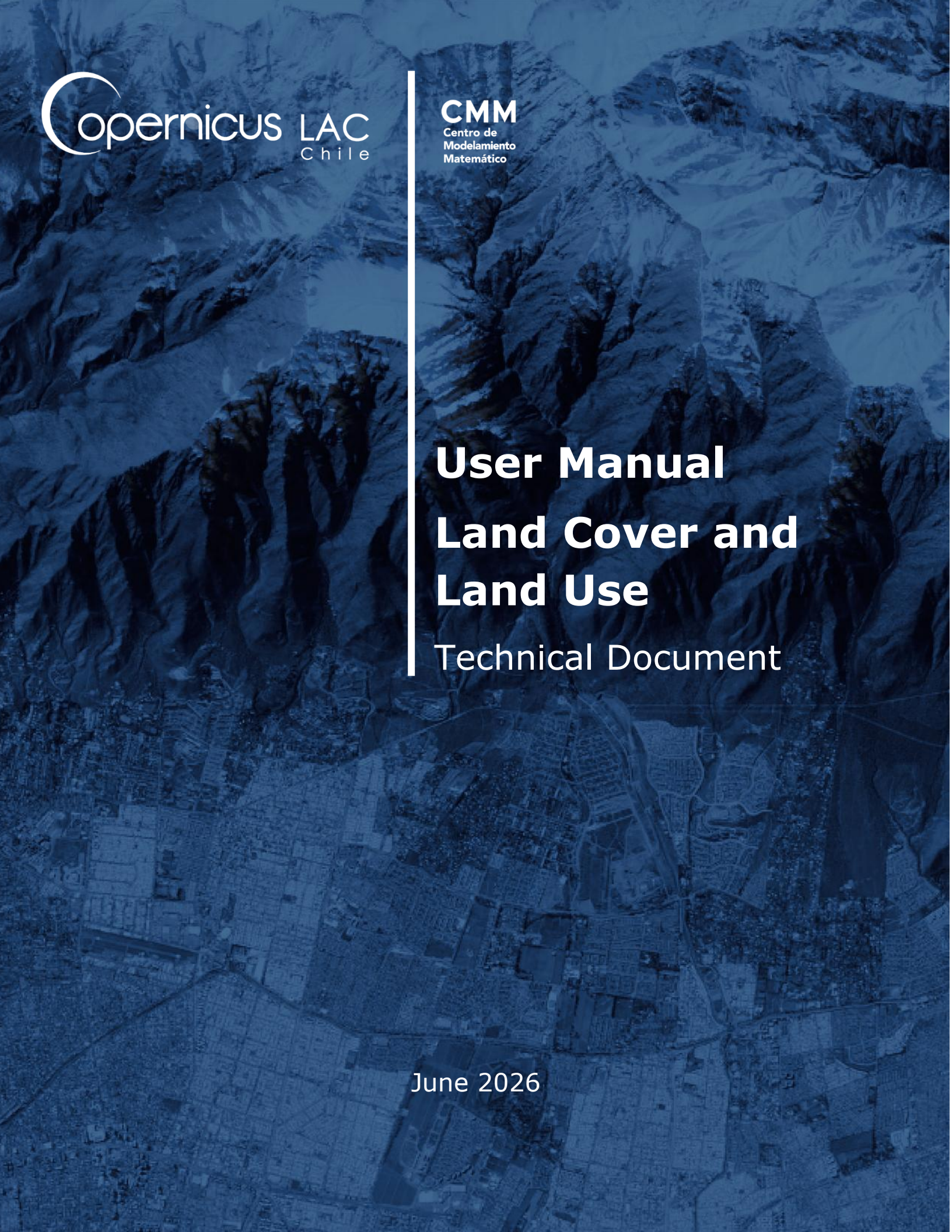


The background of the entire page is a high-resolution aerial photograph of a mountainous region. The upper portion shows rugged, snow-capped mountain peaks, while the lower portion shows a valley with a grid-like pattern of agricultural fields and some urban development. The entire image is overlaid with a semi-transparent blue filter.

