MAPBIOMAS
ECUADOR

Land Use and Land Cover

General Map

Algorithm Theoretical Basis Document (ATBD)

Collection 4.0

Version 1.0

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1. Introduction

MapBiomas Ecuador is an initiative focused on monitoring land use changes across the entire national territory. This multitemporal mapping-based monitoring makes it possible to track pressures on natural ecosystems and the advance of anthropogenic land uses.

The MapBiomas Network project involves a collaborative network of specialists from each of the member countries in fields such as land use, remote sensing, GIS and programming. It uses cloud processing and automated classifiers, developed and operated on the Google Earth Engine platform, to generate a historical series of annual land cover and land use maps of the Amazon.

In 2025, in Ecuador, under the leadership of EcoCiencia, the third collection of national-scale land use change maps was generated, and the third collection of the monitoring of surface water bodies across the country was also updated as part of the regional MapBiomas Water initiative.

Map collections 1 to 6 (published between 2019 and 2023) of the MapBiomas Amazon initiative considered as their working scope only the area of Ecuador within the RAISG boundary, which corresponds to the part of continental Ecuador that belongs to the Amazon basin, defined from the watershed divide boundary obtained from official cartographic information provided by SENAGUA (2014) and CONALI (2016). This territory covers a total area of 132,292 km2, equivalent to 53% of the country and 1.6% of the Amazon basin (Figure 1).

Collections 1 to 4 (published between 2023 and 2025) of the MapBiomas Ecuador initiative consider as their study area **the entire Ecuadorian territory, including the Galápagos Islands,** equivalent to 256,609 km2. The boundary was defined from official cartographic information provided by CONALI (2021). This series of annual land cover and land use maps therefore represents MapBiomas Ecuador Collection 4.0.

2. General characteristics of the country

2.1. Brief description of Ecuador.

Ecuador is located in the northwestern corner of South America. It borders Colombia to the north, Peru to the east and south, and the Pacific Ocean to the west. The political-administrative division of the country consists of 24 provinces, 221 cantons, 396 urban parishes and 799 rural parishes. The national territory, including the Galápagos Islands, covers a total area of 256,608 km2[1].

According to official figures, as of 2020, 48.96% of continental Ecuador is covered by native forest, equivalent to an area of 12,191,125.41 hectares. Of this area, the largest share (75%) is located in the Amazon region (as defined politically and administratively), approximately 14% in the Coastal region and 11% in the Highlands (MAATE,2024).

[1]* International and internal territorial boundaries correspond to those defined by the National Committee on Internal Boundaries, CONALI (2021), modified by Fundación EcoCiencia (2023). Scale 1:50,000. Additionally, the analysis area considered by the MapBiomas Ecuador initiative is used, which excludes some islets that, due to their size, cannot be analyzed at the spatial resolution of the satellite imagery.

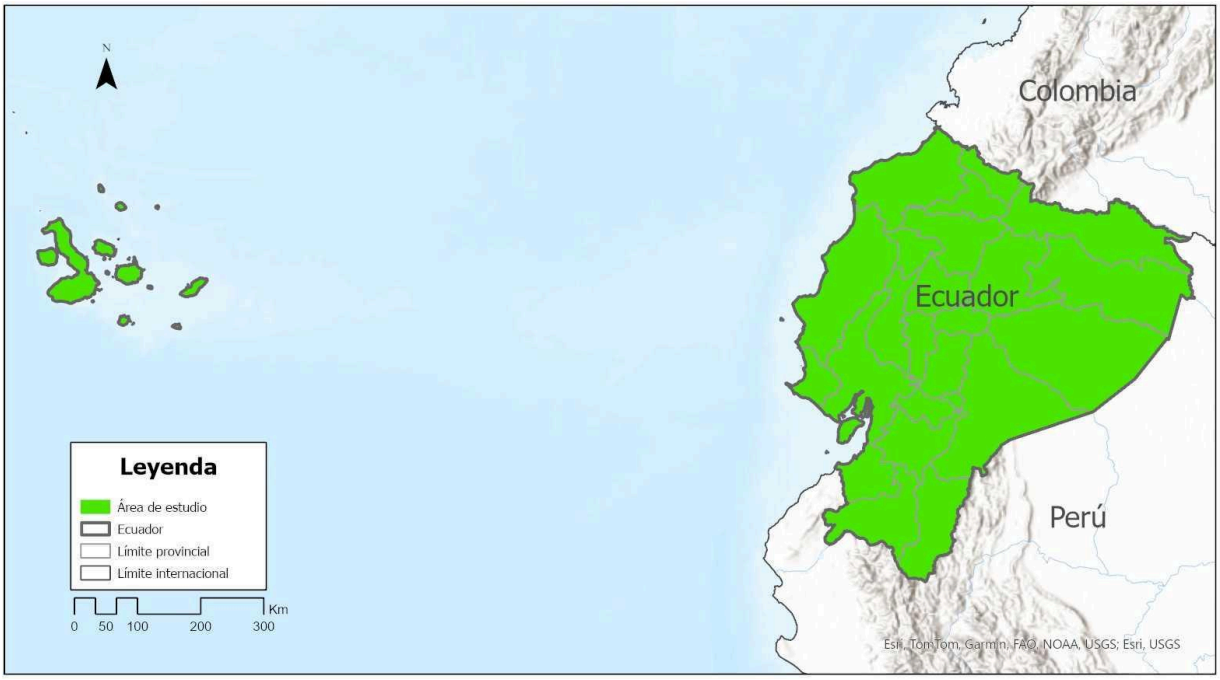


Figure 1. *Study area in Ecuador, Collection 4.0 (Prepared by Ecociencia).*

2.2. Biomes of Ecuador.

For Ecuador, the MapBiomas project defined five ecoregions, referred to within the MapBiomas project as "biomes": Pacific Tropical Moist Forest, Equatorial Dry Forest, Andes, Amazon and Galápagos (Figure 2, Table 1).
The delimitation of these ecoregions was carried out based on technical criteria on ecosystem distribution, using as reference the following national maps:

- Biogeographic sectors[2] (MAATE, 2013b)
- Ecosystems of Continental Ecuador (MAATE, 2013a)
- Ecosystems of the Northern and Central Andes (Josse et al., 2009)
- SRTM 90 m digital elevation model (Jarvis et al., 2008)
- Ecoregions Map (Dinerstein et al., 2017)
- Ecological systems of Latin America and the Caribbean (Josse et al., 2003)
- Land Cover and Land Use and Agricultural Production Systems Map of Continental Ecuador (MAG, 2021)
- Availability of cloud-free Landsat images

[2] Defined by MAATE as: "A representation of the biogeography of continental Ecuador, this map allows us to explain the distribution areas of species according to patterns that make it possible to identify their centers of origin and dispersal, as well as to understand the spatial patterns of biological diversity. These units are based on vegetation physiognomy, landscape criteria, climatic conditions and floristic components."

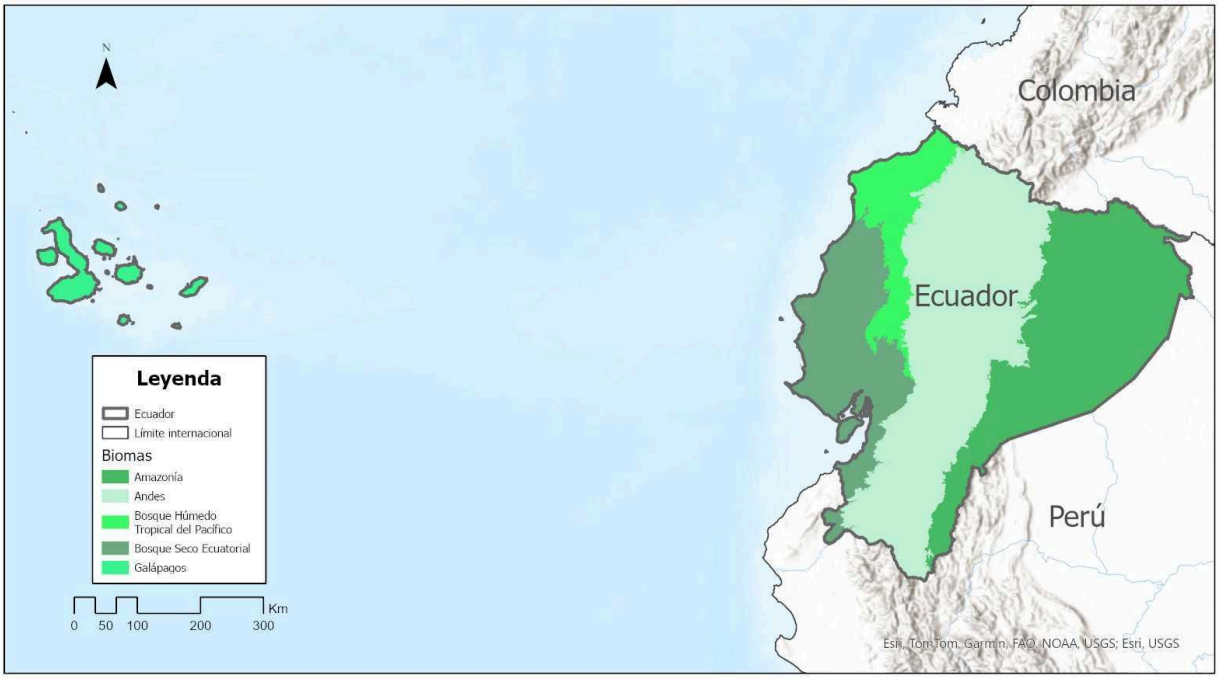


Figure 2. *Biomes of Ecuador: Regions used for MapBiomas Ecuador Collection 4.0 (Prepared by Ecociencia).*

Table 1. Biomes as part of the MapBiomas Ecuador project. Areas measured using the SIRGAS 2000 coordinate reference system (Prepared by Ecociencia).

Biome	Km^2	%	Provinces that are part of each biome (totally or partial
Amazon	81,482	32	Orellana, Napo, Morona Santiago, Pastaza, Zamora Chinchipe, Sucumbios
Andes	101,367	40	Azuay, Bolívar, Orellana, Cañar, Guayas, Chimborazo, Imbabura, Loja, Napo, El Oro, Pich Santo Domingo de los Tsáchilas, Tungurahua, Cotopaxi, Pastaza, Zamora Chinchipe, Car
Pacific Tropical Moist Forest	22,053	9	Bolívar, Guayas, Imbabura, Manabí, Pichincha, Los Ríos, Santo Domingo de los Tsáchilas,
Equatorial Dry Forest	43,709	17	Azuay, Bolívar, Cañar, Guayas, Chimborazo, Loja, Manabí, El Oro, Los Ríos, Santa Elena, E
Galápagos	7,992	3	Galápagos
Total	256,609		

2.2.1. Pacific Tropical Moist Forest Biome

The Pacific Tropical Moist Forest biome covers an area of 22,050 km^2, equivalent to 9% of the study area (Figure 2). It lies within an elevation range of 0 to 300 m, and is characterized by warm and humid conditions.

This biome includes closed-canopy forests, with trees that can reach 30 m in height and an understory dominated by ferns and plants of the Araceae family. Tree diversity is high (more than 100 species per hectare, but lower than in the Amazon Biome).

Anthropogenic habitat degradation in this ecoregion is among the highest in Ecuador; almost 75% of the forest has been destroyed by human activities. This biome is absent from the lowlands of southwestern Ecuador, where dry conditions predominate.



Figure 3. *Photo of the Pacific Tropical Moist Forest Biome. Photo: Jorge Vinueza.*

2.2.2. Equatorial Dry Forest Biome

The Equatorial Dry Forest biome covers an area of 43,709 km^2, equivalent to 17% of the study area (Figure 2). It is characterized by a combination of warm and extremely dry conditions. Mean annual precipitation may not exceed 60 mm (at the westernmost locality, Salinas, Guayas Province). It is found mainly along the coastal margin, in central Ecuador. In some areas, herbaceous species introduced for livestock have replaced the native vegetation. In the driest habitats, cacti and other spiny plants predominate.

The deciduous forests of the coast are also part of this biome, characterized by drier conditions and lower tree density compared to evergreen forests. Trees are generally less than 20 m tall, and there is an understory that can be dense, with abundant herbaceous plants. Some tree species, such as ceibos, shed their leaves during the dry season. Human impact in this region has been severe. It has been estimated that more than 60% of its area has been destroyed by human activities, especially agriculture and livestock farming



Figure 4. *Photo of the Equatorial Dry Forest Biome*

2.2.3. Andes Biome

The Andes biome comprises the regions known as "Andes" and "Upper Amazon", covering an area of 101,367 km^2, equivalent to 40% of the study area (Figure 2). This biome begins at approximately 300 m a.s.l. on the Pacific slope and from 400 m a.s.l. towards the Amazon. It comprises the montane, upper montane, highest montane, subnival and nival bioclimatic belts (MAATE, 2013c), with altitudes ranging between 2300 and 5800 m a.s.l. Temperatures in this region rarely exceed 25^{0}C. The relief is characterized by mountain ranges and ridges, with valleys of glacial and/or tectonic origin, forming a landscape composed of mountain peaks, calderas, craters, lava deposits and high hills, among which plains and extensive valleys are found. The melting of the glaciers that cover the summits of several volcanoes forms systems of lakes, wetlands and narrow water bodies that make up the headwaters of the Andean-origin basins of the Amazon Basin.

This region, known locally as the "Sierra" (to distinguish it from the "Costa" and "Oriente" regions), is characterized by the presence of montane forests, and other non-forest ecosystems, such as natural shrublands and grasslands, commonly known as "páramos", many of which have lacustrine, flooded or subnival characteristics, and whose phenology varies between evergreen, seasonal evergreen and semi-deciduous (MAATE, 2013c). Areas bordering the Amazon receive a strong influence of humidity and there is continuous forest cover. As altitude increases, vegetation stature decreases and its physiognomy changes, until it becomes absent in places such as sandy areas, exposed rock, scars of eruptive events and glaciers.

In the north of the country, the Andean range has an eastern and a western branch, between which lie densely populated inter-Andean valleys. Both branches of the range have a high concentration of volcanoes. Moving from north to south, this pattern changes: the maximum altitudes of the range decrease and the western massif loses considerable height at the latitude of the Gulf of Guayaquil, the point corresponding to the division between the Northern Andes to the north and the Central Andes to the south, which have different geological origins (Cuesta et al. 2009).

The slopes of the inter-Andean valleys show alternating dry and wet periods, strongly influenced by the rain shadow effect.

The Andean zone of Ecuador has been extensively transformed by the development of urban areas, infrastructure and, owing to the quality of its soils, by the expansion of agricultural and livestock uses. In part of these transformed zones, there are currently forests of introduced species, established for commercial or aesthetic purposes (mainly eucalyptus Eucalyptus spp and pine Pinus spp).



Figure 5. *Photo of the Andes Biome*

2.2.4. Amazon Biome

The Amazon biome comprises the "Lower Amazon" region, which covers an area of 81,482 km^2, equivalent to 32% of the study area (Figure 2). It includes the foothills of the Andean cordillera and transition zones to the Amazon lowlands, where the piedmont, lower montane and montane bioclimatic belts are found (MAATE, 2013c), with altitudes ranging between approximately 700 and 2300 m a.s.l. Its relief consists of piedmont and mountain ranges, characterized by rugged terrain with steep slopes and deep ravines. Due to their topography, foothill soils are subject to frequent landslides, which are exacerbated by anthropogenic processes such as deforestation and soil erosion.

These are hyper-humid zones, characterized by intense and almost constant rainfall, permanent cloud cover and low temperatures. Given the orographic influence in the area, these ecosystems capture large volumes of water from the fog that accumulates in them (a phenomenon known as horizontal precipitation or incidental rainfall), which is why the forests of this ecoregion, or "Northern Andean montane forests" (Cuesta et al. 2009), are known as 'rain forests', 'cloud forests' or 'fog forests'. The average height of these forests ranges from 20 to 30 meters, and their phenology is evergreen. Humidity values decrease latitudinally in the Upper Amazon region, reaching their lowest levels in areas bordering Peru, where remnants of seasonal evergreen forests with restricted distribution are found. In some portions of this region, montane evergreen shrublands and grasslands are also found, especially in areas reaching higher altitudes, such as branches of the Andes cordillera or the summits of the Amazonian mountain ranges proper.

The ecosystems of this biome play an especially important role as regulators of water flow, both locally and regionally. In addition, this ecoregion hosts some of the most biodiverse forests on the planet. However, it is also where the most fragile ecosystems are concentrated, at risk of disappearing due to the current and growing conversion of forests into pastures, crops and settlements as a

result of human occupation. In the case of Ecuador, certain portions of these ecosystems lie within protected areas; however, where these conservation figures do not exist, the degree of transformation is so high that forests have been restricted to slopes with rugged topography or to land with soils unsuitable for agriculture.

The Lower Amazon region comprises the lowland bioclimatic belt of the Ecuadorian Amazon (MAATE, 2013c), with altitudes between approximately 700 and 100 m a.s.l. Its relief includes peri-Andean piedmont, peneplain and plain, with topography ranging from plateaus and medium-sized hills to flatlands and terraces. Due to its topography and abundant rainfall, this region is prone to flooding, either seasonally or permanently. It is characterized by the predominance of dense tropical lowland evergreen forests, some of which are flooded or permanently inundated. These forests reach heights exceeding 30 meters, and are accompanied by lacustrine-riparian grasslands.



Figure 6. *Photo of the Amazon biome*

2.2.5. Galápagos Biome

The Galápagos biome covers an area of 7,992 km2, equivalent to 3% of the study area (Figure 2). It is located in the Pacific Ocean, 972 km from the continental coast of Ecuador, with an elevation range between 345 and 1707 m a.s.l. It is formed by the Galápagos archipelago, made up of 13 islands of volcanic origin with a total area of 8,010 km² (Consejo de Gobierno del Régimen Especial de Galápagos, 2015).

The climate of the Galápagos Islands is determined almost entirely by ocean currents, which in turn are influenced by the trade winds that drive them. It includes a warm season between January and April, with temperatures fluctuating between 26°C and 28°C, and a cool season during the rest of the year with temperatures below 24°C, with temperatures of 14°C recorded at certain western sites (Consejo de Gobierno del Régimen Especial de Galápagos, 2015).



Figure 7. *Photo of the Galápagos Biome*

3. National-Scale Land Cover and Land Use Mapping Initiatives

The most recent official and unofficial national-level initiatives for mapping vegetation cover and land use in Ecuador are summarized in Table 2 and detailed in Annex 1.

Table 2. Existing cartographic data on vegetation cover and land use for Ecuador (Prepared by Ecociencia).

Map	Reference	Description	Scale	Year mapped
Ecosystem Map of Continental Ecuador	MAATE, 2013	Spatial distribution of the remaining ecosystems of continental Ecuador as of 2012, for areas with natural cover.	1:100,000	2012
Land Cover and Land Use Map	MAGAP, SIGTIERRAS, IEE 2009-2015	Detailed information on production systems, land cover, plot size and crop seasonality.	1:25,000	Between 2009 and 2015, depending on the canton
Land Cover and Land Use (CUT) Maps of Continental Ecuador	MAATE, MAGAP, 2016 MAATE, MAGAP, 2017 MAATE, MAGAP, 2019 MAATE,MAGAP,2023 MAATE, MAGAP, 2023 MAATE, MAGAP,2025	At the 1st level, it maps the 6 classes defined by the IPCC (forest, agricultural land, shrub and herbaceous vegetation, water body, anthropic zone and other lands). At the 2nd level, it defines 16 land cover and land use classes in greater detail.	1:100,000	1990, 2000, 2008, 2014, 2016, 2018, 2020, 2022, 2024
Land Cover and Land Use and Agricultural	MAG, 2021	Detailed information on production systems, land cover, plot size and crop seasonality. Version edited by the Ministry of Agriculture and Livestock in 2020.	1:25.0000	Between 2009 and 2015, edited in 2020

Methodology for mapping native and invasive vegetation cover in archipelagos: An example from the Galápagos Islands.	Rivas et al., 2018, Universidad San Francisco de Quito.	Detailed information on a methodology for mapping vegetation and assessing species invasion in Galápagos National Park. Identification of native ecosystems and invasive species. The vulnerability of deciduous forests and threats to high-mountain ecosystems are highlighted.	1:75,000	2015 y 2016
Collection 1 of Annual Land Cover and Land Use Maps 2000-2017 of the Amazon	MapBiomas Amazonía, 2019	Annual land cover and land use maps of the Amazon for the period 2000 to 2017, generated from Landsat satellite images classified using empirical decision trees.		Annual, 2000 to 2017
Collection 2 of Annual Land Cover and Land Use Maps 1985-2018 of the Amazon	MapBiomas Amazonía, 2020	Annual land cover and land use maps of the Amazon for the period 1985 to 2018, generated from Landsat satellite images classified using the Random Forest algorithm in Google Earth Engine.		Annual, 1985 to 2018
Collection 3 of Annual Land Cover and Land Use Maps 1985-2020 of the Amazon	MapBiomas Amazonía, 2021	Annual land cover and land use maps of the Amazon for the period 1985 to 2020, generated from Landsat satellite images classified using the Random Forest algorithm in Google Earth Engine.		Annual, 1985 to 2020
Collection 4 of Annual Land Cover and Land Use Maps 1985-2021 of the Amazon	MapBiomas Amazonía, 2022	Annual land cover and land use maps of the Amazon for the period 1985 to 2021, generated from Landsat satellite images classified using the Random Forest algorithm in Google Earth Engine.		Annual, 1985 to 2021
Collection 5 of Annual Land Cover and Land Use Maps 1985-2022 of the Amazon	MapBiomas Amazonía, 2023	Annual land cover and land use maps of the Amazon for the period 1985 to 2022, generated from Landsat satellite images classified using the Random Forest algorithm in Google Earth Engine.		Annual, 1985 to 2022
Collection 6 of Annual Land Cover and Land Use Maps 1985-2023 of the Amazon	MapBiomas Amazonía, 2024	Annual land cover and land use maps of the Amazon for the period 1985 to 2023, generated from Landsat satellite images classified using the Random Forest algorithm in Google Earth Engine.		Annual, 1985 to 2023
Collection 1 of Annual Land Cover and Land Use Maps 1985-2022 of Ecuador	MapBiomas Ecuador, 2023	Annual land cover and land use maps of Ecuador for the period 1985 to 2022, generated from Landsat satellite images classified using the Random Forest algorithm in Google Earth Engine.		Annual, 1985 to 2022.
Collection 2 of Annual Land Cover and Land Use Maps 1985-2023 of Ecuador	MapBiomas Ecuador, 2024	Annual land cover and land use maps of Ecuador for the period 1985 to 2023, generated from Landsat satellite images classified using the Random Forest algorithm in Google Earth Engine.		Annual, 1985 to 2023

4. Methodological Details Applied in MapBiomas Ecuador Collection 4.0

Collection 4.0 of Annual Land Use and Land Cover Maps of Ecuador was generated with a standardized methodology shared by the entire MapBiomas network.

4.1. Generation of Annual Mosaics

The first step in generating land cover and land use maps is the construction of annual mosaics, built from satellite images captured by the **Landsat project**. To this end, the MapBiomas Ecuador initiative used two methods:

1. For the area within the RAISG boundary: mosaics were processed based on a uniform grid derived from the International Map of the World at the Millionth Scale (1:250,000 scale), where each sheet covers a total of 1°30' of longitude by 1° of latitude. Based on this division, 16 unit sheets cover the Ecuadorian Amazon. However, given the seasonality of the cover types to be mapped, it became necessary to subdivide certain sheets, for which the boundaries of the Andes, Upper Amazon and Lower Amazon regions were used (Figure 8), totaling 27 units or "sheet-regions" (Table 3).

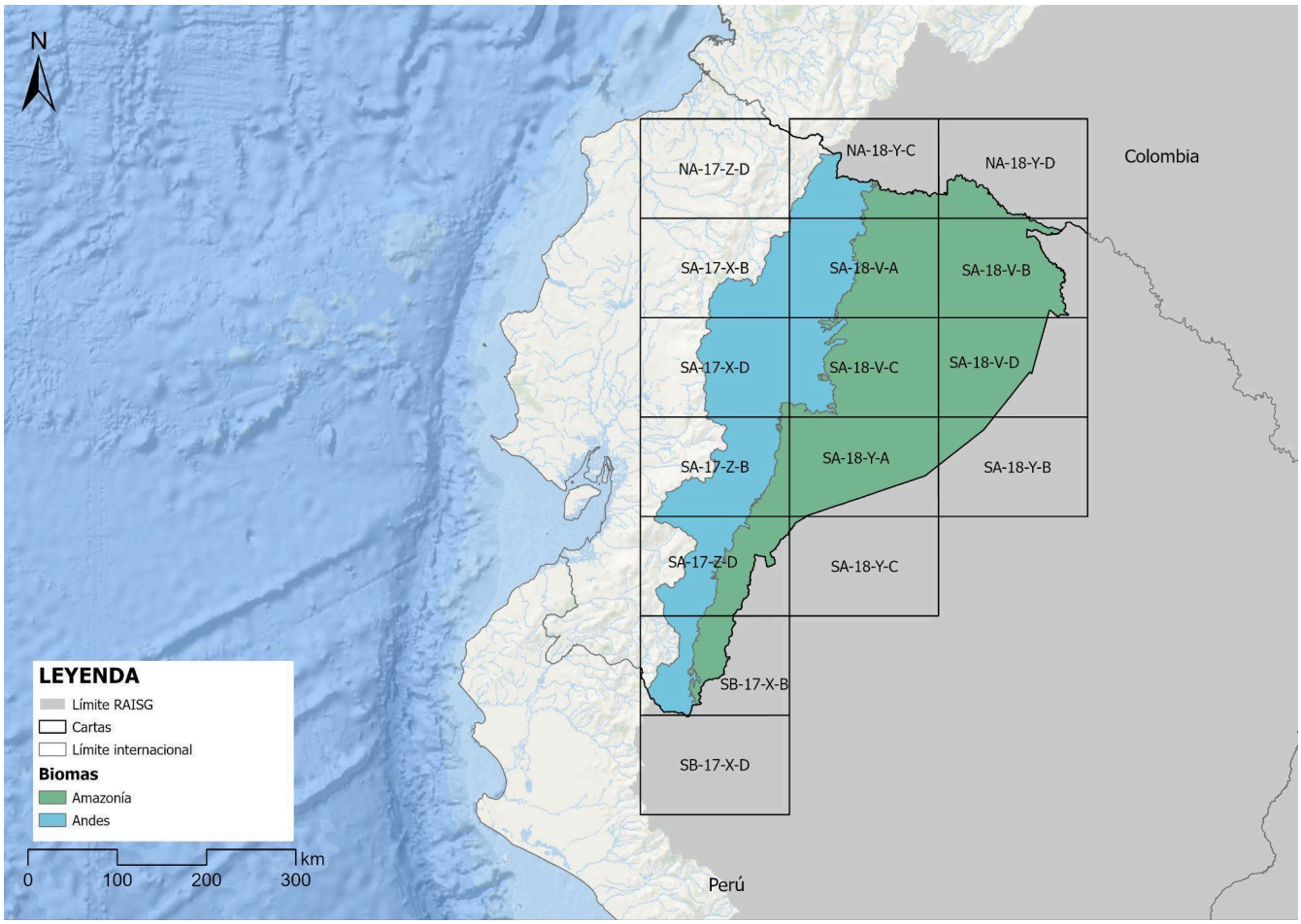


Figure 8. *Sheets for the RAISG boundary (Prepared by Ecociencia).*

Table 3. Number of annual mosaics processed per region for the area within the RAISG boundary (Prepared by Ecociencia).

Country	Region	Sheets per region	Mosaics parameterized and processed for the time series 1985-2024
	Andes	8	294
Ecuador	Upper Amazon	10	430
	Lower Amazon	9	321
Total		**27**	**1045**



Figure 9. *Annual mosaics 1985-2024 of MapBiomas Ecuador Collection 4.0 within the RAISG boundary (Prepared by Ecociencia).*

2. For the area outside the RAISG boundary: the reference unit used for the construction of the mosaics was the Landsat path/row grid. The entire Ecuadorian territory, both continental and insular, is covered by 17 path/rows. Table 4 summarizes the corresponding number per region.

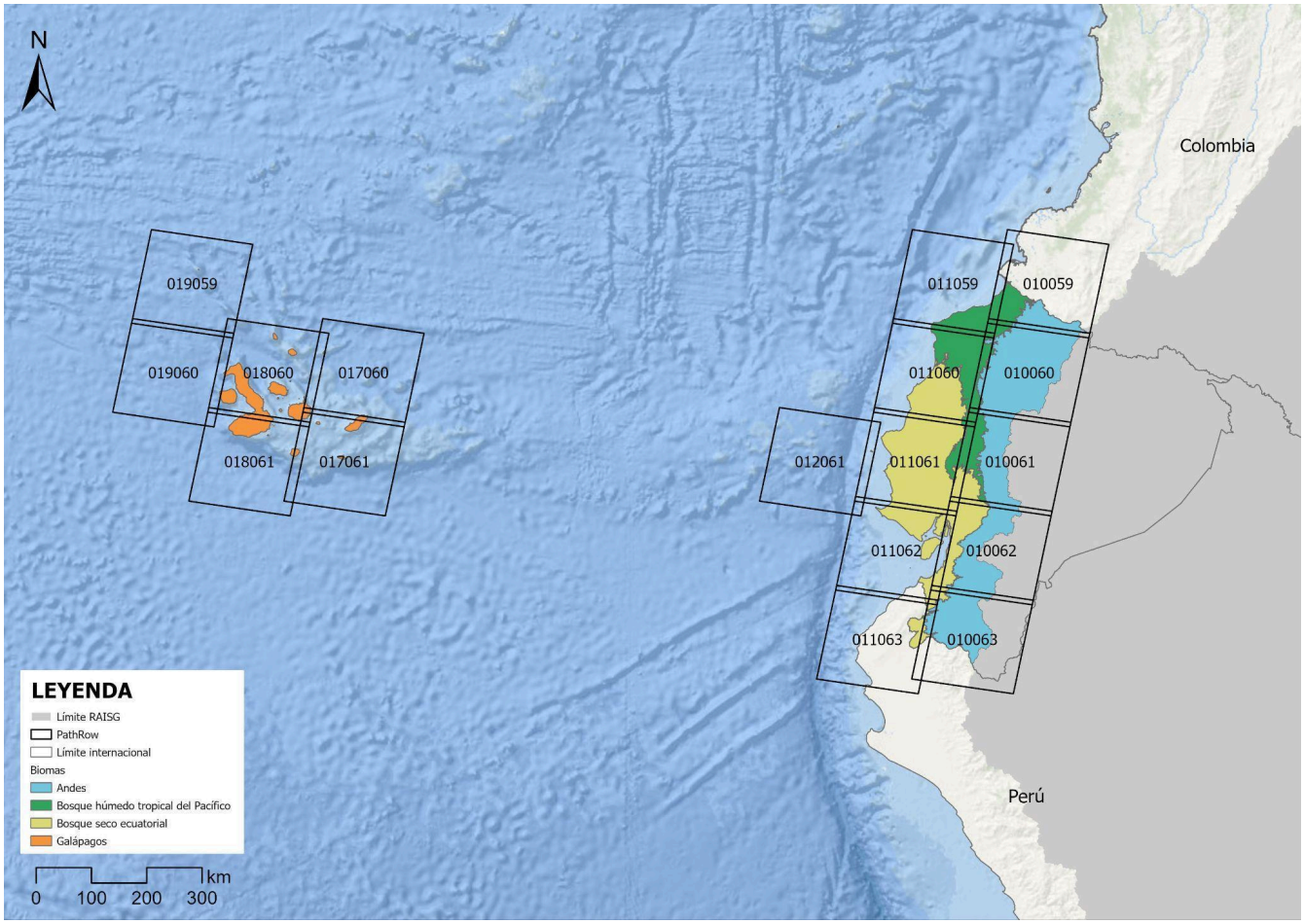


Figure 10. *Non-RAISG PathRows, Ecuador (Prepared by Ecociencia)*

Table 4. Number of annual mosaics processed for the area outside the RAISG boundary (Prepared by Ecociencia).

