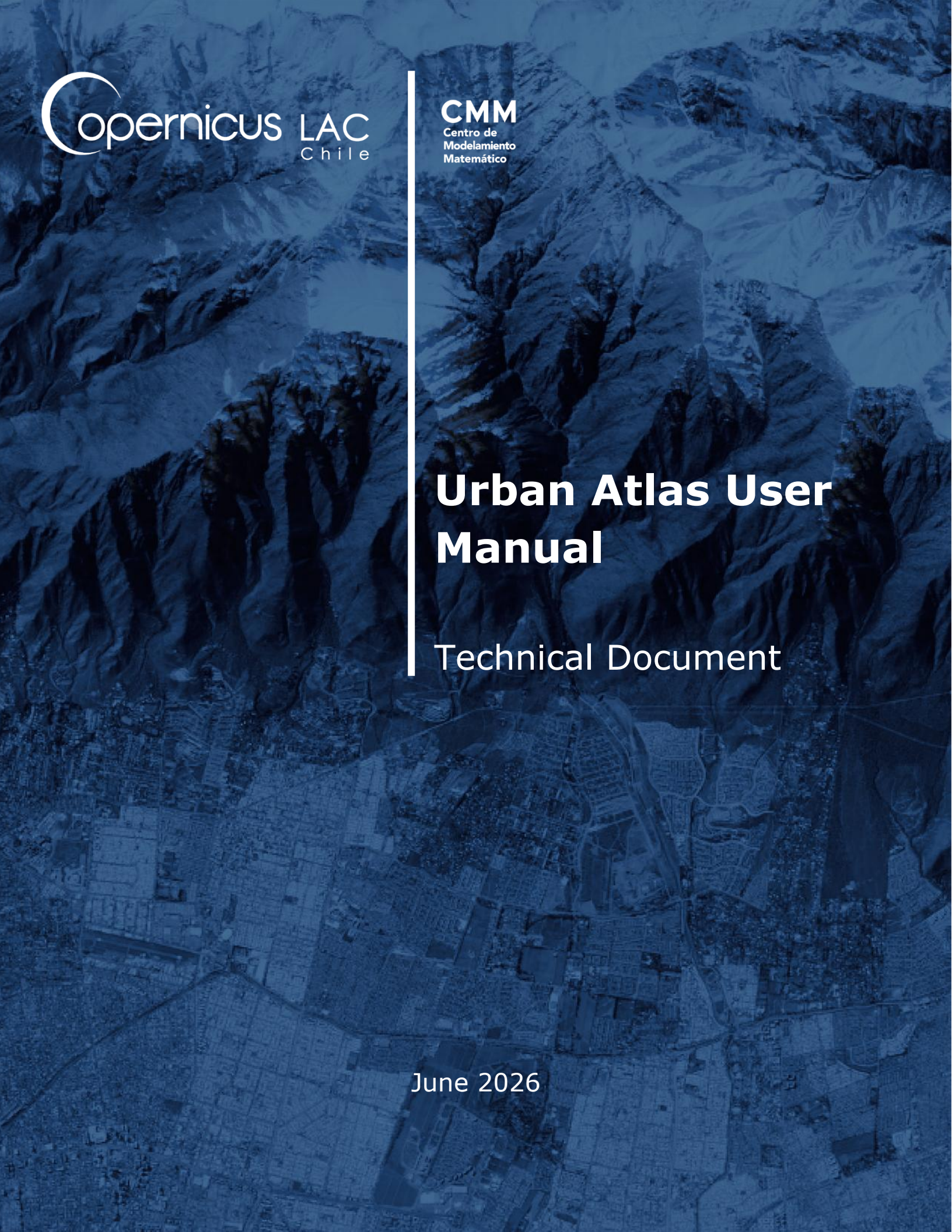

Copernicus LAC Chile

CMM Centro de Modelamiento Matemático

Urban Atlas User Manual

Technical Document

June 2026

Table of Contents

Access and license

Files available at https://www.copernicuslac-chile.eu

License: Open & Free Data - CopernicusLAC.

