

Estimating Deforestation Due to Coca Cultivation in the Peruvian Amazon (2011-2021)



Jaime A. García Díaz

2024



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1^a ed. – March de 2024

Legal Deposit at the National Library of Peru: 2024-03374

ISBN No. 978-612-49617-1-7

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Cover design: Equis Equis S.A.

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This publication has been reviewed by peer referees.

This book has been made possible thanks to the support of the People of the United States of America through the United States Agency for International Development (USAID). The opinions expressed here are those of the authors and do not necessarily reflect the opinions of USAID or the Government of the United States of America.

Layout: Equis Equis S.A.

1st ed. DIGITAL, March 2024

Available at <http://repositorio.pucp.edu.pe/index/handle/123456789/123985>

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ACRONYMS

CBP	Cocaine Base Paste
CDC-UNALM	Centro de Datos para la Conservación – Universidad Nacional Agraria La Molina
CHC	Cocaine Hydrochloride
CNC	Crime and Narcotics Center
CORAH	Proyecto Especial Control y Erradicación de Cultivos de Coca en el Alto Huallaga
DAC	Deforestation Associated with Coca
DDC	Direct Deforestation from Coca
TDCA	Total Deforestation in Coca Areas
TDPA	Total Deforestation in the Peruvian Amazon
DCI	Declaración Conjunta de Intención
DEVIDA	Comisión Nacional para el Desarrollo y Vida Sin Drogas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
INEI	Instituto Nacional de Estadística e Informática
INRENA	Instituto Nacional de Recursos Naturales
MINAM	Ministerio del Ambiente
NPA	Natural Protected Area
PA	Peruvian Amazon
PNCBMCC	Programa Nacional de Conservación de Bosques para la Mitigación del Cambio Climático
PPF	Permanent Production Forest
SERFOR	Servicio Nacional Forestal y de Fauna Silvestre
SERNANP	Servicio Nacional de Áreas Naturales Protegidas por el Estado
UNODC	United Nations Office on Drugs and Crime
VRAEM	Valles de los Ríos Apurímac, Ene y Mantaro
ZA	Zona de Amortiguamiento

EXECUTIVE SUMMARY

The largest negative environmental impact in the Peruvian Amazon (PA) is deforestation. To date, more than 8.4 million hectares have already been deforested, and they continue to grow. Deforestation for the 2011-2020 was 50% higher than that of the 2001-2010 period.

Deforestation in the Peruvian Amazon is linked to several factors that include agricultural activities, logging, petroleum drilling, urban growth and road building as the major drivers of the process. Illicit activities such as illegal gold mining with a strong impact in Madre de Dios and illegal logging and illicit coca cultivation throughout the Amazon region are also playing an increasingly major role in deforestation of the Peruvian Amazon.

Illicit coca has spread through the PA through several stages since the 1970's. There are no detailed records of coca areas before the 80's. As of 2001 with the initiation of UNODC monitoring we have detailed information regarding location and magnitude of coca growing areas. Beginning in 2014, there is a more detailed identification of the GPS polygons of coca plots that allows for a better analysis of the behavior and impact of coca cultivation.

Promoted by drug trafficking organizations, coca cultivation improvements have resulted in the adaptation of coca cultivars to continuously lower elevation levels. Over the past two decades, more than 70% of coca has been established at lower levels than 400 m.a.s.l. of the Amazon basin. Increases in productivity and coca yields per hectare, as well as the coca to cocaine conversion ratios have also been achieved by these organizations.

Drug promoters plan and direct the location of coca planting and cocaine production. They study and select new production areas based on criteria such as agronomic conditions, road and river access, the absence of government security forces, and access to labor. In addition, they finance the migration of "cocaleiros", the participation of settlers ("colonos") already in the area, the coopting of indigenous communities, etc. They also facilitate and finance the entire production process, purchase the coca leaves, and provide chemical precursors for cocaine base paste (CBP) and cocaine hydrochloride (CHC) production.

Regarding deforestation, it is evident that slash and burn process related to coca cultivation in the upper and lower Peruvian Selva (Selva Alta and Selva Baja), have taken place. While some efforts have been made to quantify the deforestation effect of coca, only qualitative approximations have been made to date. With the information available as of today, we have developed a meth-

odology that allows for a more objective approach to quantify deforestation for the 2011-2021 period.

Total Deforestation in the PA (TDPA) for the 2011-2021 period was 1,722,355 ha. In the area of interest for this evaluation, that is, where coca is grown, Total Deforestation in Coca Areas (TDCA) was 1,096,192 ha or 63% of the TDPA. Direct Deforestation from Coca (DDC) in TDCA was 83,232 ha (i.e., the planted coca area) corresponding to 7.6% of TDCA and 4.8% of TDPA. If we consider DDC plus the Deforestation Associated with Coca (DAC) or a buffer zone of 100 m surrounding the plantation, the DDC + DAC rises to 296,297 ha or 27% of TDCA and 17.2% of the TDPA. If we further increase the distance surrounding the plantation itself to 500 m the DDC + DAC goes up to 438,250 ha or 40% of TDCA and 25.4% of TDPA.

For our analysis, the buffer zone of 300 m has been considered, so it can be concluded with a certain level of confidence that the deforestation caused by coca leaf crops in Peru, between the years 2011-2021 was 385,122 hectares, which represents 35.1% of Total Deforestation in Coca Areas (TDCA), and 22.4% of Total Deforestation in the Peruvian Amazon (TDPA).

The rise of illicit coca areas has resulted in increased invasion of Natural Protected Areas (NPA) and their buffer zones as well as those of indigenous communities, logging concessions and natural reserves.

Coca cultivation and drug manufacturing have additional detrimental environmental impacts stemming from the intensive cultivation techniques depleting the soil; intensive use of fertilizers and agrochemicals (pesticides, insecticides, fungicides); use of chemical precursors for the preparation of drugs that is carried out in the same growing areas; final disposal of agrochemical and chemical precursors and their containers as well as detritus from coca maceration. The adverse impacts affect the environment throughout: air, soil and bodies of water, biodiversity and people's health.

The growing impact of coca growing on deforestation in the PA requires an urgent response from the Government of Peru. All national and local public, private and civil society actors, and especially the affected indigenous communities need to be involved in the design and implementation of solutions to this problem. It is not only possible to develop early warning systems for new deforestation in order to take immediate remedial action, but it is also possible to enlist and promote active vigilance by indigenous communities, identify criminal organizations that promote illicit crops, eradicate these crops, and implement alternative development programs with sufficient resources to restore the affected areas. International cooperation can play an important role in remedying this situation.

INTRODUCTION

The Peruvian Amazon (PA) is strongly impacted by human activities, which have increased in recent years. According to the National Forest Conservation Program for the Mitigation of Climate Change (PNCBMCC for its Spanish acronym), deforestation has increased by over 50% from an average of 105,221 ha per year for the 2001-2010 decade to an average 158,438 ha for the 2011-2020 decade.

Various factors contribute to deforestation in the PA. Migration and strong population growth in the area is one of them. According to the National Institute of Statistics and Information (INEI in Spanish), the Selva registered a 204% growth in population between 1972 and 2017, while the Coast grew by 173% and the Sierra by only 39%. During that period, agricultural, livestock and mining activities, as well as road and urban infrastructure development in the PA were the drivers of deforestation.