Country	Biome	Scenes per biome	Mosaics parameterized and processed for the time series 1985-2024
Ecuador	Andes, Pacific Tropical Moist Forest and Equatorial Dry Forest	11	398
	Galápagos	6	186
Total		**17**	584

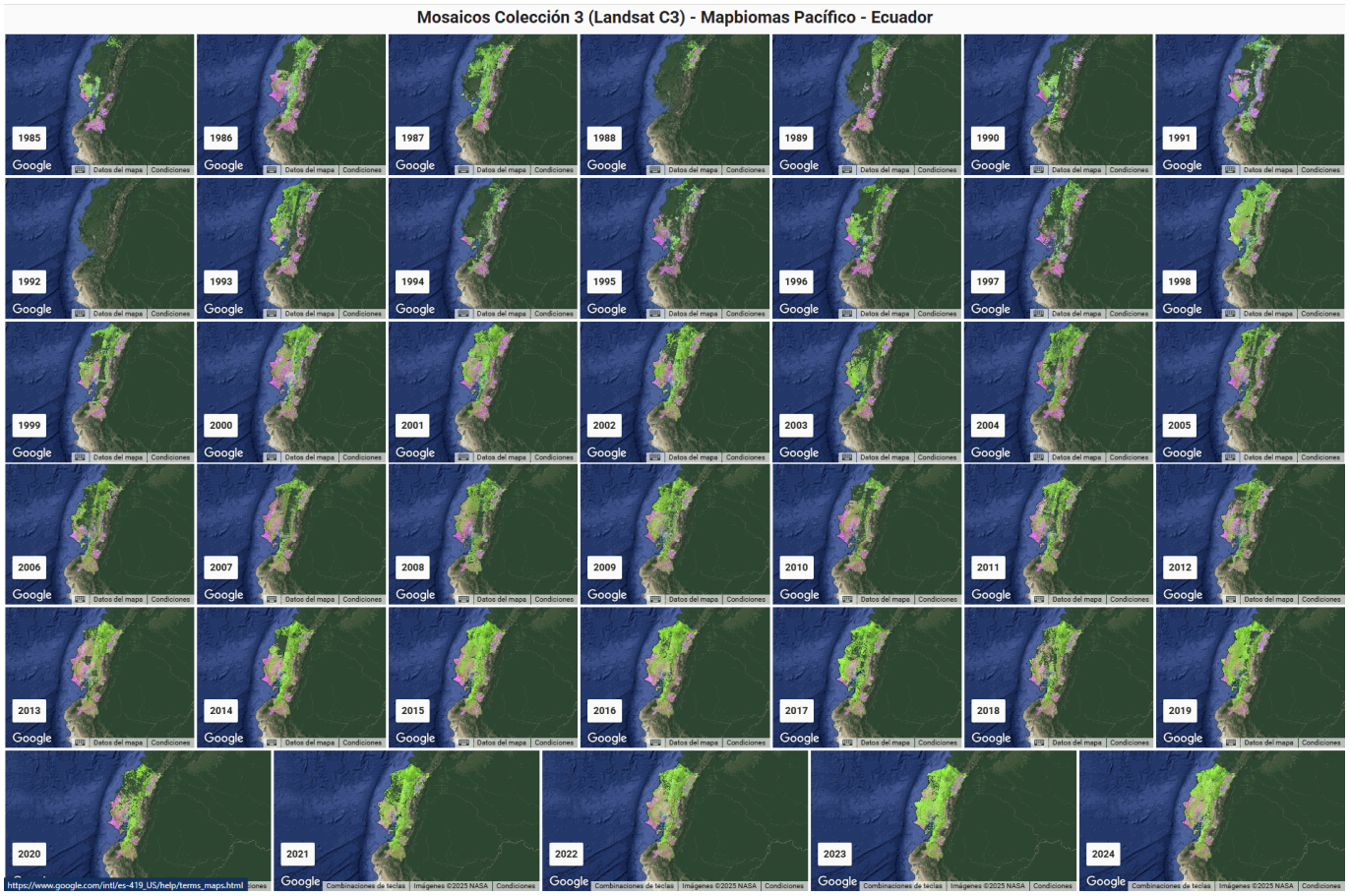


Figure 11. *Annual mosaics 1985-2024 of MapBiomas Ecuador Collection 4.0 outside the RAISG boundary (Prepared by Ecociencia).*

For Collection 4.0, the mosaic for the year 2025 was built exclusively using the Path / Row method, with the aim of beginning to unify the methodologies used for mosaic generation. The entire Ecuadorian territory is covered by 24 path/rows.

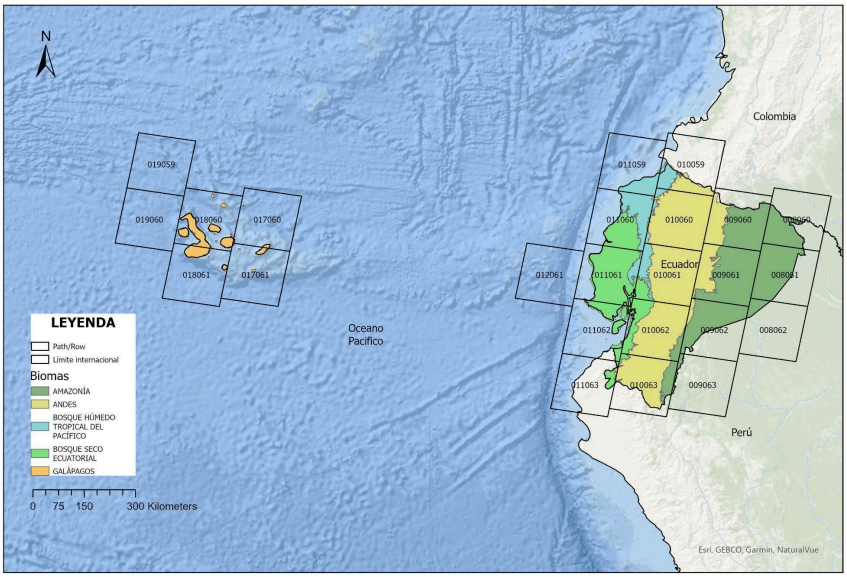


Figure 12: Distribution of the Path/Rows for processing the 2025 mosaic. Prepared by: Ecociencia.

Both within and outside the RAISG boundary, each satellite image acquired during the period 1985-2025 and available in Collection 2 of the Landsat image catalog was visually evaluated through Google Earth Engine. This image collection was filtered

using parameters defined individually for each sheet, which included: cloud cover thresholds, data search period (time window) and even the exclusion of specific images of insufficient quality due to excessive clouds, sensor failures, pre-processing failures, among other factors. The images selected for each year were reduced to a single image, or annual mosaic (image composite), using operators called reducers, available in Google Earth Engine (Figure 13).

Median mosaic: For each sheet and each year, a mosaic of Landsat 4, 5, 7, 8 and 9 images was built. Each mosaic is composed of at least 2 images, where the value of each pixel per band in the composite is assigned using the median value of the set of selected images. This operation is applied to the visible red, near-infrared and mid-infrared bands, as shown in Figure 12.

In this way, the pixel used for classification corresponds to the median value of the time series. For example, if the final mosaic for a sheet is composed of images obtained between October and December, with a maximum cloud cover of 30%, to obtain the final result the remaining clouds or shadows are first masked and then the median statistical reducer is used to build the final interpretation mosaic.

Each sheet was processed individually using the median value of the images selected for each year of the 1985 - 2025 time series. Figure 11 shows the mosaics for the continental area of the Ecuadorian territory. Due to the lack of information in the Landsat collections or high cloud cover, gaps persist throughout the time series; this lack of information occurred temporally, most notably at the beginning of the series between 1985 and 1988 and between 1992 and 1996, and spatially in high-mountain areas, such as páramos and glaciers, and the Chocó biogeographic region; this situation affected the results in areas with highly dynamic land cover change, where the capacity of the method to fill these gaps was insufficient.

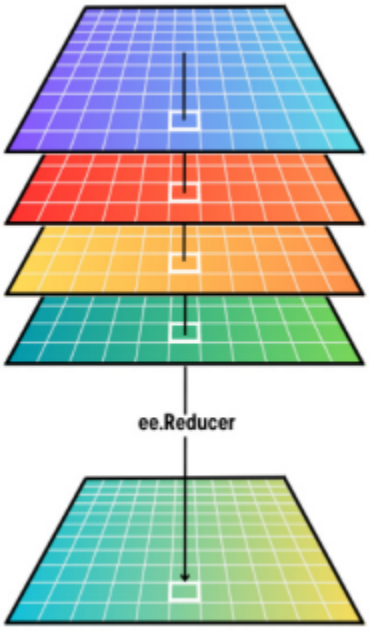


Figure 13. *Effect of applying a reducer to an image collection to build a mosaic (composite) (Google, 2020[3]).*

In total, specific parameters were defined for each of the 41 years of the period 1985 to 2025, for each of the 27 "sheet-regions" and 24 Landsat scenes. However, due to data gaps in the catalog, a total of 1045 mosaics were processed (Tables 3 and 4) for the area within the RAISG boundary of Ecuador and 584 mosaics for the area outside the RAISG boundary. The parameterization made it possible to build annual mosaics with the best possible quality, the greatest coverage of useful data and the fewest clouds or interferences (Figure 11). Data from Landsat 4, 5, 7, 8 and 9 were used in this collection.

Within Ecuador, and as shown in Table 5, there is a total of 11805 Landsat Surface Reflectance (SR) satellite images belonging to Collection 2, which have captured data over the country since 1985; these amount to more than 10 TeraBytes of information; these images are analyzed, discarded or processed as part of the generation of the annual mosaics. It is worth mentioning that this collection includes Landsat 9, a relatively new satellite whose data are already available in Google Earth Engine.

[3] Taken from: https://developers.google.com/earth-engine/guides/reducers_image_collection

Table 5. Number of Landsat satellite images that have captured information over Ecuador up to 2024 (Prepared by Ecociencia).

	Lt4	Lt5	Lt7	Lt8	Lt9	Total
1980-1989	109	371	0	0	0	480
1990-1999	30	1,048	90	0	0	1,168
2000-2010	0	406	1,956	0	0	2,362
2010-2019	0	53	2,461	2,293	0	4,807
2020-2023	0	0	946	1,275	685	2,906
2024 - 2025	0	0	0	592	658	1,250
Total	139	1878	5453	4160	1343	12,973

Despite efforts to recover as much good-quality useful data as possible, the resulting mosaics are not free of data gaps. Ecuador is a country where the availability of satellite data from optical sensors such as Landsat for the period 1985-2025 has been greatly affected by:

- The continuous presence of clouds, which limits the number of useful pixels (cloud-free observations), with the Pacific Tropical Moist Forest and Equatorial Dry Forest, Andes and Upper Amazon regions presenting the greatest limitations;
- Failures in the equipment for receiving and recording low-orbit satellite data within the coverage range of the "Cotopaxi" Station antenna[4], which permanently affected data recording for the period 1991-1995, which is why it was not possible to generate mosaics for most sheets for these years.

4.1.1 Feature Space

For each pixel with useful data in each annual mosaic, 151 variables were calculated that make up the feature space, which is composed of: reflectance bands, indices derived from the spectral bands, spectral fractions obtained from a spectral mixture analysis, and spectral fraction indices (Annex 4). These variables are the main input for the classification algorithm.

The following statistical reducers were applied[5] to the variables to obtain:

- *Median*: Calculation of the median[6] applied to all pixels available in the annual mosaic at that location.
- *Dry season median*: Calculation of the statistical median applied to the pixels of the quartile with the lowest NDVI values (dry season proxy).
- *Wet season median*: Calculation of the statistical median applied to the pixels of the quartile with the highest NDVI values (wet season proxy).
- *Amplitude*: Range of variation among all pixels available in the annual mosaic.
- *Standard deviation*: Standard deviation of the values of all pixels available in the annual mosaic for a given location.
- *Minimum*: Lowest value of all pixels available in the annual mosaic at a given location.
- *Maximum*: Highest value of all pixels available in the annual mosaic at a given location.
- *Dry period minimum*: Calculation of the lowest value of all available pixels from the images of the quartile with the lowest NDVI values (dry season proxy).
- *Wet period minimum*: Calculation of the lowest value of all available pixels from the images of the quartile with the highest NDVI values (wet season proxy).
- *Dry period maximum*: Calculation of the highest value of all available pixels from the images of the quartile with the lowest NDVI values (dry season proxy).

[4] Installed by NASA and transferred in 1982 to CLIRSEN (now the Ecuadorian Space Institute), the Cotopaxi Station aims to receive, record and process satellite data within its reception range.

[5] Reducers are applied at the pixel level, so that each pixel in the output is computed from all the pixels of the images in the collection at that location.

[6] The median is the value separating the upper half from the lower half of a data sample or a population. Documentation of the tool in Google Earth Engine.

- *Wet period maximum*: Calculation of the highest value of all available pixels from the images of the quartile with the highest NDVI values (wet season proxy).
- *Dry period QMO*: The highest value of the band at the evi2 index in the dry season.
- *Wet period QMO*: The highest value of the band at the evi2 index in the wet season.

Each variable makes up a band in the final annual mosaic. Additionally, variables such as slope, altitude, hillshade and flood susceptibility, among others, were included, so that the final annual mosaics are composed of 151 bands (the complete list of bands is attached as Annex 4).

4.2. General Map Classification

The classification of the base map or general land cover and land use map of Ecuador was carried out following a regionally standardized methodological protocol (MapBiomas methodology), based on the use of the Random Forest supervised classification algorithm at the pixel level. The entire process was executed in the cloud geoprocessing environment called Google Earth Engine (GEE), following a sequence of iterative steps, which are carried out as many times as necessary until a quality classification product is achieved (Figure 14).

The complete processing chain for generating the general map of MapBiomas Ecuador Collection 4.0 is summarized in Figure 14.

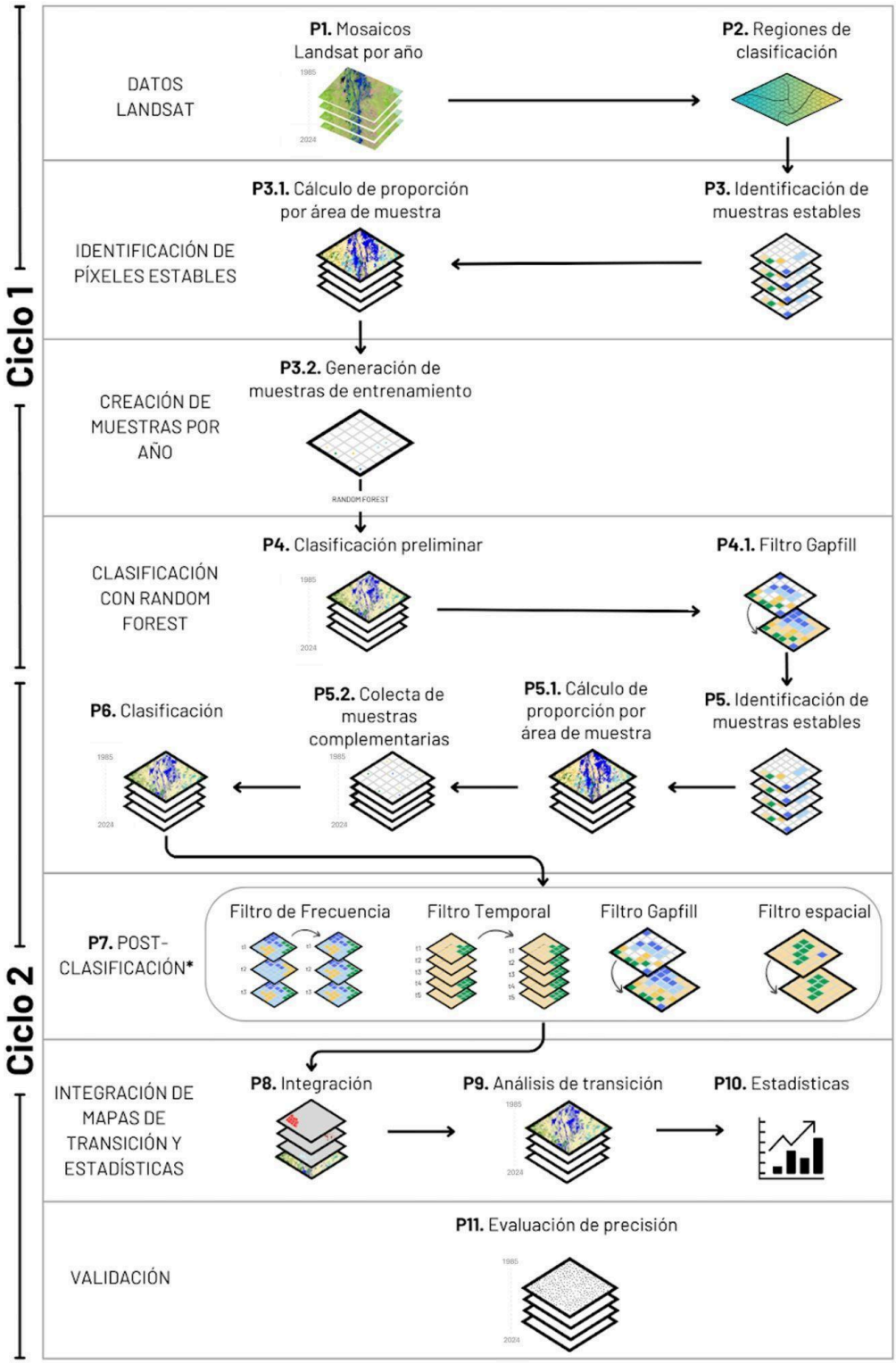


Figure 14. *Complete processing chain of the General Map of MapBiomas Ecuador Collection 4.0 (Prepared by Gaia Amazonas).*

In our experience, the determining factors in classification quality were:

- Training and classification based on the use of mapping units that follow criteria of the spatial distribution of land cover and land use types (called classification regions),
- The balanced distribution of training samples, both geographically and among classes (where the least represented or most restricted class reaches about 12% of the total samples for a region),

- The identification of a threshold or number of trees allowed (although increasing the number of trees yields better results, beyond a certain point accuracy declines),
- The number of iterations (each additional round strengthens the final product. With each iteration, the map of stable pixels, from which the training samples are drawn, gains accuracy, generating an increasingly less spectrally ambiguous set of samples),
- The evaluation and selection of the variables that contribute most to class discrimination (although our annual mosaics are composed of 151 bands, better results were obtained when excluding those bands whose values (classification variables) contribute least to the classifier; this adjustment was performed individually for each classification region).

4.2.1 Classification regions

The sequence of classification steps is applied independently to each mapping unit or classification region. In Ecuador, twenty-nine (29) classification regions were defined (Figure 15, Table 5), following criteria based on the spatial distribution of land cover and land use types[7].

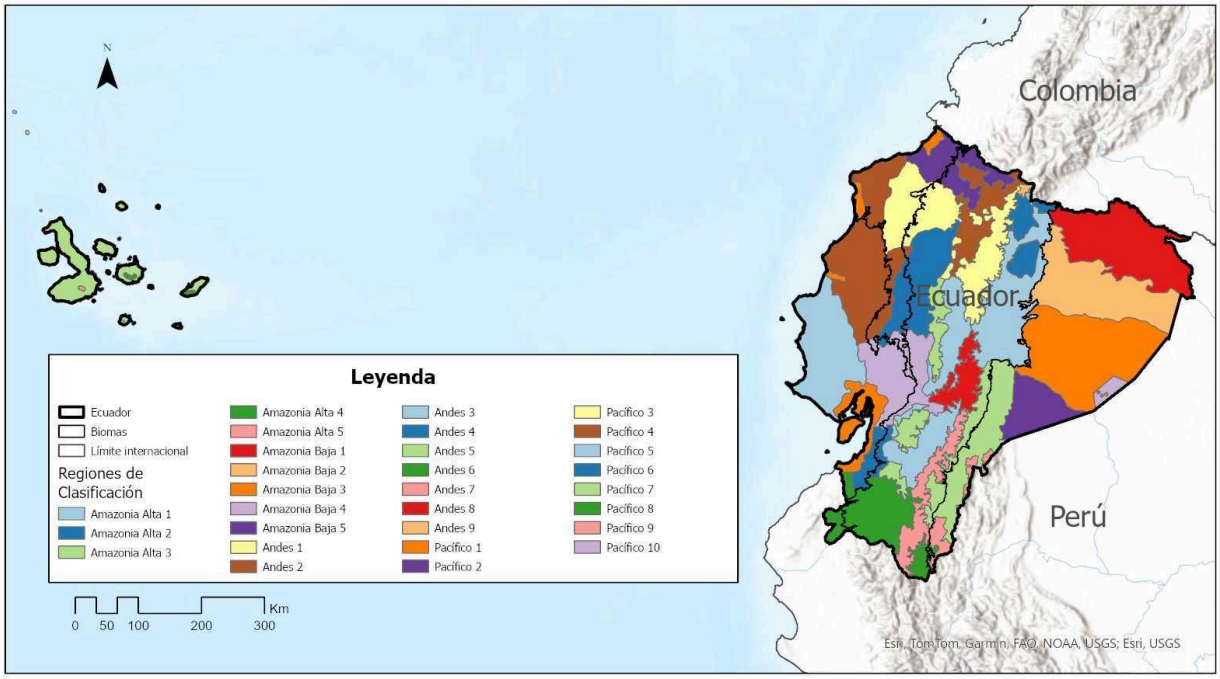


Figure 15. *Classification regions of Ecuador for MapBiomas Ecuador Collection 4.0 (Prepared by Ecociencia).*

The reasons for dividing the country into classification regions are as follows:

- Andes: Its conditions of greater seasonality and persistent cloud cover call for a mosaic-building time period different from that of the Amazon. The aim was to strengthen the mapping of formations specific to this region (glaciers, páramos) and to avoid confusion (given their spectral similarity) between non-forest natural covers dominated by herbaceous species and land use areas such as agriculture and planted pastures.
- Upper Amazon: Its information gaps due to persistent cloud cover make it necessary to establish broader temporal parameters for building the annual mosaic. Due to its topography and cloudiness, it shows an increase in shadows that hinder the classification of forests in shaded areas and of narrow water bodies.
- Lower Amazon: Its physiography of plains and gently rolling hills facilitates the mapping of its evergreen forests, wide water bodies and agricultural land use areas.
- Pacific Basin and Galápagos: since this is a first collection for these regions, the criteria for delimiting regions were based on the use of secondary reference maps (mainly ecosystem distribution and land use maps). Based on the lessons learned and the mapping results obtained in this 1st collection, the classification regions will be refined as a strategy to strengthen the mapping of future collections.

[7] The classification regions were defined following criteria of ecological and hydrological units based on the Ecosystem Map of Ecuador (MAATE, 2013), together with the presence or absence of anthropogenic intervention and lessons learned from past Collections.

Table 6. Classification regions defined in Ecuador. Areas measured using the Sphere Sinusoidal coordinate reference system (Prepared by Ecociencia).

No.,	Code	Classification region	Area (km2)	%	Mosaic region
1	40101	Upper Amazon 1	14058,34	5,36%	Amazon
2	40102	Upper Amazon 2	4596,82	1,75%	Amazon
3	40103	Upper Amazon 3	14410,30	5,49%	Amazon
4	40104	Upper Amazon 4	1815,47	0,69%	Amazon
5	40105	Upper Amazon 5	2590,40	0,99%	Amazon
6	40201	Lower Amazon 1	18886,06	7,20%	Amazon
7	40202	Lower Amazon 2	17766,97	6,77%	Amazon
8	40203	Lower Amazon 3	23756,79	9,05%	Amazon
9	40204	Lower Amazon 4	1215,02	0,46%	Amazon
10	40205	Lower Amazon 5	7111,02	2,71%	Amazon
11	40601	Andes 1	8437,38	3,22%	Andes
12	40602	Andes 2	6816,68	2,60%	Andes
13	40603	Andes 3	12807,03	4,88%	Andes
14	40604	Andes 4	12021,39	4,58%	Andes
15	40605	Andes 5	5917,19	2,25%	Andes
16	40606	Andes 6	10980,95	4,18%	Andes
17	40607	Andes 7	6182,68	2,36%	Andes
18	40608	Andes 8	4819,77	1,84%	Andes
19	40609	Andes 9	289,34	0,11%	Andes
20	40901	Pacific 1	8397,56	3,20%	Pacific
21	40902	Pacific 2	7542,49	2,87%	Pacific
22	40903	Pacific 3	16434,79	6,26%	Pacific
23	40904	Pacific 4	17556,55	6,69%	Pacific
24	40905	Pacific 5	15189,03	5,79%	Pacific
25	40906	Pacific 6	4019,16	1,53%	Pacific
26	40907	Pacific 7	10690,86	4,07%	Pacific
27	40908	Pacific 8	285,92	0,11%	Pacific

28	40909	Pacific 9	87,93	0,03%	Pacific
29	40910	Pacific 10	7723,87	2,94%	Pacific

4.2.2 Legend

MapBiomas uses a common legend for all its initiatives, of which Ecuador uses a subset of classes according to their occurrence in the country. The operational definition of each class can be found on our website. The classes mapped in Ecuador (Figure 16) for MapBiomas Ecuador Collection 4.0 are: Forest (ID = 3), Open forest (ID = 4), Mangrove (ID = 5), Flooded forest (ID = 6), Wetland non-forest natural formations (ID = 11), Grassland (ID = 12), Andean grasslands and shrublands (ID = 81), Andean flooded grasslands (ID = 82), Other non-forest natural formation (ID = 13), Rocky outcrop (ID = 29), Mosaic of agriculture and pasture (ID = 21), Forest plantation (ID = 9), Banana (beta) (ID = 74), Urban infrastructure (ID = 24), Mining (ID = 30), Beach, dune or sand spot (ID = 23), Other non-vegetated anthropic area (ID = 25), Other non-vegetated natural area (ID = 68), Rivers, lakes or ocean (ID = 33), Aquaculture (ID = 31), Glaciers (ID = 34) and Not observed (ID = 27).



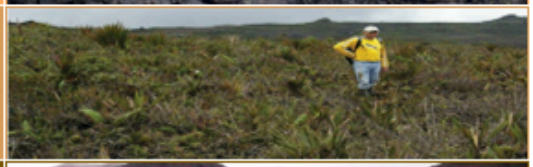
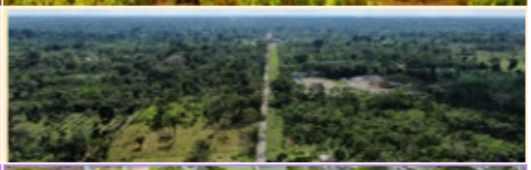
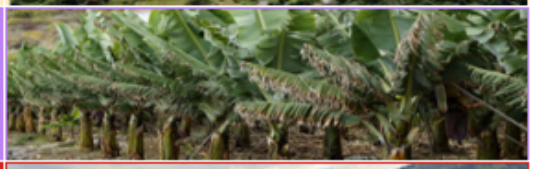
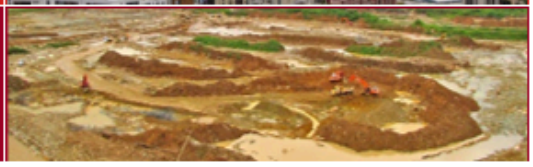
(ID12) Herbazal	
(ID81) Herbazales y arbustales andinos	
(ID82) Herbazales andinos inundables	
(ID29) Afloramiento rocoso	
(ID13) Otra formación natural no forestal	
(ID9) Silvicultura	
(ID21) Mosaico de agricultura y pastos	
(ID74) Banano (beta)	
(ID24) Infraestructura urbana	
(ID30) Minería	



Figure 16. *Classes mapped in MapBiomas Ecuador Collection 4.0 (Prepared by Ecociencia).*

The legend classes of MapBiomas Ecuador Collection 4.0 group the vegetation formations of the Mapa de los Ecosistemas de Ecuador (MAATE, 2013a), the Mapa de Cobertura y Uso de la Tierra (MAATE, 2014) and the Ecosistemas de Galápagos ((Rivas et al., 2018). Annexes 5, 6 and 7 show their (spatial and/or conceptual) correspondence.

4.2.3 Classification routines

The following sequence of steps describes the routines that make up the classification method. The sequence was implemented in JavaScript and executed in the Google Earth Engine (GEE) processing environment.

The mapping of Collections 1 to 3 was available, which served as inputs for this process. Therefore, the sequence, repeated for each classification region independently, consisted of the following steps, adjusting the parameters [8] until a classification of satisfactory quality was achieved.

1. Pixels that consistently kept the same class throughout the 40-year series (1985-2024) in the maps of MapBiomas Ecuador Collection 3 were identified. Based on this information, a map of stable pixels was generated for each of the legend classes. The map was visually inspected and manually corrected. The manual correction included 1) the exclusion of pixels that, through visual inspection of Landsat images, were found not to be stable, and 2) the reassignment (reclassification) of misclassified pixels.
2. Within the extent of the stable pixel map, training points (Figure 17c) or locations were randomly drawn. For each one, the values of every variable making up the feature space were extracted (151 values per location, one per variable; see section 4.1 Generation of annual mosaics and section 4.1.1 feature space). These values spectrally describe the cover types to be classified and therefore represent the training samples for the Random Forest supervised classification algorithm.

[8] The parameters used for each region are detailed in section 3.4.3 "Classification parameters".

3. From the total set of stable pixels, a sample of points was obtained by random drawing. The drawing was balanced and stratified, aiming for the number of samples obtained per class to be proportional to the known extent of each class (estimated a priori for each region). In this phase, the interpreter evaluated the correct spatial distribution of the samples and the distribution of points per class, and adjusted the parameters (Table 6) to ensure balanced sampling. After several rounds of evaluation, it was found that the best results were obtained when the drawing ensured that between 10% and 15% of the total sample corresponded to points of the least abundant class. When deemed necessary, additional samples, called "complementary samples", were collected to strengthen the classification of under-represented classes or classes whose classification needed to be strengthened.

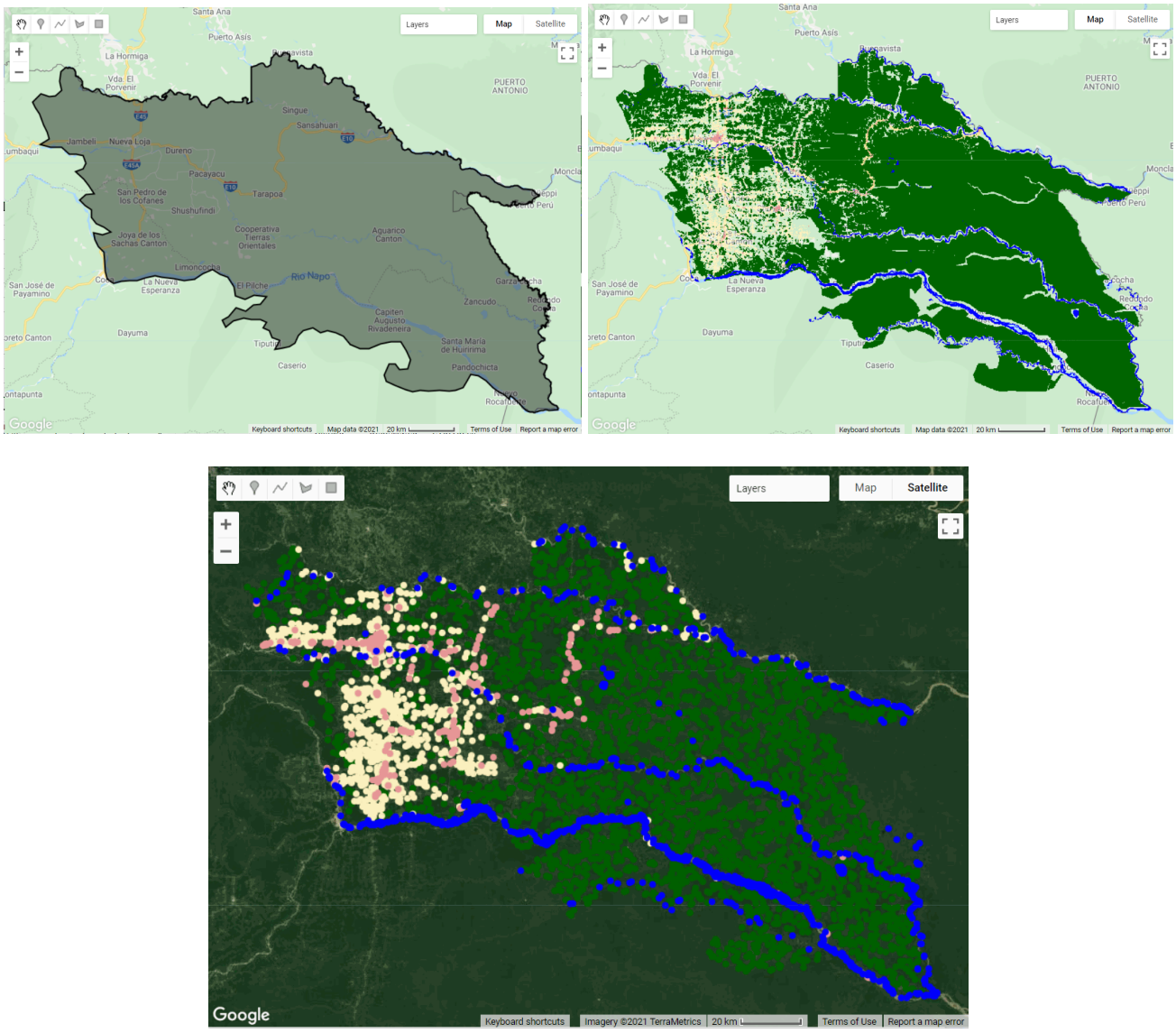


Figure 17. *Example of the random drawing of training sample points for a classification region of the Ecuadorian Amazon. a) Boundary of classification region 40201 "Lower Amazon 1". b) Stable pixel map for drawing sample points. c) Sample points drawn in region 40201 (Prepared by Ecociencia).*

4. Another element that determines classification quality is the number of trees the classifier uses to solve the classification. After several tests, 120 trees was found to be the optimal number, a value that was standardized for all regions (Table 6). Lower values result in decreased classification accuracy, while higher values bring no gains in quality and demand more processing resources.
5. A classification was generated for each year of the time series (1985-2025). The resulting classification is the final product of the classification round, ready to move on to the post-classification phase (see section 3.4.4) and subsequently to the integration phase (see section 3.6).

