Sustainable Cities and Communities: Which Role for CubeSats?

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Abstract

The paper discusses the role of CubeSats in advancing sustainable cities and communities, emphasizing their value in urban monitoring. CubeSats, small and cost-effective satellites, enable near-real-time Earth Observation (EO), providing crucial geospatial data for managing urban environments. Their modular design facilitates flexibility in various applications. Organized in constellations, CubeSats can deliver high revisit frequencies, enhancing temporal resolution critical for dynamic urban analyses.
The study highlights the proliferation of CubeSats, including their distribution across countries and organizations, which now include private companies, universities, and non-profits, alongside traditional space agencies. Their affordability has democratized space access, enabling participation from developing nations and diverse institutions. Despite individual satellites' limitations in spatial and temporal resolution, CubeSat constellations significantly improve urban EO data quality.
Key applications of CubeSats in urban settings include currently monitoring air quality, urban heat, vegetation health, and greenness, offering insights into public health and environmental well-being. Their utility spans urban planning, disaster management, and carbon sequestration.

1. Introduction

In an era marked by rapid urbanization, digital twin models and the emerging urban metaverse are vital tools for addressing complex environmental and socio-economic challenges in cities. To effectively manage these dynamic urban environments, comprehensive geospatial data and advanced geoAI models are essential, and CubeSats—small, low-cost satellites—offer innovative solutions by expanding access to near-real-time Earth Observation (EO) data.

The first CubeSats for Earth observation were simple in their design and supposed to demonstrate the viability of small, low-cost satellites for monitoring the Earth.

QuakeSat (launched in 2003) was a 3U CubeSat developed for geophysical research to monitor Extremely Low Frequency (ELF) signals, which were believed to be linked to earthquake precursors. It was built by a company (Quakefinder) in collaboration with Stanford University; the mission lasted 1 year and a half (QuakeFinder, 2010).

BeeSat (Berlin Experimental and Educational Satellite) was a cubesatellite project of the Technical University of Berlin developed in 2009 mainly for educational purposes (eoPortal, 2025a).

The CINEMA (CubeSat for Ions, Neutrals, Electrons, and Magnetic Fields) was developed to study the Earth's magnetosphere and it was a collaboration between the University of California, Berkeley, Imperial College London, KHU (Kyung Hee University) NASA/ARC (Ames Research Center). The first satellite of this series was launched in 2012 and it was a 3U CubeSat (eoPortal, 2025b).

Lemur-1 launched in 2014 by the company Spire Global, carried two Earth-observation payloads: an electro-optical imaging system, operating in the visible band with a ground resolution of approximately 5m and a low-resolution IR imaging system, with an approximate ground resolution of 1km. In the following years, more Lemurs were launched and their main aim is weather monitoring and maritime navigation data collection (Kulu, 2025c).

Dove 1 (Kulu, 2025b), developed by Planet Labs (now Planet)(Planet Labs, 2025c) as a technology demonstrator and launched in 2013, marked the beginning of the commercial use of CubeSats for Earth observation. Since then, Planet has launched numerous Dove satellites, followed by SuperDove, an upgraded version of the original Dove. The temporal resolution of the constellation, which comprises various Flocks (groups of satellites, as detailed in Table 1), is one day. They operate in Sun-synchronous orbits at altitudes ranging from 475 km to 525 km, with an orbital inclination of 98°. These orbits ensure they cross the equator at local solar times between 9:30 and 11:30 AM. The image resolution ranges from 3 to 5 meters, depending on the satellite type. These satellites are equipped with either 4-band multispectral sensors or 8-band sensors (see Table 2) (Planet Labs, 2023).

Although it is not a CubeSat but rather part of the SmallSat family (probably around 150 kg in weight and 1 meter in length, although detailed information is not available), it is noteworthy that during the launch of the latest Flock of SuperDove satellites on August 16, 2024, Planet also launched its first hyperspectral satellite, Tanager-1. This satellite is designed to provide hyperspectral data for both Planet and Carbon Mapper (Mapper, 2025), which is a non-profit organization involving Planet, NASA's Jet Propulsion Laboratory (JPL), the State of California, the University of Arizona, Arizona State University, RMI, and various philanthropic sponsors. Carbon Mapper is dedicated to identifying, quantifying, and monitoring global methane and carbon dioxide (CO_2) emissions. Tanager-1 is equipped with visible and infrared imaging spectrometers developed by NASA's JPL, capable of delivering data at a resolution of 30 meters per pixel. It is designed to provide comprehensive, accurate, and timely measurements of methane, carbon dioxide, and other environmental indicators. Covering a spectral range of 400–2500 nm with more than 420 spectral bands, the satellite

