

# CHOCO DEPARTMENT, COLOMBIA NESTED JNR FREL

## JNR Baseline Description

Document Prepared By



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## 1. JURISDICTIONAL BASELINE SUMMARY

### 1.1. Summary Description of the Jurisdictional Baseline

#### 1.1.1. Type of Jurisdiction and Location

The Chocó Department is an administrative region that is the first administrative level below the National Level in Colombia. Chocó is mainly located in the Pacific Coast biome of Colombia, and it also includes some land in the Urabá Gulf on the Atlantic Coast. Chocó Department is grouped into five subregions: 1) Alto Atrato, foothills of the Western Cordillera of Colombia to the west of the Chocó department; 2) Medio Atrato, alluvial plains of the Atrato River in the central zone of the department; 3) Bajo Atrato, alluvial plains and estuarine zones of the Atlantic Ocean to the North of the department; 4) Pacific Coast, alluvial plains with estuarine zones of the Pacific Ocean to the southwest of the department; and 5) San Juan, alluvial plains and low hills in the San Juan River basin to the southeast of the department. Chocó Department is characterized by high rainfall, with annual values of up to 9,000 mm, an average annual temperature of 26 °C, and a relative humidity of 80%. The department has forests of high richness, diversity, and variety of endemism (Poveda et al. , 2004).

Natural resources management over the Jurisdictional Area is assigned to the Autonomous Regional Corporation for Sustainable Development of Chocó (CODECHOCO), which, under Article 23 of Law 99 of 1993, enjoys administrative and financial autonomy, as well as its own assets and legal personality, and is tasked with safeguarding, preserving, restoring, and sustainably managing natural resources and the environment within its respective jurisdiction.

#### 1.1.2. UNFCCC REDD+ Activities Included

For this Jurisdictional Baseline the activity in the Agriculture, Forestry and Other Land Use sector (AFOLU) of the UNFCCC included is reducing emissions from unplanned deforestation and degradation of native forests (REDD+), which aligns with the Intergovernmental Panel on Climate Change (IPCC) category of conversion of forest to non-forest land. The scope of activities in the Jurisdictional FREL being validated under this Baseline Description currently only accounts for emissions from unplanned deforestation (UDef). This Jurisdictional FREL will be updated in the future will expand the scope to include emissions from unplanned degradation (UDeg) and removals from (i) forest carbon enhancement (EN) and (ii) reforestation/regeneration (RF) of areas deforested during the crediting period. The Jurisdictional FREL that covers, DF, DG, EN, and RF is presented in Appendix 3: Choco Department, Colombia JNR FREL for Unplanned Deforestation and Forest Degradation (UDef + UDeg) .

#### 1.1.3. Projects to be Nested

The land tenure systems in the JNR Area include Protected Public Areas, Indigenous Communities (Resguardos Indígenas) and Black Communities (Afrocolombian) which account for 80% of all land in the Chocó Department.

The Consejo Comunitario Mayor de la Asociación Campesina Integral del Atrato (COCOMACIA) is the largest Afrocolombian tenure holder in Colombia and was founded in 1982. COCOMACIA has ownership rights over 695,245 hectares of land in the Middle Atrato, as established by Resolution 04566 dated December 29, 1997, issued by INCORA, now known as INCODER. According to Law 70 of 1993,

The Jurisdictional Baseline has been jointly developed with the Government Environmental Authority CODECHOCO, COCOMACIA and Terra Global. The COCOMACIA Community REDD+ Program, Chocó/Antioquia Colombia (Verra ID 2071) will adopt this Jurisdictional Baseline which has been developed using risk mapping to spatially allocate the baseline emissions to projects within the JNR Area. There are eleven other AUDD REDD+ projects are currently registered or working on registration under Verra (IDs: 1390, 1391, 1396, 1400, 1806, 2071, 2356, 2723, 3210, 3218, 3475) within the Chocó Jurisdiction some of them could potentially adopt the Chocó Colombia JNR Baseline.

COCOMACIA will be the first project area to apply the Choco FREL. However, interest has been shown by other VCS Projects in Choco will transition to this JNR FREL or its future version that the include both UDef and UDeg.

### 1.1.4. Jurisdictional Baseline GHG Emissions

The FREL baseline has UDef emissions of **53,805,015 tCO<sub>2</sub>e** over the initial 6-year Crediting Period with an average of **8,967,503 tCO<sub>2</sub>e** per year.

## 1.2. Jurisdictional Proponents

There are three entities that through their existing legal agreements have “overall control and responsibility” for the JNR FREL. Below is a summary of how each Proponent has control and/or responsibility.

CODECHOCO, a legally authorized government agency to oversee natural resources in the department of Choco, provides all oversight for the activities related to natural resources, will administrator the FREL allocation to projects seeking nest under the JNR FREL and supports stakeholder holder engagement on the FREL within the department. It has and will continue to accompany and promote all the meetings to disseminate information on the Jurisdictional FREL in the Department of Chocó.

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COCOMACIA is responsible for coordinating and supporting the collection the field data used to calculate the carbon stocks across the department, with support for Terra Global. In addition, through its directors and community leaders, it is responsible for disseminating information related to the development of the JNR FREL in the COCOMACIA project area and with other stakeholders in the Department of Chocó. They have, through a private sector investment managed by Terra Global Investment Management, LLC, financed all the work required to complete the Choco FREL and will be the first nested project under the FREL.

<b>Organization name</b>	Consejo Comunitario Mayor de la Asociación Campesina Integral del Atrato - COCOMACIA
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Terra Global is responsible for the technical development of the Jurisdictional FREL and supporting the validation as defined in the Market Standard. This includes providing CODECHOCO with the training and support to manage the spatial allocation of the FREL to the Project Areas. As specified in the triparty FREL Collaboration Agreement, this includes carbon quantification analysis, historical land use change analysis and being responsible for the management of the validation by the VVB as required for the initial JNR FREL

Validity Period and all periods in which the JNR FREL must be reassessed. Terra Global is also responsible for providing a FREL allocation software tool to calculate baseline emissions for the Project Areas and across the JNR Area.

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### 1.3. Other Entities Involved in the Jurisdictional Baseline

No other entities are involved in the development of the jurisdictional baseline.

### 1.4. Jurisdiction Location and Geographic Boundaries

The Chocó Colombia JNR FREL Area covers the Chocó Department, which is one of Colombia's 32 Departments and is located in the Pacific Biome. Chocó is situated on the northwestern frontier of the country at coordinates 5°58'05.1"N 76°55'39.4"W, the department comprises 30 municipalities primarily inhabited by Afro-Colombians, with smaller populations of indigenous and mestizo communities.

As indicated in Map 1, Chocó shares its boundaries to the North with the Republic of Panama, the Pacific Ocean, and the Caribbean Sea; to the East with the departments of Antioquia, Risaralda, and Valle del Cauca; to the South with the Valle de Cauca Department; and to the West with the Pacific Ocean. The total JNR Area is 4,947,039 hectares of which 4,552,525 hectares is forest (as of 2021) and has a maritime extension of 1,382 kilometers, which constitutes 57% of Colombia's Pacific Ocean coastline.



Map 1. Chocó Colombia JNR FREL Area

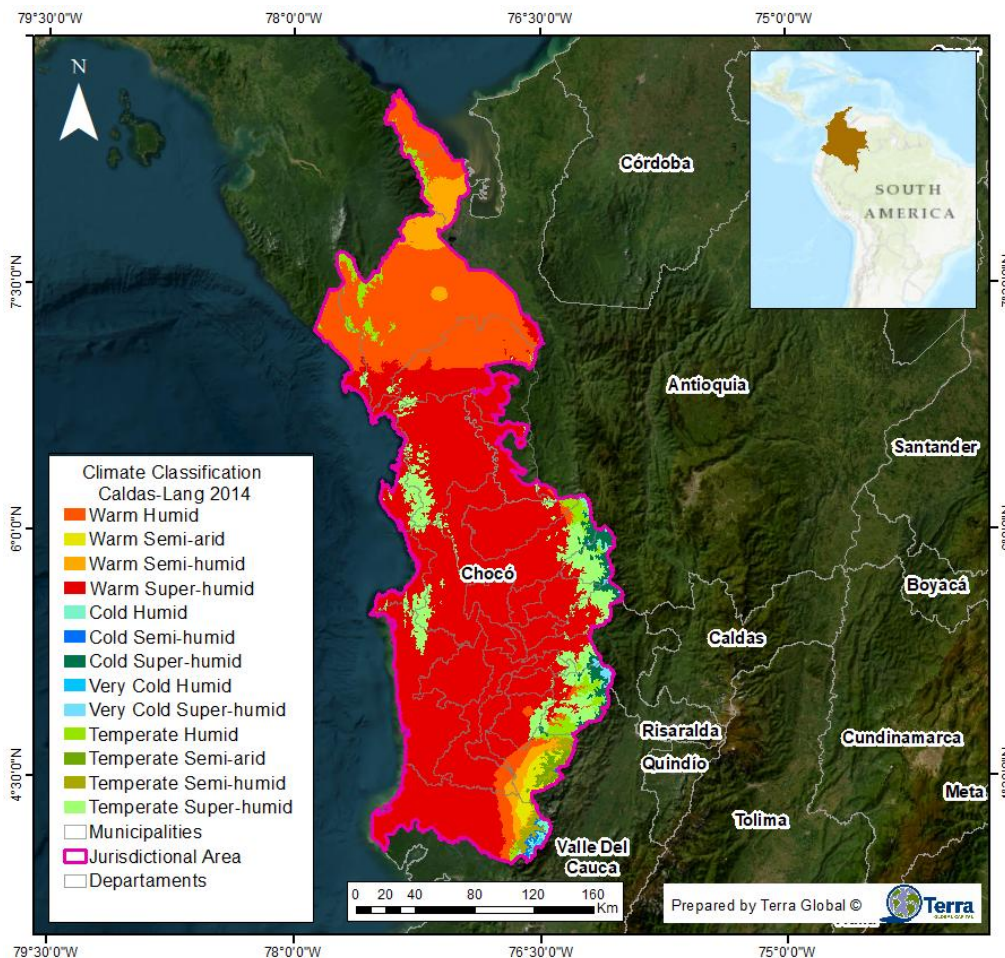
The JNR FREL Area also includes a small portion of the adjacent Department of Antioquia. This inclusion is due to the presence of the Consejo Comunitario Mayor de la Asociación Campesina Integral del Atrato (COCOMACIA) which is the owner of one of the largest Afrocolombian land holdings and is the first nested project under the Choco FREL, COCOMACIA Community REDD+ Program (Verra ID 2071). This portion of the COCOMACIA legal territory includes an additional contiguous area that spans 177,153 hectares of forest that managed by COCOMACIA within the Department of Antioquia, despite the COCOMACIA being mostly located in the Department of Chocó. The variation between the departmental administrative boundary and the limits of the Community Council arises because communal lands in Colombia are defined by historical and ancestral community settlements where traditional practices have evolved, which may or may not align with national administrative boundaries. The legally authorized government agency to oversee natural resources in the department of Antioquia is Corporación para el Desarrollo Sostenible del Urabá (CORPOURABA) who has signed an agreement with CODECHOCO allowing for the inclusive on this area in the Choco FREL, and agreeing that carbon credits may not be issued from this area, to ensure there is no double counting.

It is worth noting that the JNR FREL Area situated inside Antioquia is ecologically linked to the forests in Chocó in terms of carbon dynamics, biodiversity, and ecosystem services, therefore making it relevant to include them as part of broader landscape-level management strategies.

## 1.5. Conditions Prior to Jurisdictional Baseline Start Date

### 1.5.1. Climate

In the Chocó Department, various climate classifications are prevalent. As depicted in Map 2, the most prominent classes include "Calid-Humid," "Calid Semi-humid," and "Calid-Superhumid," which are widespread in the central and eastern areas of municipalities such as Medio Atrato, Atrato, Lloró, Medio Baudó, Condoto, Medio San Juan, Bajo Baudó, Istmina, and Cértegui. Furthermore, in the eastern part of the Department, classifications like "Mild humid" and "Mild superhumid" can be observed, primarily due to the higher elevation above sea level in the mountainous areas, including El Carmen, Bagadó, and San José del Palmar.

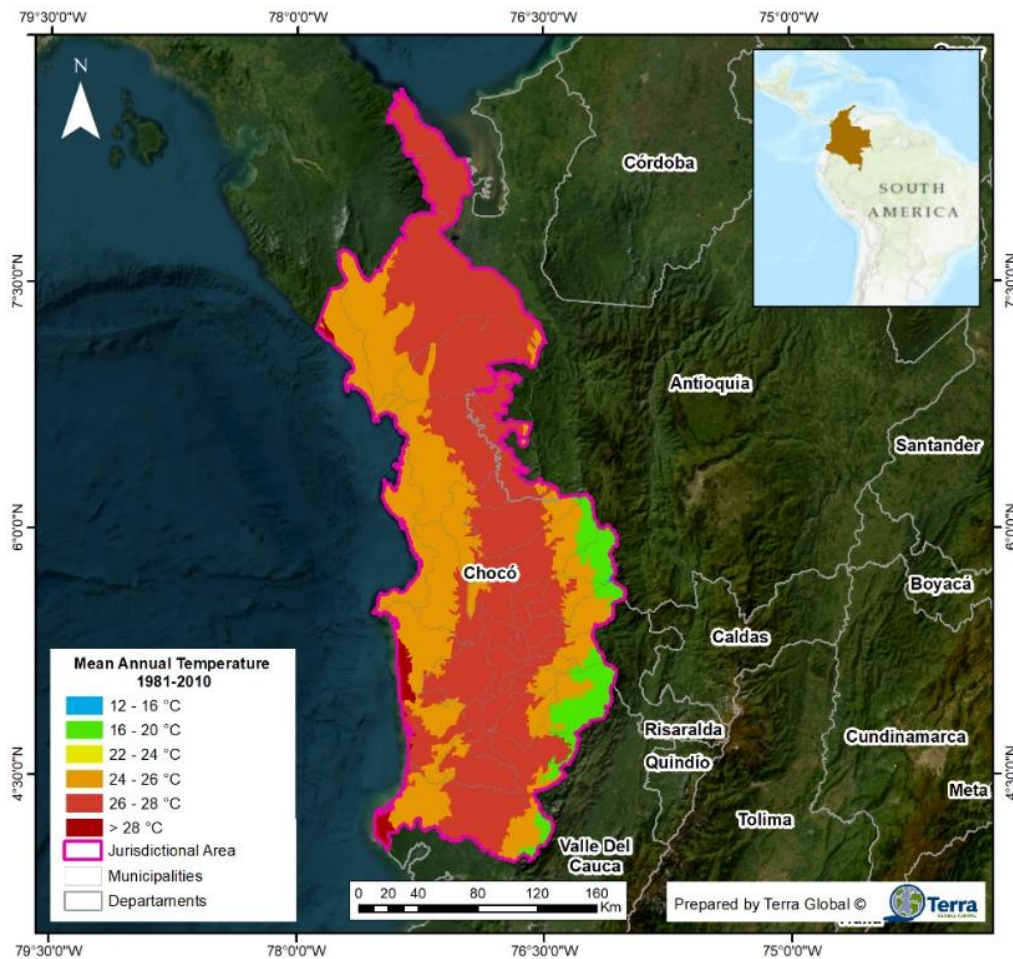


Map 2. Climate Classification of the Chocó Department (IDEAM, 2014).

The Department is situated in the equatorial doldrums, renowned for its abundant rainfall, often exceeding 9,000 mm annually. The valleys and coastal lowlands in this area maintain temperatures surpassing 27°C, coupled with an average relative humidity of 90% (see Map 3). Owing to its strategic location and favorable climate, this Department boasts a diverse and flourishing vegetation (CODECHOCO, 2013).

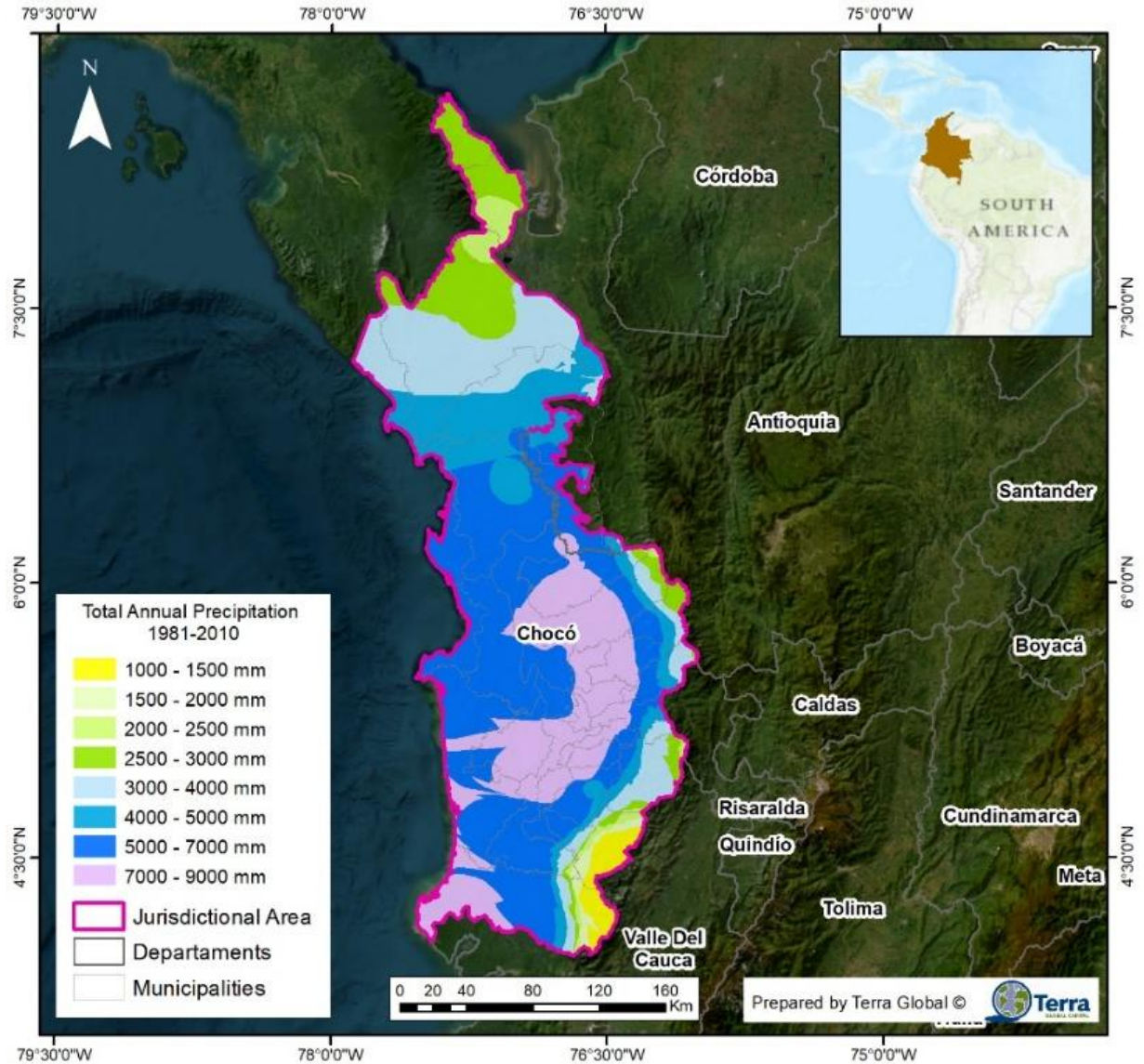
As depicted in Map 3, the average annual temperature at lower elevations remains below 25 degrees Celsius, generally increasing from South to North at altitudes below 1,200 meters. To the East, within the

Occidental Cordillera, mean annual temperatures can drop to as low as 7 to 15 degrees. The temporal variation of climatographic elements follows a bimodal distribution, characterized by two periods of relative maximum values and two of relative minimums, influenced by the movement of the Intertropical Confluence zone (Mena Rentería, 2008).



Map 3. Chocó Department Mean Annual Temperature (°C) (IDEAM, 2014).

Map 4 shows the distribution of Annual Total Precipitation (mm) across Chocó Department. Most of the Department falls within the range of 3,000 to 9,000 mm of annual precipitation. Nevertheless, there are two noteworthy exceptions: the area surrounding Quibdó, where precipitation exceeds 9,000 mm, and a smaller region in Sipí, specifically along the coastal area of San Juan (Docordó), where annual precipitation measures below 2,000 mm.



Map 4. Annual Total Precipitation (mm). Source: IDEAM (IDEAM, 2014).

**1.5.2. Hydrology**

The Chocó Department, situated within the Colombian Pacific Region, boasts a unique geographical position that, in addition to its diverse topography and climatic conditions, offers abundant environmental wealth. It is home to significant hydrographic basins that flow into both the Gulf of Urabá, opening into the Atlantic Ocean, and the Pacific Ocean. Among these basins, the primary rivers are the Atrato, San Juan, and Baudó, while other important rivers include Truandó, Sipí, Ipurdú, and Bojayá some of them can be viewed on the Map 5.



Map 5. Chocó Department Hydrology.

The San Juan River Basin has an area for 12,000 km<sup>2</sup>, is located the West Cordillera and the low hills of the Pacific Coast. It is born in the upper area of the Municipality of Mistrató in the Department of Risaralda in the Cerro de Caramanta, in the western mountain range of the Colombian Andes. Its waters flow southwest through the Chocó Department and flowing into the Pacific in the Municipality San Juan through a delta of about 300 km<sup>2</sup> called "Siete Bocas", and it is located about 60 kilometers northwest of the port of Buenaventura, and includes numerous islands surrounded by mangroves.

The Baudó River, on the other hand, originates in the Baudó mountain range, specifically at Alto del Buey, at an elevation of roughly 1,200 meters within the Ensenada de Utría National Natural Park, flowing into the Pacific Ocean to the south of the Bajo Baudó municipality.

Atrato River born in the Western Cordillera, in the Altos de la Concordia and the Farallones del Citará at an altitude of 3,900 meters above sea level, in Carmen del Atrato and flow into the Gulf of Urabá on the Caribbean Sea, its channel length is 750 kilometers, it has an average depth of 11 meters and an average width is 282 meters.

The hydrology of the area is made up of the Atrato River Basin, recognized as the longest in Colombia and one of the most navigable, it serves as the Departmental border between Chocó and Antioquia, its flow is influenced by the high levels of precipitation in the area, making it one of the most important rivers in Colombia.

### 1.5.1. Topography

Based on its predominant topographic features, the Chocó region can be divided into four general landscape types (Poveda et al. , 2004):

- **Coastal Plain:** Found mainly along the southern and central Pacific coast and the southern half of the Gulf of Urabá (Caribbean), this landscape includes river deltas, beaches, coastal bars and ridges, and mangrove-lined channels.
- **Alluvial Plains:** Shaped by river systems, these areas contain oxbow lakes, natural levees, terraces, and alluvial fans. The Atrato River plain is the largest and most diverse, constantly shifting in search of a stable course.
- **Hills and Low Mountain Ranges:** Divided into three subtypes:
  - Isolated hills and ranges under 500 meters high, common in the northern Pacific region and northwestern Gulf of Urabá.
  - Foothill zones below 500 meters that flank the Andes, forming a gently rolling terrain.
  - Sub-Andean hills between 500 and 2,000 meters, featuring steep, rugged slopes and broken terrain.
- **High Mountain Zone:** Areas above 2,000 meters on the western slopes and crest of the Andes, characterized by high-altitude ecosystems.

### 1.5.2. Soil

The soils of Chocó are the result of geological and geomorphic processes that hold significant importance for the Colombian Pacific Region and are renowned for their high productivity. The prevailing landscapes in this Department, covering 75% of the territory, include Denudational Mountains, Denudational Hills, and Structural Mountains.

Most of the soils in Chocó Department have loamy textures. In the mountain landscape covered by volcanic ash mantles, loamy sandy textures predominate, and occasionally loamy clayey sandy textures. In the hilly landscape, the texture varies from loamy clayey to sandy. In the valley landscape, the textures exhibit similar characteristics to those observed in the previous hilly landscape; however, the silt fraction is present in higher proportions (IGAC, 2009).

The types of soils present in the Chocó Department and their main characteristics are described in detail below in Table 1.

*Table 1. Description of the characteristics of the most predominant soils in Chocó. Source: (IGAC, 2009)*

Soil Types Chocó Department	Characteristics
Clastic sedimentary rocks, sandy (sandstones and siltstones) and chemical carbonate rocks (siliceous limestone).	Shallow to deep, well-drained, very strongly to moderately acidic, high to low organic matter content, moderately coarse to moderately fine textures, high to moderate fertility.
Clastic sedimentary rocks, silty clayey.	Moderately deep to deep, well-drained, very strongly to strongly acidic, high to moderate organic matter content, moderately fine textures, low to very low fertility.
Mafic volcanic igneous rocks (diabases and basalts).	Deep, well-drained, extremely to strongly acidic, high organic matter content at the surface and low at depth, moderately fine textures, low fertility.

Soil Types Chocó Department	Characteristics
Hydrogenic clastic deposits (clays and silts) and organic deposits.	Areas with permanent surface water and hydrophilic vegetation.
Clastic sedimentary rocks, clay-silt and sandy.	Deep, well-drained, strong to very strongly acidic, fine to medium textures, low fertility.
Hydrogenic clastic deposits (alluvial mixtures) and organic deposits.	Moderately deep, moderately well-drained, very strongly acidic, medium to low organic matter content, moderately coarse to fine textures, low to moderate fertility.
Intermediate plutonic igneous rocks (diorites) and felsic (quartz diorite).	Deep, well-drained, neutral to very strongly acidic, very high and low organic matter content, medium to moderately fine textures, high to low fertility.
Clastic sedimentary rocks, silty clayey with inclusions of clastic sedimentary rocks, sandy.	Moderately deep, well-drained, strong to extremely acidic, high and low organic matter content, medium to moderately fine textures, low to very low fertility.
Unconsolidated pyroclastic deposits (ash) on low-grade metamorphic rocks.	Deep and moderately deep, very strongly to moderately acidic, moderate organic matter content, moderately coarse textures, low fertility.
Clastic sedimentary rocks, sandy (conglomeratic sandstones).	Very deep, well-drained, extremely to very strongly acidic, high organic matter content at the surface and low at depth, moderately fine textures, low fertility.
Unconsolidated pyroclastic deposits (ash) on igneous rocks (basalts and granites).	Shallow to very deep, well-drained, strong to very strongly acidic, high to medium organic matter content, coarse to moderately coarse textures, high to low fertility.
Hydrogenic clastic deposits (clays and silts).	Very shallow to deep, poor to moderate drainage, strong to very strongly acidic, high to moderate organic matter content, variable textures, moderate to low fertility.
Hydrogenic clastic deposits (alluvial mixtures) and organic deposits.	Very shallow to shallow, imperfect to poor drainage, extremely to strongly acidic, very high to very low organic matter content, medium to fine textures, very low fertility.
Unconsolidated pyroclastic deposits (ash) on igneous rocks (basalts and granites).	Very shallow to deep, well-drained, extremely to moderately acidic, medium to very low organic matter content, moderately coarse and medium textures, high to low fertility.

### 1.5.3. Vegetation and Ecosystems

Vegetation in Chocó Department differs depending on the elevation and soil variations throughout the jurisdiction. A notable diversity of forest vegetation types occurs in the Colombian Pacific Region. Distinctions between vegetation types arise from many of the climate and soil related variations. In their year 2000 report on ecological zoning with the Colombian Pacific Region, the Colombian Ministry of Environment and Geographic Institute Agustín Codazzi describes five categories of Andean, Sub-Andean, and shrub forest growing at higher elevations in the Pacific Region. While many vegetation type distinctions correspond to elevation, others are azonal distinctions due to extremes in localized factors such as soil types and moisture regimes (COCOMACIA Executive Board, Members of the Disciplinary Committee, and WWF, 2016). In the Chocó Department it is possible to differentiate up to 20 ecosystems, whose biotic components were associated with variations in physiography and in the content of water and mineral elements in the substrate. Among the ecosystems present in the Chocó Department, some are listed below: Mangrove ecosystem with *Rhizophora mangle* and *R. harrisonii* or *Prioria copaifera* forest ecosystem; swampy low elevation forest ecosystem with *Mora megistosperma* or partially submerged forests like *Camposperma panamensis* (Sajales); other lowland forest ecosystems like Guandal ecosystem, Guandal forests ecosystem with *Otoba gracilipes*; montane ecosystems like forests dominated by *Thalia geniculata* grasslands and *Montrichardia arborescens* herbaceous-scrub ecosystems that can be associated to grasslands and pastures; freshwater ecosystems by waterbodies like Camalotal ecosystems dominated by *Paspalum repens* (Rangel, 2004).

These ecosystems, which encompass the central part of the Chocó Department and the western fringes of the Antioquia Department, constitute a network of natural spaces and corridors necessary to maintain

biodiversity and essential ecological processes, and thus are considered integral parts of the Main Ecological Structure of the Biogeographic region of Chocó (Valoyes, 2012).

Table 2. Land Use Types in the Chocó JNR Area

Land Use	Forest/ Non-forest	Description
Water (WTR)	Non-forest	Water bodies, rivers, lagoons, dams
Settlement (SMT)	Non-forest	Rural and urban settlements, usually characterized by individual homes, commonly surrounded by household use trees.
Agriculture (AGW)	Non-forest	Agricultural areas, commonly found in the alluvial plains, crop lands, etc.
Grasslands-Pastureland (PST)	Non-Forest	Areas dominated by grasses and herbaceous plants, with few or no trees. In the Chocó JNR Area these are mainly anthropogenic, created through deforestation and land conversion for agriculture or grazing.
Bare (BAR)	Non-forest	Areas along roadsides, areas converted to non-forest uses. Clear-cut areas.
Closed Forest Upland (CFU)	Forest	Upland forests are located at higher elevations, often found on foothills and mountains. These forests are characterized by dense, diverse vegetation, cooler temperatures, and high levels of rainfall.
Closed Forest Lowland (CFL)	Forest	Lowland forests are situated at lower elevations. These forests experience high temperatures and extreme humidity, with some of the highest rainfall levels in the world.
Open Forest Upland (OFU)	Forest	Upland areas where natural forest cover has been significantly altered or reduced due to human activities; the fine woods of species of the genera <i>Quararibea</i> , <i>Matisia</i> , <i>Nectandra</i> and <i>Ocotea</i> have generally been decimated.
Open Forest Lowland (OFL)	Forest	Lowland areas where the natural forest has been heavily impacted by activities such as degradation and illegal timber harvesting; the fine woods of species of the genera <i>Quararibea</i> , <i>Matisia</i> , <i>Nectandra</i> and <i>Ocotea</i> have generally been decimated.
Mangroves (MGR)	Forest	Coastal forests are found in intertidal zones where saltwater meets the land. These ecosystems are characterized by salt-tolerant tree species, complex root systems, and high productivity, and are dominated by species such as <i>Rhizophora mangle</i> , <i>Rhizophora harrisonii</i> and the <i>Mora megistosperm</i> .

### 1.6. Approvals

The government agency that has control of and responsibility for reviewing and giving approval is the Corporación Autónoma Regional (CAR) para el Desarrollo Sostenible del Chocó (CODECHOCO) (car.gov.co, 2025), is at the first administrative level, called a department in Colombia.

CODECHOCO has responsibility for the JNR Area and is one of the Jurisdictional Proponents, in its capacity as the CAR for Choco department. The small portion of the JNR Area in Antioquia is under the CAR of Corporación para el Desarrollo Sostenible del Urabá (CORPOURABA) who has signed an agreement letter to allow this area to be included in the Choco JNR FREL.

Under the General Environmental Law (Ley General Ambiental) 99 of 1993, ARTICLE 23. Legal Nature. Regional Autonomous Corporations are public corporate entities, created by law, made up of territorial entities that, due to their characteristics, geographically constitute a single ecosystem or form a geopolitical, biogeographic or hydrogeographic unit, endowed with administrative and financial autonomy, their own assets and legal personality, charged by law with managing, within the area of their jurisdiction, the environment and renewable natural resources and promoting their sustainable development, in accordance with the legal provisions and policies of the Ministry of the Environment.

CARs possess administrative and financial autonomy, as well as their own assets and legal personality. They are mandated by law to manage, within their jurisdictional areas, the environment and renewable natural resources, while also promoting sustainable development in accordance with the legal provisions and policies set forth by the Ministry of Environment (Law 99 of 1993, Article 23, 1993). Further details regarding the laws supporting approval authority are included in Section 1.7.11.7.1.

## 1.7. Compliance with Laws, Statutes and Other Regulatory Frameworks

The Jurisdictional FREL Proponents are committed to complying with all applicable laws, statutes, property rights and other regulatory frameworks. Listed below are laws that are applicable to the JNR Baseline as established by the national and regional governments that pertain to the land management, territory rights, carbon rights and requirements, and security of the members of all communities of the Chocó Department and those with overlap with Antioquia Department Colombia.

### 1.7.1. Authority and Powers of the Regional Autonomous Corporations (CARs)

#### 1.7.1.1. CARs Authority over Natural Resources

CODECHOCO serves as the primary environmental authority within its territorial jurisdiction, which encompasses 97% JNR Area. Established under General Environmental Law (Ley General Ambiental) 99 of 1993, CODECHOCO is tasked with safeguarding, preserving, restoring, and sustainably managing natural resources and the environment within its respective jurisdiction. This provision must be read in light of the Political Constitution of Colombia, which states in Article 79 that "...It is the duty of the State to protect the diversity and integrity of the environment, conserve areas of special ecological importance, and promote education to achieve these goals." Furthermore, Article 80 elaborates on this duty by stipulating that 'the State shall plan the management and utilization of natural resources to ensure their sustainable development, conservation, restoration, or replacement'. Consequently, and given Colombia's immense diversity, CODECHOCO was established alongside other Autonomous Regional Corporations (CARs), as a means to decentralize environmental management and tailor policies and initiatives to the unique characteristics of each ecoregion.

As a CAR, CODECHOCO is a decentralized entity responsible for environmental management in the region under its jurisdiction, wielding authority over critical areas such as watershed management, biodiversity conservation, air and water pollution control, territorial and environmental planning, forest resource management, and environmental education, among others (Law 99 of 1993, Article 31, 1993). CODECHOCO collaborates closely with governmental institutions, local communities, the private sector, and civil society to foster sustainable development that aligns environmental conservation with the economic and social advancement of its territory.

Significantly, CODECHOCO operates with administrative, financial, and budgetary autonomy, empowering it to make independent decisions and carry out actions within its domain of expertise and jurisdiction. Moreover, it has management and citizen participation structures, such as assemblies and governing councils, which foster democratic and transparent involvement in decision-making processes.

#### 1.7.1.2. Registration under RENARE

According to Resolution 1447 (2018), Chapter 2, Article 10, what must be registered in the RENARE are the mitigation initiatives, and according to the definitions in the same resolution Title I, Article 3, the baseline is a scenario, not a mitigation initiative.

For the above reasons, the Baseline is not registered in the RENARE. However, all projects seeking to nest under the FREL would require registration under RENARE

Below are the texts that the chapters, titles, and articles that support this conclusion.

**Chapter 2 Article 10.** National Registry of GHG Emission Reductions. The National Registry of GHG Emission Reductions – RENARE – is a technological platform of the MRV System with the purpose of managing information at a national level on GHG mitigation initiatives, which is part of the National Information System on Climate Change. In turn, the National Registry of Programs and Projects of actions

for the Reduction of Emissions due to deforestation and forest degradation in Colombia – REDD+ is part of RENARE.

### **Title I, Article 3 Definitions:**

**Baseline:** is the scenario that represents the GHG emissions that will occur in the absence of a GHG mitigation initiative.

**GHG Mitigation Initiative:** These are programs, projects, actions or activities developed at a national, regional, local and/or sectoral level whose objective is to reduce emissions, remove and capture GHG. Initiatives are classified as GHG emission reduction initiatives and GHG removal initiatives. These initiatives may be sectoral or REDD+. For the purposes of this resolution, the regional and local implementation level shall be understood as the subnational level.

#### **1.7.1.3. Nested Projects Tenure Rights Across Department Borders**

For the contiguous portion of the JNR Area outside CODECHOCO jurisdiction, COCOMACIA, with the first nested project, have secured the authority from CORPOURABA to include the area located in Antioquia, in accordance of Law 70, 1993, as describe below:

The allocation of collective ownership of the territory was made by a competent national authority in force at that time (Colombian Institute for Agrarian Reform INCORA) as indicated in LAW 70 in Chapter III, Article 8.

As mentioned in Chapter II, Article 2 and Chapter III, Article 4 and 8, the political division of Colombia was not taken into account, meaning the division by departments was not a determining factor for the allocation. According to Law 70, the determining factors for this allocation of territory are those mentioned in articles 1, 2, 4 and 8.

Due to the above, it is confirmed that the portion of the project area that is located in the department of Antioquia is property of COCOMACIA and no subnational or private project can overlap this area for the generation of tCO<sub>2</sub>.

Below are the texts that the chapters, titles, and articles that support this conclusion.

Law 70 Chapter I, Article 2:

For the purposes of this law, the following definitions apply:

5. Black Community. This is the group of families of Afro-Colombian descent who possess their own culture, share a history and have their own traditions and customs within the relationship between the countryside and the town, which reveal and preserve an awareness of identity that distinguishes them from other ethnic groups.

6. Collective Occupation. This is the historical and ancestral settlement of black communities on lands for their collective use, which constitute their habitat, and on which they currently develop their traditional production practices.

CHAPTER III Regulated by National Decree 1745 of 1995

Recognition of the right to collective property.

ARTICLE 4. The State shall award to the black communities referred to in this law collective ownership of the areas that, in accordance with the definitions contained in the second article, include the vacant lands of the rural areas bordering the rivers of the Pacific Basin and those located in the areas referred to in the second paragraph of article 1 of this law that they have been occupying in accordance with their traditional production practices. The lands for which the right to collective ownership is determined shall be called for all legal purposes "Lands of the Black Communities. "

CHAPTER III Regulated by National Decree 1745 of 1995

ARTICLE 8. For the purposes of the award referred to in article 4, each community shall submit the respective request to the Colombian Institute of Agrarian Reform Incora. This may initiate the award ex officio. A commission made up of Incora, the "Agustín Codazzi" Geographic Institute and Inderena or the entity that takes its place will carry out, following a report from the Community Council, a technical evaluation of the applications and will determine the limits of the area that will be granted through the collective property title.

## **1.7.2. Colombian Related Carbon Laws**

### **1.7.2.1. Law 1819 of December 29, 2016**

PART IX. Article 221 and Article 222 Carbon Tax imposes a national tax that is levied on the carbon content of all fossil fuels, including all petroleum derivatives and all types of fossil gas that are used for energy purposes, as long as they are used for combustion.

### **1.7.2.2. Decree 926 of June 1, 2017, Title 5**

This decree defines the ability for a taxed entity to be "carbon neutral" as neutralizing or mitigating the GHG emissions associated with the use of fuel under the national carbon fuel tax (Law 1819 of December 29, 2016). Eligible mitigation activities include programs, projects, actions, or activities carried out at a national, regional or local level aimed at reducing, avoiding, removing or capturing GHGs. This is achieved through the voluntary retirement of qualifying verified emission reductions/removals (VERs) in the name of the taxable entity. Parties that are most interested in offsetting the carbon tax are fuel wholesalers, airlines and cargo and passenger transport companies. The GHG standards accepted for mitigation under the law are broadly defined and require that their GHG Validation and Verification Bodies (OVV) must meet one of the following criteria: be accredited by the National Accreditation Agency of Colombia (ONAC), be a signatory to the International Accreditation Forum (IAF), and/or the program must be accredited under the requirements of ISO 14065 or the UNFCCC.

### **1.7.2.3. Resolution 1447, 2018**

Resolution 1447 of May 2018 covers the process for registrations and approvals under the Minister of the Environment and Sustainable Development for people and entities seeking results-based payments or similar compensation.

#### **1.7.2.3.1. Articles 1 and 2 of 1447**

ARTICLE 1. OBJECT. The purpose of this resolution is to regulate the Monitoring, Reporting and Verification System of mitigation actions at the national level, in relation to the Accounting System for the Reduction and Removal of Greenhouse Gas Emissions and the National Registry for the Reduction of Greenhouse Gas Emissions (GHG), which includes the National Registry of Action Programs and Projects for the Reduction of Emissions due to Deforestation and Forest Degradation of Colombia (REDD+).ARTICLE 2. AREA OF APPLICATION. This resolution applies to any natural or legal person, public or private, who intends to register their GHG mitigation initiative to qualify for results-based payments or similar compensation as a result of actions that generate emission reductions and removals of Greenhouse Gases, and the one that intends to register its GHG mitigation initiative to demonstrate its mitigation results within the framework of compliance with the national climate change goals established under the UNFCCC, as a consequence of the implementation of said actions.

Resolution 1447 states that any project or program that intends to register a GHG mitigation initiative, and seeks to receive payment for results and emission reduction/removal activities must monitor, report, and verify their actions in accordance with guidelines managed by the IDEAM. It regulates the Monitoring, Reporting and Verification System of mitigation actions at the national level, in relation to the Accounting System for the Reduction and Removal of Greenhouse Gas Emissions and the National Registry for the Reduction of Greenhouse Gases. Greenhouse Gas Emissions (GHG), which includes the National Registry of Programs and Projects of actions for the Reduction of Emissions due to Deforestation and Forest Degradation of Colombia (REDD+).

According to Resolution 1447, only GHG mitigation initiatives are registered in RENARE. Since the Choco Department, Colombia Nested JNR FREL this is not a mitigation initiative, jurisdictional program, or REDD+ project, the Chocó JNR FREL does not required registration in RENARE.

#### 1.7.2.3.2. Article 20 1447

Resolution 1447 has requirements which define the maximize potential for GHG mitigation in REDD+ projects (Article 20 Law 1447 May 2018). This applies the same for REDD+ Projects and REDD+ Programs (as defined under 1447).

#### 1.7.2.4. Article 41 of 1447

A translation of the law states: “The holder of the REDD+ Project must establish its baseline using the most up-to-date FREL that has been formally submitted by Colombia and evaluated by the UNFCCC. This FREL must include the project's geographic area, as well as REDD+ activities, periods, and carbon stocks in which the initiative is to be implemented. Establishing the baseline from the FREL involves the methodological reconstruction of the FREL over the project area, demonstrating consistency with it. This methodological reconstruction involves calculating the expected GHG emissions in the REDD+ Project area, consistently using the variables employed in the FREL. This is done using information provided by the Forest and Carbon Monitoring System (SMByC), including the definition of forest, global warming potentials, emission factors by forest type, historical deforestation data for the project area, and its method of estimating and projecting emissions over time”.