User Manual

Land Cover and

Land Use

Technical Document

June 2026

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Access and Licence

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

Licence: Open & Free Data - CopernicusLAC.

Recommended citation:

- **User manual:** "CopernicusLAC Chile. (2025). User manual: Land Cover and Land Use for Latin America and the Caribbean (Version 1.0). <https://www.copernicuslac-chile.eu>"
- **Data:** "CopernicusLAC Chile. (2025). Land Cover and Land Use for Latin America and the Caribbean (Version 2.0) [Dataset]. <https://www.copernicuslac-chile.eu>"

1. Summary

This document describes a version of the Land Cover/Land Use (LCLU) classification service, specifically designed for the Latin America and the Caribbean (LAC) region. Its main objective is to establish a continuous monitoring system that provides the scientific community, citizens, and decision-makers with a reliable, open, and up-to-date source of information on the composition, distribution, and territorial dynamics of the region, with spatial and temporal consistency.

For the development of this initiative, a harmonized set of general land use and land cover classes was defined, adapted to the ecological and productive characteristics of the countries in the region. Integrating these classes 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 imagery from the Copernicus programme, resampled to a spatial resolution of 20 m. This multi-source, multi-scale approach enables a more realistic representation of the territory, incorporating the diversity of bioclimatic environments that characterize Latin America and the Caribbean. Future versions of the product will seek to refine and expand the classification levels, moving toward a hierarchical structure of up to three levels of detail that allows the different types of land cover and land use to be distinguished with greater precision, as well as increasing the number of annual publications of these maps. This process of continuous improvement aims to consolidate a robust, interoperable, and sustainable service over time, capable of supporting environmental assessments, territorial planning, and evidence-based public policy.

The 2024 Land Cover and Land Use product covers a total of 2,602 Sentinel-2 tiles (110×110 km each), providing geospatial information at 20 m spatial resolution across the whole of Latin America and the Caribbean. This initiative contributes directly to monitoring the Sustainable Development Goals related to the sustainable management of terrestrial ecosystems (SDG 15) and climate action (SDG 13), providing government institutions, the scientific community, and decision-makers with an open, up-to-date, and spatially consistent source of territorial information for environmental monitoring and land-use planning at the regional scale.

2. Product Specifications

This chapter details the technical specifications of the Land Cover and Land Use 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 downloading, integration, and use of the product in geographic information systems and territorial and environmental analysis platforms.

2.1 General Information

This subsection brings together the fundamental technical parameters that characterize the Land Cover and Land Use product for Latin America and the Caribbean. This information allows the user to know the product's essential operational attributes before downloading it and integrating it into environmental or territorial analysis projects. Table 1 gathers the product's general attributes, including name, version, source sensor (Sentinel-2), spatial resolution (20 m), periodicity, distribution format (Shapefile and GeoTIFF), processing level, classification scheme (FAO GLC-SHARE, 11 classes), coordinate reference system, and coverage extent over the 2,602 tiles that make up the Latin America and the Caribbean domain.

Table 1. General information of the Land Cover and Land Use product.

Product ID	Land Cover and Land Use Map
Spatial resolution	0.0001796630568239042966° (~20 m at the equator)
Temporal resolution	Annual
Variable	Land Cover and Land Use
Format	TIFF
Geographic coverage	33° north, -60° south, -123° west, and -25° east
Temporal coverage	2024

Source: own elaboration.

2.2 Product Description

The 2024 Land Cover and Land Use Map covers a total of 2,602 tiles defined by the Sentinel-2 Level 2A standard, each with an extent of 110×110 kms. and a spatial resolution resampled to 20 m. These tiles completely cover the Latin America and the Caribbean (LAC) region, constituting the operational spatial base on which the regional classifications are generated.