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Satellite/ Constellation	Launch	No. sat launched	Status
Dove 2	Apr 2013	1	R
Dove 1	Apr 2013	1	RE
Dove 3	Nov 2013	1	R
Dove 4	Nov 2013	1	FD
Flock 1	Jan 2014	28	RE
Flock 1c	Jun 2014	11	R
Flock 1b	Jul 2014	28	RE
Flock 1d	Oct 2014	26	FL
Flock 1d’	Jan 2015	2	RE
Flock 1e	Apr 2015	14	RE
Flock 1f	Jun 2015	8	FL
Flock 2b	Aug 2015	14	RE
Flock 2e	Dec 2015	12	O
Flock 2e’	Mar 2016	20	O
Flock 2p	Jun 2016	12	O
Flock 3p	Feb 2017	88	O
Flock-3p’	Jan 2018	4	D
Dove Pioneer	Jan2018	1	D
Flock-3r	Nov 2018	16	O
Flock-3s	Dec 2018	3	O
Flock 3k	Dec 2018	12	O
Flock-4a	Apr 2019	20	O
Flock 4p	Nov 2019	12	O
Flock-4e	Jul 2020	5	FL
Flock-4v	Sep 2020	26	O
Flock 4e’	Oct 2020	9	O
Flock 4s	Jan 2021	48	O
Flock 4y	Jan 2023	36	O
Flock 4x	Jan 2023	44	O
Flock 4q	Nov 2023	36	O
Flock 4BE	Aug 2024	36	O

Table 1. Planet Satellites/Constellations, Launch Dates, Number of Satellites, and Current Status. (extrapolated from: https://www.eoportal.org/satellite-missions/planetspacecraft) (R = Retired; RE = REentered; Failed Deployment = FD; Failed Launch = FL; Operational = O; Decayed = D).

achieves a weekly revisit rate.

CubeSats have increased in number (see Figure 1 - these statistics and the following are extrapolated from (Kulu, 2024) and have evolved significantly since these early missions. Today, they play a crucial role in Earth observation for various applications, including climate monitoring, disaster response, and urban planning.

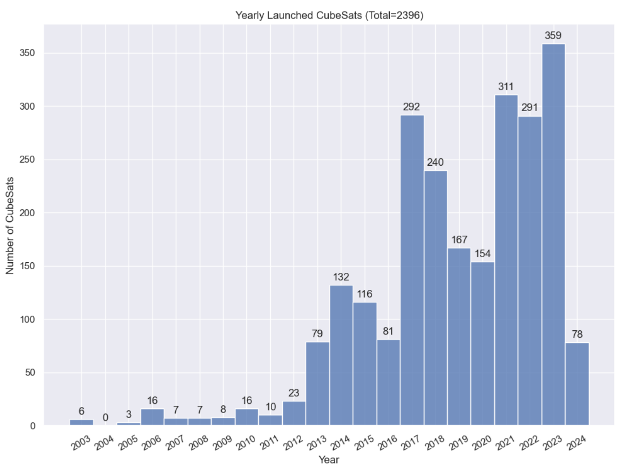

Figure 1. CubeSat launched in the years (extrapolated from (Kulu, 2024)).

This paper presents the current status of the exploitation of CubeSats focusing specifically on applications of interest for sustainable cities and communities.

Dove-Classic (PlanetScope-0) spectral bands (nm)	Blue: 455 - 515 Green: 500 - 590 Red: 590 - 670 NIR: 780 - 860
Dove-R (PlanetScope-1) spectral bands (nm)	Blue: 464 - 517 Green: 547 - 585 Red: 650 - 682 NIR: 846 - 888
SuperDove (PlanetScope-2) spectral bands (nm)	Coastal Blue 431-452 Blue: 465-515 Green I: 513. - 549 Green: 547. - 583 Yellow: 600-620 Red: 650 - 680 Red-Edge: 697 - 713 NIR: 845 - 885

Table 2. Spectral bands of Dove satellites.

2. Definition for CubeSats

The terminology used for CubeSats and small satellite categories generally relates to their mass and size. Concerning their mass, we can distinguish the so-called small satellites (less than 500 kg) among:

1. **Zeptosatellites**: satellites with weights between 0.1 g and 1 g; Attosatellites: satellites with weights between 1 g - 10 g; Femtosatellites: satellites with weights between 10 g and 100 g. As an example, Cornell’s Space Systems Design Studio has been developing satellites of this mass, named ChipSats , since 2006 (CubeSat, 2025).
2. **Picosatellite**: satellites with weighs between 100 g and 1 kg. These satellites are often used for testing very lightweight components or for highly specific, low-power applications.
3. **Nanosatellite**: satellites with weighs between 1 and 10 kg. These satellites are larger than picosatellites but still small enough to be launched in groups or ”swarms.” Nanosatellites are commonly used in research, remote sensing, and communication tasks.
4. **Microsatellite**: satellite with weighs between 10 and 100 kg. Microsatellites offer greater capacity for instrumentation and power compared to nanosatellites, allowing for more complex missions, including Earth observation and scientific research.
5. **Minisatellite**: satellite with weighs between 100 and 500 kg. They do not fall under the category of Cubesats.