6. Although the classification process can be iterated (repeated) as many times as the interpreter deems necessary to achieve a satisfactory product, for the current Collection we adopted the strategy of correcting steps 1 and 2 as many times as necessary, which reduced the number of intermediate products requiring physical storage.
7. An additional step that improves classification quality should be highlighted: based on a diagnosis of the contribution of the 151 variables to class separability, the number of variables available to the classifier was filtered, so that in the final training of the classifier only the information from the most determinant variables was used (that is, the variables that contributed least to class separability were excluded). This dimensionality reduction (feature space) made it possible to tailor the use of the most significant variables to the natural formations and land use types specific to each region. The variables selected for each region are detailed in Table 7.
8. This collection relied on canopy height data derived from GEDI (Dubayah, 2021; Potatov et. al., 2021) to remove areas with a low probability of being forest. In several regions, the strategy adopted was to use the corrected maps of Collections 1, 2 and 3 to exclude areas that had already been corrected in previous collections. These corrections improved the pool of training data.

4.2.4 Classification parameters

Table 7. Sampling parameters and number of decision trees used per classification region (Prepared by Ecociencia).

Biome	Code region	Number of iterations	Parameters for stratified sampling		Stable samples exported			Number of trees Random Forest
			Maximum sample	Minimum sample	Sample of the least represented class		Final sample size	
Amazon	40101	1	1500	300	300	12,90%	2326	120
	40102	1	1000	300	300	16,12%	1861	120
	40103	1	1000	300	300	18,16%	1652	120
	40104	1	1000	200	200	16,74%	1195	120
	40105	1	900	400	150	24,27%	618	120
	40201	1	1000	400	400	18,88%	2119	120
	40202	1	1000	400	400	18,54%	2157	120
	40203	1	2550	550	550	13,35%	4120	120
	40204	1	1000	150	150	13,18%	1138	120
	40205	1	1000	200	200	5,37%	3724	120
Andes	40601	1	1500	350	350	10,55%	3319	120
	40602	1	1500	250	250	10,29%	2429	120
	40603	1	1000	200	200	11,42%	1751	120
	40604	1	950	250	250	14,83%	1686	120
	40605	1	1000	250	250	10,36%	2412	120
	40606	1	1000	250	250	16,55%	1511	120
	40607	1	1000	300	300	13,19%	2274	120
	40608	1	1400	350	350	10,22%	3423	120

	40609	1	1500	300	300	14,64%	2049	120
Pacific	40901	1	1100	300	300	13,21%	2271	120
	40902	1	4000	600	600	10,72%	5596	120
	40903	1	3000	500	500	12,58%	3976	120
	40904	1	1000	200	200	14,55%	1375	120
	40905	1	2000	300	300	10,94%	2741	120
	40906	1	4000	500	500	11,37%	4399	120
	40910	1	1500	300	300	11,63%	2579	120
Galápagos	40907	1	350	150	150	8,57%	1115	120
	40908	1	250	100	100	16,05%	623	120
	40909	1	120	80	80	16,67%	480	120

Table 8. Most significant variables identified per classification region (Prepared by Ecociencia).

Biome	Code region	Selected variables
Amazon	40101	ndbi_min', 'swir1_wet_max', 'gcvi_wet', 'mndwi_dry', 'swir1_median', 'red_wet_max', 'red_wet', 'ndfi_dry', 'hallcover_median', 'ndwi_gao_median', 'ndwi_gao_dry', 'ndwi_gao_wet_max', 'ndwi_gao_wet_min', 'ndwi_gao_wet_qmo', 'ndwi_gao_dry_min', 'ndwi_mcfeeters_amp', 'ndvi_median', 'ndvi_wet', 'nir_dry_qmo', 'ndvi_dry', 'ndsi_min', 'blue_median', 'ndsi2_min', 'ndsi2_median', 'ndrb_wet', 'ndmir_wet', 'ndmir_min', 'ndmir_max', 'ndwi_mcfeeters_median', 'pri_median', 'nir_median', 'nir_wet_qmo', 'swir2_wet_qmo', 'swir2_wet', 'swir2_min', 'swir2_median', 'swir2_dry_min', 'swir2_dry', 'swir1_wet_qmo', 'swir1_wet_min', 'swir1_wet',
	40102	ndmi_dry', 'textG_median', 'ndmi_max', 'ndmir_max', 'ndvi_wet', 'blue_median', 'gcvi_median', 'ndwi_gao_wet_max', 'ndwi_gao_wet', 'ndwi_gao_dry_min', 'ndvi_dry', 'ndsi_min', 'ndsi_median', 'ndsi2_min', 'nir_dry', 'ndsi2_max', 'ndrb_wet', 'ndrb_stdDev', 'ndrb_min', 'ndmir_stdDev', 'ndmir_min', 'ndmir_median', 'ndmi_median', 'ndwi_gao_wet_min', 'ndgb_median', 'nir_stdDev', 'swir2_wet_qmo', 'swir2_wet', 'swir2_min', 'swir2_dry_min', 'swir1_wet_min', 'swir1_dry_qmo', 'swir1_dry', 'savi_wet', 'savi_median', 'red_wet', 'red_min', 'red_median', 'red_dry_qmo', 'red_dry_min', 'red_dry_max', 'red_dry', 'pri_dry', 'nir_wet_qmo', 'nir_wet', 'nir_min', 'ndsi2_wet', 'evi2_dry', 'mndwi_wet', 'gli_max', 'gcvi_wet', 'gcvi_dry', 'green_min', 'green_wet_qmo', 'fns_dry', 'evi2_wet', 'evi2_median', 'mndwi_dry', 'mndwi_max', 'green_dry', 'ndfi_dry', 'ndfi_wet', 'cai_wet_min', 'cai_max', 'cai_min', 'cai_median',
	40103	swir1_median', 'green_wet_qmo', 'gcvi_median', 'mndwi_median', 'green_median', 'green_min', 'ndwi_gao_dry_min', 'ndmir_wet', 'nir_wet_qmo', 'pri_dry', 'ndwi_gao_dry', 'nir_stdDev', 'ndwi_gao_wet_min', 'ndwi_gao_wet_max', 'ndwi_gao_wet', 'red_dry', 'nir_dry_qmo', 'red_dry_qmo', 'ndvi_wet', 'ndvi_median', 'ndvi_dry', 'ndsi_min', 'ndsi_median', 'blue_median', 'ndsi2_median', 'ndsi2_max', 'ndmir_stdDev', 'ndmir_min', 'ndmir_median', 'ndmir_max', 'red_dry_min', 'red_wet', 'red_median', 'red_min', 'wefi_amp', 'textG_median', 'swir2_wet_qmo', 'swir2_wet_max', 'swir2_median', 'swir2_dry_qmo', 'swir2_dry_min', 'swir2_dry', 'swir1_wet_qmo', 'swir1_wet_min', 'swir1_wet_max', 'swir1_wet', 'swir1_min', 'swir1_dry_qmo', 'swir1_dry_max', 'swir1_dry', 'soil_median', 'shade_median', 'sefi_dry', 'savi_wet', 'savi_median', 'red_wet_max', 'ndmi_max', 'ndmi_median', 'wefi_wet', 'hallcover_median', 'fns_dry', 'green_wet_min', 'green_dry_qmo', 'green_dry', 'gli_min', 'mndwi_dry', 'gvs_dry', 'ndbi_dry', 'ndbi_max', 'gcvi_wet', 'gcvi_dry', 'mndwi_wet', 'ndfi_dry', 'evi2_dry', 'cai_wet_min', 'ndfib_median', 'cai_min', 'cai_median', 'cai_max',
	40104	evi2_median', 'fns_dry', 'nir_wet_qmo', 'swir1_dry_max', 'swir2_min', 'red_dry_min', 'green_median', 'shade_median', 'red_wet', 'swir1_wet_max', 'ndwi_gao_dry_min', 'ndwi_gao_median',
	40105	'altitude', 'latitude', 'longitude', 'shademask2', 'slope', 'slppost', 'hand30_1000', 'hand30_5000', 'hand90_1000'

	40201	textG_median', 'ndvi_median', 'cai_min', 'ndmir_wet', 'swir2_min', 'mndwi_wet', 'ndbi_dry', 'nir_min', 'evi2_wet', 'ndwi_gao_dry_min', 'ndwi_gao_dry', 'ndwi_gao_wet_max', 'ndwi_gao_median', 'ndvi_wet', 'ndwi_mcfeeters_median', 'nir_dry', 'nir_dry_qmo', 'ndwi_gao_amp', 'ndvi_dry', 'ndvi_stdDev', 'ndsi_min', 'ndsi_median', 'ndsi2_min', 'ndsi2_max', 'ndsi2_dry', 'ndrb_stdDev', 'ndmir_median', 'nir_median', 'red_dry', 'nir_wet_qmo', 'swir1_dry', 'swir2_wet_max', 'swir2_wet', 'swir2_dry_qmo', 'swir2_dry', 'swir1_wet_min', 'swir1_wet_max', 'swir1_min', 'swir1_median', 'swir1_dry_qmo', 'swir1_dry_max', 'soil_median', 'pri_dry', 'shade_median', 'sefi_median', 'savi_wet', 'red_wet_max', 'red_wet', 'red_min', 'red_median', 'red_dry_min', 'ndmi_median', 'ndmir_max', 'ndsi2_wet', 'wefi_wet', 'gcvi_median', 'ndbi_median', 'mndwi_median', 'mndwi_max', 'green_wet_min', 'gcvi_dry', 'gcvi_wet', 'ndfi_amp', 'hallcover_median', 'gvs_stdDev', 'gli_median', 'gli_min', 'green_median', 'green_wet_qmo', 'ndbi_min', 'mndwi_dry', 'green_min', 'cai_wet_min', 'evi2_median', 'cai_median', 'evi2_dry', 'ndfi_wet', 'ndgb_dry',]), staticVariables: ee.List([//Include only those found in the variable importance list 'altitude', 'latitude', 'longitude', 'shademask2', 'slope', 'slppost', 'hand30_1000', 'hand30_5000', 'hand90_1000'
	40202	swir1_median', 'ndvi_dry', 'textG_median', 'nir_dry', 'ndmir_max', 'ndbi_max', 'swir2_dry_min', 'shade_median', 'soil_median', 'ndsi_median', 'nir_dry_qmo', 'ndwi_mcfeeters_median', 'ndwi_gao_wet_qmo', 'ndwi_gao_wet_max', 'ndwi_gao_median', 'ndwi_gao_amp', 'ndvi_amp', 'nir_min', 'ndsi2_max', 'ndsi2_dry', 'ndrb_stdDev', 'ndmir_stdDev', 'ndmir_min', 'ndmir_median', 'ndmi_median', 'ndmi_max', 'nir_median', 'red_dry', 'nir_wet', 'nir_wet_qmo', 'swir2_wet_qmo', 'swir2_wet_max', 'swir2_wet', 'swir2_median', 'swir2_dry_qmo', 'swir1_wet_qmo', 'swir1_wet_min', 'swir1_wet_max', 'swir1_wet', 'swir1_min', 'swir1_dry_qmo', 'swir1_dry_max', 'swir1_dry', 'savi_wet', 'savi_median', 'red_wet', 'red_median', 'red_dry_min', 'ndgb_max', 'ndgb_median', 'ndsi2_wet', 'wefi_wet', 'mndwi_wet', 'green_median', 'gv_median', 'gli_median', 'hallcover_median', 'green_wet_min', 'gcvi_wet', 'gcvi_median', 'gcvi_dry', 'fns_dry', 'evi2_wet', 'evi2_dry', 'evi2_amp', 'ndbi_min', 'cai_median', 'cai_wet_min', 'cai_min', 'ndbi_median', 'ndfi_median',
	40203	'altitude', 'latitude', 'longitude', 'shademask2', 'slope', 'hand30_1000', 'hand30_5000', 'hand90_1000'
	40204	swir2_median', 'swir2_dry_min', 'green_dry_qmo', 'swir1_wet_qmo', 'swir1_dry', 'ndwi_gao_dry_min', 'swir1_wet_max', 'red_dry', 'gcvi_wet', 'swir2_wet', 'ndbi_min', 'ndmir_median', 'red_wet', 'red_wet_max', 'ndmi_dry', 'savi_dry', 'ndmir_wet', 'savi_median', 'ndgb_median', 'savi_wet', 'sefi_dry', 'ndfib_median', 'shade_median', 'nir_median', 'ndmir_min', 'red_median', 'ndrb_min', 'ndwi_gao_dry', 'nir_dry', 'nir_wet', 'ndwi_gao_wet_min', 'nir_wet_qmo', 'ndwi_gao_wet', 'ndwi_gao_median', 'pri_median', 'ndbi_max', 'red_dry_max', 'blue_median', 'ndsi2_min', 'ndsi2_median', 'ndsi2_max', 'ndrb_wet', 'ndbi_median', 'nir_dry_qmo', 'green_dry', 'swir1_median', 'gli_dry', 'fns_dry', 'gli_median', 'gli_min', 'swir2_dry', 'green_wet_min', 'green_wet_qmo', 'gv_median', 'gvs_median', 'swir1_min', 'gvs_wet', 'evi2_median', 'cai_wet_min', 'mndwi_median', 'cai_max', 'cai_min', 'swir2_min', 'evi2_dry',
	40205	red_median', 'evi2_dry', 'nir_median', 'red_wet_max', 'savi_median', 'swir1_dry', 'gcvi_wet', 'mndwi_median', 'nir_wet_qmo', 'ndsi2_max', 'blue_median', 'ndwi_gao_wet_max', 'nir_min', 'ndmir_min', 'nir_dry_qmo',
Andes	40601	evi2_median', 'savi_wet', 'nir_dry', 'ndbi_min', 'ndwi_gao_dry_min', 'ndsi2_min', 'gcvi_wet', 'evi2_dry', 'ndwi_gao_wet_qmo', 'nir_wet_qmo', 'ndmir_max', 'nir_wet', 'ndmir_median', 'nir_min', 'nir_median', 'nir_dry_qmo', 'ndmir_min', 'ndwi_mcfeeters_median', 'ndwi_gao_wet_min', 'ndsi2_max', 'ndwi_gao_wet_max', 'ndwi_gao_median', 'ndmir_wet', 'pri_median', 'ndrb_wet', 'ndwi_gao_dry', 'ndvi_median', 'ndsi2_dry', 'ndsi2_median', 'pri_dry', 'red_median', 'red_dry', 'red_dry_qmo', 'textG_median', 'swir2_wet_qmo', 'swir2_wet_max', 'swir2_min', 'swir2_median', 'swir2_dry_qmo', 'swir2_dry_min', 'swir2_dry', 'swir1_wet_qmo', 'swir1_wet_min', 'swir1_wet_max', 'swir1_wet', 'swir1_min', 'swir1_median', 'swir1_dry_qmo', 'swir1_dry_max', 'swir1_dry', 'shade_median', 'sefi_median', 'sefi_dry', 'savi_median', 'red_wet', 'ndmi_max', 'ndmi_median', 'ndsi2_wet', 'ndmi_dry', 'gv_median', 'ndbi_dry', 'mndwi_wet', 'hallcover_median', 'gvs_wet', 'ndgb_wet', 'green_wet_qmo', 'ndbi_median', 'green_min', 'green_median', 'green_dry_qmo', 'gcvi_median', 'gcvi_dry', 'fns_dry', 'evi2_wet', 'cai_wet_min', 'ndbi_max', 'wefi_wet', 'ndgb_max', 'ndfi_wet', 'ndgb_median',
	40602	green_wet_min', 'ndwi_gao_wet_min', 'savi_median', 'blue_median', 'evi2_median', 'green_min', 'swir2_wet', 'ndmi_max', 'mndwi_max', 'nir_median', 'ndwi_gao_dry_min', 'nir_min', 'nir_dry_qmo', 'nir_dry', 'nir_wet', 'ndwi_gao_median', 'ndvi_wet', 'ndwi_gao_amp', 'red_dry_max', 'ndvi_median', 'ndvi_dry', 'ndsi_min', 'ndsi2_max', 'ndrb_stdDev', 'ndrb_min', 'ndmir_wet', 'ndmir_min', 'ndgb_wet', 'nir_wet_qmo', 'red_wet', 'red_dry_min', 'red_median', 'wefi_amp', 'swir2_wet_qmo', 'swir2_min', 'swir2_median', 'swir2_dry_qmo', 'swir1_wet_qmo', 'swir1_wet_max', 'swir1_median',
	40603	nir_wet_qmo', 'red_min', 'savi_median', 'gv_median', 'ndvi_wet', 'mndwi_wet', 'green_dry', 'ndmir_max', 'ndwi_gao_wet_qmo', 'nir_dry_qmo', 'nir_dry', 'ndwi_mcfeeters_median',

	40604	'green_median', 'savi_wet', 'nir_wet_qmo', 'ndvi_wet', 'ndvi_median', 'ndsi_median', 'wefi_wet', 'cai_min', 'evi2_median', 'pri_median', 'nir_wet', 'nir_min', 'nir_median', 'nir_dry_qmo', 'nir_dry', 'ndwi_gao_wet', 'ndwi_gao_dry', 'ndwi_gao_amp', 'cai_wet_min', 'ndvi_amp', 'ndsi_min', 'ndsi2_max', 'ndrb_min', 'ndmir_wet', 'ndmir_min', 'ndmir_median', 'ndmir_max', 'ndmi_median', 'cai_median', 'red_dry', 'ndmi_dry', 'red_dry_max', 'wefi_amp', 'textG_median', 'swir2_median', 'swir2_dry_min', 'swir2_dry', 'swir1_wet_qmo', 'swir1_wet', 'swir1_dry_qmo', 'swir1_dry_max', 'sefi_dry', 'cai_max', 'savi_stdDev', 'savi_median', 'red_wet_max', 'red_min', 'red_median', 'red_dry_min', 'ndmi_max', 'ndvi_dry', 'ndsi2_min', 'gcvi_median', 'green_wet_qmo', 'green_wet_min', 'green_min', 'evi2_dry', 'hallcover_median', 'mndwi_dry', 'gli_median', 'mndwi_wet', 'gli_max', 'gcvi_wet', 'gv_median', 'gcvi_dry', 'ndfi_median', 'ndbi_median', 'evi2_wet', 'fns_dry', 'ndfi_wet', 'ndfi_amp',
	40605	evi2_dry', 'red_median', 'green_dry_qmo', 'ndwi_gao_wet_min', 'ndwi_gao_wet_max', 'ndbi_max', 'swir1_median', 'nir_min', 'ndsi2_median', 'nir_median', 'nir_dry_qmo', 'nir_dry', 'ndwi_mcfeeters_median', 'ndwi_gao_wet_qmo', 'ndmir_max', 'ndmir_min', 'ndmir_wet', 'ndrb_min', 'ndsi2_max', 'ndwi_gao_wet', 'ndwi_gao_dry_min', 'ndwi_gao_dry', 'ndsi2_dry', 'nir_wet', 'ndvi_median', 'ndvi_dry', 'ndsi_median', 'ndsi2_min', 'ndrb_wet', 'pri_median', 'nir_wet_qmo', 'swir1_min', 'wefi_amp', 'swir2_wet_qmo', 'swir2_wet_max', 'swir2_min', 'swir2_median', 'swir2_dry_qmo', 'swir2_dry_min', 'swir2_dry', 'swir1_wet_min', 'swir1_wet_max', 'swir1_wet', 'swir1_dry_max', 'pri_dry', 'shade_median', 'savi_wet', 'savi_median', 'red_wet', 'red_min', 'red_dry_qmo', 'red_dry_min', 'red_dry_max', 'red_dry', 'ndmi_max', 'ndmi_median', 'ndsi2_wet', 'gv_median', 'mndwi_wet', 'mndwi_dry', 'hallcover_median', 'gvs_wet', 'green_wet_min', 'green_min', 'green_median', 'gli_min', 'gli_median', 'gli_max', 'gli_dry', 'gcvi_wet', 'gcvi_median', 'gcvi_dry', 'fns_dry', 'evi2_wet', 'evi2_median', 'evi2_amp', 'cai_min', 'mndwi_median', 'wefi_wet', 'ndbi_dry', 'ndbi_min', 'ndfi_median', 'ndfib_median', 'ndgb_dry', 'ndfi_wet',
	40606	'ndmi_median', 'ndmi_dry', 'blue_median', 'nir_dry', 'mndwi_median', 'ndbi_median', 'cai_median', 'gcvi_wet', 'ndrb_stdDev', 'ndrb_wet', 'ndrb_min', 'ndmir_wet', 'ndsi2_dry', 'ndsi2_median', 'ndmir_median', 'ndmi_max', 'ndgb_wet', 'ndgb_stdDev', 'ndgb_max', 'ndfib_median', 'red_dry', 'ndfi_stdDev', 'shade_median', 'ndsi_median', 'ndfi_dry', 'red_dry_min', 'red_dry_qmo', 'red_median', 'nir_wet_qmo', 'nir_wet', 'red_wet', 'nir_median', 'nir_dry_qmo', 'ndwi_mcfeeters_median', 'red_wet_max', 'savi_dry', 'savi_median', 'ndwi_gao_wet', 'ndwi_gao_dry_min', 'ndwi_gao_dry', 'sefi_dry', 'ndvi_wet', 'sefi_median', 'ndvi_median', 'swir1_dry_qmo', 'swir1_dry_max', 'red_dry_max', 'green_wet_min', 'evi2_wet', 'swir2_dry_min', 'fns_dry', 'gv_median', 'swir2_wet_max', 'green_wet_qmo', 'ndbi_min', 'gvs_wet', 'gcvi_dry', 'gcvi_median', 'green_median', 'green_dry_qmo', 'green_dry', 'swir2_min', 'gli_dry', 'swir1_wet_min', 'evi2_median', 'mndwi_dry', 'ndbi_max', 'ndbi_dry', 'cai_min', 'mndwi_wet', 'cai_wet_min', 'mndwi_max', 'swir1_wet_max', 'hallcover_median', 'evi2_dry', 'gli_max',
	40607	evi2_wet', 'ndvi_wet', 'nir_wet_qmo', 'red_min', 'red_wet', 'green_dry', 'swir1_median', 'ndmi_max', 'swir1_wet', 'nir_median', 'nir_dry', 'ndwi_mcfeeters_median', 'swir2_median',
	40608	evi2_median', 'savi_wet', 'blue_median', 'ndsi2_dry', 'ndbi_median', 'gvs_wet', 'green_wet_qmo', 'ndsi2_min', 'ndvi_dry', 'ndwi_gao_wet_min', 'red_dry', 'pri_dry', 'nir_wet_qmo', 'nir_wet', 'nir_min', 'nir_median', 'nir_dry_qmo', 'nir_dry', 'ndwi_mcfeeters_median', 'ndwi_gao_wet_qmo', 'ndwi_gao_wet_max', 'red_dry_min', 'ndwi_gao_median', 'ndwi_gao_dry', 'ndvi_wet', 'ndvi_median', 'ndsi_median', 'ndsi2_wet', 'cai_min', 'ndrb_wet', 'ndmir_min', 'ndmir_median', 'red_dry_max', 'red_dry_qmo', 'ndmi_max',
	40609	swir1_wet_min', 'ndmir_wet', 'shade_median', 'evi2_wet', 'ndsi2_median', 'ndwi_gao_dry', 'swir2_min', 'nir_dry', 'nir_median', 'ndwi_mcfeeters_median', 'ndwi_gao_wet_qmo', 'ndwi_gao_dry_min', 'ndwi_gao_wet_max', 'ndwi_gao_wet', 'nir_dry_qmo', 'ndwi_gao_median', 'ndvi_dry', 'ndvi_wet', 'nir_wet', 'ndsi_min', 'ndsi2_wet', 'blue_median', 'ndsi2_max', 'ndsi2_dry', 'ndmir_min', 'ndmir_median', 'ndmi_median', 'nir_min', 'pri_median', 'nir_wet_qmo', 'swir1_dry_qmo', 'swir2_wet_qmo', 'swir2_wet_max', 'swir2_wet', 'swir2_dry_qmo',
Pacific	40901	'swir1_median', 'savi_dry', 'gcvi_wet', 'ndvi_dry', 'nir_median', 'cai_min', 'evi2_median', 'nir_dry_qmo', 'swir2_dry_min', 'swir1_dry_max', 'swir2_median', 'hallcover_median', 'mndwi_median', 'swir1_wet', 'ndwi_mcfeeters_median', 'ndbi_min', 'ndvi_median', 'swir1_wet_qmo', 'savi_wet', 'red_median', 'ndvi_wet', 'nir_dry', 'textG_median', 'nir_wet_qmo', 'swir2_wet', 'red_min', 'gcvi_median', 'swir1_wet_max', 'swir1_min', 'swir1_dry_qmo', 'swir2_wet_max',//30 'mndwi_dry', 'ndsi_min', 'swir1_wet_min', 'nir_min', 'cai_max', 'evi2_wet', 'evi2_dry', 'ndmir_wet', 'red_dry', 'nir_wet',//40 'green_min', 'shade_median', 'ndsi2_dry', 'wefi_wet', 'green_wet_qmo', 'mndwi_wet', 'red_wet_max', 'cai_median', 'savi_median', 'swir2_min',
	40902	shade_median', 'ndwi_gao_median', 'evi2_wet', 'savi_median', 'ndvi_wet', 'ndsi2_wet', 'nir_wet', 'ndsi2_median', 'swir1_wet_max', 'ndsi2_max', 'savi_wet', 'savi_dry', 'ndsi_median', 'ndsi_min', 'swir2_wet_qmo', 'mndwi_max', 'nir_min', 'mndwi_dry', 'nir_wet_qmo', 'swir1_median', 'ndbi_dry', 'mndwi_median', 'gv_median', 'wefi_wet', 'ndwi_gao_wet_max', 'ndwi_gao_wet_qmo', 'nir_dry',
	40903	red_wet_max', 'evi2_wet', 'nir_wet', 'swir1_wet_max', 'gcvi_dry', 'red_dry', 'nir_median', 'swir2_dry', 'ndwi_mcfeeters_median', 'snow_min', 'nir_wet_qmo', 'mndwi_max', 'ndgb_dry', 'green_wet_qmo', 'pri_median', 'ndgb_median', 'swir2_wet_qmo', 'evi2_dry', 'nir_dry_qmo', 'hallcover_median', 'ndmi_dry', 'ndmir_min', 'gcvi_wet', 'red_min', 'red_dry_qmo', 'swir1_dry_max', 'ndsi2_min', 'ndgb_wet', 'mndwi_median', 'swir1_wet_min', 'ndwi_gao_wet_min', 'cai_median', 'snow_median', 'ndwi_gao_wet_max', 'swir2_wet', 'ndwi_gao_median', 'swir2_median', 'evi2_stdDev', 'gli_min', 'shade_median', 'ndmir_median', 'ndwi_mcfeeters_amp', 'ndsi_median',