In recent decades, illegal activities have added to deforestation: drug trafficking, illegal logging and illegal mining. Drug trafficking in Peru refers mainly to the production and export of CBP and CHC. Cocaine production relies on the production of coca leaves from which the alkaloids are extracted. In Peru, coca is mostly grown in the Amazon basin.

Thousands of hectares of coca are planted every year, as drug traffickers have been able to adapt the cultivation to ever decreasing altitudes. Coca can now be grown in the High Forest (Selva Alta) as well as the Low Forest (Selva Baja). Coca cultivation is increasingly invading NPA and their buffer zones, indigenous communities' territories, and conservation, ecotourism and logging concessions.

In addition to direct deforestation due to coca cultivation, deforestation associated with the crop also occurs as a result of clearing of forests for trails, building homes for coca farmers, drying and drug production areas, installation of clandestine airstrips and the development of complementary activities such as agriculture for food production and livestock.

Additionally, other negative environmental impacts of coca include soil contamination and degradation and contamination of streams and bodies of water caused by the intensive use of agrochemicals and fertilizers for cultivation and chemicals for the production of the drug.

The objective of this study is to analyze deforestation due to coca cultivation for the 2011-2021 period, develop a methodology to quantify deforestation, determine other environmental impacts and formulate recommendations to avoid deforestation by coca crops and mitigate the impacts caused.

CHAPTER I

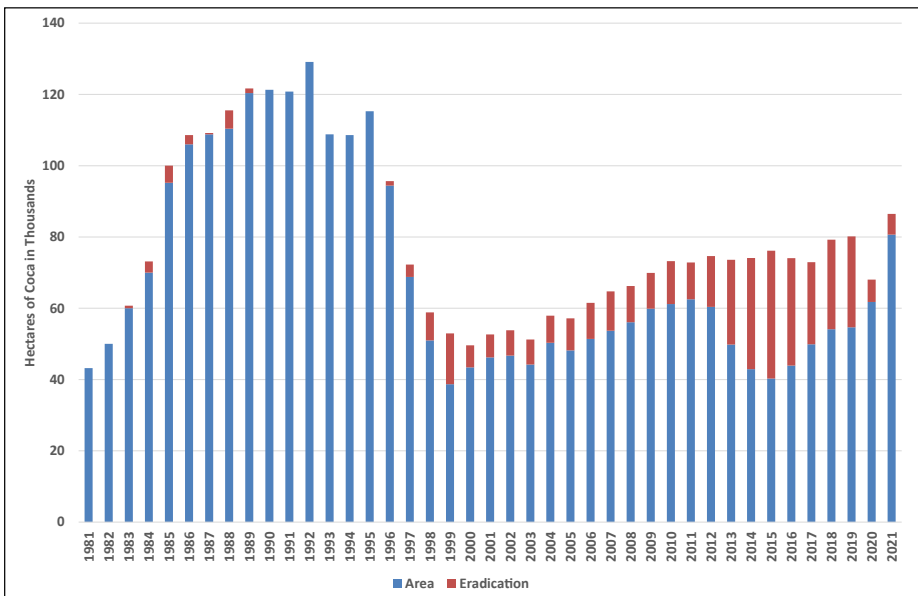
COCA CULTIVATION IN PERU

1.1. Evolution of coca cultivation

To determine the contribution of coca cultivation to deforestation in Peru, as well as its collateral environmental damages, it is necessary to calculate the area of the crops in a given period. To do so, there are two key sources to consider: First, the annual measurement of the coca cultivation areas that are monitored by UNODC and DEVIDA and, secondly, the areas that have been eradicated annually, because they refer to coca areas that have been planted but that the monitoring measurement does not consider. The sum of these two variables provides a good approximation of the total area of coca planted in a given year.

Evolution of coca areas over the last four decades (1981-2021) is presented in Graph 1 below. As a reference, the total monitored areas add up to 2,887,040 ha and the eradicated areas to 372,904 ha, totaling 3,255,953 ha of coca areas over the period. This is an important reference as to the magnitude of the problem as most of these areas (over 90%) are destined for the production of cocaine.

Graph 1
Evolution of Coca Areas (1981-2021) Hectares



Sources: Area: 1981-1999 CNC, 2000-2017 UNODC, 2018-2021 DEVIDA
Eradication: 1983-2021 CORAH

Regarding the annual monitoring and measurement of coca cultivation, the following is important: (i) monitoring of coca measures only the areas with plants over one year old, thus the areas under one year old are not considered; (ii) the areas of coca for traditional (licit) use are older plantations of over 10 years old and thus are counted again every year; (iii) the eradicated areas are, on average, between 2 and 5 years old; (iv) Non-eradicated areas have older plants between 3 and 6 years old; and (v) crop rotation varies in different geographic areas depending on soil degradation, crop eradication activities, and plant productivity.

The evolution of coca cultivation has been pendular with at least five well defined stages:

1981-1992 Coca boom: During those years there was a strong growth of coca areas, production of coca paste (PBC for its acronym in Spanish), and export of PBC to Colombia by air, for its refining and conversion into cocaine hydrochloride (CHC).

1993-1999 The fall of Coca: The sharp fall in coca areas was related to two important factors: air interdiction that deactivated the air routes between Peru and Colombia for the shipment of PBC and the massive shift of coca cultivation to Colombia (after massive adaptation of coca to Colombian agronomic conditions). This caused a drop in demand and the price of coca leaf in Peru.

2000-2010 Recovery of Coca: Coca growing began a new stage of sustained growth mainly due to insufficient eradication of crops (only 9,000 hectares on average per year) and the refusal to eradicate in emblematic coca-growing valleys such as Monzon and VRAEM. In addition, the anti-drug strategy (interdiction, eradication, and alternative development) was financed mainly with international cooperation funding, especially from the US, with a relatively small contribution from the Peruvian Public Budget.

2011-2015 Reduction of Coca: Reduction of coca areas as a result of a more effective intervention by the Peruvian Government. The budget for the fight against drugs was substantially increased and, for the first time, Government resources became the main source of financing for the eradication of illicit crops, alternative development programs and interdiction. Direct government expenditures for the fight against drugs grew from US\$64 million in 2010 to US\$210 million in 2015 (García, 2016). Eradication increased from 10,350 ha in 2011 to 35,868 ha in 2015.

2016-2021 Expansion of Coca: Coca cultivation areas expanded again during this period. The Peruvian Public Budget to finance the counternarcotics strategy did not continue to increase and in some years even decreased (García & Qwist-

gaard, 2021). Crop eradication levels were reduced, especially due to COVID 19 and the post-pandemic situation. In the years 2020 and 2021 only 6,270 ha and 5,775 ha respectively were eradicated. The area of coca monitored doubled from 40,300 ha in 2015 to 80,681 ha in 2021.

Obviously, the evolution of coca cultivation has not been homogeneous in all areas, valleys, departments, provinces or coca growing districts.