#### 1.7.2.5. Legal Implications for the Maximum VCUs for Nested Project Issuance

As this FREL is initially developed to support REDD+ Projects under Scenario 1, each REDD+ Project seeking to nest under this FREL is required to adhere to the requirements under Law 1447. Projects using the Choco FREL are required by the Resolution 1447 to be register under RENARE and apply a “methodological reconstruction” to determine the maximum mitigation potential (MMP), which limits the number of carbon credits that a project can issue, to ensure transparency, methodological consistency, and preventing double counting with the National Level accounting system. For some vintages, rather than apply methodological reconstruction the these nested projects will be subject to a maximum mitigation as determined in accordance with 1447.

Prior to issuance of VCUs each nested project shall demonstrate that it is registered under RENARE and provide in the Monitoring Report, the maximum mitigation potential from the government or demonstration of the application of a methodological reconstruction, which will be checked against the ex-post monitored results before issuance. The total number of VCUs that may be issued during any monitoring period, shall not exceed the sum of the maximum mitigation potential provided by the government measured the same vintage years as the monitoring period or the result of the methodological reconstruction.

The UNFCCC FREL submitted by the government covering 2018 to 2022, has completed its Technical Review under UNFCCC, projects seeking issuing during this period are required to have a Maximal Mitigation Potential assigned by IDEAM or the Ministry of Environment. Colombia submitted its third National Forest Emission Reference Level (NREF/FREL) to the UNFCCC in January 2024 for the 2023–2027 period; the submission completed UNFCCC technical assessment, and the assessment report was published on August 21, 2025. In line with Resolution 1447 of 2018 projects seeking issuance for vintages within this NREF period will need estimate their maximal mitigation potential with the assessed NREF (i.e., undertake the “reconstrucción metodológica” once the Ministry issues detailed guidance); as of today, that specific guidance has not yet been released.

##### 1.7.2.5.1. Application of MMP for First Nested Project

For the first two years of the baseline validity period (2021, 2022), the government has provided the MMP for the COCOMACIA Community REDD+ Program. However, for the other years in the baseline validity period (2023-2026), the regulation is unclear and there was no detailed guidance provided by the Colombian government on how to actually do a “methodological reconstruction” of the FREL to projects. This is particularly unclear given that much of the area inside of the Choco FREL are not included in the

Colombia’s UNFCCC FREL as it specifically excludes protected areas, areas under Afrocolombia tenure and Resguardos tenure. Terra Global requested to the national government (Ministry of Environment and Sustainable Development) clarification on this issue and how to perform the methodological reconstruction or whether it is required.

For the first two years of the baseline validity period which correspond with the first two vintages of the COCOMACIA Community REDD+ Program, through meetings, direct emails to government offices and through the process of a “derecho petición” Terra Global has secured responses on this issue as it relates to the first nested project, COCOMACIA Community REDD+ Program to apply this baseline.

For the COCOMACIA REDD+ Program, the first vintage of issuance is 2021 (start of the Choco FREL Baseline Validity Period), and the first monitoring period for the COCOMACIA Project is 2021 to 2023. On November 7, 2024, for the second time, a request was made to Ministry of Environment and Sustainable Development for the maximum mitigation potential for the COCOMACIA Community REDD+ Program. In January 2025, the answer was provided by Ministry of Environment and Sustainable Development, which included an attachment from IDEAM who conducted the technical process to estimate that potential for the Maximum Mitigation Potential for the COCOMACIA REDD+ Area for the period of 2018-2022, of which only 2021 and 2022 are relative for the COCOMACIA Community REDD+ Program.

La **Tabla 3** presenta la estimación del Potencial Máximo de Mitigación (PMM) para el periodo 2018-2022 basada en el NREF y los parámetros específicos del proyecto REDD+.

Año	NREF Nacional (t CO2 eq)	Potencial Máximo de Mitigación (t CO2 eq)
2018	120770431,4	442.107,57
2019	127011963,2	464.956,12
2020	132520275,3	485.120,54
2021	137130393,5	501.996,93
2022	140732334,7	515.182,65

The IDEAM states the following: “La proporción que representa el área del proyecto REDD+ en relación con el Nivel de Referencia de Emisiones Forestales (NREF) nacional es de 0,00366072 lo que equivale a un 0,3661 % del total establecido en el NREF nacional”, translated to English: “The proportion that the REDD+ project area represents in relation to the national Forest Reference Emission Level (FREF) is 0.00366072, which is equivalent to 0.3661% of the total established in the national NREF.”

As provided in the table above, this maximum mitigation potential (MMP) covers only deforestation as the UNFCCC FREL for this period only includes deforestation, not degradation. Meaning the ex-post verified credits from degradation can be recognized as quantified with any limitation. This MMP for reducing deforestation, covers the monitoring years 2021 and 2022, but not 2023 which is part of the first monitoring period.

At the time that Terra Global requested the MMP for 2023 from the government, it received a response that since the technical review under UNFCCC of the FREL for years 2023 to 2028 had not been completed, that it was not provided. Noting, that this next version of the UNFCCC FREL includes both deforestation and degradation, but still excludes protected areas, areas under Afrocolombia tenure and Resguardos tenure. In January 2025, the responsibility for establishment of the MMP and providing guidance on the methodological reconstruction moved from IDEAM to the Ministry of Environment and Sustainable Development. Terra Global and COCOMACIA met in person with Ministry of Environment and Sustainable Development, to get guidance on how (or whether) to apply the methodological reconstruction of Colombia’s UNFCCC FREL for the COCOMACIA Community REDD+ Program for vintages 2023 and beyond to complete the issuance of 2023 vintages. During the meeting, Ministry staff indicated they are preparing detailed guidance stating that projects seeking issuance after 2022 will not receive an MMP

allocation. Instead, each project will be required to conduct a methodological reconstruction based on the UNFCCC 2023–2027 FREL, to obtain the maximum credits that Project could claim for AUDef and AUDeg. Despite several formal requests submitted, the Ministry has not yet published the guidance; therefore, the reconstruction cannot be completed at this time. Accordingly, for 2023 the MMP for Avoided Deforestation was calculated by applying the same fraction (0.3661%) of the UNFCCC deforestation FREL, and no MMP was applied to emission reductions from Avoided Degradation.

#### **1.7.2.6. Decree 446 of March 2020**

Indicates that, until December 31, 2020, OVV's that are accredited by the Executive Board of the Clean Development Mechanism may be verifiers and validators as Designated Operating Entity, after that date they must be accredited by ONAC.

#### **1.7.2.7. Law 1844 of 2018**

"by which the "Paris Agreement" is approved, adopted on December 12, 2015, in Paris, France. The Government of Colombia welcomed the Reinforced Transparency Framework and committed through its Contribution Nationally Determined (NDC) to reduce 20% of its Greenhouse Gas emissions with respect to the projected emissions of the year 2030 and up to 30% conditional on international support. Likewise, it committed to periodically provide a report on the inventory of emissions and the information necessary to track the progress made in the implementation and compliance of its NDC through the use of common methodologies and metrics, ensuring methodological consistency, including for the baselines, between the communication and the implementation of the NDC, and seeking completeness and exhaustiveness in the monitoring of the NDC.

#### **1.7.2.8. Article 175 of Law 1753 of 2015**

Creates "the National Registry for the Reduction of Greenhouse Gas Emissions (GHG) is created, of which the National Registry of Programs and Projects of actions for the Reduction of Emissions due to Deforestation and Forest Degradation of Colombia -REDD+. These will be regulated and administered by the Ministry of Environment and Sustainable Development.

#### **1.7.2.9. Law 164 of 1994**

The Congress of the Republic of Colombia approved the United Nations Framework Convention on Climate Change, whose objective is the stabilization of concentrations of greenhouse gases - GHG in the atmosphere, at a level that prevents dangerous anthropogenic interference in the climate system.

#### **1.7.2.10. Law 629 of 2000**

Fulfill the quantified obligations to reduce GHG emissions for developed countries and provides flexibility mechanisms that will serve, in a complementary manner, to achieve the established reductions, which allow the exchange of allowable emission quotas of the countries. Kyoto Protocol, approved by the Congress of the Republic of Colombia.

### **1.7.3. Land Tenure Laws**

In Chocó, land tenure is characterized by a range of informal and formal systems reflecting the region's unique socio-economic and environmental context.

#### **1.7.3.1. Private Individual Land Holders**

Private individual landholders include campesino households and other private owners. In Chocó, a significant portion of these individual landholders have informal land tenure. The extent of informal tenure varies by municipality, ranging from 7% to 78% of the population (ADR, 2021). The following are the most common types of informal individual land tenure (ANT, 2018):

- Possession: A person without a valid property title is considered to possess a property belonging to someone else or to be an heir of an unsettled estate.

- Occupation: Refers to land that is unclaimed (property without an owner).
- False Tradition: Article 7 of Decree-Law 1250 of 1970 allows for the registration of the transfer of incomplete or unsubstantiated property or rights in the Public Instruments Registry. The property is received from someone who was not the rightful owner. These are precarious titles that do not transfer ownership.
- Unregistered Titles: A public deed, a court ruling, or a resolution of adjudication exists, but it has not been registered.

In contrast, individual private landholders who have formal and legally recognized titles enjoy full ownership rights over their land. Their property is documented with a formal land title that has been registered in the Public Instruments Registry. This title grants them legal ownership and the rights to use, sell, or transfer the property (República de Colombia, 1991).

### 1.7.3.2. Collective Land Holders

Collective land tenure is prevalent, particularly due to the ethnic composition of its population. Specifically, 126 indigenous resguardos collectively own 1,290,024 hectares, while 67 Black community councils hold 3,052,985 hectares of land, with both groups having private collective titles recognized by the National Constitution (ADR, 2021). The law mandates that property rights over the lands of these communities be granted collectively in their favor. Individual members or households within these communities are entitled to usufruct rights according to traditional communal ownership practices. This means they can enjoy the use of the collective land and its resources, but must preserve its integrity and substance. However, they do not possess individual private ownership, as the land remains collectively owned. The right to usufruct of the lands worked by each family can only be sold to individuals who belong to the community and are part of the internal census of the Collective Territory (URT, 2016).

#### 1.7.3.2.1. Black Communities Rights and Indigenous Rights under the 1991 Constitution (with Amendments in 2005)

As many areas in Chocó are owned by Indigenous and Black communities it is important to define why these unique groups have specific land ownership rights. Law 21 of 1992. Colombia constitutionally recognized the Black communities and was recognized as a multi-ethnic and pluricultural country.

The following summarizes the rights under the Colombian constitution (Ng'weno, 2000):

- **Law 21 of 1991** "Through which Convention No. 169 on indigenous and tribal peoples in independent countries, adopted by the 76th, is approved. Meeting of the General Conference of the O.I.T., Geneva 1989".
- **Decree Law 4635 of 2011** "By which measures of assistance, care, comprehensive reparation and land restitution are issued to victims belonging to Black, Afro-Colombian, Raizales and Palenqueras Communities".
- **Decree 1320 of 1998** "By which prior consultation with indigenous and black communities is regulated for the exploitation of natural resources within their territory."
- **Decree 1745 of 1995** "By which Chapter III of Law 70 of 1993 is regulated, the procedure for the recognition of the right to collective property of the" Lands of the Black Communities "is adopted and other provisions are issued".
- **Decree 3770 of 2008** "by which the High-Level Consultative Commission of Black, Afro-Colombian, Raizales and Palenqueras Communities is regulated; the requirements for the Registration of Community Councils and Organizations of these communities are established and other provisions are issued".
- Articles 63 and 330 of the Colombian Constitution recognize the "Consejos Comunitarios," the "Recognition of the Right of Black Colombians to Collectively Own and Occupy their Ancestral Lands" and addressed land ownership, specifically communal lands of ethnic groups.
- **Political Constitution of 1991**, articles, 1, 2, 7, 8, 10, 13, 18, 63, 68, 72, 85, 96, 171, 246, 329, 330, 357, Transitory Article 76 Regulation of Indigenous Territorial Entities ETIS

- **Law 89 of 1890**, recognition of indigenous people, which contributed to the protection and conservation of indigenous peoples and their territories.
- Decree 1396 of 1996, which creates the Human Rights Commission of Indigenous Peoples (attached to the Ministry of the Interior), with broad representation of the state and indigenous organizations.

#### 1.7.3.2.2. Black Communities Tenure and Indigenous Tenure, Natural Resource Use and Governance

Many areas in Chocó Department are owned by Indigenous and Black communities, and it is important to define why these unique groups have unique land tenure. In order to receive the titled lands, the communities in proposed areas need to form 'Consejos Comunitarios', or Community Councils, in accordance with the regulations of the National Government. The Community Council is made up of the general assembly, the community council board, and the participation of one legal representative of the communities. All member of the council must be a part of the Black community and a native to the specified land areas. Members are selected through a direct, democratic election every three years, having their terms end on the 31<sup>st</sup> of December in the third year. Collectively, the council has an annual meeting. The general assembly consists of representatives from each village and is responsible for designing and regulating internal regulation. The board is made up of members selected by the general assembly, and the legal representatives are there to represent the community members. All decisions and elections made by the council affects the social, economic, political, cultural lives of the community members (Guerrero Pino, 2017).

**Law 2 of 1959; Forest Reserves Act.** Establishes a classification and management regime for the lands that fall under its purview including public lands, Resguardos and Black communities' lands; this is separate from the National Parks system and does not represent property rights of the state (Gómez, 2019).

**Article 76 of the General Environmental Law of Colombia (1993)** states that the exploitation of natural resources should be done without detriment to the cultural, social, and economic characteristics of Indigenous or Black communities referred to Law 70 of 1993 and Article 330 of the National Constitution and the decisions of the matter shall be made after consultation with representatives of such communities.

**Law 70 1993 of the In Recognition of the Right of Black Colombians to Collectively Own and Occupy their Ancestral Lands (1993)**, Article 5, introduces the Consejos Comunitarios de las Comunidades Negras, gives the right to lands to the Black communities, the internal management of property lands collective agreement, ensures conservation and protection of the rights of collective property, as well as the use and conservation of natural resources. Article 7, states that in each community, the part of the lands of the black communities destined collective use is inalienable, unpredictable, and unattached; only those areas that are assigned to a family group may be alienated due to the exercise of the preferential right of occupation or acquisition may only fall on other members of the community and on its defect in another member of the ethnic group, with the purpose of preserving the integrity of the lands of the black communities and the cultural identity. Article 15 states that occupations that are carried out by people not belonging to the black ethnic group on the lands adjudicated in collective property to the black communities that thus law deals with, will not entitle the interested party to obtain the title or recognition of improvements and for all legal purposes will be considered as possessors of bad faith.

**Decree 1745 of 1994** acknowledges the rights to the black communities in Colombia, and their rights to titled lands, and sets procedures and guidance for setting Community Councils.

**Regulatory Decree 1745 of 1995.** Article 3 acquires for there to be high authority of internal administration within the lands of black communities; Consejos Comunitarios were exempt from the property tax payment but there has been no rule that has compensated for municipalities.

**Law 60 of 1916** gave the power to demarcate inhabited indigenous territories that were considered vacant.

**Law 135 of 1961**, Requires that they should not give adjudications on vacant territories occupied by indigenous people, except under the approval of the Division of Indigenous Affairs

**Law 30 of 1988**, establishes that any delivery of territory to the indigenous people will be done under the figure of reservation. The indigenous reservations are the collective property of the indigenous communities in favor of which they are constituted and in accordance with articles 63 and 329 of the Constitution. Policy

**Decree 1088 of 1993**, Regulates the creation of indigenous associations and councils.

**Decree 2164 of 1995**, Provision and titling of land to indigenous communities for the constitution, restructuring, expansion and sanitation of the Indigenous Reservations in the national territory.

**Decree 1397 of 1996** National Commission of Indigenous Territories

**Decree 1953 of 2014**, By which a special regime is created in order to put the Indigenous Territories into operation with respect to the administration of the indigenous peoples' own systems until Congress issues the law referred to in article 329 of the Political constitution.

#### 1.7.4. International Treaties and Legislation

Colombia has also adopted the following international legislation:

- Convention for the Protection of the World Cultural and Natural Heritage. Paris, 1972.
- Convention of International Trade in Endangered Species: wild fauna and flora. Washington D.C., 1973.
- Convention on Biological Diversity. Rio de Janeiro, 1992.
- Colombia ratified the Paris Agreement on July 12, 2018 and began enforcing the agreement on August 11, 2018, in which Colombia, and all other countries that signed and ratified, must strengthen their efforts to regulate their emissions to prevent the global temperature from rising (UNFCCC, 2024)

#### 1.7.5. Other Relevant Laws

**Judgment T-622 of 2016.** Recognize the Atrato River, its basin and its tributaries as an entity subject to rights. Design a plan to decontaminate the Chocó water sources, starting with the Atrato Basin, recover its ecosystems and avoid further damage. Joint action plan to neutralize and permanently eradicate illegal mining activities in the Atrato and other tributaries of Chocó. Comprehensive action plan to recover the traditional forms of subsistence and food, within the framework of the concept of ethno-development, which ensures minimum food security. Toxicological and epidemiological studies of the Atrato and its communities. Process of monitoring and accompanying the fulfillment and execution of orders. Effectively comply with Recommendations of Resolution 064 of 2014 of the Defensoría, which declared an environmental and humanitarian crisis in Chocó.

**Judgment T-248 of 2024** The importance of strengthening initiatives to mitigate greenhouse gases (GHG), such as REDD+ projects, is emphasized in the global fight against climate change. The projects are not only a viable option for sustainable forest management, but also for the governance of indigenous communities, especially in the Colombian Amazon, which constitutes 48% of the region. The indigenous communities on the banks of the Pira Paraná River, whose territories are extensive and highly forest-conserved, are a clear example of this situation.

It was highlighted that there are challenges and particular circumstances that result in a lack of protection of the collective rights of these communities and unconstitutional practices that make their unique needs and circumstances invisible.

## 2. JURISDICTIONAL BASELINE DETAILS

### 2.1. Jurisdictional Baseline Start Date and Frequency of Update

The Chocó FREL Baseline Start Date is January 1, 2021, and will be updated every 6 years following Section 3.12 of the JNR Scenario Requirements-v4.1. The selection of the start date was based on the pixel weighted date of the last image of the historical reference period, which is December 23, 2020, and set to the beginning of 2021 for convenience of use for vintage recognition. This also aligns with the start date of the first nested project.

#### 2.1.1. FREL Baseline Validity Periods for Project Baseline Validity Period

The baseline validity follows VMD0055 Section 5.3.1 Initial Jurisdictional Baseline Validity Period. This approach requires defining the historical period over a 6-year temporal interval before a project validity period. In particular, the 6-year interval defined here aligns with the starting date of projects currently applying to this JNR FREL.

The temporal boundaries of the Jurisdictional Baseline are the following:

- Historical reference period: 2015-2021
- Frequency of baseline update: 6 years
- FREL validity period January 1, 2021, to December 31, 2026

### 2.2. Previously Established Jurisdictional Baseline Establishment and/or Reduction Commitments

There is no Jurisdictional Baseline (or FREL) for Chocó Department that has been accepted nor approved under the UNFCCC or another GHG program for domestic or international compliance.

At the national level, the Forest Reference Emission Level (FREL) was submitted to the UNFCCC by the Ministry of Environment and Sustainable Development in December 2019 for the whole country and updated in January 2024. The UNFCCC FREL was not quantified in a way that would meet the JNRs Rules and Requirements or accurately capture the baseline emissions in the Chocó Department much less support spatially explicit allocations to projects.

As no higher-level jurisdictional baseline has been adopted or approved, all activities and pools in the Chocó Colombia Jurisdictional Baseline Area will be accounted as an independent subnational jurisdiction.

The Chocó Regional Government does not have any commitments to reduce land based GHG emissions or enhance carbon stocks within the jurisdiction that are not intended to be financed via market mechanisms and this REDD+ Program. This Jurisdictional Baseline is planned to be used for the COCOMACIA Community REDD+ Program and potentially by new VCS projects as well as existing VCS projects needing to transition to a jurisdictional level FREL.

### 2.3. REDD+ Activities and Drivers of Deforestation and/ or Degradation

#### 2.3.1. Activities

The Jurisdictional FREL submitted under this document for validation, follows JNR Rules and Requirements, VM0048, VMD0055 and VT0007, currently it only accounts for emissions from unplanned deforestation (UDef). Given the significance of unplanned forest degradation (UDeg), in Colombia and specifically in the Choco Department, as demonstrated by several existing VCS projects, Terra Global is collaborating with Verra on the development of a risk-mapping and allocation tool to incorporate both UDef and UDeg with M0397. Once the M0397 tool is approved and the necessary additions are made to VMD0055 to support degradation, the scope of activities for the Choco FREL will be expanded accordingly. Appendix 3 provides projected UDef + UDeg baseline emissions based on the tool under development.

The JNR FREL will support the crediting from Project Activity Instances following Scenario 1 of the JNR Standard.

**2.3.2. Drivers of Deforestation and/or Degradation**

This section follows the requirements of section 5.2.2 Identification of Drivers of Deforestation Agents of the VMD0055 module. Table 3 provides a ranking of the main drivers of deforestation in the Jurisdiction, and the following sections provides a description and background on significance.

*Table 3. Main drivers of deforestation in the Jurisdiction and their ranking*

Driver of Deforestation	Ranking (%)
Conversion of Forestland to Grassland for grazing	34
Illegal Logging for Timber	25
Illegal Small Scale Mining	12
Unplanned Fires	12
Illegal crops	9
Shifting agriculture for subsistence	9

**2.3.2.1. Conversion of Forestland to Grassland for grazing**

The conventional systems employed in Chocó for livestock farming have resulted in the loss of approximately 11,000 hectares of native forest for the establishment of new pastures in the municipality of Acañí between 2001 and 2010. Other municipalities within Choco where livestock farming is significant include Unguía, Rio Sucio, and Carmen de Atrato (Arellano, 2011). Small-scale livestock farming causes deforestation mainly on open forest areas in lowlands.

**2.3.2.2. Illegal Logging for Timber**

The amount of wood legally extracted in Chocó in 2013, was 291,142 m<sup>3</sup> (CODECHOCO, 2013). Additionally, it is estimated that 50% of the wood extracted in Chocó is extracted illegally (CODECHOCO, 2013). Whereas an academic study carried out during 2007 showed that 1,784,000 m<sup>3</sup> of wood is extracted illegally from Chocó every year (Ramírez-Moreno & Ledezma-Rentería, 2007).

Illegal logging in Chocó primarily targets high-value species, leading to forest degradation and a decline in species diversity. Wood has long been a key part of the region’s economy, traditionally exploited in an artisanal manner using family labor. Trees are selected and cut in the jungle, then chopped and transported downstream, floating along the river to sawmills, where the processed logs are negotiated by intermediaries and sold—often to be taken out of the region. Private companies have also established a network of local intermediaries who, while not direct employees or part of a formal organization, are considered "contractors" responsible for supplying wood to third parties. (LEON, 2007)

**2.3.2.3. Illegal Small scale Mining**

According to CODECHOCO (2013) and IIAP (2008), the Abarco tree (*Cariniana pyriformis*) is the most extracted species corresponding to 88% of the total extracted, followed by the Chanul tree (*Humiriastrum procera*). Other threatened timber species in Chocó include the Algarrobo (*Hymenaea courbaril*), Mahogany (*Swietenia macrophylla*), Carrá (*Huberodendrum patinoi*), Cativo (*Prioria copaifera*), Cedar (*Cedrela odorata*), and Choibá (*Dipteryx oleifera*). These high-value species are commonly extracted from Choco and sold in bigger markets.

Local communities use timber extracted from within Choco for local use. The rate of extraction for local use is sustainable and is legal following their land-use rights.

Colombia is one of the main gold producers in Latin America. The National Mining Agency estimated a national production of 61,805 kg during 2016, with 348 km<sup>2</sup> (42%) of alluvial mining located in the collective territories of the Pacific coast (Anaya et al., .

The platinum and gold mining fronts are concentrated in the center of the Chocó Department. The main settlements of alluvial platinum mining are located on the banks of the Condoto and Sipí rivers, with lesser concentrations on the Baudó, Bojayá, Unguía, and Atrato rivers. The municipalities with active precious metals mining are Istmina, Nóvita, Sipí, Condoto, Medio Baudó, Lloró, Quibdó, Medio Atrato, and Bojayá.

Based on UNODC reports and GFC forest loss, an approximate 25% of the Chocó Department area is directly affected or under the influence of illicit crops or alluvial mining and that 60% of forest loss was associated with these two drivers.

According to, in the Chocó region, there are reports of 317,458 hectares of deforested forest due to mining as of the year 2013, been mostly primary forest in the highest altitudes.

**2.3.2.4. Unplanned Fires**

Unplanned fires mainly occur in areas where extensive livestock farming or illicit crops are intended to be developed. This is commonly done by groups outside the law who irresponsibly start these fires that consume hectares of forest areas per year.

**2.3.2.5. Illicit crops**

The impacts of illicit crops on the landscape lie in the fact that their implementation requires clear-cutting forests, especially primary forests. According to data from the (DANE, 2015), for the establishment of 1 hectare of marijuana, coca, and poppy cultivation, the deforestation of 1.5, 4, and 2.5 hectares of forest respectively is necessary (Mosquera-Andrade, 2014).

Approximately 140 m<sup>3</sup> per hectare of timber is lost due to burning, of which 30% are economically important species and 80% by endemic species of the site (Escobar, 2004).

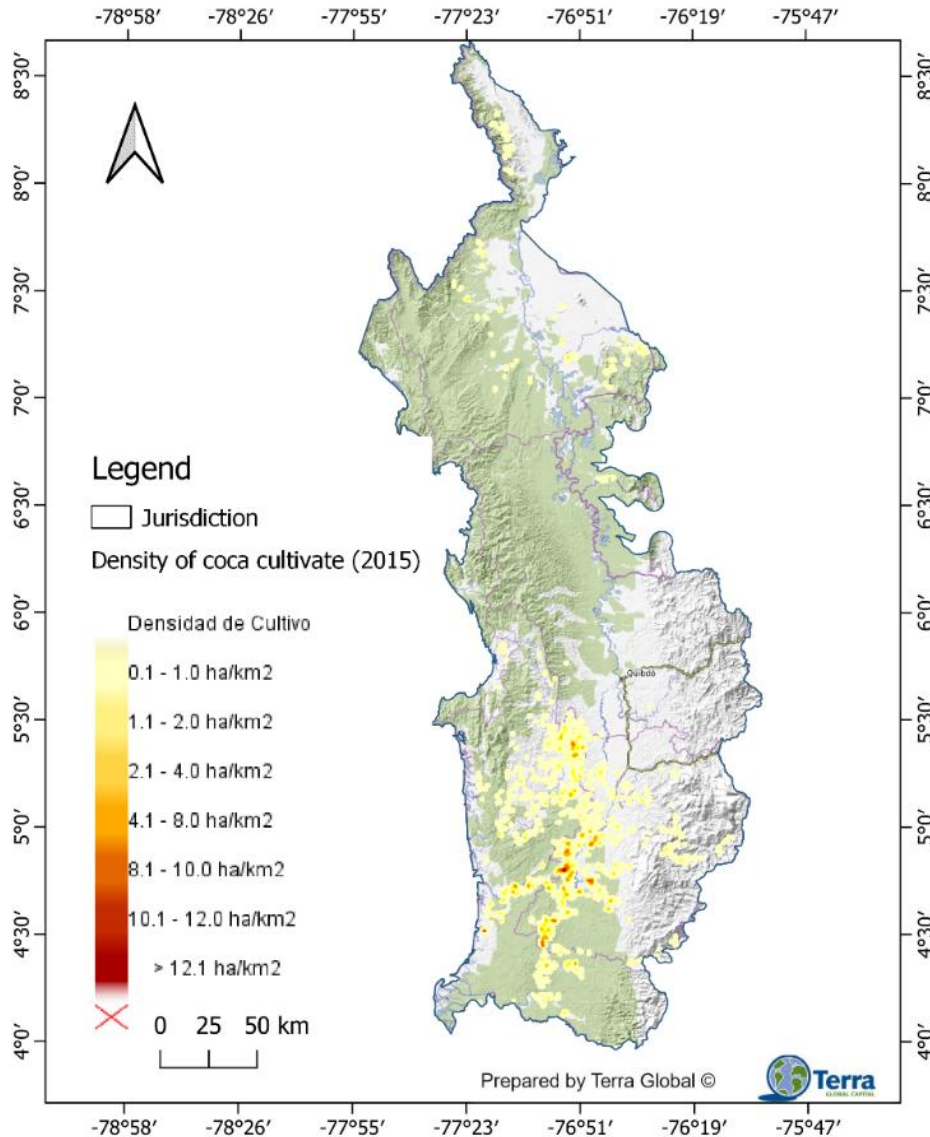
A major challenge of tracking this driver of forest loss is the poor spectral separability between coca fields and other land cover types such as natural regeneration or agricultural mosaics. Additionally, this crop is highly dynamic as it involves leaf-harvesting, replanting, abandonment, and migration to forest areas due to eradication policies (Anaya et al., 2020).

This phenomenon can be found throughout the Department but is more concentrated in the southern area of the Baudó subregion, where armed groups have a great impact on the territories and year after year they expand the borders, increasing the number of hectares and deforesting large areas.

According to UNODC’s Integrated System for Monitoring Illicit Crops between 2017 and 2022 coca crops have range from 2,688 hectares to 5,182 hectares in the Jurisdiction (UNODC, 2021) (Table 4).

*Table 4. Total surface (ha) of illicit crops within the historical period (2015-2021)*

2015	2016	2017	2018	2019	2020	2021
1,505	1,834	2,688	2,239	1,268	1,500	5,182



Map 6. Distribution of Coca crops in the jurisdiction at the beginning of the historical period (2015).  
Source: (DANE, 2015)

### 2.3.2.6. Shifting Agriculture for Subsistence

Most of subsistence agriculture in Chocó uses land areas with fertile soils, gentle slopes, and near settlements, roads, and rivers. Forest conversion to agriculture has been concentrated on lowlands. The process typically begins with clearing of small secondary forest areas for subsistence crops (<1 ha). Many such areas have later been abandoned due to loss of soil productivity, rural-urban migration, technology improvement, and globalization of markets. These processes may promote forest recovery, but in some cases abandoned lands continue in a degraded state (Nepstad et al., 2013).

The most common productive systems are mixed home gardens, whose structural composition is dominated by trees and shrubs mixed with small plots of maize, cassava, rice, plantain, and yam. Additionally, shifting agriculture keeps a significant number of trees from the remaining forest, and only in rare occasions does it surpass 1 hectare of land per family. This land is abandoned every 5-20 years and allows for natural regeneration (Mosquera-Andrade, 2014) as soil nutrients are depleted.

### 2.3.3. Agents of Deforestation and Forest Degradation

Table 5 identify and provide details on the description of the agents of deforestation in the Jurisdiction.

Table 5. Agents of deforestation

Drivers	Agents
Illegal Logging	Loggers (local community members)
Conversion of Forestland to Grassland for grazing	Cattle ranchers (local community members)
Illegal Small scale Mining	Small scale miners (local community members)
Fires	Local community members
Illegal crops	Coca growers (local community members)
Shifting agriculture for subsistence	Farmers

### 2.3.4. Quantification of Carbon Stock Enhancement

The only accounting for carbon stocks enhancements is in the context of including reforestation in the baseline and net degradation (degradation less enhancements) which will be part of the extended next version of the JNR FREL (Appendix 3: Choco Department, Colombia JNR FREL for Unplanned Deforestation and Forest Degradation (UDef + UDeg)). Related to REDD+ activities there are no relevant strategies, policies or measures that would influence this aspect to the baseline.

## 2.4. Jurisdictional Baseline Boundary

The Jurisdictional Baseline Area is all areas in the Chocó Department and the part of the Antioquia Department owned by COCOMACIA that are all subject to similar drivers and agents of deforestation (Section 1.4). The Jurisdictional Baseline Area is used for the quantification of the historical deforestation. The Jurisdictional Crediting Area is the same as the Jurisdictional Baseline Area, but it only includes the forest areas at the start of the baseline validity period. The term Jurisdictional Program Area (or Program Area) refers to the areas inside and outside of the Jurisdictional Crediting Area in which activities may be implemented.

### 2.4.1. Carbon Pools

Table 6 below describes the carbon pools included in the Chocó Colombia JNR Baseline. In this version of the FREL only UDef activity is included and follows the requirements of VMD0055 Module list of pools and related carbon pool modules (VMD0002, VMD0003, VMD0004, VMD0005).

The future scope is presented in Appendix 3: Choco Department, Colombia JNR FREL for Unplanned Deforestation and Forest Degradation (UDef + UDeg).

Table 6. Carbon Pools in Chocó Colombia JNR Baseline

Carbon pools/ sources	Gas	Included for which activities?	Justification/explanation
Aboveground tree or woody biomass	CO <sub>2</sub>	Yes Deforestation	Carbon pool affected by deforestation. Required pool under section 3.10.1 and 3.10.2 of the JNR Requirements Scenario 1.v4.1
Aboveground non-tree or non-woody biomass	CO <sub>2</sub>	Yes / Optional Deforestation	Carbon pool affected by deforestation. Optional pool to be included if found significant based on section 3.10.3 of the JNR Requirements Scenario 1.v4.1

Carbon pools/sources	Gas	Included for which activities?	Justification/explanation
Belowground biomass	CO <sub>2</sub>	Yes Deforestation	Carbon pool affected by deforestation. Required pool under section 3.10.1 and 3.10.2 of the JNR Requirements Scenario 1.
Litter	CO <sub>2</sub>	Yes Deforestation	Carbon pool affected by deforestation. Optional pool to be included if found significant based on sections 3.10.3 and 3.10.4 of the JNR Requirements Scenario 1.v4.1
Dead wood	CO <sub>2</sub>	Yes Deforestation	Carbon pool affected by deforestation. Optional pool to be included if found significant based on section 3.10.3 and 3.10.4 of the JNR Requirements Scenario 1.v4.1
Soil organic carbon (including peat)	CO <sub>2</sub>	Yes Deforestation	Terrestrial Forest classes include SOC, which is Carbon pool affected by deforestation. Optional pool to be included if found significant based on section 3.10.4 of the JNR Requirements Scenario 1.v4.1
		Yes, Optional Deforestation	Mangrove SOC was conservatively excluded in the first validity period, which might be included once enough information is available. Excluding SOC at this stage is conservative because it avoids overstating reductions and keeps estimates comparable to other forest strata.  Optional pool conservatively excluded based on section 3.10.4 of the JNR Requirements Scenario 1.v4.1
	CH <sub>4</sub>	Yes / Optional	Mangrove CH <sub>4</sub> will be excluded in the first validity period, and it will be included once enough information is available. Optional pool conservatively excluded based on section 3.10.4 of the JNR Requirements Scenario 1.v4.1
Wood products	CO <sub>2</sub>	Excluded	Carbon pool affected by deforestation. Pool conservatively excluded based on section 3.10.4 of the JNR Requirements Scenario 1.v4.1

### 2.4.2. Exclusion of Mangroves SOC from Emissions Factors

Mangrove soil baseline emissions will not be included in this baseline validity period, but it will be included in future baseline assessment once methods are available. Mangrove SOC estimation method depends also in stratification of organic soils. For the future inclusion of mangrove SOC pool the procedures to be followed are described in Appendix 3: Choco Department, Colombia JNR FREL for Unplanned Deforestation and Forest Degradation (UDef + UDeg).

### 2.4.3. Significance of GHG Emission

In accordance with VM0048's Appendix 1, the GHG emissions significance test was applied to determine which emission sources and carbon pools should be included within the boundaries of jurisdiction and which

can be justified as insignificant. This procedure is mandatory both for the initial determination of boundaries and for each baseline reassessment.

The procedure followed is described below:

1. The test was conducted considering the evaluation of the jurisdictional baseline.
2. Potential sources of emissions and changes in carbon reservoirs were identified and estimated, as well as emissions from leaks attributable to mitigation measures. Estimates were based on site-specific data, following applicable carbon accounting modules.
3. All emissions were expressed in tCO<sub>2</sub>e using 100-year global warming potentials (GWP), in accordance with the guidelines of the latest version of the VCS Standard.
4. For each source or reservoir evaluated, its relative contribution (RC<sub>Ei</sub>) to the project's total emissions and leakage was determined by applying the equation defined in Appendix 1 of VM0048.

$$RC_{Ei} = \frac{E_i}{\sum_{i=1}^I E_i} \quad \text{Equation 1}$$

Where:

- RC<sub>Ei</sub> = Relative contribution of each source *i* to the sum of project and leakage GHG Emissions.
- E<sub>i</sub> = GHG project and leakage emissions for source *i* as estimated under Step 2a–c Above.
- i* = Index for individual sources of project and leakage GHG emissions due to leakage mitigation measures (*I* = total number of sources considered in Step 1)

5. GHG emissions were ranked in descending order according to their relative RCEi contributions and sorted according to their ranking (i.e., the lowest emission obtained the highest ranking and occupied the last position in the ordered sequence of fugitive emissions).

6. The cumulative sum of the relative contributions (RCEi), previously ordered according to Step 5, was calculated, starting with the one with the lowest rank. The summation was interrupted once the accumulated sum reached the lowest value, not lower than the established threshold of 0.95.

7. GHG emissions by source that were excluded from the cumulative sum in Step 6 were considered insignificant when their total was less than five percent of the net anthropogenic GHG reductions in the project area.

#### 2.4.4. Jurisdictional Baseline Area

The definitions used within this document for areas are as follows:

Table 7. Area Terms Definitions

Term	Description
Jurisdictional Baseline Area	The total area inside the boundary of the Chocó department including the small portion of Antioquia that COCOMACIA's territory covers.
JNR FREL Area	The area that is included for the FREL, and which are subject to unplanned deforestation and forest degradation. This excludes the areas subject to planned deforestation or degradation. Identified exclusions are described in Section 2.5.8
JNR Crediting Area	The total forest area at the end of the Historical Reference Period inside JNR FREL Area.

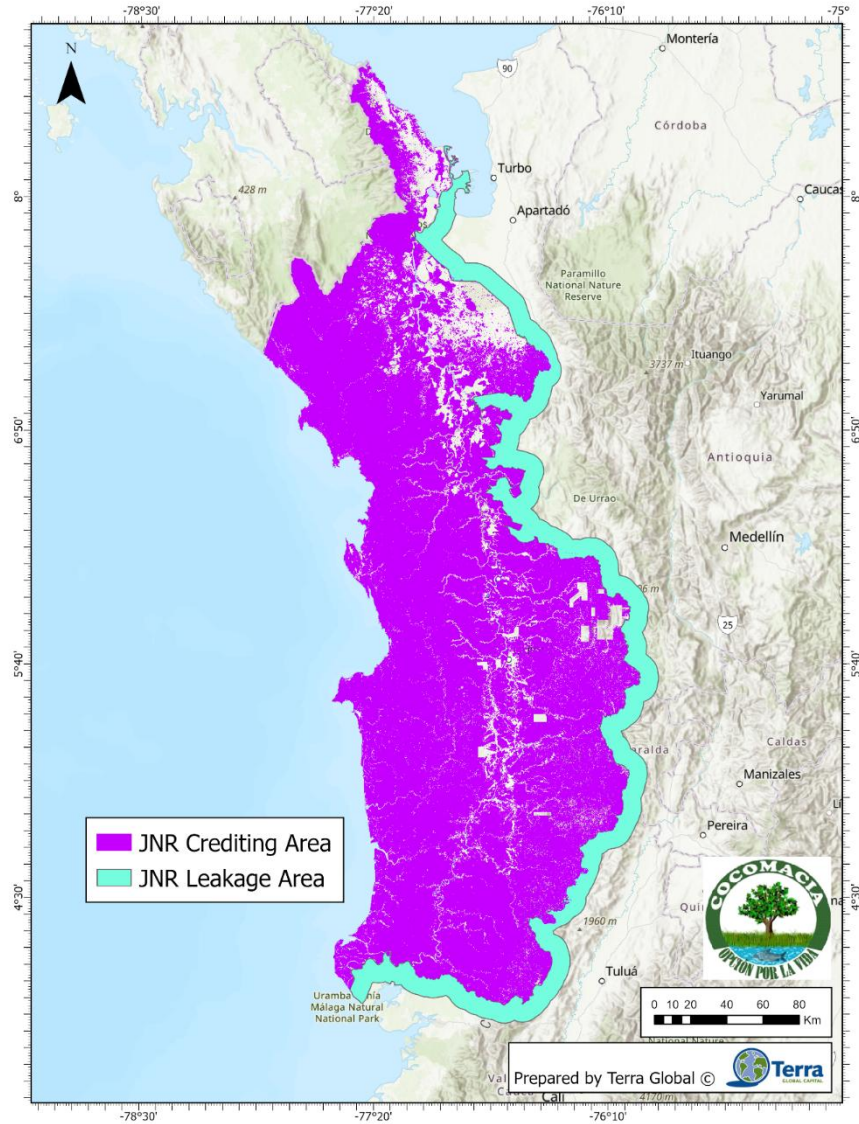
Term	Description
JNR Leakage Area	The total forest area at the end of the Historical Reference Period within a 10km buffer area outside the from the boundary of the Jurisdictional Baseline Area and within the boundaries of Colombia. This was used to calculate the UDef risk map for the 10 km area around the JNR as required by VMD0055, Section A1.4.3. Step 1.

The Jurisdictional Baseline Area is all the forest areas in the Chocó Department and the portion of Antioquia Department, where community councils have overlapping areas (Map 8). The Jurisdictional Baseline Area includes the forests that are subject to unplanned deforestation and forest degradation that are all subject to similar drivers and agents of deforestation. The JNR FREL Area is used for the quantification of the historical deforestation as well as the carbon stock for each land-use type (Map 8). A future version of this baseline will also include degradation, reforestation, and enhancement rates (Appendix 3: Choco Department, Colombia JNR FREL for Unplanned Deforestation and Forest Degradation (UDef + UDeg)). This ensures that only REDD+ related emissions deforestation, reforestation net degeneration (deforestation-enhancements) are included.