	40904	cai_wet_min', 'swir1_median', 'sefi_dry', 'swir1_wet_max', 'cai_min', 'nir_median', 'evi2_dry', 'ndwi_gao_wet', 'cai_median', // 'ndsi_median', // 'ndmi_median', 'gcvi_wet', 'mndwi_wet', 'gli_max', 'swir2_min', 'mndwi_median', 'savi_median', 'nir_min', 'swir1_dry_max', 'hallcover_median', // 'hand30_1000', // 'ndmir_median', 'nir_dry', // 'altitude', 'swir1_wet_min', 'green_dry_qmo', // //'ndsi2_median', // 'ndmir_wet', // 'nuaci_median', 'ndbi_median', 'ndvi_median', 'mndwi_dry', 'evi2_median', 'blue_median', // 'ndsi_min', 'nir_dry_qmo', 'swir1_wet', 'soil_median', // 'latitude', // 'hand30_100', 'green_wet_qmo', 'ndbi_min', //'hand30_5000', 'ndvi_dry', 'swir2_wet', 'ndwi_gao_wet_max', // 'ndsi2_min', 'ndrb_wet', // 'slope', 'swir2_wet_qmo', 'sefi_median', 'evi2_wet', 'gcvi_dry', 'pri_dry', 'red_median', 'ndwi_gao_wet_min', 'ndgb_dry', 'ndvi_wet', 'swir2_dry', // 'ndrb_min', // 'ndwi_gao_median', 'nir_wet_qmo', 'red_dry_qmo', // 'ndgb_median', 'cloud_median', 'savi_dry', 'ndfi_dry', 'swir1_wet_qmo', // 'ndmir_min', 'swir1_min', 'wefi_wet', 'swir2_median', 'red_wet', 'shade_median', 'gcvi_median', 'ndsi2_wet', 'swir2_dry_min', 'red_wet_max', 'gvs_dry', 'ndwi_gao_wet_qmo', 'ndsi2_dry', 'gli_dry', 'green_median', 'red_min', 'gli_median', 'mndwi_max', 'gv_median', 'swir2_wet_max', 'savi_wet', // 'ndwi_mcfeeters_median', 'textG_median', 'swir1_dry', // 'ndsi2_max', 'red_dry', 'cai_max', 'green_dry', 'green_wet_min', 'ndbi_max', 'swir2_dry_qmo', 'nir_wet', 'ndfi_median', 'ndwi_gao_dry_min', 'red_dry_min', 'gvs_median', 'npv_median', 'ndfib_median', 'ndbi_dry', 'green_min', 'ndgb_wet', 'swir1_dry_qmo', 'red_dry_max', // 'longitude', // 'slppost', 'gvs_wet', 'ndfi_wet', 'ndvi_stdDev', 'gli_min', 'fns_dry', // 'ndmi_max', 'ndmi_dry', 'ndwi_gao_dry', // 'hand90_1000', // 'ndmir_max', 'ndfi_amp', // 'ndmir_stdDev', 'npv_stdDev', 'gv_amp', 'wefi_stdDev', 'evi2_stdDev', // 'ndgb_stdDev', // 'ndwi_gao_amp', // 'ndgb_max', 'pri_median', 'fns_stdDev', 'soil_stdDev', 'gvs_stdDev', 'snow_median', 'evi2_amp', 'ndvi_amp', 'savi_stdDev', 'sefi_stdDev', 'wefi_amp', // 'ndrb_stdDev', // 'ndwi_mcfeeters_amp', 'nir_stdDev', 'soil_amp', 'snow_min', 'gv_stdDev', 'ndfi_stdDev', 'ndfib_amp', // 'shademask2',
	40905	nuaci_median', 'ndsi_median', 'mndwi_median', 'gcvi_median', 'blue_median', 'ndsi_min', 'green_median', 'ndwi_mcfeeters_median', 'ndsi2_max', 'gcvi_dry', 'savi_dry', 'ndbi_max', 'red_min', 'green_min', 'ndvi_median', 'savi_median', 'mndwi_max', 'gcvi_wet', 'green_wet_qmo', 'swir1_wet_min', 'mndwi_dry', 'red_wet', 'nir_median', 'ndvi_dry', 'evi2_median', 'swir1_dry_max', 'savi_wet', 'hallcover_median', 'ndwi_gao_dry_min', 'red_dry_max', 'red_median', 'green_wet_min', 'green_dry_qmo', 'ndbi_median', 'ndvi_wet', 'green_dry', 'evi2_dry', 'cai_max', 'ndmir_max', 'evi2_wet',
	40906	red_wet_max', 'evi2_wet', 'nir_wet', 'swir1_wet_max', 'gcvi_dry', 'red_dry', 'nir_median', 'swir2_dry', 'ndwi_mcfeeters_median', 'snow_min', 'nir_wet_qmo', 'mndwi_max', 'ndgb_dry', 'green_wet_qmo', 'pri_median', 'ndgb_median', 'swir2_wet_qmo', 'evi2_dry', 'nir_dry_qmo', 'hallcover_median', 'ndmi_dry', 'ndmir_min', 'gcvi_wet', 'red_min', 'red_dry_qmo', 'swir1_dry_max', 'ndsi2_min', 'ndgb_wet', 'mndwi_median', 'swir1_wet_min', 'ndwi_gao_wet_min', 'cai_median', 'snow_median', 'ndwi_gao_wet_max', 'swir2_wet', 'ndwi_gao_median', 'swir2_median', 'evi2_stdDev', 'gli_min', 'shade_median', 'ndmir_median', 'ndwi_mcfeeters_amp', 'ndsi_median',
	40910	evi2_wet', 'red_median', 'green_median', 'ndvi_wet', 'nir_wet', 'ndvi_median', 'gcvi_wet', 'ndwi_mcfeeters_median', 'nir_wet_qmo', 'nuaci_median', 'green_min', 'swir1_median', 'ndsi_median', 'green_wet_qmo', 'evi2_median', 'ndwi_gao_wet_min', 'ndmir_min', 'savi_dry', 'gcvi_median', 'mndwi_median', 'green_wet_min', 'red_min', 'swir2_median', 'hallcover_median', 'evi2_dry', 'red_wet', 'wefi_wet', 'cai_max', 'cai_median', 'red_wet_max', 'ndmir_max', 'swir1_wet', 'ndvi_dry', 'ndrb_min', 'red_dry', 'swir2_wet', 'savi_wet', 'cai_wet_min', 'red_dry_qmo', 'nir_median', 'ndmir_wet', 'ndbi_min', 'ndbi_median', 'ndwi_gao_dry_min', 'savi_median',
Galápagos	40907	NA
	40908	'swir1_median', 'savi_dry', 'gcvi_wet', 'ndvi_dry', 'nir_median', 'cai_min', 'evi2_median', 'nir_dry_qmo', 'swir2_dry_min', 'swir1_dry_max', 'swir2_median', 'hallcover_median', 'mndwi_median', 'swir1_wet', 'ndwi_mcfeeters_median', 'ndbi_min', 'ndvi_median', 'swir1_wet_qmo', 'savi_wet', 'red_median', 'ndvi_wet', 'nir_dry', 'textG_median', 'nir_wet_qmo', 'swir2_wet', 'red_min', 'gcvi_median', 'swir1_wet_max', 'swir1_min', 'swir1_dry_qmo', 'swir2_wet_max', 'mndwi_dry', 'ndsi_min', 'swir1_wet_min', 'nir_min', 'cai_max', 'evi2_wet', 'evi2_dry', 'ndmir_wet', 'red_dry', 'nir_wet', 'green_min', 'shade_median', 'ndsi2_dry', 'wefi_wet', 'green_wet_qmo', 'mndwi_wet', 'red_wet_max', 'cai_median', 'savi_median', 'swir2_min'
	40909	'swir1_median', 'savi_dry', 'gcvi_wet', 'ndvi_dry', 'nir_median', 'cai_min', 'evi2_median', 'nir_dry_qmo', 'swir2_dry_min', 'swir1_dry_max', 'swir2_median', 'hallcover_median', 'mndwi_median', 'swir1_wet', 'ndwi_mcfeeters_median', 'ndbi_min', 'ndvi_median', 'swir1_wet_qmo', 'savi_wet', 'red_median', 'ndvi_wet', 'nir_dry', 'textG_median', 'nir_wet_qmo', 'swir2_wet', 'red_min', 'gcvi_median', 'swir1_wet_max', 'swir1_min', 'swir1_dry_qmo', 'swir2_wet_max', 'mndwi_dry', 'ndsi_min', 'swir1_wet_min', 'nir_min', 'cai_max', 'evi2_wet', 'evi2_dry', 'ndmir_wet', 'red_dry', 'nir_wet', 'green_min', 'shade_median', 'ndsi2_dry', 'wefi_wet', 'green_wet_qmo', 'mndwi_wet', 'red_wet_max', 'cai_median', 'savi_median', 'swir2_min',

4.3 Post-classification

The post-classification phase consists of applying different types of filters aimed at reducing information gaps or inconsistencies and ensuring comparability of the maps across the different years of the time series. All filters are applied to the classification resulting from the process described above (no filter is applied to the Landsat mosaics).

Four different types of filters were used. The process was carried out by applying the filters in a defined order according to the needs and conditions of each region, at the interpreters' discretion, including the option of using a filter more than once. This flexibility represented a change in the methodology and reduced sources of error identified in previous collections. The option of excluding specific classes and years, selected by the interpreters, from the effects of any filter was also adopted.

A description of each tool is presented below:

4.3.1 Gap fill filter (GapFill)

According to the MapBiomas legend, pixels lacking information due to constraints on their observation at the time of satellite image acquisition are classified as “not observed” (ID = 27). This filter is especially useful in regions such as Ecuador, which are severely affected by a persistent presence of clouds that obstruct data acquisition by optical remote sensors such as Landsat. The gap fill (Gapfill) filter replaces these information gaps in the time series, so that pixels lacking a classification value take the temporally closest known value (class) (i.e., the last value for which there was an observation). As a result of this filter, a classification practically free of gaps is obtained (Figure 18). Persistent gaps may occur when not a single observation was obtained throughout the entire time series. In addition, for Ecuador, the option of excluding years that introduced a greater amount of noise into the classification was implemented, i.e., these years were not used to carry their pixels over to neighboring years; likewise, classes could also be excluded, thereby creating a block that prevented certain errors occurring in the pre-filter classifications from being propagated.

This filter was applied in all regions of the Ecuador study area, and the parameters used are summarized in Table 9.

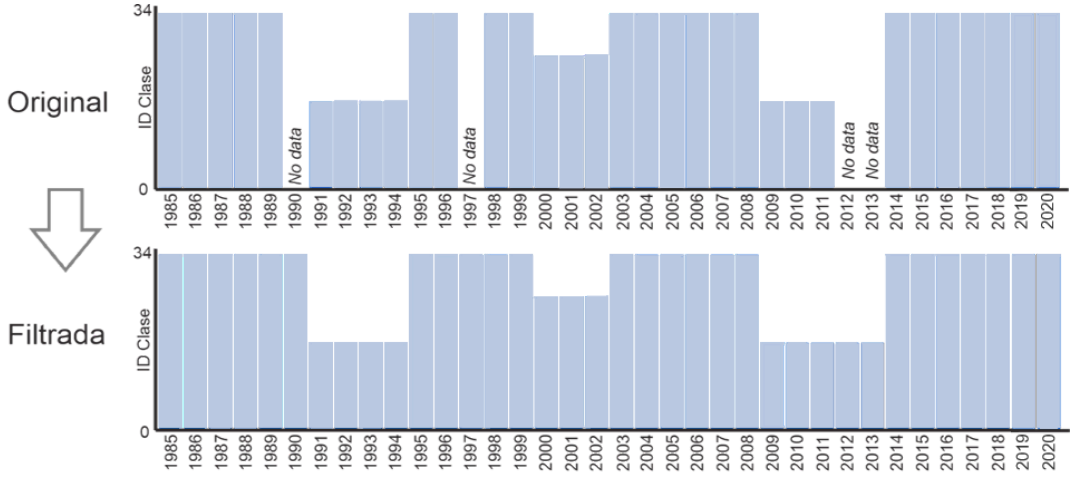


Figure 18. *Functionality of the Gapfill filter of MapBiomas Ecuador Collection 4.0 (Prepared by MapBiomas).*

Table 9. Gapfill filter parameters defined for each classification region of MapBiomas Ecuador Collection 4.0 (Prepared by Ecociencia).

Biome	Code region	Number of Iterations	Order	Excluded classes	Excluded years	Reason for repeated application
AMAZON	40101	1	t0tn_tnt0	NA	NA	
	40102	2	tnt0_t0tn	NA	1986, 1987, 1988, 1991, 1996, 2006, 2007, 2017, 2020	Exclusion of years
			t0tn_tnt0	NA	NA	
	40103	2	tnt0_t0tn	NA	NA	Correct extreme years
			t0tn_tnt0			
	40104	2	t0tn_tnt0	NA	NA	Correct extreme years
			t0tn_tnt0	NA		
	40105	2	t0tn_tnt0	21,33	1988,1990,1992	Exclusion of years and

						classes
			t0tn_tnt0	NA	NA	
	40201	1	t0tn_tnt0	NA	NA	
	40202	1	t0tn_tnt0	NA	NA	
	40203	1	t0tn_tnt0	NA	1986,1987,1988,1989,1990,1991,1992, 1993,1994	Exclusion of years
			t0tn_tnt0	NA	1986,1987,1988,1989,1990,1991,1992, 1993,1994	
	40204	1	t0tn_tnt0	NA	NA	
	40205	2	t0tn_tnt0	NA	NA	Correct extreme years
			tnt0_t0tn	NA	NA	
ANDES	40601	1	t0tn_tnt0	NA	NA	
	40602	1	t0tn_tnt0	NA	NA	
	40603	2	t0tn_tnt0	NA	NA	Correct extreme years
			t0tn_tnt0	NA	NA	
	40604	2	t0tn_tnt0	33	NA	Exclusion of classes
			t0tn_tnt0	NA	NA	
	40605	2	tnt0_t0tn	NA	NA	Correct extreme years
			t0tn_tnt0	NA	NA	
	40606	2	tnt0_t0tn	NA	1986,1987,1988, 1991	Exclusion of classes
			t0tn_tnt0	NA	NA	
	40607	2	t0tn_tnt0	NA	NA	Correct extreme years
			t0tn_tnt0	NA	NA	
	40608	1	t0tn_tnt0	NA	NA	
	40609	2	t0tn_tnt0	33	NA	Exclusion of classes
			t0tn_tnt0	NA	NA	
PACIFIC	40901	1	t0tn_tnt0	NA	NA	
	40902	3	t0tn_tnt0	NA	2005,2006,2007,2008,2009,2010,2011, 2012,2013,2014,2015,2016,2017,2018, 2019,2020,2021,2022,2023,2024,2025	Exclusion of years
			t0tn_tnt0	NA	1985,1986,1987,1988,1989,1990,1991, 1992,1993,1994,1995,1996,1997,1998, 1999,2000,2001,2002,2003,2004	Exclusion of years
			t0tn_tnt0	NA	NA	
	40903	2	tnt0_t0tn	NA	NA	Correct extreme years
			tnt0_t0tn	NA	NA	
	40904	2	t0tn_tnt0	11, 33	NA	Exclusion of classes
			t0tn_tnt0	NA	NA	
	40905	1	t0tn_tnt0	NA	NA	
	40906	2	tnt0_t0tn	NA	NA	Correct extreme years
			tnt0_t0tn	NA	NA	
	40910	1	t0tn_tnt0	NA	NA	

GALÁPAGOS	40907	2	tnt0_t0tn	33	1989,1990,1991,1992, 1993,1995, 1996,1997,1998,1999, 2000,2001,2002,2003,2004, 2005,2006,2007,2008,2009, 2010,2011,2012,2013,2014, 2015,2016,2017,2018	Exclusion of years and classes
			t0tn_tnt0	NA	NA	
	40908	1	t0tn_tnt0	NA	NA	
	40909	2	t0tn_tnt0	NA	1991,1993,1997,1998,1999,2000,2001, 2002,2004,2005,2006,2010,2011,2012, 2013,2014,2015,2017,2018,2021,2022	Exclusion of years
			t0tn_tnt0	NA	NA	

4.3.2 Temporal filter

This filter seeks to reduce information gaps, temporal inconsistencies, noise or classification errors by using the historical record based on three types of rules (Figure 19):

a. General rules (GR) seek to correct the value of the central year (T) based on the pixel values of the preceding (T-1, T-2) and following (T+1, T+2) years. This rule modifies values in the classifications from 1986 to 2024. Windows or time periods of three, four and five years can be used.
b. First-year rules (FR) correct the value of the first year (1985) based on the values of the following two consecutive years.
c. Last-year rules (LR) correct the value of the last year (2025) taking into account the values of the two preceding years.

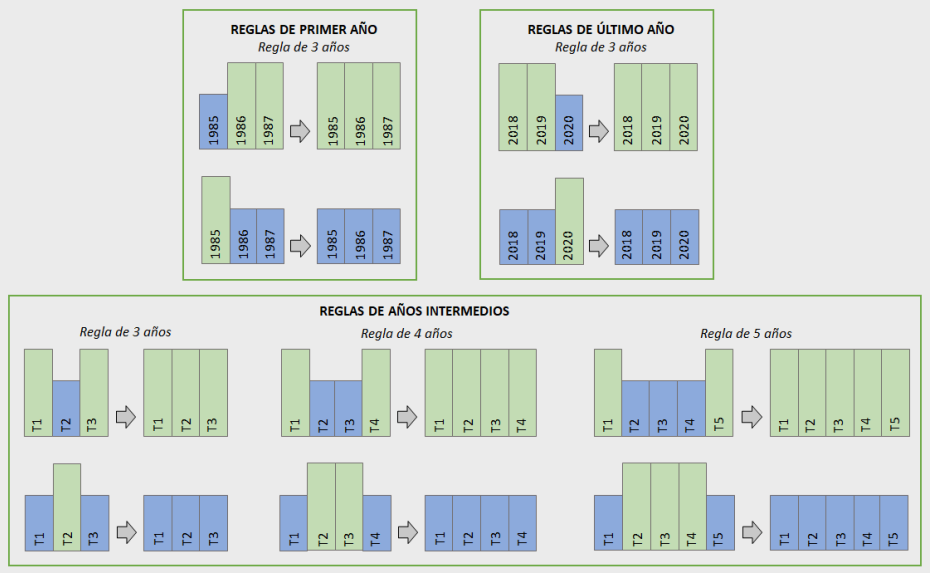


Figure 19. *Functionality of the MapBiomas Ecuador temporal filter (Prepared by MapBiomas).*

In Ecuador, temporal filters were applied in all classification regions. The parameters of each rule were defined according to the needs of each region (Table 10):

- first3: class execution order for the first-year rule.
- last3: class execution order for the last-year rule.
- middle3: class execution order for the 3 intermediate years rules.
- middle4: class execution order for the 4 intermediate years rules.
- middle5: class execution order for the 5 intermediate years rules.

Table 10. Temporal filter parameters defined for each classification region of MapBiomas Ecuador Collection 4.0 (Prepared by Ecociencia).

Biome	Region code	Rule order	Execution order	Excluded classes/years
AMAZON	40101	last3	var ordem_exec_last = [21, 25]	NA
		last3	var ordem_exec_last = [21, 25]	NA
		Middle3, Middle4, Middle3	var ordem_exec_middle = [21, 3, 33, 25, 13]	NA
		Middle5, Middle4	var ordem_exec_middle = [21, 11, 12, 3, 33, 25, 13]	NA
		Middle3	var ordem_exec_middle = [21, 11, 12, 3, 33, 25, 13]	NA
	40102	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 21] var ordem_exec_last = [21, 25] var ordem_exec_middle = [33, 21, 3, 13, 25]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 21] var ordem_exec_last = [21, 25] var ordem_exec_middle = [33, 21, 3, 13, 25]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 21] var ordem_exec_last = [3, 11, 13, 25, 21] var ordem_exec_middle3 = [3, 11, 13, 21] var ordem_exec_middle4 = [3, 11, 13, 21] var ordem_exec_middle5 = [3, 11, 13, 21] var ordem_exec_middle3 = [3, 11, 13, 25, 21]	NA
	40103	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 33] var ordem_exec_last = [25, 33, 21] var ordem_exec_middle = [3, 33, 21]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3] var ordem_exec_last = [25] var ordem_exec_middle = [13, 11, 12, 25]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [11, 12, 13] var ordem_exec_last = [11, 12, 13] var ordem_exec_middle = [11, 12, 13]	NA

		Middle3, Middle4, Middle5, last3, first3	var ordem_exec_first = [13, 3, 33, 25, 11] var ordem_exec_last = [13, 21, 25, 33, 13, 11] var ordem_exec_middle3 = [13, 21, 3, 25, 33, 11] var ordem_exec_middle4 = [13, 21, 25, 3, 33, 13, 11] var ordem_exec_middle3 = [13, 21, 25, 3, 33, 13, 11]	NA
		Middle4, Middle3, Middle3, last3, first3, Middle3	var ordem_exec_first = [13, 3, 33, 25, 11] var ordem_exec_last = [13, 21, 25, 33, 13, 11] var ordem_exec_middle = [13, 21, 25, 3, 33, 13, 11]	NA
	40104	first3, Middle3	var ordem_exec_first = [3, 21] var ordem_exec_middle = [21, 25, 3, 33]	NA
		Middle4, Middle3	var ordem_exec_middle = [21, 25, 3, 33]	NA
		Middle5, Middle4, Middle3, last3	var ordem_exec_last = [21, 25, 3] var ordem_exec_middle = [21, 25, 3, 33]	NA
	40105	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 13, 25, 33, 21] var ordem_exec_last = [25, 33, 3, 13, 21] var ordem_exec_middle3 = [33, 25, 21, 13, 3] var ordem_exec_middle4 = [3, 25] var ordem_exec_middle3 = [3, 25] var ordem_exec_middle5 = [13, 33] var ordem_exec_middle4 = [13, 33] var ordem_exec_middle3 = [13, 33]	NA
	40201	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 33, 13, 11] var ordem_exec_last = [21, 33, 13, 11] var ordem_exec_middle = [21, 3, 33, 25, 13, 11]	Classes: 25
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 33, 13, 11] var ordem_exec_last = [21, 33, 25, 13, 11] var ordem_exec_middle = [21, 3, 33, 25, 13, 11]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 33, 13, 11] var ordem_exec_last = [21, 33, 13, 11]	Excluded years: 2025, 2026

			var ordem_exec_middle = [3, 21, 33, 25, 13, 11]	
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [11, 3, 23, 25, 21] var ordem_exec_last = [11, 3, 23, 25, 21] var ordem_exec_middle3 = [11, 3, 23, 25, 22] var ordem_exec_middle4 = [11, 3, 23, 25, 23] var ordem_exec_middle3 = [11, 3, 23, 25, 24] var ordem_exec_middle5 = [11, 3, 23, 25, 25] var ordem_exec_middle4 = [11, 23] var ordem_exec_middle3 = [11, 23]	NA
	40202	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [11, 3, 21] var ordem_exec_last = [11, 3, 21] var ordem_exec_middle = [11, 3, 21]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [11, 25] var ordem_exec_last = [3] var ordem_exec_middle = [25, 33, 11, 21, 3]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 21] var ordem_exec_last = [21, 25] var ordem_exec_middle3 = [33, 21, 3, 13, 25] var ordem_exec_middle4 = [3, 22] var ordem_exec_middle3 = [33, 21, 3, 13, 26] var ordem_exec_middle5 = [3, 23] var ordem_exec_middle4 = [33, 21, 3, 13, 27] var ordem_exec_middle3 = [3, 24]	NA
	40203	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 25, 21, 33] var ordem_exec_last = [25, 33, 21, 3] var ordem_exec_middle3 = [25, 21, 3, 33] var ordem_exec_middle4 = [3, 25, 21, 33] var ordem_exec_middle3 = [3, 25, 21, 33] var ordem_exec_middle5 = [3, 25, 21, 33]	NA

		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 25, 21, 33] var ordem_exec_last = [25, 33, 21, 3] var ordem_exec_middle3 = [25, 21, 3, 33] var ordem_exec_middle4 = [3, 25, 21, 33] var ordem_exec_middle3 = [3, 25, 21, 33] var ordem_exec_middle5 = [3, 25, 21, 33]	NA
	40204	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [13, 25, 3] var ordem_exec_last = [13, 3, 33] var ordem_exec_middle = [13, 3, 33]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [13, 3, 25] var ordem_exec_last = [13, 3] var ordem_exec_middle = [13, 3]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [13, 3] var ordem_exec_last = [13, 3, 33] var ordem_exec_middle = [13, 3, 33]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 13] var ordem_exec_last = [13, 24, 33, 3] var ordem_exec_middle = [13, 3, 24]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3] var ordem_exec_last = [13, 33] var ordem_exec_middle3 = [13, 3] var ordem_exec_middle4 = [13, 3] var ordem_exec_middle3 = [13] var ordem_exec_middle5 = [13] var ordem_exec_middle4 = [13] var ordem_exec_middle3 = [13, 33]	Classes: 25 Excluded years: 2025
	40205	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [13, 21, 25, 33, 3] var ordem_exec_last = [13, 21, 25, 33, 3] var ordem_exec_middle = [13, 21, 25, 33, 3]	NA
		first3, Middle	var ordem_exec_first = [3, 33, 21, 25]	NA

			var ordem_exec_middle = [21, 33, 11, 3, 13, 25]	
		Middle4, Middle3	var ordem_exec_middle = [21, 33, 11, 3, 13, 25]	NA
		Middle5, Middle4, Middle3	var ordem_exec_middle = [21, 33, 11, 3, 13, 25]	NA
		last3	var ordem_exec_last = [13, 21, 25]	NA
ANDES	40601	last3	var ordem_exec_first = [21]	NA
		last3	var ordem_exec_first = [21, 25, 33]	NA
		Middle3, Middle4, Middle3	var ordem_exec_middle = [21, 3, 33, 25, 13, 11, 12]	NA
		Middle5, Middle4, Middle3	var ordem_exec_middle = [21, 3, 33, 25, 13]	NA
	40602	Middle3, Middle4, Middle3	var ordem_exec_middle3 = [3, 11, 12, 13] var ordem_exec_middle4 = [21, 3, 33, 25, 13, 11, 12] var ordem_exec_middle3 = [21, 3, 33, 25, 13, 11, 12]	NA
		last3	var ordem_exec_last = [25]	Excluded years: 2026
		last3	var ordem_exec_last = [25]	NA
		first3	var ordem_exec_first = [3, 13, 33]	NA
		Middle5, Middle4, Middle3	var ordem_exec_middle = [21, 3, 33, 25, 13, 11, 12]	NA
	40603	first3, Middle3	var ordem_exec_first = [21, 3, 13, 12, 25, 33] var ordem_exec_middle = [21, 3, 13, 12, 25, 33]	NA
		Middle4, Middle3	var ordem_exec_middle = [21, 3, 13, 12, 25, 33]	NA
		Middle5, Middle4, Middle3, last3	var ordem_exec_last = [21, 3, 13, 12, 25, 33] var ordem_exec_middle = [21, 3, 13, 12, 25, 33]	NA
	40604	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 12, 11, 25, 21, 33] var ordem_exec_last = [3, 12, 11, 25, 21, 33] var ordem_exec_middle = [3, 12, 11, 25, 21, 33]	NA

	40605	first3, Middle3, Middle4	var ordem_exec_first = [11, 3, 33] var ordem_exec_middle = [3, 33, 21, 11, 12, 13]	NA
		first3, Middle3, Middle5	var ordem_exec_first = [11, 3, 33] var ordem_exec_middle = [3, 33, 21, 11, 12, 13]	NA
		first3, Middle4, Middle3, last3	var ordem_exec_first = [11, 3, 2003] var ordem_exec_last = [3, 21, 25, 33, 11, 12, 13] var ordem_exec_middle = [3, 33, 21, 11, 12, 13]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [34, 25, 13] var ordem_exec_last = [25, 13, 21] var ordem_exec_middle3 = [34, 25, 13] var ordem_exec_middle4 = [34, 25, 13] var ordem_exec_middle5 = [25, 13]	NA
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 13, 11, 25] var ordem_exec_last = [3, 13, 11, 25] var ordem_exec_middle = [3, 13, 11, 25]	Classes: 34
	40606	first3, Middle3, Middle4, Middle3	var ordem_exec_first = [4, 3, 13, 25] var ordem_exec_middle = [4, 3, 13, 25]	Excluded years: 1990, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2009, 2010, 2011, 2012, 2013, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024
		first3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [4, 3, 13, 25] var ordem_exec_last = [4, 3, 13, 25] var ordem_exec_middle = [4, 3, 13, 25]	Excluded years: 1990, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2009, 2010, 2011, 2012, 2013, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024

		first3, Middle3, Middle4, Middle3, Middle4, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [11, 3, 2003] var ordem_exec_last = [3, 12, 21, 13, 25, 11, 33] var ordem_exec_middle3 = [3, 4, 13] var ordem_exec_middle4 = [3, 12, 21, 4, 11, 13, 25, 33] var ordem_exec_middle3 = [3, 21, 4, 13] var ordem_exec_middle5 = [3, 12, 21, 4, 13] var ordem_exec_middle4 = [3, 21, 4, 13] var ordem_exec_middle3 = [3, 12, 21, 4, 11, 13, 25, 33]	NA
		first3, Middle3, Middle4, Middle3, Middle4, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [33, 3, 4, 13] var ordem_exec_last = [33, 4, 3, 13, 21, 25] var ordem_exec_middle = [33, 4, 3, 13, 21, 25]	NA
	40607	first3, Middle3, Middle4, Middle3	var ordem_exec_first = [3, 4, 13, 12, 11, 21, 25] var ordem_exec_middle = [3, 4, 13, 12, 11, 21, 25]	NA
		Middle5, Middle4, Middle3, last3	var ordem_exec_last = [3, 4, 13, 12, 11, 21, 25] var ordem_exec_middle = [3, 4, 13, 12, 11, 21, 25]	NA
	40608	last3	var ordem_exec_last = [21, 25]	Ignored years: 2026
		last3	var ordem_exec_last = [21, 25]	NA
		Middle3, Middle4	var ordem_exec_first = [21, 25, 3, 11, 12, 13, 33, 34] var ordem_exec_middle = [21, 25, 3, 11, 12, 13, 33, 34]	NA
		Middle3, Middle5	var ordem_exec_middle = [21, 25, 3, 11, 12, 13, 33, 34]	NA
		first3	var ordem_exec_first = [3, 12, 13, 11]	NA
	40609	last3	var ordem_exec_last = [3, 11, 13]	Ignored years: 2025, 2026
		last3	var ordem_exec_last = [11]	Excluded years: 2026
		last3	var ordem_exec_last = [11]	NA
		Middle3, Middle4	var ordem_exec_middle = [21, 25, 3, 11, 12, 13, 33]	NA
		Middle3, Middle5, Middle4, Middle3	var ordem_exec_middle = [21, 25]	NA

PACIFIC	40901	first3, Middle3, Middle4, Middle3, Middle4, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [4, 3, 21, 25] var ordem_exec_last = [4, 3, 21, 25] var ordem_exec_middle = [4, 3, 21, 25]	NA
		first3, Middle3, Middle4, Middle3, Middle4, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [3, 4, 13] var ordem_exec_last = [3, 4, 21, 13] var ordem_exec_middle3 = [3, 4, 25, 33, 13] var ordem_exec_middle4 = [3, 4, 13, 33] var ordem_exec_middle3 = [3, 4, 13, 33] var ordem_exec_middle5 = [3, 4, 13] var ordem_exec_middle4 = [3, 4, 13] var ordem_exec_middle3 = [3, 4, 13]	NA
	40902	Middle3, Middle4, Middle3, first3, last3	var ordem_exec_first = [21, 3, 12, 33, 25, 11] var ordem_exec_last = [12, 21, 3, 25, 33, 11] var ordem_exec_middle = [21, 3, 33, 25, 12, 11]	NA
		Middle5, Middle4, Middle3, first3, last3	var ordem_exec_first = [21, 12, 3, 33, 25, 11] var ordem_exec_last = [12, 21, 3, 25, 33, 11] var ordem_exec_middle = [21, 12, 3, 33, 25, 11]	NA
		Middle3, Middle4, Middle3	var ordem_exec_middle = [11, 33, 25]	NA
		Middle3, Middle4, Middle3	var ordem_exec_middle = [11, 33, 25]	NA
	40903	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [21, 3, 12, 33, 25] var ordem_exec_last = [21, 3, 12, 33, 25] var ordem_exec_middle = [21, 3, 12, 33, 25]	Classes: 13
		first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [21, 33, 11, 3, 25] var ordem_exec_last = [33, 21, 11, 3, 25] var ordem_exec_middle = [33, 21, 11, 3, 25]	Classes: 13
		Middle4, Middle3, Middle5, Middle4, Middle3	var ordem_exec_middle = [12, 33, 21, 3, 25]	Classes: 13

	40904	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [11, 3, 33, 21, 25] var ordem_exec_last = [11, 3, 33, 21, 25] var ordem_exec_middle3 = [11, 3, 33, 21, 2511, 3, 33, 21, 25] var ordem_exec_middle4 = [11, 3, 33, 21, 25] var ordem_exec_middle3 = [11, 3, 33, 21, 25] var ordem_exec_middle5 = [11, 3, 33, 21, 25]	NA
		Middle3, Middle4, Middle3, Middle5, Middle4, Middle3, last3	var ordem_exec_first = [21, 3, 25] var ordem_exec_last = [21, 3, 25] var ordem_exec_middle = [21, 3, 25]	NA
	40905	last3	var ordem_exec_last = [21, 3, 2004]	Ignored years: 2026
		last3	var ordem_exec_last = [21, 25, 3, 4, 13]	NA
		Middle3, Middle4, Middle3	var ordem_exec_middle = [21, 25, 3, 4, 13, 33]	NA
		Middle5, Middle4	var ordem_exec_middle = [21, 25, 3, 4, 13, 33]	NA
		Middle5, Middle4, Middle3	var ordem_exec_middle = [21, 4]	NA
		Middle3	var ordem_exec_first = [25, 4, 13, 33]	NA
	40906	first3, Middle5, Middle4, Middle3	var ordem_exec_first = [4, 3, 11, 21, 25, 33] var ordem_exec_middle = [4, 3, 11, 21, 25, 33]	NA
		Middle4, Middle3, Middle3, last3	var ordem_exec_last = [4, 3, 11, 21, 25, 33] var ordem_exec_middle = [4, 3, 11, 21, 25, 33]	NA
	40910	last3	var ordem_exec_last = [21]	NA
		last3	var ordem_exec_last = [11, 4]	Excluded years: 2026
		Middle3, Middle4, Middle3, last3	var ordem_exec_last = [13] var ordem_exec_middle = [13]	NA
		last3	var ordem_exec_last = [13, 11, 2004]	NA

		first3	var ordem_exec_first = [11, 12, 13]	Excluded years: 1985
		first3	var ordem_exec_first = [4, 11, 12, 13, 21]	NA
		Middle3, Middle4	var ordem_exec_middle = [3, 4, 11, 12, 13, 33]	NA
		Middle3, Middle5, Middle4	var ordem_exec_middle = [3, 4, 11, 12, 13, 33, 21, 25]	NA
		Middle3	var ordem_exec_middle = [3, 4, 11, 12, 13, 33, 21, 25]	NA
GALAPAGOS	40907	first3, Middle3, Middle4, Middle3, Middle5, Middle4, Middle3	var ordem_exec_first = [11, 12, 13, 3, 4, 33, 25] var ordem_exec_middle = [11, 12, 13, 3, 4, 33, 25]	NA
		Middle4, Middle3, last3	var ordem_exec_last = [11, 12, 13, 3, 4, 33, 25] var ordem_exec_middle = [11, 12, 13, 3, 4, 33, 25]	NA
	40908	first3, Middle5	var ordem_exec_first = [11, 3, 21, 25, 4, 33] var ordem_exec_middle = [11, 3, 33, 4, 25, 21]	NA
		Middle3, Middle4, Middle3, last3, Middle5, Middle4, Middle3	var ordem_exec_last = [11, 25, 21, 4, 3, 33] var ordem_exec_middle3 = [33, 11, 4, 25, 3, 21] var ordem_exec_middle4 = [11, 3, 4, 25, 21, 33] var ordem_exec_middle3 = [11, 3, 4, 25, 21, 33] var ordem_exec_middle5 = [11, 4, 3, 25, 33] var ordem_exec_middle4 = [11, 4, 3, 25, 33] var ordem_exec_middle3 = [11, 4, 3, 25, 33]	NA
	40909	first3, Middle3, last3	var ordem_exec_first = [11, 12, 13, 3, 4, 25, 33] var ordem_exec_last = [11, 12, 13, 3, 4, 25, 21, 33] var ordem_exec_middle = [11, 12, 13, 3, 4, 25, 33, 21]	NA
		Middle4	var ordem_exec_middle = [11, 12, 13, 3, 4, 25, 33, 21]	NA

4.3.3 Spatial filter

The spatial filter seeks to reduce the number of isolated and/or discontinuous pixels (Figure 20). Groups of pixels that do not meet the equivalent of the minimum mapping unit (≈ half a hectare; circa 5 pixels) are identified through neighborhood rules and reclassified (they take the value of the surrounding class).