Recommended citation:

- **User manual:** "*CopernicusLAC Chile. (2025). User Manual: Urban Atlas for Latin America and the Caribbean (Version 1.0)*. https://www.copernicuslac-chile.eu"
- **Data: "***CopernicusLAC Chile. (2025). Urban Atlas for Latin America and the Caribbean (Version 1.0) [Data set]*. https://www.copernicuslac-chile.eu"

1. Summary

This document describes a version of the Urban Atlas service, specifically designed for the Latin America and the Caribbean (LAC) region, which responds to the need to generate geospatial information on urban land cover and land use that represents the reality of each country in the region, in order to monitor, manage and allocate resources to improve urban conditions, as well as to contribute to the Sustainable Development Goal related to creating sustainable cities (SDG 11).

The Urban Atlas product offers a classification at a resolution of 10m. in the capital urban areas of the countries of the region, adapted to their needs, based on the classifications carried out by the Urban Atlas (European Commission, 2011) developed for the European territory. The adaptation of these classes was based on the availability of data for each category, as well as their representation at the 10m scale. The information used corresponds mainly to Earth Observation data and local and auxiliary datasets, depending on the geospatial data availability of each country.

The geospatial information set produced for the cities of the region, together with the Sentinel-2 multispectral images, were used to develop two machine learning models to resolve the detection of more detailed structures, such as streets and buildings, and, on the other hand, the other proposed classes that require greater contextual information to improve segmentation performance.

A harmonized set of general land use and land cover classes was defined, where their integration with information provided by national and regional institutions made it possible to train supervised machine learning models, based on large volumes of Sentinel-2 multispectral images from the Copernicus program, resampled to a spatial resolution of 10m.

Future versions of the product will seek to refine and expand the classification levels, advancing toward a hierarchical structure of up to two levels of detail that allows the different urban structures to be distinguished with greater precision. This process aims to consolidate a robust, interoperable and long-term sustainable service, through constant collaboration with institutions in the region, seeking to generate a solid tool to improve territorial planning in Latin America and the Caribbean.

2. Product specifications

This chapter details the technical specifications of the Urban Atlas product for Latin America and the Caribbean, organized into the following aspects: general product information, description of its thematic content, distribution format, layer structure and metadata attributes. This documentation is intended to facilitate the correct download, integration and use of the product in geographic information systems and territorial analysis platforms.

2.1 General information

This subsection brings together the fundamental technical parameters that characterize the Urban Atlas product for Latin America and the Caribbean. This information allows the user to understand the operational attributes of the product before downloading and integrating it into territorial analysis and urban planning projects. Table 1 summarizes the general attributes of the product, including name, version, source sensor (Sentinel-2 or others), spatial resolution (for example, 10m.), periodicity, distribution format (Shapefile and GeoTIFF), processing level, classification scheme, coordinate reference system and regional coverage extent over the national capitals of Latin America and the Caribbean.

Table 1. General information of the Urban Atlas product.

Product	Urban Atlas map for Latin America and the Caribbean
Spatial resolution	0.000089° (~10 m. at the equator)
Temporal resolution	Annual
Variable	Urban land use
Format	GeoTIFF / Shapefile
Geographic coverage	33° north, -60° south, -123° west and -25° east
Temporal coverage	2020 to 2024. (Historical dataset in production)

Source: Own elaboration.

2.2 Product description

The Urban Atlas for Latin America and the Caribbean focuses on the regional capitals presented in Table 2. These cities span 38 Sentinel-2 Level 2A tiles, each with an extent of 110x110 kms. and a spatial resolution resampled to 10m. (Figure 1). These tiles constitute the operational spatial base on which the urban classifications are generated.

Table 2. National capitals considered for the development of the Urban Atlas.

Country	City
Brazil	Brasília
Bolivia	La Paz
Chile	Santiago
Ecuador	Quito
Peru	Lima
Paraguay	Asunción
Argentina	Buenos Aires
Uruguay	Montevideo
Mexico	Mexico City
Guatemala	Guatemala City
Cayman Islands	George Town
Costa Rica	San José
Aruba	Oranjestad
Panama	Panama City
El Salvador	San Salvador
Grenada	Saint George's
Suriname	Paramaribo
French Guiana	Cayenne
Saint Lucia	Castries

Country	City
Honduras	Tegucigalpa
Nicaragua	Managua
Belize	Belmopan
Turks and Caicos Islands	Grand Turk
Jamaica	Kingston
Haiti	Port-au-Prince
Dominican Republic	Santo Domingo
Colombia	Bogotá
Bahamas	Nassau
Cuba	Havana
Venezuela	Caracas
Trinidad and Tobago	Port of Spain
Guyana	Georgetown
Puerto Rico	San Juan
Anguilla	The Valley
Antigua and Barbuda	Saint John's
Martinique	Fort-de-France
Barbados	Bridgetown

Source: Own elaboration.