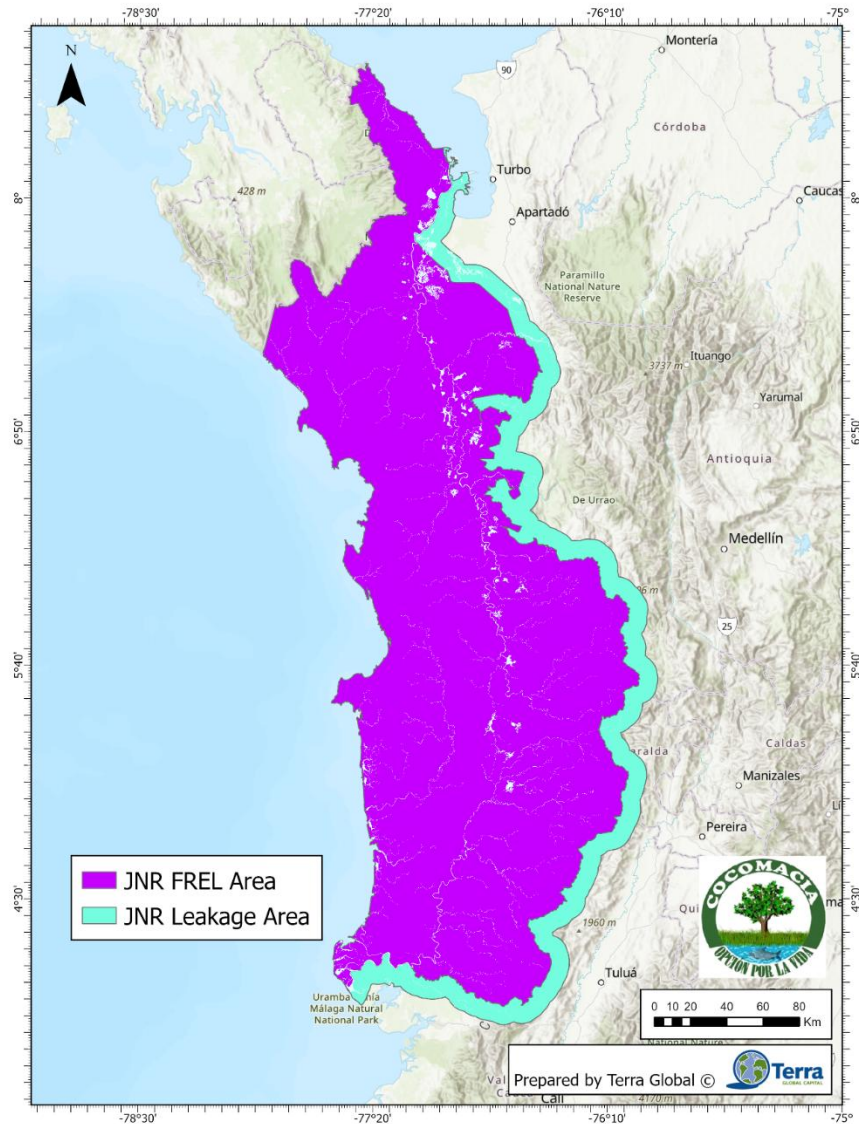
The Jurisdictional Baseline Area meets the following conditions as specified under the JNR Rules and Requirements to ensure the baseline area is representative and unbiased under Scenario 1:

The jurisdiction’s geographic area does not contain unaccounted areas, except the following case:

- 1) Parts of the jurisdictional area subject to exceptional conditions: non-forest areas at program start are not subject to Drivers and Agents of Deforestation as they are non-forest. This Jurisdictional Program uses the political boundary of the Chocó Department including a small portion of Antioquia.



Map 7. Jurisdictional Crediting Area (Purple) and JNR Leakage Crediting Area (Cyan)



Map 8. The JNR FREL area for the Jurisdiction (Purple) and the JNR Leakage (Cyan).

#### 2.4.5. GHG Emissions Sources and Sinks

In accordance with the Jurisdictional and Nested REDD+ (JNR) Requirements and the VCS methodology, the GHG emissions of CO<sub>2</sub>, N<sub>2</sub>O, and CH<sub>4</sub> are accounted for if found to be significant (Table 8). These include fuel CO<sub>2</sub> emissions due to patrolling of the forest, increased N<sub>2</sub>O and CH<sub>4</sub> emissions from greater fertilizer use related to agricultural intensification, intensification of livestock management, and associated manure management. There are no baseline emissions from N<sub>2</sub>O, and CH<sub>4</sub>, as they are expected to be minimal in the Jurisdictional Baseline Area.

Insignificant emission sources will be excluded according to the rules of the VCS and using the VM0048 Appendix 1: Testing significance of GHG emissions.

Table 8. GHG emissions included in accounting in JNR FREL

Source		Gas	Included?	Justification/explanation
Baseline	Baseline deforestation	CO <sub>2</sub>	Yes	Emissions are related to changes in carbon pools in terms of deforestation.
		CH <sub>4</sub>	Optional	Conservatively omitted. CH <sub>4</sub> emissions from Mangrove SOC pool will be included in future baseline reassessment when enough information is available (Appendix 3: Choco Department, Colombia JNR FREL for Unplanned Deforestation and Forest Degradation (UDef + UDeg)).
		N <sub>2</sub> O	Optional	N <sub>2</sub> O emissions from burning woody biomass are assumed negligible and conservatively excluded.

## 2.5. Description of Jurisdictional Baseline Method(s)

### 2.5.1. Accounting Method

This baseline employs activity-based accounting, using existing Verra methodologies, modules, and tools to estimate baseline emissions. Under the JNR Standard version 4.1 and following the JNR Rules and Requirements for Scenario 1 v4.1, the baseline uses the VM0048 Methodology for Reducing Emissions from Deforestation and Forest Degradation version 1.0 as the underlying methodology, applying VMD0055 and VT0007 tool for Unplanned Deforestation Allocation (UDef-A) version 1.0. The Choco FREL applying these standards, methodologies, modules, and tools for deforestation, should allow nested projects to generate ICVCM CCP compliant VCUs.

Terra Global is also developing a new tool (M0397) designed for risk mapping of UDef and UDeg and for the allocation of baseline emissions from UDef+UDeg. Details of the risk modeling approach and the procedures for allocating emissions to nested projects are provided in Appendix 1: Application of VT0007 Unplanned Deforestation Risk Mapping and Allocation (UDef-A).

In addition, Appendix 3 presents Choco FREL from applying, VM0048 and the M0397 tool to UDef+UDeg risk mapping and allocation in the Chocó Department, Colombia Nested JNR FREL. These results will be incorporated into the scope of this baseline once the M0397 tool is formally approved.

### 2.5.2. Methodical Deviations and Justification

#### 2.5.2.1.1. Inclusion of Mangroves JNR Scenario 1 Requirements Deviation

Considering the following JNR FREL Requirements, a deviation will be applied to the Choco Department, Colombia Nested JNR FREL (ID 5079) to include AGB, BGB, Deadwood and Litter pools from mangrove forest.

Section 3.2.4 of the JNR Scenario 1 Requirements v4.1 states: Deviations from the jurisdictional FREL description are permitted at validation following the process for project description deviations set out in the VCS Standard mutatis mutandis.

Section 3.10.1 states: The relevant carbon pools for REDD activities are aboveground biomass, belowground biomass, litter, dead wood, harvested wood products (HWP), and soil.<sup>7</sup>

<sup>7</sup> Although wetlands are not currently included within the JNR program, peat soil may be a relevant carbon pool (e.g., where leakage may affect wetlands).

Section 3.10.5 states: All carbon pool and GHG emission source exclusions must be conservative and shall be demonstrated and justified at validation based on approximate calculations, references from scientific,

peer-reviewed literature, including applicable default (Tier 1) data, or tools from an approved GHG program. Note - Requirements to account for GHG emission reductions from organic soils in wetlands (including peatlands) and GHG emissions from biomass burning will be included in a future update to the JNR Requirements.

According to the VCS Program Definitions v4.4 of 29 August 2023, a Wetland is: Land that is inundated or saturated by water for all or part of the year (e.g., peatland), at such frequency and duration that under natural conditions they support organisms adapted to poorly aerated and/or saturated soil. Wetlands (including peatlands) cut across the different AFOLU categories. Project activities may be specific to wetlands or may be combined with other AFOLU activities

Considering that mangrove forests are part of the broader category of Wetlands, we propose a methodology deviation to include AGB, BGB, deadwood, and litter for mangrove forest strata within the Chocó Jurisdictional FREL, while excluding soil organic carbon (SOC) from mangrove soils for the current FREL validity period. Excluding mangrove forest SOC at this stage is a conservative choice, it avoids overstating reductions and keeps estimates comparable to other forest strata, with the intention to include SOC in a future FREL update once robust, validated methods are available.

This deviation does not introduce a new activity or sector (e.g., wetland restoration) beyond JNR Scenario 1. Although mangroves are coastal wetlands, in Colombia they meet the national forest definition (canopy cover, height, area) and are therefore treated as forest within the JNR boundary; mangroves are simply a forest subset for which we are refining pool accounting.

#### 2.5.2.1.2. Activity Data from Wall-to-Wall Map

According to VMD0055 Section A1.4.1 “Historical AD must be estimated using a sample-based approach that uses human interpretation of high-resolution imagery within sample plots 21F 23 distributed in a representative manner across the jurisdiction.” For the present FREL baseline a wall-to-wall mapping approach has been used to estimate the AD for the following reasons:

The decision to utilize a wall-to-wall mapping approach for generating activity data in the context of the Chocó FREL is based on the following considerations and meets the Verra standards requirements for deviations as documented below.

#### *Cost Consideration and Methodological Requirements*

Although sample-based approaches are often less expensive—because randomized sampling with visual interpretation requires fewer resources (Jeffrey Pickeringa, 2019)—this cost advantage does not apply under methodology VT0007. VT0007 explicitly requires a complete wall-to-wall map to produce the Forest Cover Benchmark Map (FCBM). The FCBM must show forest presence or absence across the entire jurisdiction at the start, mid-point, and end of the Historical Reference Period (HRP), creating eight distinct forest-transition classes. This full-coverage map is a mandatory input for calculating the Jurisdictional and Nested REDD+ (JNR) Baseline and for quantifying emissions reductions, making wall-to-wall mapping an essential step in the VT0007 process.

#### *Interpreter Bias and Image Complexity*

While sample-based approaches allow for the formal estimation of confidence intervals associated with strata areas and land-use transition classes (e.g., DF), they are also susceptible to interpreter bias. This limitation becomes especially critical in regions with challenging remote sensing conditions, such as the Department of Chocó, which experiences average cloud cover exceeding 90%. Under such conditions, imagery is often difficult to classify accurately through visual interpretation alone. Moreover, visual analysis is limited to three spectral bands at a time, increasing the risk of misclassification, particularly for interpreters unfamiliar with the local landscape (Ronald E. McRoberts, 2018). These biases can propagate into activity data (AD) estimates without being captured in reported uncertainty metrics.

### *Advantages of Algorithmic Interpretation and Bias Correction*

Despite potential classification bias in wall-to-wall approaches, these can be addressed and quantified using a two-step validation framework. A key advantage of algorithmic methods is their ability to process and interpret high-dimensional data, such as the fusion of multisensor imagery, which surpasses human visual capacity.

### *Adoption of a Hybrid Approach*

Given the above, a hybrid methodology was adopted for Chocó. In this approach, visual interpretations were categorized into three uses:

- Training data for algorithm development,
- Held-out random samples for accuracy assessment of land-use/land-cover (LULC) maps, and
- Stratified samples for validation of DF transitions.

This design enables the calculation of both accuracy and uncertainty in the AD derived from wall-to-wall maps, using a limited but high-quality set of visual interpretations, while leveraging the strength of algorithms in analyzing multisensor data.

### **Uncertainty Estimation and Bias Correction**

For the Chocó implementation, sample-based area estimation informed by interpreter analysis was used to calculate the uncertainty associated with DF transitions.

This information was applied to bias-correct the estimates of unplanned DF activity data following the procedures in VMD0055, Section 5.3.3.2:

- Step 3: Uncertainty was calculated for each transition class.
- Step 4: An inflation factor was applied only if the percentage uncertainty exceeded 10%. Since the uncertainty for unplanned deforestation was below this threshold, no correction was applied, and the inflation factor was set to zero.

If the percentage uncertainty had exceeded 10%, estimates for DF would have been adjusted downward using the inflation factor (IFUDef), as described in Equation 29 of Section 5.3.3.2 of VMD0055.

#### **2.5.2.1.3. Deviation in Calculating Predicted LULC Risk Maps for the application phase (Section 5.6 of VT0007)**

Originally, VT0007 requires the use of the frequency table referring to DF throughout the HRP and a 30 classes vulnerability map to spatially predict deforestation risk and the deforestation activity data over the 6 years of the BVP. The method applied in TerraChange calculated the deforestation maps for the application phase by applying the probability maps year-by-year and using a continuous probability of deforestation gradient rather than the 30 classes. This method different from VT0007, by applying the risk model for each year in the BVP, based on annual updates of the dynamic risk factors such as distance to forest edge rather than one application across all six years. These probability maps were used for allocating LULC change based off historical activity data. This was possible because TerraChange is already able to spatially distribute transitioned pixels throughout the Jurisdiction without having to be clumped into the 30 discrete classes, thus providing more detailed spatial patterns. In addition, the process incorporates the TerraChange scarcity factor, which applies a downward adjustment on deforestation and degradation rates as forest and closed-forest areas are progressively reduced. This mechanism constrains expected deforestation by reflecting forest scarcity and results in more conservative projections. Therefore, instead of relying on a one-time 30-class vulnerability map, the predictive deforestation maps for the BVP are produced dynamically by applying the annually updated deforestation probabilities for all modeling classes, running the TerraChange simulation across the jurisdiction and its 10 km leakage region.

### Treatment of the SOC Pool

A deviation to VMD0004 was applied by adding a deduction to Equation 1 of the module for Coarse Fragment Correction (Equation 9), based on field observation in each SOC subplot, an estimated percentage of rocks in the soil horizon was recorded, then a deduction was applied to the carbon stock in soil organic carbon for sample plot *sp*, stratum *i*. This adjustment better represents the true soil volume available for organic carbon storage by excluding the fraction occupied by rocks. Without this correction, estimates of SOC stocks would be systematically inflated in soils with high coarse fragment content, since the “apparent” volume of soil is greater than the actual fine earth fraction that stores carbon.

By applying a deduction, the project ensures that no overestimation of SOC stocks occurs. This aligns with the principle of conservativeness required by the VCS, as the adjusted values are lower (or equal) to those obtained under the uncorrected equation. This approach therefore avoids crediting emissions reductions or removals that are not genuinely achieved.

Because the correction is based on empirical field observations of coarse fragment content at each subplot, it leverages site-specific data rather than generic assumptions, increasing methodological robustness.

This deviation introduces a scientifically justified and conservative correction that increases both environmental integrity and methodological transparency. It does not alter the structure of VMD0004 but refines Equation 1 with an empirically measured deduction, ensuring that SOC stocks are not overestimated in soil with significant rock content.

## 2.5.3. Most Plausible Jurisdictional Baseline Scenario

### 2.5.3.1. Discussion of Historical and Future Deforestation Trends

Historically, deforestation and forest degradation in the Chocó Department of Colombia has been driven by a combination of 1) Illegal Logging, 2) Shifting Agriculture for Subsistence, 3) Illicit crops, 4) Illegal Small-scale Mining and 5) Unplanned Fires. Since the 1930s, extensive deforestation has occurred, particularly affecting valuable tree species such as *Prioria copaifera* and *Anacardium excelsum* in the Darién region. By the early 2000s, deforestation had escalated significantly. The destruction of tropical rainforest ecosystems for illicit crop cultivation has also contributed, with approximately 1,360 hectares of forest (Ramírez-Moreno & Ledezma-Rentería, 2007).

Mining, particularly for gold and platinum, has been a major factor in deforestation and forest degradation in Chocó. The use of heavy machinery such as backhoes and suction dredges has intensified since the 1990s, leading to widespread deforestation, habitat fragmentation, and soil erosion. In addition to the direct loss of forest cover, mining contributes to river sedimentation, contaminates water sources with mercury and other pollutants, and disrupts local biodiversity. The expansion of these activities has been driven by economic incentives, with both legal and illegal operators exploiting the region’s rich mineral resources (Valois-Cuesta & Martínez-Ruiz, 2016).

Looking ahead, deforestation and forest degradation in Chocó is likely to continue unless effective conservation policies and sustainable development strategies are implemented. Current trends suggest that mining and timber exploitation remain dominant economic activities, threatening primary forests and the biodiversity they support. Moreover, increasing global demand for minerals and timber may exacerbate deforestation rates, particularly in regions with weak environmental governance. However, conservation efforts, such as the legal recognition of collective land titles for Afro-Colombian communities and indigenous groups, offer a potential pathway for sustainable land management and forest preservation (Ramírez-Moreno & Ledezma-Rentería, 2007).

Future deforestation trends in Chocó will depend on the balance between economic pressures and conservation efforts. Strengthening environmental regulations, promoting community-based forest management, and incentivizing sustainable economic alternatives such as ecotourism and agroforestry could help mitigate deforestation. Without such measures, the continued expansion of extractive industries threatens to accelerate the loss of Chocó’s unique and ecologically valuable rainforests (Ramírez-Moreno & Ledezma-Rentería, 2007).

The most plausible Baseline Scenario is assumed to be the same as the conditions at start of the baseline validity period as described in Section 1.5. Choco Jurisdictional FREL Area will also experience the same conditions prior to the baseline validity period initiation – continual population growth (with pressures from small scale illegal mining, drivers listed above. Drivers of land-use change described in Section 2.3.2 will increase and the pressure on the forest will remain steadfast. No adjustments were made to the historical reference period of the Jurisdiction to create the Jurisdictional Baseline.

**2.5.3.2. Baseline Scenarios**

Three different alternative baseline scenario were built from the trend of historical rates using three models; exponential, linear and logarithmic curves that were fitted to historical data and used to predict the deforestation rate into the future.

In addition, a alternative baseline scenario was built form the historical annual average deforestation, degradation, reforestation and enhancement trends during the extent of the historical reference period.

**2.5.3.3. Baseline Scenarios Using Different Models based on Historical Trend**

While the number of observations is limited to only three time periods the historical trend data was used to estimate three different alternative baseline scenarios by applying i) exponential, ii) linear and iii) logarithmic models to predict future deforestation into the future.

These alternative baseline scenario projections are provided in figures below.

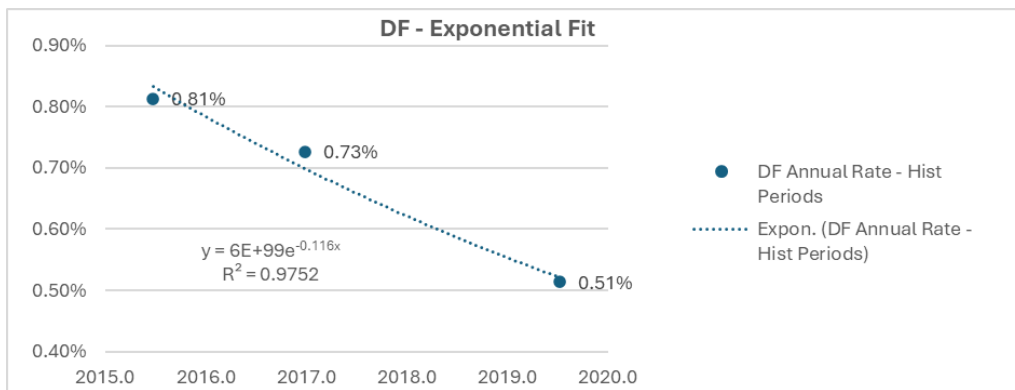


Figure 1. Deforestation Baseline Scenarios Projected with Exponential Fit (X axis = midpoint of time period, Y axis annual rate)

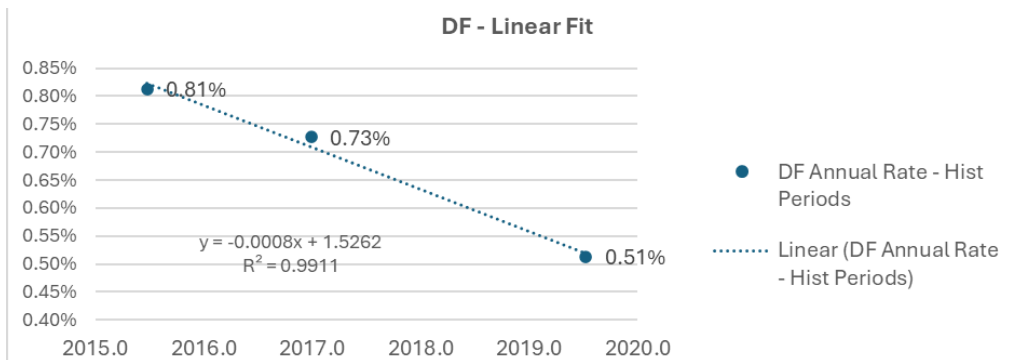


Figure 2. Deforestation Baseline Scenarios Projected with Linear Fit (X axis = midpoint of time period, Y axis annual rate)

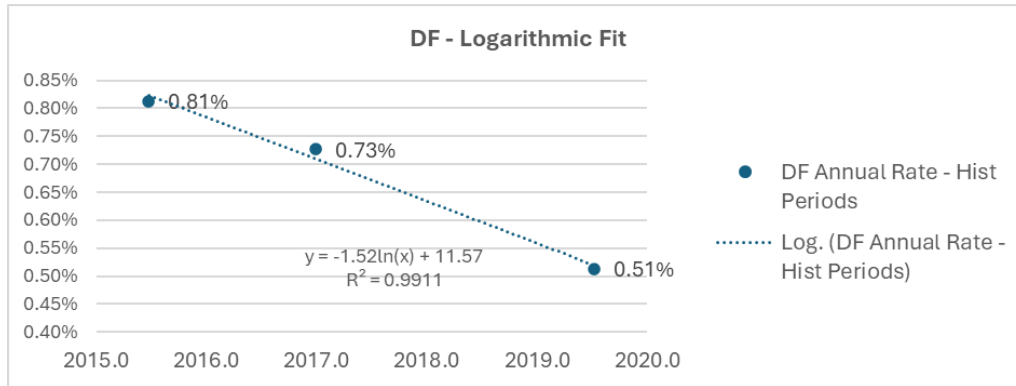


Figure 3. Deforestation Baseline Scenarios Projected with Logarithmic Fit (X axis = midpoint of time period, Y axis annual rate)

Extrapolating deforestation (DF) with simple trend fits (exponential, linear, logarithmic) produces implausible results, with rates collapsing toward zero within a short horizon. Such curves ignore the jurisdiction’s complex socio-economic, political, and environmental drivers of land-use change.

The problem is compounded by scarce historical data: with only a few observations (e.g., three years), trend estimates are unstable and highly sensitive to small input changes. All tested regressions under-shoot when extrapolated, and the linear fit is especially unreliable given the minimal data supporting its slope.

Consequently, curve-fitting from limited history is not a credible basis for DF (or degradation) projections and would inject bias and substantial uncertainty into the baseline.

#### 2.5.3.4. Baseline Scenario Using Historical Average

The historical average deforestation derived from wall-to-wall LULC maps developed at three points in time, (a) the beginning of the historical period, (b) in the middle of the historical period, and (c) at the end of the historical period was the baseline scenario used to predict deforestation during the baseline validity period. The scenario assumes that the JNR FREL Area experiences both degradation and deforestation, characterized by a mosaic pattern, with patches of deforestation and degradation depending on a combination of spatial drivers. Degradation and reforestation, while calculated in the same manner, are not validated for this version of the FREL, but are included in Appendix 3: Choco Department, Colombia JNR FREL for Unplanned Deforestation and Forest Degradation (UDef + UDeg).

Figure 4 provides the deforestation rates for each time period in the historical reference period with an average annual historical DF rate of 0.63%.

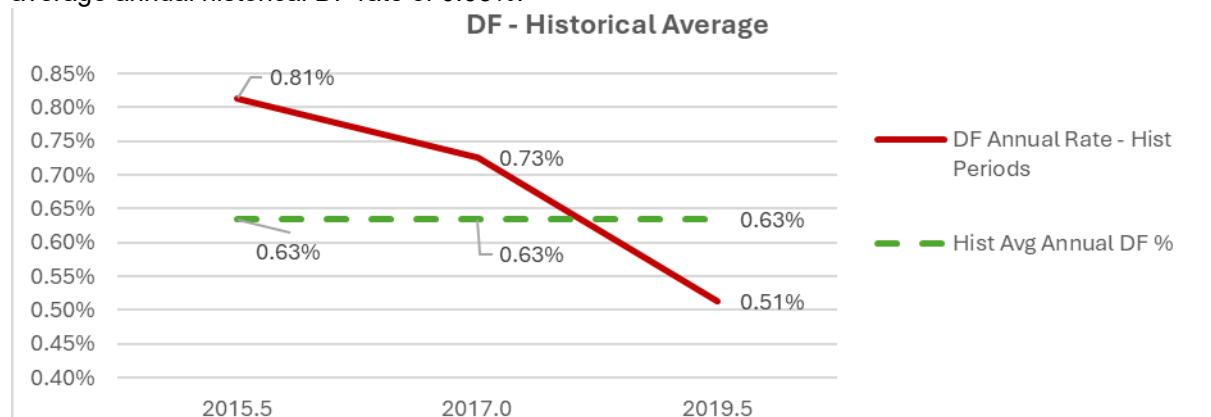


Figure 4. Historical Deforestation (DF) Rates and Average Annual Rate (X axis = midpoint of time period, Y axis annual rate)

The historical annual average deforestation and degradation calculated from wall-to-wall LULC maps at different points in the reference period, provides a more robust and realistic representation of land-use dynamics in the jurisdiction. Unlike Scenario 1, which applies regression models (linear, exponential, and logarithmic) to a limited dataset, Scenario 2 avoids statistically unstable extrapolations that are highly sensitive to small variations in input data. Using curve-fitting techniques with so few data points introduces significant uncertainty and may lead to unrealistic outcomes, such as deforestation and degradation rates approaching zero in a short timeframe.

Thus, the most conservative baseline scenario is the **historical average annual** deforestation rates which were applied in the baseline.

#### 2.5.4. Baseline Scenario Selection Method

Using the JNR Rules and Requirements, a JNR FREL was developed for Colombia’s Chocó Department. Because the dynamics of forest and land-use in the Chocó Region are primarily subject to unplanned deforestation and degradation, the Jurisdictional Baseline was constructed using:

- Methodology VM0048 Reducing Emissions from Deforestation and Forest Degradation, v1
- Module VMD0055 Estimation Of Emission Reductions From Avoiding Unplanned Deforestation v1.1 and related modules, and
- Tool VT0007 for Unplanned Deforestation Allocation (UDEF-A)

To demonstrate the jurisdictional baseline emissions for both deforestation and degradation, the application of the M0397 tool (under development) for Risk Mapping Deforestation and Degradation has been presented in Appendix 3: Choco Department, Colombia JNR FREL for Unplanned Deforestation and Forest Degradation (UDef + UDeg).

Under these methodologies and modules and tools, the baseline scenario is based off the assumption that future rates, change in rates, and dynamics in deforestation and degradation stay the same as the historical annual rates and dynamics in deforestation and degradation. This methodology involves the quantification of baseline emissions and removals using wall-to-wall accounting for land-use change activities based on historical average data.

For this version of the JNR FREL Baseline the historical reference period is over the most recent historical 6-year period before JNR Baseline Validity Period Start, meeting the requirements of the JNR Standard. It also provides detailed requirements for the quantification of emission factors and uncertainty. This methodology includes applicability criteria that cover the conditions in the Jurisdictional Baseline Area and thus the detailed steps included in this methodology were applied to construct the Jurisdictional Baseline following the historical annual average scenario. Any additional requirements under the Jurisdictional Baseline Rules and Requirements have also been applied.

Table 9 below outlines the framework, methodologies, modules, and tools applied to establish the Jurisdictional Baseline for UDef.

Table 9. Framework, Methodologies, Tools and Modules used for Unplanned Deforestation under methodologies VM0048, VMD0055, and VT0007 (UDef)

Type (methodology, tool, module)	Reference ID (if applicable)	Title	Version
Framework	N/A	JNR Requirements Scenario 1	v4.1
Methodology	VM0048	VM0048 Reducing Emissions from Deforestation and Forest Degradation	v1.0
Module	VMD0055	VMD0055 Estimation of Emission Reductions from Avoiding Unplanned Deforestation	v1.0

Type (methodology, tool, module)	Reference ID (if applicable)	Title	Version
Module	VMD0002	VMD0002 Estimation of Carbon Stocks in the Dead Wood Pool (CP-D)	v1.1
Module	VMD0003	VMD0003 Estimation of Carbon Stocks in the Litter Pool (CP-L)	v1.1
Module	VMD0004	VMD0004 Estimation of Carbon Stocks in the Soil Organic Carbon Pool (CP-S)	v1.1
Module	VMD0005	VMD0005 Estimation of Carbon Stocks in the Long-Term Wood Products Pool (CP-W).	v1.1
Module	VMD0016	VMD0016 Methods for Stratification of the Project Area (X-STR)	V1.3
Tool	VT0005	VT0005 Tool for measuring aboveground live forest biomass using remote sensing	V1.0
Tool	VT0007	VT0007, Unplanned Deforestation Allocation (UDef-A)	v1.0

The GHG accounting for the JNR FREL Area applies the best of Verra’s standards, methodologies, modules, and tools as detailed in Table 10.

*Table 10. Application of Verra’s standards, methodologies, modules, and tools for JNR FREL Baseline Validation*

Methodological Component		Steps		Method Applied	BD Section
1	Jurisdictional Baseline Boundary	1.1	Geographic Boundaries	VMD0055 A1.2.1	1.4
		1.2	Carbon Pools	VM0048 Section 5.2	2.4.1
		1.3	Sources of GHG E missions	VM0048 Section 5.3	2.4.2
		1.4	Significance of GHG Emission Sources	VM0048 Appendix 1	2.4.3
2	Baseline Scenario	2.1	Conditions Prior to Jurisdictional Baseline Start Date	VMD0055 Section 5.2	1.5
		2.2	Identification and Characterization of Agents, Drivers and Underlying Causes of Deforestation.	VMD0055 Section 5.2	2.3.2 2.3.3
		2.3	Determination of the Most Plausible Baseline Scenario	VM0048 Section 6.1	2.5.3
		2.4	Baseline Scenario Selection Method	VM0048 Section 6.1	2.5.4
3	Baseline emissions	3.1	LULC Stratification Map	VMD0055 Section 5.3.2.1	2.5.4.6
		3.2	Areas of Identified Exclusions	VMD0055 A1.4.1	2.5.5.2
		3.3	Jurisdictional Activity Data for unplanned deforestation	VMD0055 with deviation for Wall-to-Wall Land Cover Map	2.5.4.2
		3.4	Calibration of a risk-based land-use change model	VT0007	2.5.4.3
		3.4.1	Jurisdictional Deforestation Risk Map	VT0007	2.5.4.3.2
		3.5	Allocation of Projected Activity Data to PAs and LBs	VT0007	2.5.4.4

Methodological Component		Steps		Method Applied	BD Section
		3.6	Estimation of Carbon Stocks per Forest Stratum	VMD0055 Section 5.3.2.3	2.5.4.5
		3.7	Estimate uncertainty-discounted emission factors	VMD0055 Section 5.3.2.3	2.5.4.5.5
		3.8	Estimation of Annual Baseline Emissions from Carbon Stock Changes	VMD0055 Section 5.3.2.3	2.5.4.5.6
4	Leakage	4	Leakage Emissions	VM0048 Section 8.3	2.5.4.6
		4.1	Activity-shifting leakage	VMD0055 Section 5.3.4.1	2.5.4.6.1
		4.2	Activity-shifting leakage mobile agents	VMD0055 Appendix 2	2.5.4.6.2

### 2.5.4.1. Applicability Conditions for Project Areas Using JNR FREL

For projects seeking to nest by apply this Choco FREL for issuance of VCUs, besides meeting the Standard’s requirements for projects to transition to jurisdictional baselines, they must meet the following conditions:

1. The area must be deforested or degraded in absence of the REDD project activity and the deforestation and degradation must be mosaic in nature as described in the VCS AFOLU Requirements.
2. Drivers of deforestation and forest degradation must be unplanned.
3. If deforestation from a specific driver is occurring because of planned forest conversion activities, the area(s) subject to such driver must be excluded from analysis.
4. The area does not include peatland soil.
5. The project start date must be within the number of years as specified by the VCS Standard of the start of the jurisdictional FREL validity period.
6. Project activities are designed to reduce unplanned deforestation and degradation.
7. Project applies Verra approved methodologies, modules, tools, and other guidance to quantify ex-post leakage from geographically constrained activity shifting leakage, non-geographically constrained activity shifting leakage and market leakage (if relevant).
8. For mangroves, projects cannot claim VCUs from SOC, as this FREL does not include the SOC pool for the initial validity period. Mangrove SOC pool could be included in future baseline reassessments once sufficient information is available.

The outcome of this step defines whether a project seeking to apply this JNR FREL for crediting under an AFOLU methodology meets the applicability criteria.

All projects applying this baseline must also comply with Colombia’s legal requirements for Maximal Mitigation Potential (MMP) (see Section 1.7.2.5) and/or methodological reconstruction.

The following section outlines the procedure for obtaining the MMP, which is not part of the quantification of project VCUs directly, but is a legal requirement they may limit the issuance of project VCUs to that which is lower than those which are ex-post generated and verified in the project’s monitoring report. .

#### 2.5.4.1.1. Maximal Mitigation Potential (PMM) Prescribed by Colombian Law

Projects must comply with Colombian regulations (section 1.7) regarding Maximal Mitigation Potential or Methodological Reconstruction (section 1.7.2.5). To ensure that REDD+ projects do not exceed the limits imposed by the government.

#### 2.5.4.2. Jurisdictional Activity Data for Unplanned Deforestation

Procedures to collect and compile jurisdictional deforestation AD follow the steps described in VMD0055's Appendix 1: Determination of Jurisdictional Data for Project AD Allocation.

##### 2.5.4.2.1. Step 1: Historical Land Cover/Land Cover Change Dataset

Land cover transitions were assessed by analyzing LULC (Land Use/Land Cover) wall to-wall maps across the historical reference period (description of this methodological deviation is in section 2.5.2). Transitions were identified by comparing pixel classifications between two consecutive time steps, allowing for the detection of changes in land cover classes over time. This analysis enabled the generation of transition maps for deforestation for each interval within the historical period.

The historical LULC analysis was carried out within the boundaries of the Jurisdictional Baseline Area (Table 7. Area Terms Definitions) which excludes the areas described in Section 2.5.8. Detailed procedures for the interpretation process are described in Section 2.5.4.6.

##### 2.5.4.2.2. Step 2: Total Area of Each AD Category

Transition maps were then used to calculate the average annual deforestation rates. Although the JNR FREL Area at t=0 includes only forested areas, the baseline scenario must also consider forest loss that occurred during the historical period. The outputs derived from the LULC maps were therefore used to estimate the historical rate of deforestation across the jurisdiction. Map Accuracy Assessment and Discounting Factor Determination procedures are described in detail in Section 2.5.5.1.8.

##### 2.5.4.2.3. Step 3: Uncertainty of the Estimated Areas of Each Change Category

The percentage uncertainty of the estimated area was calculated following step 3 of the VMD0055's Appendix 1. Detail description of the procedures followed are presented in Section 2.5.5.1.8.

##### 2.5.4.2.4. Step 4: Conservatively Inflated Area of Unplanned Deforestation

The estimated historical area of unplanned deforestation was discounted based on its uncertainty level. Where the percentage uncertainty of the estimated transition area was less than or equal to 10 percent, the estimate was used without modification, and the discount factor was zero. Estimates with uncertainty levels above 20 percent were not admitted. Where the percentage uncertainty was between 10 percent and 20 percent, the area estimate was scaled down by discount factor DF. Details of the procedure followed are presented in Section 2.5.5.1.8.

##### 2.5.4.2.5. Step 5: AD for Unplanned Deforestation

The final jurisdictional deforestation rate was determined by aggregating the calculated transition rates across all strata, ensuring consistency and completeness in the estimation of historical unplanned deforestation activity data.

Areas of change were annualized by dividing the area experiencing change by the number of years elapsed from the start to the end date of the time in the transition period within the HRP.

#### 2.5.4.3. Calibration of a Risk-Based Land-Use Change Model

The following temporal boundaries are defined:

- Historical Reference Period (HRP) covers 6 years, from January 2015 to January 2021.
- Baseline (FREL) Validity Period (BVP) covers January 2021 to December 2026.
- As shown in Table 11, the HRP was divided into time periods T1, T2 and T3.

Table 11. Pixel weighted average date of the image used for generating the LULC map and its corresponding

Imagery Date (YYYY/MM/DD)	Position in the HRP
Jan 3, 2015	T1
Jan 21, 2018	T2
Dec 22, 2022	T3

The series of steps as specified under VT0007 were applied to determine the reference emission level (REL) and allocate this FREL based on a risk model to projects aimed at avoiding unplanned deforestation, according to the level of risk of unplanned deforestation that exists within each program or project area.

As detailed in VT0007, this tool is based on two stages (Testing and Application), each subdivided into 2 phases (Fitting and Prediction). For the fitting phase with data coming the first half of the HRP (i.e. T1 to T2) each model (benchmark and alternative) was fit.

This section summarizes the methods used to develop risk maps for unplanned deforestation in the JNR Baseline Area to support the allocation to project areas. This approach leverages risk mapping and applies the core of VT0007 to demonstrate the accuracy of applying an alternative risk model for deforestation. Appendix 1: Application of VT0007 Unplanned Deforestation Risk Mapping and Allocation (UDef-A) provides the detailed explanation of the risk mapping and allocation for deforestation.

#### 2.5.4.3.1. Calibration and Validation of the Alternative Model to Create the Vulnerability Maps

To spatially allocate expected deforestation in a dynamic and spatially explicit manner, the alternative model (TerraChange) utilizes a modeling module composed of two hierarchical subcomponents:

1. A logistic regression model, which estimates the probability that a land-use transition event—such as deforestation—will occur at a given location.
2. A multinomial logistic (multi-logit) model, which determines the most likely transition *destination*, i.e., the specific non-forest land-use class that a deforested pixel converts into.

For example, in the case of deforestation (DF), the first component assesses the likelihood that a DF event will occur, while the second identifies the target non-forest class (e.g., agriculture, settlement) into which the land transitions.

These estimated parameters are then integrated into the TerraChange land-use change model to predict the spatial distribution of future deforestation events across the landscape.

The logistic regression model is trained using a balanced dataset of approximately 50,000 observations, evenly split between pixels where deforestation was observed and those where it was not. The multi-logit model, by contrast, is calibrated using only those pixels where deforestation transitions were observed during the historical reference period.

The entire modeling system is re-calibrated during each baseline reset to reflect updated trends and drivers of land-use change.

Figure 5 outlines the calibration process for the risk model and the application of the VT0007 tool, which is used to:

- Determine the Jurisdictional and Nested REDD+ (JNR) Area FREL;
- Generate risk maps;
- Produce activity density (AD) data, expressed in hectares per square kilometer (ha/km<sup>2</sup>), spatially allocated across the JNR FREL to inform project-level estimates under AFOLU methodologies.

For a detailed explanation of the modeling approach and its application to unplanned deforestation (DF) within the context of VT0007, please refer to Appendix 1: Application of VT0007 Unplanned Deforestation Risk Mapping and Allocation (UDef-A) Appendix 1: Application of VT0007 Unplanned Deforestation Risk Mapping and Allocation (UDef-A).