1.2 The dynamics of coca production

Over the past four decades, the cultivation of coca leaves has shown a powerful dynamism, driven mainly by criminal organizations. Undoubtedly, the large expansion of the crop, its adaptation to diverse agro-ecological conditions, the selection of more productive and disease resistant varieties, and the increases in productivity have not been spontaneous but rather driven by a growing demand for cocaine and the high prices received.

1.2.1 Adaptation of the coca plant

According to Tosi, J., (1960) the coca leaf has had an ancestral presence in the Andean territory. Traditionally it has been cultivated between 700 and 1,500 m.a.s.l., although there is also evidence of its cultivation in Selva Baja areas according to DEVIDA, (2022a). However, over the span of four decades a greater adaptation of the coca leaf to lower elevations has been consolidated. In the Colombian case, the coca plant has been adapted to altitudes between 1 and 2,000 m.a.s.l., as indicated by the Colombian National Police – Anti-Narcotics Directorate (2014).

In the case of Peru, there has also been a shift of coca cultivation into lower elevations, where biodiversity is greater, entering into the Selva Baja in the eastern Amazon, in the Omagua region or Amazon Tropical Forest (Pulgar Vidal, 1996). To the extent that coca cultivation is adapted to lower altitudinal areas, the suitable areas for coca cultivation increase exponentially. This also means less of a risk for criminal organizations due to the large number of areas available but also a greater risk of deforestation and degradation for Amazonian tropical forests. Research carried out by Rodriguez (1995), indicates that with decreasing altitudes in the Amazon basin, soils become poorer and have lower fertility. This situation could cause a faster rotation of land required for the planting of coca and therefore greater deforestation.

A presentation made by CORAH (March 2017), estimated that areas with potential agronomic conditions for coca cultivation in Peru in 2016 were 13,416,088 ha, most of them in the Selva Baja.

A comparison of coca production areas between 2001 and 2021 is presented in table 1 below. In 2001, 46,232 ha of coca areas were monitored (identified), of which approximately 3% (some 1,401 ha) were planted below 400 m.a.s.l. In 2021, 80,681 ha of coca areas were monitored with 30% (24,332 ha) grown below the 400 m.a.s.l. line. The most important new coca producing areas are Bajo Amazonas, Calleria, Putumayo, Contamana and Bajo Ucayali. In other words, between 2001 and 2021, the area under coca cultivation grew by 34,449 ha with 71% of those new areas (24,332 ha) being cultivated in the Selva Baja at less than 400 m.a.s.l.

Table 1.
Coca cultivation areas 2001 and 2021 (Hectares and altitude)

ÁREAS OF COCA CULTIVATION	2001	2021	m.a.s.l.
AREAS IN 2001			
I. ALTO HUALLAGA	14,481	2,270	900-400
II. AGUAYTÍA	1,051	2,475	290
III. VRAEM	12,600	32,106	700-500
IV. LA CONVENCIÓN-LARES	13,980	4,841	1000-750
V. SELVA CENTRAL	350	4,096	250
VI. SANDIA, SAN JUAN DEL ORO	2,520	9,730	1300-400
VII. OTROS	1,250	4,660	
NEW AREAS AFTER 2001			
VIII. CONTAMANA		1,095	134
IX. CALLERÍA		6,004	120
X. BAJO AMAZONAS		6,472	60
XI. PUTUMAYO		2,193	111
XII. KOSÑIPATA		1,672	527
XIII. SAN GABAN		1,070	580
XIV. BAJO UCAYALI		1,750	220
XV. MADRE DE DIOS		247	186
TOTAL	46,232	80,681	

Sources: UNODC, 2001; DEVIDA, 2021.

As reported by Carnegie Institute (2014), the forests most exposed to deforestation by coca cultivation are those located in the Selva Baja and sub montane regions of the Amazon below 500 m.a.s.l. Along the same lines, Zanne et al (2009) and Baker et al (2004) reported that carbon stock values are higher in the eastern Amazon and lower towards the west. These are the forests that are most exposed to deforestation by coca crops.

1.2.2. Increased productivity of the coca leaf

Another driving factor in coca cultivation has to do with the increase in productivity. According to the UNODC 2002 Coca Monitoring Report, for the year 2001, the average productivity of coca fields at the national level was 1.065 t/ha (tons per hectare) with an average maximum in the VRAEM of 2.2 t/ha, with a few plantations in that valley with 300,000 plants per hectare and a productivity of up to 3.0 t/ha. The 2018 report of UNODC Coca Monitoring Report indicated that by the year 2017, average productivity at the national level had increased to 2.352 t/ha, an increase of 121%. Maximum averages in the VRAEM were 3.63 t/ha. Productivity levels have not been assessed for later years but it is likely that the trend of higher productivity has continued.

These increases in productivity have not come without negative impacts on the environment for at least three reasons. In the first place, they require unrestricted high use of pesticides and herbicides to avoid pests and diseases. Second, the overuse of chemical fertilizers ensures higher yields. Third, the high plant density required (>200,000 plants per hectare) depletes the soil of essential micro-nutrients not supplied by chemical fertilizers. The impacts on soil degradation and contamination of soils and water courses are high under those conditions. This in turn causes greater need to rotate planting areas, leaving behind degraded areas and relocating to newly deforested areas. In addition, there is the growing use of chemical precursors for the production of cocaine and the indiscriminate disposal of waste, chemical residues and the remainder of macerated coca leaves impregnated with chemicals (detritus) to soils and water sources.

1.2.3 The “narco” promoter¹

Drug traffickers act as very effective agrarian promoter agents. They select the areas for the installation of new crops; organize the relocation of coca farmers; provide adequate seeds; facilitate technical assistance for the management of nurseries, planting and growing; provide advanced financing for the purchase of agrochemicals (pesticides, herbicides) and fertilizers and, in some cases, irrigation systems. They also advance money for the payment of wages for the harvest and finally pay in cash for the harvest that they collect regularly from the farms. In other words, they ease the work of the coca grower, reduce their production costs and risks, and reward them with a higher relative price than licit crops such as coffee and cacao. In addition, they offer protection and security.

A recent study in the Ramon Castilla province of Loreto (on the Peruvian-Brazilian border) by Huerta, P. (2022), indicated that drug traffickers have gone even further, by paying “rights to the community” (royalties) for the use of land

¹ The concept of “promoter” is considered in the Article 296 Promoting or favoring the Drug Trafficking and others of the Peruvian Penal Code

for coca growing. With these resources, communities improve their living conditions, build or repair communal spaces and sports grounds, and make improvements to schools or health centers, among others. That is to say, they have become a kind of “narco-benefactor”. In addition, they provide employment for growing and harvesting coca, becoming an important source of income for the community and its members. This relationship generates interdependence between the members of the community and drug traffickers, which also favors them when defending the illegal activities against eradication or interdiction of precursor chemicals for cocaine production.

Revilla (1993) indicates that by shifting into the production of illicit coca growing, peasants sought to diversify their income and reduce the risks and uncertainty of their agricultural activities. The study was carried out in the Alto Huallaga in the 1980s. In this sense, the main factors that explained the behavior of cocaleros were the income differential (between the price of coca leaf and other licit crops) and the perception of security-related risks (due to acts of violence during the period in the study). His conclusions are along the same lines as those of other researchers such as Collins (1987), Deere & De Janvry (1979) and Guillet (1981).