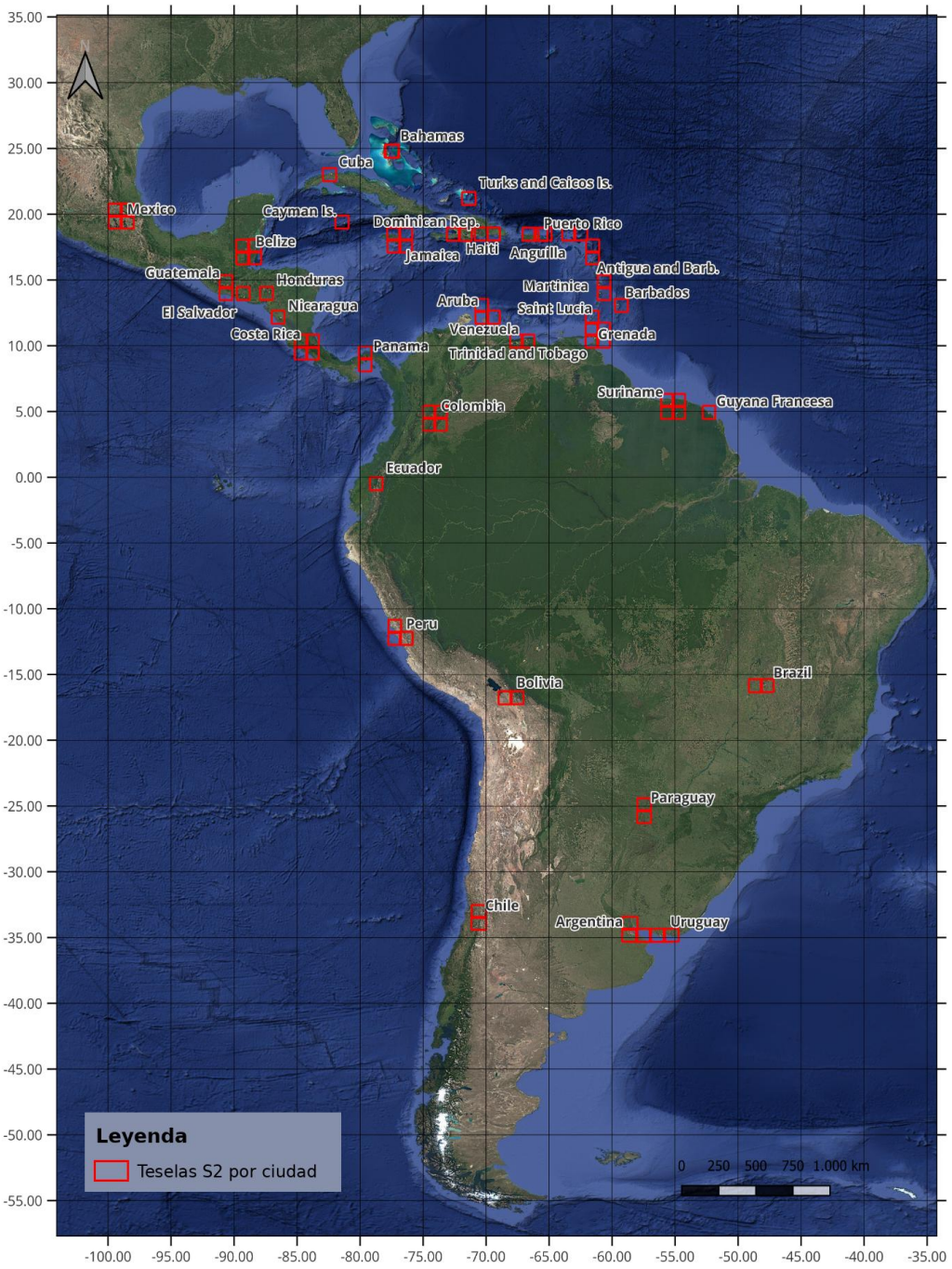

Figure 1. Coverage of Sentinel-2 tiles used per city. Source: Own elaboration.