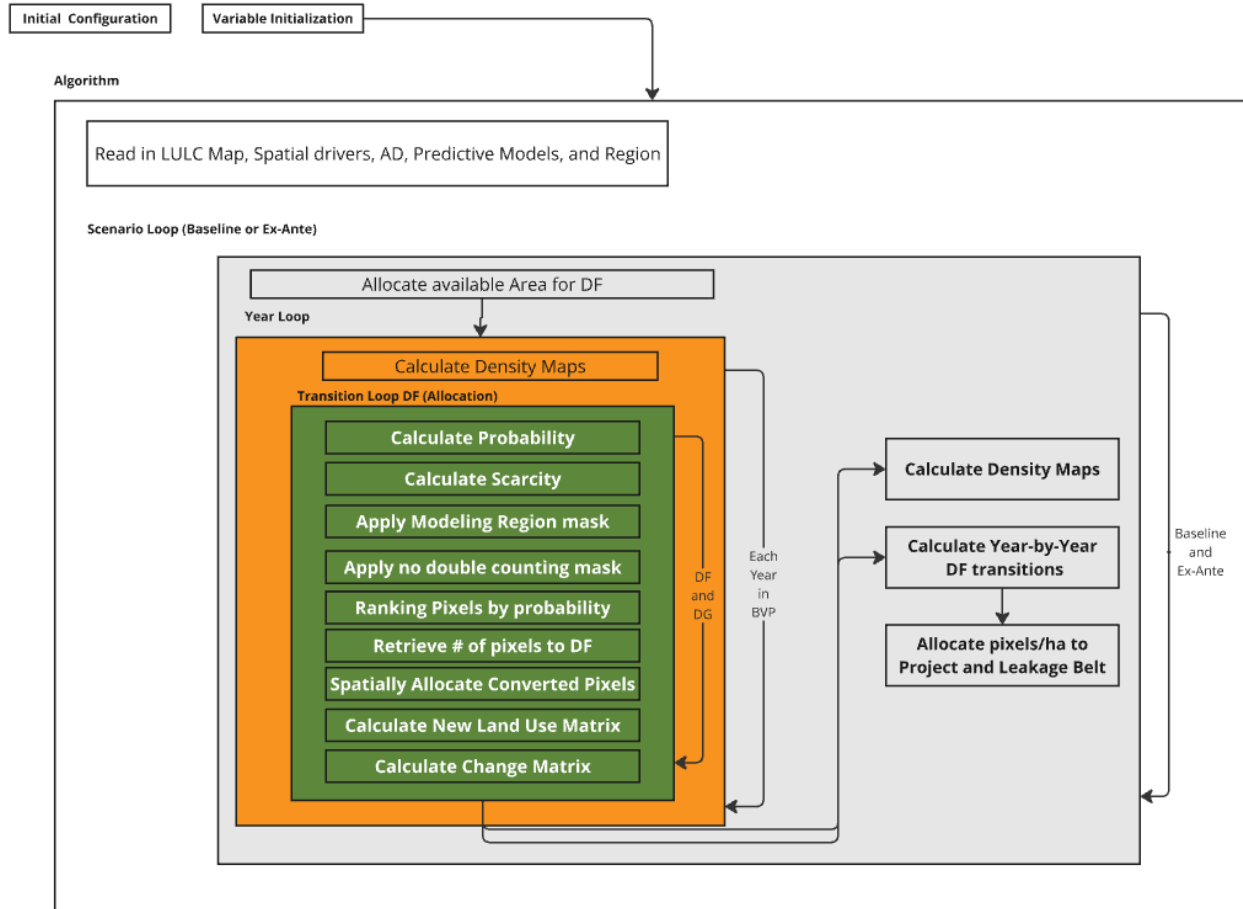
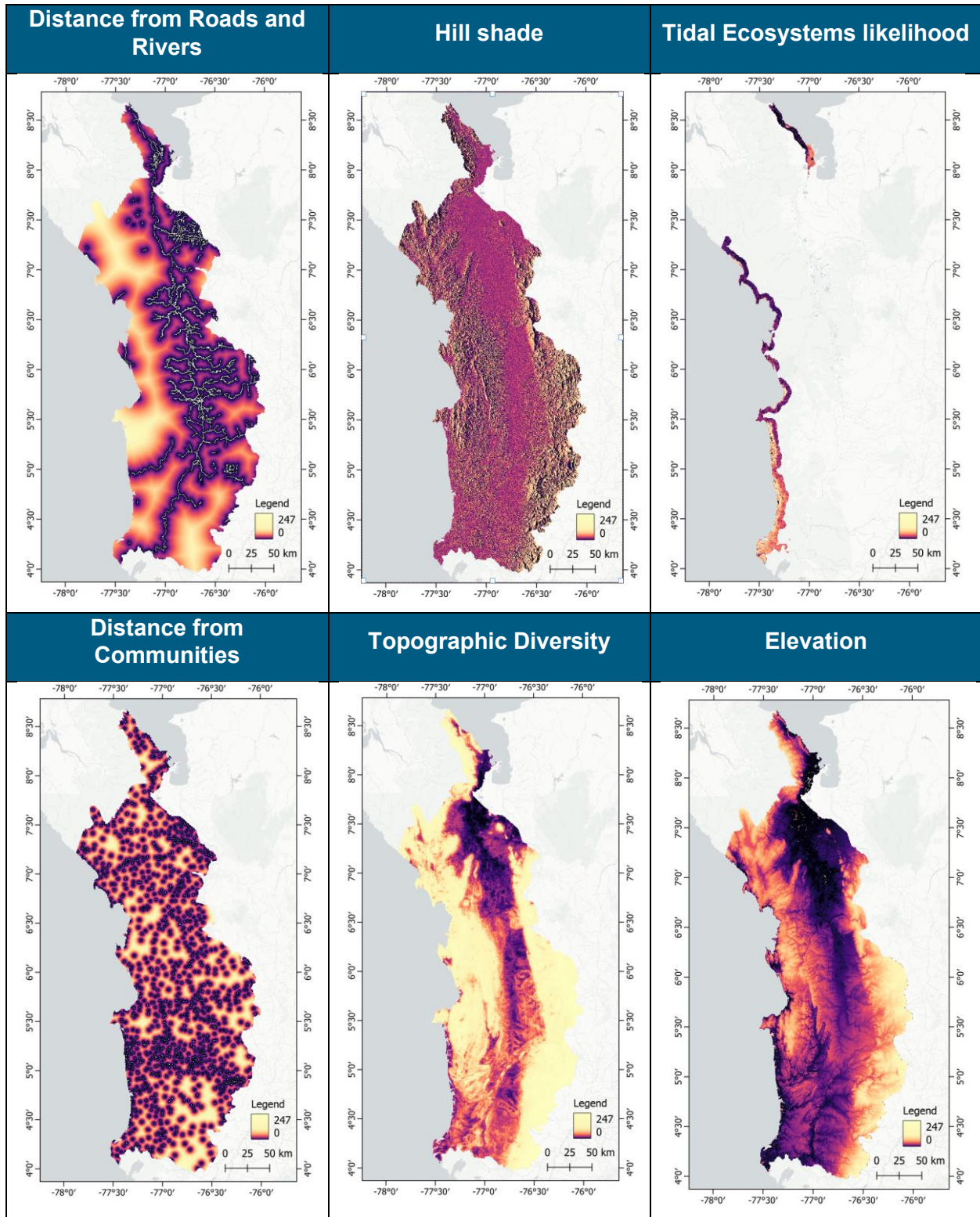


Figure 5. Application of TerraChange to generate DF risk maps used in the VERRA-UDef-ARP Tool

The TerraChange module and its two modeling components were trained using a stepwise feature selection process, which removed redundant or statistically insignificant variables. The feature selection drew from a suite of spatial variables identified as potential deforestation drivers, as described in Section 2.3.3. In addition, forest density and distance from forest edge were included as explanatory variables, given their relevance to the accessibility of forest resources and the likelihood of human encroachment.

A comprehensive list of all spatial driver variables used in model training is provided in Section 5.1.10 of the Appendix 1: Application of VT0007 Unplanned Deforestation Risk Mapping and Allocation (UDef-A)”, and their spatial distribution is illustrated in Map 9.



Map 9. Visual Representation of Spatial Drivers for Risk Modelling

2.5.4.3.2. Calculation of Risk Vulnerability Maps and Modeling Region Map

Risk maps were generated by integrating the TerraChange model with Verra’s UDef-ARP tool, following the methodology described in Section 5.4 of VT0007. Specifically, TerraChange was used to generate the Empirical Transition Potential (EVP) map, based on outputs from a logistic regression model calibrated with observed deforestation data.

The logistic regression model offers several advantages for generating risk maps in the context of deforestation modeling:

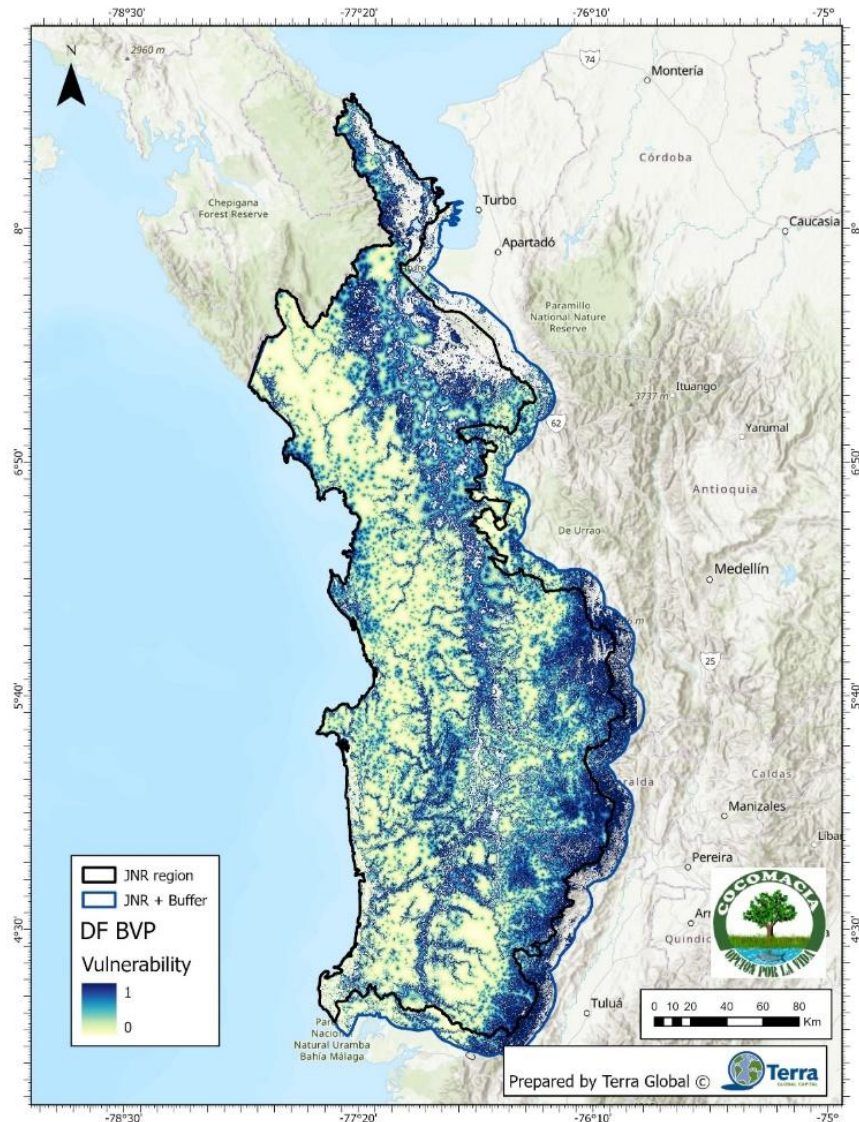
1. It provides the probability of deforestation at time  $t+1$  conditioned on the spatial and environmental state at time  $t$ ;
2. It yields interpretable parameters for each predictor variable, including measures of statistical significance, allowing for insight into the relative importance of different deforestation drivers;
3. It accommodates a mix of continuous and categorical variables, making it well suited for modeling complex land-use systems;
4. It assumes no temporal autocorrelation, which is particularly relevant for modeling independent deforestation events over time.

The assumption of temporal independence (Point 4) is especially important in the generation of EVP maps (see Map 10). It implies that the probability of a pixel being deforested at time  $t$  is not directly influenced by whether it was deforested at time  $t-1$ . This property enables a multiplicative framework to estimate cumulative deforestation probabilities over time.

For any EVP required by the tool, the cumulative probability of deforestation over a time interval was calculated using the complement of the "no-deforestation" probability at each time step. Specifically, the cumulative EVP from year  $t_0$  to year  $t$  is computed as:

$$P_{\text{deforestation}} = 1 - \prod_{i=t_0}^t (1 - P(\text{deforest}, i)) \tag{Equation 2}$$

Where  $P_{\text{deforestation}}$  is the modeled probability of deforestation at time step  $i$ . This approach provides a theoretically consistent and computationally efficient method to assess long-term deforestation risk under the VT0007 framework.

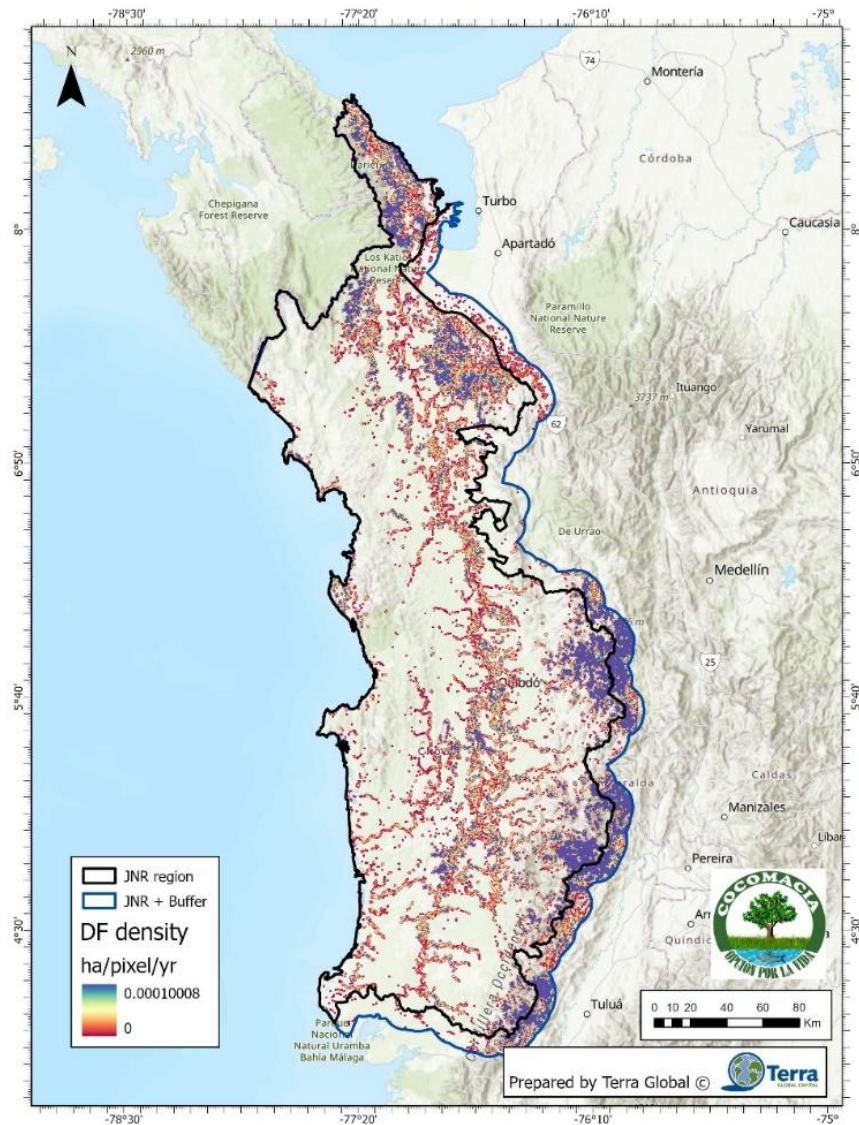


Map 10. Example of EVP and Vulnerability map for deforestation calculated from the cumulate probability from the beginning to the end of the Baseline Validity Period.

The TerraChange probability maps were used to identify, on a spatially and temporally explicit basis, the areas subject to unplanned deforestation (UDef) on a year-by-year basis. This output was then used to determine the allocation of activity densities across the jurisdiction.

Deforestation (DF) density maps were generated in accordance with the methodology outlined in Section 5.3.1.3 of VT0007, which specifies the use of relative frequencies of observed DF events. These frequencies were calculated by taking the mean value of binary pixel data within a defined neighborhood. Since pixel values are represented as either 0 (no event) or 1 (event occurred), the mean of these values within each convolution region provides the local frequency of deforestation.

Unlike the current default implementation in VT0007, where density is calculated at the level of broader modeling regions, in this application the density was calculated at the pixel level using a 1 km<sup>2</sup> convolution filter centered on each pixel. This approach yields a smoothed and spatially continuous density surface, providing a more realistic and spatially nuanced representation of the distribution of DF activity.



Map 11. Deforestation Density Map for the Baseline Validity Period.

#### 2.5.4.3.3. Comparison of the Alternative Model with the Benchmark Model

To assess model performance, the Median Absolute Error (MedAE) was used to compare the TerraChange model with the Benchmark model as defined in Section 5.3 of VT0007. MedAE measures the median of the absolute differences between predicted and observed values, with lower values indicating better predictive accuracy.

For the Chocó jurisdiction, the TerraChange model demonstrated a significantly better fit to the training data, achieving a MedAE of approximately 403.45, which corresponds to a reduction in error of approximately 6.7% relative to the Benchmark model, which recorded a MedAE of approximately 431.95.

The TerraChange model also outperformed the Benchmark on held-out (validation) data, achieving a MedAE of approximately 240.80, representing a 16% improvement compared to the Benchmark's MedAE of approximately 288.50. These results reflect an improved generalization of the TerraChange model to data outside the fitting period.

Across both training and validation datasets, the TerraChange model consistently delivered superior predictive performance for the Chocó Jurisdiction. In addition to its accuracy, TerraChange was also selected for further analysis due to its tendency to produce more conservative (lower-bound) estimates of deforestation, aligning with the requirements of Section 5.4 of VT0007. As such, the TerraChange model satisfied the necessary conditions for acceptance as an Alternative Model and was adopted for final baseline analysis.

2.5.4.3.4. Impact of Scarcity with Verra JNR Allocation Tool

The application of the scarcity factor reduces the modeled deforestation transitions during the baseline validity period, as described in the section above. Specifically, the scarcity factor was applied during the TerraChange run, which spans six years, and this had the effect of limiting the number of pixels transitioning to deforestation classes. As a result, a greater proportion of the area was allocated to Class 0 (no risk), reflecting lower transition potential. This adjustment leads to a more conservative Forest Reference Emission Level (FREL), as the application of the scarcity factor effectively reduces the projected baseline emissions.

2.5.4.4. Allocation of Projected Activity Data to PAs and LBs

Based off the LULC predicted maps for each year of the BVP, it was possible to record any pixel transitioned from any to any other LULC class for any sub-region of the JNR, including a 10km belt outside of the JNR. Thus, Allocation to the JNR non-excluded areas and Allocation of the JNR Leakage Area were achieved by counting year-by-year all pixel’s transitions within the target area. This produced a table of areas (in ha) transitioned from-to any allowable class pair for each year of the BVP.

Estimates of emissions were generated by assigning the emissions factor in t CO2e/ha to each forest strata for the jurisdiction. This map was then multiplied by the allocated risk (adjusted prediction density) map. The result is an expected emissions map in tCO2e/pixel.

2.5.4.4.1. Allocation of Projected DF only Activity Data to PAs and LBs using VT0007

Using the VT0007 tool, the vulnerability and modeling region maps presented in Appendix 1: Application of VT0007 Unplanned Deforestation Risk Mapping and Allocation (UDef-A) (Section 5.5.2) were applied to determine the historical annual baseline rates of deforestation for each modeling region, to be used during the baseline validity period.

In accordance with the guidance provided in VT0007 Section 5.3.2.2, the sum of the density maps was used to allocate the projected deforestation (DF) activity data across the areas of interest. The density map is a map where each pixel represents the expected area of deforestation (or degradation) in hectares, calculated by multiplying the predicted probability of deforestation for that pixel by the areal resolution of the imagery (e.g., 0.09 ha for 30 m resolution).

2.5.4.5. Estimation of Emissions from Carbon Stocks Changes

This section describes methods used for estimating emissions from unplanned deforestation (UDef) in the baseline for the Choco Department, Colombia Nested JNR FREL.

The data presented Table 12 below was utilized to estimate carbon stock densities for the forest strata within the Jurisdictional FREL Area.

Table 12. Selected Biomass and Emission Factors Data Sources

Data Source	Methodology	Application
Field Sample – Calibration plots within lidar transects	Stratified selected plots within lidar transects.	Plot-based measurements within the LULC class or forest stratum are employed for both calibrating and validating remote sensing sampling unit data, as well as for measuring carbon pools.
IPCC	Default values allowed by VCS	Root-to-shoot ratios for estimation of below-ground biomass.

Data Source	Methodology	Application
Locally developed allometric equations	To develop the allometric equations, trees from the Jurisdiction were selected and harvested, covering a variety of species, diameters, and height categories.	These equations were utilized to determine the above-ground biomass of the forest from field data, which were subsequently employed to calibrate and validate remote sensing estimates of forest biomass.
Remote sensing-based carbon estimates	Airborne lidar data random samples in forest strata and LULC classes.	Utilized to estimate above-ground forest biomass and to create models for extrapolating data to other carbon pools.
Literature based estimates	Existing data from literature on non-tree vegetation.	Applied to estimate the carbon pool in non-tree vegetation and litter.

Plot-based measurements were aggregated within the LULC class or forest stratum they belong. Since degradation was included, biomass inventory plots located in forest area were assigned the appropriate forest stratum using the forest stratification model developed in Section 2.5.5.1.6.

#### 2.5.4.5.1. Step 1. Estimation of Carbon Stocks per Forest Stratum

Carbon stocks in each of the carbon pools and sources selected for the Jurisdictional Boundary (section 2.4.1) are estimated using VCS modules.

Carbon stocks in above-ground and below-ground living biomass were estimated using module *VMD0001 Estimation of Carbon Stocks in the Above- and Belowground Biomass in Live Tree and Non-tree Pools (CP-AB)*. This module is designed for ex ante estimation of carbon stocks in above-ground and below-ground woody biomass of trees and non-trees.

##### *Aboveground Tree Biomass*

Plot-level aboveground tree-biomass carbon estimates informed calibration of the LiDAR model (Section 2.5.7.3.3); the field-plot estimation methods are described below.

This section focuses on estimating carbon stocks in above-ground tree biomass per unit area, based on field measurements. Fixed-area plots were used in conjunction with appropriate allometric equations to estimate biomass from measured tree dimensions, diameter at breast height (DBH), and total height.

$$C_{AB\_tree,sp,i} = \sum_j^S \sum_{l=1}^{N_{j,sp,i}} f_j(X, Y, \dots) * CF_j \tag{Equation 3}$$

Where:

$C_{AB\_tree,sp,i}$  = Carbon stock in aboveground biomass of trees in plot sp in stratum i; t C

$CF_j$  = Carbon fraction of biomass for species group j; t C t-1 d.m.

$f_j(X, Y, \dots)$  = Aboveground biomass of trees based on allometric equation for species group j based on measured tree variable(s); t. d.m. tree-1

$i$  = 1, 2, 3, ... M strata

$j$  = 1, 2, 3, ... S tree species

$l$  = 1, 2, 3, ...  $N_{j,sp,i}$  Sequence number of individual trees of species group j in sample plot sp in stratum i

To estimate the aboveground biomass of trees regionally appropriate or locally developed allometric equations were used (Table 13).

Table 13. Allometric equation for forest type/group of species. AGB: aboveground biomass. DBH: diameter at breast height. H> height. WD: wood density. DMF: dry mass fraction

Vegetation	Allometric equation	Source
Mangroves	$AGB = 0.0509 \times WD \times DBH^2 \times H$	(Chave et al., 2005)
Palms	$AGB = 0.334 \times (DBH^2 \times H \times DMF)^{0.803}$	(Duque, et al., 2017)
Tropical Wet	$Ln(AGB) = -2.857 + 2.081 \times Ln(DBH) + 0.587 \times Ln(H) + 0.453 \times Ln(WD)$	(Alvarez, et al., 2012)

To calculate the mean carbon stock in the aboveground biomass for each stratum, converted to carbon dioxide equivalents Equation 4 was used.

$$C_{AB\_tree,i} = \sum_{sp=1}^{P_i} \frac{C_{ABtree,sp,i}}{A_{sp,i}} * \frac{44}{12} \tag{Equation 4}$$

Where:

- $C_{AB\_tree,i}$  = Mean aboveground biomass carbon stock in stratum i; t CO2-e ha-1
- $C_{ABtree,sp,i}$  = Aboveground biomass carbon stock of trees in sample plot sp of stratum i, t C
- $A_{sp,i}$  = Area of sample plot sp in stratum i; ha
- $sp$  = 1, 2, 3 ...  $P_i$  sample plots in stratum i
- $i$  = 1, 2, 3, ...M strata
- $\frac{44}{12}$  = Ratio of molecular weight of CO2 to carbon, t CO2-e t C-1

**Belowground Tree Biomass**

Average carbon stocks in belowground tree biomass per unit area were estimated from field measurements obtained in fixed area plots. Root-to-shoot (R:S) ratios, derived from allometric methods commonly applied to estimate aboveground biomass, were used for this calculation. Differentiated R:S factors were applied: one specific for tropical forest species and another for mangrove species (Table 14).

Table 14. Root to Shoot Ratios

Species Group	Root to Shoot Ratio	Source
Tropical Forest	0.21	(Mosquera & Moreno, 2017)
Mangrove Forest	1.14	(Santos et al., 2017)

**Aboveground Non-Tree Biomass**

Aboveground Non-tree biomass was estimated from circular subplots of 1 m diameter established within each 50 x 50 m main plot. Seedlings and herbaceous species were recorded in these subplots. The biomass of the seedlings was determined by applying specific allometric equations, while for the herbaceous species, laboratory drying methods were used until constant weight. With this information, the total biomass per subplot was obtained. The equations used are presented below.

**Belowground Non-Tree Biomass**

Non-tree belowground biomass was estimated from non-tree aboveground biomass by applying the root-to-shoot used for Tropical Forest species except for mangrove species (0.21).

Carbon stocks in the Dead Wood Pool were estimated by using module VMD0002 Estimation of Carbon Stocks in the Dead Wood Pool (CP-D). This module is designed for ex ante estimation of carbon stocks in above-ground and below-ground woody biomass of trees and non-trees.

### Standing Dead Wood Biomass

Standing dead trees were measured using the same used for measuring live trees in the 50m x 50m plots. Two decomposition classes were used 1) Tree with branches and twigs that resembles a live tree (except for leaves) and 2) Tree with signs of decomposition (other than loss of leaves) including loss of twigs, branches, or crown.

For trees classified as decomposition class 1, the same allometric equation was applied as for live trees while for trees classified as decomposition class 2 Equation 5 was used.

$$B_{SWL,j,sp,i} = \frac{1}{3} \times \pi \times \left( \frac{DBH_{SDWL,sp,i}}{200} \right)^2 \times H_{SWL,sp,i} \times D_{DWdc} \quad \text{Equation 5}$$

Were:

$B_{SWL,j,sp,i}$	Biomass of standing dead tree l from sample plot/point sp in stratum i; t d.m.
$DBH_{SDWL,sp,i}$	Diameter at Breast Height of standing dead tree l from sample plot/point sp in stratum i; cm
$H_{SWL,sp,i}$	Height of standing dead tree l from sample plot/point sp in stratum i; m
$D_{DWdc}$	Mean wood density of dead wood in the density class (dc) – sound (1), and rotten (2); t d.m. m-3
$sp$	1, 2, 3, ... Pi sample plots/points in stratum i
$i$	1, 2, 3, ...M strata in the project scenario

Mean biomass stuck per unit area in standing dead wood for each stratum as calculated using the fixed area plot option provided in VMD0002.

### Lying Dead Wood Biomass

Lying dead wood was sampled using the line intersect method. Two 50-meter lines were established bisecting each sample plot and the diameters of the dead wood ( $\geq 5$  cm diameter) intersecting the lines were measured. Lying dead wood was assigned to one of the three density states (sound, intermediate and rotten) using the ‘machete test’, as recommended by IPCC Good Practice Guidance for LULUCF (2003), Section 4.3.3.5.3. The volume of lying dead wood per unit area was estimated using Equation 6.

$$V_{LDWi} = \frac{1 \times (\sum_{n=1}^N Dia_{dc,n,i}^2)}{8 \times L} \quad \text{Equation 6}$$

Where:

$V_{LDWi}$	Volume of lying dead wood per unit area in density class dc in stratum i; m3 ha-1
$Dia_{dc,n,i}$	Diameter of piece n of dead wood along the transect in stratum i; cm
$n$	1, 2, 3, ... N sequence number of wood pieces in density class dc intersecting the transect
$L$	Length of the transect
$dc$	Dead wood density class – sound (1), intermediate (2), and rotten (3); dimensionless
$i$	1, 2, 3, ...M strata in the project scenario

Volume of lying dead wood was converted into biomass using the following Equation 7

$$B_{LDWi} = \sum_{dc=1}^3 V_{LDWdc,i} \times D_{DWdc} \quad \text{Equation 7}$$

Finally, mean carbon stock in dead wood for each stratum was calculated as the sum of standing and lying dead wood components, converted to carbon dioxide equivalents.

### Litter Biomass

To estimate the carbon stock in litter pool module VMD0003 Estimation of Carbon Stocks in the Litter Pool (CP-L) was used.

Mean carbon stock per unit area in litter for each project area stratum was calculated using Equation 8.

$$C_{LI,i} = \frac{10}{A_{sp,i}} \times \sum_{sp=1}^{Pi} B_{LI,sp,i} \times CF \times \frac{44}{12} \quad \text{Equation 8}$$

Where:

$C_{LI,i}$	Mean carbon stock in litter for stratum i; t CO <sub>2</sub> -e ha <sup>-1</sup>
$B_{LI,sp,i}$	Biomass of litter in sample plot sp in stratum i; kg d.m.
$CF$	Carbon fraction; t C t <sup>-1</sup> d.m.
$A_{sp,i}$	Total area of all sample plots in stratum i; m <sup>2</sup>
$sp$	1, 2, 3, ... P <sub>i</sub> sample plots in stratum i
$i$	1, 2, 3, ... M strata
$\frac{44}{12}$	Ratio of molecular weight of CO <sub>2</sub> to carbon, t CO <sub>2</sub> -e t C <sup>-1</sup>

### Soil Organic Carbon

Measurements of initial stocks employed in the baseline were taken in 3 randomized location within the 50m x 50m sample plots. For estimation of carbon stocks in soil organic carbon in the baseline (for both pre- and post-deforestation stocks) module VMD0004 Estimation of Carbon Stocks in the Soil Organic Carbon Pool (CP-S) was used.

To estimate the carbon stock in soil organic carbon per unit area for sample plot sp, stratum i

$$C_{SOC,sp,i} = C_{SOCsample,sp,i} \times BD_{sample,sp,i} \times Dep_{sample,sp,i} \times 100 \times CoarseFragment \quad \text{Equation 9}$$

Where:

$C_{SOC,sp,i}$	Carbon stock in soil organic carbon for sample plot sp, stratum i; t C ha <sup>-1</sup>
$C_{SOCsample,sp,i}$	Soil organic carbon of the sample in sample plot sp, stratum i; determined in the laboratory in g C/100 g soil (fine fraction <2mm).
$BD_{sample,sp,i}$	Bulk density of fine (<2 mm) fraction of mineral soil in sample plot sp, stratum i; determined in the laboratory in g fine fraction cm <sup>-3</sup> total sample volume
$Dep_{sample,sp,i}$	Depth to which soil sample is collected in sample plot sp in stratum i; cm
$CoarseFragment$	Portion of a soil layer made up of particles >2 mm (gravel, cobbles, stones, boulders) (%) (methodological deviation described in section 2.5.2).
$sp$	1, 2, 3, ... P <sub>i</sub> sample plots in stratum i
$i$	1, 2, 3, ... M strata

To estimate the mean carbon stock in soil organic carbon, converted to carbon dioxide equivalents, per unit area for stratum *i* carbon stocks in each subplot were averaged.

#### 2.5.4.5.2. Step 2. Estimation of Emissions from Carbon Stock Changes

Stock changes in each carbon pool were calculated by subtracting the post-deforestation carbon stocks from forest carbon stocks. The stock changes were calculated for each pool in each forest stratum using Equation 10.

$$\Delta C_{p,i} = C_{p,i} - C_{p,post,i} \quad \text{Equation 10}$$

Where:

$\Delta C_{p,i}$	Estimated emissions from carbon stock change in pool <i>p</i> in forest stratum <i>i</i> (t CO2e/ha)
$C_{p,i}$	Estimated carbon stock in pool <i>p</i> of forest stratum <i>i</i> (t CO2e/ha)
$C_{p,post,i}$	Estimated carbon stock in post-deforestation pool <i>p</i> in forest stratum <i>i</i> (t CO2e/ha)
<i>p</i>	Carbon pool: aboveground tree biomass (AB_tree), aboveground non-tree biomass (AB_nontree), belowground tree biomass (BB_tree), belowground non-tree biomass (BB_nontree), dead wood (DW), litter (LI) and soil organic carbon (SOC)
<i>i</i>	1, 2, 3, ..., M forest stratum

#### 2.5.4.5.3. Step 3. Evaluation of Uncertainty of Carbon Stock Estimates

To evaluate uncertainty, the standard error of each estimate was calculated. The uncertainty of this estimate is evaluated in terms of the half-width of its two-sided 90 percent confidence interval. The percentage uncertainty is the uncertainty expressed as a percentage of the estimate.

Error propagation was used to track uncertainty through the various calculation steps involved in estimating carbon stocks. The uncertainty of the estimated emissions from stock change in each carbon pool and stratum was calculated using the error propagation as follows:

$$U(\Delta C_{p,i}) = U(C_{p,i} - C_{p,post,i}) = \sqrt{U(C_{p,i})^2 + U(C_{p,post,i})^2} \quad \text{Equation 11}$$

Where:

<i>U()</i>	Uncertainty as half-width of the two-sided 90 percent confidence interval (t CO2e/ha)
$\Delta C_{p,i}$	Estimated emissions from carbon stock change in pool <i>p</i> of forest stratum <i>i</i> (t CO2e/ha)
$C_{p,i}$	Estimated carbon stock in pool <i>p</i> of forest stratum <i>i</i> (t CO2e/ha)
$C_{p,post,i}$	Estimated carbon stock in post-deforestation pool <i>p</i> in forest stratum <i>i</i> (t CO2e/ha)
<i>p</i>	Carbon pool: aboveground tree biomass (AB_tree), aboveground non-tree biomass (AB_nontree), belowground tree biomass (BB_tree), belowground non-tree biomass (BB_nontree), dead wood (DW), litter (LI) and soil organic carbon (SOC)
<i>i</i>	1, 2, 3, ..., M forest stratum

#### 2.5.4.5.4. Step 4. Estimation of an Uncertainty Discount Factor

To establish the uncertainty discount factor, first stock changes were averaged over forest strata and carbon pools. The stock changes were averaged over the area of UDef AD within each forest stratum over the baseline period for each pool separately, using an area-weighted average. The stock changes are calculated as follows:

$$W\Delta C_p = \frac{\sum_{i=1}^M AD_{BSL,PA-UDef,i,t} \times \Delta C_{p,i}}{\sum_{i=1}^M AD_{BSL,PA-UDef,i,t}} \quad \text{Equation 12}$$

Where:

$W\Delta C_p$	UDef AD baseline weighted average emissions from carbon stock change in pool p (t CO2e/ha)
$AD_{BSL,PA-UDef,i,t}$	UDef AD in the baseline scenario allocated to forest stratum i in the UDef PA for year t (ha)
$\Delta C_{p,i}$	Estimated emissions from carbon stock change in pool p in forest stratum i (t CO2e/ha)
$p$	Carbon pool: aboveground tree biomass (AB_tree), aboveground non-tree biomass (AB_nontree), belowground tree biomass (BB_tree), belowground non-tree biomass (BB_nontree), dead wood (DW), litter (LI) and soil organic carbon (SOC)
$i$	1, 2, 3, ..., M forest stratum
$t$	1, 2, 3, ..., t* years elapsed since the start of the project

The UDef AD baseline weighted stock changes were then summed across all relevant carbon pools. To establish the discount factor, this was undertaken for all pools together, although soil organic carbon is kept separate when emission factors are applied to AD (Equation 13).

$$W\Delta C = W\Delta C_{ABtree} + W\Delta C_{BBtree} + W\Delta C_{ABnontree} + W\Delta C_{BBnontree} + W\Delta C_{DW} + W\Delta C_{LI} + W\Delta C_{SOC} \quad \text{Equation 13}$$

Where:

$W\Delta C$	Overall UDef AD baseline weighted average emissions from carbon stock changes (t CO2e/ha)
$W\Delta C_{ABtree}$	UDef AD baseline weighted average emissions from carbon stock change in the aboveground tree biomass pool (t CO2e/ha)
$W\Delta C_{BBtree}$	UDef AD baseline weighted average emissions from carbon stock change in the belowground tree biomass pool (t CO2e/ha)
$\Delta C_{ABnontree}$	UDef AD baseline weighted average emissions from carbon stock change in the aboveground non-tree woody biomass pool (t CO2e/ha)
$W\Delta C_{BBnontree}$	UDef AD baseline weighted average emissions from carbon stock change in the belowground non-tree woody biomass pool (t CO2e/ha)
$W\Delta C_{DW}$	UDef AD baseline weighted average emissions from carbon stock change in the dead wood pool (t CO2e/ha)
$W\Delta C_{LI}$	UDef AD baseline weighted average emissions from carbon stock change in the litter pool (t CO2e/ha)
$W\Delta C_{SOC}$	UDef AD baseline weighted average emissions from carbon stock change in the soil organic carbon pool (t CO2e/ha)

Uncertainty was propagated accordingly. In doing this, the AD area values were considered as simple multiplication factors with no uncertainty (Equation 14).

$$U(W\Delta C_p) = \frac{\sqrt{\sum_{i=1}^M (AD_{BSL,PA-UDef,i,t} \times U(\Delta C_{p,i}))^2}}{\sum_{i=1}^M AD_{BSL,PA-UDef,i,t}} \quad \text{Equation 14}$$

Where

- $U()$  = Overall UDef AD baseline weighted average emissions from carbon stock changes (t CO2e/ha)
- $W\Delta C_p$  = UDef AD baseline weighted average emissions from carbon stock change in the aboveground tree biomass pool (t CO2e/ha)
- $AD_{BSL,PA-UDef,i,t}$  = UDef AD baseline weighted average emissions from carbon stock change in the belowground tree biomass pool (t CO2e/ha)
- $C_{p,i}$  = UDef AD baseline weighted average emissions from carbon stock change in the aboveground non-tree woody biomass pool (t CO2e/ha)  
Pool: aboveground tree biomass (AB\_tree), aboveground non-tree biomass
- $p$  = (AB\_nontree), belowground tree biomass (BB\_tree), belowground non-tree biomass (BB\_nontree), dead wood (DW), litter (LI) and soil organic carbon (SOC)
- $i$  = 1, 2, 3, ..., M forest stratum
- $t$  = 1, 2, 3, ..., t\* years elapsed since the start of the project

Further, uncertainty was propagated using Equation 15 and Equation 16.

$$U(W\Delta C) = \sqrt{\frac{U(W\Delta C_{ABtree})^2 + U(W\Delta C_{BBtree})^2 + U(W\Delta C_{ABnontree})^2 + U(W\Delta C_{BBnontree})^2 + U(W\Delta C_{DW})^2 + U(W\Delta C_{LI})^2 + U(W\Delta C_{SOC})^2 + U(WC_{WP})^2 + U(WC_{WP100})^2}{}}$$

Equation 15

$$U\%(W\Delta C) = 100 \times \frac{U(W\Delta C)}{W\Delta C} \quad \text{Equation 16}$$

Where

- $U()$  = Uncertainty as half-width of the two-sided 90 percent confidence interval (t CO2e/ha)
- $U\%()$  = Percentage uncertainty (i.e., uncertainty expressed as a percentage of the estimate) (%)
- $W\Delta C$  = Overall UDef AD baseline weighted average emissions from carbon stock changes (t CO2e/ha)
- $W\Delta C_{ABtree}$  = UDef AD baseline weighted average emissions from carbon stock change in the aboveground tree biomass pool (t CO2e/ha)
- $W\Delta C_{BBtree}$  = UDef AD baseline weighted average emissions from carbon stock change in the belowground tree biomass pool (t CO2e/ha)
- $W\Delta C_{ABnontree}$  = UDef AD baseline weighted average emissions from carbon stock change in the aboveground non-tree woody biomass pool (t CO2e/ha)
- $W\Delta C_{BBnontree}$  = UDef AD baseline weighted average emissions from carbon stock change in the belowground non-tree woody biomass pool (t CO2e/ha)

belowground non-tree woody biomass pool (t CO<sub>2</sub>e/ha)  
 $W\Delta C_{DW}$  = UDef AD baseline weighted average emissions from carbon stock change in the dead wood pool (t CO<sub>2</sub>e/ha)  
 $W\Delta C_{LI}$  = UDef AD baseline weighted average emissions from carbon stock change in the litter pool (t CO<sub>2</sub>e/ha)  
 $W\Delta C_{SOC}$  = UDef AD baseline weighted average emissions from carbon stock change in the soil organic carbon pool (t CO<sub>2</sub>e/ha)

Finally, the discount factor for emissions from carbon stock change,  $DF_{W\Delta C}$ , is calculated based on the resulting uncertainty of the baseline UDef AD weighted average carbon stock change,  $U\%(W\Delta C)$ . The discount factor is calculated using Equation 17 or Equation 18.

$$\text{If } U\%(W\Delta C) \leq 10\% \text{ then } DF_{W\Delta C} = 0 \quad \text{Equation 17}$$

$$\text{If } U\%(W\Delta C) > 10\% \text{ then } DF_{W\Delta C} = \frac{U\%(W\Delta C) + t_{\alpha=66.67\%}}{100 \times t_{\alpha=10\%}} \quad \text{Equation 18}$$

Where

$DF_{W\Delta C}$  = Uncertainty discount factor for stock changes  
 $U\%(W\Delta C)$  = Percentage uncertainty in emissions from carbon stock change (%)  
 $t_{\alpha=10\%}$  = Value of the t distribution for a two-sided 90 percent confidence interval  
 $t_{\alpha=66.67\%}$  = Value of the t distribution for a one-sided 66.67 percent confidence interval

#### 2.5.4.5.5. Step 5. Conservative Estimation of Emissions from Carbon Stock Change

Conservative estimates of the emissions from carbon stock change in the UDef JNR Area were calculated by summing over the carbon stock pools and applying the discount factor. This adjustment was done separately for each carbon pool following Equation 19, Equation 20 and Equation 21.

$$\Delta C_{AB-LI,i} = (\Delta C_{ABtree,i} + \Delta C_{ABnontree,i} + \Delta C_{LI,i}) \times (1 - DF_{W\Delta C}) \quad \text{Equation 19}$$

Where:

$\Delta C_{AB-LI,i}$  Conservatively estimated emissions from carbon stock change in the UDef JNR Area in aboveground biomass and litter pools in forest stratum i (t CO<sub>2</sub>e/ha)  
 $\Delta C_{ABtree,i}$  Emissions from carbon stock change in the aboveground tree biomass pool in forest stratum i (t CO<sub>2</sub>e/ha)  
 $\Delta C_{ABnontree,i}$  Emissions from carbon stock change in the aboveground non-tree woody biomass pool in stratum i (t CO<sub>2</sub>e/ha)  
 $\Delta C_{LI,i}$  Emissions from carbon stock change in the litter pool in forest stratum i (t CO<sub>2</sub>e/ha)  
 $DF_{W\Delta C}$  Uncertainty discount factor for stock changes  
*i* 1, 2, 3, ..., M forest stratum

$$\Delta C_{BB-DW,i} = (\Delta C_{BBtree,i} + \Delta C_{BBnontree,i} + \Delta C_{DW,i}) \times (1 - DF_{W\Delta C}) \quad \text{Equation 20}$$

Where:

$\Delta C_{BB-DW,i}$	Conservatively estimated emissions from carbon stock change over a 10-year period in the UDef JNR Area in belowground biomass and dead wood pools in forest stratum <i>i</i> (t CO <sub>2</sub> e/ha)
$\Delta C_{BBtree,i}$	Emissions from carbon stock change in the belowground tree biomass pool in forest stratum <i>i</i> (t CO <sub>2</sub> e/ha)
$\Delta C_{BBnontree,i}$	Emissions from carbon stock change in the belowground non-tree biomass pool in forest stratum <i>i</i> (t CO <sub>2</sub> e/ha)
$\Delta C_{DW,i}$	Emissions from carbon stock change in the dead wood pool in forest stratum <i>i</i> (t CO <sub>2</sub> e/ha)
$DF_{W\Delta C}$	Uncertainty discount factor for stock changes
<i>i</i>	1, 2, 3, ..., M forest stratum

$$\Delta C_{SOC,i} = \Delta C_{SOC,i} \times (1 - DF_{W\Delta C}) \quad \text{Equation 21}$$

Where:

$\Delta C_{SOC,i}$	Conservatively estimated emissions from carbon stock change over a 20-year period in the UDef JNR Area in the soil organic carbon pool in forest stratum <i>i</i> (t CO <sub>2</sub> e/ha)
$\Delta C_{SOC,i}$	Emissions from carbon stock change in the soil organic carbon pool in forest stratum <i>i</i> (t CO <sub>2</sub> e/ha)
$DF_{W\Delta C}$	Uncertainty discount factor for stock changes
<i>i</i>	1, 2, 3, ..., M forest stratum

#### 2.5.4.5.6. Step 6: Estimation of Annual Baseline Emissions from Carbon Stock Changes

The sum of emissions projected to take place in the UDef JNR Area are estimated using the area of AD and the emissions from the carbon stock changes resulting from unplanned deforestation. Stock changes in the aboveground and litter carbon pools are assumed to be emitted at the time of land use transition. Following the land use transition, emissions from the belowground, dead wood and soil organic carbon pools are assumed to take place gradually over time; those from the belowground biomass and dead wood pools at an annual rate of 1/10 of the stock change, and those from soil organic carbon at an annual rate of 1/20 of the stock change (Equation 22).

$$\begin{aligned} \Delta C_{BSL,JNR-UDef,i,t} = & (AD_{BSL,JNR-UDef,i,t} \times \Delta C_{AB-LI,i}) \\ & + \sum_{t-10}^t (AD_{BSL,JNR-UDef,i,t}) \times \frac{\Delta C_{BB-DW,i}}{10} \\ & + \sum_{t-20}^t (AD_{BSL,JNR-UDef,i,t}) \times \frac{\Delta C_{SOC,i}}{20} \end{aligned} \quad \text{Equation 22}$$

Where:

$\Delta C_{BSL,JNR-UDef,i,t}$	Total emissions from the baseline carbon stock change in all carbon pools in forest stratum <i>i</i> within the UDef JNR Area in year <i>t</i> (t CO <sub>2</sub> e)
$AD_{BSL,JNR-UDef,i,t}$	UDef AD in the baseline scenario allocated to forest stratum <i>i</i> in the UDef JNR Area for year <i>t</i> (ha)

$\Delta C_{AB-LI,i}$	Conservatively estimated emissions from carbon stock change in the UDef JNR Area in aboveground biomass and litter pools in forest stratum $i$ (t CO <sub>2</sub> e/ha)
$\Delta C_{BB-DW,i}$	Conservatively estimated emissions from carbon stock change over a 10- year period in the UDef JNR Area in belowground biomass and dead wood pools in forest stratum $i$ (t CO <sub>2</sub> e/ha)
$\Delta C_{SOC,i}$	Conservatively estimated emissions from carbon stock change over a 20- year period in the UDef JNR Area in the soil organic carbon pool in forest stratum $i$ (t CO <sub>2</sub> e/ha)
$i$	1, 2, 3, ..., M forest stratum
$t$	1, 2, 3, ..., $t^*$ years elapsed since the start of the project

### 2.5.4.6. Leakage

The procedures for estimating leakage under the jurisdictional FREL are based on a coordinated set of data inputs and methodological steps that must be implemented jointly by the Jurisdictional Proponent and the nested projects. Next, a description of the methodology and roles is presented.