The CubeSat is a type of small satellite, defined by its standardized modular units (U), where each unit is a 10 cm cube. CubeSats can range in size from 0.25U to 27U, with weights from approximately 0.1 to 40 kilograms. According to the previous definition, small satellites, including micro ones, can theoretically belong to the CubeSat category.

Common CubeSat sizes include (see Figure 2):

- 1U CubeSat: Measures 10 cm x 10 cm x 11.35 cm.
- 2U CubeSat: Measures 10 cm x 10 cm x 22.70 cm.
- 6U CubeSat: Measures 20 cm x 10 cm x 34.05 cm.

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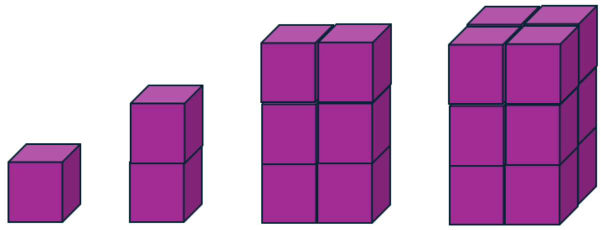

Figure 2. 1U, 2U, 6U and 12U Cubesats.

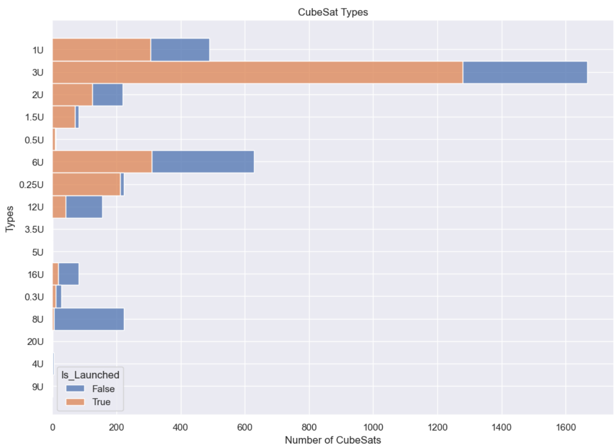

Figure 3. 1U, 2U, 6U and 12U Cubesats.

- 12U CubeSat: Measures 20 cm x 20 cm x 34.05 cm.

even if the most common size is 3U, as visible in Figure 3.

CubeSats for Earth Observation are similar to other CubeSats, with the vast majority of those launched falling within the 3U configuration.

3. Distribution of CubeSats by type of organizations and countries

The CubeSats currently in orbit and those planned have been analyzed in terms of their geographical distribution and the types of organizations to which they belong. The statistics reveal the emergence of new players, such as some developing countries, and new types of organizations. Alongside traditional space agencies, private companies are becoming a significant player in the CubeSat sector, with some cases involving universities, research centers, and non-profit organizations.

Organization Type	Count
Company	1445
University	614
Military	103
Space agency	85
Non-profit	72
Institute	62
School	14
Individual	1

Table 3. Launched CubeSats by organization types (extrapolated from (Kulu, 2024)).

Figure 4 shows the percentage of entities that have been key players in the launch of CubeSats, while the absolute value is reported in Table 3. Figure 5, on the other hand, illustrates the temporal evolution, revealing a clear upward trend as well as a stronger involvement of universities (the year 2024 is not significant because the data available for statistics only extends up to May).

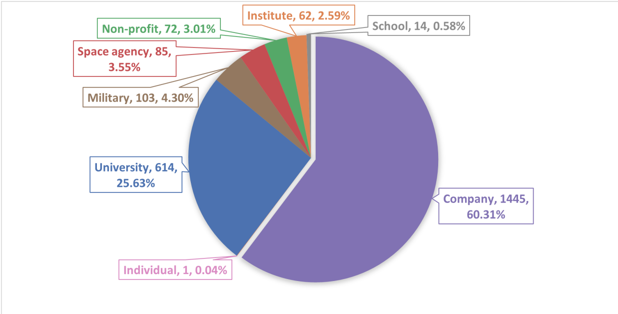

Figure 4. Launched CubeSats by organization types (extrapolated from (Kulu, 2024)).