2.3 Product format

File downloadable from the platform in vector format (Shapefile) and raster file (GeoTIFF).

Shapefile: When downloading the product, the user obtains a compressed file (.zip) that contains:

- The standard components of the format (.dbf, .prj, .shp, .shx).
- An additional file in CSV format that acts as a class dictionary, including the codes, names and descriptions associated with the classification scheme used.

GeoTIFF: When downloading the product, the user obtains the files:

- Raster per tile (.tiff), following the naming convention defined above.
- Virtual Raster Tile (.vrt) that acts as a general mosaic for the visualization and continuous processing of the requested area.

This distribution scheme allows both local analysis and smooth integration into GIS projects through virtual mosaics.

2.4 Product content

The Urban Atlas service viewer allows the visualization of a discrete classification map representing 11 classes, derived from the classification proposed by the Urban Atlas (European Commission, 2011) and adapted to the reality of Latin America and the Caribbean. The product considers a spatial resolution of 10m., ensuring consistency in regional interpretation.

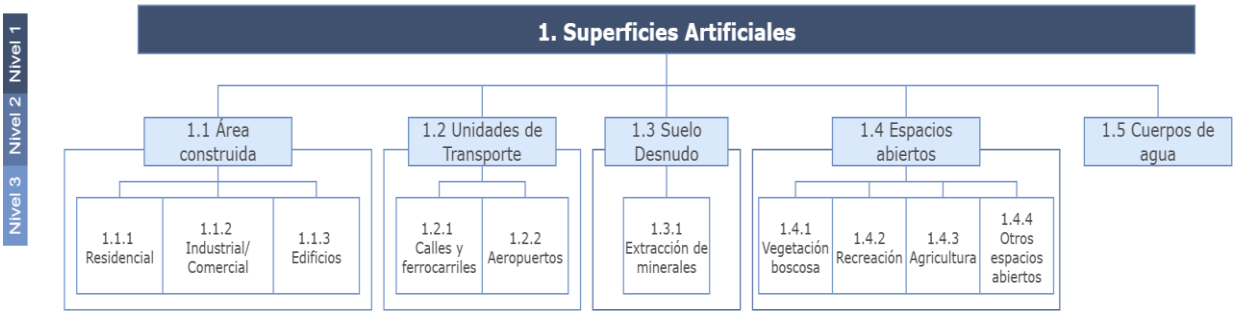

Figure 2. Proposed class scheme for the Urban Atlas. Source: Own elaboration.

2.5 Product layers

The Urban Atlas service viewer makes it possible to visualize a map composed of discrete values representing 11 land use and land cover classes, through the adaptation proposed by the European land monitoring service. This product has a spatial resolution of 10m. The official definitions table is presented below, adapted from the European service's mapping guide, used as a reference for the regional classification.

Table 3. Description of classes present in the Urban Atlas.

Vector/ raster code	Nomenclature	Additional information
4096	Artificial surfaces	Corresponds to surfaces with anthropic intervention, excluding agricultural land use. They include areas with artificial structures and surfaces with natural vegetation present in urban facilities, such as parks, squares and urban trees, and the artificial vegetation present mainly in sports facilities. The associated unsealed and vegetated surfaces are areas functionally related to human activities, except agriculture.
4368	Residential zone	Corresponds to predominantly residential use, regardless of their housing scheme. They may include central business districts (CBD) provided there is partial residential use.
4384	Industrial/commercial zone	Land featuring buildings and/or artificial structures with non-residential use, that is, where industrial, commercial or transport- and storage-related uses are dominant.
4400	Buildings	These correspond to artificial structures with an unknown intended use; they may be isolated buildings and associated buildings.
4608	Transport units	In the case of transport units and associated land, land routes, service routes and land associated with airports, railways, ports, among others, are considered.
4624	Streets and railways	Main roads, highways, residential axes and service areas are considered.
4640	Airports	Airport facilities are considered: runways, buildings and associated land.
36864	Bare soil	The detection of bare soil surface has high value within urban planning and public space management, mainly because these represent potential building sites, established or unofficial dumps, or mining extraction sites near urban areas but without a predominant presence of buildings.