#### 2.5.4.6.1. Activity Shifting by Geographically Constrained Agents

In accordance with the requirements outlined in VMD0055 (A2.1 Step 1), the spatial extent of each project’s Unplanned Deforestation Leakage Belt (UDef LB) must be delineated using a standardized methodology. This section outlines the approach that will be used to generate these boundaries and describes the planned development of a custom geospatial tool to automate and ensure consistent application of the delineation rules.

##### *Methodological Approach*

Each project’s UDef LB will be delineated as the area of forest, as shown on the jurisdictional Forest Cover Benchmark Map (FCBM), located within a 10 km buffer surrounding the boundary of the UDef Protected Area (PA). This buffer will serve as the starting point for the delineation process, with the following mandatory exclusions applied:

- **National Boundary Exclusion:** Any portion of the buffer that falls outside the national boundary will be excluded from the UDef LB.
- **Identified Exclusions:** Areas explicitly designated for exclusion, as defined under Section A1.4.1 Step 1, will also be removed from the buffer.

Following the application of these exclusions, the forest area within the resulting buffer will be compared to the forested area of the UDef PA at the project start date. If the forest area in the UDef LB exceeds that of the UDef PA, the buffer width will be reduced iteratively until the total forest area in the UDef LB is equal to the UDef PA forest extent. A minimum buffer width of 2 km will be maintained in all cases, even if this results in a UDef LB forest area that slightly exceeds the target.

##### *Treatment of Disjoint Project Areas*

Where a project includes non-contiguous forest patches or consists of multiple project activity instances (e.g., grouped projects), each discrete patch will be treated as an individual Protected Area segment (PA segment) for the purpose of UDef LB delineation. To reduce fragmentation:

- PA segments whose boundaries are separated by no more than 4 kilometers will be grouped into a single PA segment before generating the buffer.
- The UDef LB buffer will then be applied to the combined forest area of the grouped segment, and the buffer width adjusted accordingly.

This approach allows for appropriate delineation of leakage belts around fragmented or multi-part projects while ensuring that leakage risk is assessed proportionally.

### *Exclusion of Overlapping Project Areas*

As specified in Section 5.1.3 of the methodology, the final UDef LB must account for spatial overlaps with other registered and active VCS AFOLU projects:

- Any part of the UDef LB that overlaps with another project's PA or LB will be excluded from the delineation.
- This ensures that leakage areas are not double-counted and that spatial boundaries remain distinct across the jurisdiction.

### *Tool Development for UDef LB Delineation*

To support this process, we will develop a dedicated geospatial tool to automate the delineation of UDef LBs according to the VMD0055 methodology. The tool will incorporate the following features:

- Integration with the jurisdictional FCBM, national boundary datasets, and the UDef PA shapefiles;
- Automated generation of variable-width buffers around PA segments, including logic to reduce the buffer where forest area thresholds are exceeded;
- Functionality to group adjacent PA segments based on spatial proximity ( $\leq 4$  km);
- Application of identified exclusions and overlap filtering with existing VCS AFOLU projects;
- Export of the final UDef LB as standard geospatial files (e.g., shapefile, GeoJSON) along with metadata and area calculations.

This tool will ensure that the delineation process is transparent, replicable, and compliant with all applicable rules. It will also streamline the workflow for current and future projects, enabling efficient and consistent implementation across the jurisdiction.

#### *2.5.4.6.2. Activity Shifting by Geographically Mobile Agents*

The definition of the jurisdictional emission factor for areas outside the UDef LB subject to deforestation from activity shifting by geographically mobile agents is a responsibility of the Jurisdictional Proponent. Procedure to define this emission factor is described next.

In accordance with Appendix 2 of module VMD0055, emissions from deforestation outside UDef LB are estimated using a single emission factor that encompasses all land available for conversion to agricultural use within the national extent. This emission factor is approximated using the area-weighted carbon stocks of all land within the national extent.

The steps for this estimate are as follows:

#### *Step 1: Spatially Delineate Land Available for Activity Shifting Outside the UDef PA and UDef LB*

In accordance with the requirements of VMD0055 (Module A2.1, Step 1), a spatial analysis was conducted to delineate land within the jurisdiction of the Chocó that is available for activity shifting by geographically mobile actors. This analysis considered land located outside the boundaries of the UDef Protected Areas (PAs) and UDef Leakage Belts (LBs) were not considered because they are not available in the Registry, and were based on three core factors:

1. Suitability of land for agriculture
2. Physical accessibility
3. Relative protection status

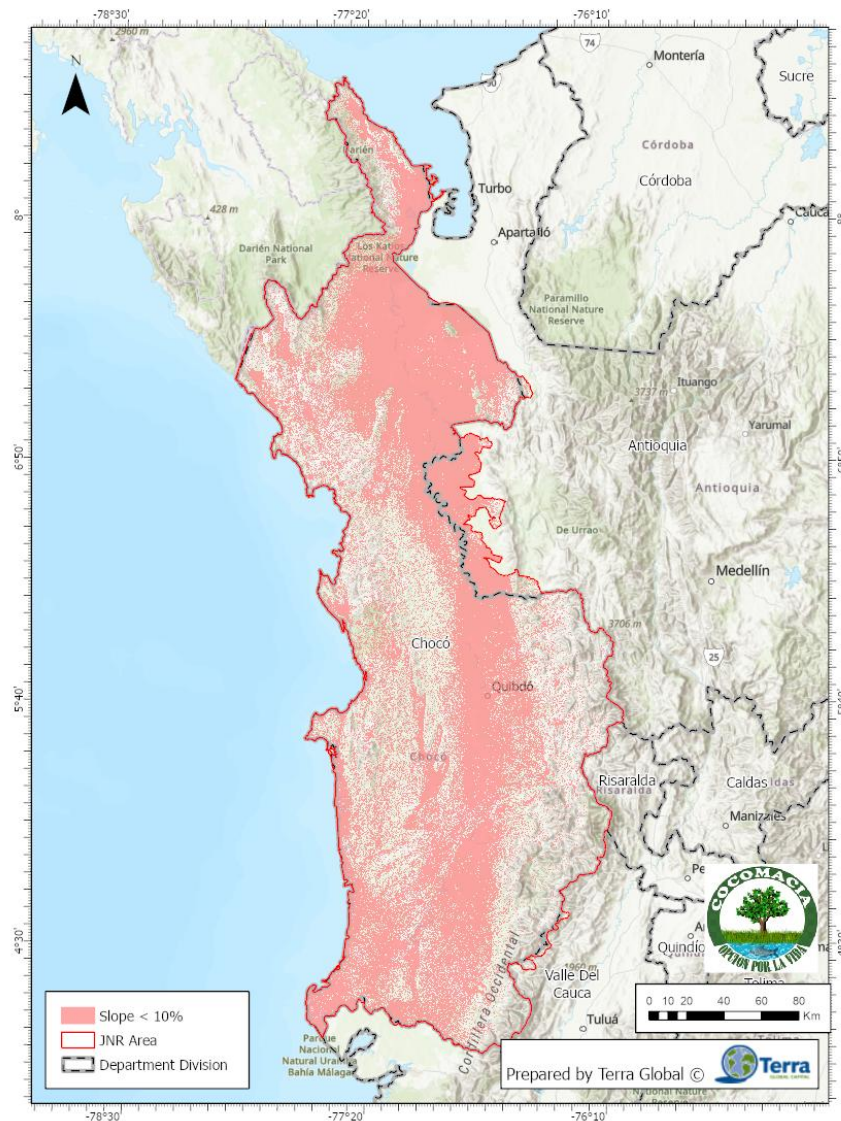
Each factor was mapped using jurisdiction-specific data sources, and the three resulting layers were integrated to produce a final classification of land as either available or unavailable for activity shifting

*Suitability of Land for Agriculture*

Based on peer-reviewed cartographic sources and accuracy assessments, potentially arable land was identified, excluding areas currently under agriculture. All tropical forests were considered arable, except those with slopes greater than 10% or located on serpentine or flood-prone soils. The result was a digital map classifying each pixel as “potentially arable” or “non-arable.”

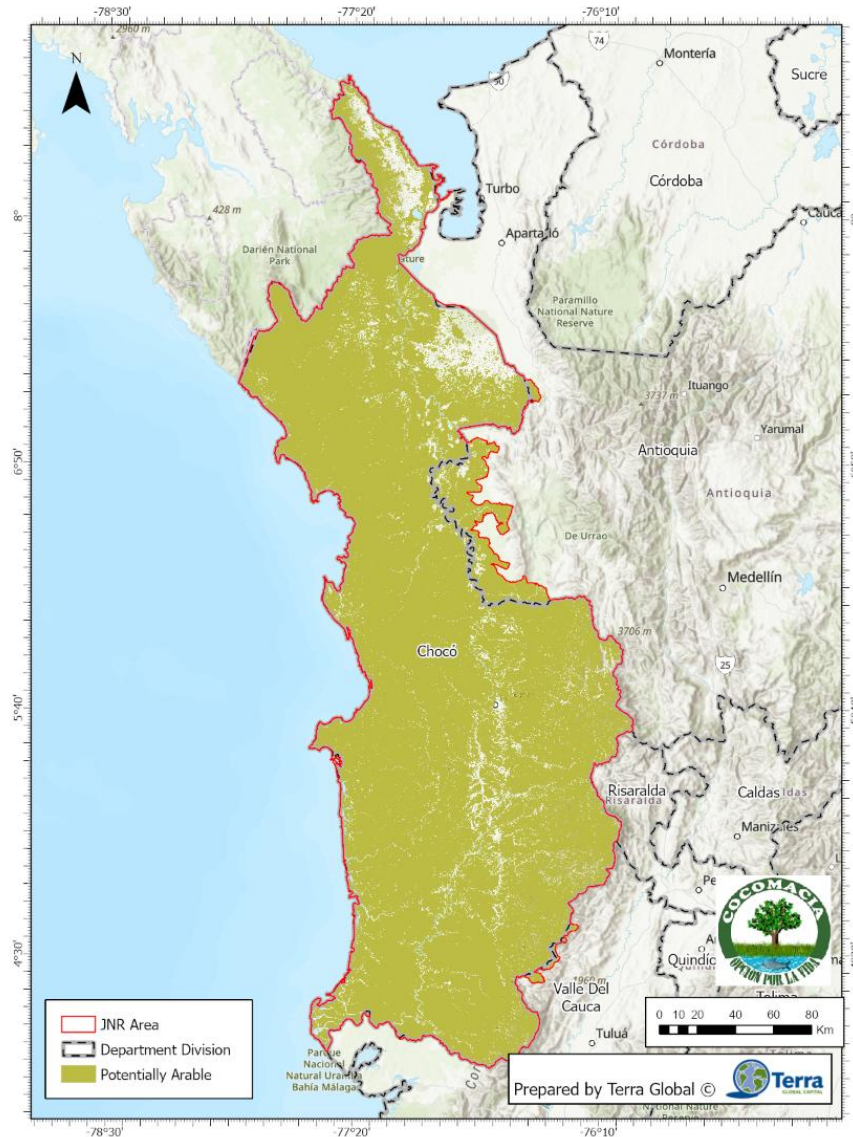
Potentially arable land was identified using a locally developed land cover classification for the Chocó region, created at the end of the historical reference period. All areas classified as actively managed agricultural lands were excluded from this assessment.

- **Forested Lands:** All natural forests were considered potentially arable except:
  - Areas with slopes greater than 10%, identified using a high-resolution Digital Elevation Model (DEM) (Map 12),



Map 12. Slope < 10% in the JNR FREL Area

- **Non-Forest Natural Vegetation:** Grasslands, savannas, shrublands, bushlands, and wetlands were assessed for suitability using climatic thresholds (Map 13).



Map 13. Potential Arable Land in the JNR FREL Area

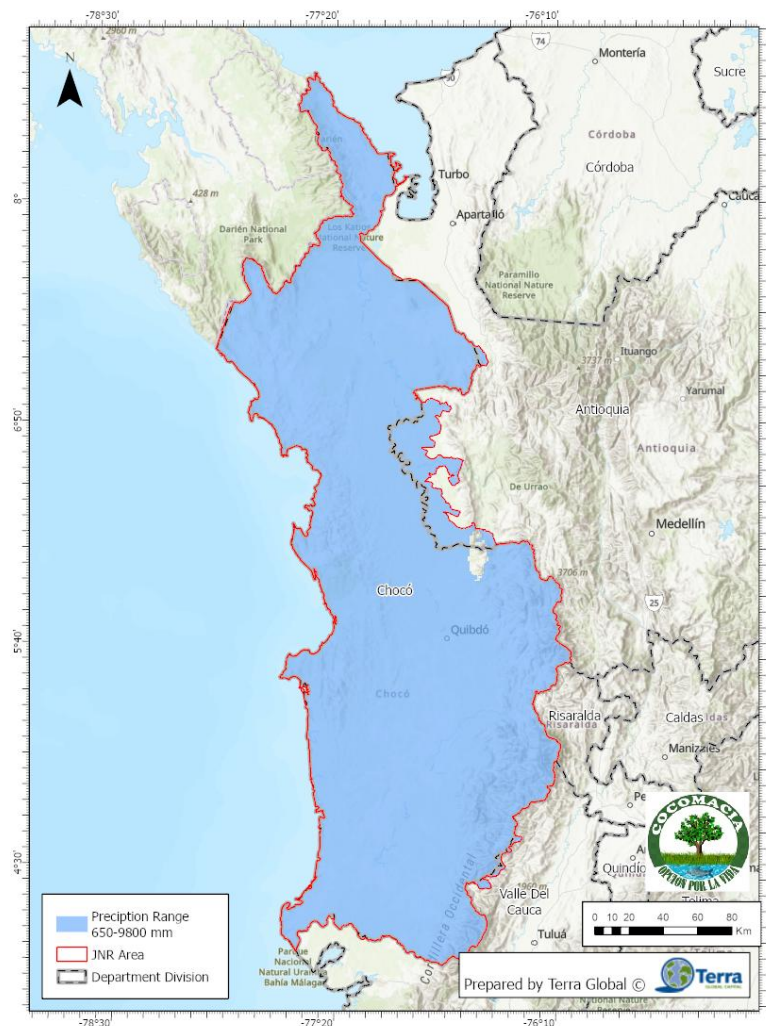
- Precipitation Criteria:** Mean annual precipitation values were extracted from the OpenLandMap Precipitation dataset. Based on the requirements of locally relevant crops, areas receiving less than 650 mm or more than 9800 mm annually were considered unsuitable for rain-fed agriculture (Map 14). The precipitation ranges for representative crops (DANE, Encuesta Nacional Agropecuaria - ENA - Departamento del Chocó, 2020) are summarized below:

Table 15. Choco Jurisdiction Representative Crops and Precipitation Range

Crop	Suitable Precipitation Range (mm/year)
Cacao <sup>1</sup>	1500–3800

<sup>1</sup> <https://www.mundocacao.com.co/condiciones-agroclimaticas/c/0/i/66474843/precipitacion>

Crop	Suitable Precipitation Range (mm/year)
Sugar cane <sup>2</sup>	1500–1750
Avocado <sup>3</sup>	650–1500
Banana <sup>4</sup>	1200–2314
Coffee <sup>5</sup>	1500–1800



Map 14. Precipitation Range 650-9800 mm in the JNR FREL Area

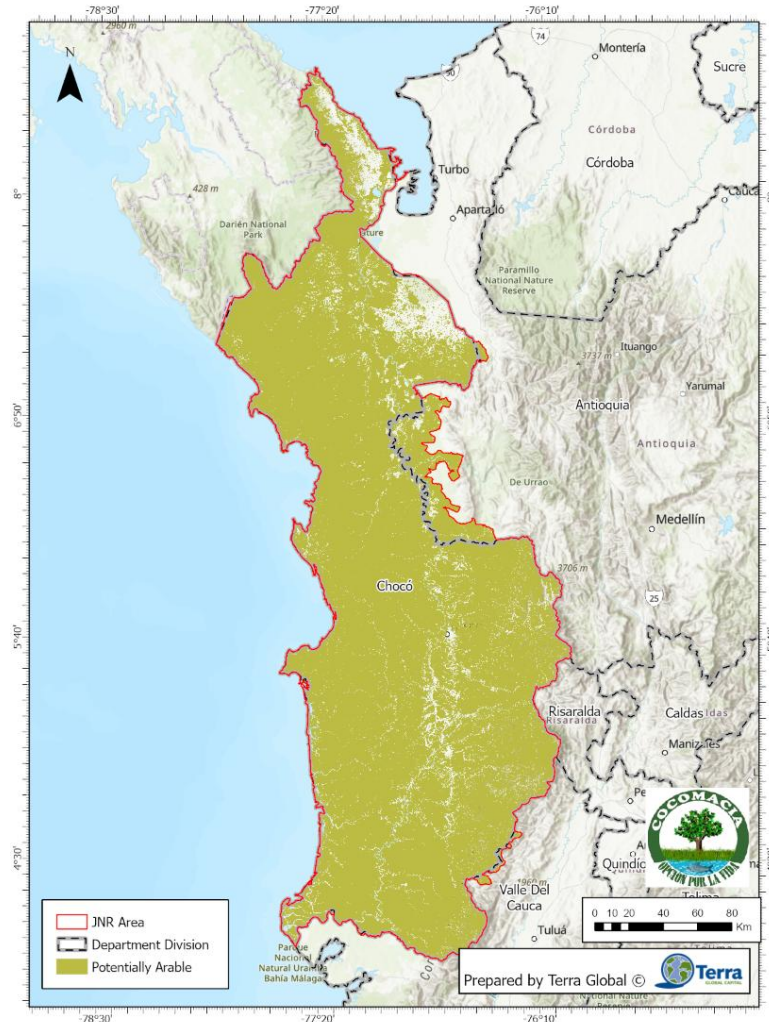
The output of this step was a binary raster map classifying land as either *potentially arable* or *not potentially arable* (Map 15).

<sup>2</sup>[https://cortolima.gov.co/images/POMCA/Rio\\_Coello/2004/4fase/apendice/Ba-\\_Apendice\\_Plan\\_negocios.pdf](https://cortolima.gov.co/images/POMCA/Rio_Coello/2004/4fase/apendice/Ba-_Apendice_Plan_negocios.pdf)

<sup>3</sup> <https://www.asohofrucol.com.co/img/pdflibros/17libro.pdf>

<sup>4</sup> [http://www.scielo.org.co/scielo.php?script=sci\\_arttext&pid=S0123-42262012000200010](http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0123-42262012000200010)

<sup>5</sup> <https://biblioteca.cenicafe.org/bitstream/10778/859/17/15.%20Agroclimatología%20cafe.pdf>



Map 15. Potentially Arable Land in the JNR FREL Area

*Physical Accessibility*

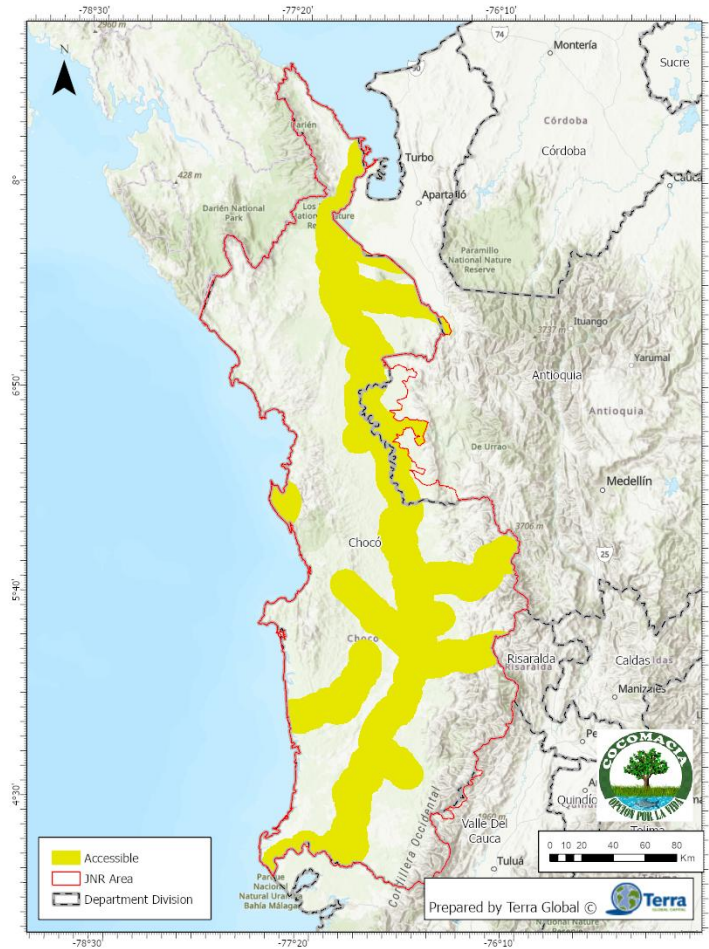
To assess accessibility, the potentially arable land layer was intersected with a road network dataset and rivers derived from national road infrastructure and OpenStreetMap (Map 16).

- A 10-kilometer buffer was applied around all roads to define the accessible zone.
- Potentially arable land falling within this buffer was classified as *accessible*; all other land was deemed *inaccessible*.



Map 16. Rivers and Roads in the JNR FREL Area

The output was a digital accessibility map with binary values: *accessible* or *inaccessible* (Map 17).



Map 17. Accessible Land in the JNR FREL Area

Relative Protection Status

Protection status was assessed based on legal, administrative, and de facto restrictions that would limit activity shifting. The following areas were classified as *protected*: National Protected Areas (

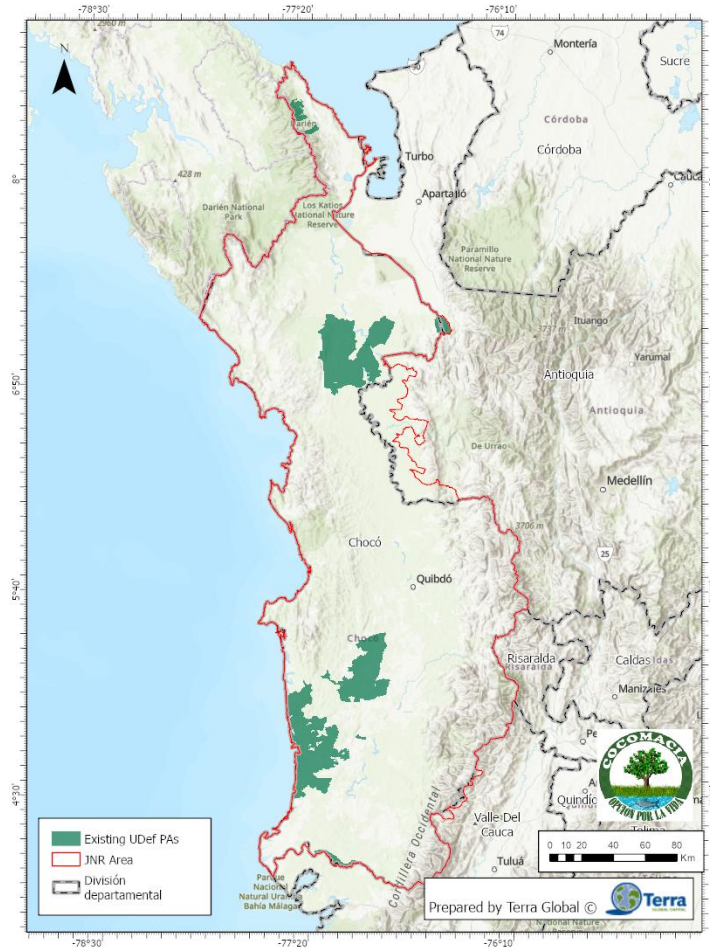
Map 18).



Map 18. National Protected Areas in the JNR FREL Area

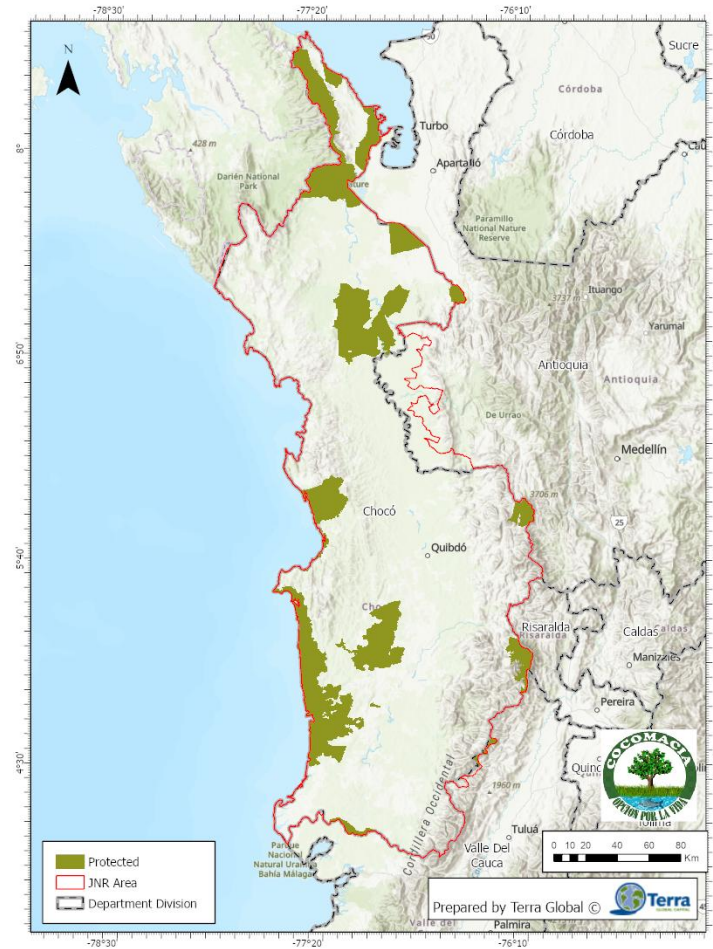
UDef PAs projects validated or verified within the last five years (Map 19):

- 1395 - Bajo Calima y Bahía Málaga (BCBM) REDD+ Project
- 1400 - Concosta REDD+ Project
- 1399 - Mutatá REDD+ Project
- 1391 - Svirú-Usaragá-Pizarro-Pilizá (Supp) REDD+ Project
- 1390 - Carmen del Darién (CDD) REDD+ Project
- 1396 - Rio Pepe y ACABA REDD+ Project
- 856 - The Chocó-Darién Conservation Corridor REDD Project



Map 19. Existing UDef PAs Projects

The result was a protection status map with binary values: *protected* or *unprotected* (Map 20).



Map 20. Relative Protection Status in the JNR FREL Area

*Integrated Classification*

The final step consisted of overlaying the three binary maps to produce a single map classifying each spatial unit as *available* or *unavailable* for activity shifting. The classification rules were as follows:

- Land was classified as unavailable if it was:
  - Not potentially arable, or
  - Inaccessible, or
  - Protected
- Land was classified as available only if it met all of the following conditions:
  - Potentially arable,
  - Accessible,
  - Unprotected

*Step 2: Develop Area-Weighted Emission Factor for Activity Shifting to Outside the UDef LB*

According to Appendix 2 of module VMD0055 (v1.1), the single carbon stock factor ( $\Delta C_{OLB}$ ) corresponding to the land available for displacement of activities outside the Leakage Belt was estimated.

The calculation of the factor was made by applying the following expression, not included in the module.

$$\Delta C_{OLB} = \frac{\sum_j (A_j * C_j)}{\sum_j A_j} \quad \text{Equation 23}$$

Where:

- $\Delta C_{OLB}$  Emissions from carbon stock change due to land cover transition in areas available for activity shifting outside the UDef LB (t CO<sub>2</sub>e/ha)
- $A_j$  Available area of the stratum  $j$ , in (hectares);
- $C_j$  Aboveground biomass per hectare for the stratum  $j$ , in (t CO<sub>2</sub>e/ha)

The value of the emission factor weighted by the forest area susceptible to deforestation was used to obtain emissions outside UDef PA and UDef LB.

### 2.5.4.6.3. Market-effects Leakage

Total leakage due to market effects, should be estimated by projects using this baseline and is equal to the sum of market-effects leakage through decreased timber harvest and decreased harvest for fuelwood/charcoal production.

$$\Delta C_{LK-ME} = LK_{MarketEffects,timber} + LK_{MarketEffects,FW/C} + LK_{MarketEffects,Peat} \quad \text{Equation 24}$$

Where:

- $\Delta C_{LK-ME}$  = Net greenhouse gas emissions due to market-effects leakage (t CO<sub>2</sub>e)
- $LK_{MarketEffects,timber}$  = Total GHG emissions due to market-effects leakage through decreased timber harvest (t CO<sub>2</sub>e)
- $LK_{MarketEffects,FW/C}$  = Total GHG emissions due to market-effects leakage through decreased harvest of fuelwood and charcoal sold into regional and/or national markets (t CO<sub>2</sub>e)
- $LK_{MarketEffects,Peat}$  = Total GHG emissions due to market-effects leakage through decreased timber, fuelwood and charcoal harvest resulting in increased peatland drainage (t CO<sub>2</sub>e)

#### Market-Effects Leakage Through Decreased Timber Harvest

Section 5.1 of document VMD0011 explains how carbon leakage in the market caused by reduced logging is calculated. This calculation considers the amount of timber that could have been harvested in the jurisdiction and compares it with the availability of timber in other areas to determine the risk that logging will simply shift to another location.

Emissions due to market leakage are calculated as follows:

$$LK_{MarketEffects,timber} = \sum_{i=1}^M (LF_{ME} * LK_{MAF} * AL_{T,i}) \quad \text{Equation 25}$$

Where:

- $LK_{MarketEffects,timber}$  = Total GHG emissions due to market-effects leakage through decreased timber harvest (t CO<sub>2</sub>e)
- $LF_{ME}$  = Leakage factor for market-effects calculations (dimensionless)
- $LK_{MAF}$  = Leakage management adjustment factor (dimensionless)
- $AL_{T,i}$  = Summed emissions from timber harvest in stratum  $i$  in the baseline case potentially displaced through implementation of the project (t CO<sub>2</sub>e)
- $i$  = 1, 2, 3, ...M strata (dimensionless)

For each stratum, the commercial biomass was calculated and divided by the total aerial biomass to obtain a proportion of the total aerial biomass. This proportion is compared with the following table in the module:

Deduction Factors for $LF_{ME}$	
$PML_{FT}$ is equal ( $\pm 15\%$ ) to $PMP_i$	$LF_{ME} = 0.4$
$PML_{FT}$ is > 15% less than $PMP_i$	$LF_{ME} = 0.7$
$PML_{FT}$ is > 15% greater than $PMP_i$	$LF_{ME} = 0.2$

Where:

$PML_{FT}$  = Mean merchantable biomass as a proportion of total aboveground tree biomass for each forest type (%)

$PMP_i$  = Merchantable biomass as a proportion of total aboveground tree biomass for stratum  $i$  within the project boundary (%).

$LF_{ME}$  = Leakage factor for market-effects calculations (dimensionless).

Optional:

If the proponent maintains production of merchantable biomass in leakage-management areas under its control that supply the same national/regional markets, discount timber market-effects leakage in proportion to the substitution achieved:

$$LK_{MAF} = 1 - \left( \frac{PRODMB_{LMA,t}}{PRODMB_{BL,t}} \right) \quad \text{Equation 26}$$

Where:

$LK_{MAF}$  = Leakage management adjustment factor (dimensionless)

$PRODMB_{LMA,t}$  = Production biomass in commercial species that is merchantable in year  $t$  in leakage management areas (t per year)

$PRODMB_{BL,t}$  = Production of biomass in commercial species that is merchantable in year  $t$  in the baseline case (t per year)

$t$  = 1, 2, 3, ...  $t^*$  time elapsed since the start of the project activity (years)

The next step is to estimate the emissions associated with the displaced logging activity. This is based on the total volume that would have been logged in the baseline in the project area across strata and time periods:

$$AL_{T,i} = \sum_{t=1}^t (C_{BSL,XBT,i,t}) \quad \text{Equation 27}$$

Where:

$AL_{T,i}$  = Summed emissions from timber harvest in stratum  $i$  in the baseline case laced through implementation of carbon project (t CO<sub>2</sub>e)

$C_{BSL,XBT,i,t}$  = Carbon emission due to displaced timber harvests in the baseline scenario in stratum  $i$  in year  $t$  (t CO<sub>2</sub>e)

$i$  = 1, 2, 3, ...  $M$  strata in the project scenario

$t$  = 1, 2, 3, ...  $t^*$  time elapsed since the start of the project activity (years)

The carbon emission due to the displaced logging has two components: the biomass carbon of the extracted timber (see also module CP-W which uses the same equation) and the biomass carbon in the forest damaged in the process of timber extraction:

$$C_{BSL,XBT,i,t} = \left( (V_{BSL,XE,i,t} \times D_{mn} \times CF) + (V_{BSL,XE,i,t} \times LDF) + (V_{BSLXE,i,t} \times LIF) \right) \times \frac{44}{12} \quad \text{Equation 28}$$

Where:

- $C_{BSL,XBT,i,t}$  = Carbon emission due to timber harvests in the baseline scenario in stratum i in year t (t CO<sub>2</sub>e)
- $V_{BSL,XE,i,t}$  = Volume of timber projected to be extracted from within the project boundary during the baseline in stratum i in year t (m<sup>3</sup>).
- $D_{mn}$  = Mean wood density of commercially harvested species (t d.m.m-3)
- $CF$  = Carbon fraction of biomass for commercially harvested species j (t C t d.m.-1)
- $LDF$  = Logging damage factor (t C m-3)
- $LIF$  = Logging infrastructure factor (t C m-3)
- $i$  = 1, 2, 3, ...M strata
- $t$  = 1, 2, 3, ... t\* time elapsed since the start of the project activity (years)

The logging damage factor (LDF) is a representation of the quantity of emissions that will ultimately arise per unit of extracted timber (m<sup>3</sup>). These emissions arise from the noncommercial portion of the felled tree (the branches and stump) and trees incidentally killed during tree felling.

The logging infrastructure factor (LIF) is a representation of the quantity of emissions that will ultimately arise per unit of timber (m<sup>3</sup>) from roads, skid trails and logging decks.

#### Market-Effects Leakage Through Decreased Harvest of Fuelwood and Charcoal Sold into Regional and/or National Markets

Section 5.2 of module VMD0011 describes how to estimate leakage due to market effects associated with the reduction in the supply of firewood and/or charcoal by the project. The module assumes that, unlike wood, the proportion of merchantable biomass and the associated infrastructure are not decisive for this flow; therefore, it sets a constant market leakage factor  $LF_{ME}=0.4$  for all strata, unless it is demonstrated that the displacement will occur exclusively outside the country, in which case the component is set to zero.

Displaceable emissions are obtained, by stratum and year, from the baseline firewood volume minus the project volume (both converted to CO<sub>2</sub>e with density and C fraction) and are aggregated over the period; optionally, a leakage management factor is applied if the proponent maintains production in areas under its control that supply the same national/regional markets, allowing the leakage to be discounted proportionally; if that production equals or exceeds the baseline, the leakage is assumed to be zero.

#### 2.5.4.6.4. Leakage Mitigation Emissions

This emissions should be estimated by Projects using this baseline. According to module VMD0011, when such activities result in significant increases in emissions from changes in carbon stocks, biomass burning, and/or increased fertilizer use, these emissions should be conservatively accounted for and included in their entirety as emissions caused by project implementation.

Where the net sum of carbon stock changes within the leakage management zones over the monitoring period is greater than zero, the net increase is conservatively ignored in the calculation of net GHG emission reductions of the project activity.

Where emissions are significant, they shall be taken into account in the ex ante leakage estimate, and emissions in land units where leakage mitigation measures are applied shall be subject to monitoring,

reporting, and verification (MRV). Where emissions are not significant, they may be excluded, and changes in carbon stocks in the leakage management zone shall not be subject to MRV requirements.

These emissions are calculated as follows:

$$GHG_{LK,E,t} = \sum_{t=1}^{t^*} (E_{Cstocks,LMZ,t} + E_{MP,BiomassBurn,t} + N_2O_{MP,direct-N,t}) \quad \text{Equation 29}$$

Where:

- $GHG_{LK,E,t}$  = Cumulative other GHG emissions as a result of leakage mitigation measures in year t (t CO2e)
- $E_{Cstocks,LMZ,t}$  = Net CO2e emissions from carbon stock changes in above- and belowground tree biomass in the leakage management zone resulting from implementation of leakage mitigation measures in year t (t CO2e)
- $E_{MP,BiomassBurn,t}$  = Non-CO2 monitored emissions due to biomass burning as part of project activities in year t (t CO2e)
- $N_2O_{MP,direct-N,t}$  = Direct N2O monitored emissions as a result of nitrogen application on an alternative land use in year t (t CO2e)
- $t$  = 1, 2, 3, ..., t\* years elapsed since the start of the project

### 2.5.5. Land Cover Maps

This section describe the process for generating Land Cover Maps, forest stratification and land-use and land-use change.

To fill the gaps in LULC maps, images used for generating the LULC maps were gap filled using well established imputing techniques, as described in Section 2.5.5.1.5 of this document. Also, the use of the temporal filter potentially allowed for further filling the gaps in the image between the beginning and the end of the historical period. As a result, this approach allowed for generating wall to wall maps with no or negligible number of pixels with no class.

#### 2.5.5.1. LULC Stratification Map

To define the forest strata to be used for calculating JNR Baseline Emissions, the VCS Module VMD0016 Methods for Stratification of the Project Area (X-STR) Section 4.1. was used. This forest stratification map was used to calculate historical transitions using a wall to wall mapping approach, as described in more detail further in this section.

##### 2.5.5.1.1. Description of Data Sources

All land use and land-use change (LULC) maps were created by developing wall-to-wall land cover maps. These maps determined historical rates of land use change and allowed for the development efficient stratified sampling for estimating the activity data required VMD0055 and as suggested in A1.4.1 "Estimate Areas of Unplanned Deforestation that Took Place in the Jurisdiction During the HRP". Pre-stratification of the area was based of ancillary data, according to VMD0016 Section 4.1.

Historical satellite data images were retrieved from three different sensors and preprocessed to generate cloud-free images resampled at a resolution of 30m x 30m and are shown in Table 16. The specific date of the image created through the multi-sensor collection was defined as the average across the date of the Landsat-8, Sentinel-1 and Sentinel-2 composite images. Images were preprocessed to ensure a cloud-free coverage and high-quality standards. For Landsat 8, Level 2, Collection 2, Tier 1 data was used (i.e. images collections "LANDSAT/LC08/C02/T1\_L2"). As such, all images were calibrated, radiometrically corrected, orthorectified and atmospherically corrected before being retrieved. All relevant bands in the visible and infrared were used as shown below.

Table 16. Historical Reference Period images overview and characteristics.

Source	Average Weighted Range	Type	Sensors	Processing Level
USGS Landsat 8 Level 2, Collection 2, Tier 1	1/13/2015	Satellite	OLI/TIRS	Geometric & Radiometric correction
USGS Landsat 8 Level 2, Collection 2, Tier 11/13/2015SatelliteOLI/TIRSGeometric & Radiometric correction USGS Landsat 8 Level 2, Collection 2, Tier 1, Sentinel-1 SAR GRD	12/1/2015	Satellite	OLI/TIRS, SAR C-band	Geometric & Radiometric correction
USGS Landsat 8 Level 2, Collection 2, Tier 1, Sentinel-1 SAR GRD, Harmonized Sentinel-2 MSI, Level 1C	1/21/2018	Satellite	OLI/TIRS, SAR C-band, MSI	Geometric & Radiometric correction
USGS Landsat 8 Level 2, Collection 2, Tier 1, Sentinel-1 SAR GRD, Harmonized Sentinel-2 MSI, Level 1C	12/22/2020	Satellite	OLI/TIRS, SAR C-band, MSI	Geometric & Radiometric correction

For Sentinel-2 data, top of the atmosphere Level 1C orthorectified data was used (i.e. image collection "COPERNICUS/S2"). As such, all images were calibrated, orthorectified and radiometrically corrected before being retrieved. All relevant bands in the visible and infrared were used and resampled to be of 30 m resolution again shown in Table 17.

