHNA, LSTM - InSAR (Interferometric Synthetic Aperture Radar)
Mobility & Infrastructure	- Monitoring of commuting and traffic patterns (frequency, types of vehicles, peak times, congestion) - Detection of infrastructure damage after extreme weather events - Mapping and updating construction sites or road closures to support traffic management - Monitoring demolition of buildings and brownfield areas for potential material reuse and urban redevelopment	- Traffic pattern and congestion analysis using high-resolution optical imagery and Sentinel-2 time series - Post-event infrastructure damage assessment using Sentinel-1 SAR and optical data - Construction site and road closure monitoring through change detection on optical imagery and aerial photos - Identification of brownfield/fallow areas via high-resolution optical images and land-use data to support recycling and redevelopment initiatives

Table 1: Summary of Priority Fields, Key Urban Challenges and Relevant Earth Observation Data

5 EO-BASED APPLICATION DOMAINS IDENTIFIED IN LITERATURE AND PRACTICE

5.1 Overview of international EO-related urban projects and services

This section presents the main EO application domains identified in the scientific literature and international projects on using satellite data for urban decision-making in the context of climate-resilient cities. A literature analysis has been conducted, screening a total of almost 240 relevant projects and publications from various sources (publication databases, project databases, etc.). These were then clustered and the topics were visualised in a matrix (Figure 2). Among the sources were the FFG project database with a focus on the Austrian Space Application Programme (ASAP). The entire database was screened, and the Horizon Europe project databases were systematically reviewed. The ESA portfolio was also considered, particulary its demonstration projects and thematically relevant projects ("Infrastructure & Smart Cities") which were added to the list. Another source was a collection of ESA services which are continuously updated as a "living document". The "Urban EO Service Catalogue" (ESA, 2025a) lists a total of 17 services on urban heat (private access [11], public access [6]), 37 services on mapping urban areas (private access [29], public access [8]), and 15 services on air quality (private access [9], public access [6]). Recent activities originating from the Horizon project "Space4Cities" (Forum Virium Helsinki, 2025) were also reviewed. At the beginning of 2025, the project launched a €2.87 million call for proposals, and the winners have now been announced. Ten of the 20 selected consortia will now have the opportunity to further develop their solutions to common challenges in European cities, such as flood detection, identifying heat islands, reducing traffic emissions, preventing wildfire risks, protecting cultural heritage sites, locating underground pipe leaks, and monitoring the condition and changes of green spaces, bridges, and roads. The five best prototypes will then be tested in real-life situations in fifteen European cities from July 2026 to February 2027 (Space4cities, 2025).

5.2 Key thematic clusters identified in the literature

The urban planning theme covers projects that develop digital models (e.g. digital twins, 3D models) for analysing urban structures, vegetation areas and thermal properties, and for supporting planning decisions.

[1] Details on satellite technology see chapter 6.

They differ in their specific fields of application, which range from mapping green spaces, analysing the urban heat island effect and solar potential, improving urban resilience and adapt to climate change, optimising urban mobility and parking space utilisation, to automated mapping of land use and land cover (FFG 2026b; ESA, 2026), and supporting visually impaired people in urban areas. Projects in the field of heat islands deal with the combination of satellite data, meteorological information and climate models in order to obtain the most up-to-date or real-time picture possible of urban overheating areas (Cure-Copernicus, n.a; Geoville, 2025; LUP, n.a.; LAND, 2026). Surface temperature maps are created using satellite data or aerial survey data in order to provide cities with a basis for decision-making when planning green and blue infrastructure (Stadt Konstanz, 2025; UrbanFootprint, 2026). Covering the building domain, the creation of digital twins is common, both for individual buildings and for entire neighbourhoods (Buildspace Project, 2026). Projects adressing green spaces aim to monitor and optimise green spaces and their ecological functions (biodiversity, cooling potential, biotope areas, etc.) (BOKU, 2025; GrünStattGrau, 20, FFG 2026c). One project covering many of these aspects is the Green Transition Information Factory (GTIF), an ESA initiative designed to demonstrate the added value of EO. The Austrian GTIF currently covers various narratives tackling the named topics like Heat Risk Maps, High-Resolution Forecasts of Solar Potential and Extreme Temperature, Brownfield Recovery Potential, Wind Atlas, Urban Energy Performance Monitor (GTIF Austria, 2026).