Although the economic factor continues to be the main incentive for the growing of illicit coca, in recent years and specially during the last decade, drug trafficking organizations have played a much more active role in the process. Shifting of coca into new areas is not a spontaneous process as the higher prices of coca leaves are not enough to elicit a spontaneous mobilization of farmers. This is more so when analyzing the new territories in which coca has been planted. The relocation of coca growers would not be possible without the direct involvement and permanent guidance of drug traffickers, who identify new growing areas and provide or facilitate transportation, seeds, tools, wages, technical assistance, fertilizers, and herbicides. In addition, they provide security for cocaleros, especially when they invade territories such as those of indigenous communities and logging concessions.

Drug traffickers play a central role in locating new areas for growing coca by identifying areas with limited Government presence, located far from the security forces, but with neighboring communities that can provide the necessary labor for the production of coca. They also mobilize experienced coca growers from other geographical areas, mainly Alto Huallaga and VRAEM. When identifying populations to supply labor needs, DEVIDA (2021) has reported an increasing encroachment into indigenous communities’ territories.

The same “enclave” (cluster) effect observed in Colombia (UNODC, 2022a) appears to be also happening in Peru. An enclave is where there is a large con-

centration of coca plots, a long presence of these crops, and where all the links in the drug production chain are present. In addition, these enclaves are close to transit routes. In Peru, this enclave effect appears to have been replicated in the new areas of coca promoted by drug traffickers during the last decade. In the Peruvian case, we can add, that the process is not a spontaneous development, but rather promoted by criminal organizations that seek to produce, export and diversify their sources of supply of cocaine.

CHAPTER II

DEFORESTATION DUE TO COCA CULTIVATION IN PERU

Undoubtedly, the main detrimental environmental impact of the installation of illicit coca is the deforestation of the Amazon forests that, as has been mentioned above, has increasingly invaded more fragile territories, causing further destruction of biodiversity.

2.1. Previous studies of deforestation and coca in Peru

One of the first articles referring to the environmental impact of coca growing and cocaine production in the Peruvian Amazon was published by Marc Dourojeanni (1989). In his analysis, he indicated that the deforested areas from coca production included: land currently planted with coca (more than 200,000 hectares at that time); land used by cocaleros for subsistence agriculture, where they plant cassava, plantain, corn and other crops; land that is abandoned after the soil becomes infertile; land deforested by peasants leaving areas dominated by drug traffickers and terrorists; lands deforested by cocaleros that disseminate due to political violence; and land for clandestine airstrips (of which he reported the existence of more than 100), laboratories and camps. He assumed that, in the Amazon region, deforestation resulting directly and indirectly from coca cultivation had been around 700,000 hectares since the early 1970s, when coca production increased significantly. It is estimated that these areas represented 10% of the accumulated total deforestation at that time.

In addition, Dourojeanni indicated that deforestation, especially on protected lands and those only suitable for forests, had severe environmental repercussions, including: loss of soil due to erosion; extinction of genetic resources; damage to the hydrological system by increased risk of flooding; reduction of hydroelectric potential; difficulties in water transport; reduction of hydrobiological potential; and loss of forest resources, wood, food, etc. Burning the debris left behind by deforestation brings with it other problems, such as air pollution, deterioration of the topsoil, and loss of soil nutrients.

Another study by Garnica (2001), published in March of 2001, stated that the precise quantification of deforestation due to coca was extremely complicated. He used the INRENA Peruvian Amazon Deforestation Monitoring and Project base document, which he estimated at 9,559,817 ha deforested throughout the Peruvian Amazon as of 2000. Based on a “qualitative appreciation” he estimated 2,331,000 ha deforested for coca, which corresponded to 24.38% of the total deforested or 3.08% of the total Amazon area. Garnica’s results are presented in table 2 below.

Table 2
Area deforested by coca cultivation in Peru

DEPARTAMENT	AREA	DEFORESTED AREA		DEFORESTED AREA BY COCA		
		Ha.	%	Ha.	% (1)	% (2)
1. AMAZONAS	3.464.300	1.860.866	53,72%	60.000	1,44%	2,69%
2. SAN MARTIN	4.904.800	1.926.418	39,28%	800.000	16,31%	41,53%
3. LORETO	36.279.500	1.586.419	4,37%	300.000	0,83%	18,91%
4. JUNIN	2.338.600	905.241	38,71%	100.000	4,28%	11,05%
5. UCAYALI	10.137.500	877.713	8,66%	200.000	1,97%	22,79%
6. HUANUCO	2.296.500	722.686	31,47%	450.000	19,60%	62,27%
7. CAJAMARCA	505.000	462.318	91,55%	50.000	9,90%	10,82%
8. CUSCO	3.406.200	567.961	16,67%	200.000	5,87%	35,21%
9. PASCO	1.811.300	323.825	17,88%	100.000	5,52%	30,88%
10. MADRE DE DIOS	8.460.000	151.626	1,79%	1.000	0,01%	0,66%
11. AYACUCHO	324.600	76.335	23,52%	50.000	15,40%	65,50%
12. PUNO	1.345.200	69.209	5,14%	20.000	1,49%	28,90%
13. LA LIBERTAD	117.100	20.800	17,76%			
14. PIURA	47.700	8.400	17,61%			
15. APURIMAC	72.800					
16. HUANCVELICA	42.800					
17. LAMBAYEQUE	6.600					
TOTAL	75.560.500	9.559.817	12,65%	2.331.000	3,08%	24,38%

Lima, September 2000

(1) : % in relation with Departament Area

(2) : % in relation with Deforested Area

Unidad de Monitoreo y Evaluación
CONTRADROGAS

Source: Garnica (2001)

UNODC (2011), carried out some studies on deforestation analyzing coca in the Pichis Palcazu valley. This was an economic analysis that made an approximation to deforestation in general and the incidence of coca growing. It de-

terminated that the area of coca cultivation was increasing and that its impact on deforestation was also increasing, since concrete development alternatives were not implemented for the population.

UNODC (2014) reported the results of an economic study that analyzed how much alternative development activities compensated for deforestation in San Martín. Without reaching a quantification, UNODC acknowledged that coca-growing activity encouraged deforestation, especially in the 1980s. They also indicated that the eradication of coca crops followed by the implementation of alternative development has partly discouraged the advance of drug trafficking and deforestation in San Martín.

For reference, in the case of Colombia, the Colombian National Police (2014) quantified 608,000 hectares directly deforested for coca cultivation in the 15 years between 1998 and 2012. Gallegos (2022) calculated that 171,000 ha had been deforested for coca in Colombia between the years 2014-2017. GIZ (2017) determined that, in 2015, around 37,000 ha of the deforested areas in Colombia during the year were associated with coca, representing 31% of the total deforested area. The study provided a deeper understanding of the process in the Amazon and Catatumbo regions as shown in Table 3 below.

Table 3
Deforestation due to coca growing in the Amazon and Catatumbo regions in Colombia in the period 2005-2014

REGION	DEFORESTATION				
	TOTAL (ha)	DIRECT BY COCA (ha)	%	ASSOCIATED BY COCA (ha)	%
AMAZONÍA	728,546	17,564	2.4%	298,474	41.0%
CATATUMBO	52,833	2,205	4.2%	28,719	54.4%

Source: GIZ (2017).