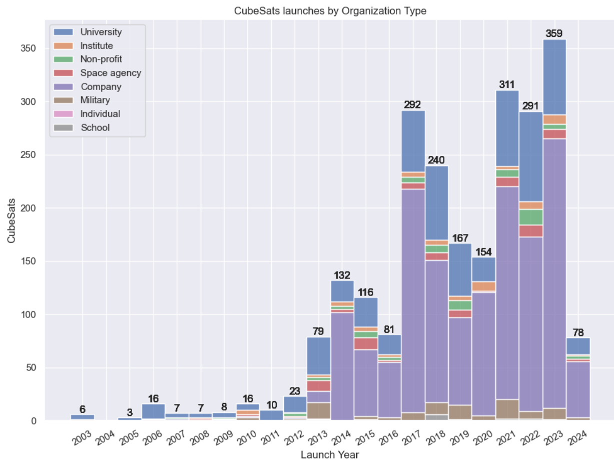

Figure 5. Time evolution of launched Cubesats launched by organization type (extrapolated from (Kulu, 2024)).

A key driver in the increase of entities that have been key players in the launch of CubeSats can be due to the support of Space agencies, offering resources for development and launch. NASA’s CubeSat Launch Initiative (CSLI) (NASA, 2025a) supports U.S. educational and non-profit organizations with low-cost access to space missions. CSLI selects proposals annually, focusing on educational impact and alignment with NASA’s Strategic Plan, pairing selected CubeSats with launches through ELaNa missions. Over 150 CubeSats have been launched on more than 40 ELaNa missions, involving 200 missions from more than 100 organizations in 42 U.S. states. Selected organizations must independently fund CubeSat production but may collaborate with industry or academic partners for resources.

ESA’s ”Fly Your Satellite!” (European Space Agency, 2025a) program supports educational CubeSat projects, with recent missions including Ireland’s EIRSAT-1, Portugal’s ISTSat-1, and Spain’s 3Cat-4. ESA offers development facilities and expertise to university-led projects, emphasizing educational outcomes. Japan’s JAXA and other space agencies also runs CubeSat programs, fostering development and testing of nanosatellite technologies. These programs promote hands-on STEM education, innovation, and global collaboration in space research. As an example, Figure 6 reports the number of Cubesats selected by CSLI as of August 2024.

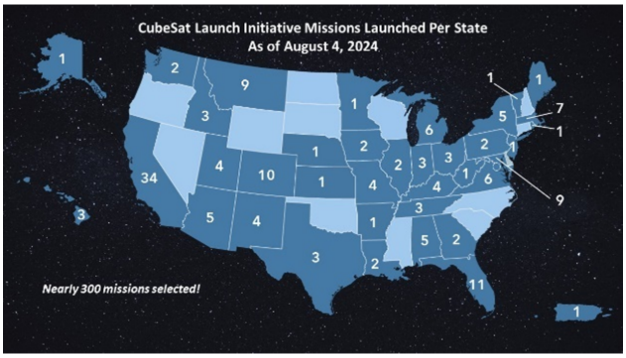

Figure 6. Number of CSLI selections by state as of Aug. 4, 2024. (source: https://www.nasa.gov/cubesat-launch-initiative-introduction/).

Organization	Count
Planet Labs	592
Swarm Technologies	213
Sky and Space	211
Spire	188
NASA Ames Research Center	55
Aerospace Corporation	36
Astrocast	32
Astro Digital	31
Sitronics Group	29
Apogeo Space	29

Table 4. Number of CubeSats launched per organization (extrapolated from (Kulu, 2024)).

Referring to the most active actors in the world of CubeSat, beside the already mentioned Planet Lab, other relevant organizations (Table 4) are Swarm Technologies, Sky and Space and Spire. Among them, the Planet are the most interesting referring to Earth Observation.

Lastly, an important aspect to highlight is the geographic distribution of organizations contributing to CubeSat strategy development. Table 5 presents the count and percentage of satellites launched by country.

Location	Count	%
US	1975	52%
Europe	975	26%
Russia	150	4%
Japan	115	3%
China	112	3%
Canada	73	2%
South and Central America	62	2%
Africa	37	1%
India	31	1%
Rest of the World	289	8%

Table 5. CubeSats launched per country (extrapolated from (Kulu, 2024)).

Clearly, by 2024, the country that relies most on CubeSats is the US, even though this new technology has enabled many more nations to experiment with their first space endeavors by launching a CubeSat as their first satellite (see Table 6).

Many satellites, especially of non-spacefaring nations, were developed and launched in the frame of the BIRDS program (named Joint Global Multi-Nations Birds Satellite project), primarily supported by the Kyushu Institute of Technology (KIT) in Japan, which provided technical guidance and support.