In the field of natural hazards, projects focus on the early detection, monitoring, documentation and prediction of specific hazards such as forest fires or flooding, as well as on the creation of dynamic, comprehensive hazard maps. The projects differ in terms of the natural hazard they address, such as fire, water or mass movements, the level of detail in the analysis (from large-scale monitoring to specific hazard locations such as aquaplaning) and the focus of application (real-time warning, support for authorities, traffic safety, dynamic mapping) (FFG, 2026a; Joanneum, 2025; FFG, 2026d).

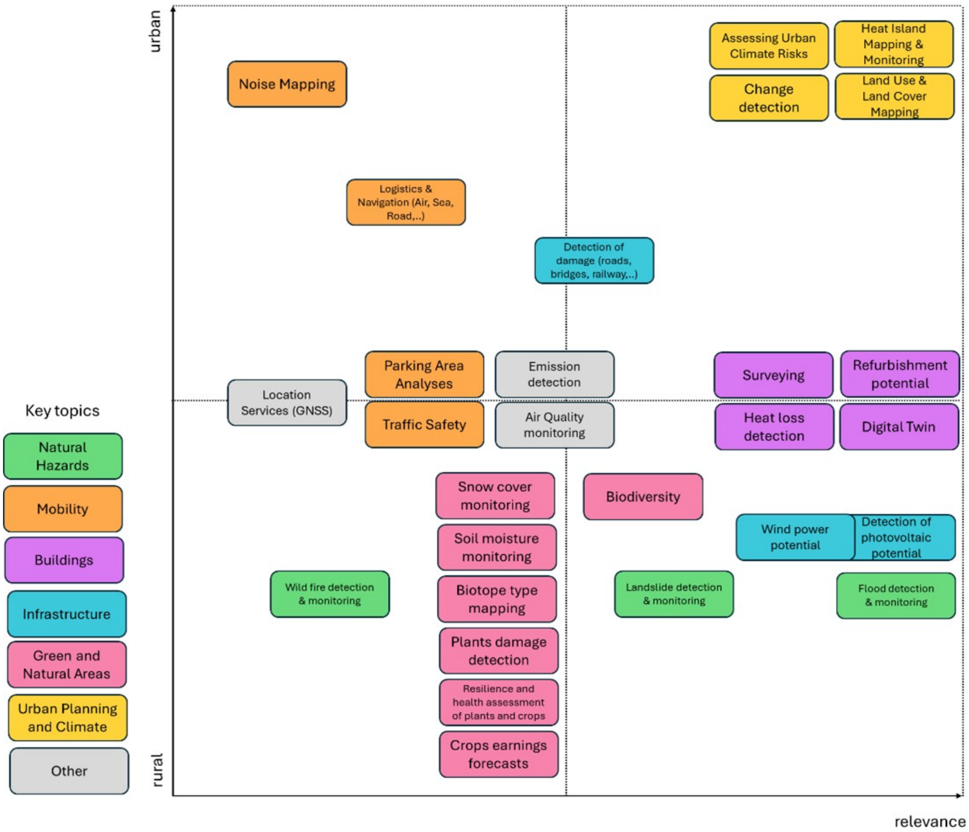

Figure 2: Illustration of the subject areas narrowed down into relevance, rural and urban focal points © AIT

Projects in the field of mobility and infrastructure aim to optimise and secure transport systems and monitor infrastructure. The applications range from high-precision positioning for accident prevention and route optimisation for cyclists to satellite-based detection of available parking spaces and road conditions. Due to space constraints only two of the 22 identified projects covering mobility are quickly mentioned. Firstly, SatPark is a completed FFG project from 2019 covering georeferencing, identification and classification of vehicles based on satellite data to enable improved parking space analysis and navigation (FFG, 2026e). Secondly, ESERCOM-D is a project concerning the implementation of satellite-based data to support greener and smarter road usage, optimise road maintenance, and enhance traffic safety (EU-Project, 2026). In addition, solutions are being developed for the management of infrastructure assets such as power grids, street lighting and dams in order to improve their maintenance and resilience. In the literature analysis 17 projects and services have been identified that are within the field of infrastructure monitoring. For example, the FFG project RAVEN developed a radar-technology-based methodology for detecting structural and ground movement changes in urban buildings, enabling improved monitoring of infrastructure stability and early warning capabilities (FFG, 2026e).