In Peru, estimates of the effect of coca cultivation on deforestation have been based mainly on qualitative approaches, such as those indicated above by Dourojeanni and Garnica.

This study aims to quantify deforestation in the Peruvian Amazon due to illicit coca growing. The information regarding deforestation, held by various public and private institutions, has allowed the development of a methodolo-

gy to achieve a more objective approximation of the results for a given period of time.

2.2. Methodological description for the calculation of deforestation due to coca cultivation in Peru.

In Annex 1, a detailed Methodological Guide¹ that explains the logic and sequence developed for the quantification of deforestation due to coca growing is included. It is a guide for the use of the various ARCGIS PRO tools that were the basis for obtaining numerical and geospatial information to determine the relationship between coca cultivation and deforestation.

Information gathering:

- Shapefiles of the plots identified with the area cultivated with coca in the period 2014-2021 were provided by DEVIDA. The 2014-2017 period source is UNODC and for the 2018-2021 period the source is DEVIDA.
- Shapefiles of the plots eradicated by the Special Project for Control and Eradication of Coca Cultivation in Alto Huallaga (CORAH) for the period 2004-2021 were provided by CORAH.
- Shapefiles of deforestation or loss of vegetation cover (Forest) in the Peruvian Amazon, were obtained from the National Forest Conservation Program for Climate Change Mitigation (PNCBMCC) for the base year 2000 and for the period 2001 – 2021.
- Shapefiles of the political borders at the departmental, provincial and district level, updated to 2023, were obtained from the National Institute of Statistics and Informatics (INEI).
- Shapefiles of the permanent production forests (PPF) were provided by the National Forestry and Wildlife Service (SERFOR).
- Shapefiles of the National Forestry and Wildlife Service (SERFOR) were used to determine logging concessions.
- Shapefiles of the Indigenous Communities were provided by the Instituto del Bien Común (IBC).
- Shapefiles of highways at the national, departmental and neighborhood level and unified highways were obtained from the Ministry of Transport and Communications.
- Shapefiles of the main rivers were obtained from the Conservation Data Center (CDC-UNALM).

¹ See for Methodological Guide and database: https://josesaito132-my.sharepoint.com/personal/jose_saito_josesaito_com/_layouts/15/onedrive.aspx?id=%2Fpersonal%2Fjose%5Fsaito%5Fjosesaito%5Fcom%2FDocuments%2FDatos%20adjuntos%2FSr%5FGarcia&g=1

Study period:

The key information for this study is the location of the coca growing areas. There are only two sources of information available: CORAH, which reports the eradication and the respective shapefiles (polygons) for the period 2004 to 2021; and UNODC and DEVIDA, which provide the shapefiles (polygons) of the monitored areas for the period 2014-2021.

The period 2011-2021 was selected as the study period, because it has more information on coca growing. Although the shapefiles of the coca areas monitored by UNODC in the years 2011 to 2013 were not obtained, it has been assumed that information for this period can be estimated from information on the eradicated areas, where applicable, and that the crops identified in the year 2014 (the earliest year for which the shapefiles are available), as they refer to plants older than 1 year, on average, it can be assumed that they are at least four years old and would have been installed around 2011 or earlier.

Study areas:

The study areas have been defined based on the classification made by DEVIDA (2022b) of the areas with presence of monitored coca. (See page 17 of the Methodological Guide).

Information processing:

With the collection of information obtained and the study period defined, the information was processed using the sequence described in the Methodological Guide.

2.3. Consolidated results obtained

A summary of the results is presented in table 4 below. The following columns of information are presented:

Geographic Scope: 14 geographical zones are detailed according to the study zones described and indicated by DEVIDA in its coca growing monitoring reports. These areas are made up of districts, provinces and departments. Details on these areas are described on page 17 of the Methodological Guide.

Total Deforestation: Refers to the total accumulated deforestation in the period 2011-2021. This was calculated for each of the proposed geographical areas. This information was obtained from the PNCBMCC.

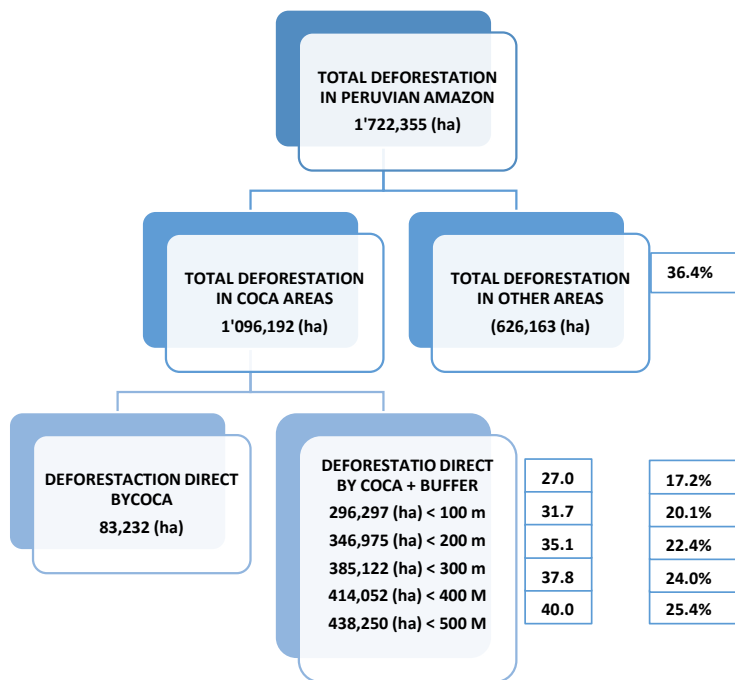
Deforestation by Direct Coca: Calculated from the Total Coca Area, which is the sum of the plots identified as having coca cultivation through annual monitoring and the plots eradicated by CORAH, ensuring that the plots are not duplicated. This Total Coca Area is then compared to the Loss of Forest

Cover in the Study Period (2011-2021) and Deforestation by Direct Coca is obtained.

Deforestation Associated with Coca (Buffer): The installation of coca has indirect effects on deforestation, as highlighted by Dourojeanni (1989) and also GIZ (2017). GIZ proposes the concept of deforestation associated with coca cultivation, as the loss of forest cover in surrounding areas (1 km or 1,000 meters away) conditioned by the presence of anthropic activities resulting from the appearance of coca in the area ("spearhead" effect). MINAM (2016), in its National Strategy on Forests and Climate Change indicates that the income generated by coca is invested in developing other productive activities, generally agriculture and livestock. In the case of Peru, a sensitivity analysis is being presented that considers surrounding areas (Buffer) of 100, 200, 300, 400 and 500 meters as buffer areas for a more detailed analysis.