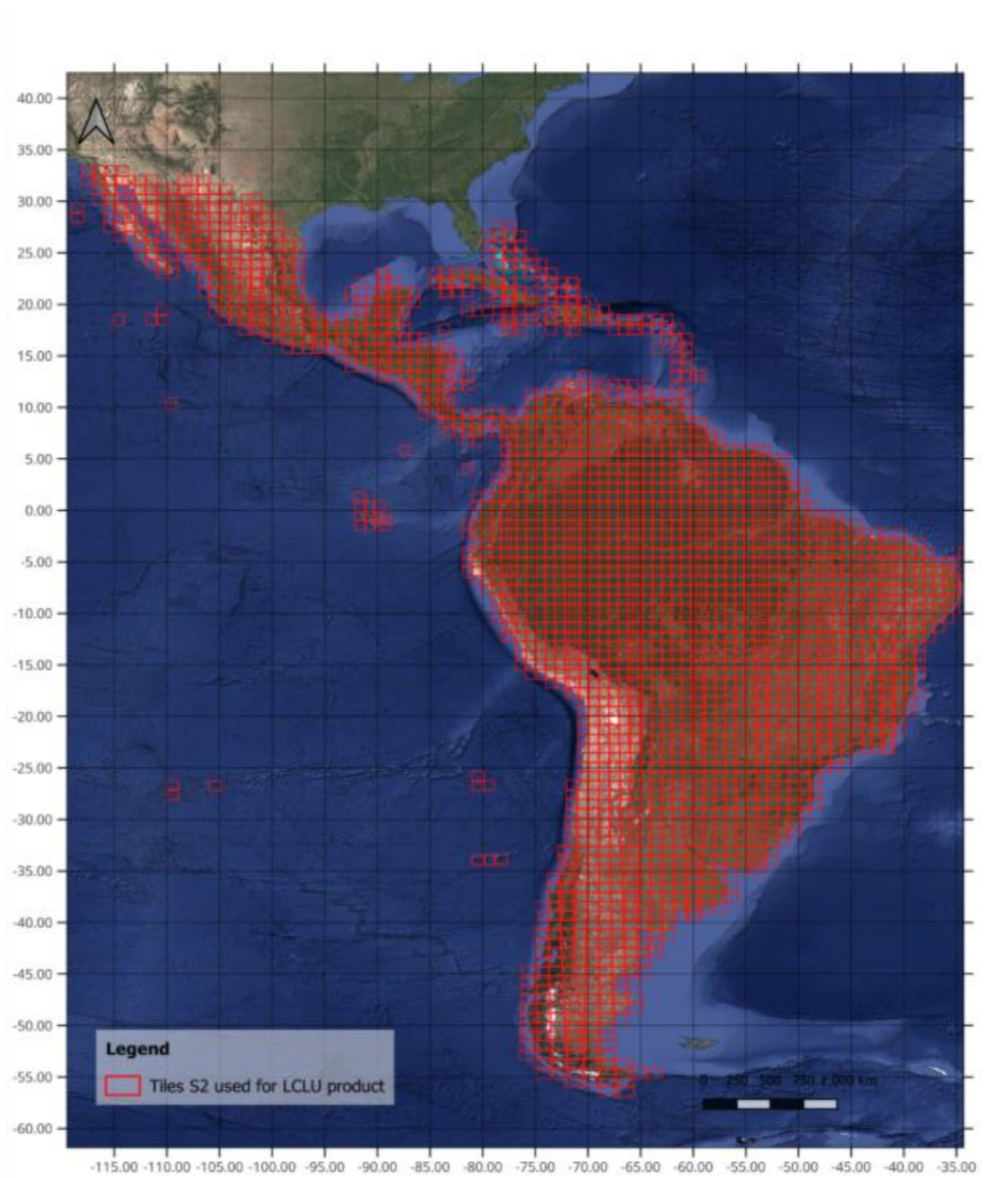


Figure 1. Sample of the tiles covering the study region. Source: own elaboration.

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) containing:

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

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

- Raster per tile (.tiff), following the naming convention of each Sentinel-2 tile included in the selected polygon.
- Virtual Raster Tile (.vrt) that acts as a general mosaic for the continuous visualization and processing of the requested area.