The literature review confirms a strong alignment between international EO-based urban services and the needs expressed by Austrian cities, particularly in the domains of urban climate, buildings, and natural hazards. However, gaps remain regarding spatial resolution, operational integration into municipal workflows, and long-term sustainability of services.

6 SATELLITE DATA SUPPORTING URBAN DECISION-MAKING

6.1 Relevant satellite data types for urban applications

Optical, radar (SAR) and thermal satellite data each provide unique strengths and are suited for specific applications. To address the complexity of urban planning tasks, they are often combined to facilitate the complementary information content, which they provide.

Due to often limited resources in cities, they need to pay attention to costs. Therefore, for urban applications, it is crucial to distinguish between freely available satellite data and commercial datasets. Open-access Copernicus missions such as Sentinel-1 SAR and Sentinel-2 optical provide consistent, long-term time series with high temporal coverage, making them well suited for continuous monitoring and trend analysis for cities. Thermal open access data such as e.g. ECOSTRESS can be applied to assess urban heat dynamics such as e.g. UHI mapping and heat stress analysis. Commercial datasets such as Pléiades (Airbus, 2026) offer very high spatial resolution and are valuable for detailed analyses at building or object level. Due to higher costs and task-based acquisitions, they are typically used selectively, complementing freely available data where finer spatial detail is required.

6.2 Future satellite missions and their potential for urban applications

While these currently operational satellites already provide valuable data for urban applications, a new generation of satellite missions, both public and commercial, will significantly expand the availability of high-resolution, freely accessible, and near-real-time Earth observation data. These missions will provide a valuable addition to existing satellite missions, thereby offering Austrian cities enhanced capabilities for monitoring, analysis, and decision-making. The main new satellite missions are:

- TRISHNA (Thermal Infra-Red Imaging Satellite for High-Resolution Natural Resource Assessment): A French-Indian mission scheduled for launch in 2026, TRISHNA will provide thermal data at 57 m resolution, bridging the gap until Sentinel-8 LSTM becomes operational. Its focus on water resources and land surface temperature makes it highly relevant for heat stress monitoring (CNES/ISRO, 2025).
- Sentinel-8 LSTM (Land Surface Temperature Monitoring): Planned for launch in 2029, LSTM will deliver land surface temperature data at 30–50 m resolution with revisit times of 1–3 days. These EO data will be crucial for monitoring urban heat islands, energy efficiency, and climate adaptation strategies (ESA, 2025b).
- ROSE-L (Radar Observing System for Europe in L-band): Expected launch in 2028, ROSE-L will operate in the L-band, enabling penetration through vegetation and cloud cover. With 5–10 m resolution and revisit times of 3–6 days, it will support applications such as infrastructure monitoring, flood risk assessment, and land cover monitoring (ESA, 2025b).
- NISAR (NASA-ISRO Synthetic Aperture Radar): already launched in 2025, NISAR offers comparable L-band SAR capabilities as ROSE-L, providing early access to datasets relevant for European urban resilience planning (for details see: NASA, 2025).