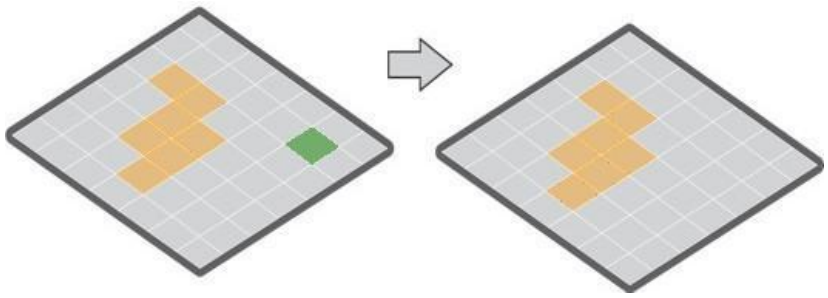


***Figure 20**. Functionality of the spatial filter of MapBiomas Ecuador Collection 4.0 (Prepared by MapBiomas).*

In the Ecuadorian Amazon, a spatial filter was used in all classification regions; its parameters were adjusted according to the region and are detailed in the following table.

Table 11. Spatial filter parameters defined for each classification region of MapBiomas Ecuador Collection 4.0 (Prepared by Ecociencia).

Biome	Region code	Number of iterations	Minimum number of connected pixels	Excluded classes/years
AMAZON	40101	1	5	NA
	40102	1	5	NA
	40103	1	5	NA
	40104	1	5	NA
	40105	1	5	NA
	40201	2	5	NA
			5	NA
	40202	1	5	NA
	40203	1	5	NA
	40204	1	5	NA
	40205	1	5	NA
ANDES	40601	1	5	NA
	40602	1	5	NA
	40603	1	5	NA
	40604	1	5	NA
	40605	2	5	NA
			5	NA

	40606	1	5	NA
	40607	1	5	NA
	40608	1	5	NA
	40609	0	NA	NA
PACIFIC	40901	2	5	NA
			5	NA
	40902	1	5	NA
	40903	1	5	NA
	40904	1	5	NA
	40905	1	5	NA
	40906	1	5	NA
	40910	1	5	NA
GALAPAGOS	40907	1	5	NA
	40908	1	5	NA
	40909	1	5	NA

4.3.4 Frequency filter

This filter takes into account the frequency of occurrence of natural classes (IDs 3, 4, 6, 11, 12, 13, 29, 33, 34) throughout the entire time series, whereby classes with sporadic occurrences along the series are replaced by the value of the most frequent class (temporally), provided that this most frequent class meets a stability criterion throughout the time series. This filter helps reduce temporal oscillations associated with natural dynamics that are misclassified as a different class or as a class change. Applying this filter results in a more consistent classification of natural classes by reducing the frequency of false positives related to natural dynamics while preserving consolidated trajectories.

Each pixel, evaluated over the historical series, must meet two criteria simultaneously for the filter to be applied: the occurrence of a single natural class must exceed a minimum percentage throughout the series (showing relative stability), and the majority class must exceed a minimum percentage of occurrence in order to prevail as the definitive class. Based on the value of the class that meets this latter percentage, those "temporally isolated" pixels that have a high probability of being classification errors are updated (Figure 21).

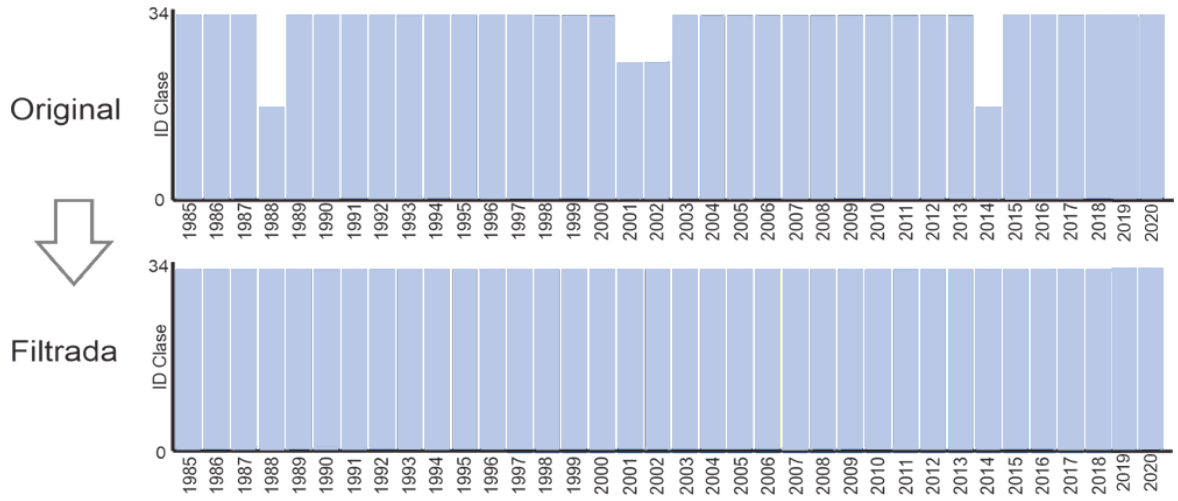


Figure 21. *Functionality of the MapBiomas Ecuador frequency filter (Prepared by MapBiomas).*

In addition, and to meet the specific needs of the Ecuadorian territory, work was done to adapt and implement the possibility of generating inclusion or exclusion geometries, that is, specific or localized zones where the filter was or was not applied. These geometries were called *hidden*, and an example of them can be seen in Figure 22.

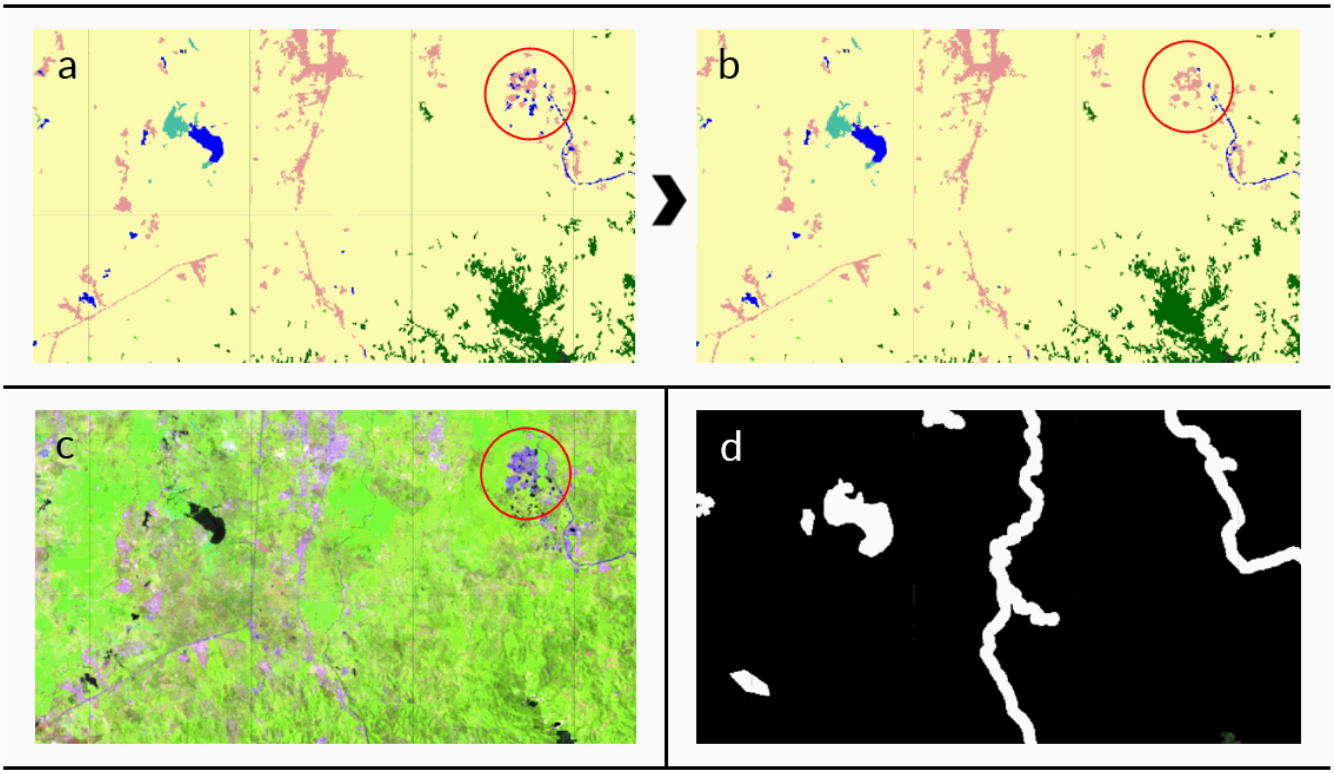


Figure 22. *Exclusion geometries (hidden). a) Pre-filter classification. b) Classification after the frequency filter. c) Landsat mosaic for 2022. d) Exclusion zone in white (Prepared by MapBiomas).*

In Ecuador, the two criteria were adjusted according to the needs of each classification region and are summarized in Table 12.

Table 12. Frequency filter parameters defined for each classification region of MapBiomas Ecuador Collection 4.0 (Prepared by Ecociencia).

Biome	Region code	Number of iterations	Native vegetation			Excluded classes/years
			% native vegetation	% majority class	Included classes	
AMAZON	40101	1	70	50	3	Classes: 11, 12
	40102	1	30	80	11, 3, 13, 25, 21	NA
	40103	2	80	94	13, 11, 12, 33, 3, 21, 25	NA
			60	80	21	NA
	40104	2	80	50	3, 33	Classes: 21, 25
			90	50	33, 21	Classes: 3
	40105	5	90	90	3, 13	Classes: 21, 33
			85	85	25, 33, 3, 13, 21	Years: 2015-2025
			40	40	3	Classes: 25
			75	75	3, 13, 25	NA
			40	40	33	NA
	40201	2	60	70	3, 33	Classes: 21, 13, 25
			20	60	11	Years: 2025, 2026
	40202	2	50	70	11, 3, 21, 25	Years: 1985-1993, 2000-2026
			50	80	11, 3, 21, 25	NA
	40203	2	85	85	3, 25, 33, 21	NA
			50	50	3	NA
	40204	6	90	70	13, 3	Classes: 33, 25
			10	10	33	NA
			10	10	33	Years: 1985-2013, 2025

			80	70	33, 13, 3	NA
			50	10	33	Years: 2015-2026
			70	80	13, 3, 33	Classes: 25 Years: 2025
	40205	2	80	60	3, 33, 13	Classes: 21
			50	50	21	NA
ANDES	40601	2	80	60	3, 12, 13, 21, 25, 33	NA
			10	10	21	NA
	40602	1	80	30	12, 11, 33, 13	NA
	40603	4	50	60	13, 12, 3, 25, 33	Classes: 23, 12, 21
			70	50	3	Classes: 23, 13, 12, 25, 33 Years:2006,2007,2008,2009,2010,2011,2012,2013,2014,2015,2016,2017,2018,2019,2020,2021,2022,2023,2024,2025,2026
			90	90	13, 12, 3, 25, 33	NA
			50	40	NA	Years: 1985,1986,1987,1988,1989,1990,1991,1992,1993,1994,1995,1996,1997,1998,1999,2000,2001,2002,2003,2004,2005,2006,2007,2008,2009,2010,2011,2012,2013,2014,2015,2016,2017,2018,2019,2020,2021,2022
	40604	3	85	80	21	NA
			75	65	3	NA
			60	50	21, 3	NA
	40605	6	60	80	3, 21, 13, 12, 11, 25	Classes: 34

			30	50	3, 12, 21, 25	NA
			30	95	3, 12, 21, 25	Years: 2025
			50	60	13, 11	Years: 2025, 2026
			60	60	11	Classes: 34
			70	70	12	Classes: 34 Years: 1985-2024
	40606	6	20	20	12, 13	NA
			50	90	33, 12, 4, 3, 21	NA
			30	40	3	Years: 2013-2026
			30	40	33	Classes: 12 Years: 1985-2017
			30	30	13	NA
			60	92	3, 4, 21, 11, 12, 13, 25, 33	NA
	40607	3	40	40	3, 4, 13, 12	Classes: 3
			10	10	3, 21, 25	Classes: 12
			90	40	3, 4, 13	Classes: 12
	40608	1	40	20	3, 11, 13	NA
	40609	2	60	40	3, 11, 12, 13	NA
			40	20	25	Classes: 25
PACIFIC	40901	4	60	70	3, 21	NA
			60	60	21, 3	Classes: 33, 25 Years: 1985-1998
			60	60	33	Years: 1985-1998, 2000-2002, 2004-2011, 2013, 2015-2026

			60	87	11, 12, 13, 3, 4, 21, 33, 25	NA
	40902	1	90	90	12, 33, 3, 25, 21	NA
	40903	1	80	60	13, 12, 3, 25, 33	Classes: 25, 21
	40904	6	30	30	33	NA
			80	70	3, 21, 25, 33	NA
			30	20	33	Classes: 11
			60	45	3	Years: 2010-2026
			30	30	21	Classes: 3, 33 Years: 1985-1999
			30	20	33	Classes: 11 Years: 1985-1998
	40905	2	60	40	3, 4	NA
			60	40	13	NA
	40906	2	40	40	21, 3	Classes: 4, 25, 33
			80	50	3	NA
	40910	3	40	20	4	NA
			40	20	11, 12, 13	NA
			60	40	3, 21	NA
GALAPAGOS	40907	2	75	70	4, 33, 3, 12, 13, 25	NA
			50	60	13, 12, 3, 4, 25, 33	NA
	40908	3	90	80	4, 25, 33, 3, 13, 21	NA

			87	85	4, 12, 25, 33, 3, 13, 21	NA
			50	50	13, 3	NA
	40909	3	75	70	4, 33, 3, 13, 12	Classes: 25
			80	85	13, 4, 3, 25, 21	NA
			18	18	3	Classes: 21, 25

4.3.5 Order of Filter Application by Region in Ecuador

According to the needs of each classification region, the order (Table 13) and the parameters of each filter (Tables 7 to 12) were adjusted.

Table 13. Order of filter application by classification region in MapBiomas Ecuador Collection 4.0 (Prepared by Ecociencia).

Biome	Region code	Filters	Mask
AMAZON	40101	Gapfill, Temporal, Temporal, Temporal, Temporal, Temporal, Frequency, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40102	Gapfill, Gapfill, Temporal, Temporal, Temporal, Temporal, Mask 1, Spatial	mascara_ID23_EC_col4
	40103	Gapfill, Gapfill, Temporal, Temporal, Temporal, Mask 1, Frequency, Frequency, Temporal, Temporal, Mask 2, Mask 3, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40104	Gapfill, Gapfill, Temporal, Temporal, Temporal, Frequency, Frequency, Masks, Spatial	mascara_ID23_EC_col4
	40105	Gapfill, Gapfill, Frequency, Frequency, Temporal, Frequency, Frequency, Frequency, Mask 1, Mask 2, Spatial	mascara_ID68_EC_col4 // mascara_ID23_EC_col4
	40201	Gapfill, Temporal, Temporal, Mask 1, Frequency, Mask 2, Temporal, Mask 3, Mask 4, Spatial, Frequency, Temporal, Spatial	mascara_ID23_EC_col4
	40202	Gapfill, Temporal, Temporal, Frequency, Frequency, Temporal, Mask 1, Spatial	mascara_ID23_EC_col4

	40203	Gapfill, Gapfill, Temporal, Frequency, Temporal, Mask, Spatial	mascara_ID23_EC_col4
	40204	Gapfill, Temporal, Temporal, Temporal, Temporal, Frequency, Frequency, Frequency, Frequency, Frequency, Frequency, Temporal, Mask 1, Spatial	NA
	40205	Gapfill, Gapfill, Temporal, Temporal, Temporal, Temporal, Temporal, Frequency, Mask, Frequency_remap, Spatial	mascara_ID23_EC_col4
ANDES	40601	Gapfill, Temporal, Temporal, Temporal, Temporal, Frequency, Frequency, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40602	Gapfill, Temporal, Temporal, Temporal, Temporal, Temporal, Frequency, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40603	Gapfill, Gapfill, Temporal, Temporal, Temporal, Frequency, Frequency, Frequency, Frequency, Mask, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40604	Gapfill, Gapfill, Temporal, Frequency, Frequency, Spatial, Frequency	NA
	40605	Gapfill, Gapfill, Temporal, Temporal, Temporal, Temporal, Frequency, Mask 1, Frequency, Frequency, Mask 2, Mask 3, Spatial, Frequency, Frequency, Frequency, Temporal, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40606	Gapfill, Gapfill, Temporal, Temporal, Frequency, Mask 1, Temporal, Frequency, Frequency, Frequency, Frequency, Temporal, Frequency, Mask 2, Mask 3, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40607	Gapfill, Gapfill, Temporal, Temporal, Frequency, Frequency, Frequency, Mask, Spatial	mascara_ID23_EC_col4
	40608	Gapfill, Temporal, Temporal, Temporal, Temporal, Temporal, Temporal, Frequency, Spatial	mascara_ID68_EC_col4
	40609	Gapfill, Gapfill, Temporal, Temporal, Temporal, Temporal, Temporal, Frequency, Frequency, Spatial	NA

PACIFIC	40901	Gapfill, Frequency, Temporal, Frequency, Mask 1, Frequency, Temporal, Frequency, Mask 2, Mask 3, Spatial, Mask 4, Mask 5, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4 // mascara_ID18_EC_col4 // mascara_IDbanano_EC_col4
	40902	Gapfill, Gapfill, Gapfill, Temporal, Temporal, Frequency, Temporal	mascara_ID23_EC_col4
	40903	Gapfill, Gapfill, Temporal, Frequency, Temporal, Temporal, Mask, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40904	Gapfill, Gapfill, Temporal, Temporal, Temporal, Frequency, Frequency, Frequency, Frequency, Frequency, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40905	Gapfill, Temporal, Temporal, Temporal, Temporal, Temporal, Temporal, Frequency, Frequency, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40906	Gapfill, Gapfill, Temporal, Temporal, Frequency, Frequency, Masks, Spatial	mascara_ID23_EC_col4
	40910	Gapfill, Temporal, Temporal, Temporal, Temporal, Temporal, Temporal, Temporal, Temporal, Temporal, Frequency, Frequency, Frequency	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
GALAPAGOS	40907	Gapfill, Gapfill, Mask, Frequency, Temporal, Temporal, Frequency, Mask, Mask, Spatial	mascara_ID23_EC_col4 // mascara_ID68_EC_col4
	40908	Gapfill, Temporal, Temporal, Frequency, Frequency, Mask, Mask, Spatial	mascara_ID23_EC_col4
	40909	Gapfill, Gapfill, Frequency, Temporal, Temporal, Frequency, Frequency, Mask, Mask, Spatial	mascara_ID23_EC_col4

4.3.6 Masks

Rocky outcrop (ID 29)

It should be noted that above a certain elevation, vegetation is reduced and affected by factors such as temperature and the amount of oxygen in the atmosphere. According to the Holdridge life zones[9], above 4000 meters above sea level we find the subalpine, alpine and nival altitudinal belts, which are characterized by sparse or no vegetation. Based on this knowledge, different sources of information were combined, such as the contour lines of the Instituto Geográfico Militar (Military Geographic Institute) at a scale of 1:250,000, the MAG Land Use and Cover and Production Systems Map, and satellite imagery. By applying spatial analysis techniques and visual analysis of all these inputs, it was consistently determined that rocky outcrops are found above the 4000 meters above sea level contour. Thus, a mask was built from that elevation to remap pixels categorized as non-vegetated areas to the rocky outcrop class. However, this analysis also revealed that rocky outcrops occur at lower elevations on the slopes of

[9] *The Holdridge* life zones system is a model that divides the land into life zones ordered according to latitudinal region, altitudinal belt and humidity. Different zones are defined as a function of mean annual precipitation, mean annual temperature and altitude.

the Sumaco and Reventador volcanoes. Therefore, for these two cases the altitudinal criterion was set from 2400 meters for Sumaco and 2000 meters for Reventador; this was done exclusively in the Upper Amazon 2 classification zone (ID 40102).

This process was carried out only in certain mapping regions (see Table 13).

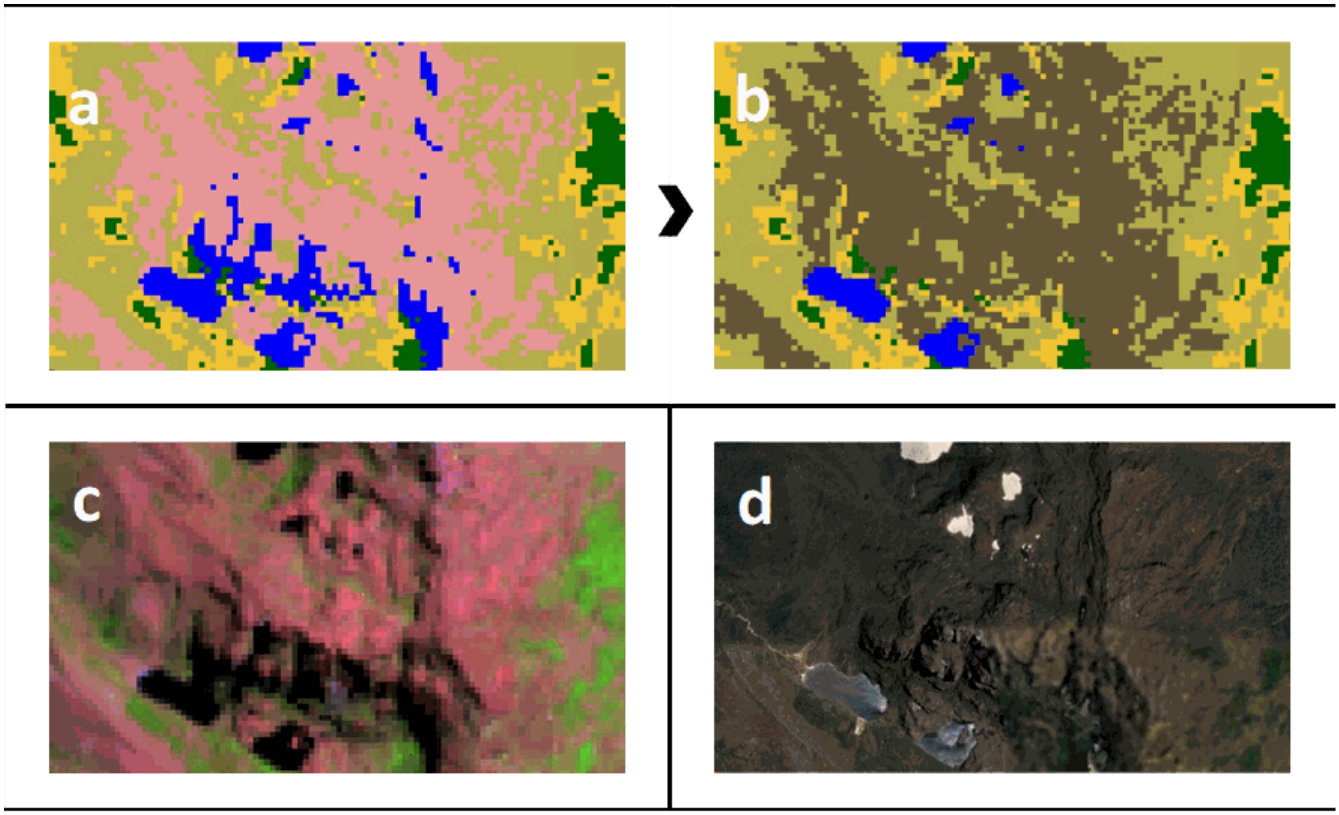


Figure 23. *Rocky outcrop mask (ID 29). a) Original classification (before applying the mask). b) Application of the rocky outcrop mask. c) Landsat mosaic for 2022. d) Google Earth high-resolution image (Prepared by Ecociencia).*

Forest plantation (ID 9)

Forest plantation mapping is based on assigning the corresponding value (ID = 9) to pixels classified as one of the forest categories within the polygons of the Ministry of Agriculture and Livestock from the available historical record inputs.

This layer defines a forest plantation as the "wooded area obtained artificially by planting native or exotic species, which are of the same age and have homogeneous spacing. Its purpose is to obtain timber and non-timber products." This layer can be consulted at: http://geoportal.agricultura.gob.ec

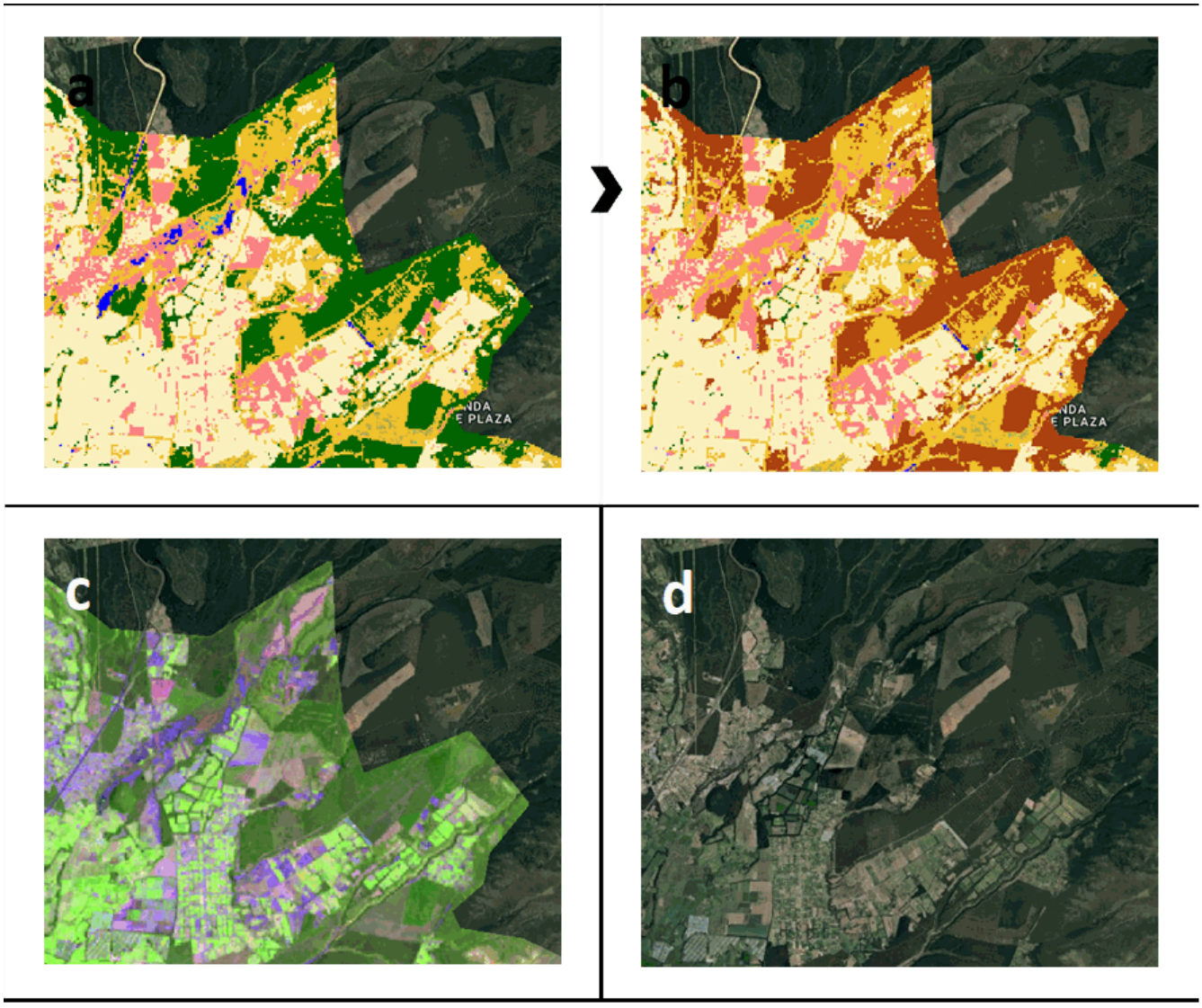


Figure 24. *Forest plantation mask (ID = 9). a) Original classification (before applying the mask). b) Application forest plantation mask. c) Landsat mosaic for 2022. d) Google Earth high-resolution image (Prepared by Ecociencia).*

Aquaculture (ID 31)

Aquaculture mapping is based on assigning the corresponding value (ID = 31) to pixels classified as water (ID = 33) within the polygons of the Ministry of Agriculture and Livestock:

- Mapa de Cobertura y uso de la tierra y Sistemas productivos agropecuarios del Ecuador continental (version edited by the Ministry of Agriculture and Livestock in 2020), scale 1:25.000, years 2009 - 2015

It should be emphasized that from this reference only those polygons whose "land use" category matched the description "aquaculture" were selected. This layer can be consulted at: http://geoportal.agricultura.gob.ec

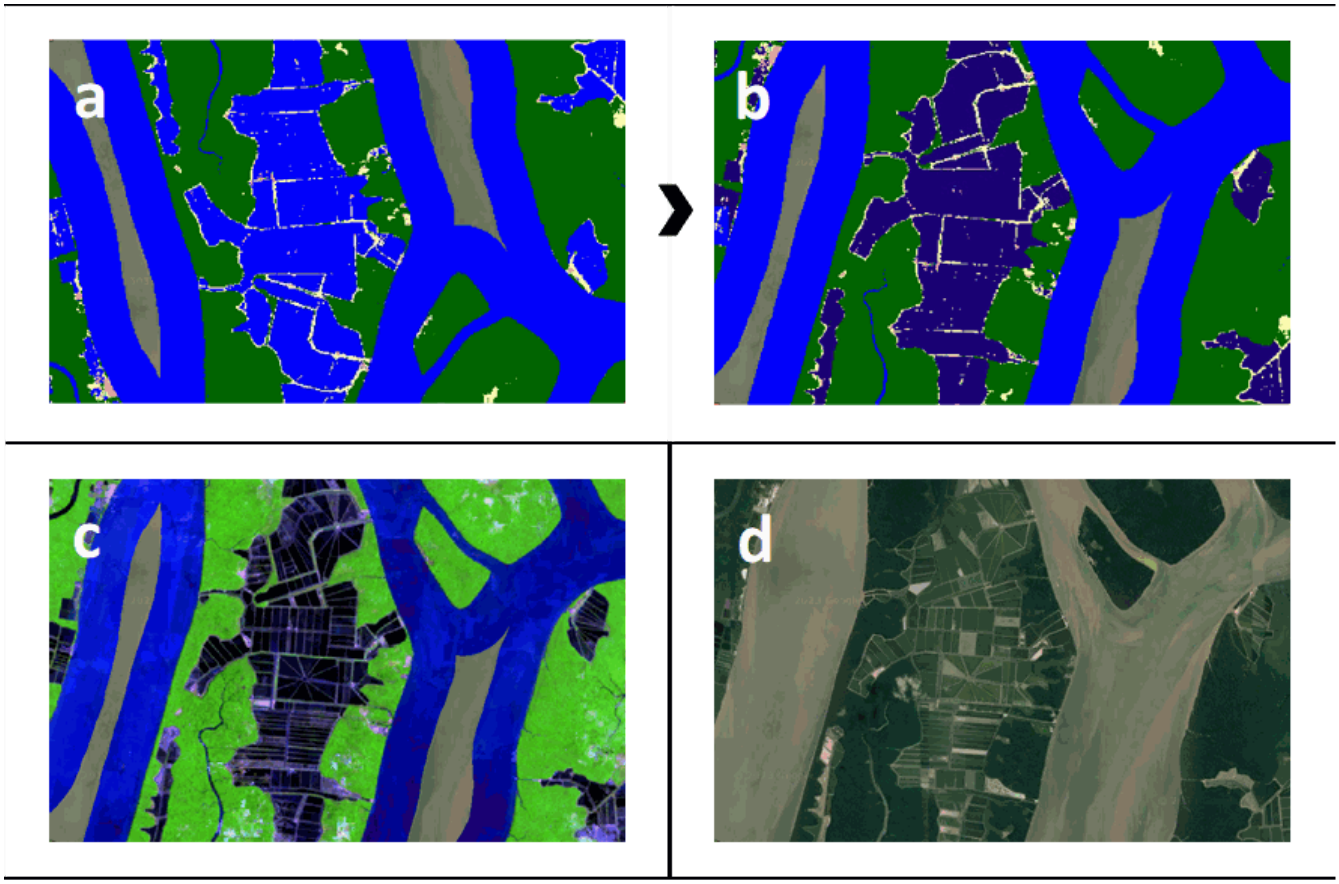


Figure 25. *Aquaculture mask (ID = 31). a) Original classification (before applying the mask). b) Application of aquaculture mask. c) Landsat mosaic for 2022. d) Google Earth high-resolution image (Prepared by Ecociencia).*

Remapping of beaches, dunes and sand spots (ID 23)

To generate the mask for beaches, dunes and sand banks, the layer **"2009-2015 - Mapa de Cobertura y Uso de la Tierra y Sistemas Productivos Agropecuarios del Ecuador continental"** was used as a reference, in its version edited by the **Ministry of Agriculture and Livestock (MAG) in 2020**. This layer, at a scale of 1:25,000, covers the period 2009-2015.