Country	Satellite name	Launch Year
Columbia	Libertad 1	2007
Switzerland	SwissCube	2009
Hungary	Masat-1	2012
Romania	Goliat	2012
Poland	Pwsat 1	2012
Ecuador	NEE-01 Pegaso	2013
Estonia	EstCube 1	2013
Peru	PUCPSat-1	2013
Lithaunia	LitSat 1	2014
Lithaunia	LitaunicaSat 1	2014
Uruguay	Antelsat	2014
Iraq	Tigrisat	2014
Finland	Aalto 2	2017
Bangladesh	BRAC Onnesha	2017
Ghana	Ghanasat-1	2017
Mongolia	Mazaalai	2017
Slovakia	SKCUBE	2017
Latvia	Venta-1	2017
Kenya	1KUNS-PF	2018
Costa Rica	Irazu	2018
Bulgaria	EnduroSat One	2018
Bhutan	BHUTAN-1	2018
Jordan	JYAT (JO-97)	2018
Sri Lanka	Raavana 1	2019
Nepal	NepaliSat-1	2019
Rwanda	RWASAT-1	2019
Guatemala	Queztzal-1	2020
Slovenia	TRISAT	2020
Monaco	OSM-1 CICERO	2020
Paraguay	GuaraniSat-1	2021
Zimbabwe	ZIMSAT-1	2022
Uganda	PearlAfricaSat-1	2022

Table 6. List of CubeSats launched as the first national satellite.(Cho, 2021)

The Japan Aerospace Exploration Agency (JAXA) offered logistical and technical assistance, facilitating satellite launches via the International Space Station (ISS). The United Nations Office for Outer Space Affairs (UNOOSA) played a key role in enabling non-spacefaring nations to participate through its UNOOSA-JAXA program. SpaceX contributed by launching the satellites aboard Falcon 9 rockets as part of its Cargo Resupply Missions (CRS). Participating countries, including Ghana, Bangladesh, Mongolia, Bhutan, Malaysia, and the Philippines, developed satellites with support from local universities and space agencies. Identical 1U Cubesat characterized the 5 phases of the BIRDS:

- BIRDS-1: 5 satellites by Bangladesh*, Ghana*, Japan, Mongolia*, and Nigeria (Figure 7)
- BIRDS-2: 3 satellites by Bhutan*, Malaysia and Philippine
- BIRDS-3: 3 satellites by Japan, Sri Lanka* and Nepal*
- BIRDS-4: 3 satellites by Japan, Philippine and Paraguay*
- BIRDS-5: 3 satellites by Japan, Zimbabwe* and Uganda*

where the (*) denotes that it is the first satellite of the country. Many of these satellites are equipped with Earth observation instruments, including multispectral cameras.

4. CubeSats and Instruments for Earth Observation

The number and types of Earth Observation (EO) instruments on CubeSats remain limited due to their small size, but ad-

Figure 7. CubeSats launched in the frame of BIRDS1 (source: https://www.nanosats.eu/sat/toki).

Satellite	Launch year
GHGSat-D (Claire)	2016
GHGSat-C1 (Iris)	2020
GHGSat-C2 (Hugo)	2021
GHGSat-C3 (Luca)	2022
GHGSat-C4 (Penny)	2022
GHGSat-C5 (Diako)	2022
GHGSat-C6 (Mey-Lin)	2023
GHGSat-C7 (Gaspard)	2023
GHGSat-C8 (Océane)	2023
GHGSat-C9 (Juba)	2023
GHGSat-C10 (Vanguard)	2023
GHGSat-C11 (Eliott)	2023

Table 7. GHGSat operational.

vancements are progressing rapidly. Although a single satellite generally does not provide impressive performance in terms of spatial and temporal resolution, the low cost of the satellite typically allows for the management of satellite constellations, which drastically improve the temporal resolution of available observations.

The following section provides a summary of the current status of CubeSats in relation to various Earth observation sensing technologies. In certain cases, where technologies remain in the experimental phase, information is either scarce, incomplete, or inconsistent. Significant efforts have been made to gather the most reliable data available from online sources.

Optical cameras are the most common instruments on CubeSats, fitting into 2U to 6U configurations depending on resolution. Examples include Planet Labs' Dove satellites, which we have seen in the previous sessions.