37120	Mineral extraction	Corresponds to open-pit extraction sites, whether sand extraction or quarries, visible according to the MinMU unit. It also considers landfill sites of different ownership (public, private, legal or illegal), and their associated land (which may include vegetated areas or service areas).
5120	Open spaces	Corresponds to land mainly free of construction; it considers urban green areas as well as agricultural and wild-use areas.
5168	Recreation	Sports and leisure facilities are considered, such as synthetic grass fields, golf courses, racetracks, urban parks, zoos or green medians that meet the minimum mapping units, among others.
5152	Agriculture	Within urban areas, anthropic activity associated with crops, orchards and plantations is recognized, occurring extensively or in the presence of a significant layer of natural vegetation.
5136	Forest vegetation	Areas occupied by forests and wooded zones, with an extensive and dense vegetation pattern, present in urban areas.
5184	Other open spaces	Abandoned lands with shrubs; steep, shrubby slopes of eroded areas; grasslands in the process of natural colonization; wild vegetation; sparse vegetation, among others.
45056	Water bodies	Considers all water bodies and watercourses, natural (rivers, lakes, lagoons, wetlands) or artificial (reservoirs, pools, tailings ponds), that meet the minimum cartographic mapping unit.

Source: Own elaboration.

2.6 Metadata attributes

The GeoTIFFs are described at the file level (Table 4) and at the band level (Table 5):

Table 4. GeoTIFF metadata at the file level.

Attribute	Description	Example		
Copyright	Copyright notice	CopernicusLAC Chile 2025 / reference data		
Data type	data type	UInt16 - 16-bit unsigned integer		
Image format	GDAL driver metadata	GeoTIFF		
		Shapefile		
Coordinate reference system	CRS used	EPSG:4326 - WGS 84		
Units	Map units	Lat/long (geographic)		
Pixel size	Spatial resolution in degrees	-8.83E+13		
		-8.83E+13		
Legend	Classes based on hexadecimal numbering	Class	Level	Decimal number
		Artificial surfaces	1	4096
		Residential zone	2	4368
		Commercial/Industrial zone	2	4384
		Buildings	2	4400
		Transport units	1	4608
		Streets and railways	2	4624
		Airports	2	4640
		Bare soil	1	36864
		Mineral extraction	2	37120
		Open spaces	1	5120
		Forest vegetation	2	5136
		Agriculture	2	5152
		Recreation	2	5168
		Other open spaces	2	5184

Source: Own elaboration.

Table 5. GeoTIFF metadata at the band level,

Attribute	Description	Example
Description	Band name	Band 1
noData value	Value used to represent pixels with no information or no defined class	0
Offset	offset to apply to the data	NA
Scale	scale to apply to the data	NA
Color table	Color representation information	RGB

Source: Own elaboration..

3. Methodological summary

For the Urban Atlas product, a classification scheme with 11 land cover and land use classes is proposed, including: Residential zone, Industrial/commercial zones, Other buildings, Streets and railways, Airports, Forest vegetation, Agriculture, Recreation, Other open spaces, Mineral extraction, and Water bodies. The satellite images used correspond to annual medians of Sentinel-2 for each city, in addition to having local cloud-cover filters, depending on the complexity of the area to be studied. The images were used separately as a multiband file for their 10 m. resolutions (B02, B03, B04, B08) and their 20 m. resolutions (B05, B06, B07, B8A, B11 and B12), in order to obtain information at the pixel level and its spatial context; for the final product the bands are resampled to the minimum resolution of the product, obtaining a product at 10 m.

Regarding the preparation of the data for applying the models, datasets were selected for the training phase, these being a combination of OpenStreetMap (OSM, 2023), Open Buildings (Google Research, 2023) and Microsoft's Building Footprints (2022), where the classes of each of these layers were harmonized according to the equivalences of the classes proposed for the Urban Atlas. In addition to data from governmental institutions of different countries in the region, this set provides consistent, high-quality global annotations for buildings and land use. This information—satellite imagery and the data sources mentioned—was extracted for 30 capital cities and intermediate cities of the region, using the year 2023 as a reference, with the aim of capturing diversity and variability considering their different sizes, geographic contexts and development patterns in Latin America and the Caribbean. For the training data and the satellite images, labeled patches

of 192 x 192 pixels were created for the 10 m. resolution dataset and 96 x 96 pixels for the 20 m. resolution dataset.