In this layer, the attributes corresponding to **level 3** were selected, which include the specific categories of sand banks and beaches. Subsequently, a spatial analysis was performed using the **"Select by location"** tool, with a double-line river shapefile as a reference. This process made it possible to identify and delineate the relevant areas associated with **ID23** within the generated mask. Subsequently, manual-visual digitization was carried out using Planet Explorer basemaps to refine and delineate these areas more precisely.

The combined approach of spatial analysis and manual digitization ensured accuracy and reliability in delineating the areas of interest.

Remapping of Other natural non-vegetated area (ID 68)

In order to detect natural non-vegetated zones or areas, once the general map has been integrated, the following adjusted filters are applied, which modify the pixel value only in zones covered by anthropic non-vegetated areas (Id25):

4.3.7 Adjusted Temporal Filter

This filter seeks to detect ID 68 provided that the pixel is surrounded by natural cover within an interval of at most 6 years in the time series; in addition, the filter is applied only in areas that various sources (see Annex 3) indicate are not anthropic zones.

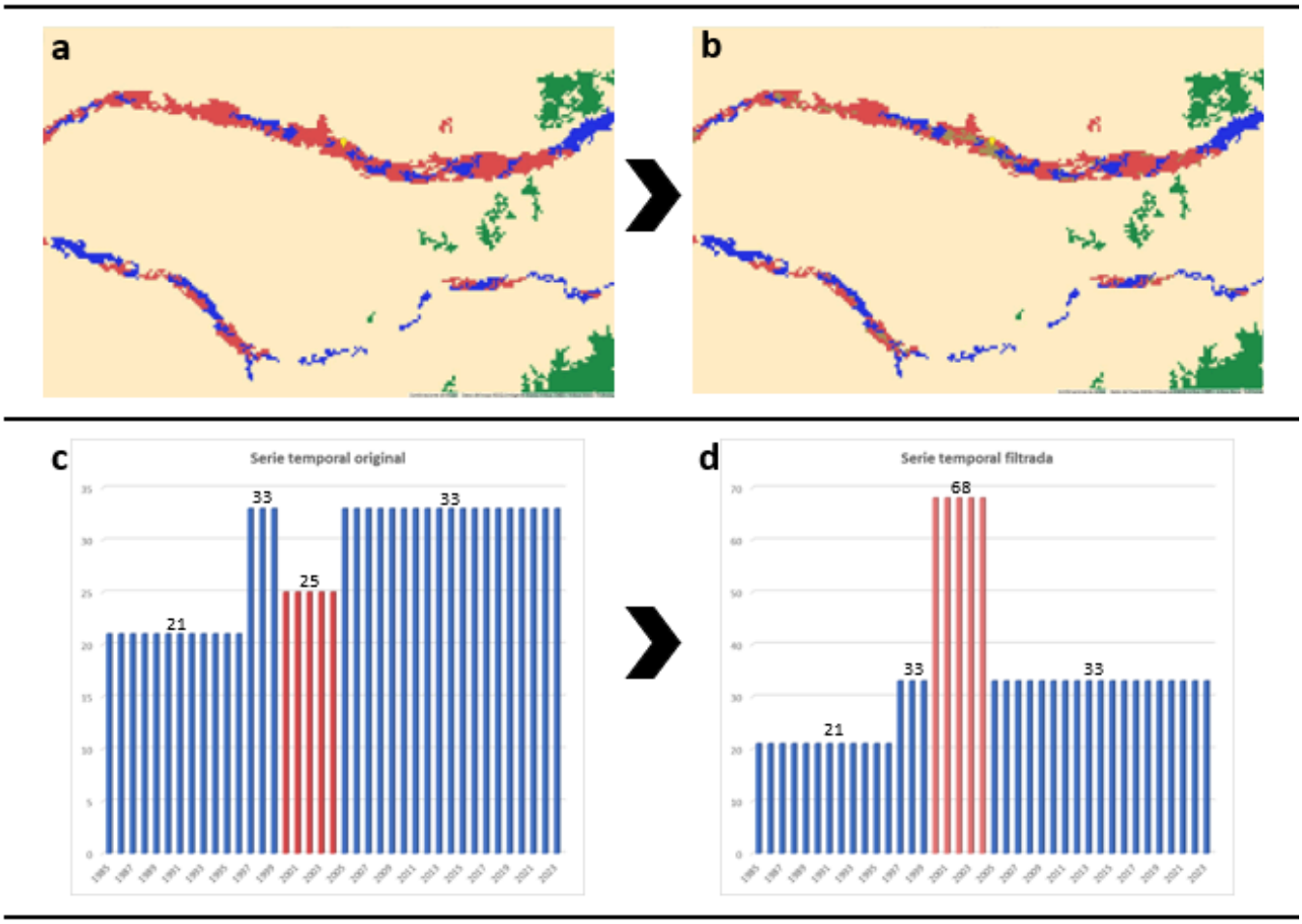


Figure 27. *Adjusted temporal filter for the natural non-vegetated area class (ID = 68). a) Original classification (before applying the filter). b) Classification after applying the filter. c) Pre-filter time series. d) Post-filter time series (Prepared by Ecociencia).*

4.3.8 Adjusted Frequency Filter

This filter aims to detect ID 68 provided that, in the pixel-by-pixel analysis, natural cover or anthropic non-vegetated area has been detected in 100% of the series; the filter is applied only in areas that various sources (see Annex 3) indicate are not anthropic zones.

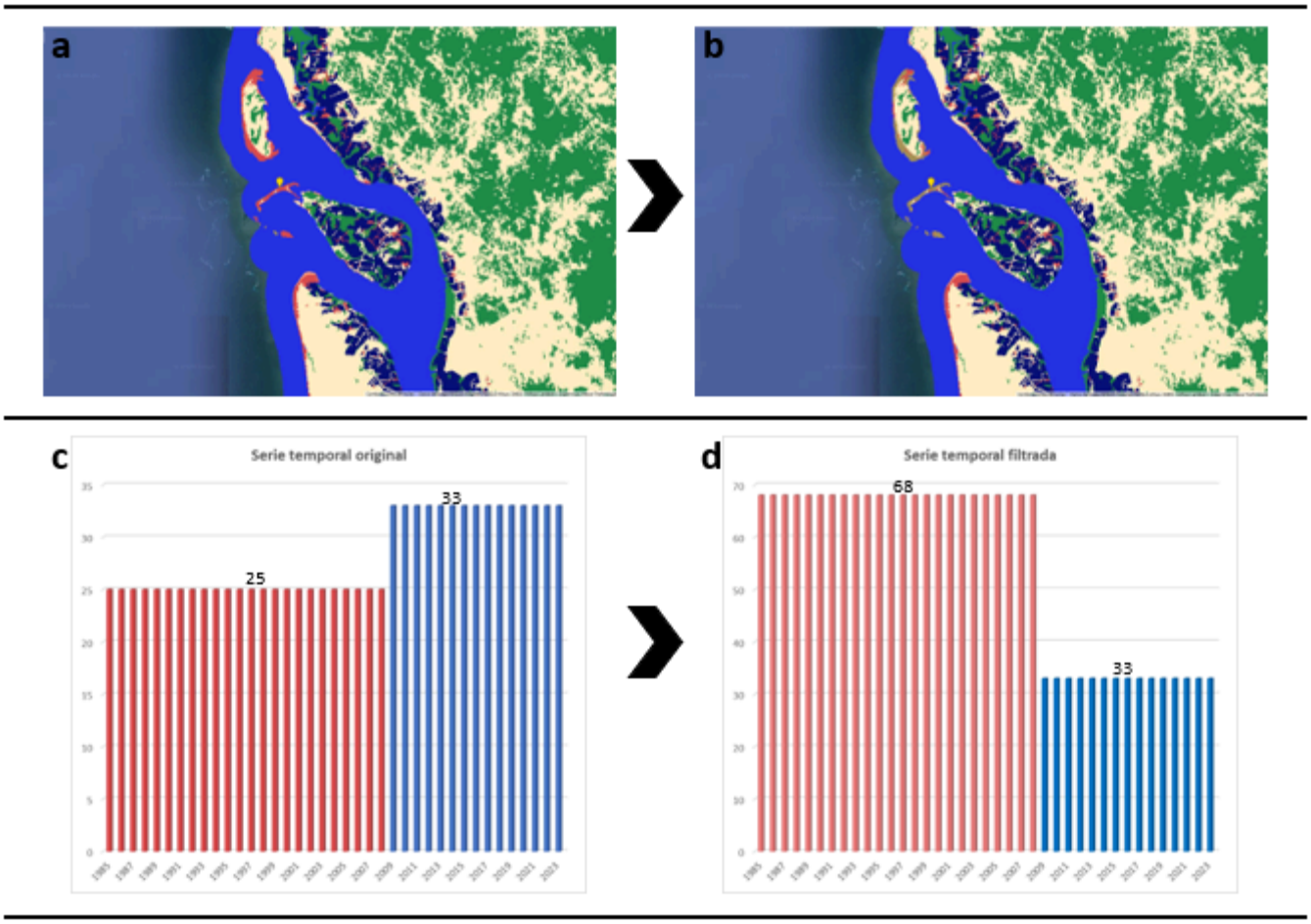


Figure 28. *Adjusted frequency filter for the natural non-vegetated area class (ID = 68). a) Original classification (before applying the filter). b) Classification after applying the filter. c) Pre-filter time series. d) Post-filter time series (Prepared by Ecociencia).*

4.4 Classification of Cross-cutting Themes

For cases where there are limitations in differentiating certain classes, specific methodologies have been developed to overcome these limitations. These methodologies are called "cross-cutting themes" because they map information for these classes independently of the general map, or cross-sectionally. Each methodology developed considers only the class of interest. For MapBiomas Ecuador Collection 4.0, 6 classes are mapped as cross-cutting themes (Figure 29): mangrove, flooded forest, urban infrastructure, mining, glaciers and, in this latest collection, banana cultivation has been incorporated in a beta phase. This information has been included in the final map at a stage called "integration". Each cross-cutting methodology is described in its respective thematic ATBD.

The following details which classes were mapped following the General Map methodology or as cross-cutting themes (Figure 29).

ID	COLLECTION 4	TYPE	GENERAL MAP	CROSS-CUTTING MAP
1	**1. Forest Formation**			
3	1.1. Forest	COVER	X	
4	1.2. Open forest	COVER	X	
5	1.3. Mangrove	COVER		X

6	1.4. Flooded forest	COVER		X
10	**2. Non-forest natural formation**			
11	2.1. Flooded non-forest natural formation	COVER	X	
12	2.2. Grassland	COVER	X	
81	2.3. Andean grasslands and shrublands	COVER	X	
82	2.4. Flooded Andean grasslands	COVER	X	
29	2.5. Rocky outcrop	COVER	X	
13	2.4. Other non-forest natural formation	COVER	X	
14	**3. Agriculture and forest plantation**			
9	3.1 Forest plantation	USE	X	
21	3.2 Mosaic of agriculture and/or pasture	USE	X	
74	3.3. Banana	USE		X
22	**4. Non-vegetated area**			
24	4.1. Urban infrastructure	USE		X
30	4.2. Mining	USE		X
23	4.3. Beach, dune or sand spot	COVER	X	
25	4.4. Other anthropic non-vegetated area	USE	X	
68	4.5. Other natural non-vegetated area	COVER	X	
26	**5. Water body**			
33	5.1 River, lake or ocean	COVER	X	
34	5.2 Glacier	COVER		X
31	5.3 Aquaculture	USE	X	

Figure 29. *Methodological scheme used for each legend class in Ecuador (Prepared by Ecociencia).*

4.5 Integration

4.5.1 National Integration

This phase integrates all the results obtained for each mapping region into a single national product. This process involved merging the classified results of the 28 classification regions that make up the General Map with the results of the cross-cutting themes. To this end, rules were defined (Figure 30) that establish an order of prevalence and determine which class predominates in the integrated map when more than one value is possible for the same pixel due to the overlap of the resulting layers.

Class	Map	ID	Prevalence
Glacier	T	34	1
Mining	T	30	2
Urban Infrastructure	T	24	3
Grassland	G	12	4
Other Non-Forest Natural Formation	G	13	5

Rocky outcrop	G	29	6
Aquaculture	G	31	7
Mangrove	T	5	8
Forest Plantation	G	9	9
River, Lake or Ocean	G	33	10
Flooded Non-Forest Natural Formation	G	11	11
Banana	T	74	12
Mosaic of Agriculture and Pasture	G	21	13
Flooded Forest	T	6	14
Other Natural Non-Vegetated Area	G	68	15
Other Non-Vegetated Area	G	25	16
Open forest	G	4	17

***Figure 30**. Prevalence rules used during the national integration phase of MapBiomas Ecuador Collection 4.0. The letters "G" (General Map) and "T" (Cross-cutting Theme) next to each class name distinguish the origin of the data (Prepared by Ecociencia).*

The prevalence rules are the product of evaluating the overlap of layers for each classification region.

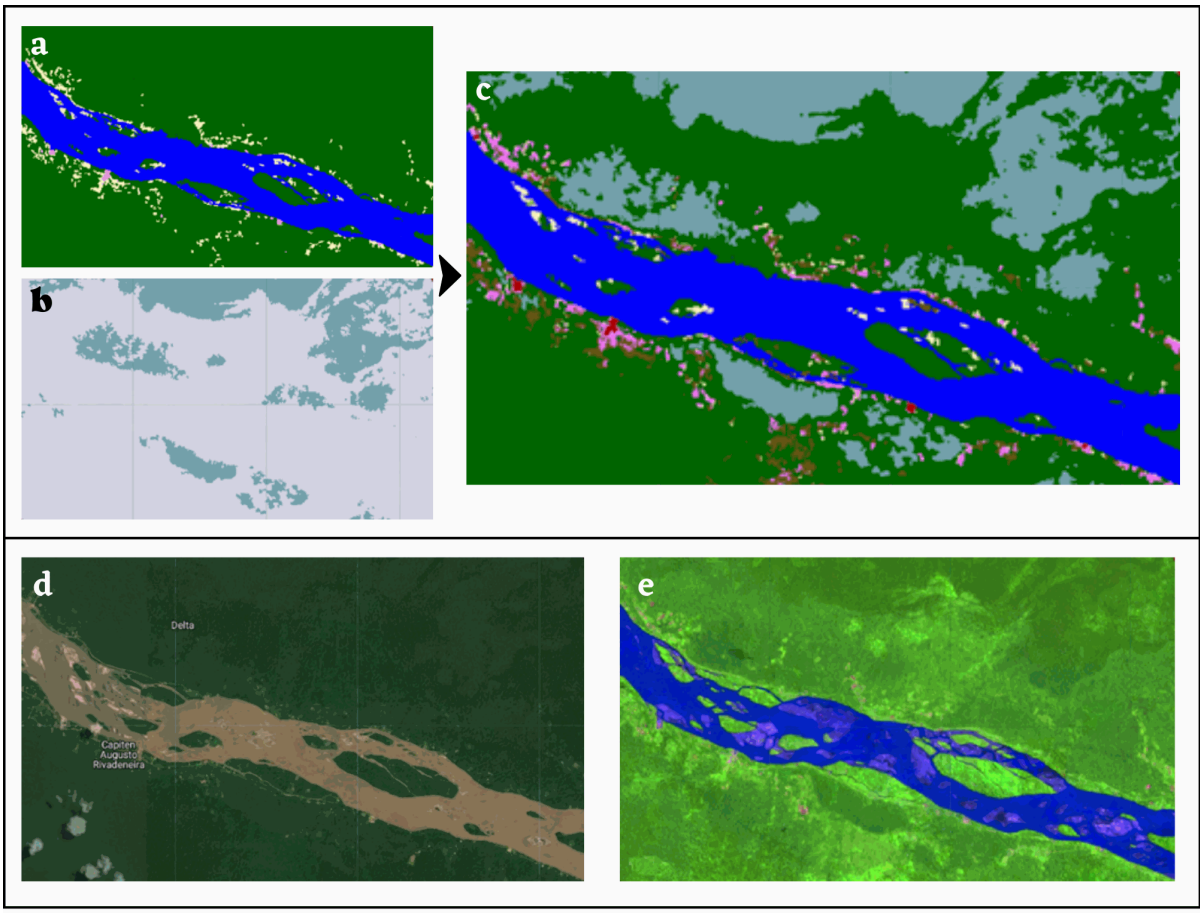


Figure 31. *Example of the effect of layer integration for an area in the Ecuadorian Amazon (region 40201). a) Classified result of the 2021 General Map; b) Classified result of the 2021 "**flooded forest**" cross-cutting theme; c) Final map showing the result of the "**flooded forest**" theme integrated into the 2021 general map result; d) Google Earth Engine basemap (undated high-resolution image); e) Landsat mosaic for 2021 (Prepared by Ecociencia).*

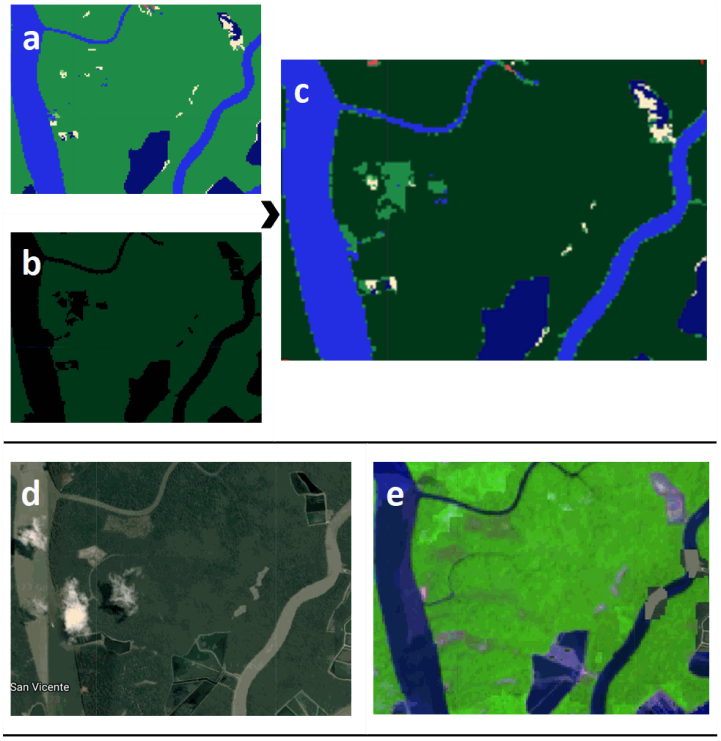


Figure 32. *Example of the effect of layer integration for an area in the Ecuadorian Pacific (region 40904). a) Classified result of the 2022 General Map; b) Classified result of the 2022 "**mangrove**" cross-cutting theme; c) Final map showing the result of the "**mangrove**" theme integrated into the 2022 general map result; d) Google Earth Engine basemap (undated high-resolution image); e) Landsat mosaic for 2022 (Prepared by Ecociencia).*

The result of this phase is a single national product. The complete time series (1985-2024) for Ecuador is presented below:



Figure 33. Annual maps 1985-2025 resulting from the national integration of Ecuador (Prepared by Ecociencia).

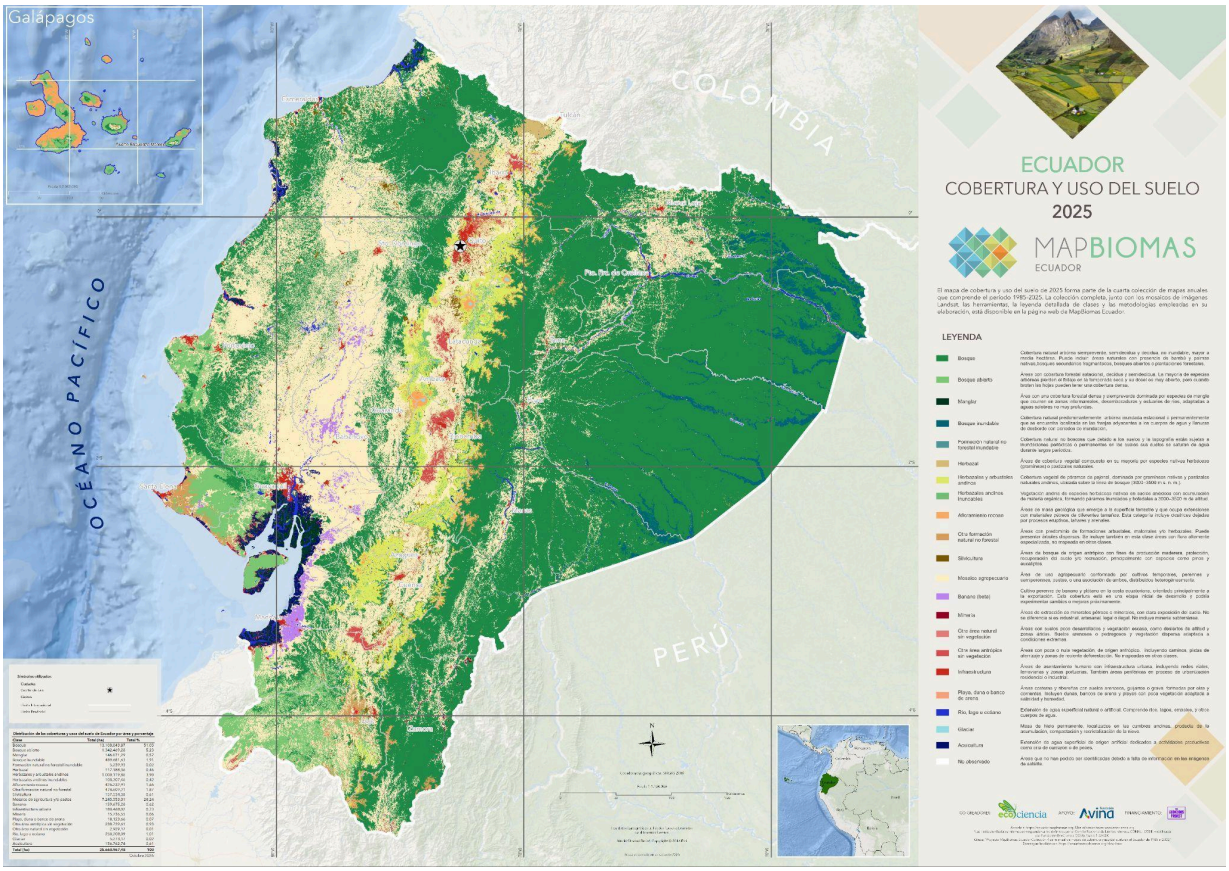


Figure 34. *Wall map of the Land Cover and Land Use mapping for the year 2025 (Prepared by Ecociencia).*

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6. Annexes

Annex 1: Reference Maps

6.1 Ecosystem Map of Continental Ecuador at 1:100,000 Scale

The ecosystem map (Figure 1) was produced in 2013 by the Ministry of Environment, Water and Ecological Transition of Ecuador at a scale of 1:100,000 (MAATE, 2013a). This map provides detailed information on the characterization, location and spatial distribution of the ecosystems of continental Ecuador remaining as of 2012 for areas with natural cover, making it possible to distinguish types of forest and non-forest natural formations from intervened areas. The methodology developed a biophysical model based on biotic and abiotic environmental factors relevant to ecosystem distribution, whose delineation was supported by land cover information derived from the interpretation of satellite imagery. The map presents a nested hierarchical classification system. The map defines 87 ecosystems for the entire continental national territory, the details of which can be reviewed in Annex 1 of this document. Described by MAATE as: "This coverage represents the characterization, location and distribution of the ecosystems of Continental Ecuador as of 2012. Produced at a scale of 1:100,000 from biophysical modeling, interpretation of satellite images (2010-2012) and field validation. It is a baseline input for explaining the state of biodiversity through different types of analysis and a tool to facilitate the management and creation of policies consistent with the appropriate use and management of natural resources." These data are available for download at: http://ide.ambiente.gob.ec/mapainteractivo/

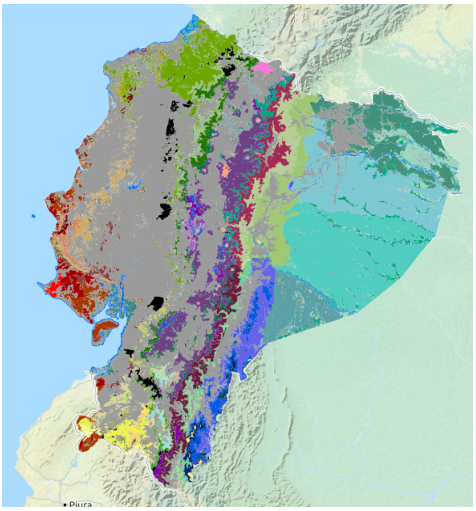


Figure 1. Official map of the Ecosystems of Continental Ecuador. Details of the legend are provided in Annex 1 of this document. Image taken from the SUIA Interactive Environmental Map.

6.2. Land Cover and Land Use Map at 1:25,000 scale

The land cover and land use map at 1:25,000 scale (Figure 2) is a national-level product created between 2009 and 2015 through a collaborative effort among the Ministry of Livestock (formerly MAGAP), SIGTIERRAS, the Ecuadorian Space Institute (IEE) and SENPLADES 2017. The information was generated at the canton level, with a different periodicity for each canton within the stated period. This map provides detailed information on production systems, land cover, plot size and crop seasonality. In 2017, the Ministry of Agriculture harmonized the canton-level information, producing the national land cover and land use map. These data are available as a geo-service at http://www.geoportaligm.gob.ec/p_afc/ows?service=wms&version=1.3.0&request=GetCapabilities

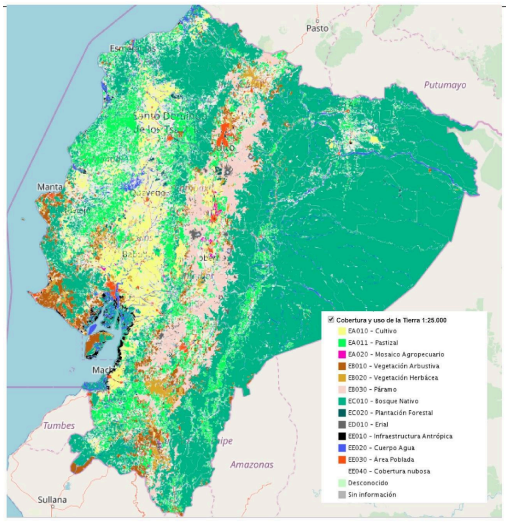


Figure 2. Official Land cover and land use map of Ecuador. Details of the legend are provided in Annex 2 of this document. Image taken from the Geoportal of the Ministry of Agriculture and Livestock

6.3 Land Cover and Land Use and Agricultural Production Systems Map of Continental Ecuador (version edited by the Ministry of Agriculture and Livestock in 2020) at 1:25,000 scale

The Land cover and land use and agricultural production systems map of continental Ecuador (version edited by the Ministry of Agriculture and Livestock in 2020) was produced by the Ecuadorian Space Institute (IEE) and the Ministry of Agriculture and Livestock (MAG) through the National Information System for Rural Lands and Technological Infrastructure (SIGTIERRAS program). Inconsistencies were identified in the 2015 product, so the information for some variables was corrected in 2020. This map identifies the different cover types occupying the land surface and determines the human use of each of them, characterizing the production system. The working scale is 1:25,000, which means that the map information cannot be used for studies requiring more detailed scales, since the established Minimum Mapping Unit (MMU) is 1.0 hectare. These data are available for download at: http://geoportal.agricultura.gob.ec/

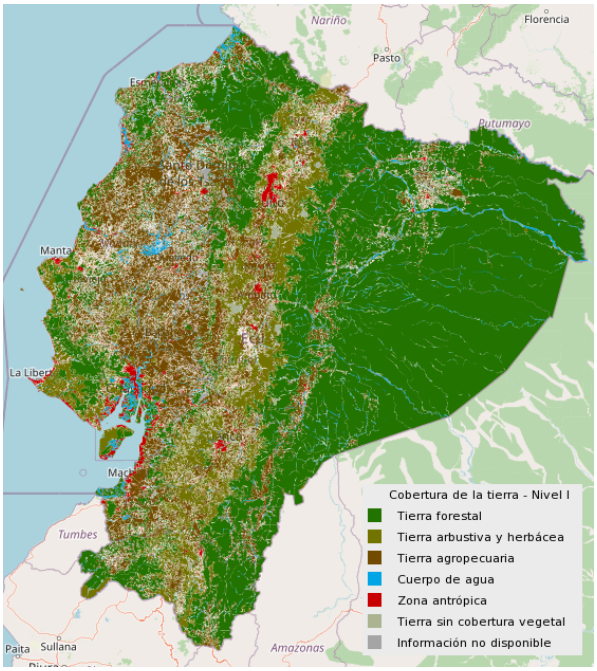
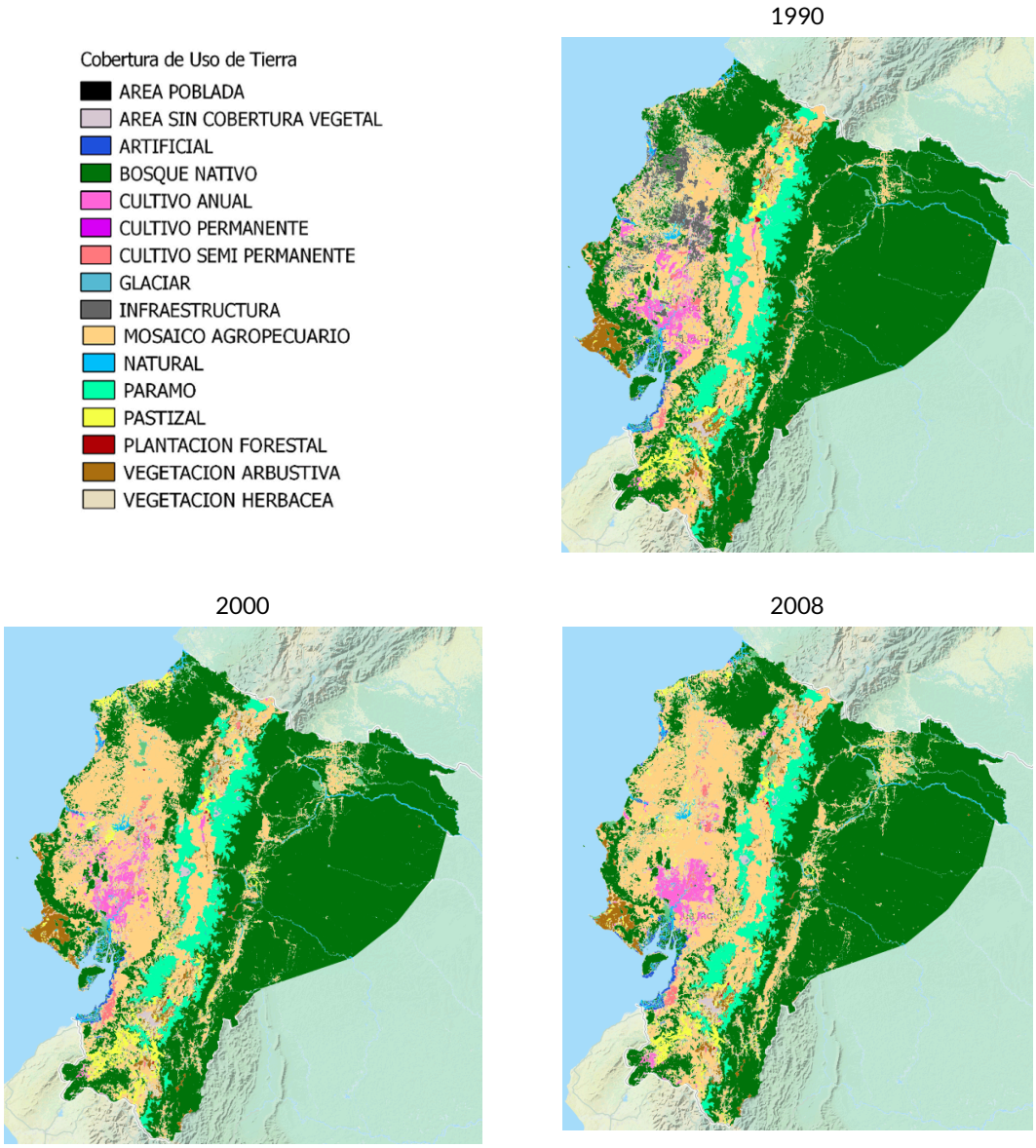