Another notable instrument is the spectrometer, whose relevant example is represented by the GHGSat constellation. GHGSat uses 2U to 6U CubeSats, each weighing 15 kg, to monitor methane and carbon dioxide emissions worldwide. The constellation, operational since 2016, provides high-resolution data critical for climate action. By now, 12 satellites are in orbit (see Table 7), with 4 more planned for next years, increasing the fleet to 16 units. These satellites operate at altitudes of 512–550 km, with a 14-day revisit cycle and orbital inclinations of 97.3° to 97.5°.

Focused on methane detection from industries such as oil & gas, mining, and agriculture, GHGSat helps mitigate emissions from one of the most impactful greenhouse gases. With a resolution of 25 meters and global coverage, GHGSat satellites enable actionable insights for industries, governments, and researchers.

To access GHGSat data is possible to visit the GHGSat website (GHGSat, 2025) for data services and tasking requests, focusing on greenhouse gases like methane and CO_2; an API is also available. An intriguing alternative for researchers, though currently unavailable, is the ESA Earth Observation Portal. GHGSat data is expected to be accessible through the ESA Third Party Mission (TPM) program (European Space Agency, 2025e). GHGSat joined ESA's renowned Earthnet TPM program in 2022. While GHGSat data was previously available upon submission and approval of a project proposal, the evaluation of new proposals is currently on hold, even if efforts are underway to renew the agreement with the TPM provider.

Shifting focus now to a different technology, the development of CubeSats equipped with Synthetic Aperture Radar (SAR) for Earth observation remains highly constrained by significant technical challenges. These challenges include the substantial power consumption required for radar operations and the necessity of large antennas to achieve sufficient spatial resolution.

Efforts to miniaturize SAR systems are primarily in the experimental and technological research phases. For example, NASA JPL's RainCube (Jet Propulsion Laboratory, 2025), a 6U CubeSat weighing 12 kg, served as a demonstrative project featuring a Ka-band weather radar. Another initiative, Umbra SAR (eoPortal, 2025d), developed by Umbra Labs, focuses on small SAR systems aimed at extreme miniaturization, although the operational versions currently weigh 70 kg. The constellation launched its first satellite, Umbra-01, in June 2021 and aims for 32 satellites in total which will be used for applications in urban planning, disaster response, and maritime surveillance. Umbra's SAR technology operates in the X-band with a 10 m² antenna and 1.2 GHz bandwidth, offering capabilities like SAR video and bistatic imaging for advanced observations.

The same applies to LiDAR: there is increasing interest in miniaturizing LiDAR systems for CubeSat applications, but the technology is not currently available.

HiVE (High-precision Versatile Ecosphere) (eoPortal, 2025c)(Kulu, 2025a) is part of ConstellR's microsatellite constellation focused on providing high-resolution thermal infrared (TIR) data for Earth observation. The system delivers daily Land Surface Temperature (LST) data with a 30-meter resolution, specifically targeting agricultural, urban, and industrial environments. The thermal sensors used in HiVE are miniaturized to fit 3U to 6U CubeSats, offering highly precise temperature measurements and thermal insights that can be applied at the field level.

The constellation aims to revolutionize global land surface temperature monitoring by providing daily, sub-field thermal imagery. ConstellR's planned constellation includes 30 satellites, with one prototype already launched. The launch of the remaining satellites is scheduled for the first quarter of 2025. A service is designed for customers to subscribe to data for their Areas of Interest (AOI), with costs based on factors such as area size, revisit frequency, and data latency. The data is processed to Level-2 LST and made available through an API.

Before concluding this section, it is important to highlight another significant example where the integration of new instruments with Artificial Intelligence enhances the efficiency of image management on small satellites.

Phi-Sat-1 (Φ-Sat-1)(European Space Agency, 2025b), developed by the European Space Agency (ESA), was an innovative 6U CubeSat designed to advance Earth observation through the integration of Artificial Intelligence (AI). Launched on 3 September 2020, the satellite carried the HyperScout-2 instrument, a compact hyperspectral imager operating in the visible and near-infrared (VNIR) range with a spatial resolution of 75 m and thermal infrared (TIR) with a spatial resolution of 390 m. One of the mission's key innovations was its onboard AI processing, facilitated by an Intel Movidius chip with a Myriad II VPU. This capability allowed the satellite to analyze acquired data in real-time, specifically filtering out cloud-covered images to reduce the volume of data transmitted to Earth. This efficiency is critical for managing the large data volumes generated by hyperspectral imaging, addressing the challenge of limited onboard resources while ensuring the most valuable data was prioritized for downlink. Operating in a Sun-synchronous orbit at an altitude of 540 km, Phi-Sat-1 completed its mission on 31 December 2021.