The workflow was divided into the application of two models with complementary deep-learning architectures: HRNet (High-Resolution Network), used separately to detect structural elements such as roads and main urban infrastructure, maintaining high spatial resolution throughout the network to improve the detection of edges and details (Johnson et al., 2022)—this model being used to correctly handle the detection of thin and smaller-area surfaces, such as buildings and the streets and railway network class; and another model, SFANet (Spatial Feature Aggregation Network) based on U-Net with an EfficientNet-B3 backbone (Tan & Le, 2019), which was pre-trained on the ImageNet-1k dataset (Deng et al., 2009). In this case, it was used to classify the remaining Urban Atlas classes, without considering structural axes and buildings. It was selected because it manages to integrate contextual information and spatial hierarchies to improve the performance of semantic segmentation in heterogeneous urban landscapes (Hwang et al., 2024). For training, strategies were included to handle class imbalance, using a focal loss function and hybrid weights to give greater importance to underrepresented categories, such as “airports” and “mineral extraction”. The training dataset split corresponds to 80% training and 20% test data, where precision and F1-score metrics were evaluated, obtaining optimal results for urban areas. For the street HRNet model, an F1-score of 0.973 and an IoU of 0.95 were obtained; for the buildings HRNet model, an F1-score of 0.972 and an IoU of 0.95 were obtained. Finally, for the SFANet results, the global metrics obtained were an F1-score of 0.74 and an IoU of 0.74.