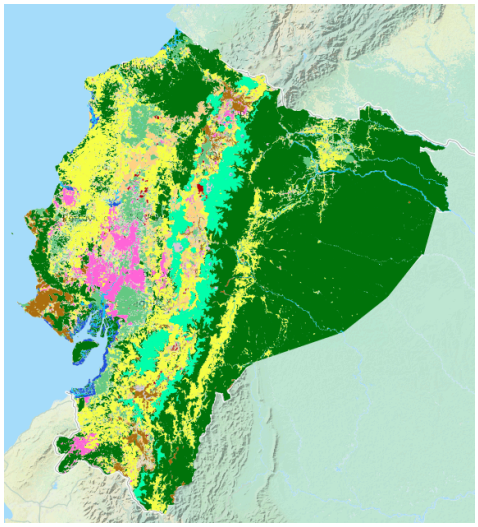
Figure 3. Official map of Land cover and land use and agricultural production systems of continental Ecuador. . Image taken from the Geoportal of the Ministry of Agriculture and Livestock

6.4 Land Cover and Land Use (CUT) Maps of Continental Ecuador at 1:100,000 scale

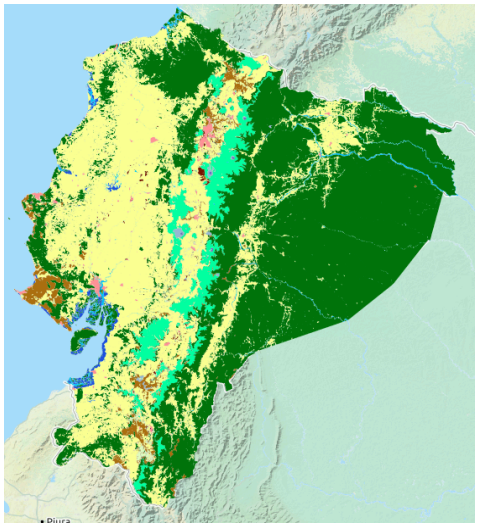
The land cover and land use maps produced by the Ministry of Environment, Water and Ecological Transition and MAGAP (2014) for the years 1990, 2000, 2008, 2014, 2016, 2018 and 2020 at the national continental level (Figure 4) identify units with common characteristics, ranging from forests to agricultural areas and transformed areas, at 1:100,000 scale. The maps have two levels of detail: a) level I corresponds to the 6 classes defined by the IPCC (Intergovernmental Panel on Climate Change); b) level II corresponds to 16 (more detailed) classes agreed upon in intersectoral dialogue roundtables. Available for download at: http://ide.ambiente.gob.ec/mapainteractivo/



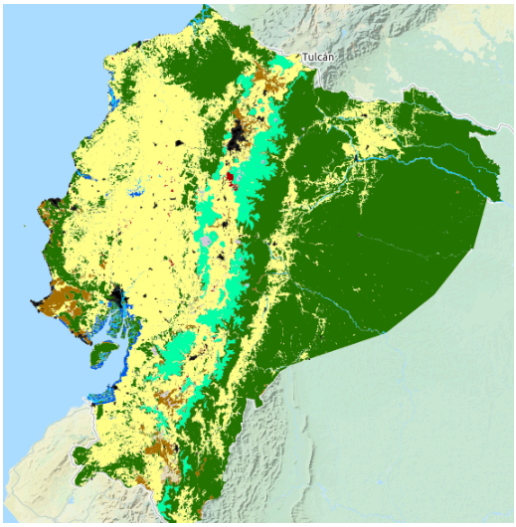
2014



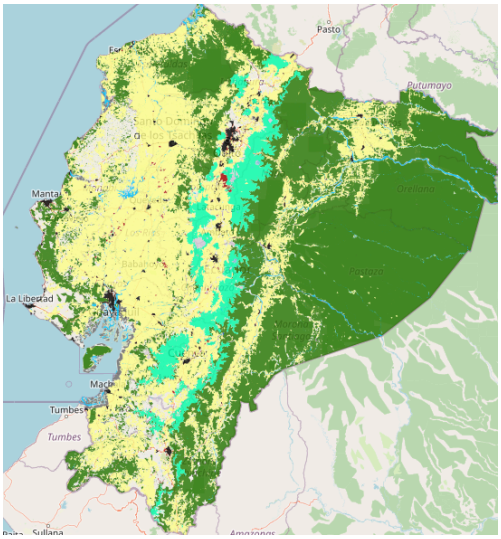
2016



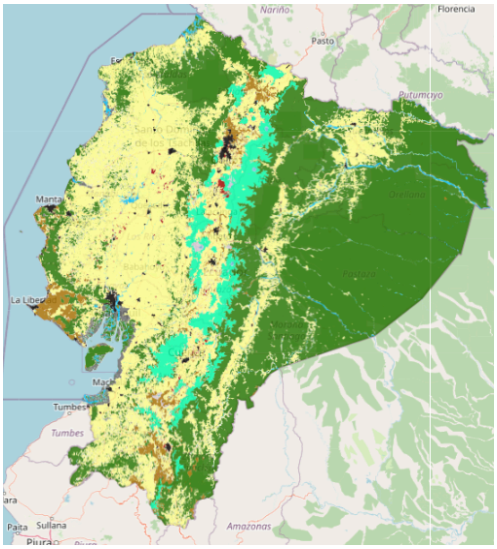
2018



2020



2022



2024

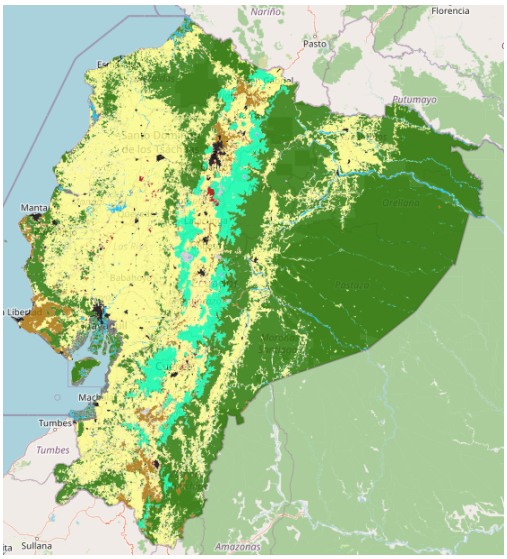


Figure 4. Official land cover and land use maps of Ecuador for 1990, 2000, 2008, 2014, 2016, 2018, 2020 and 2022. Images taken from the SUIA Interactive Environmental Map.

6.5 Galápagos Ecosystem Map

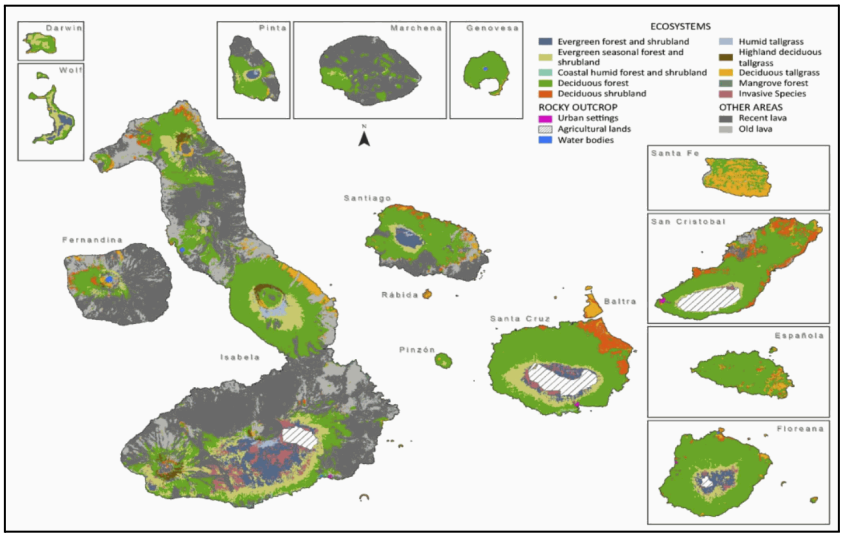


Figure 5. Galápagos Ecosystem Map (Rivas et al., 2018, Universidad San Francisco de Quito)

6.6 Collection 1 of Annual Land Cover and Land Use Maps 2000-2017 of the Amazon

In 2019, RAISG and the MapBiomas Amazonía Project presented their collection of annual land cover and land use maps of the Pan-Amazon. It was generated by classifying Landsat satellite imagery from 2000 to 2017 using empirical decision trees for satellite image interpretation. The MapBiomas Amazonía project is jointly developed by the RAISG partners in the Amazonian countries following a single methodology.

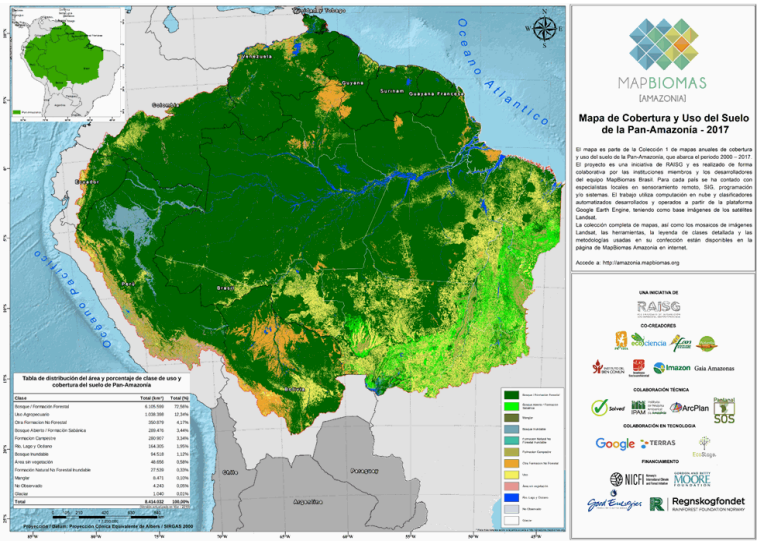


Figure 6. Wall map (year 2017) of MapBiomas Amazonía Collection 1 (RAISG, 2019).

6.7 Collection 2 of Annual Land Cover and Land Use Maps 1985-2018 of the Amazon

In 2020, RAISG presented its second collection of annual land cover and land use maps of the Pan-Amazon. Unlike the First collection, this updated map covers the period 1985 to 2018. The maps were generated by classifying Landsat satellite imagery using Random Forest through scripts implemented entirely on the Google Earth Engine platform.

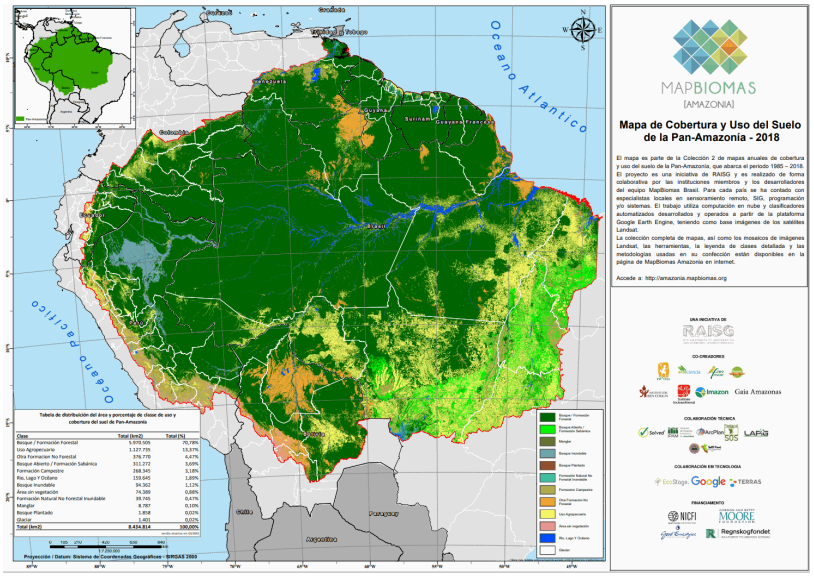


Figure 7. Wall map (year 2018) of MapBiomas Amazonía Collection 2 (RAISG, 2020).

6.8 Collection 3 of Annual Land Cover and Land Use Maps 1985-2020 of the Amazon

In 2021, RAISG presented its third collection of annual land cover and land use maps of the Pan-Amazon. Unlike the Second collection, this updated map covers the period 1985 to 2020. The maps were generated by classifying Landsat satellite imagery using Random Forest through scripts implemented entirely on the Google Earth Engine platform.

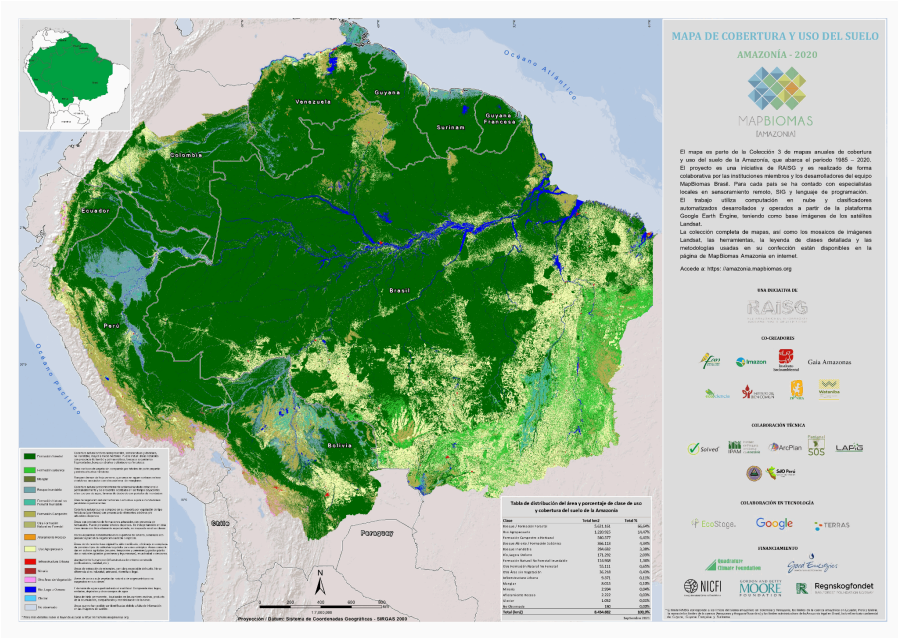


Figure 8. Wall map (year 2020) of MapBiomas Amazonía Collection 3 (RAISG, 2021).

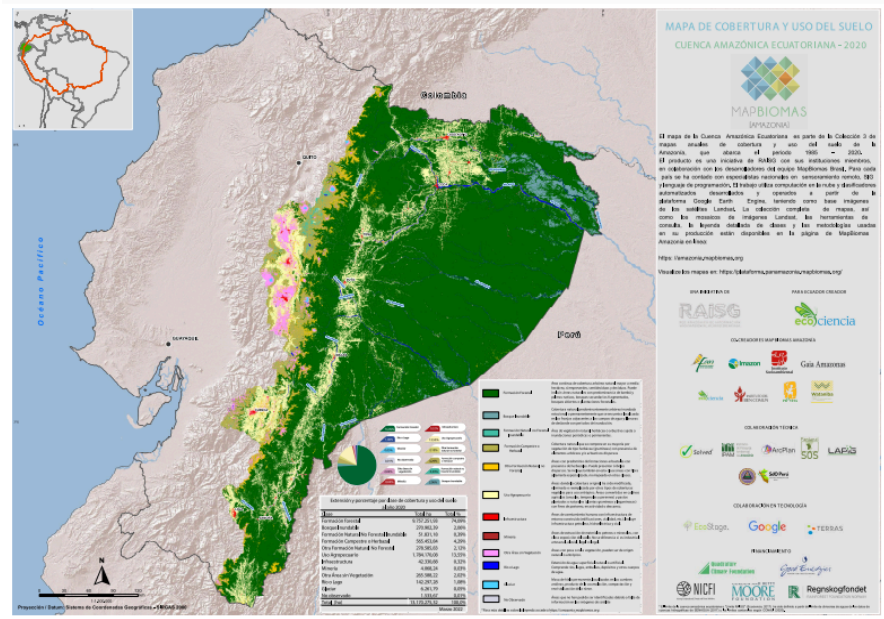


Figure 9. Wall map (year 2020) of Ecuador from MapBiomas Amazonía Collection 3 (RAISG, 2021).

6.9 Collection 4 of Annual Land Cover and Land Use Maps 1985-2021 of the Amazon

In 2022, RAISG presented its fourth collection of annual land cover and land use maps of the Pan-Amazon. This updated map covers the period 1985 to 2021. The maps were generated by classifying Landsat satellite imagery using Random Forest through scripts implemented entirely on the Google Earth Engine platform.

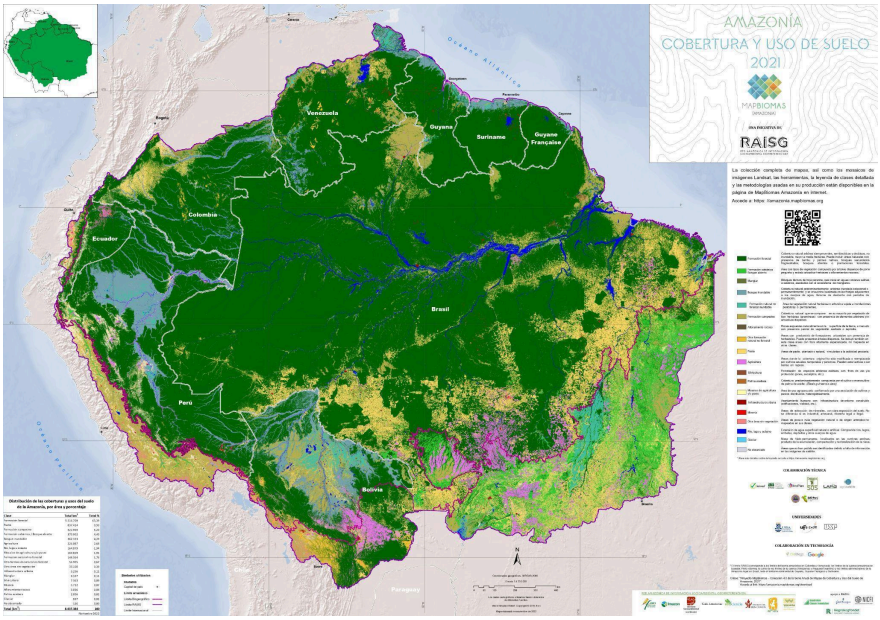


Figure 10. Wall map (year 2020) of MapBiomas Amazonía Collection 4 (RAISG, 2022).

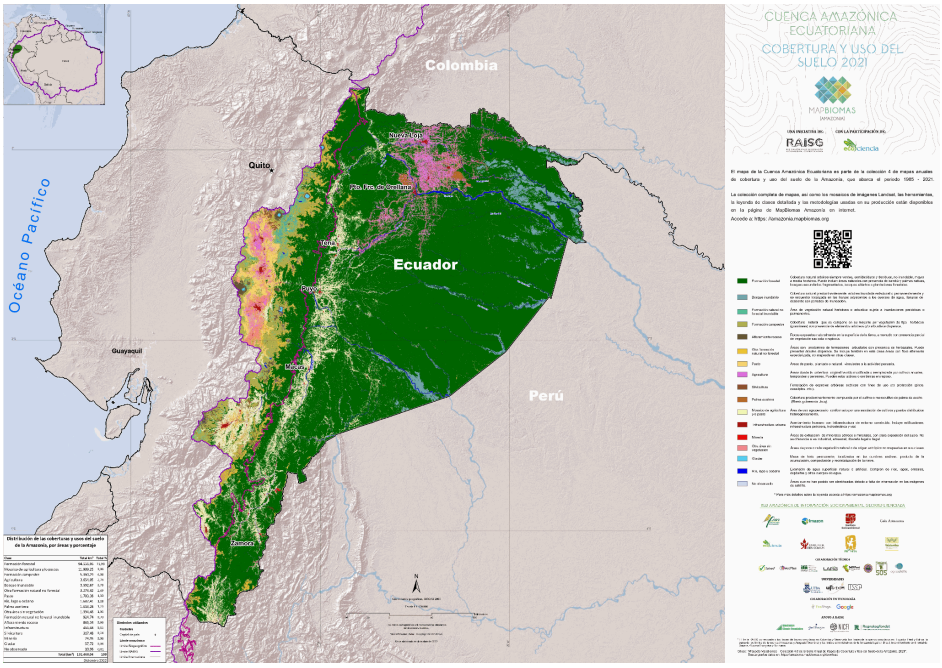


Figure 11. Wall map (year 2021) of Ecuador from MapBiomas Amazonía Collection 4 (RAISG, 2022).

6.10 Collection 5 of Annual Land Cover and Land Use Maps 1985-2022 of the Amazon

In 2023, RAISG presented the fifth collection of annual land cover and land use maps of the Pan-Amazon. This updated map covers the period 1985 to 2022. The maps were generated by classifying Landsat satellite imagery using Random Forest through scripts implemented entirely on the Google Earth Engine platform.

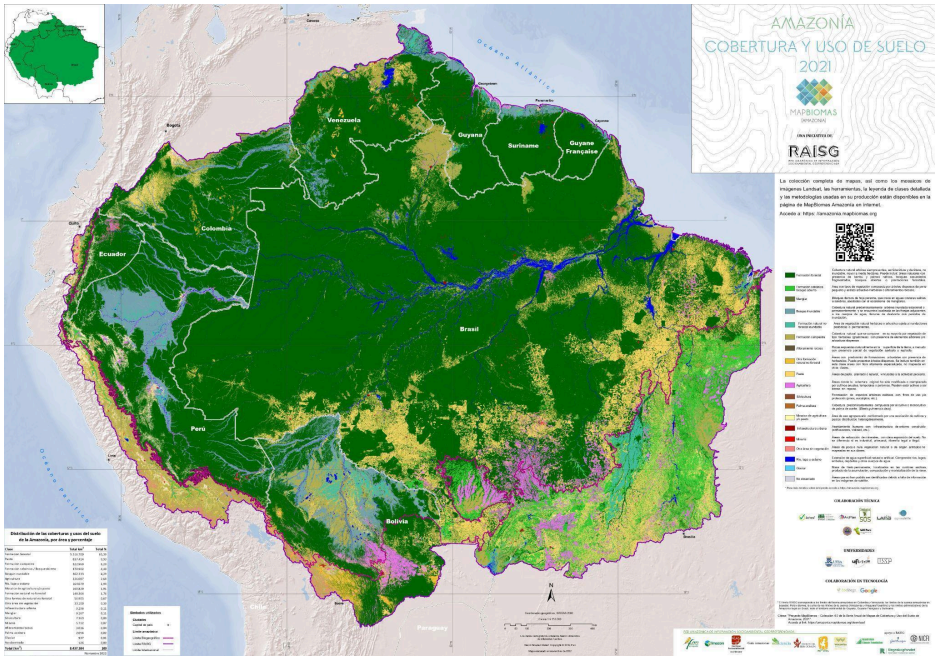


Figure 12. Wall map (year 2022) of MapBiomas Amazonía Collection 5 (RAISG, 2023).

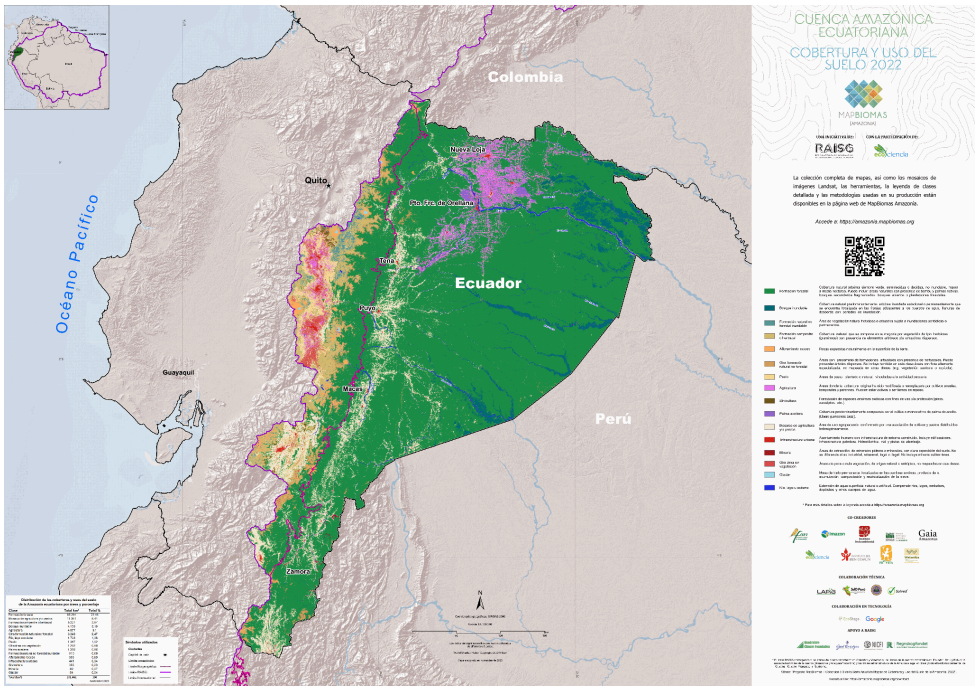
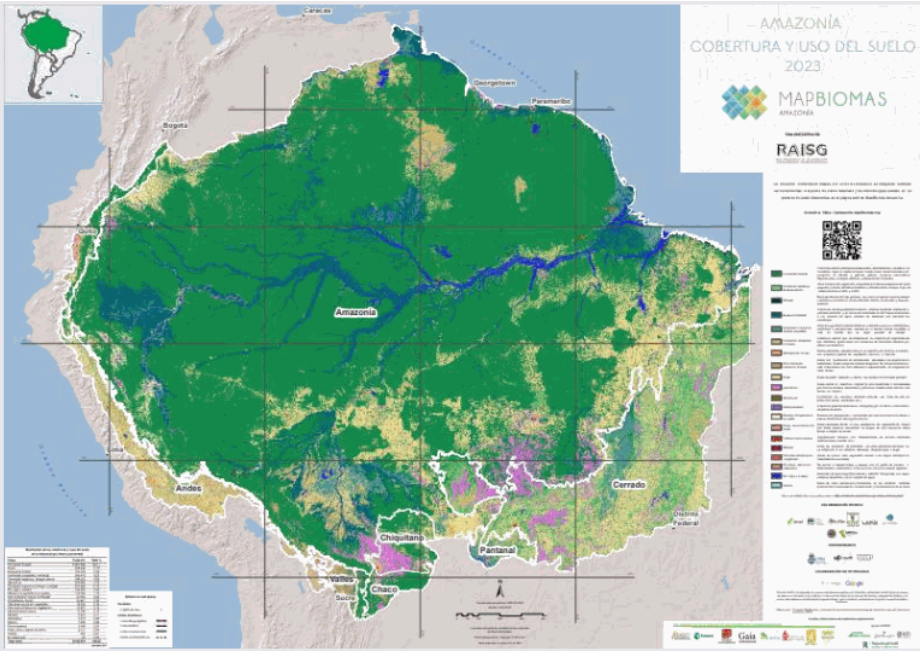


Figure 13. Wall map (year 2022) of Ecuador from MapBiomas Amazonía Collection 5 (RAISG, 2023).

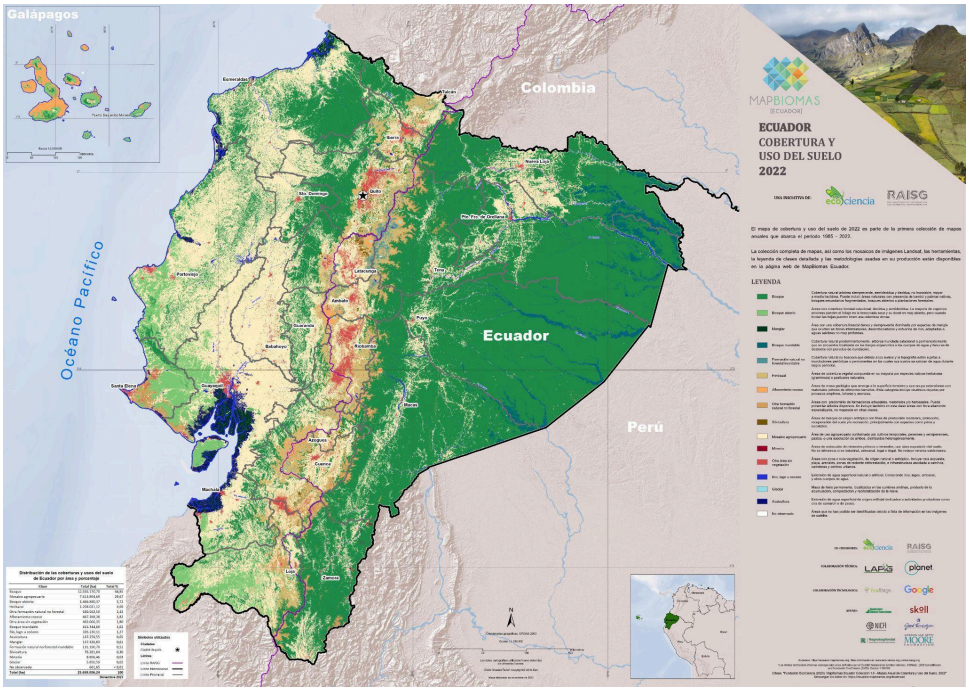
6.11 Collection 6 of Annual Land Cover and Land Use Maps 1985-2023 of the Amazon

In 2024, RAISG presented the fifth collection of annual land cover and land use maps of the Pan-Amazon. This updated map covers the period 1985 to 2023. The maps were generated by classifying Landsat satellite imagery using Random Forest through scripts implemented entirely on the Google Earth Engine platform.