Φsat-2 (European Space Agency, 2025c), the successor in this satellite series, retains the 6U CubeSat design, with a slightly increased weight of 9 kg compared to approximately 5 kg for its predecessor. Operating at an altitude of 510 km, it features a multispectral imager capable of capturing data in eight spectral bands within the visible to near-infrared range, achieving a ground sampling distance of 5 meters. The imager produces 20 x 20 km images, which are stored onboard during approximately 15 daily orbits. Leveraging advanced onboard AI capabilities, Φsat-2 performs radiometric correction, alignment, and geolocation of the images prior to transmitting them to Earth at least four times per day. Its suite of AI applications includes cloud detection, street mapping, marine vessel tracking, image compression, wildfire monitoring, and marine anomaly detection. Launched in August 2024, Φsat-2 is designed to operate for a minimum mission duration of 14 months.

5. State of Art

The state of CubeSats in the urban domain was initially explored through a keyword search on the Scopus platform, focusing on "CubeSat" and "urban." The search mostly returned literature (9 papers) on CubeSat missions and technological advancements, which were not directly relevant to urban applications. To refine the search, we focused on organizations actively involved in CubeSat launches, specifically "PlanetScope," "Spacebee,"(Spacebee belongs to "Swarm Technologies - SpaceX" and it is in operation), "Diamond" (Diamond belongs to "Sky and Space Global" and it in operation) and "Lemur" (lemur belongs to "Spire" and it in operation). The search for "PlanetScope" and "urban" resulted in 51 relevant papers, while no significant results emerged from the other searches. Combining the results from both searches and excluding one duplicate paper, we constructed a histogram to illustrate the publication trends over time. The data clearly show a significant increase in interest, with the number of publications in the last year more than doubling compared to previous years (Figure 8).

Notably, 12 papers were published in the last 5 months alone, reflecting increased interest due to two key factors: PlanetScope imagery has a daily temporal resolution, 3–4-meter spatial resolution, and up to 8 spectral bands, relevant characteristics for the scientific community.

The second aspect is the availability of data through various programs for research purposes, even though the data are proprietary and therefore not open or freely accessible.

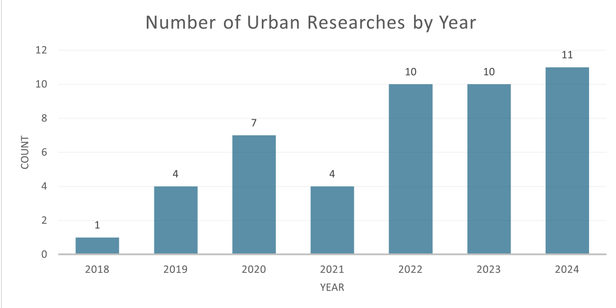

Figure 8. Number of papers in Scopus referring to urban study developed thanks to CubeSats.

The NASA Commercial SmallSat Data Acquisition (CSDA) Program (NASA, 2025b), for instance, provides free access to PlanetScope data for researchers funded by federal agencies or affiliated with U.S. academic institutions.

ESA provides access to the archive of PlanetScope mission data (European Space Agency, 2025f) for scientific research and application development following two different imagery offerings: PlanetScope Full Archive (European Space Agency, 2025h) and PlanetScope ESA Archive (European Space Agency, 2025g).

For the PlanetScope Full Archive, a proposal must be submitted and evaluated by ESA, a process that generally takes between 4 and 6 weeks. Access is granted to users in ESA Member States, ESA Cooperating/Associate States, and China (under the Dragon cooperation program), excluding those in "Embargoed Jurisdictions" (regions subject to U.S. trade or investment restrictions) or "Sanctioned Persons" (individuals or entities subject to U.S. economic sanctions, including those on the Specially Designated Nationals and Blocked Persons list). The archive offers two categories of products. The first, the PlanetScope Basic Analytic Radiance (TOAR) product, is an unrectified image that provides scaled top-of-atmosphere radiance data. It is sensor-corrected but not adjusted for geometric distortions and is not mapped to a cartographic projection. Rational Polynomial Coefficients (RPCs) are provided to enable user-driven orthorectification, and the product is intended for advanced users with expertise in image processing and geometric correction. The second category, the PlanetScope Ortho Scene product, is radiometrically, sensor- and geometrically corrected, and projected to a UTM/WGS84 cartographic map projection. Geometric correction uses high-resolution Digital Elevation Models (DEMs) with a post spacing ranging from 30 to 90 meters. This product is ready for analysis in GIS applications. As per ESA policy, imagery of conflict areas is not available.

Regular updates to the PlanetScope archive ensure cloud-free data (less than 5% cloud cover) for Europe, collected in the last 3 years, and for Africa, 5 years.