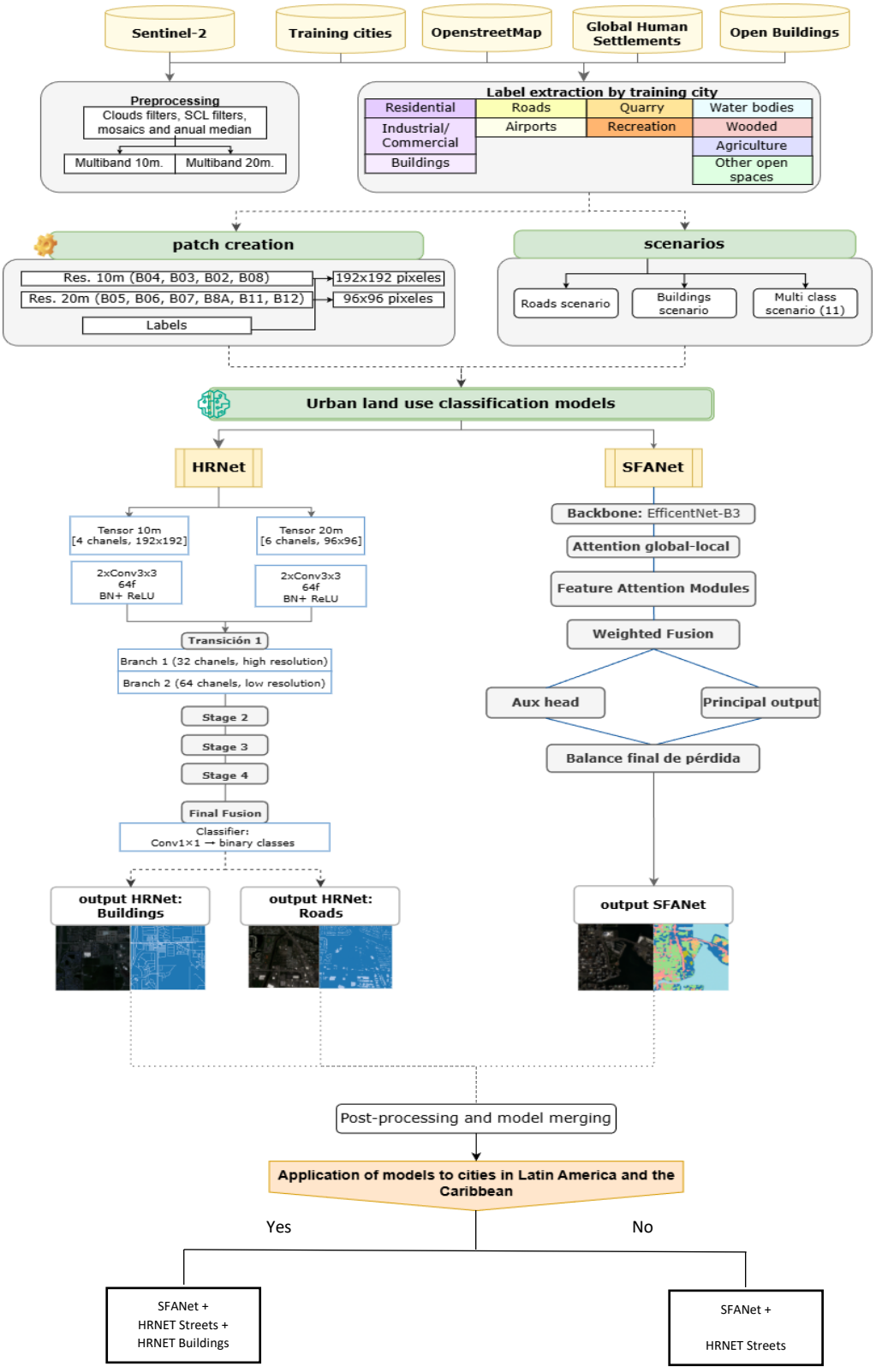

Figure 3. General methodology used in the development of the Urban Atlas. Source: Own elaboration.

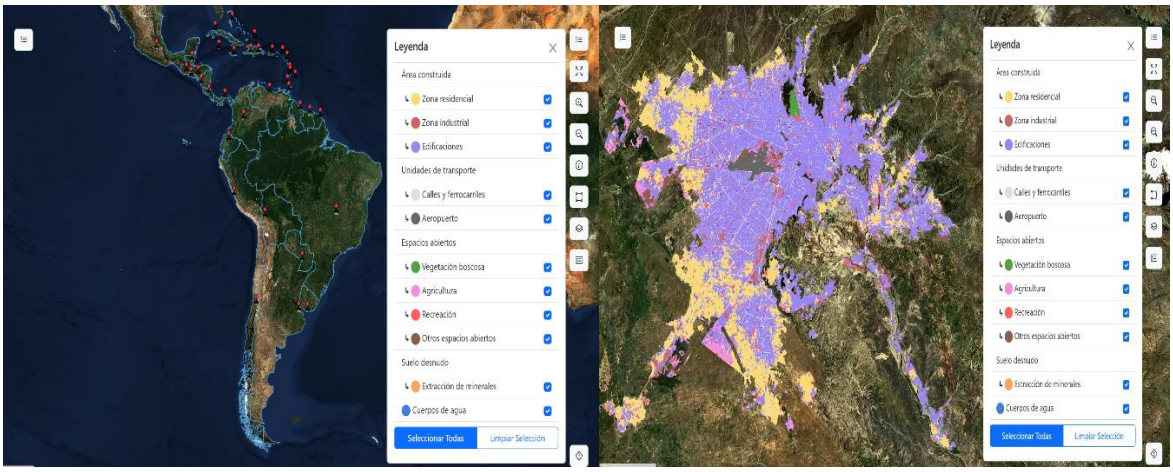

Figure 4. a) Display of the Urban Atlas with the markers for each city. b) Presentation of results for La Paz, Bolivia. Source: Own elaboration.