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

2.4 Product Content

The Land Cover and Land Use service viewer allows the display of a discrete classification map representing 11 land cover classes for the territory, derived from the global scheme led by the FAO (2014) and adapted to the ecological reality of Latin America and the Caribbean. The product maintains a spatial resolution of 20m., ensuring consistency in regional interpretation.

The next section presents the official table of classes, with their definition and conceptual correspondence according to FAO standards (Latham et al., 2014).

2.5 Product Layers

In the Land Cover and Land Use service application, it is possible to display a map composed of discrete values representing 11 land cover classes (Figure 2). This product has a spatial resolution of 20m. and is based on the classification scheme proposed by the FAO in its 2014 global map (Latham et al., 2014). The official table of definitions (Table 2) is presented below, adapted from the FAO's original documentation and used as a reference for the regional classification.

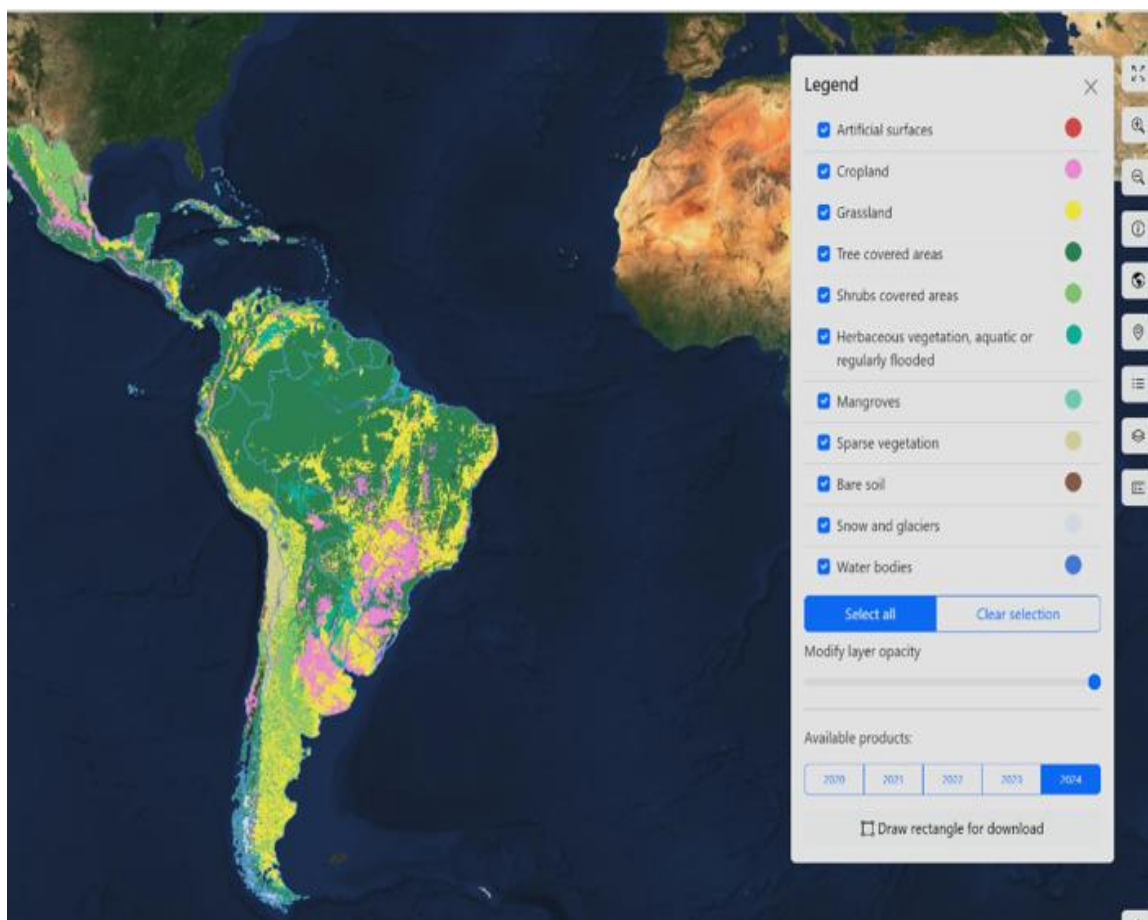


Figure 2. Display of the Land Cover and Land Use map. Source: own elaboration.