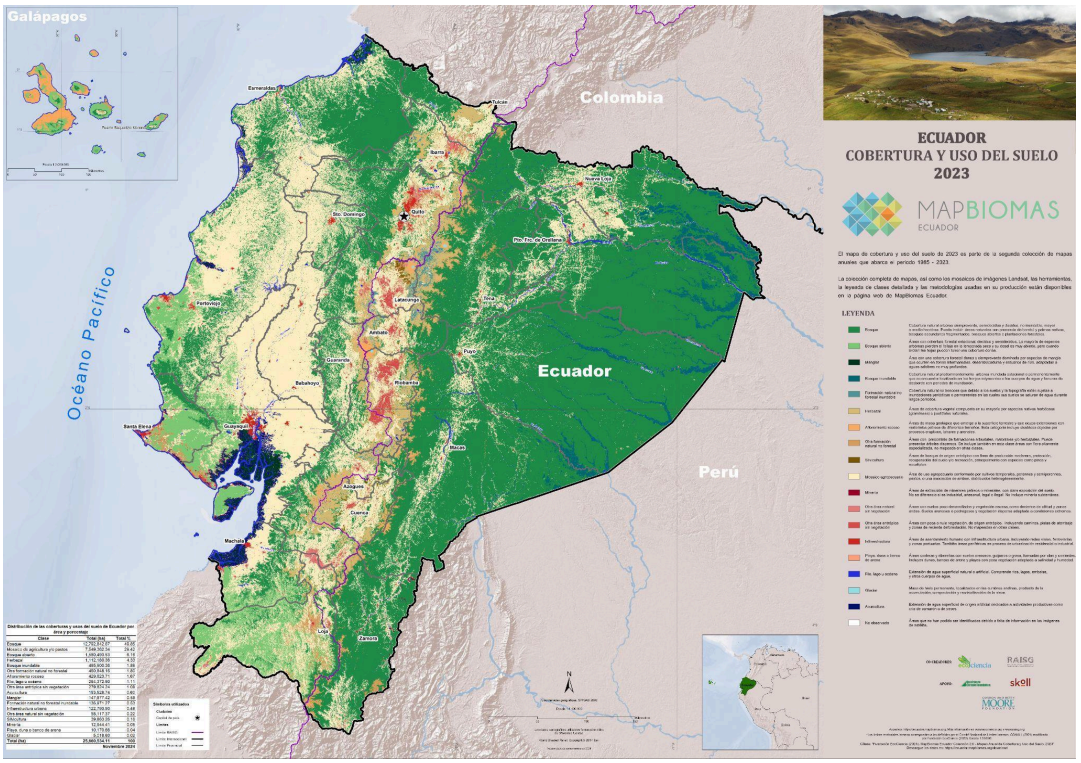
6.12 Collection 1 of Annual Land Cover and Land Use Maps 1985-2022 of Ecuador

In 2023, MapBiomas Ecuador presented the first collection of annual land cover and land use maps of Ecuador. This updated map covers the period 1985 to 2022. The maps were generated by classifying Landsat satellite imagery using Random Forest through scripts implemented entirely on the Google Earth Engine platform.



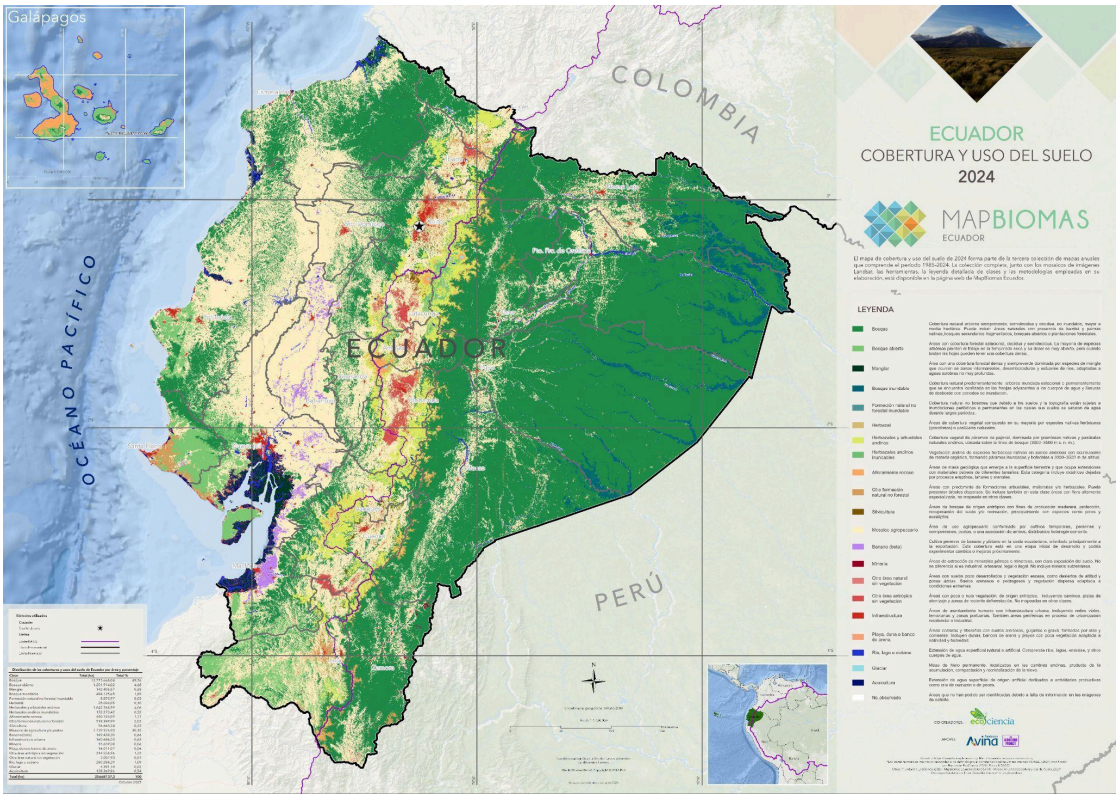
6.13 Collection 2 of Annual Land Cover and Land Use Maps 1985-2023 of Ecuador

In 2024, MapBiomas Ecuador presented the second collection of annual land cover and land use maps of Ecuador. This updated map covers the period 1985 to 2023. The maps were generated by classifying Landsat satellite imagery using Random Forest through scripts implemented entirely on the Google Earth Engine platform.



6.14 Collection 3 of Annual Land Cover and Land Use Maps 1985-2024 of Ecuador

In 2025, MapBiomas Ecuador presented the third collection of annual land cover and land use maps of Ecuador. This updated map covers the period 1985 to 2024. The maps were generated by classifying Landsat satellite imagery using Random Forest through scripts implemented entirely on the Google Earth Engine platform.



Annex 2: Legend of the Ecosystem Map of Ecuador




Bosque siempreverde montano alto del Norte de la Cordillera Oriental de los Andes
Bosque siempreverde montano alto del Sur de la Cordillera Oriental de los Andes
Bosque siempreverde montano bajo de Cordillera Costera del Chocó
Bosque siempreverde montano bajo de Cordillera Occidental de los Andes
Bosque siempreverde montano bajo de Galeras
Bosque siempreverde montano bajo de las cordilleras del Cóndor-Kutukú
Bosque siempreverde montano bajo del Catamayo-Alamor
Bosque siempreverde montano bajo del Norte de la Cordillera Oriental de los Andes
Bosque siempreverde montano bajo del Sur de la Cordillera Oriental de los Andes
Bosque siempreverde montano bajo sobre mesetas de arenisca de las cordilleras del Cóndor-Kutukú
Bosque siempreverde montano de Cordillera Occidental de los Andes
Bosque siempreverde montano de las cordilleras del Cóndor-Kutukú
Bosque siempreverde montano del Catamayo-Alamor
Bosque siempreverde montano del Norte de la Cordillera Oriental de los Andes
Bosque siempreverde montano del Sur de la Cordillera Oriental de los Andes
Bosque siempreverde montano sobre mesetas de arenisca de la cordillera del Cóndor
Bosque siempreverde piemontano de Cordillera Occidental de los Andes
Bosque siempreverde piemontano de Galeras
Bosque siempreverde piemontano de las cordilleras del Cóndor-Kutukú
Bosque siempreverde piemontano del Catamayo-Alamor
Bosque siempreverde piemontano del Norte de la Cordillera Oriental de los Andes
Bosque siempreverde piemontano del Sur de la Cordillera Oriental de los Andes
Bosque siempreverde piemontano sobre afloramientos de roca caliza de las Cordilleras Amazónicas
Bosque siempreverde piemontano sobre mesetas de arenisca de las cordilleras del Cóndor-Kutukú
Bosque siempreverde sobre mesetas de arenisca de la cordillera del Cóndor en la baja Amazonía ecuatoriana
Bosque y Arbustal semideciduo del norte de los Valles
Bosque y Arbustal semideciduo del sur de los Valles
Herbazal del Páramo
Herbazal húmedo montano alto superior del Páramo
Herbazal húmedo subnival del Páramo
Herbazal inundable del Páramo
Herbazal inundable ripario de tierras bajas del Chocó Ecuatorial
Herbazal inundable ripario de tierras bajas del Jama-Zapotillo
Herbazal inundado lacustre del Pacífico Ecuatorial
Herbazal inundado lacustre-ripario de la llanura aluvial de la Amazonía
Herbazal lacustre montano bajo del Sur de la Cordillera Oriental de los Andes
Herbazal ultrahúmedo subnival del Páramo
Herbazal y Arbustal siempreverde del Páramo del volcán Sumaco
Herbazal y Arbustal siempreverde subnival del Páramo
Intervención
Manglar del Chocó Ecuatorial
Manglar del Jama-Zapotillo
Otras áreas
Rosetal caulescente y Herbazal del Páramo (frailejones)
Sin información
Otros

Annex 3: Legend of the Land Cover and Land Use Map of Continental Ecuador

Level I	Level II	Operational Definition	Source
Forest	Native Forest	Tree-dominated ecosystem, primary or secondary, regenerated by natural succession; characterized by the presence of trees of different native species, of varied ages and sizes, with one or more strata.	MAE (2016)
	Forest Plantation	Tree stand established by human action with one or more forest species.	MAE (2011)
Shrub and Herbaceous Vegetation	Shrub Vegetation	Areas with a substantial component of native non-tree woody species. Includes degraded areas in transition to a dense canopy cover.	MAE (2011)
	Páramo	High-Andean tropical vegetation characterized by dominant non-tree species, including native forest fragments typical of the area.	MAGAP - IEE (2012)
	Herbaceous Vegetation	Areas consisting of native herbaceous species with spontaneous growth that receive no special care, used for sporadic grazing, wildlife or protection purposes.	MAGAP - IEE (2012)
Agricultural Land	Annual Crop	Comprises land devoted to agricultural crops whose vegetative cycle is seasonal and which may be harvested one or more times a year.	MAGAP - IEE (2012)
	Semi-permanent Crop	Comprises land devoted to agricultural crops whose vegetative cycle lasts between one and three years.	MAGAP - IEE (2012)
	Permanent Crop	Comprises land devoted to agricultural crops whose vegetative cycle exceeds three years and which provide several harvests during this period.	MAGAP - IEE (2012)
Agricultural Land	Pasture	Herbaceous vegetation dominated by introduced grass and legume species, used for livestock purposes, which require cultivation and management practices for their establishment and maintenance.	MAGAP - IEE (2012)
	Mosaic of Agriculture and Pasture (Association)	Groupings of cultivated species that are intermixed and cannot be individually distinguished; exceptionally, they may be associated with natural vegetation.	MAGAP - IEE (2012)
	Banana crop	Areas mainly devoted to the establishment of banana plants (Musa spp.), cultivated continuously and homogeneously, generally in plots of variable size. This crop may occur in association with other agricultural species or with secondary vegetation along plot edges, although its dominant cover is banana.	MAE (2023)
Water Body	Natural	Surface and associated volume of static or flowing water.	MAGAP - IEE (2012)
	Artificial	Surface and associated volume of static or flowing water associated with human activities and water resource management.	MAGAP - IEE (2012)
Anthropic Zone	Urban Area	Areas mainly occupied by housing and buildings intended for communities or public services.	MAGAP - IEE (2012)
	Infrastructure	Civil works for transport, communication, agro-industry and social purposes.	MAGAP - IEE (2012)
Other Lands	Area without vegetation cover	Areas generally devoid of vegetation which, due to edaphic, climatic, topographic or anthropic limitations, are not used for agricultural or forestry purposes, although they may have other uses.	MAGAP - IEE (2012)
	Glacier	Snow and ice located on the summits of the Andean peaks.	MAGAP - IEE (2012)

Annex 4: Feature space of MapBiomas Amazonía Collection 4.0.

Tipo	Variable	Fórmula	Descripción	Reductor aplicado												
				Med	DryMed	WetMed	Max	Min	Amp	StdDev	DryMin	DryMax	WetMin	WetMax	DryQmo	WetQmo
Banda	blue	B1 (L5 y L7); B2 (L8)	Espectro visible azul	■												
	green	B2 (L5 y L7); B3 (L8)	Espectro visible verde	■	■			■					■		■	■
	red	B3 (L5 y L7); B4 (L8)	Espectro visible rojo	■	■	■		■			■	■		■	■	
	nir	B4 (L5 y L7); B5 (L8	Infrarrojo cercano	■	■	■		■		■					■	■
	swir1	B5 (L5 y L7); B6 (L8)	Infrarrojo de onda corta 1	■	■	■		■				■	■	■	■	■
	swir2	B7 (L5); B8 (L7); B7(L8)	Infrarrojo de onda corta 2	■	■	■		■			■			■	■	■
Índices	cai	(swir2 / swir1)		■			■	■					■			
	evi2	(2.5 * (nir - red)/(nir + 2.4 * red + 1)	Modificación del Índice de Vegetación Mejorado (EVI) que solo utiliza NIR y Red, obviando la banda azul.	■	■	■			■	■						
	gli	(2xGREEN−RED−BLUE) / (2xGREEN+RED+BLUE)	green leaf index	■	■		■	■								
	mndwi	(Green-NIR)/(Green+NIR)	Modificación del índice de diferencia normalizada de agua	■	■	■										
	ndbi	(SWIR1-NIR)/(SWIR1+NIR)	Normalized Difference Built-Up Index	■	■		■	■								
	ndgb	(Green-Blue)/(Green+Blue)	Diferenca normalizada de las bandas verde y azul	■	■	■	■			■						
	ndmi	(NIR - SWIR1) / (NIR + SWIR1).	Diferenca normalizada de las bandas del infrarrojo cercano y mediano	■	■		■									
	ndmir	(SWIR1-SWIR2)/(SWIR1+SWIR2)	Diferenca normalizada de las bandas del infrarrojo mediano	■		■		■		■						
	ndrb	(Red-Blue)/(Red+Blue)	Diferenca normalizada de las bandas rojo y azul			■		■		■						
	ndsi	(green-swir1)/(green+swir1)	Índice Diferencial Normalizado de Nieve	■				■								
	ndsi2	(SWIR1 - NIR) / (SWIR1 + NIR)		■	■	■	■	■								
	ndvi	(nir - red)/(nir + red)	Índice de vegetación de diferencia normalizada	■	■	■			■	■						
	ndwi_gao	(nir - swir)/(nir + swir)	Índice de agua de diferencia normalizada (gao)	■	■	■			■		■		■	■		■
	ndwi_mcfeeters	(green - nir)/(green+nir)	Índice de agua de diferencia normalizada (mcfeeters)	■					■							
	gcvi	(nir / green) - 1	Green Clorophyll Vegetation Index	■	■	■										
	hallcover	(-red * 0.017) - (nir * 0.007) - (swir2 * 0.079) + 5.22	Índice espectral de cubierta terrestre	■												
	pri	(blue - green)/(blue + green)	Índice de reflectancia fotoquímica (Photochemical Reflectance Index)	■	■											
	savi	(1 + L) * (nir - red)/(nir + red + 0,5)	Índice de vegetación ajustada al suelo	■	■	■				■						
	textG	('median_green') .entropy(ee.Kernel .square({radius: 5}))	Entropía en la banda Azul	■												
	nuaci	$UNTL*(1-\sqrt{(NDWIi-uNDWI)2+(NDVIi-uNDVI)2+(NDBIi-uNDBI)2})$	Índice Normalizado Compuesto de Áreas Urbanas	■												
Fracción MME	gv		Abundancia fraccional de vegetación verde dentro del pixel	■					■	■						
	npv		Abundancia fraccional de vegetación no fotosintética dentro del pixel	■						■						
	soil		Abundancia fraccional de suelo dentro del pixel	■					■	■						
	snow		Abundancia fraccional de nieve dentro del pixel	■				■								
	cloud		Abundancia fraccional de nube dentro del pixel	■												
	shade	100 - (gv + npv + soil +cloud)	Abundancia fraccional de sombra dentro del pixel	■												
	gvs	gv / (gv + npv + soil + cloud)	Vegetación verde normalizada por sombra	■	■	■				■						
Índice MEM	ndfi	(gvs - (npv + soil)) /(gvs + (npv + soil))	Índice de fracción de diferencia normalizada	■	■	■			■	■						
	sefi	(gv+npv -soil) /(gv+npv + soil)	Índice de fracción del ecosistema de sabana	■	■					■						
	wefi	((gv+npv)-(soil+shade))/(gv+npv)+ (soil+shade)	Índice de fracciones del ecosistema de humedales			■			■	■						
	fns	((gv+shade) - soil) / ((gv+shade) + soil)	Índice basada en fracciones gv, shade y soil		■					■						
	ndfib	GV-(NPV+Soil+Snow)/ GV+ (NPV+Soil+Snow)	Adaptación del NDFI para los Andes	■					■							
Estáticas	altitud		Altitud													
	slope		Pendiente													
	slppost		Pendiente Estratificada													
	latitude		Latitud													
	longitude		Longitud													
	Shademask		Mapa de sombras													
	hand30_100		Inundabilidad													
	hand30_1000		Inundabilidad													
	hand30_5000		Inundabilidad													
	hand90_1000		Inundabilidad													
	water_HAND_0m		Inundabilidad													
	water_HAND_10m		Inundabilidad													
	water_HAND_1m		Inundabilidad													
	water_HAND_2m		Inundabilidad													
	water_HAND_5m		Inundabilidad													

Annex 5: Ecosystems of the Ecuadorian Amazon grouped according to the equivalent land cover and land use classes of the MapBiomas Ecuador legend.

LEGEND		Biome	ECOSYSTEMS (MAATE, 2013a)
LEVEL 1	LEVEL 2		
FOREST FORMATION	Forest (ID = 3)	Amazon	MONTANE EVERGREEN FOREST OF THE CÓNDOR-KUTUKÚ CORDILLERAS
			LOWER MONTANE EVERGREEN FOREST OF THE CÓNDOR-KUTUKÚ CORDILLERAS
			PIEDMONT EVERGREEN FOREST OF THE CÓNDOR-KUTUKÚ CORDILLERAS
			LOWLAND EVERGREEN FOREST OF THE PASTAZA FAN
			LOWLAND EVERGREEN FOREST OF THE AGUARICO-PUTUMAYO-CAQUETÁ
			LOWLAND EVERGREEN FOREST OF THE NAPO-CURARAY
			LOWLAND EVERGREEN FOREST OF THE TIGRE-PASTAZA
		Andes	UPPER MONTANE EVERGREEN FOREST OF THE WESTERN CORDILLERA OF THE ANDES
			LOWER MONTANE EVERGREEN FOREST OF THE SOUTHERN EASTERN CORDILLERA OF THE ANDES
			UPPER MONTANE EVERGREEN FOREST OF THE NORTHERN EASTERN CORDILLERA OF THE ANDES
			LOWER MONTANE EVERGREEN FOREST OF THE WESTERN CORDILLERA OF THE ANDES
			MONTANE EVERGREEN FOREST OF THE SOUTHERN EASTERN CORDILLERA OF THE ANDES
			MONTANE EVERGREEN FOREST OF THE WESTERN CORDILLERA OF THE ANDES
			PIEDMONT EVERGREEN FOREST OF THE WESTERN CORDILLERA OF THE ANDES
			LOWER MONTANE EVERGREEN FOREST OF THE NORTHERN EASTERN CORDILLERA OF THE ANDES
			MONTANE EVERGREEN FOREST OF THE NORTHERN EASTERN CORDILLERA OF THE ANDES
			PIEDMONT EVERGREEN FOREST OF THE NORTHERN EASTERN CORDILLERA OF THE ANDES
		Equatorial Dry Forest	MANGROVE OF THE JAMA-ZAPOTILLO
			LOWLAND DECIDUOUS FOREST OF THE JAMA-ZAPOTILLO
			SEMI-DECIDUOUS FOREST OF THE EQUATORIAL PACIFIC COASTAL CORDILLERA
			LOWLAND SEMI-DECIDUOUS FOREST OF THE JAMA-ZAPOTILLO
			LOWLAND SEASONAL EVERGREEN FOREST OF THE JAMA-ZAPOTILLO
			LOWER MONTANE SEASONAL EVERGREEN FOREST OF THE EQUATORIAL PACIFIC COASTAL CORDILLERA
			PIEDMONT SEASONAL EVERGREEN FOREST OF THE EQUATORIAL PACIFIC COASTAL CORDILLERA
		Pacific Tropical Moist Forest	LOWER MONTANE EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ COASTAL CORDILLERA
			SEASONAL EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ LOWLANDS
			PIEDMONT SEASONAL EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ COASTAL CORDILLERA
			EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ LOWLANDS
	Open forest (ID = 4)	Andes	SEMI-DECIDUOUS SHRUBLAND OF THE SOUTHERN VALLEYS
			LOWER MONTANE DECIDUOUS FOREST OF THE CATAMAYO-ALAMOR
			SEMI-DECIDUOUS FOREST AND SHRUBLAND OF THE SOUTHERN VALLEYS
			PIEDMONT DECIDUOUS FOREST OF THE CATAMAYO-ALAMOR
			PIEDMONT SEASONAL EVERGREEN FOREST OF THE CATAMAYO-ALAMOR
			LOWER MONTANE SEMI-DECIDUOUS FOREST OF THE CATAMAYO-ALAMOR

			PIEDMONT SEMI-DECIDUOUS FOREST OF THE CATAMAYO-ALAMOR
		Equatorial Dry Forest	LOWLAND DESERT SHRUBLAND OF THE JAMA-ZAPOTILLO
			LOWLAND SEASONAL EVERGREEN FOREST OF THE JAMA-ZAPOTILLO
			PIEDMONT SEMI-DECIDUOUS FOREST OF THE CATAMAYO-ALAMOR
			PIEDMONT DECIDUOUS FOREST OF THE CATAMAYO-ALAMOR
			LOWER MONTANE SEASONAL EVERGREEN FOREST OF THE EQUATORIAL PACIFIC COASTAL CORDILLERA
			DECIDUOUS FOREST OF THE EQUATORIAL PACIFIC COASTAL CORDILLERA
			PIEDMONT SEASONAL EVERGREEN FOREST OF THE EQUATORIAL PACIFIC COASTAL CORDILLERA
			SEMI-DECIDUOUS FOREST OF THE EQUATORIAL PACIFIC COASTAL CORDILLERA
			LOWLAND SEMI-DECIDUOUS FOREST OF THE JAMA-ZAPOTILLO
			LOWLAND DECIDUOUS LOW FOREST AND SHRUBLAND OF THE JAMA-ZAPOTILLO
			LOWLAND DECIDUOUS FOREST OF THE JAMA-ZAPOTILLO
		Pacific Tropical Moist Forest	LOWLAND SEMI-DECIDUOUS FOREST OF THE JAMA-ZAPOTILLO
			SEASONAL EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ LOWLANDS
			EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ LOWLANDS
	Mangrove (ID = 5)	Equatorial Dry Forest	MANGROVE OF THE JAMA-ZAPOTILLO
		Pacific Tropical Moist Forest	FLOODED FOREST OF THE EQUATORIAL CHOCÓ ALLUVIAL PLAIN
			MANGROVE OF THE EQUATORIAL CHOCÓ
	Flooded forest (ID=6)	Amazon	FLOODABLE FOREST OF THE ALLUVIAL PLAIN OF RIVERS OF AMAZONIAN ORIGIN
			LOWLAND EVERGREEN FOREST OF THE AGUARICO-PUTUMAYO-CAQUETÁ
			LOWLAND EVERGREEN FOREST OF THE PASTAZA FAN
			LOWLAND EVERGREEN FOREST OF THE TIGRE-PASTAZA
			FLOODABLE FOREST OF THE ALLUVIAL PLAIN OF RIVERS OF ANDEAN AND AMAZONIAN CORDILLERA ORIGIN
			FLOODED FOREST OF THE AMAZON ALLUVIAL PLAIN
			FLOODED PALM FOREST OF THE AMAZON ALLUVIAL PLAIN
		Andes	FLOODABLE FOREST OF THE ALLUVIAL PLAIN OF RIVERS OF ANDEAN AND AMAZONIAN CORDILLERA ORIGIN
			PIEDMONT EVERGREEN FOREST OF THE NORTHERN EASTERN CORDILLERA OF THE ANDES
NON-FOREST NATURAL FORMATION	Wetland (flooded non-forest natural formation) (ID=11)	Amazon	FLOODED FOREST OF THE AMAZON ALLUVIAL PLAIN
			LOWLAND EVERGREEN FOREST OF THE NAPO-CURARAY
			FLOODABLE FOREST OF THE ALLUVIAL PLAIN OF RIVERS OF AMAZONIAN ORIGIN
			LOWLAND EVERGREEN FOREST OF THE TIGRE-PASTAZA
			FLOODABLE FOREST OF THE ALLUVIAL PLAIN OF RIVERS OF ANDEAN AND AMAZONIAN CORDILLERA ORIGIN
		Andes	SUBNIVAL HUMID GRASSLAND OF THE PÁRAMO
			CAULESCENT ROSETTE AND GRASSLAND OF THE PÁRAMO (FRAILEJONES)
			UPPER-SUPERIOR MONTANE HUMID GRASSLAND OF THE PÁRAMO
			EVERGREEN SHRUBLAND AND GRASSLAND OF THE PÁRAMO
			FLOODED GRASSLAND OF THE PÁRAMO
			SUBNIVAL EVERGREEN GRASSLAND AND SHRUBLAND OF THE PÁRAMO
			GRASSLAND OF THE PÁRAMO
		Equatorial Dry Forest	LOWLAND RIPARIAN FLOODED GRASSLAND OF THE JAMA-ZAPOTILLO

			MANGROVE OF THE JAMA-ZAPOTILLO
			LOWLAND DECIDUOUS LOW FOREST AND SHRUBLAND OF THE JAMA-ZAPOTILLO
		Pacific Tropical Moist Forest	MANGROVE OF THE EQUATORIAL CHOCÓ
			FLOODED FOREST OF THE EQUATORIAL CHOCÓ ALLUVIAL PLAIN
	Grassland (ID=12)	Andes	SEMI-DECIDUOUS SHRUBLAND OF THE SOUTHERN VALLEYS
			UPPER-SUPERIOR MONTANE HUMID GRASSLAND OF THE PÁRAMO
			CAULESCENT ROSETTE AND GRASSLAND OF THE PÁRAMO (FRAILEJONES)
			SUBNIVAL EVERGREEN GRASSLAND AND SHRUBLAND OF THE PÁRAMO
			EVERGREEN SHRUBLAND AND GRASSLAND OF THE PÁRAMO
			GRASSLAND OF THE PÁRAMO
		Equatorial Dry Forest	LOWLAND SEMI-DECIDUOUS FOREST OF THE JAMA-ZAPOTILLO
			LOWLAND DECIDUOUS LOW FOREST AND SHRUBLAND OF THE JAMA-ZAPOTILLO
			LOWLAND SEASONAL EVERGREEN FOREST OF THE JAMA-ZAPOTILLO
			PIEDMONT SEASONAL EVERGREEN FOREST OF THE CATAMAYO-ALAMOR
		Pacific Tropical Moist Forest	SEASONAL EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ LOWLANDS
	Rocky outcrop (ID=29)	Andes	SUBNIVAL HUMID GRASSLAND OF THE PÁRAMO
			UPPER-SUPERIOR MONTANE HUMID GRASSLAND OF THE PÁRAMO
			EVERGREEN SHRUBLAND AND GRASSLAND OF THE PÁRAMO
			SUBNIVAL EVERGREEN GRASSLAND AND SHRUBLAND OF THE PÁRAMO
			SUBNIVAL ULTRA-HUMID GRASSLAND OF THE PÁRAMO
			GRASSLAND OF THE PÁRAMO
	Other non-forest natural formation (ID=13)	Amazon	MONTANE EVERGREEN SHRUBLAND AND GRASSLAND OF THE CORDILLERA DEL CÓNDOR
			MONTANE EVERGREEN FOREST ON SANDSTONE PLATEAUS OF THE CORDILLERA DEL CÓNDOR
		Andes	MONTANE EVERGREEN SHRUBLAND OF THE NORTHERN ANDES
			MONTANE EVERGREEN SHRUBLAND OF THE SOUTHERN ANDES
			LOWER MONTANE SEMI-DECIDUOUS FOREST OF THE CATAMAYO-ALAMOR
			MONTANE EVERGREEN FOREST OF THE NORTHERN EASTERN CORDILLERA OF THE ANDES
			UPPER MONTANE EVERGREEN FOREST OF THE SOUTHERN EASTERN CORDILLERA OF THE ANDES
			UPPER MONTANE EVERGREEN FOREST OF THE NORTHERN EASTERN CORDILLERA OF THE ANDES
			SEMI-DECIDUOUS SHRUBLAND OF THE SOUTHERN VALLEYS
			EVERGREEN SHRUBLAND AND GRASSLAND OF THE PÁRAMO
			GRASSLAND OF THE PÁRAMO
		Equatorial Dry Forest	LOWLAND DECIDUOUS FOREST OF THE JAMA-ZAPOTILLO
			LOWLAND DECIDUOUS LOW FOREST AND SHRUBLAND OF THE JAMA-ZAPOTILLO
			LOWLAND DESERT SHRUBLAND OF THE JAMA-ZAPOTILLO
		Pacific Tropical Moist Forest	EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ LOWLANDS
WATER BODY	Aquaculture (ID=31)	Equatorial Dry Forest	MANGROVE OF THE JAMA-ZAPOTILLO
			LOWLAND DECIDUOUS FOREST OF THE JAMA-ZAPOTILLO
		Pacific Tropical Moist Forest	MANGROVE OF THE EQUATORIAL CHOCÓ
			SEASONAL EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ LOWLANDS
			EVERGREEN FOREST OF THE EQUATORIAL CHOCÓ LOWLANDS

Annex 6: Land Use Categories of Ecuador grouped according to the equivalent land cover and land use classes of the MapBiomas Ecuador legend.

LEGEND		REGION	LAND COVER AND LAND USE CLASSES ACCORDING TO MAATE, 2019
LEVEL 1	LEVEL 2		
FOREST FORMATION	Forest (ID = 3)	Amazon Andes	- Native forest
	Open forest (ID = 4)		- Native forest
	Mangrove (ID = 5)		- Native forest
	Flooded Forest (ID = 6)	Amazon	- Native forest
NON-FOREST NATURAL FORMATION	Wetland (Flooded Non-Forest Natural Formation) (ID = 11)	Amazon Andes	- Herbaceous vegetation - Páramo
	Grassland (ID = 12)	Andes	- Herbaceous vegetation - Páramo
	Rocky outcrop (ID= 29)	Amazon Andes	- Area without vegetation cover
	Other Non-Forest Natural Formation (ID = 13)	Amazon Andes	- Shrub vegetation
FARMING AND FOREST PLANTATION	Forest plantation (ID= 9)	Amazon Andes	- Forest plantation
	Mosaic of agriculture and/or pasture (ID= 21)	Amazon Andes	- Mosaic of agriculture and pasture - Pasture - Annual crop - Semi-permanent crop - Permanent crop
NON-VEGETATED AREA	Urban Infrastructure (ID = 24)	Amazon Andes	- Urban area - Infrastructure
	Mining (ID = 30)	Amazon	- Area without vegetation cover
	Other non-vegetated area (ID = 25)	Amazon Andes	- Area without vegetation cover - Urban area - Infrastructure
WATER BODY	River, Lake or Ocean (ID = 33)	Amazon Andes	- Water body - Natural - Artificial
	Aquaculture (ID = 31)		- Artificial
	Glacier (ID = 34)	Andes	- Glacier

Annex 7: Native Ecosystem Categories of Galápagos grouped according to the equivalent land cover and land use classes of the MapBiomas Ecuador legend.

LEGEND		BIOME	LAND COVER AND LAND USE CLASSES ACCORDING TO Rivas et al., 2018
LEVEL 1	LEVEL 2		
FOREST FORMATION	Forest (ID = 3)	Galápagos	- Humid Beach Forest and Shrubland - Deciduous Forest - Seasonal Evergreen Forest - Evergreen Forest and Shrubland - Humid Grassland
	Open forest (ID = 4)	Galápagos	- Humid Beach Forest and Shrubland - Deciduous Forest - Seasonal Evergreen Forest - Evergreen Forest and Shrubland - Deciduous Shrubland - Mangrove - Humid Grassland - Deciduous Grassland
	Mangrove (ID = 5)	Galápagos	- Humid Beach Forest and Shrubland - Deciduous Forest
NON-FOREST NATURAL FORMATION	Grassland (ID = 12)	Galápagos	- Deciduous Grassland - Deciduous Shrubland - High-elevation Deciduous Grassland - Deciduous Forest - Seasonal Evergreen Forest
	Rocky outcrop (ID= 29)	Galápagos	- Old Lava - Recent Lava
	Other Non-Forest Natural Formation (ID = 13)	Galápagos	- Evergreen Forest and Shrubland - Deciduous Grassland - Deciduous Shrubland - Deciduous Forest
WATER BODY	River, Lake or Ocean (ID = 33)	Galápagos	- Mangrove - Water - Old Lava - Recent Lava