- FireSat: Developed by the Earth Fire Alliance with partners including Google Research, FireSat aims to deliver near-real-time global fire detection with a 20-minute revisit cycle when the full constellation is operational. The first protoflight satellite launched in March 2025, and the system will expand in coming years (Earth Fire Alliance, 2025).
- HotSat Constellation (Satellite Vu): Following the HotSat-1 demonstrator (2023), HotSat-2 and HotSat-3 are planned for launch soon. These satellites allow monitoring of heat stress and detection of heat losses in buildings and industrial facilities, supporting energy efficiency measures in cities (SatVu, 2025).
- CO3D (Constellation Optique 3D): Jointly developed by Centre national d´études spatiales (CNES) and Airbus Defence and Space, CO3D was already launched in 2025, and the commercial phase is expected to begin in 2027. It will generate high-resolution 3D surface models, enabling systematic urban morphology analysis and supporting spatial planning. Global coverage is expected within 3–5 years, with annual updates for priority regions (CNES, 2025).

The integration of these missions into Austrian urban planning frameworks offers several opportunities for Urban Climate Resilience:

- Enhanced monitoring of heat islands, water resources, and vegetation.
- Improved early warning systems for floods and fires.
- Detailed 3D urban models for infrastructure resilience and redensification strategies.
- Support for compliance with EU regulations such as the Nature Restoration Regulation.

Together, these missions represent a paradigm shift in satellite-based services, enabling cities to access actionable, high-resolution data for climate-resilient developments. Combined with existing Copernicus datasets and local geodata, this information forms the backbone of future applications and can now be turned into practical services to address municipal priorities, as presented exemplarily in the next chapter.

7 SERVICE DEVELOPMENT

7.1 Translation of requirements into service concepts

Based on the first Stakeholderworkshop, the consortium developed over 15 initial service concepts that directly address the priority fields identified by Austrian cities. The concepts cover a range of urban challenges, including climate resilience, energy efficiency in buildings, mobility and infrastructure, and natural hazard monitoring. These concepts were briefly described with graphical abstracts and evaluated by stakeholders through an online survey providing feedback on relevance, feasibility, and potential impact. This participatory approach ensured that the concepts reflect real municipal needs and priorities. For example, some ideas already highlighted ways to monitor urban heat hotspots or assess rooftop solar potential – practical services that cities could implement. The most promising concepts will be refined in a second workshop and translated into a roadmap, including their potential value, feasibility, and research needs. This process ensures that the resulting services are actionable, relevant, and ready to support decision-making in Austrian cities.

7.2 Legal, regulatory and organizational considerations

Legal, regulatory and organisational aspects play a crucial role in determining whether EO-based services can be operationally adopted by cities. Rather than acting as barriers, these framework conditions define boundary conditions that must be systematically considered during service design, implementation and long-term operation.

Within the Urban Sky project, the legal framework is primarily shaped by European and national regulations governing data protection, data governance, environmental monitoring and the use of geospatial information. A central element is compliance with the General Data Protection Regulation (GDPR), particularly where EO-derived data is combined with auxiliary datasets that could enable the identification of individuals or sensitive urban patterns. Objects or locations captured in very high-resolution imagery that can be linked to specific individuals – such as homes, vehicles, or other personal property – constitute personal data under the GDPR. Although EO data are typically non-personal, downstream processing, data fusion and spatial resolution must be carefully assessed to avoid indirect personal data inference. Consequently, privacy-by-design and data minimisation principles are integral to the development of Urban Sky services.

In addition, the regulatory environment for spatial data infrastructures plays a significant role. The INSPIRE Directive (Directive 2007/2/EC) establishes common standards for the harmonisation, interoperability and sharing of geospatial data across public authorities within the European Union.

From an environmental and urban governance perspective, EO-based services operate within a framework of sector-specific regulations related to climate adaptation, air quality, land use planning and disaster risk management. In this context, the EU Nature Restoration Regulation (Regulation (EU) 2024/1991), which entered into force in 2024, introduces legally binding targets for the restoration of degraded ecosystems, including those located in urban and peri-urban areas. Organisational considerations are closely intertwined with the legal framework. The adoption of EO-based services requires clear role definitions between data providers, service operators and municipal end users. Responsibilities related to data stewards, quality assurance, liability and long-term maintenance must be contractually defined to ensure sustainability.

In summary, the legal and organisational framework provides a structured environment that shapes service development and deployment. By addressing these conditions proactively, Urban Sky aims to ensure regulatory compliance, institutional acceptance and long-term usability of EO-based services for urban decision-making, thereby supporting their transition from pilot applications to operational tools within city administrations.