Graph 2, below, shows a summary of the results obtained between the years 2011 and 2021. The Total Deforestation in the Peruvian Amazon (TDPA) was 1,722,355 ha. For the area or geographical scope of the study, that is, where there is a presence of coca, the Total Deforestation in Coca Areas (TDCA) for all concepts was 1,096,192 ha, which represents 63% of the Total Deforestation in the Peruvian Amazon. In the geographical area of study, Deforestation by Direct Coca was 83,232 ha, which corresponds to 7.6% of TDCA or 4.8% of TDPA. Deforestation by Direct Coca (DDC) plus Deforestation Associated with Coca (DAC), a range is presented from 100 m away from coca plots that calculates an accumulated deforestation of 296,297 ha, which corresponds to 27% of Total Deforestation in Coca Areas or 17.2% of the Total Deforestation in the Peruvian Amazon. If a buffer distance of 500 m is considered, deforestation rises to 438,250 ha, which corresponds to 40% of the Total Deforestation in Coca Areas or 25.4% of the Total Deforestation in the Peruvian Amazon.

Graph 2
Deforestation due to coca growing in the Peruvian Amazon in the years 2011-2021



The calculation of Deforestation by Direct Coca is a more robust figure than that of DDC + DAC, though there may be some problems in the quality of the information. The calculation of 7.6% of deforestation due to coca cultivation in the study areas is, in any case a minimum, it could be higher if other coca plots not identified by the age of the plant (less than 1-year-old) or by not having been located. It is also true that there is a “spearhead” effect with the entry of coca and the associated deforestation that it produces (buffer), as has been explained. What is more complicated to determine is the radius of influence. As indicated, some authors (GIZ, 2017) propose a 1,000-meter radius. As a reference, for the year 2020, the Ministry of the Environment and Sustainable Development of Colombia (2021), quantified at 12,939 ha the area deforested for coca cultivation, which corresponds to 7.54% of total deforestation in Colombia and 38,449 ha as deforestation associated with coca (that it is less than the 1,000-meter buffer) corresponding to 22.45% of total deforestation in Colombia in 2020.

Determining the radius of influence (buffer) with greater precision requires analyzing a series of variables and taking into consideration that the pattern is not the same in all coca-growing areas. What does seem clear is that to the extent that the radius of influence (buffer) is reduced, the quantification of the level of deforestation associated with coca is more likely to be correct. Within a radius of 100 meters, the probability is very high of the true relationship of deforestation associated with coca. For this study, estimates for a range between 100 m and 500 m have been made. This seems reasonable and invites further analysis according to geographical areas.

For the analyses in this study, we will use an average radius of 300 m, so it can be concluded with a certain level of confidence that deforestation caused by coca cultivation in Peru, between the years 2011-2021, was 385,122 ha or 35.1% of TDCA and 22.4% of TDPA.

Detailed information by geographical area of study is presented in table 4, below. The table has been ordered based on the geographical areas where coca cultivation has had the greatest impact on deforestation:

Inambari – Tambopata, in Puno, has the highest incidence of direct coca deforestation, 26.0%; if the area associated with a buffer of only 300 meters is included, this goes up to 76.7%. This geographical area is very important environmentally, due to its proximity to the Bahuaja Sonene National Park and its buffer zone that has been invaded by illicit coca growers.

San Gaban, also in Puno, is the zone with the second highest incidence due to direct coca deforestation, 24.5%; if the area associated with 300 meters of buffer is included, it goes up to 43%.

Bajo Amazonas, in Loreto, is the third zone with the highest incidence due to direct coca deforestation, 15.4%; if the area associated with only 300 meters of buffer is included, it goes up to 52.6%.

Callería, in Ucayali, is the fourth area with the highest incidence due to direct coca deforestation, 12.6%; if the area associated with only 300 meters of buffer is included, it rises to 52.7%.

Aguytía, also in Ucayali, in absolute terms is where the impact of deforestation has been the greatest, 18,655 ha were deforested, direct coca deforestation was 10.5%, and if the area associated with only 300 meters of buffer is included, it rises to 53%.

Table 4
Deforestation due to Coca Cultivation between 2011-2021 (in hectares)

COCA AREAS	TOTAL DEFOR- ESTATION	DEFORESTACIÓN POR COCA											
		DIRECT BY COCA	%	BUFFER 100 m	%	BUFFER 200 m	%	BUFFER 300 m	%	BUFFER 400 m	%	BUFFER 500 m	%
INAMBARI TAMBOPATA	22,718	5,905	26.0%	15,714	69.2%	16,815	74.0%	17,427	76.7%	17,786	78.3%	18,042	79.4%
SAN GABAN	20,275	4,959	24.5%	8,146	40.2%	8,471	41.8%	8,728	43.0%	8,884	43.8%	8,985	44.3%
BAJO AMAZONAS	62,390	9,582	15.4%	26,895	43.1%	30,271	48.5%	32,848	52.6%	34,732	55.7%	36,329	58.2%
CALLERIA	61,618	7,755	12.6%	27,305	44.3%	30,467	49.4%	32,488	52.7%	34,095	55.3%	35,493	57.6%
KOSÑIPATA	9,130	1,040	11.4%	3,183	34.9%	3,554	38.9%	3,872	42.4%	4,058	44.4%	4,262	46.7%
AGUAYTIA	177,233	18,655	10.5%	71,600	40.4%	84,450	47.6%	93,875	53.0%	100,924	56.9%	106,182	59.9%
VRAEM	126,863	9,864	7.8%	34,795	27.4%	40,554	32.0%	44,222	34.9%	47,022	37.1%	49,080	38.7%
PUTUMAYO	32,501	2,322	7.1%	6,943	21.4%	8,002	24.6%	8,744	26.9%	9,303	28.6%	9,782	30.1%
PICHIS PALCAZU PACHITEA	240,607	13,734	5.7%	60,393	25.1%	73,021	30.3%	83,888	34.9%	92,317	38.4%	100,363	41.7%
HUALLAGA	114,160	4,998	4.4%	25,857	22.6%	32,963	28.9%	37,927	33.2%	41,798	36.6%	44,898	39.3%
LA CONVENCION LARES	25,123	657	2.6%	3,652	14.5%	5,019	20.0%	6,018	24.0%	6,800	27.1%	7,384	29.4%
CONTAMANA	84,252	2,125	2.5%	5,471	6.5%	6,119	7.3%	6,716	8.0%	7,273	8.6%	7,730	9.2%
BAJO UCAVALI	110,101	1,634	1.5%	6,327	5.7%	7,245	6.6%	8,337	7.6%	9,019	8.2%	9,678	8.8%
MARAÑON	9,220	2	0.0%	15	0.2%	24	0.3%	33	0.4%	40	0.4%	43	0.5%
Total	1,096,192	83,232	7.6%	296,297	27.0%	346,975	31.7%	385,122	35.1%	414,052	37.8%	438,250	40.0%