Table 2. Definition of the categories to be classified.

Label	Land cover types	Description
1	Artificial Surfaces	This class is composed of any type of area with a predominantly artificial surface. Any urban feature or feature related to the urban environment is included in this class, for example, urban parks (squares, parks, sports facilities). The class also includes industrial areas, landfills (dumps), and extraction sites.
2	Croplands	<u>Herbaceous Crops: This class is composed of a predominant cover of cultivated herbaceous plants (grasses or "forbs"). This includes herbaceous crops used for hay. All non-perennial crops that do not last more than one or two growing seasons, and crops such as sugarcane where the upper part of the plant is harvested regularly while the roots may remain in the field for more than a year, are included in this class.</u>
		<u>Woody Crops: This class is composed mainly of a layer of permanent crops (trees and/or shrub crops) and includes all types of orchards and plantations (fruit trees, coffee and tea plantations, oil palm, rubber plantations, Christmas trees, etc.).</u>
		<u>Multiple or layered crops: This class combines different types of land cover: Two layers of different crops (woody + herbaceous): a common case is the presence of a layer of woody crops (trees or shrubs) and another layer of herbaceous crops, as in the case of wheat fields with olive trees in the Mediterranean area and intensive horticulture, oases, or the typical agriculture of the African coast where herbaceous fields are covered with oil palm trees, etc. Presence of a significant layer of natural vegetation (mostly trees) covering a layer of crops: a typical example is coffee plantations shaded by natural trees in the equatorial area of Africa.</u>
3	Grasslands	This class includes any geographic area dominated by natural herbaceous plants (grasslands, meadows, steppes, and savannas) with a cover of 10% or more, regardless of the various human and/or animal activities, such as grazing, selective fire control, etc. Woody plants (trees and/or shrubs) may be present, assuming their cover is less than 10%.

4	Tree-covered areas	This class includes any geographic area dominated by natural trees with a cover of 10% or more. Other types of plants (shrubs and/or herbs) may be present, even at a higher density than the trees. This class includes areas seasonally or permanently flooded with fresh water. This class excludes coastal mangroves. (*Areas planted with trees for afforestation purposes and plantations are not included in this class.)
5	Shrub-covered areas	This class includes any geographic area dominated by natural shrubs that have a cover of 10% or more. Trees may be present in a scattered form if their cover is less than 10%. Herbaceous plants may also be present at any density. This class includes shrub-covered areas permanently or regularly flooded by fresh water. This class excludes shrubs flooded by salt or brackish water in coastal areas.
6	Herbaceous, aquatic, or regularly flooded vegetation	This class includes any geographic area dominated by natural herbaceous vegetation (cover of 10% or more) that is permanently or regularly flooded by fresh or brackish water (swamps, marshes, etc.). Flooding must persist for at least 2 months per year to be considered regular. Woody vegetation (trees and/or shrubs) may be present if its cover is less than 10%.
7	Mangroves	This class includes any geographic area dominated by woody vegetation (trees and/or shrubs) with a cover of 10% or more that is permanently or regularly flooded by salt or brackish water, located in coastal areas or in river deltas.
8	Sparse vegetation	This class includes any geographic area where natural vegetation cover is between 2% and 10%. This includes permanently or regularly flooded areas.
9	Bare soil	This class includes any geographic area dominated by natural abiotic surfaces (bare soil, sand, rocks, etc.) where natural vegetation is absent or almost absent (cover less than 2%). This class includes areas regularly flooded by fresh water (lake shores, riverbanks, salt flats, etc.). This class excludes coastal areas affected by the tidal movement of salt water.
10	Snow and glaciers	This class includes any geographic area covered by snow or glaciers that persist for 10 months or more.