7.3 Example Services

While this paper focuses on cities needs and the development and evaluation of the services, an analysis of their potential economic benefits for cities and stakeholders will be addressed in follow-up work. Nevertheless, two example service concepts are briefly described here to provide an idea of the direction.

7.3.1 Heat Dynamics

The service aims at enabling automated recording and analysis of spatio-temporal heat dynamics in urban areas in Austria. It provides cities with detailed insights to assess urban thermal stress and serves as a decision-making aid for urban planning and climate adaptation. The service combines multiple freely available datasets to ensure accurate and actionable results. This includes thermal satellite time series from ECOSTRESS, TRISHNA, Landsat, and in the future ESA-LSTM, calibrated and validated with meteorological station data from GeoSphere Austria. Additionally, Sentinel-2 optical imagery, land use data from zoning plans or the Copernicus Urban Atlas, aerial imagery, and LiDAR-based terrain and vegetation models are integrated to capture the urban landscape in detail. By merging these sources, the service identifies heat hotspots, monitors changes over time, and provides practical guidance for urban planners aiming to reduce thermal stress.

7.3.2 Remote sensing for the implementation of the EU Nature Restoration Regulation in cities

The aim of the service is to assess and support the restoration of urban ecosystems in Austria based on satellite remote sensing. The focus is on implementing Article 8 of EU Nature Restoration Regulation, in particular ensuring "no net loss" of urban green spaces and tree canopy cover by 2030. It integrates multiple freely available datasets to provide accurate and actionable insights. These include Sentinel-2 optical time series, land use data from zoning plans, the Copernicus Urban Atlas, aerial imagery and LiDAR, and the LUCAS land cover inventory (Eurostat, 2026). By combining these sources, the service derives ecological indicators, monitors changes over time, and guides planning and management decisions for greener, healthier urban environments.

8 CONCLUSION AND OUTLOOK

Based on the current findings of this study, satellite-based EO has strong potential to support cities on their way to climate-neutrality by providing consistent and spatially accurate information for planning, monitoring and decision-making. Freely available EO data already enable cities to better assess their key challenges such as heat stress, maintaining green infrastructure, detecting natural hazards, identifying buildings and tracking land use changes over time in a transparent and comparable way.

A key advantage of satellite data lies in the nature of the data itself, which makes it usable by stakeholders from different sectors: Mostly freely available access, automated and frequent updates, a holistic view from top and the ability to visualise continuous areas. This enables satellite data to be applied and transferred to all fields of application that benefit from change detection and continuous monitoring, spatially and temporally. Due to changing legislations on monitoring and reporting obligations, satellite data technology is becoming increasingly relevant.

To maximise the user uptake of the ESA Programme (e.g. Copernicus and Galileo) and address gaps in spatio-temporal resolution, the project is moving towards a multi-modal data fusion strategy for the considered services. This strategy synthesises freely available Copernicus and Galileo data, as well as non-remotely sensed data (e.g. socio-economic and/or environmental data), and considers commercial satellite products. Integrating non-remotely sensed data is essential, because satellite sensors alone cannot provide the services needed to adress cities´ specific needs. Adding, combining and layering data from multiple sources enables the development of services which might allow to monitor rapid, localised events, that would otherwise remain undetectable by single-sensor platforms or single data sources, and to respond to them in a timely manner.

Using satellite data strengthens transdisciplinary collaboration both horizontally across municipal departments and vertically between different administrative units and economic actors. In this context, start-ups and specialised service providers play an important role as experts in providing satellite data understanding and following the fast changes in this rather young technology. Public administration can benefit from the fast advancements of the Earth observation sector in terms of data-based decision-making and completely new perspectives on data collection.

So far, there is still a lack of communication and common ground between data providers, researchers and end users such as in public administration. This means that offered services often do not align with the requirements of public administration and are therefore less likely to be implemented and a fix component of running systems. For this reason, the Urban Sky project plays a valuable role in ensuring the practical applicability of solutions developed using satellite data.

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