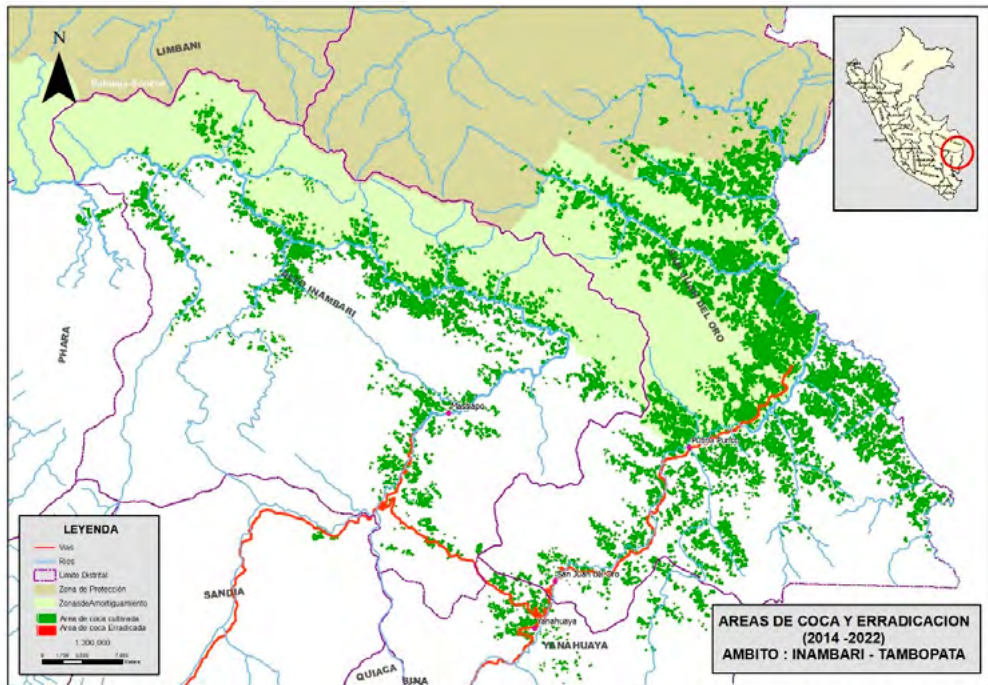
Source: Generated by the author from PNCBMCC, UNODC, DEVIDA data.

CHAPTER III

ANALYSIS OF DEFORESTATION DUE TO COCA GROWING BY GEOGRAPHICAL AREAS IN PERU

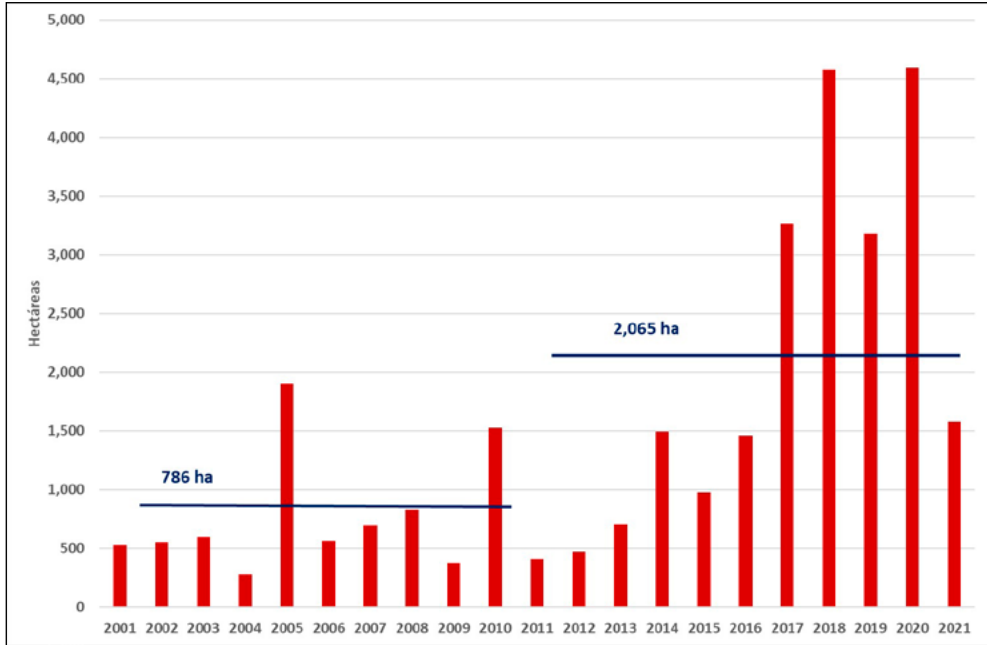
3.1 Inambari-Tambopata

Map 1
Distribution of cultivated and eradicated coca areas in Inambari-Tambopata (2014-2022)



The zone considers the districts of San Pedro de Putina Punco, Alto Inambari, San Juan del Oro, San Juan del Oro, Yanahuaya, Phara and Sandia of the Sandia province in the department of Puno. This zone is linked to the main two valleys of the Inambari and Tambopata rivers.

Graph 3
Total deforested area in Inambari-Tambopata
(2001-2021)



Source: PNCBMCC.

Figure 1. Deforestation due to coca
in Inambari-Tambopata

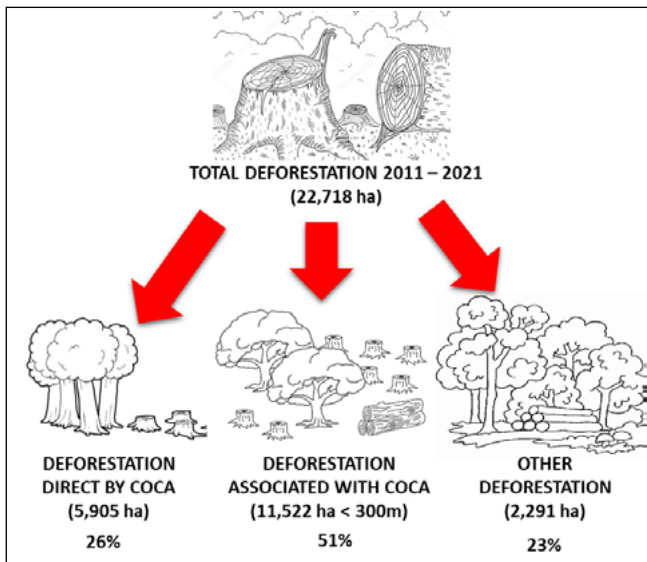


Table 5. Direct Coca
Deforestation
Inambari-Tambopata

Año	ha
2011	133
2012	168
2013	331
2014	758
2015	491
2016	556
2017	1,081
2018	1,477
2019	415
2020	404
2021	92
TOTAL	5,905

Source PNCBMCC.

Table 6. Associated Coca Deforestation Tambopata-Inambari (2011-2021)

BUFFER	ha	%
100m	9,810	43.18%
200m	10,910	48.02%
300m	11,522	50.72%
400m	11,881	52.30%
500m	12,137	53.42%
1000m	12,886	56.72%

Roads and rivers play an important role in the establishment of coca plots. The hydrographic characteristics in Inambari-Tambopata and the lack of controls and eradication have allowed for 48% of the plots be installed within 1 km from the rivers.