Sentinel 1 SAR GRD data consisted of a dual-polarization C-band Synthetic Aperture Radar (SAR) instrument at 5.405GHz (C band). All data was radiometrically calibrated and ortho-corrected using the Sentinel-1 Toolbox. All data was rescaled to a 10 m resolution. Of the four original bands only the single co-polarization, vertical transmit/vertical receive (VV) and the dual-band cross-polarization, vertical transmit/horizontal receive (VH) were used. A third band was generated by calculating the ratio between the two.

Several ancillary layers were used for the classification. These layers consist of (a) imagery publicly available; and (b) spectral indexes and clustering based off the Landsat and Sentinel data described above. Specifically, topographic data from the Advanced Land Observing Satellite "ALOS" (elevation, aspect, hill shade and slope) was used; information about the potential presence of intertidal ecosystems from the Global Tidal Wetland Change dataset (Murray, 2022) was used as well; and the Global Human Settlement Layers produced (Pesaresi, 2016), to have an indication of urbanization patterns in the area. All images were processed to be overlapping in shape and resolution, and all pixels were aligned.

Table 17. Bands and resolution of the sensors data

Source	Band (#)	Resolution (m)	Band name	Wavelength (µm)			
				from	to	mid	FWHM
USGS Landsat 8 Level 2, Collection 2, Tier 1	1	30	Ultra Blue	0.435	0.451	0.443	0.035
	2	30	Blue	0.452	0.512	0.482	0.04
	3	30	Green	0.533	0.59	0.5615	0.03
	4	30	Red	0.636	0.673	0.6545	0.07
	5	30	NIR	0.851	0.879	0.865	0.1
	6	30	SWIR 1	1.566	1.651	1.6085	1.05
	7	30	SWIR 2	2.107	2.294	2.2005	0.135
Harmonized Sentinel-2 MSI, Level 1C	B1	60	Aerosols	0.4423	0.4439	0.4431	0.0008
	B2	10	Blue	0.4921	0.4966	0.49435	0.00225
	B3	10	Green	0.559	0.56	0.5595	0.0005
	B4	10	Red	0.6645	0.665	0.66475	0.00025
	B5	20	Red Edge 1	0.7038	0.7039	0.70385	5E-05

Source	Band (#)	Resolution (m)	Band name	Wavelength (µm)			
				from	to	mid	FWHM
	B6	20	Red Edge 2	0.7391	0.7402	0.73965	0.00055
	B7	20	Red Edge 3	0.7797	0.7825	0.7811	0.0014
	B8	10	NIR	0.833	0.8351	0.83405	0.00105
	B8A	20	Red Edge 4	0.864	0.8648	0.8644	0.0004
	B11	20	SWIR 1	1.6104	1.6137	1.61205	0.00165
	B12	20	SWIR 2	2.1857	2.2024	2.19405	0.00835
Sentinel-1 SAR GRD	VV	10	vertical transmit vertical receive	-50	1	25.5	25.5
	VH	10	vertical transmit horizontal receive	-50	1	25.5	25.5

Next, Table 18 describes the Land-Use change analysis data sources.

Table 18. Land-use Change Analysis Data Sources

Data Source	Main Use for Data	Information Needed about the Data Collected
Landsat-8 MSI (LANDSAT/LC08/C02/T1_L2), Sentinel-1 SAR (COPERNICUS/S1_GRD), Sentinel-2 MSI (COPERNICUS/S2) satellite remote sensing imagery	Training of classification procedures for LULC mapping. Generate maps of land use and land use transitions over the historical period. Performing sample-based approach as defined in VMD0055.	Source: Google Earth Engine Type: Satellite Imagery Resolution (30m) Coordinate system: MAGNA-SIRGAS / Colombia West zone - Projected
High resolution ESRI and Google Earth Basemaps	Assisting with selecting a dataset of points used for training, validating-testing the accuracy of LULC maps.	Source ESRI and Google Basemaps. Type: Orthophotos and High-resolution satellite data.
LULC maps	Estimate historical rates of land cover change. Building a stratified sampling approach for estimating activity data and uncertainty in line with VM0048 and VMD0055.	Source: ML classifier Type: wall-to-wall maps of land cover across the historical period.
Fixed spatial drivers	Analyze agents and drivers of deforestation and degradation.	Source ESRI and Google Basemaps Type: Orthophotos and High-resolution satellite data.
Direct field observations for calibration of the classification and stratification procedures and validation of the calibration and classification accuracy.	Each biomass sample plots contains field observation of LULC as well as geotagged photos that would support the QAQC procedures to check the accuracy of the classification.	Acquisition date Type of data coordinate system Location of coordinates and LULC with special attention to degraded forest.

2.5.5.1.2. Definition LULC Classes and Forest Strata



Land cover classes were identified within the Jurisdictional Baseline Area based on the Intergovernmental Panel on Climate Change’s 2006 Guidelines for National GHG Inventories for Agriculture, Forestry and Other Land Use. Specifically, 4 IPCC LULC classes were identified (Forest Land, Crop Land, Grassland, Settlements). Forest Lands were stratified across 4 strata based off Closed Upland Forest, Closed Lowland Forest, Open Lowland and Open Upland forests. The distinction between upland and lowland forests was set as 10 degrees of slope and above 50 meters of elevation and was based off the fact that these forests have different structures and thus different carbon stocks, justifying their stratification as instructed in Section 5.1 of VMD0016. The distinction between Open and Closed forests was made to assess degradation.

Among the non-forest classes the distinction between water bodies, agricultural land, settlements, pastures and bare land was originally applied. However, settlements, pastures and bare land were merged into a single class and are therefore presented as BAR class throughout the rest of the Baseline Description and LULC maps. The distinction between agricultural and bare land was justified by the significant difference in aboveground biomass shown by the two classes in VCS projects in the area (e.g. VCS ID# 1389, 1390, 1391, 1392, 1395, 1396, 1399, 1400). Additionally, two “no-data” classes were used in the classification. These classes were No Data (NOD), representing pixels with no reflectance data, and Cloud cover (CLD). Since pixels with significant cloud coverage were removed in preprocessing or substituted by imputed values when possible, the CLD class was then removed.

Water was only considered for quantifications GHG emissions from mangrove deforestation. Cloud and no-data have always been removed for purposes of quantifications of GHG emissions and removals.

These classes also follow the requirements of VMD0055 A1.3 as they allow us to identify a sample dataset with the categories defined for which historical deforestation is needed for the AD Baseline Allocation Report and shown in Table 10 in VMD0055 v.1.0, as further described in this section.

Table 19. Forest classes and Strata within the classification

Forest Classes	Class Codes: CFU, CFL, OFU, OFL
	<p><b>Closed Upland Forest (CFU)</b>                      This stratum is made up of a dense canopy formed by tall, broadleaf evergreen trees. This creates a dark, humid environment on the forest floor. The forest has a complex vertical structure, with multiple layers of vegetation from the forest floor to the emergent trees that rise above the canopy. This class is characterized in medium resolution satellite multispectral imagery by a year-round high Near Infrared spectral signature. It is visually identified in high resolution imagery by its closed canopy, and rich green color. This forest stratum is described as CFU.</p>
	<p><b>Closed Lowland Forest (CFL)</b>                      This stratum is characterized by dense and continuous tree canopies and High Leaf Area Index (LAI), indicating thick vegetation cover. It is dominated by evergreen trees with heights typically exceeding 30 meters. Regarding the spectral properties, in the visible spectrum it has high absorption in the red band due to chlorophyll and low reflectance in blue and green. In the Near-Infrared (NIR) spectrum, it has high reflectance due to the internal structure of leaves. In the shortwave Infrared (SWIR) it has moderate to high absorption indicative of moisture content in vegetation. The distinction between upland and lowland forests was set as 5 degrees of slope. This forest stratum is described as CFL.</p>




Forest Classes	Class Codes: CFU, CFL, OFU, OFL
	<p><b>Open Upland Forest (OFU)</b>            Open forests are characterized by a mix of deciduous and evergreen trees, where the forest canopy remains semi-open allowing more sunlight to reach the forest floor. This increased sunlight allows for the growth of a greater variety of understory plants. Openings within the forest may resemble savanna, with grasses and herbaceous plants dominating. The distinction between upland and lowland forests was set as 5 degrees of slope. This class is characterized in medium resolution satellite multispectral imagery by low Near Infrared spectral signature. It is visually identified in high resolution imagery by its patchy open canopy, with some emergent trees. This forest stratum are described as OFU.</p>
	<p><b>Open Lowland Forest (OFL)</b>            Open forests are characterized by a mix of deciduous and evergreen trees, where the forest canopy remains semi-open allowing more sunlight to reach the forest floor. This increased sunlight allows for the growth of a greater variety of understory plants. Openings within the forest may resemble savanna, with grasses and herbaceous plants dominating. The distinction between upland and lowland forests was set as 50m altitude and for slope greater than 10 degrees. Regarding the spectral properties, in the visible spectrum it is similar to closed forest but with higher reflectance in the green band due to more exposed understory. In the NIR spectrum, moderately high reflectance from vegetation, but lower than closed forests due to gaps in the canopy. This forest stratum is described as OFL.</p>
	<p><b>Mangrove Forest (MGR)</b>            This class includes mangroves areas. This class is characterized by distinctive spectral reflectance signature due to dense vegetation, saline water interactions, and often waterlogged soils. Specifically, low reflectance in visible, high in near infrared, and moderate reflectance in the shortwave infrared due to soil moisture and salinity. Because they occur at low altitudes, typically from sea level up to about 10 meters this class prioritizes intertidal zones, river deltas, lagoons and sheltered coastlines. This forest stratum is described as MGR.</p>

Table 20. Basic characteristics for the identified non-forest LULC classes





Non-Forest Classes	Class Codes: BAR, AGW, WTR
	<p><b>Bare (BAR)</b>            This class includes exposed soil, settlements, and pastures. Shrub areas that do not meet the definition of forest due to low stature, or low canopy cover are also in this class. Characterized by very low Near Infrared multispectral response and is readily identifiable in high resolution imagery.</p>
	<p><b>Agriculture (AGW)</b>            The diverse agricultural practices in the region can lead to variations in crop types and management practices making it challenging to develop a single representative spectral signature for this class. The spectral signature can vary from medium to low reflectance in the near infrared (NIR) region. It is influenced by crop type, the growth stage, the soil conditions and the environment. This class is described as AGW.</p>
	<p><b>Water (WTR)</b>            This class includes dammed areas, open water, large rivers and water saturated soils. This class is characterized by almost complete absorption of Near Infrared wavelengths.</p>

Table 21. No-Data Class

No-Data Classes	Class Codes: NOD, CLD
	<p><b>Cloud</b> The high rainfall and frequent cloud cover in the region can limit the availability of cloud-free satellite imagery, making it difficult to obtain consistent and reliable spectral data. Cloud obscures the underlying land cover class thus requiring these areas to be removed from analysis. Cloud class is reclassified into the CLD class code prior to analysis.</p>

2.5.5.1.3. Differentiation of Peatland from Non-Peatland

As stated in VMD0016 Methods for stratification of the project area (X-STR) v 1.3 Section 4.2, official data from Colombian Government was employed to identify wetlands and peatland (Instituto Geográfico Agustín Codazzi - IGAC, 2022). The official information do not confirm the existence of peat soils in Chocó. In a conservative approach, all types of wetlands present in the jurisdiction were excluded as potential peat soil.

2.5.5.1.4. Define Land Transitions between LULC Classes/Forest Strata

The following transitions are allowable under the Jurisdictional Crediting Baseline and shown in Table 22:

**Deforestation** is the transition of a forest class to a non-forest class (bare land or cropland). Any forest class is susceptible to deforestation including from OFL/OFU and CFU/CFL to either of the non-forest classes BAR or AGW.

**Regrowth** is a transition from a non-forest class (BAR or AGW) to the low-biomass forest classes (OFL/OFU). As CFS is a unique old growth forest system, BAR or AGW to CFU/CFL is an unallowable transition. As specified as REDD+ under JNR Requirements v 3.4. for the Jurisdictional Crediting Areas must be forest at the start of their crediting period, and thus regrowth occurs only after deforestation to a non-forest class during the crediting period.

Because of the topographic nature of the distinction between upland and lowland forests, transitions from/to different forest quality types only occurred within the same topography. As such transitions from upland to lowland forests, or vice versa, were not allowed.

Table 22. Transition Types and Classes

Transition Type	From Class_ To Class
Deforestation	CFU_BAR
	OFU_BAR
	CFU_AGW
	OFU_AGW
	CFL_BAR
	OFL_BAR
	CFL_AGW
Regrowth	BAR_OFU
	BAR_OFL
	AGW_OFU
	AGW_OFL

#### 2.5.5.1.5. Pre-processing of Remote Sensing Data

The region is constantly characterized by significant cloud coverage, making it impossible to access satellite images as complete scenes from a single day for the entire jurisdictional area. To solve this issue, a complete cloud-free composite image was created by pooling from a collection of images in a prescribed temporal range, and select pixels based off a “pixel-quality” algorithm for pixel prioritization. Specifically, 1 year time range was used (from the first of January to the 31<sup>st</sup> of December) as the image collection temporal window making up each image. This large temporal window was selected because (a) the jurisdiction is characterized by heavy cloud coverage in both dry and rainy seasons; (b) the vegetation shows no significant change across seasons. Based on this approach, pixels from a 1-year range were extracted. From each collection, all pixels not likely to be clouds or clouds’ shadows were included. From the bag of candidate pixels, for each pixel location, the one with the median reflectance was chosen, thus generating a single image. Given that each pixel was attached to its record date, the date of any image was assigned as the pixel weighted average date. Since this approach used images from three different sensors, the date of the multi-sensor collection was defined as the average across the date of the Landsat-8, Sentinel-1 and Sentinel-2 composite images.

Since they rely on different sensors and processing algorithms, slightly different rationales were followed to prioritize cloud free pixels from Sentinel 2 and Landsat 8 collections. For Landsat 8, Level 2, Collection 2, Tier 1 data was used (i.e. images collections "LANDSAT/LC08/C02/T1\_L2"). As such, all images were calibrated, radiometrically corrected, orthorectified and atmospherically corrected before being retrieved. To remove pixels with clouds and cirrus all available images were parsed in each yearly collection and filtered out portions that did not pass quality check. To do that, a bit mask on the ‘QA’ was applied (quality assessment) band of Landsat 8 data and flagged out pixels based on 4 conditions: (a) cloudShadowBitMask = (1 << 3) (which identifies cloud shadows), (b) cloudsBitMask = (1 << 5) (which identifies clouds), (c) highConfidenceCloudBitMask = (1 << 7) (which targets high-confidence clouds, which are more likely to be actual clouds); (d) cirrusBitMask = (1 << 9) (which identifies cirrus clouds, which are high-altitude clouds often missed by standard cloud masking). These values used for the bitwise function were taken from the “Landsat Collection 2 Quality Assessment Bands” documentation (<https://www.usgs.gov/landsat-missions/landsat-collection-2-quality-assessment-bands>). The remaining pixels were used to calculate the median reflectance over the jurisdiction for the specific composite image.

For Sentinel-2 data, top of the atmosphere Level 1C orthorectified data was used (i.e. image collection “COPERNICUS/S2”). As such, all images were calibrated, orthorectified and radiometrically corrected before being retrieved. To remove clouds, shades and cirri, an algorithm was built to leverage the information in the MEAN\_SOLAR\_AZIMUTH\_ANGLE, CLOUDY\_PIXEL\_PERCENTAGE and S2\_CLOUD\_PROBABILITY bands. Specifically, images represented by cloud cover for more than 90% of their surface were removed. From the remaining images, pixels whose probability of being clouds exceeded 0.5 (i.e. 50%) were removed. Finally, all pixels that were within 30 meters from pixels shaded by cloud (adjusted by solar angle) were removed. All the pixels that had reflectance in Band 8 (near infrared) was lower than 0.2 were defined as shaded. The remaining pixels were used to calculate the median reflectance over the jurisdiction for the specific composite image.

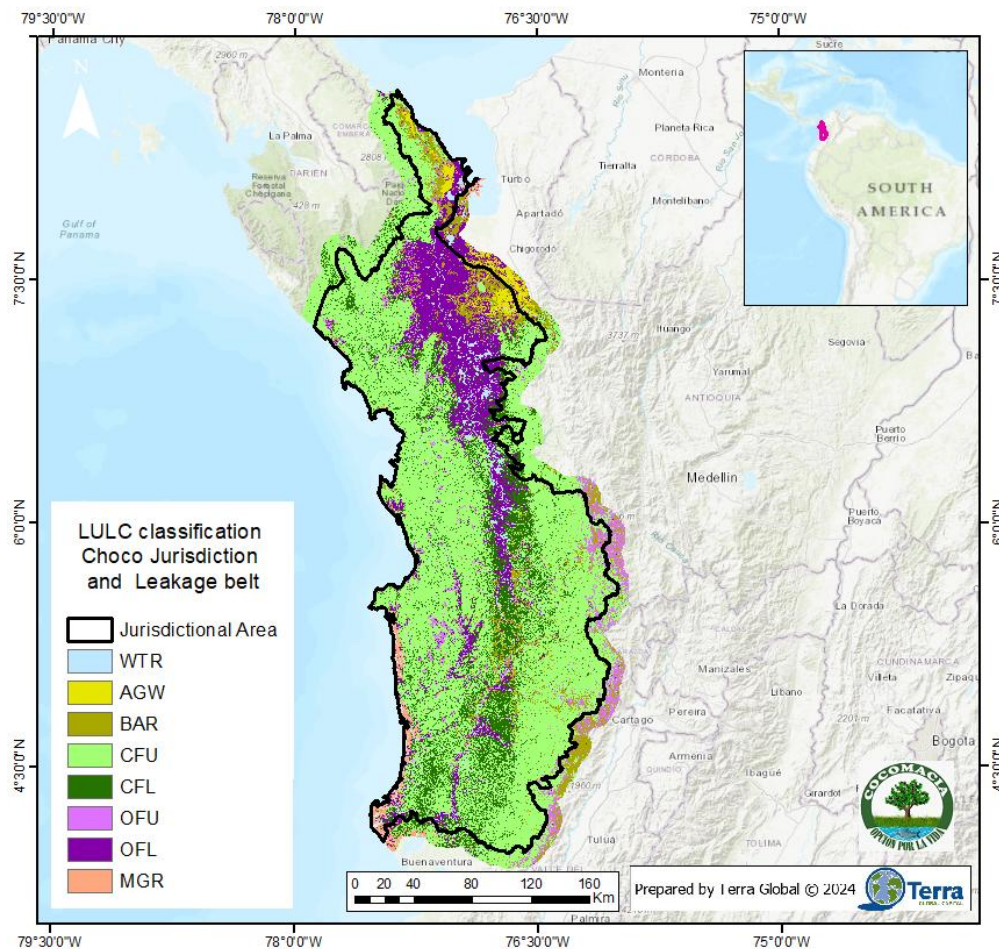
Landsat-8 and Sentinel-2 imagery were normalized using a level 2 pixel-based vector normalization. This approach is often used in literature to reduce anomalies in luminance across portions of the image and can be especially useful for mosaics based on multitemporal mosaic (Fan, 2020) (Singh, 2015).

When no pixels were available for the entire yearly collection of one between Landsat-8 or Sentinel-2 data product while being available for the other, the missing values were imputed using KNN distance imputing technique to estimate the reflectance value of the missing sensor (Troyanskaya, 2001). Each imputed pixel was based off a 500x500 window and 50 nearest neighbors using Manhattan distance. This extra step allowed for reducing the number of unclassifiable pixels to a non-significant percentage.

#### 2.5.5.1.6. LULC Classification and Forest Stratification

Historical deforestation and degradation were assessed in a multi-step process. First, a machine learning classifier specific for each year included in the imagery dataset was built and used to map landcover for

that specific image. Each classifier was built using the training data, representing 70% of the total reference points. To reduce the negative effect of class unbalance on training, a stratified sampling technique was used, aiming at providing a well-balanced number of points for each class, extracted randomly throughout the Jurisdiction, leakage area, and project area. To ensure the test dataset was representative for each class, the training-verification dataset was split by classes, ensuring that each class had a comparable number of points in the 30% withheld verification dataset. The algorithm used was an ensemble of pixel-level classifiers based off a combination of 4 base estimators: (1) a random forest classifier (2) a k-nearest neighbors' classifier, (3) a histogram gradient boosting classifier (4) an extreme gradient boosting decision tree classifier. Entropy loss was used to measure the quality of tree-splits for random forests, categorical cross-entropy as the loss function for the gradient boosting and the Manhattan distance for calculating the distance between k-nearest neighbors in the KNN classifier. These pixel-based models were stacked by using the probability vectors produced by each classifier as the features for an elastic-net model.



Map 21. LULC map (2021) produced by the classification. The classified area outside the borders of the Jurisdiction represents the 10km buffer around the JNR

#### 2.5.5.1.7. Post Processing of Classified Images

##### Application of Filters

Raw outputs of the classification were post-processed to remove noise and errors. Specifically, a spackle filter was used to smooth the landcover maps. This filter used a convolution window to remove spackle noise (i.e. of pixels). A topographic filter was used to remove potential errors in distinguished upland/lowland forests. The topographic filter was set to enforce upland forests to any conditions where elevation was greater than 50m and slope greater than 10%. To reduce temporal noise and unrealistic transitions, a temporal filter was applied to revert pixels transitions for pixels transitioning from and to the same land

cover class at two consecutive transitional periods (e.g. from Forest to Non-Forest, back to Forest within 3 consecutive maps). This temporal filter operates in such a way that if a pixel transitions from one class to another back to the same class within 3 consecutive images, the filter will change the class of the image in the middle to be the same as the first and third period.

*Conduct Post Processing to Ensure Only Allowable Transitions*

Beside topographic, spackle noise and unrealistic transitions, there are several transitions that are not possible biogeochemically. These transitions can occur during classification and need to be corrected in post-processing. To do so, a filter to revert any transition identified as unallowable, such as transitions from non-forests directly to primary forests, was implemented. The transitions not allowed by this last filter are listed in Table 23.

Table 23. Unallowable Transitions

From Class	To Class
WTR	BAR, AGW, CFU, CFL, OFU, OFL
AGW	WTR, CFU, CFL, MGR
BAR	WTR, CFU, CFL, MGR
CFL	WTR, MGR, CFU, OFU
OFL	WTR, MGR, CFU, OFU
CFU	WTR, MGR, CFL, OFL
OFU	WTR, MGR, CFL, OFL
MGR	CFL, OFL

2.5.5.1.8. Map Accuracy Assessment and Discounting Factor Determination

Classification Uncertainty Estimates of activity data in the historical reference period needed to fall within a reasonable range of uncertainty. The uncertainty in the LULC analysis follows the VCS tool VMD0055 v1-0 (This Section refers to VMD0055 v1-0, Section 5.3.3.2 UDef PA and UDef LB Deforestation Data for the Monitoring Period Steps 3-4) and requires evaluating the accuracy of the LULC maps in assessing (a) how accurately they represent Forest and Non-Forest classes at the end of the Historical Reference Period (HRP) (required for deforestation) and (b) evaluate how accurately they match observed transitions.

For both (a) and (b), a stratified sampling design was employed, and a sample-based approach was used to visually classify each plot. A random stratified sample of locations were extracted in geolocations at which the LULC maps registered a transition. This was done to extract a dataset of required change categories as instructed in VMD0055 A1.4.1 “Estimate Areas of Unplanned Deforestation that took place in the Jurisdiction During the HRP”. Specifically, LULC maps were used as a baseline layer to design the stratified sampling framework that complied with the directions in VMD0055 Section 5.3.2. Each forest stratum used for emission accounting used a sampling stratum. To do so, the entire jurisdiction was stratified based off (1) the LULC class in Table 24, as identified by the maps for regions where no transition was observed across the historical period; (2) a transition class among DF, and RF, for those regions that showed a transition as defined in Table 24.

Table 24 Stratification for Sample-based Approach

From Class	To Class	CHC*
CFU	CFU	Stable Forest
CFL	CFL	Stable Forest
OFU	OFU	Stable Forest
OFL	OFL	Stable Forest
MGR	MGR	Stable Forest
AGW	BAR	Stable non-forest
BAR	AGW	Stable non-forest
AGW	AGW	Stable non-forest
BAR	BAR	Stable non-forest

From Class	To Class	CHC*
CFU	AGW	Deforestation
CFL	AGW	Deforestation
OFU	AGW	Deforestation
OFL	AGW	Deforestation
MGR	AGW	Deforestation
CFU	BAR	Deforestation
CFL	BAR	Deforestation
OFU	BAR	Deforestation
OFL	BAR	Deforestation
MGR	BAR	Deforestation
MGR	WTR	Deforestation
AGW	OFU	Forest regrowth
AGW	OFL	Forest regrowth
AGW	MGR	Forest regrowth
BAR	OFU	Forest regrowth
BAR	OFL	Forest regrowth
BAR	MGR	Forest regrowth
WTR	MGR	Forest regrowth

\*-S= stable (i.e. no change)

For point (a), a dataset of 318 plots was generated for measuring accuracies between Forest Non-Forest and a dataset of 201 plots for measuring the accuracies between Open Forests and Closed Forests. For point (b) a dataset of 292 plots was extracted to measure the accuracies of transitions across the HRP (175 stable forest, 70 transitioned forests, 47 non-forests). The samples were selected for deforestation (DF), reforestation (RF), Stable Closed Forest (CFS-Stable) and Stable Open Forest (OFS) transitions. This created a dataset of 245 plots for which visual interpretation was performed at each exact timestamp as the source image for the algorithmic classifier was produced. Each plot covered an area of 810 m<sup>2</sup> and was interpreted by two remote sensing experts using satellite imagery from Sentinel (10m spatial resolution) or Landsat data (30m spatial resolution) when Sentinel was not yet available (early 2015). Since the HRP covered a period of time preceding the launch of the Sentinel program, Landsat imagery was the only viable solution offering temporal continuity, therefore making it unfeasible to access remote sensing data at higher resolution.

The following Standard Operating Procedure was used for data quality management and Sample Plot Interpretation: First, for each 1200x1200m clip a 3x3 subplots grid covering 270mx270m centered at the center of the image clip was over imposed to the clip image. This provided a set of 9 squares, each covering 90mx90m. For each of these 9 squares, a minimum of two remote sensing specialists assigned a class from the list in Table 24. When more than 30% of the squares were assigned to a Forest class, that image was identified as forest, in any other case, as non-forest. Among plots classified as forests, a Closed and Open Forest class was assigned to the specific clip, based on majority rule. To account for uncertainty in interpreters class assignments, all plots for which the interpreters did not reach consensus were discarded.

Results from the Table 25 show that the user’s and producer’s accuracies are greater than 90% for areas mapped as forest and for areas mapped as open-forests at the end of the HRP, as required in Step 1 of Section A1.4.3. of VMD0055 subsection titled “Accuracy Assessment of the Jurisdictional FCBM”.

Table 25. User and Producer accuracy for Forests at the end of the HRP, and for Open Forests at the end of the HRP

	Closed Forest	Non-Forest	Open Forest	Total
Closed Forest	146	1	2	149

	Closed Forest	Non-Forest	Open Forest	Total
Non Forest	1	89	4	94
Open Forest	9	1	91	101
User Accuracy	0.93	0.98	0.98	0.94
Producer Accuracy	0.98	0.95	0.92	0.90

Table 26. Number of samples per change category (CHC) as required by A.1.4.5 of VMD0055 documentation

Land Cover Class	Total
CF-S	67
DF	36
MG-S	35
NF-S	36
OF-S	71
RF	14

The visual interpretation of each sample plot was then used to generate the error matrix of sample counts and the error matrix of estimated area proportions as instructed in VMD0055’s Appendix 1.

The results of the visual interpretation were used to group plots into deforestation, based on the transitions observed throughout the HRP. For example, plots that changed at any point during the HRP from forest to non-forests, were attributed to the class of deforestation. These results were cross-referenced with the modeled strata and their classification to generate the error matrix of sample counts shown in Table 27.

Table 27. Error Matrix of Sample Counts

		Visual Classifier						
		CFS	DF	MG	NF	OFS	RF	TOT
LULC model	CF-S	64	0	0	0	3	0	67
	DF	0	32	0	2	2	0	36
	MG-S	0	0	35	0	0	0	35
	NF-S	1	0	0	33	1	1	36
	OF-S	0	0	0	2	68	0	71
	RF	0	0	0	1	1	12	14
	Total	67	33	36	38	81	13	293

Table 28. User and Producer Accuracy, Overall Accuracy and Total Number of Valid Plots per Class.

	Transition Class	User Accuracy	Producer Accuracy	F1 score	Total
LULC model	<b>CF-S</b>	0.96	0.96	0.96	67
	<b>DF</b>	0.97	0.89	0.93	36
	<b>MG-S</b>	0.97	1	0.99	35
	<b>NF-S</b>	0.87	0.92	0.89	36
	<b>OF-S</b>	0.82	0.96	0.88	71
	<b>RF</b>	0.92	0.86	0.89	14

The results from Table 27 were used to calculate the user’s and producer’s accuracies for DF shown in Table 28. For both transitions, all accuracy was greater than 70%, as required in Step 1 of Section A1.4.3. of VMD0055 subsection titled “Accuracy Assessment of the Jurisdictional FCBM”.

From this data, the number of samples belonging to each LULC class and historical transitions category was determined following the directions in VMD0055:

- 1) For each sampling stratum, the relative frequency of DF, CFS, OFS and Non-Forest, was calculated as illustrated in Table 12 of VMD0055
- 2) The sample strata weights were calculated as the ratio between each sampling stratum and the total area of the jurisdiction (respectively AJ<sub>SS</sub> and AJ in VMD0055 Table 13, where AJ is the Jurisdictional area and AJ<sub>SS</sub> is the jurisdictional area in the stratum SS);
- 3) For each stratum the area proportion in each Change Category was calculated as defined in VMD0055 Eq. 53. The resulting proportions were summarized as required by VMD0055 in tabular form.

$$Prop_{J(CHC,SS)} = w_{SS} * (Count_{J(CHC,SS)}) / (Count_{J_{SS}}) \quad (Prop_{J(CHC,SS)} = w_{SS} * (COUNT_{J(CHC,SS)}) / (Count_{J_{SS}}) Prop_{J(CHC,SS)}) \quad \text{Equation 30}$$

Where:

- Prop<sub>JCHC,SS</sub> = Weighted proportion of AJ that falls into stratum SS and is classified as class CHC
- w<sub>SS</sub> = weight of sampling stratum
- Count<sub>JCHC,SS</sub> = total count of sampling units (i.e. plots) in stratum SS and class CHC
- Count<sub>J<sub>SS</sub></sub> = total count of sampling units (i.e. plots) in stratum SS
- CHC = Chage category: one of the categories in Table 9
- ss = sampling stratum.

- 4) Following Step 2 in VMD0055 A1.4.1 the historical area of each change category was calculated using the totals for the proportions estimated in the previous point, as follows:

$$AJ_{CHC} = \sum_{SS=1}^{SS} Prop_{JCHC,SS} \times Aj \quad \text{Equation 31}$$

Where:

- AJ<sub>CHC</sub> = Area of the Jurisdiction classified as change category (CHC) over the historical period.
- Prop<sub>JCHC,SS</sub> = Weighted proportion of AJ that falls into stratum SS and is classified as class CHC.
- AJ = Jurisdictional area.
- CHC = Chage category: one of the categories in Table 9

SS = 1, 2, 3, ..., SS sampling stratum

The results from Table 27 were also transformed into proportions weighted by the weight of each transition ( $ws$ ). Then, the results were used to estimate the area proportion of each transition within each stratum and calculate the standard error to each estimate. The standard error was calculated as follows:

$$S(Prop)_{CHC} = \sqrt{\sum_{SS=1}^{SS} ws_{SS}^2 \times \left( \frac{CountJ_{CHC}}{CountJ_{SS}} \times \left( 1 - \frac{CountJ_{CHC}}{CountJ_{SS}} \right) \right) / (CountJ_{SS} - 1)} \quad \text{Equation 32}$$

Where:

S(Prop<sub>CHC</sub>) = Standard error of the proportion of the project sampling frame in change category CHC (dimensionless)

WS<sub>ss</sub> = Weight of sampling stratum ss (dimensionless)

Count<sub>CHC,ss</sub> = Number of observations of change category CHC in sampling stratum ss (sample units)

Count<sub>ss</sub> = Total count of sample units in sampling stratum ss (sample units)

CHC = Change category: unplanned deforestation (UDef), stable forest (SF), stable non-forest (SNF), regrowth (Reg)

ss = 1, 2, 3, ..., SS sampling stratum

Calculate the standard error of the areas:

$$S(A)_{CHC} = S(Prop)_{CHC} * A_{CHC} \quad \text{Equation 33}$$

Where:

S(A<sub>CHC</sub>) = Standard error of the estimated area of change category CHC within the project sampling frame over the monitoring period (ha)

S(Prop<sub>CHC</sub>) = Standard error of the proportion of the project sampling frame in change category CHC (dimensionless)

A<sub>PSF</sub> = Area of project sampling frame (ha)

CHC = Change category: unplanned deforestation (UDef), stable forest (SF), stable non-forest (SNF), regrowth (Reg)

Calculate the percentage uncertainty of the estimated area. The percentage uncertainty is defined as the half-width of the two-sided 90 percent confidence interval, expressed as a percentage of the estimated area.

$$U\%(A_{CHC}) = t_{\alpha=10\%} \times S(A_{CHC}) / \left( \sum_{i=1}^M A_{PA,CHC,i} + \sum_{i=1}^M A_{LB,CHC,i} \right) \times 100 \quad \text{Equation 34}$$

Where:

- U%(A<sub>CHC</sub>) = Percentage uncertainty of the estimated area of change category CHC within the project sampling frame over the monitoring period (%)
- S(A<sub>CHC</sub>) = Standard error of the estimated area of change category CHC within the project sampling frame over the monitoring period (ha)
- A<sub>PA,CHC,i</sub> = Area of the UDef PA classified as change category CHC over the monitoring period (ha)
- A<sub>LB,CHC,i</sub> = Area of the UDef LB classified as change category CHC over the monitoring period (ha)
- t<sub>alpha=10%</sub> = Value of the t distribution for a two-sided 90 percent confidence interval (a value of 1.6449 may be used for UDef AD analyses)
- CHC = Change category: unplanned deforestation (UDef), stable forest (SF), stable non-forest (SNF), regrowth (Reg)
- i = 1, 2, 3, ..., M forest stratum

Once the Uncertainty was calculated, the estimate of the inflation factor was calculated as follows:

The inflation factor, IF<sub>UDef</sub> is calculated as follows:

$$IF_{UDef} = \left( U\%(A_{UDef}) \right) / (100 \times t_{alpha=10\%}) \times t_{alpha=66.67\%} \quad \text{Equation 35}$$

$IF_{UDef} = \left( U\%(A_{UDef}) \right) / (100 \times t_{alpha=10\%}) \times t_{alpha=66.67\%}$  Where:

- IF<sub>UDef</sub> = Inflation factor for area of unplanned deforestation (%)
- U%(A<sub>UDef</sub>) = Percentage uncertainty of the estimated area of unplanned deforestation (where CHC = UDef) within the project sampling frame over the monitoring period (%)
- t<sub>alpha=10%</sub> = Value of the t distribution for a two-sided 90 percent confidence interval (a value of 1.6449 may be used for AD analyses)
- t<sub>alpha=66.67%</sub> = Value of the t distribution for a one-sided 66.67% confidence interval (a value of 0.4307 may be used for AD analyses)

Using the estimated area and the inflation factors, calculate the final AD values for UDef PA:

$$A_{PA,inflated,UDef,i} = A_{PA,UDef,i} \times (1 + IF_{UDef}) \quad \text{Equation 36}$$

Where:

- A<sub>PA,inflated,UDef,i</sub> = Area of unplanned deforestation within forest stratum i of the UDef PA over the monitoring period, conservatively inflated for uncertainty (ha)
- A<sub>PA,UDef,i</sub> = Uninflated area of unplanned deforestation (where CHC = UDef) within forest stratum i within the UDef PA over the monitoring period (ha)
- IF<sub>UDef</sub> = Inflation factor for area of unplanned deforestation (%)
- i = 1, 2, 3, ..., M forest stratum

Using the estimated area and the inflation factors, calculate the final AD values for UDef LB:

$$A_{LB,inflated,UDef,i} = A_{LB,Udef,i} \times (1 + IF_{UDef}) \quad \text{Equation 37}$$

Where:

- $A_{LB,inflated,UDef,i}$  = Area of unplanned deforestation within forest stratum i in the UDef LB over the monitoring period, conservatively inflated for uncertainty (ha)
- $A_{LB,UDef,i}$  = Uninflated area of unplanned deforestation (where CHC = UDef) within forest stratum i within the UDef LB over the monitoring period (ha)
- $IF_{UDef}$  = Inflation factor for area of unplanned deforestation (%)
- i = 1, 2, 3, ..., M forest stratum

### 2.5.5.2. Areas of Identified Exclusions

In accordance with VMD0055 and related requirements, several categories of land were excluded from the JNR Baseline Area. These exclusions were made to ensure consistency with national regulations, the Consolidated Methodology, and best practices in emissions accounting.

#### Mining Areas

Mining areas authorized and deforested during the historical reference period were excluded from the JNR Baseline, provided they exceeded 1,000 hectares. These areas were identified using shapefiles from the National Mining Agency. Areas in the exploratory phase, which had not yet experienced deforestation, remain part of the baseline, as they are still subject to unplanned deforestation risks.

#### Urban Areas and Infrastructure

Urban and infrastructure-related areas were mapped using the Land Cover 100K (2018) dataset. The following land cover types were excluded from the baseline:

- Continuous urban areas
- Discontinuous urban areas
- Industrial or commercial areas
- Roads, railways, and associated lands
- Port areas
- Airports
- Waterworks infrastructure
- Mining extraction areas
- Waste disposal sites
- Urban green areas
- Recreational facilities

These categories were converted into a raster map, later transformed into vector format for spatial analysis. A “multipart to singlepart” operation allowed the selection and exclusion of individual urban polygons exceeding 1,000 hectares. Excluding such areas provides a conservative approach to accounting for unplanned deforestation, particularly around cities where infrastructure expansion may contribute to forest loss.

#### Water Bodies

Natural water bodies were removed from the JNR Baseline Area, as these are not subject to deforestation or emissions from land-use change.

### **Intertidal Wetlands and Mangroves**

Given that the jurisdiction contains over 1,000 hectares of mangroves, intertidal wetland zones were included in the baseline. These ecosystems are at risk of deforestation and degradation. However, their inclusion requires the application of methodological guidance outlined in VMD0050 and VMD0016, as detailed in Section 2.4.2.

### **Timber Concessions**

All areas identified as active timber concessions during the historical reference period were excluded from the Jurisdictional Baseline. These concessions represent planned forest operations authorized by the State and do not qualify as unplanned deforestation. Their exclusion is necessary to ensure the accuracy of emissions reduction estimates and to avoid double-counting of forest-related activities.

Timber concessions often overlap with areas designated under Law 2 of 1959, which established Colombia's National Forest Reserve Zones. These zones are legally protected areas created to conserve forest ecosystems, regulate land use, and promote sustainable management of natural resources. Activities within these reserves are subject to strict environmental regulations aimed at preserving biodiversity, protecting watersheds, and reducing deforestation.

To support the effective governance of these reserves, the Ministry of Environment and Sustainable Development, through its Biodiversity and Ecosystem Services Directorate, has developed zoning and planning tools. These instruments provide technical and policy guidance for land use planning across productive sectors, without altering the legal status or land-use restrictions of the Forest Reserves.

However, portions of these reserves may be formally removed through a process known as permanent exclusion (*sustracción definitiva*). These exclusions are granted via administrative resolutions issued by the Ministry or its delegated authorities, typically in response to formal requests by public or private entities. The process involves legal and technical evaluations to ensure compliance with national environmental policies.

Once excluded, these areas may be used for alternative purposes—such as agriculture, infrastructure, or mining—while the recipient is required to fulfill specific environmental compensation obligations. These compensatory measures are designed to offset the ecological impact of removing forest land from the reserve system.

In the context of the JNR Baseline, areas under active timber concessions, whether inside or outside Forest Reserves, are treated as planned deforestation and are excluded from baseline emissions estimates accordingly.

Only areas exceeding 1,000 hectares and deforested during the historical reference period were considered under this category. These areas were selected based on the significant scale and impact of the activities, as outlined in the Consolidated Methodology.

In cases where planned deforestation areas below 1,000 hectares are detected in future monitoring periods, they may only be excluded if credible, documented, and verifiable evidence is provided showing that the deforestation was executed by a single, identifiable agent. Otherwise, they must be included in the net emissions assessment.

### **Natural Disturbances**

No large-scale, infrequent natural disturbances (e.g., wildfires, hurricanes) were recorded in the jurisdiction during the historical reference period. Therefore, no areas were excluded under this category.

2.5.6. Data and Parameters Available at Validation

<b>Data / Parameter</b>	AJ
<b>Data unit</b>	ha
<b>Description</b>	Area of the jurisdiction
<b>Equations</b>	Equation 32Equation 31
<b>Source of data:</b>	Digital map of jurisdictional boundaries
<b>Value Applied:</b>	Calculated within a GIS
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	Prior to the start of each BVP
<b>Purpose of Data</b>	Calculation of AD
<b>Comments</b>	Area should be calculated within the coordinate system of the digital map of jurisdictional boundaries

<b>Data/Parameter</b>	AJNR-UDef
<b>Data unit</b>	ha
<b>Description</b>	Area of the jurisdiction where unplanned deforestation will take place during the BVP
<b>Equations</b>	N/A
<b>Source of data</b>	Calculated within a GIS
<b>Value applied</b>	
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	
<b>Purpose of data</b>	Allocation of baseline Activity Data
<b>Comments</b>	

<b>Data / Parameter</b>	$CF_j$
<b>Data unit</b>	[Mg C (Mg DM) <sup>-1</sup> ]
<b>Description</b>	Carbon fraction of dry matter in wood
<b>Source of data:</b>	Equation 3, 8, 29
<b>Value Applied:</b>	0.47

<b>Justification of choice of data or description of measurement methods and procedures applied</b>	IPCC GPG-LULUCF 2003 default value
<b>Purpose of Data</b>	Partitions carbon from biomass data. Used in calculations of annual carbon loss. This data is used for: <ul style="list-style-type: none"> <li>• Calculation of baseline emissions</li> <li>• Calculation of leakage emissions</li> </ul>
<b>Comments</b>	

<b>Data / Parameter</b>	$CF_{soc}$
<b>Data unit</b>	[Mg C (Mg DM) <sup>-1</sup> ]
<b>Description</b>	Carbon fraction of soil organic matter
<b>Source of data:</b>	Equation 9
<b>Value Applied:</b>	0.58
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	2006 IPCC Guidelines for National Greenhouse Gas Inventories default value
<b>Purpose of Data</b>	Calculation of baseline emissions
<b>Comments</b>	

<b>Data / Parameter [EA6]:</b>	$sc_1$
<b>Data unit</b>	[-]
<b>Description</b>	First shape factor for the forest scarcity equation; steepness of the decrease in deforestation rate (greater is steeper).
<b>Source of data:</b>	Statistical fitting procedure. Using remotely sensed forest cover data in heavily deforested areas close to the Project Area such as neighboring provinces, states or countries
<b>Value Applied:</b>	20
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	Used model-fitting procedures for alternative risk model
<b>Purpose of Data</b>	Calculation of baseline emissions
<b>Comments</b>	This parameter is calculated by Terra Global.