Data access through the PlanetScope program is governed by Data Vouchers, which specify a maximum area in square kilometers that can be ordered and downloaded over 12 months, starting from the date of the project proposal acceptance. Each voucher includes streaming access for up to 20,000 tiles per month during the project period. The available data cover areas of up to 60,000 km^2, with the specific area depending on ESA's decision.

The second option is to access the PlanetScope ESA Archive. To do so, users must submit a request form, which ESA typically evaluates within 2 days. Upon approval, download instructions will be provided. This data is available globally without geographic restrictions on users and is offered at level 1B or 3A (Ortho Tiles) / 3B (Ortho Scene). The spatial coverage of the collection can be checked through the Third-Party Missions Dissemination Service (European Space Agency, 2025d). For instance, a search over the city of Hanoi identified six available products for the period from September to December 2021 (Figure 9). Although the number of images may be limited, it is still recommended to check for potentially relevant data.

Figure 9. Map of the PlanetScope ESA TPM Online Catalogue; search on Hanoi.

An interesting initiative is Norway's International Climate & Forests Initiative (NICFI)(NICFI, 2025), which provides access to analysis-ready mosaics of the world's tropical regions to help reduce and reverse the loss of tropical forests, combat climate change, conserve biodiversity, and promote sustainable development for non-commercial purposes. Since 2020, NICFI has offered users worldwide free access to high-resolution and analysis-ready images of tropical areas. These images are provided by Kongsberg Satellite Services (KSAT) in partnership with Airbus and Planet.

To access the NICFI Satellite Data Program (Planet Labs, 2025b), users must first sign up on the NICFI Satellite Data Program webpage. Once the Terms of Service, supporting the NICFI mission, are agreed upon, users will be redirected to the Planet Explorer to access the data products.

The PlanetScope mosaics are orthorectified, analysis-ready satellite images generated as mosaics covering entire tropical regions. These mosaics are composed of images selected to minimize cloud coverage and enhance visual quality. The data covers all global tropical forests, with PlanetScope data providing a spatial resolution of 4 meters per pixel. This resolution enables detailed landscape analysis, which is particularly useful for monitoring deforestation and other environmental changes. The mosaics are updated monthly, enabling continuous monitoring of tropical regions.

To conclude, a useful resource for universities is the educational program (Planet Labs, 2025a) offered by Planet Labs. This program grants access to PlanetScope imagery for non-commercial research purposes, specifically targeting students, researchers, and faculty affiliated with academic institutions. It offers limited access in terms of both geographic area and the number of images available for download.

The standard download quota is 3,000 km^2 per month, with global basemaps provided and a 30-day delay in data availability. A personal research license is granted, and applications are reviewed by the PlanetScope team, with processing taking up to 3 weeks.

In addition to this free access, there are advanced options available for grantees, research teams, and entire academic campuses, which come with variable costs and download quota conditions.

Following this valuable discussion on data accessibility, the focus will now shift to a concise overview of the research content presented in the papers. Given the growing interest in these data, it would be beneficial for the scientific community, as outlined in Coetzee et al. (Coetzee et al., 2020), if at least historical archives were made open and accessible.

Field	Subfield	Count
New Missions		5
Urban Air quality		2
Flood Monitoring and Disaster Management		9
3D Reconstruction		1
Urban Planning and Development	Building Footprint	3
	Housing Type Mapping	1
	Urban Hydrology	2
	Urban Green Spaces Management	8
	Informal Settlements	3
	Social-Economic Analysis	1
	Urban Open Spaces and streets	2
Urban Land Use and Land Cover		6
Urban Forestry and Carbon sequestration		10
Urban Temperature		6

Table 8. Fields of Urban Research benefitting from CubeSats.

In Table 8, it is possible to see the number of papers using CubeSats by field and subfield. This technology can be beneficial in different fields, and, as discussed in the previous sections related to geographic distribution and organizations managing CubeSats, it can become a viable option for developing countries that are unable to afford costly and complex space missions. It will be interesting in the coming years to have more of these data available to also assess their quality.

6. Conclusion

When organized in constellations, CubeSats offer significant advantages, including high revisit frequencies and relatively low-cost deployment, which enable continuous urban monitoring and rapid response capabilities. Equipped with optical and hyperspectral sensors, CubeSats can monitor essential indicators such as air emissions, urban heat, vegetation health, and greenness—all of which have direct implications for public health and well-being. This paper provides an overview of the current state of CubeSats, tailored for those interested in sustainable development for cities and communities. In addition to presenting key characteristics, it includes a quick overview of the scientific literature on CubeSat applications for urban monitoring and research. Notably, the affordability of these platforms has allowed non-traditional actors, such as developing countries, universities, and non-profit organizations, to enter the field by launching and managing CubeSat missions.

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