11	Water bodies	This class includes any geographic area covered for most of the year by fresh water bodies. In some cases the water may be frozen during part of the year (less than 10 months). Because the geographic extent of water bodies can change, the boundaries must be determined consistently with class 11 according to the dominant situation during the year and/or across multiple years.
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Source: Adapted from Latham et al. (2014), FAO GLC-SHARE.

2.6 Metadata Attributes

The GeoTIFFs are described at the file level (Table 3) and at the band level (Table 4):

Table 3. GeoTIFF metadata at the file level.

Attribute	Description	Example		
copyright	Copyright notice	CopernicusLAC Chile 2025 / reference data		
data type	data type	UInt18 - 16-bit unsigned integer		
image format	GDAL driver metadata	GeoTIFF		
src	Coordinate reference system	EPSG:4326 - WGS 84		
units	CRS units	Lat/long (geographic)		
pixel size	Spatial resolution in degrees	0.0001796630568239042966, -0.0001796630568239042966		
legend	Meaning of hexadecimal code	Class	Class no.	Decimal number
		Artificial surfaces	1	4096
		Cropland	2	8192
		Grasslands	3	12288
		Tree-covered areas	4	16384
		Shrub-covered areas	5	20480
		Herbaceous, aquatic, or regularly flooded vegetation	6	24576
		Mangroves	7	28672
		Sparse vegetation	8	32768
		Bare soil	9	36864
		Snow and glaciers	10	40960
		Water bodies	11	45056

Source: own elaboration.

Table 4: GeoTIFF metadata at the band level

Attribute	Description	Example
Description	Band name	Band 1
noDataValue	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

The project aims to generate a land cover and land use map for the Latin America and the Caribbean (LAC) region. To this end, a diverse set of input data is used, including Sentinel-2 satellite imagery, the Copernicus GLO-30 digital elevation model (30m), and reference classification maps from several countries. The classification legend is based on the FAO's GLC-SHARE system (Latham et al., 2014), which consists of 11 categories. A key decision was to maintain the distinction between "Bare soil" and "Sparse vegetation", which is crucial for representing local desert ecosystems, unlike other global systems that group them together.

As part of data preparation, a thorough harmonization of the classes from the various national reference maps was carried out to ensure transnational comparability, consolidating them into 23 intermediate categories that are grouped into the 11 final classes. The 2024 Sentinel-2 imagery was processed to remove clouds, using a differentiated filtering scheme according to the cloud-cover level of each tile. From these clean images, annual temporal-spectral metrics (medians and percentiles) were computed which, together with the topographic data (elevation, slope, and aspect) (DLR e.V. & Airbus Defence and Space GmbH, 2018) and the biome information (RESOLVE, 2024), formed the set of predictor variables for the model.

For model training, an advanced neural network architecture called **SFA-Net (Hwang et al., 2024)** was used, based on **U-Net with an EfficientNet-B5 backbone (Tan & Le, 2019)**. This model is pre-trained on the ImageNet-1k dataset and was then adapted to process the spectral, topographic, and categorical variables (such as, the biome, incorporated through an embedding). Training included specific strategies to handle class imbalance, using a focal loss function and hybrid weights to give greater importance to underrepresented but ecologically critical categories, such as mangroves. The process was optimized with an efficient data loader and an early-stopping criterion to ensure a robust model.

Finally, the classification was carried out by dividing the territory into patches of 512×512 pixels, which were processed with 50% overlap to avoid edge artifacts. Each pixel was classified according to the class of maximum probability. To refine the result, post-processing was applied that included a specific cleaning of the overlap zones between patches and a median filter to smooth point noise and produce a coherent final map ready for territorial analysis at the regional scale.