<b>Data / Parameter [EA1]:</b>	$sc_2$
<b>Data unit</b>	[-]

<b>Description</b>	Second shape factor for the forest scarcity equation; relative deforested area at which the deforestation rate will be 50% of the initial deforestation rate.
<b>Source of data:</b>	Statistical fitting procedure. Using remotely sensed forest cover data in heavily deforested areas close to the Jurisdictional Area such as neighboring provinces, states or countries
<b>Value Applied:</b>	0.7
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	Used model-fitting procedures for alternative risk model
<b>Purpose of Data</b>	Calculation of baseline emissions
<b>Comments</b>	Higher values of $sc_2$ result in lower deforestation and are therefore conservative. This parameter is calculated by Terra Global.

<b>Data/Parameter:</b>	$\rho_{(wood,j)}$
<b>Data unit:</b>	[Mg DM m <sup>-3</sup> ]
<b>Description:</b>	Average basic wood density of species or species group j
<b>Source of data:</b>	GPG-LULUCF Table 3A.1.9. or published data/literature.
<b>Value Applied:</b>	0.633
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	When no species-specific or species-group specific densities are available, an average representative density may be used for all species or species groups.
<b>Purpose of Data</b>	<ul style="list-style-type: none"> <li>• Calculation of baseline emissions</li> <li>• Calculation of leakage emissions</li> </ul>
<b>Comments</b>	Average density value of all identified tree species

<b>Data/parameter [EA2]:</b>	$Bias(nh)$
<b>Data unit:</b>	ha
<b>Description:</b>	Bias correction for each land use transition
<b>Source of data:</b>	LULC classification
<b>Value Applied:</b>	See 2.5.5.1.8
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	Calculated based on the directions of the GOFI Methods and Guidance v.2.0 Box 24 and Box 25
<b>Purpose of Data</b>	Allocation
<b>Comments</b>	N/A

<b>Data/parameter [MN1]:</b>	$\Delta area_{projectAreaEAH,baselineScenario}(t, i)$
<b>Data unit:</b>	[ha yr <sup>-1</sup> ]
<b>Description:</b>	Hectares undergoing transition <i>i</i> within the Jurisdiction
<b>Sources of data:</b>	Historical LULC classification and land-use change modelling
<b>Description of measurement methods and procedures to be applied:</b>	Calculate based on the LULC classification
<b>Frequency of monitoring/recording:</b>	At least once before every baseline. Calculation of baseline emissions
<b>Value applied:</b>	See the land-use change transition matrix.
<b>Monitoring equipment:</b>	GIS
<b>QA/QC procedures to be applied:</b>	n/a
<b>Purpose of data:</b>	Used to establish LULC transitions in the baseline scenario. This data is used for: Calculation of baseline emissions
<b>Calculation method:</b>	Calculate a land-use change transition matrix, which summarizes all predicted LULC transitions.
<b>Comments:</b>	This parameter is calculated by Terra Global.

<b>Data / Parameter</b>	$t_{\alpha=10\%}$
<b>Data unit</b>	unitless
<b>Description</b>	Value of the Student's t distribution for a two-sided 90 percent confidence interval
<b>Equations</b>	Equation 18, 19
<b>Source of data</b>	Common statistical tables or software
<b>Value applied</b>	Determined by project proponent. A value of 1.6449 may be used for analyses involving 50 or more samples (e.g., AD estimates). The t value corresponding to the number of degrees of freedom must be used for cases involving less than 50 samples (e.g., carbon stock estimates).
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	Based on the central limit theorem, sample estimates are assumed to approach a normal distribution, from which a confidence interval may be constructed. The Student's t distribution is used to allow for small sample sizes.
<b>Purpose of Data</b>	Calculation of baseline emissions and project emissions
<b>Comments</b>	None

<b>Data / Parameter</b>	alpha=66.67%
<b>Data unit</b>	unitless
<b>Description</b>	Value of the Student's t distribution for a one-sided 66.67 percent confidence interval
<b>Equations</b>	Equation 18, 19
<b>Source of data</b>	Common statistical tables or software
<b>Value applied</b>	Determined by project proponent. A value of 0.4307 may be used for analyses with 50 or more samples (e.g., AD estimates). The t value corresponding to the number of degrees of freedom must be used for cases involving fewer than 50 samples (e.g., carbon stock estimates).
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	Based on the central limit theorem, sample estimates are assumed to approach a normal distribution, from which a confidence interval may be constructed. The Student's t distribution is used to allow for small sample sizes.
<b>Purpose of Data</b>	Calculation of baseline emissions and project emissions
<b>Comments</b>	None

<b>Data / Parameter</b>	fj(X,Y)		
<b>Data unit</b>	t d.m. tree-1		
<b>Description</b>	Allometric equation for species j linking measured tree variable(s) to aboveground biomass of living trees, expressed as t d.m. tree-1		
<b>Equations</b>	Equation 3		
<b>Source of data</b>	<b>Vegetation</b>	<b>Source</b>	
	Mangroves	(Chave et al., 2005)	
	Palms	(Duque, et al., 2017)	
	Tropical Wet	(Alvarez, et al., 2012)	
<b>Value applied</b>	<b>Vegetation</b>	<b>Allometric equation</b>	
	Mangroves	$AGB = 0.0509 \times WD \times DBH^2 \times H$	
	Palms	$AGB = 0.334 \times (DBH^2 \times H \times DMF)^{0.803}$	
	Tropical Wet	$Ln(AGB) = -2.857 + 2.081 \times Ln(DBH)$ $+ 0.587 \times Ln(H)$ $+ 0.453 \times Ln(WD)$	
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	-		
<b>Purpose of Data</b>	Calculation of baseline and project emissions		

<b>Comments</b>	Where new species are encountered in the course of monitoring, new carbon fraction values must be sourced from the literature or otherwise use the default value.
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<b>Data / Parameter</b>	R							
<b>Data unit</b>	t root d.m. t -1 shoot d.m.							
<b>Description</b>	Root to shoot ratio appropriate to species or forest type / biome; note that as defined here, root to shoot ratio is applied as belowground biomass per unit area:aboveground biomass per unit area (not on a per stem basis)							
<b>Equations</b>	Equation 5							
<b>Source of data</b>								
<b>Value applied</b>	<b>Species Group</b>	<b>Source</b>						
	Tropical Forest	(Mosquera & Moreno, 2017)						
	Mangroves	(Santos et al., 2017)						
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="background-color: #005596; color: white;"><b>Species Group</b></td> <td style="background-color: #005596; color: white;"><b>Root to Shoot Ratio</b></td> </tr> <tr> <td>Tropical Forest</td> <td>0.21</td> </tr> <tr> <td>Mangroves</td> <td>1.14</td> </tr> </table>		<b>Species Group</b>	<b>Root to Shoot Ratio</b>	Tropical Forest	0.21	Mangroves	1.14
<b>Species Group</b>	<b>Root to Shoot Ratio</b>							
Tropical Forest	0.21							
Mangroves	1.14							
<b>Purpose of Data</b>	Calculation of baseline and project emissions							
<b>Comments</b>	Where new species are encountered in the course of monitoring, new carbon fraction values must be sourced from the literature or otherwise use the default value.							

<b>Data / Parameter</b>	$D_{DWdc}$
<b>Data unit</b>	t d.m. m-3
<b>Description</b>	Mean wood density of dead wood in the density class (dc) – sound (1), intermediate (2), and rotten (3); t d.m. m-3
<b>Equations</b>	Equation 5
<b>Source of data</b>	The source of data shall be chosen with priority from higher to lower preference as follows: a) Research publications relevant to the project area; b) National species-specific or group of species-specific (e.g. from National GHG inventory); c) Species-specific or group of species-specific from neighboring countries with similar conditions. Sometimes (c) may be preferable to (b); d) Global species-specific or group of species-specific (e.g. IPCC GPG-LULUCF). Species-specific dead wood densities may not

	always be available, and may be difficult to apply with certainty to decomposed wood and in the typically species rich forests of the humid tropics, hence it is acceptable practice to use dead wood densities developed for forest types.
<b>Value applied</b>	
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	Project-specific determination of density is most likely necessary, requiring collection of representative samples (in terms of scale and representation of forest strata/species composition similar to the inventory), from a minimum of 20-30 trees from each density class. Density classes need not be determined for specific species or species groups. Dead wood samples are cut in discs and thickness and diameter measured to calculate green volume. Samples are oven dried (70o C) to a constant weight in the laboratory, and density calculated as dry weight (g) per unit green volume (cm <sup>3</sup> ), from which mean value and 90% confidence interval are calculated for each density class. For each density class, either: <ul style="list-style-type: none"> <li>• If the 90% confidence interval is equal to or less than 10% of the mean, the mean density value is applied in project calculations.</li> <li>• If the 90% confidence interval is greater than 10% of the mean, the lower 90% confidence bound of the mean density estimate is applied in project calculations.</li> </ul>
<b>Purpose of Data</b>	Calculation of baseline and project emissions
<b>Comments</b>	-

<b>Data / Parameter</b>	Depsample
<b>Data unit</b>	cm.
<b>Description</b>	Depth in cm to which soil sample is collected
<b>Equations</b>	Equation 9
<b>Source of data</b>	Core dimensions recorded in the field
<b>Value applied</b>	30 cm
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	Depth of sampling for soil organic carbon is centered on the upper soil horizons where root biomass and organic matter inputs are concentrated, depending on soil type and ecosystem, typically between 20 cm and 100 cm. Depth of soil sampling employed in inventories is held constant for the duration of the project.
<b>Purpose of Data</b>	Calculation of baseline and project emissions
<b>Comments</b>	-

<b>Data / Parameter</b>	FLU
<b>Data unit</b>	Dimensionless
<b>Description</b>	Land use factor before or after conversion

<b>Equations</b>	Equation 11
<b>Source of data</b>	Stock Change Factors are provided in Tables 5.5, 5.10, and 6.2 of the IPCC 2006GL Volume 4
<b>Value applied</b>	0.48
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	-
<b>Purpose of Data</b>	Calculation of baseline and project emissions
<b>Comments</b>	Stock Change Factors as defined in IPCC 2006GL are equal to the carbon stock in the altered condition as a proportion of the reference carbon stock. Stock Change Factors must be selected to reflect the circumstances most closely matching those of the project area and baseline scenario, especially regarding climate and post-conversion land-use, taking into account management practices and carbon inputs (e.g. manure).

<b>Data / Parameter</b>	FMG
<b>Data unit</b>	Dimensionless
<b>Description</b>	Management factor before or after conversion
<b>Equations</b>	Equation 11
<b>Source of data</b>	Stock Change Factors are provided in Tables 5.5, 5.10, and 6.2 of the IPCC 2006GL Volume 4
<b>Value applied</b>	1.15
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	-
<b>Purpose of Data</b>	Calculation of baseline and project emissions
<b>Comments</b>	Stock Change Factors as defined in IPCC 2006GL are equal to the carbon stock in the altered condition as a proportion of the reference carbon stock. Stock Change Factors must be selected to reflect the circumstances most closely matching those of the project area and baseline scenario, especially regarding climate and post-conversion land-use, taking into account management practices and carbon inputs (e.g. manure).

<b>Data / Parameter</b>	FI
<b>Data unit</b>	Dimensionless
<b>Description</b>	Input factor before or after conversion
<b>Equations</b>	Equation 11

<b>Source of data</b>	Stock Change Factors are provided in Tables 5.5, 5.10, and 6.2 of the IPCC 2006GL Volume 4
<b>Value applied</b>	0.92
<b>Justification of choice of data or description of measurement methods and procedures applied</b>	-
<b>Purpose of Data</b>	Calculation of baseline and project emissions
<b>Comments</b>	Stock Change Factors as defined in IPCC 2006GL are equal to the carbon stock in the altered condition as a proportion of the reference carbon stock. Stock Change Factors must be selected to reflect the circumstances most closely matching those of the project area and baseline scenario, especially regarding climate and post-conversion land-use, taking into account management practices and carbon inputs (e.g. manure).

## 2.5.7. Description of Data Collection

### 2.5.7.1. Activity Data -Remote Sensing and Spatial Data

The quantification of deforestation rates under the Choco Jurisdiction are based in part on remote sensing and other spatial data. The selection of data sources used follows Chapter 3 A.2.4 of the IPCC 2006 GL AFOLU. Remote sensing and other spatial data employed for assessing deforestation is listed in Section 2.5.5.1.1. Baseline reassessment data will use the same spatial resolution and will have the same accuracy assessment and will use the same standard error determination.

The accuracy assessment of the LULC classification for validation of the Baseline will be re-produced in the baseline assessment. The accuracy was assessed by comparing predicted LULC classes for several reference locations with independently determined LULC classes. The standard error is calculated based on the directions of the GOFI Methods and Guidance v.2.0 Box 24 and Box 25. To calculate the standard error in the transitions, a sample-based approach will be used. Reference locations within each LULC class will be systematically distributed to represent varying topography, parcels and other geographic features.

### 2.5.7.2. Biomass Plots

Plot measurements consisted of a 50m x 50m nested plot design used to measure biomass both inside and outside the Project Area. Note that this procedure only uses subplots for non-tree aboveground biomass, litter, SOC, seedlings and saplings, and trees between 5-10 cm DBH. All trees with DBH  $\geq$  10 cm were measured in the entire plot. The carbon pools measured were as follows:

- Aboveground tree biomass
- Standing deadwood biomass
- Downed deadwood biomass
- Non-tree living biomass

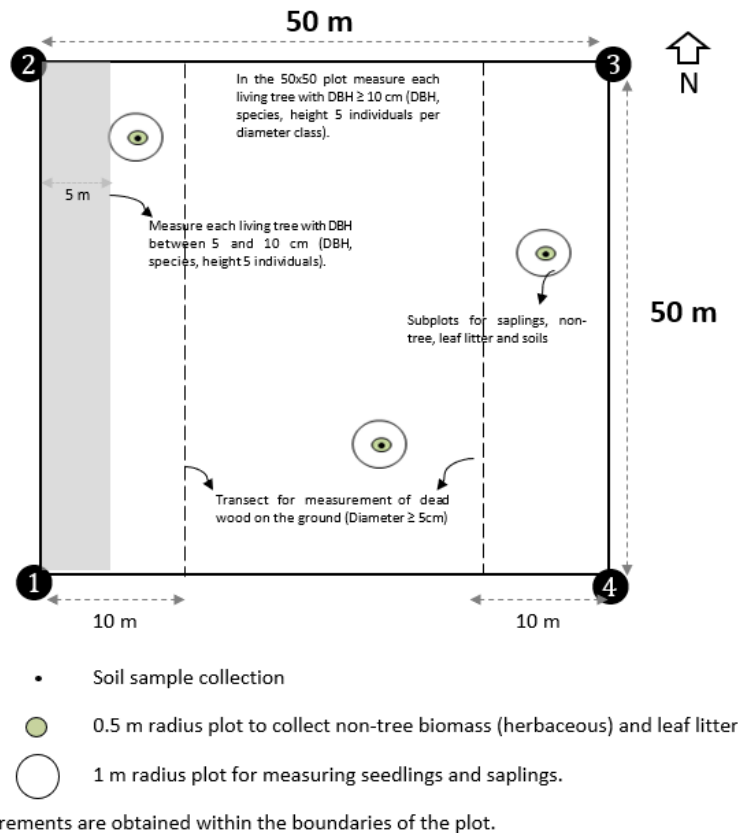


Figure 6. Biomass Sample Plot Design

The detailed sampling design and procedures to measure each of the biomass pools are described in detail in the Biomass Standard Operational Procedure-SOP.

Due to the broad spatial extension of the jurisdiction, the VT0005 tool for measuring aboveground live forest biomass using remote sensing was implemented combining remote sensing data with in-situ measurements. VT0005 was applied to this project due to its ability to provide accurate and cost-effective estimations of aboveground live forest biomass (ALFB) across varied LULC.

The size and number of plots established across the Jurisdictional Crediting Area and used to assess the LiDAR model is shown in Table 29 and Table 30.

Table 29. Plots Established in the Jurisdiction and Used in Developing and Testing the Accuracy of LIDAR Biomass Model

Biomass Inventory	Sampling Unit Type	Sampling Unit Size	Number of Samples
AGB Live Tree	Plot	2,500 m <sup>2</sup>	48
AGB Live Tree-Sapling	Plot	250 m <sup>2</sup>	48
Standing Deadwood	Plot	2,500 m <sup>2</sup>	48
Lying Deadwood	Transect	50 m	98
Non-woody	Plot	3 m <sup>2</sup>	147
Litter	Plot	0.8 m <sup>2</sup>	147
SOM	Point	30 cm deep	147

The Jurisdictional Crediting Area was divided into strata based on LULC types, then, the plots were distributed by strata as shown in Table 30.

Table 30. Number of sample plots per land cover classification.

Land cover classification	Sample plots
Closed Forest Upland (CFU)	22
Open Forest Upland (OFU)	2
Closed Forest Lowland (CFL)	9
Open Forest Lowland (OFL)	5
Mangrove (MGR)	6
Bare (BAR)	2
Agriculture (AGW)	2
<b>Total</b>	<b>48</b>

### 2.5.7.3. LiDAR Data Collection

#### 2.5.7.3.1. LiDAR Sampling Approach

Considering the jurisdiction’s size, LiDAR data were collected randomly through transects across the jurisdiction to improve the quantification of carbon stocks.

A stratified map was utilized for the region, distinguishing lowland, highland, and wetland forests (including mangroves), to guide the design of LiDAR data sampling across the entire Chocó Region. This stratification was based on previously published peer-reviewed results (Meyer, et al., 2013) and was created by combining radar and cloud-free optical remote-sensing data with digital elevation models to separate forested areas from non-forest, wetland, and higher-elevation zones (>600 m), as described in the LULC maps.

The stratified map directed the selection of sites for forest inventories and airborne LiDAR sampling. Sixty locations were randomly selected within the forest strata, and LiDAR transects of roughly 1,000 hectares each (1 km × 10 km) were developed, producing approximately 80,000 hectares of stratified, design-based LiDAR samples. All LiDAR data were collected in 2015, and some samples coincided with earlier collections from 2014, enabling the assessment of biomass changes between the two dates and the estimation of potential forest growth rates in the region.

The number and size of each transect were planned to minimize variance in biomass estimation by accounting for uncertainties in LiDAR biomass estimates, allometry, sampling errors, and natural biomass variation. LiDAR sampling covered more than 1,000 hectares, with multiple transects placed within each stratum according to its size. This deliberate oversampling relative to ground inventories fulfilled two key objectives:

1. Sampling was random and sufficiently extensive within each stratum to reduce the standard error of estimates, targeting less than 10 % error at a 95 % confidence interval. The extensive LiDAR data acquired reduced errors to roughly an order of magnitude below that target.
2. Samples were clustered along LiDAR flight paths and were large enough to provide accurate estimates of both the mean and the variance of biomass within each stratum.

The LiDAR data were processed into digital terrain models (DTMs), digital surface models (DSMs), and multiple height metrics and structural attributes across the vertical dimension that correlated with basal area and biomass at the plot level. Post-processing also included filtering anomalies, adjusting DTMs through various interpolation techniques across diverse topographic landscapes, improving the classification of ground and vegetation points, and co-registering with past LiDAR flights to detect changes such as emissions and the removal of degraded forests. After extracting LiDAR height and structural metrics, algorithmic models (e.g., multivariate power-law models) were developed to estimate above-ground biomass from LiDAR at the plot scale. Model development was evaluated to determine whether a single model or multiple models were best suited for the jurisdiction in terms of biomass-uncertainty estimates.

The uncertainty of the model estimators was calculated using sampling and residual uncertainty as outlined in VM0048/VMD0055 and in recently published approaches. Below-ground biomass was estimated using IPCC guidelines (Mokany et al., 2006) or other available local models.

To calibrate the LiDAR biomass model, biomass inventories inside the LiDAR transects were collected. The baseline employed a parametric LiDAR-biomass model, which used mean wood density and mean top-canopy height as inputs. LiDAR technology was used to estimate carbon stocks in accordance with the VCS-approved VT0005 *Tool for Measuring Above-Ground Live Forest Biomass Using Remote Sensing v1.0*, and it was applied during each baseline update. This tool was particularly suitable for the project due to the vast and remote nature of the area, where relying solely on ground-based measurements would have been cost-prohibitive.

Monitoring carbon-stock densities and transitions within LULC classes and forest strata was required to calculate actual Net Emission Reductions (NERs), including measurements of above-ground live forest biomass (ALFB). Section 2 of the VT0005 Tool supported the finding that LiDAR-based biomass inventories offered superior accuracy, particularly where statistically valid ground-based sampling was impractical. Consequently, the carbon-stock densities obtained through VT0005 were more accurate than those derived from traditional ground-based forest inventories. This approach was also aligned with VMD0016, Section 4.1, which required confirmation that no large, previously unstratified clusters (over 10 % of samples) differed significantly ( $\pm 20$  %) from the project's average biomass. If such clusters were identified, a new stratum was defined using vegetation maps or remote imagery.

Map 22 shows the location of the 49 LiDAR transects, each covering 850 hectares, along with the 24 biomass-plot locations within some of the LiDAR transects



Map 22. Distribution of LiDAR transects and field Biomass plots across the jurisdiction.

### 2.5.7.3.2. LiDAR Data Processing

A total of approximately 80,000 hectares of inventory samples were collected using airborne LiDAR in discrete-return mode, achieving an average density of 20 points per m<sup>2</sup>. This point density was sufficient for accurate forest-height measurements, enabling the quantification of the digital terrain model (DTM) and the digital surface model (DSM) (Figure 7). The difference between the DTM and DSM provided the maximum, or top-canopy, height at a 1-m<sup>2</sup> grid cell.

Preprocessing of the LiDAR point clouds involved calibration and classification to distinguish ground points from vegetation points. The final classified LiDAR points were filtered to remove artifacts in ground classification, and ground points were interpolated to improve the development of both the DSM and the DTM.

Three raster products at a 1-meter spatial resolution were generated from the LiDAR point cloud: the DTM, DSM, and canopy-height model (CHM). The DTM was created using the mean elevation of LiDAR points classified as class 2 (ground) for each 1-meter pixel, with missing data interpolated using natural-neighbor

methods. LiDAR points classified as classes 3 (low vegetation) and 4 (medium vegetation) were combined to create the DSM. The maximum elevation of the LiDAR points within each 1-meter pixel was used as the DSM value. Consequently, the CHM was calculated as the height difference between the DSM and the DTM.

The 1-meter CHM was then used to generate mean-canopy-height (MCH) estimates at 50-meter and 100-meter resolutions. To ensure that MCH values accurately represented the mean characteristics of 1-hectare pixels, MCH observations were considered valid only when at least 90 % of the pixels in the 50 m × 50 m or 100 m × 100 m grid were covered. This approach excluded edge pixels with partial coverage during the 1-hectare mapping process. The final LiDAR-derived MCH at 0.25-hectare and 1-hectare scales was then used to generate biomass estimates based on allometric models.

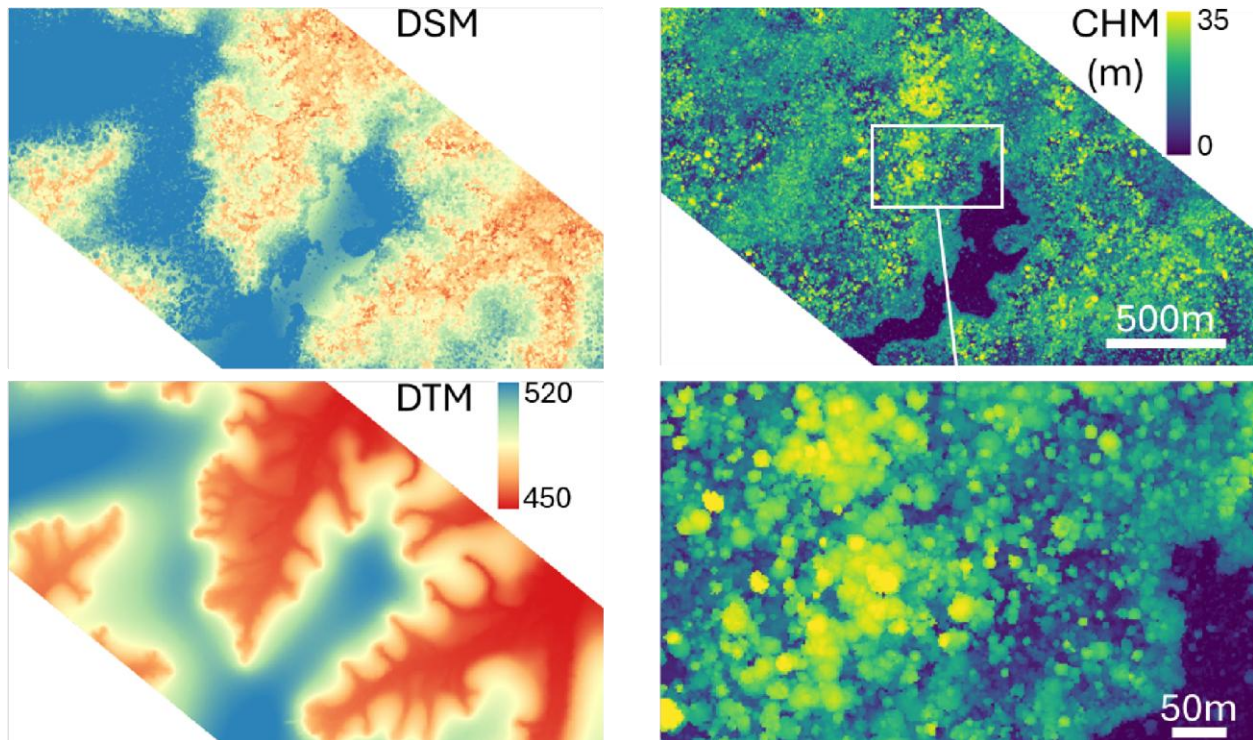


Figure 7. Generation of the Canopy height model (CHM) at 1-m resolution from the Digital Surface model (DSM) and Digital Terrain Model (DTM) interpolated from the LiDAR point clouds. Individual tree crowns can be noticed from the CHM.

#### 2.5.7.3.3. Use of Field Inventory Plots for LiDAR Estimates

Forest inventory plots were collected (section 2.5.7.2) beneath the LiDAR flights to develop models for LiDAR calibration. These square plots were used to calibrate and validate the aboveground biomass (AGB) model against the LiDAR data. Their size was sufficient to minimize errors related to geolocation and edge effects when calibrating remote-sensing data.

The plot dimensions struck a balance between smaller plots—efficient for field inventory (e.g., <0.1 ha) but prone to greater uncertainty in AGB estimates—and larger plots (e.g., 1.0 ha), which were more costly and challenging to establish but yielded lower uncertainty (~10 % relative error with no bias) (Meyer, et al., 2013; Asner & Mascaro, 2014).

A minimum of 45 plots was required for developing and validating the remote-sensing-to-AGB predictive model, with 30 plots designated for calibration and 15 for validation.

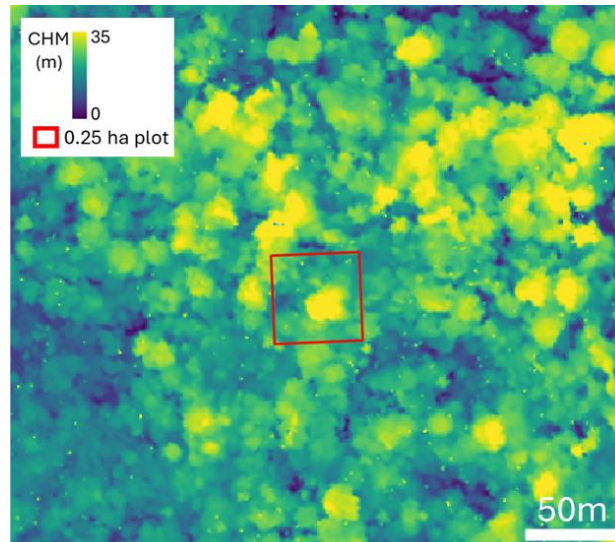


Figure 8. Shape and size of a field inventory plot within the LiDAR transects

In each plot, all trees with a diameter at breast height (DBH) of  $\geq 10$  cm were measured and identified by species to assign wood density (WD) values from the global database by (Zanne, et al., 2009). Above-ground biomass (AGB) was estimated using the allometric Equation 2 from (Chave, et al., 2014) for wet forests and mangroves, which incorporates both DBH and WD.

Below-ground biomass (BGB) was estimated using established root-to-shoot ratios: 0.21 (Quinto-Mosquera & Moreno, 2017) for all forest types except mangroves, which utilized a ratio of 1.14 (Santos, et al., 2017). Plot-level AGB was calculated by summing the AGB of all trees within each plot. AGB values ranged from  $0.52 \text{ Mg ha}^{-1}$  to  $1,164 \text{ Mg ha}^{-1}$ , with an average of  $173.7 \text{ Mg ha}^{-1}$  and a standard deviation of  $204.07 \text{ Mg ha}^{-1}$ .

#### 2.5.7.3.4. LiDAR Biomass Estimator

The LiDAR-derived above-ground biomass (AGB) model developed for the Chocó region of Colombia (Meyer, et al., 2013); Figure 9 Figure 8 was utilized to convert mean canopy height (MCH) into AGB estimates at the 1-hectare scale. This model was derived by integrating AGB and wood density (WD) measurements from 43 1-hectare plots with corresponding LiDAR-derived MCH data from the canopy height model (CHM).

$$AGB = 17.8 \times (MCH \times WD)^{10} \quad \text{Equation 38}$$

In this equation, WD represents the plot-mean wood density (in  $\text{g/cm}^3$ ), and MCH denotes the plot-mean top canopy height (in meters) obtained from LiDAR observations. A power law model with an exponent of approximately 1 was selected to maintain consistency with previous studies.

We applied the model to all LiDAR data using a map of mean wood density for each forest type. The average wood density values derived from field inventory plots (Meyer et al., 2019) are as follows: wetlands =  $0.49 \text{ g/cm}^3$ ; terra firme forests =  $0.66 \text{ g/cm}^3$ ; mangroves =  $0.73 \text{ g/cm}^3$ .

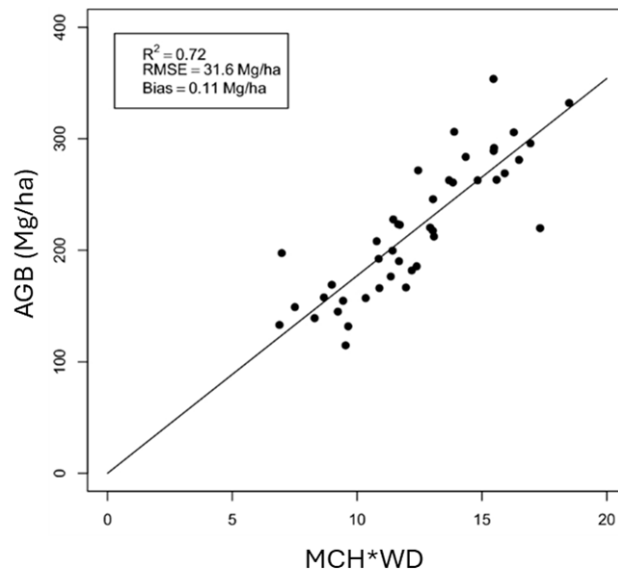


Figure 9. Calibration of airborne LiDAR measurements of the mean top canopy height (MCH) in meter to above ground biomass density (AGB) in Mg ha<sup>-1</sup> using 43 1-ha plots distributed across LiDAR flights (Meyer et al., 2019).

2.5.7.3.5. Uncertainty Estimates

*LiDAR-AGB Model Uncertainty*

We assessed the uncertainty of the AGB model using a bootstrapping cross-validation approach, performing 100 iterations. In each iteration, 70% of the data was randomly selected for model fitting, while the remaining 30% was used for validation. This process generated 100 AGB maps, which were aggregated to provide pixel-level variance in predictions. The results indicate that the model has an R<sup>2</sup> of 0.72 and a root mean squared error (RMSE) of 31.6 Mg ha<sup>-1</sup>, while remaining relatively unbiased at 0.11 Mg ha<sup>-1</sup> (Meyer, et al., 2013). Incorporating wood density as a weighting factor for LiDAR derived MCH helps reduce bias introduced by variations in tree composition.

*Pixel-level Uncertainty*

The overall uncertainty associated with AGB estimation at each pixel includes uncertainties from both the LiDAR-AGB model and plot-based AGB, calculated using standard error propagation (Cushman et al., 2023):

$$\sigma_{total}(u) = \sqrt{\sigma^2_{RS}(u) + \sigma^2_{modelling}(u)} \tag{Equation 39}$$

Where  $\sigma_{total}(u)$  is the uncertainty of the AGB estimate at the pixel level,  $\sigma^2_{RS}(u)$  is the error of the map for each pixel derived from the bootstrapping cross-validation,  $\sigma^2_{modelling}(u)$  is the error associated with the lidar-derived AGB model, including the GPS error causing discrepancies between the lidar metrics and the field AGB. The uncertainties associated with the MCH map were only based on airborne lidar measurement errors and can be considered relatively negligible.

Table 31. Mean and standard error (95% CI) of forest above ground biomass (Mg ha<sup>-1</sup>) in each LiDAR flight line using lidar derived biomass values at the 0.25-ha pixel scale.

Flight Number	AGB Mean	SE (95%CI)	AGB Min	AGB Max
(-)	(MGDM ha-1)	(-)	(MGDM ha-1)	(MGDM ha-1)
1	212.71	8.77	0.22	432.95
2	267.11	10.31	24.76	458.88

Flight Number	AGB Mean	SE (95%CI)	AGB Min	AGB Max
(-)	(MGDM ha-1)	(-)	(MGDM ha-1)	(MGDM ha-1)
3	177.50	6.60	0.12	369.86
4	316.33	15.30	68.42	508.30
5	251.08	9.72	6.26	479.35
6	151.72	6.60	0.10	382.33
7	239.97	9.55	3.23	410.14
8	295.70	12.27	99.51	480.56
9	225.54	6.04	7.44	317.74
10	210.93	7.16	0.60	365.30
11	278.12	10.17	86.14	389.53
12	182.14	6.77	0.21	351.41
13	148.27	7.21	0.08	416.05
14	207.97	7.26	6.21	399.88
15	236.59	7.88	17.91	358.72
16	183.25	6.16	1.73	302.43
17	213.27	7.45	8.70	333.03
18	206.37	8.19	1.51	361.10
19	193.23	6.09	12.92	306.79
20	220.68	7.14	1.50	362.15
21	193.11	7.01	5.19	371.75
22	187.29	5.69	0.87	282.28
23	248.41	7.74	34.10	375.32
24	256.15	9.55	34.22	402.19
25	189.90	7.76	0.20	373.01
26	217.03	7.43	8.26	348.66
27	287.98	12.02	41.25	404.69
28	229.03	7.09	19.48	414.42
29	163.48	6.99	1.84	341.64
30	149.89	6.17	1.11	299.65
31	151.14	7.28	15.20	372.68
32	218.44	8.87	0.22	379.14
33	271.92	11.94	0.17	411.16
34	266.62	10.16	20.63	388.79
35	275.72	12.02	26.14	399.63
36	322.54	16.08	171.59	514.68
37	214.58	9.19	0.15	421.53

Flight Number	AGB Mean	SE (95%CI)	AGB Min	AGB Max
(-)	(MGDM ha-1)	(-)	(MGDM ha-1)	(MGDM ha-1)
38	292.31	11.65	73.15	420.89
39	262.92	11.96	8.43	451.32
40	148.15	7.31	33.19	264.90
41	209.54	6.16	65.58	370.21
42	214.07	11.48	21.32	529.05
43	243.78	7.14	42.72	358.33
44	195.97	6.94	10.42	389.57
45	123.89	5.97	0.35	357.03
46	194.93	9.16	0.43	432.54
47	293.03	13.10	26.44	486.35
48	211.54	10.13	25.39	475.84
49	213.08	7.66	28.88	355.16
50	173.40	8.52	0.36	435.49
51	60.82	6.58	0.82	300.08
52	11.23	3.56	0.19	56.53
53	296.75	13.93	88.74	495.20
54	155.34	8.02	1.96	445.23
55	168.32	9.07	0.60	457.43
56	272.63	11.02	34.13	481.88
57	236.37	8.24	16.14	363.60
58	281.40	13.99	2.87	464.96
59	257.90	7.60	138.01	330.36

**2.5.8. Excluded Forest Loss in Historical Reference Period**

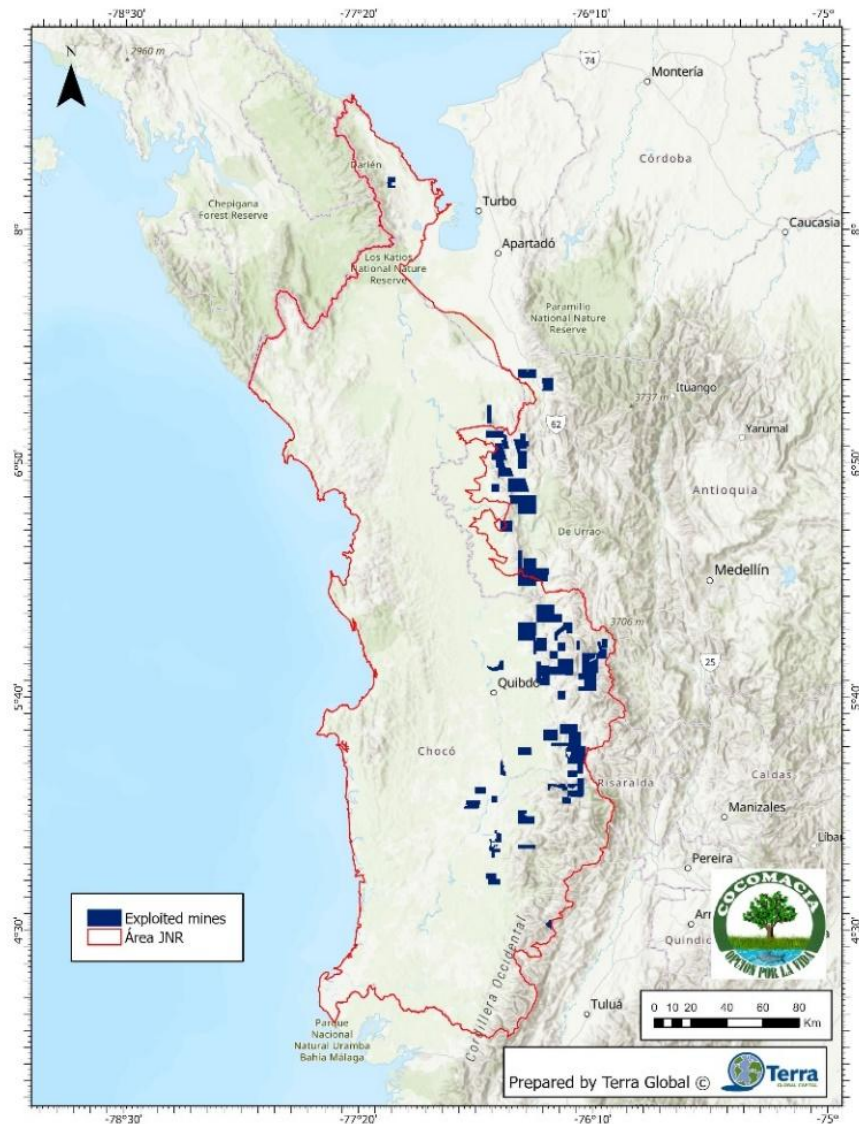
**2.5.8.1. Mining**

The assessment of planned deforestation due to mining activities was based on information provided by the National Mining Agency. On the National Mining Agency’s official website, a downloadable shapefile containing all active mining concessions in Colombia is available. From the full list of concessions, only concessions labelled as “under exploitation” before 2021 were added to the list of potential excluded areas (Map 23). Based off the content of Table 11 of VMD0055, only areas within each concession that showed more than 1,000 ha of DF during the HRP were to be assigned as excluded areas. Based on that assumption, no areas could be qualified as excluded areas for this iteration of the Baseline Description.

*Table 32. Summary of Areas Excluded and Criteria of Exclusion*

Areas of Exclusion	Criteria of Exclusion	Area Excluded (ha)
Commercial Plantations	Areas exceeding 1,000 hectares	0
Natural Disturbances	None	0

Areas of Exclusion	Criteria of Exclusion	Area Excluded (ha)
Planned Infrastructure	Areas exceeding 1,000 hectares	0
Planned Deforestation - Mining	Areas exceeding 1,000 hectares	0
Planned Deforestation - Deforestation Authorization and Concessions	Areas exceeding 1,000 hectares	0
Water	All permanent water bodies	52,433



Map 23. Spatial distribution of mining concession at “exploitation phase” in 2021, for the Chocó Department and the 10 km buffer zone around it.

**2.5.8.2. Deforestation Authorization and Concessions**

To account for planned deforestation, the areas of authorized deforestation were analyzed based on the Forest Reserve of Law 2, as previously described in Section 2.5.8, subsection “Areas of Identified Exclusions” of this document.

The process to identify and exclude large unavoidable infrastructure is described in Section 2.5.8 of this document.

**2.5.9. Large Unavoidable Infrastructure Projects**

The process to identify and exclude large unavoidable infrastructure is described in section 2.5.8 of this document.

**2.5.10. Large-Scale Commercial Deforestation**

To exclude large-scale commercial deforestation, the same approach and pipeline described in Section 2.5.5.2 was followed.