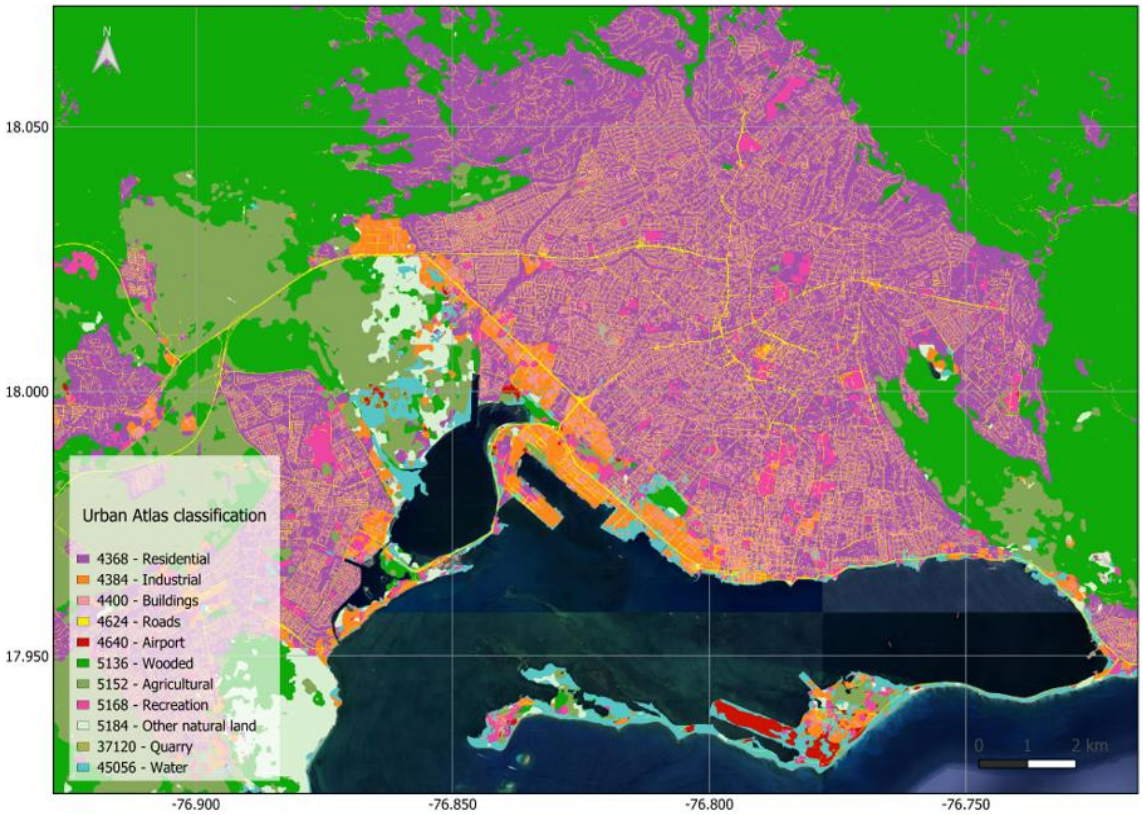

Figure 5. Detail of the 2024 Urban Atlas of Kingston, Jamaica. Source: Own elaboration.

References

Deng, J., Dong, W., Socher, R., Li, L.-J., Li, K., & Fei-Fei, L. (2009). ImageNet: A large-scale hierarchical image database. *2009 IEEE Conference on Computer Vision and Pattern Recognition*, 248–255. https://doi.org/10.1109/CVPR.2009.5206848

European Commission, Directorate-General for Regional Policy. (2011). *Mapping guide for a European Urban Atlas* (Urban Atlas land cover/land use 2006 mapping guide). https://land.copernicus.eu/en/technical-library/urban-atlas-2006-mapping-guide/@@download/file

Hwang, G., Jeong, J., & Lee, S. J. (2024). SFA-Net: Semantic feature adjustment network for remote sensing image segmentation. *Remote Sensing, 16*(17), 3278. https://doi.org/10.3390/rs16173278

Johnson, N., Treible, W., & Crispell, D. (2022). OpenSentinelMap: A large-scale land use dataset using OpenStreetMap and Sentinel-2 imagery. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops* (pp. 1333–1341).

Microsoft. (2022). *Microsoft building footprints* [Data set]. Microsoft. https://github.com/microsoft/GlobalMLBuildingFootprints

Google Research. (2023). *Open Buildings* [Data set]. Google. https://sites.research.google/open-buildings/

OpenStreetMap contributors. (2023). OpenStreetMap [Data set]. OpenStreetMap Foundation. https://www.openstreetmap.org

Tan, M., & Le, Q. V. (2019). EfficientNet: Rethinking model scaling for convolutional neural networks. In *Proceedings of the 36th International Conference on Machine Learning* (ICML). https://arxiv.org/abs/1905.11946