The model's performance evaluation was carried out on an independent test dataset (20% of the total), computing global Intersection over Union (IoU) metrics and per-class F1-score. The global results report an F1-score of 0.81 and an IoU of 0.69. The categories with the greatest extent and spectral representativeness, such as forest vegetation, agricultural land, and water bodies, presented IoU values above 0.80. The categories with lower representation in the training set, such as mangrove and sparse vegetation, showed greater variability depending on the geographic region. The consistency of the product was additionally evaluated through comparison with available national land cover maps from selected countries in the region and with the FAO's global GLC-SHARE product, confirming the coherence of the classification scheme with international reference systems and identifying areas for improvement for future versions, particularly in distinguishing between open vegetation classes and delineating ecological transition zones in savanna and páramo ecosystems.

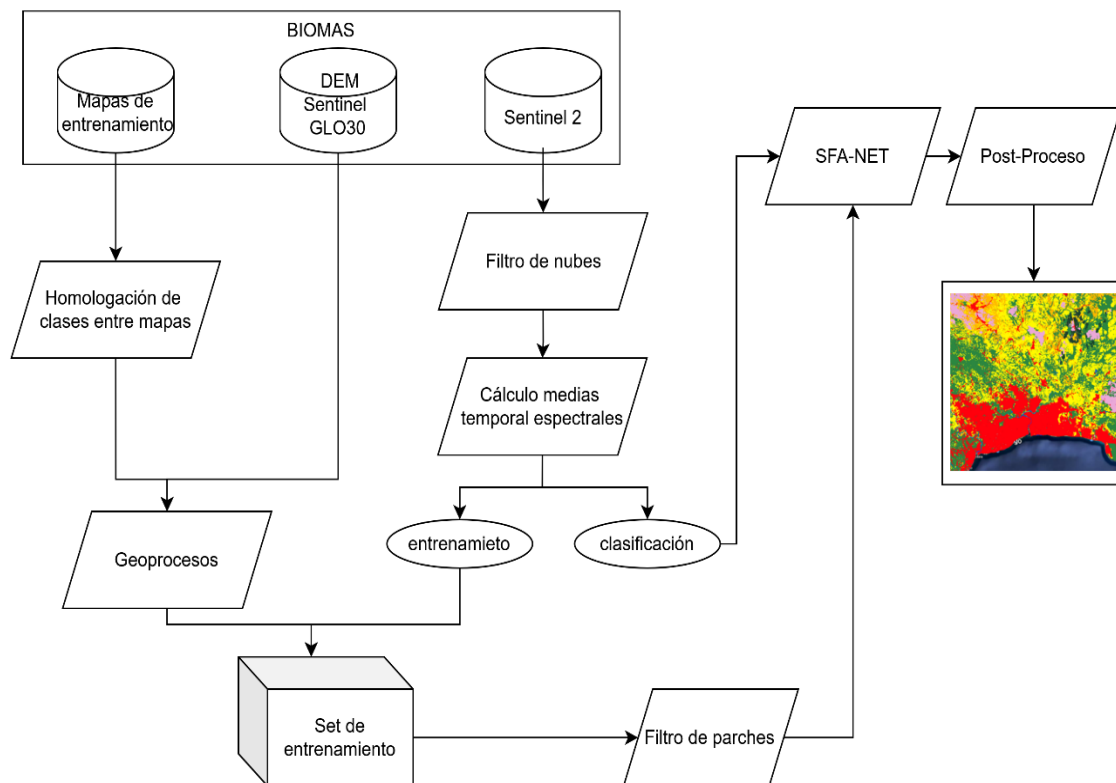


Figure 3. General methodology used in the development of the Land Cover and Land Use map. Source: own elaboration.

References

DLR e.V., & Airbus Defence and Space GmbH. (2018). *Copernicus WorldDEM-30* [Dataset]. Copernicus.

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

Latham, J., Cumani, R., Rosati, I., & Bloise, M. (2014). *FAO global land cover (GLC-SHARE) beta-release 1.0 database*. Food and Agriculture Organization of the United Nations (FAO), Land and Water Division.

RESOLVE. (2024). *Ecoregions of the World* [Map]. <https://ecoregions.world/>

Tan, M., & Le, Q. V. (2019). *EfficientNet: Rethinking model scaling for convolutional neural networks*. arXiv. <https://doi.org/10.48550/arXiv.1905.11946>