**2.5.11. Carbon Loss**

Section 2.5.3.1 describes the historical and future deforestation trends to establish the expected patterns of carbon loss into the future. The methods for the baseline scenario selection are described in Section 2.5.4, where the scenario selected is the historical average demonstrated which is the most conservative scenario. These demonstrate that it is not likely that there is an over estimation of early carbon losses. Finally the methods for estimation of emission factors was described in Section 2.5.4.5.

**2.6. Quantification of Jurisdictional Baseline Emissions**

The procedures for quantification of the jurisdictional baseline GHG emission reductions and/or removals for carbon pools and GHG sources and quantify the GHG emissions, including all relevant equations, explanation and justification of all relevant methodological choices are described in Section 2.5.4.

**2.6.1. Baseline Emissions**

Quantification of baseline emissions was done for Unplanned Deforestation following methodologies VM0048, VMD0055, and VT0007 (UDef only). Methodological details are described in section 2.5, next the results of each steps are presented.

**2.6.1.1. Historical Land Cover/Land Cover Change Dataset.**

To identify the amount of any allowable transition in the first and second half of the HRP, LULC maps generated following the method from VMD0055’s Appendix 1 Step 1 (section 2.5.4.2.1) were used. For any two consecutive maps, the count of pixels transitioned were counted in a spatial explicit way and then summarized as the count of pixels (and ha) falling in each transition, including stable, non-transitioned areas (Table 33). Since 4 LULC maps were generated, a total of three transition periods were recorded, 2 in the first half of the HRP (20150113\_20151201 and 20151201\_20180121) and 1 in the second half (20180121\_20201222). Table 33 present all transitions analyzed during the historical reference period.

*Table 33. Summary of the transitions from-to each LULC class during the historical reference period*

Change Category (CHC)	Period	Transition	Pixels	Hectares
Deforestation	20150113_20151201	MGR_WTR	10	1
Deforestation	20150113_20151201	CFU_AGW	1,673	151
Deforestation	20150113_20151201	CFL_AGW	15,506	1,396
Deforestation	20150113_20151201	OFU_AGW	5,832	525
Deforestation	20150113_20151201	OFL_AGW	50,435	4,539
Deforestation	20150113_20151201	MGR_AGW	43	4
Deforestation	20150113_20151201	CFU_BAR	22,116	1,990

Change Category (CHC)	Period	Transition	Pixels	Hectares
Deforestation	20150113_20151201	CFL_BAR	123,529	11,118
Deforestation	20150113_20151201	OFU_BAR	31,147	2,803
Deforestation	20150113_20151201	OFL_BAR	118,893	10,700
Deforestation	20150113_20151201	MGR_BAR	48	4
Deforestation	20151201_20180121	MGR_WTR	5,782	520
Deforestation	20151201_20180121	CFU_AGW	776	70
Deforestation	20151201_20180121	CFL_AGW	1,379	124
Deforestation	20151201_20180121	OFU_AGW	1,807	163
Deforestation	20151201_20180121	OFL_AGW	46,884	4,220
Deforestation	20151201_20180121	MGR_AGW	132	12
Deforestation	20151201_20180121	CFU_BAR	386,971	34,827
Deforestation	20151201_20180121	CFL_BAR	64,867	5,838
Deforestation	20151201_20180121	OFU_BAR	106,019	9,542
Deforestation	20151201_20180121	OFL_BAR	183,731	16,536
Deforestation	20151201_20180121	MGR_BAR	1,708	154
Deforestation	20180121_20201222	MGR_WTR	1,632	147
Deforestation	20180121_20201222	CFU_AGW	332	30
Deforestation	20180121_20201222	CFL_AGW	415	37
Deforestation	20180121_20201222	OFU_AGW	1,341	121
Deforestation	20180121_20201222	OFL_AGW	57,581	5,182
Deforestation	20180121_20201222	MGR_AGW	100	9
Deforestation	20180121_20201222	CFU_BAR	235,515	21,196
Deforestation	20180121_20201222	CFL_BAR	46,898	4,221
Deforestation	20180121_20201222	OFU_BAR	103,805	9,342
Deforestation	20180121_20201222	OFL_BAR	322,553	29,030
Deforestation	20180121_20201222	MGR_BAR	1,131	102
Forest regrowth	20150113_20151201	AGW_OFU	12,635	1,137
Forest regrowth	20150113_20151201	BAR_OFU	40,815	3,673
Forest regrowth	20150113_20151201	AGW_OFL	38,532	3,468
Forest regrowth	20150113_20151201	BAR_OFL	42,615	3,835
Forest regrowth	20151201_20180121	AGW_OFU	5,460	491
Forest regrowth	20151201_20180121	BAR_OFU	91,383	8,224
Forest regrowth	20151201_20180121	AGW_OFL	112,901	10,161
Forest regrowth	20151201_20180121	BAR_OFL	371,719	33,455
Forest regrowth	20180121_20201222	AGW_OFU	961	86
Forest regrowth	20180121_20201222	BAR_OFU	84,435	7,599
Forest regrowth	20180121_20201222	AGW_OFL	39,104	3,519
Forest regrowth	20180121_20201222	BAR_OFL	212,863	19,158
Stable forest	20150113_20151201	CFU_CFU	36,084,438	3,247,599
Stable forest	20150113_20151201	CFL_CFL	4,702,176	423,196
Stable forest	20150113_20151201	OFU_OFU	1,351,574	121,642
Stable forest	20150113_20151201	OFL_OFL	6,267,022	564,032
Stable forest	20150113_20151201	MGR_MGR	850,960	76,586
Stable forest	20151201_20180121	CFU_CFU	35,388,550	3,184,970
Stable forest	20151201_20180121	CFL_CFL	3,372,670	303,540
Stable forest	20151201_20180121	OFU_OFU	997,072	89,736
Stable forest	20151201_20180121	OFL_OFL	6,054,118	544,871

Change Category (CHC)	Period	Transition	Pixels	Hectares
Stable forest	20151201_20180121	MGR_MGR	833,870	75,048
Stable forest	20180121_20201222	CFU_CFU	35,405,952	3,186,536
Stable forest	20180121_20201222	CFL_CFL	3,249,435	292,449
Stable forest	20180121_20201222	OFU_OFU	1,163,876	104,749
Stable forest	20180121_20201222	OFL_OFL	7,414,175	667,276
Stable forest	20180121_20201222	MGR_MGR	820,823	73,874
Stable non-forest	20150113_20151201	WTR_WTR	572,950	51,566
Stable non-forest	20150113_20151201	AGW_AGW	762,065	68,586
Stable non-forest	20150113_20151201	BAR_AGW	53,449	4,810
Stable non-forest	20150113_20151201	AGW_BAR	73,397	6,606
Stable non-forest	20150113_20151201	BAR_BAR	1,812,402	163,116
Stable non-forest	20151201_20180121	WTR_WTR	573,891	51,650
Stable non-forest	20151201_20180121	AGW_AGW	657,053	59,135
Stable non-forest	20151201_20180121	BAR_AGW	105,409	9,487
Stable non-forest	20151201_20180121	AGW_BAR	112,610	10,135
Stable non-forest	20151201_20180121	BAR_BAR	1,598,652	143,879
Stable non-forest	20180121_20201222	WTR_WTR	580,626	52,256
Stable non-forest	20180121_20201222	AGW_AGW	687,207	61,849
Stable non-forest	20180121_20201222	BAR_AGW	71,175	6,406
Stable non-forest	20180121_20201222	AGW_BAR	86,120	7,751
Stable non-forest	20180121_20201222	BAR_BAR	2,086,116	187,750

### 2.6.1.2. Total Historical Area of Each Change Category

The total area of the jurisdiction classified as change category CHC over the HRP (ha) is presented below.

Table 34. Area within the Jurisdiction Classified in each Change Category. Values in Hectares.

Change Category (CHC)	Period		
	20150113_20151201	20151201_20180121	20180121_20201222
Deforestation	33,231	72,005	69,417
Forest regrowth	12,114	52,332	30,363
Stable forest	4,433,055	4,198,165	4,324,883
Stable non-forest	294,684	274,285	316,012

### 2.6.1.3. Uncertainty of Estimated Historical Areas of Each Change Category

The final results of the uncertainty assessment (section 2.5.5.1.8) can be observed in Table 35.

Table 35. Bias-corrected estimated activity data and standard error

Observed Transition	Std.Err	Uperc	IFUdef
Stable Forest CF	0.01509	0.00	0.0000020
Stable Forest OF	0.015634	0.01	0.0000280
Deforestation	0.002115	0.10	0.0002620
Stable non-forest	0.003384	0.03	0.0000880

**2.6.1.4. Conservatively Discount the Estimated Area of Historical Unplanned Deforestation**

Since all transitions showed Unc% lower or equal than 10% (Table 35), no modifier was applied to the observed transitions summarized in Table 33. Forest regrowth wasn't used in the UDef AD estimates, as is considered a Non-forest class according to VMD0055 section A1.3, so no discount was required for that transition.

**2.6.1.5. Jurisdictional AD for Unplanned Deforestation**

Deforestation was calculated for each forest stratum (i.e. CFU, CFL, OFU, OFL, MGR) and for each pair of subsequent images in the historical reference period. The historical average annual rates used for the baseline are presented in Table 36.

*Table 36. Average annual area of unplanned deforestation within the jurisdiction over the HRP.*

Deforestation Transitions	Average annual transitions (ha)	Area of from class (ha)	Rates
DF in CFU_AGW	42	3,308,359	0.00%
DF in CFL_AGW	262	476,652	0.05%
DF in OFU_AGW	136	152,584	0.09%
DF in OFL_AGW	2,346	615,997	0.38%
DF in MGR_AGW	4	77,234	0.01%
DF in CFU_BAR	9,763	3,308,359	0.30%
DF in CFL_BAR	3,564	476,652	0.75%
DF in OFU_BAR	3,650	152,584	2.39%
DF in OFL_BAR	9,468	615,997	1.54%
DF in MGR_BAR	44	77,234	0.06%
DF in MGR_WTR	98	77,234	0.13%
<b>Average Annual Area of UDef</b>	<b>29,376</b>	<b>4,630,826</b>	<b>0.63%</b>

**2.6.1.6. Emissions From Carbon Stock Changes**

For sampling design and quality assurance of the measured values, existing data on biomass stock densities was reviewed. Table 37 below contains the results of a detailed review based on Colombia's FREL, scientific studies and a review of projects registered in the Verra Registry to understand the existing data on biomass stocks in the main forest strata identified in the JNR FREL Area. Given the scarcity of specific data for the region, it is important to note that some of the estimates come from studies conducted in ecosystems like the Department of Chocó.

*Table 37. Literature review of parameters related to biomass forest.*

Forest/ Land Type	Total Aboveground Biomass [tCO <sub>2e</sub> ha <sup>-1</sup> ]	Source
Closed Forest/ Tropical wet forest	413	(Duque, et al., 2017)
Closed Forest/ Tropical wet forest	275	(Alvarez, et al., 2012)
Dense tropical forest	562	Concosta REDD+ Project
Alluvial forests /Dense forest	526	Mutata REDD+ Project
Alluvial forests /Dense forest	344	Rio Pepe y Acaba REDD+ Project
Intact terra firme (non-flooded) forest	413	Bajo Calima y Bahia Malaga REDD+ Project
Alluvial forests /Dense forest	445	Cajambre REDD+ Project

Forest/ Land Type	Total Aboveground Biomass [tCO <sub>2</sub> e ha <sup>-1</sup> ]	Source
Intact terra firme (non-flooded) forest	426	Siviru-Usaraga-Pizarro-Piliza REDD+ Project
wetland forest/ intact terra firme (non-flooded) forest	280	Carmen del Darien REDD+ Project
Intact terra firme (non-flooded) forest	362	Acapa-bajo Mira y Frontera REDD+ Project
Stable forest /Pacific biome	391	FREL Chocó
Mangrove forest	312	(Josephraj Selvaraj & Gallego Pérez, 2023)

2.6.1.6.1. Carbon Stock per Forest Stratum.

Results from applying VMD0055 step 1 (section 2.5.4.5.1), were used to calibrate the aboveground biomass assessment from LiDAR data, results are presented below in Table 38.

Table 38. Mean Carbon Stocks per Pool and per Forest Stratum.

Carbon Stock per Pool (tCO <sub>2</sub> e ha <sup>-1</sup> )	Forest Stratum				
	CFU	CFL	OFU	OFL	MGR
Carbon Aboveground Tree Biomass	288	462	146	212	173
Carbon Belowground Tree Biomass	60	97	31	44	198
Carbon Aboveground Biomass Nontree	11	16	19	17	0
Carbon Belowground Biomass Nontree	3	4	8	5	0
Carbon Stock of Dead Wood	22	41	6	21	4
Carbon Stock in Litter	0	0	0	0	0
Carbon Stock in Soil Organic Carbon	220	175	169	123	0
<b>TOTAL</b>	<b>604</b>	<b>795</b>	<b>378</b>	<b>422</b>	<b>375</b>

2.6.1.6.2. Emissions from Carbon Stock Changes

Results from applying VMD0055 step 2 (section 582.5.4.5.2) are presented below in Table 39.

Table 39. Estimated Emissions from Carbon Stock Change

Total Carbon Stock (tCO <sub>2</sub> e ha <sup>-1</sup> )	Forest Stratum				
	CFU	CFL	OFU	OFL	MGR
Carbon Stock Pre-Deforestation (C <sub>p</sub> )	220	175	169	123	0
Carbon Stock Post-Deforestation (C <sub>p,post</sub> )	112	89	86	62	0
<b>Estimated Emissions from Carbon Stock Change (ΔC<sub>p,i</sub>)</b>	<b>108</b>	<b>86</b>	<b>83</b>	<b>60</b>	<b>0</b>

2.6.1.6.3. Evaluation of Uncertainty of Carbon Stock Estimates

Results from applying VMD0055 step 3 (section 2.5.4.5.3) and step 4 (section 2.5.4.5.4) are presented below in Table 40.

Table 40. Estimate of Uncertainty Discount Factor

Pool	Weighted Average Emissions from Carbon Stock Change (WΔC)	Estimate Uncertainty
	(t CO <sub>2</sub> e/ha)	(tCO <sub>2</sub> e ha <sup>-1</sup> )
Aboveground Tree	226.3	123.5
Belowground Tree	49.7	26.0
Aboveground Nontree	3.1	6.4
Belowground Nontree	1.0	2.2
Litter	16.4	9.6
Deadwood	0.0	0.0
SOC	60.7	102.5
<b>U(WΔC)</b>	<b>357</b>	<b>163</b>
	<b>U%(WΔC)</b>	<b>45.7%</b>
	<b>Uncertainty Discount Factor</b>	<b>0.12</b>

2.6.1.6.4. Conservative Estimation of Emissions from Carbon Stock Change

Results from applying VMD0055 step 5 (section 2.5.4.5.5) are shown in Table 41.

Table 41. Conservative Estimation of Emissions from Carbon Stock Change

Parameter/ Forest Stratum	CFU	CFL	OFU	OFL	MGR
	(tCO <sub>2</sub> e ha <sup>-1</sup> )	(tCO <sub>2</sub> e ha <sup>-1</sup> )	(tCO <sub>2</sub> e ha <sup>-1</sup> )	(tCO <sub>2</sub> e ha <sup>-1</sup> )	(tCO <sub>2</sub> e ha <sup>-1</sup> )
$\Delta C_{CAB-LI,i}$	263	421	145	202	153
$\Delta C_{CBB-DW,i}$	75	125	39	62	177
$\Delta C_{CSOC-WP,i}$	193	154	149	108	0
<b>Annual UDef Emission Factor (tCO<sub>2</sub>e ha<sup>-1</sup> yr<sup>-1</sup>)</b>	<b>280</b>	<b>441</b>	<b>156</b>	<b>213</b>	<b>170</b>

2.6.1.7. Estimation of Annual Net Baseline Emissions for the Baseline Validity Period

The sum of emissions projected to take place in the UDef JNR Area were estimated using the area of AD and the emissions from the carbon stock changes resulting from unplanned deforestation. Results of applying VMD0055 step 6 (section 2.5.4.5.6) are presented in the Table 42 below.

Table 42. Summary of Chocó Colombia Jurisdictional Baseline Emissions from UDef

#	Year [-]	JNR Estimated baseline emissions from UDef in the JNR Area [tCO <sub>2</sub> e]
1	2021	8,687,572
2	2022	8,406,262
3	2023	8,639,863
4	2024	8,981,290
5	2025	9,359,364
6	2026	9,730,665
<b>TOTAL</b>		<b>53,805,015</b>
<b>AVERAGE [tCO<sub>2</sub>e year<sup>-1</sup>]</b>		<b>8,967,503</b>

**2.6.2. Leakage Emissions**

**2.6.2.1. Activity Shifting by Geographically Constrained Agents**

As defined in Section 3.1. of VMD0055, each project within the Jurisdiction using the JNR FREL will be assigned to a 10 km Leakage Area from the edges of the project area. To ensure this and to comply with the requirements of VT0007, ex-ante estimations of UDef for the baseline scenario are calculated separately for the JNR region and for a 10 km buffer zone around the JNR. As defined in Section A1.4.3. Step 1 of VMD0055, the buffer zone only consists of areas within the Colombia national boundaries. Since this zone extends outside of the Jurisdiction, historical UDef rates are calculated separately from the JNR area, and thus historical rates specific for the JNR Leakage area are used for a standalone run of TerraChange®. Similarly to the standalone run for the JNR area, only pixels within the Crediting Area are used for predicting spatial trends of UDef emissions in the Baseline.

Table 43 shows the summary of baseline emissions in the JNR leakage belt area.

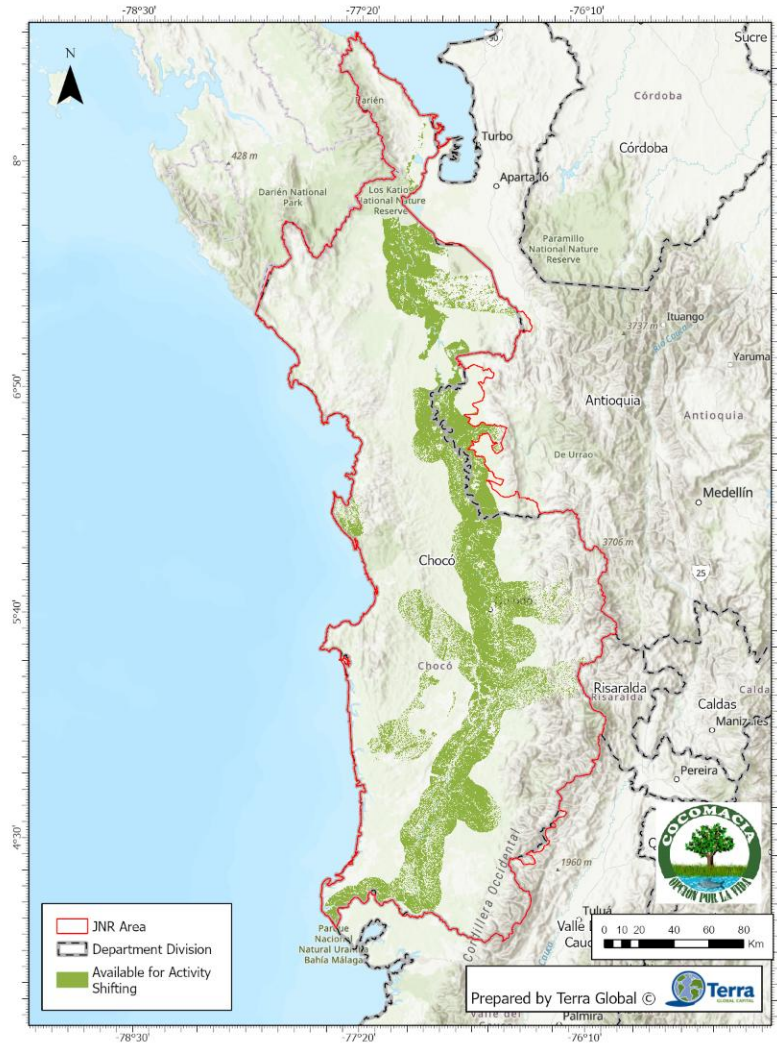
*Table 43. Summary of Chocó Colombia Jurisdictional Baseline Leakage Belt Emissions*

#	Year [-]	JNR Estimated baseline emissions from UDef in the JNR LB [tCO2e]
1	2021	4,917,750
2	2022	7,197,201
3	2023	9,521,751
4	2024	11,826,066
5	2025	14,107,242
6	2026	16,385,519
<b>TOTAL</b>		<b>63,955,528</b>
<b>AVERAGE [tCO2e year -1]</b>		<b>10,659,255</b>

**2.6.2.2. Activity Shifting by Geographically Mobile Agents**

**2.6.2.2.1. Step 1: Spatially Delineate Land Available for Activity Shifting Outside the UDef PA and UDef LB**

The resulting output was a digital map of land available for activity shifting, used as a key input for subsequent leakage risk assessments under the jurisdictional REDD+ framework (section 2.5.4.6.22.5.4.6.2).



Map 24. Available Land for Activity Shifting in the JNR FREL Area

Table 44. Land Available for Activity Shifting by Geographically Mobile Agents

Land Available for Activity Shifting- Mobile Agents	Area (ha)
Aavailable	<b>1,006,068</b>

2.6.2.2.2. Step 2: Develop Area-Weighted Emission Factor for Activity Shifting to Outside the UDef LB

The emission factor ( $\Delta C_{OLB}$ ) for areas available for the displacement of activities outside the leakage belt was estimated using field-measured biomass values and classified forest areas within the jurisdiction. This weighted factor will then be applied to determine the emissions associated with the displacement of activities outside the PA UDef and LB UDef. Table 45, show the values used to estimate the Area-Weighted Emission Factor

Table 45. Area and Aboveground Biomass per strata.

Forest	Area (ha)	Aboveground Biomass (tCO <sub>2</sub> e ha <sup>-1</sup> )
Close Forest Upland	3,177,274	299
Close Forest Lowland	296,867	478
Open Forest Upland	162,358	164
Open Forest Lowland	605,946	229
Mangrove	73,910	173

The value estimated to Area-Weighted Emission Factor is **294 t CO<sub>2</sub>e/ha**

### 3. SAFEGUARDS

This Jurisdictional Baseline was developed for the Chocó Department, with the input from various government authorities, Baseline Proponents and a subset of community representative of the forest-reliant communities in the Chocó Department. Stakeholder engagement, Program Activities definition and communication have been completed and documented in a transparent manner. There have been formal and informal meetings with stakeholders to increase Program awareness with government, forest-reliant communities, as well as other stakeholders that are present in the Chocó Department. Community stakeholders of the expected first Project Activity Instance were informed about meetings through the communication network. At the start of the Jurisdictional Baseline Validity Period, community village leaders, village head leaders and women in the expected first Project Activity Instance were engaged through the COCOMACIA council directly. Stakeholders who may have an interest in the REDD+ Program were contacted through their local government contacts at CODECHOCO. Government employee stakeholders were informed over email and through formal meeting requests.

#### 3.1. Stakeholder Consultation

##### 3.1.1. Relevant Stakeholders Consulted

The Jurisdictional Baseline was developed, with the input from government authorities, Project Proponents and a subset of Communities Councils representatives. A brief description of the relevant stakeholders is included in Table 46.

Table 46. List of Relevant Stakeholders

Stakeholders (name)	Brief Description
1) Government agencies: CODECHOCO Regional Autonomous Corporation and Ministry of Environment and Sustainable Development	<ul style="list-style-type: none"> <li>• <b>CODECHOCO Regional Autonomous Corporation</b> The Regional Autonomous and Sustainable Development Corporations in Colombia are the first environmental authority at the regional level. These are public corporate entities, created by Law, made up of territorial entities that, due to their characteristics, geographically constitute the same ecosystem or make up a geopolitical, biogeographic or hydrogeographic unit, endowed with administrative and financial autonomy.</li> <li>• <b>Ministry of Environment and Sustainable Development</b> is responsible for the management of the environment and renewable natural resources. This ministry is in charge of guiding and regulating the environmental planning of the territory and defining the policies and regulations to which the recovery, conservation, protection will be subject, of natural resources at the national level.</li> </ul>
2) Other Carbon project developers in the Jurisdiction:	<p>Thirteen (13) other REDD+ Projects within the jurisdiction, including developers and participants were identified. These other carbon project developers included but were not limited to:</p> <ul style="list-style-type: none"> <li>• BioREDD+</li> <li>• Fondo Acción</li> <li>• Biofix</li> <li>• Wildlife Works</li> </ul>
3) Interest Groups: Community Councils and Indigenous Reservations	Sixty-four (64) Community Councils (recognized under Law 70 of 1993) and Indigenous reservations (Resguardos Indígenas) were

Stakeholders (name)	Brief Description
General and Local Boards- (legal representatives)	identified and invited to the Jurisdictional Baseline Socialization meeting.

### 3.1.2. Consultation Methods and Outcomes

There have been multiple formal and informal meetings done to communicate about the development of the Jurisdictional Baseline with relevant government authorities, carbon project developers and community councils in the Jurisdiction. The inputs received were included in agreements signed in order to get approval to develop the JNR baseline, as shown in Table 47.

Table 47. Relevant stakeholder engaged and their outcomes to the Jurisdictional Baseline

Stakeholder	Consultation method	Outcomes
Corporación Autónoma Regional CODECHOCO	Meetings (6-In-person and 1-virtual)	<ul style="list-style-type: none"> <li>• Institutional cooperation framework agreement signed.</li> <li>• Collaborative Forest Reference Emissions Level Agreement (CFA) signed.</li> </ul>
Community Councils and Indigenous Reservations COCOMACIA, Asocasan, Acadesan Rio Cacarica, Rio Salaquí, Unión panamericana, Condoto	Meetings (9-In person and 9-virtual) with legal representatives of Community councils. The legal representative is responsible to communicate information to the Local Board and community members	<ul style="list-style-type: none"> <li>• Community Councils were informed and aware about the jurisdictional baseline to be developed in the Department.</li> <li>• The shift from individual projects to a jurisdictional approach was explained, highlighting its greater technical precision, reputation, and traceability.</li> <li>• The transition to the Jurisdictional Baseline was analyzed at the project-level for all other projects within the jurisdiction.</li> <li>• There was concern about the potential exclusion of mangroves and páramo ecosystems under the jurisdictional approach. Terra is discussing options with Verra to include them or establish alternative pathways.</li> <li>• The participatory nature of the process was acknowledged, but several needs were raised: <ul style="list-style-type: none"> <li>– Standardized agreements with developers</li> <li>– Promote spaces for collective analysis</li> <li>– Strengthen information-sharing and coordination among community councils.</li> </ul> </li> <li>• The event marked significant progress in the socialization of the jurisdictional baseline, helped clarify technical and political concerns, and strengthened coordination among REDD+ projects and communities. Next steps included conduct further technical consultations, community-level decision-making, and safeguarding collective rights and territorial autonomy. The Consejos agreed to review their options to continuing with future verifications within their Boards.</li> </ul>

Stakeholder	Consultation method	Outcomes
Other Carbon project developers in the Jurisdiction (BioREDD+, Fondo Accion, Biofix, Wildlife Works)	Meetings (In-person and virtual)	<ul style="list-style-type: none"> <li>Project developers were informed about the jurisdictional baseline to be done at the department-level.</li> <li>The transition to the Jurisdictional Baseline was analyzed at the project level for all other projects within the jurisdiction.</li> </ul>

### 3.2. National and Subnational Social and Environmental Safeguards Requirements

Safeguards in the design phase become guidelines and good practices to design measures and actions to bring social and environmental benefits and prevent possible negative effects.

It should be noted that for the purposes of this Jurisdictional Baseline, CODECHOCO- as the environmental authority with jurisdiction over the Jurisdictional Baseline area and as a co-proponent - follows the guidelines of the 2010 Cancun Safeguards to ensure the successful implementation of actions in the territory, with full respect for local customs and traditional land uses, as detailed in Table 48.

Table 48. Safeguard Compliance

No.	Safeguards	Compliance
1	Alignment and consistency of actions with the objectives of national forest programs and relevant international conventions and agreements	<p>Colombia’s main national strategy in the reduction of deforestation is the Estrategia Integral de Control a la Deforestación y Gestión de los Bosques (EICDGB). This strategy focuses not only on reducing deforestation but also on strengthening governance, promoting sustainable rural development, and supporting Indigenous Peoples and local communities in forest management. A Jurisdictional Baseline helps align the monitoring criteria used by various Projects, leading to better comparability, data consistency, and more credible reporting, while reducing the risk of double counting.</p> <p>CODECHOCO, the environmental authority within the Jurisdictional Baseline Area and governed by national legislation, is a co-proponent of the JNR. Furthermore, Terra Global conducted an evaluation of compliance with applicable laws, statutes, and other regulatory frameworks, which is included in Section 1.7 of this document.</p> <p>Colombia’s Nationally Determined Contribution (NDC) under the Paris Agreement explicitly includes reducing greenhouse gas emissions by 51% by 2030, and REDD+ plays a critical role in achieving this target by addressing emissions from land use, land-use change, and forestry (LULUCF), a major contributor to the country’s overall emissions. A jurisdictional baseline developed within this framework can reinforce these commitments by anchoring crediting to jurisdiction-wide performance, rather than isolated project achievements. This helps avoid fragmentation and ensures that carbon finance supports the same goals the country has committed to at the international level.</p>
2	Transparent and effective national forest	The Colombian Constitution recognizes forests as part of the nation’s natural heritage and guarantees the right to a healthy

No.	Safeguards	Compliance
	governance structures, taking into account national legislation and sovereignty;	environment. Environmental Law 99 of 1993 established the National Environmental System (SINA), a network of public institutions at the national, regional, and local levels, along with other stakeholders such as communities, NGOs, and the private sector. SINA serves as the institutional framework responsible for managing, coordinating, and implementing environmental policies and regulations across the country, including those related to biodiversity and forest management. The National Strategy for Reducing Deforestation and Forest Degradation (ENREDD+) serves as the country’s roadmap for implementing REDD+ and integrates Indigenous and Afro-Colombian governance structures, acknowledging their role in protecting forests. Colombia also uses financial mechanisms such as its carbon tax and regulatory frameworks like Decree 926 of 2017, which allows REDD+ projects to participate in the national carbon market. Additionally, the country has expanded its network of protected areas under the National Natural Parks System (SINAP) and promotes voluntary agreements with the private sector and communities to curb deforestation.
3	Respect for the knowledge and rights of indigenous peoples and members of local communities.	The Jurisdictional Baseline proponents have recognized and respected the Afro-Colombian Consejos Comunitarios and Indigenous Resguardos as ethnic authorities and primary local governance structures in the territories of the Chocó Department. Proponents have maintained assertive communication with these authorities throughout the development and socialization of the JNR, while acknowledging their livelihoods and internal norms
4	Full & effective participation of relevant stakeholders, in particular IP & local communities	See Section 3.1 on Stakeholder Consultation.
5	Natural forest, biodiversity, social & environmental benefits	The JNR will facilitate planning and decision-making at a territorial scale that reflects the ecological and cultural diversity of the region. Unlike isolated projects, a jurisdictional approach allows environmental authorities, community councils, and Indigenous Resguardos to identify priority conservation areas and enforce land-use regulations. A JNR structure can also be used as a tool to ensure that carbon finance aligns with local development plans and safeguards community rights.
6	Address risk of reversals	A JNR at the subnational level provides a stronger institutional framework to ensure the permanence of emission reductions. Local environmental authorities (like CODECHOCO and CORPOURABÁ), in collaboration with national entities, can implement monitoring systems, enforce land-use regulations, and coordinate actions across different landholders and municipalities.
7	Reduce displacement of emissions	By covering an entire department or region, the JNR system captures internal shifts in deforestation pressures and can

No.	Safeguards	Compliance
		design interventions—such as improving sustainable livelihoods, or improved enforcement—in areas at high risk of leakage. Moreover, because all REDD+ initiatives within the jurisdiction must nest into a common baseline and monitoring framework, there is better coordination and transparency, reducing the likelihood that emissions are simply relocated rather than avoided.

### 3.3. Grievance and Redress Processes

The mechanism for handling and resolving grievances and disputes related to the design of the Jurisdictional baseline are described in the following sections. Grievances will be addressed at 3 levels, the 1) Jurisdictional by CODECHOCO (Section 3.3.1), the 2) Project by COCOMACIA (Section 3.3.2) and 3) Finance and Development - Terra Global (Section 3.3.3). As this Baseline Description will be used following the JNR Scenario 1, projects that were engaged were those expected to be part of the first Project Activity Instance. Thus, at the Jurisdictional Baseline validity period start, the communities engaged were the COCOMACIA Community Councils, the expected first Project nested under the JNR Scenario 1.

#### 3.3.1. CODECHOCO

CODECHOCO supports interaction with its users as it is a way to obtain elements to continuously improve the procedures and services provided. The channels available for submitting and tracking PQRSDs (Petitions, Complaints, Claims, Suggestions, and Reports) are the following:

1. In-person at the User Service Center (CAU by the Spanish acronym), main headquarters located at Cra 3 No 22 - 96 Quibdó - Chocó.
2. Through the virtual Attention Center (Digital Kiosk), located at the CAU.
3. Through the following link <https://codeChocó.gov.co/publicaciones/2920/sistema-central-de-pqrsd/>
4. Writing an email to the following email address [contacto@codeChocó.gov.co](mailto:contacto@codeChocó.gov.co)
5. Calling the toll-free line 01 8000 963 626.

The different types of grievances are classified as follows:

- Petition or right of petition is the right that every person has to request or claim before the competent authorities for reasons of general interest or particular interest to submit respectful requests for information and/or consultation and to obtain prompt resolution of the same.
- Complaint: Any verbal, written, or electronic expression of dissatisfaction with the conduct or action of public servants or individuals carrying out a state function that requires a response. (Complaints must be resolved, addressed, or answered within fifteen (15) days from the date of submission).
- Claim: Any verbal, written, or electronic expression of dissatisfaction related to the provision of a service or the inadequate attention of a public authority, that is, it is a formal statement for the non-compliance of a right that has been harmed or threatened, caused by the deficient provision or unjustified suspension of the service. (Claims must be resolved, addressed, or answered within fifteen (15) days from the date of submission).
- Suggestion: Any verbal, written, or electronic expression of recommendation provided by the citizen, aimed at improving the service provided in each of the dependencies of the Ministry of Information and Communication Technologies, rationalizing the use of resources, or making public management more participatory. (Viability of its application will be informed within a term of ten (10) days).
- Denunciation: An act by which a subject notifies or establishes to the corresponding authorities that some type of offense has been committed.

### 3.3.2. COCOMACIA

COCOMACIA is a proponent in the development of this Baseline Description. COCOMACIA Grievance and Redress Mechanism is aligned and consistent with the objectives of the community and considers the following aspects.

- The good use of natural resources and the ethno-development model from its vision and culture as a Black people that includes languages, customs, rivers, marshes, forests, animals, sacred places, lands to cultivate and live, spirits and traditional authorities.
- Black communities have developed complex cultural systems as a result of different historical moments of occupation of the Jurisdiction and because of particular relationships they have developed with nature and the diverse ecosystems that link them.
- For the populations that have inhabited the region for centuries, the Atrato River is its ancestral territory and the basic support of material, social and symbolic life.
- The highest internal administration authority within the territory is the Major Community Council of the Integral Peasant Association of the Middle Atrato - COCOMACIA, who effectively exercises the management, control and administration of the territory and in turn takes into account the following aspects.
- The closeness between communities and their traditional relationships. The productive activities, defined within the territory, include fishing, hunting, logging, and mining, as well as areas suitable for agriculture.
- The shared use of resources in areas of common use.
- The area of influence of its inhabitants: radius of action and transit of nearby communities where daily activities are carried out.
- The Atrato River as a main axis and its tributaries in the structuring of the area of influence of each zone.

The COCOMACIA community has developed grievance and redress procedure as an official form that needs to be filled and signed by the individual or group who has a complaint or grievance with the program. This form must be presented to the COCOMACIA Local or General Board for processing. The different types of conflicts that have been identified are:

- Inter-ethnic (between black and indigenous communities) conflicts that include but not limited to, land tenure conflicts, robbery, and illegal sales with other non-ethnic (Government, Illegal Armed actors, Armed Actors, Individual Title owners) actors: Failure to comply with the regulations of ethnic groups, Geostrategic position, Recovery of sovereignty territorial, lack of clarity on land boundaries.
- The resolution process will vary according to conflict type, the organizational structure and the institutions involved. Thus, the process goes as follows:
- Intra-ethnic conflicts will follow the next steps:
  1. Diligent review of complaint file and complaints
  2. Summoning the parties to give their testimony or make their disclaimers
  3. The parties are requested to provide the evidence they have
  4. Review of the Minutes, resolutions, and agreements
  5. Review of the social and / or technical map of the community to locate where the problem is presenting.
  6. Socialization of boundaries
  7. Minutes of agreement or commitment between the parties and ethnic authorities are drawn up.
  8. The date of the field verification visit is specified

9. Notification of the results to the parties and ethnic authorities.

The entities involved are the Local Board (this will consult the Elders, notify the local assembly of the problem and document the case), Zonal Committee, General Board (Evaluate the type of problem will refer to legal, they will request support to the office of territory and autonomy) Disciplinary Committee, General Assembly.

- Conflicts involving other Collective or Individual titles will follow these steps
  1. Review of resolutions and minutes of agreement, if any.
  2. Revision of the award plan.
  3. Minutes of agreement between the parties are drawn up
  4. The verification visit is completed
  5. Results Notification

The entities involved are the Senior Board Directors, Local Boards of Directors, Legal, Territory and Autonomy Office. Other supporting Institutions are INCODER, Diocese of Quibdó, The Interior Ministry (Office of the Ombudsman, Attorney and Personnel), Environmental and Agrarian Judiciary Office, and CODECHOCO.

The COCOMACIA REDD+ Project has also set up a Community Concerns, Suggestions, and Complaints Mailbox. This mechanism provides a highly accessible platform for community participation, as anyone can share their opinions, concerns, and complaints about the REDD+ Project through various means, either anonymously or with an identified contact. To access the mailbox, any community member can submit their concerns, suggestions, or complaints in their own words through the physical mailbox at the COCOMACIA Offices or the mobile mailbox that accompanies the project teams. They can also do so through community environmental patrollers and the WhatsApp line they manage. The REDD+ Team will review the comments, organize them, and seek a solution, whenever possible; otherwise, the team will escalate the request or complaint to an authority capable of addressing it.

**3.3.3. Terra Global Capital**

Terra Global’s Feedback Grievance and Redress Mechanism (FGRM) was designed to meet the requirements under the i) Climate, Community and Biodiversity Standard (which is used for many of the Terra Global funded projects and programs), ii) Green Climate Fund’s Environmental and Social Policy, Gender Policy, and Indigenous People Policy, and iii) to follow IFC Performance Standards including PS 1,2,4,5. This corporate FGRM policy applies to Terra Global Capital LLC and its wholly-owned subsidiaries (henceforth, the “Company”).

The full policy may be found on the Terra Global website [www.terraglobalcapital.com](http://www.terraglobalcapital.com) in English, Spanish and French.

The grievance process is the following:

- Fill out a complaint in the native language (Spanish).
- The complaint should include the following information in order to be complete:
  - Complainant’s full name and contact information. If not filed directly by the complainant, proof that those representing the affected people have authority to do so, (the individual/entity can remain anonymous).
  - Name of the project or program of concern and type of grievance,
  - The harm that is or may be resulting from the project,
  - Time frame that the reported complaint occurred,
  - Attach/include supporting documents,
  - List any actions taken so far to resolve the problem, including contacting Terra Global or other local project partners or implementers,
  - Proposed solutions; and
  - Whether confidentiality is requested (stating reasons).

The complete complaint should be submitted by email to the following address [grievances@terraglobalcapital.com](mailto:grievances@terraglobalcapital.com) or by mail to the following address: Terra Global Capital, LLC, 6114 La Salle Avenue, Suite 441, Oakland, CA 94611, USA.

The review process starts when Terra Global receives the complaint (via email or mail). The complaint is recorded in Terra Global's Grievance Redress Mechanism Tracker, and the complainant is notified of receipt and informed of the next steps.

Terra Global will assess the eligibility of the complaint and provide a response as to whether it is eligible within 15 days, ineligible complaints will be recorded in the Tracker with rationale for ineligibility.

The Project Team is informed (an initial assessment may be required to understand who the involved parties are). On occasion, an involved party, particularly the complainant, may be informed later in the assessment phase, to preserve information and review baseline facts before notice.

The complaint is assessed by the Terra Global Compliance Team as it is made. This may involve interviewing additional parties to collect more information or bringing in third parties to support the investigation and assessment. The investigation is conducted by a Compliance Team member, independent of the Project Team.

A response/resolution is decided on by the Terra Global Founder & CEO, Terra Global Ethics Committee, or other decision bodies named under specific policies. The decision is made by someone independent of the Program Team.

Response is communicated to the complaining party (where possible) and to any parties involved. Resolution is recorded in the GRM tracking mechanism. Any lessons are applied internally as appropriate (e.g., updating policies or processes).

### 3.4. Additional Standards

Project Activity Instances under the Choco Department, Colombia Nested JNR FREL should strive for CCB Triple-Gold Level certification demonstrating that this Program meets the highest standards for community development and empowerment, best conserves and enhances biodiversity, as well as climate change mitigation and adaptation.

No national or subnational social and environmental safeguards requirements are relevant to the design of the jurisdictional baseline. As described above, the VCS JNR Program and baseline has addressed and respected safeguards and is in accordance relevant Cancun Safeguards contained in Appendix 1 of Decision 1/CP.16 of the UNFCCC Cancun Agreements. During the development and design of this REDD+ Program and Baseline, the following safeguards were supported and promoted:

- a. Respect for the knowledge and rights of indigenous peoples and members of local communities, by considering relevant international obligations, national circumstances and laws.
- b. The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities.
- c. Actions are consistent with the conservation of natural forests and biological diversity, ensuring that the actions are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits.

## 4. FURTHER INFORMATION

There is no further information.

## 5. APPENDIX 1: APPLICATION OF VT0007 UNPLANNED DEFORESTATION RISK MAPPING AND ALLOCATION (UDEF-A)

(appended to the end of this document)

## 6. APPENDIX 2: APPLICATION OF M0397 TOOL UNDER DEVELOPMENT FOR UNPLANNED DEFORESTATION AND FOREST DEGRADATION RISK MAPPING ALLOCATION (UDEF+UDEG -A)

(appended to the end of this document)

## 7. APPENDIX 3: CHOCO DEPARTMENT, COLOMBIA JNR FREL FOR UNPLANNED DEFORESTATION AND FOREST DEGRADATION (UDEF + UDEG) AND QUANTIFICATION OF BASELINE EMISSIONS

(appended to the end of this document)

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