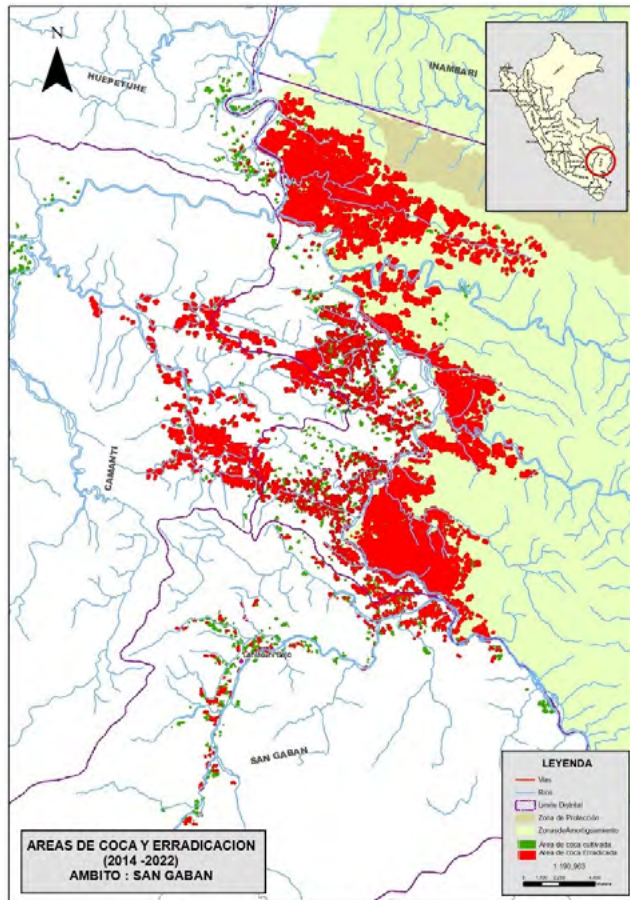
Table 7. Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	2,031	23%	2,434	28%
500 - 1000	1,239	37%	1,794	48%
1000 - 2000	1,540	54%	2,041	71%
2000 - 3000	973	66%	1,199	85%
3000 - 4000	626	73%	760	93%
4000 - 5000	451	78%	318	97%
5000 - 6000	429	83%	150	99%
6000 - 7000	303	86%	95	100%
7000 - 8000	199	88%	33	100%
8000 - 9000	190	90%	4	100%
9000 - 10000	180	92%		
MAS DE 10000	667	100%		
TOTAL	8,828		8,828	

- Sustained growth of coca areas: 3,610 ha in 2011 to 10,373 ha in 2022.
- There is a growing invasion of areas in the Bahuaja Sonene National Park and its buffer zones.
- Criminal organizations have promoted coca cultivation with migration of cocaleros from the VRAEM and Alto Huallaga as well as of local farmers.
- Deforestation has been increasing. During the 2001-2010 period, average yearly deforestation was 786 ha however, for the 2011-2021 period this rose to 2,065 ha (163% increase). For the study period (2011-2021), 22,718 ha were deforested.
- Direct coca deforestation for the 2011-2021 period was 5,905 ha, 26% of total deforestation in the area; the highest in Peru.
- Deforestation associated with coca growing, considering a 300-meter buffer amounts to 11,522 ha or 51% of the area's total deforestation. The combination of the two results in 77% of the area's total deforestation as the result of coca growing, the highest in Peru.

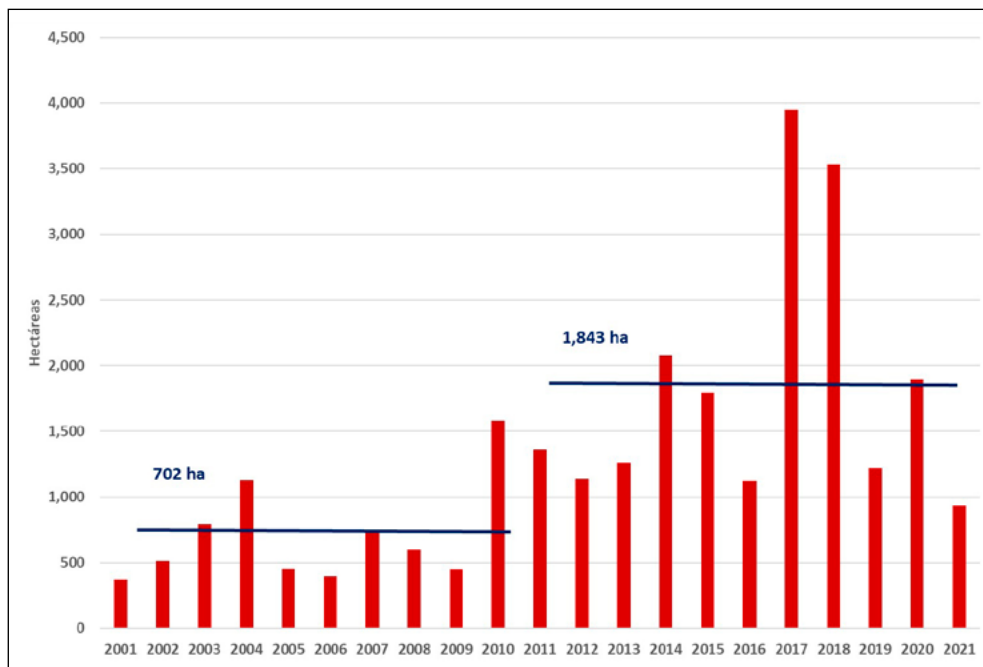
3.2. San Gaban

Map 2.
Distribution of Cultivated and Eradicated Coca Areas in San Gaban (2014-2022)



This study zone considers the department of Puno, and the provinces of Carabaya with its Ayapata and San Gaban districts. Also considered is the Huepetuhe district of the Manu province in the Department of Madre Dios. The main valleys of the San Gaban and Inambari rivers are located in this area.

Graph 4.
Total deforested area in San Gaban (2001-2021)



Source: PNCBMCC.

Figure 2. Deforestation due to coca in San Gaban

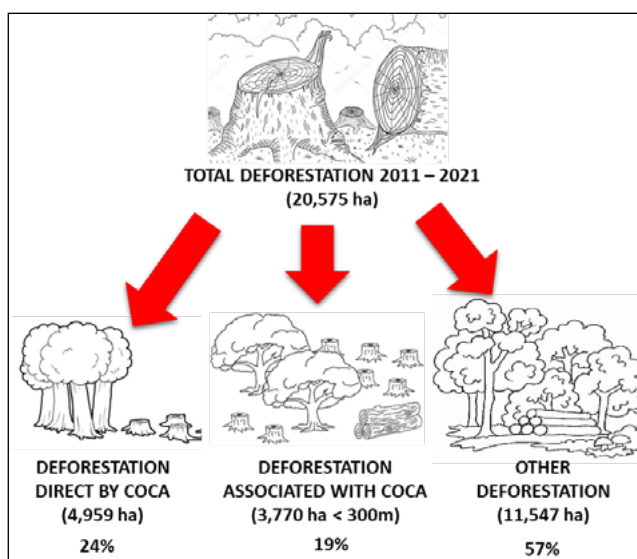


Table 8. Direct Coca Deforestation San Gaban

Año	ha
2011	302
2012	300
2013	273
2014	1,005
2015	461
2016	301
2017	1,016
2018	971
2019	118
2020	177
2021	35
TOTAL	4,959

Source PNCBMCC.

Table 9. Associated Deforestation from Coca, San Gaban (2011-2021)

BUFFER	ha	%
100m	3,188	15.72%
200m	3,512	17.32%
300m	3,770	18.59%
400m	3,926	19.36%
500m	4,027	19.86%
1000m	4,275	21.08%

Roads and rivers play an important role in the establishment of coca plots. Rivers are the main communication axis in San Gaban. 60% of plots are within 1 km of the rivers.

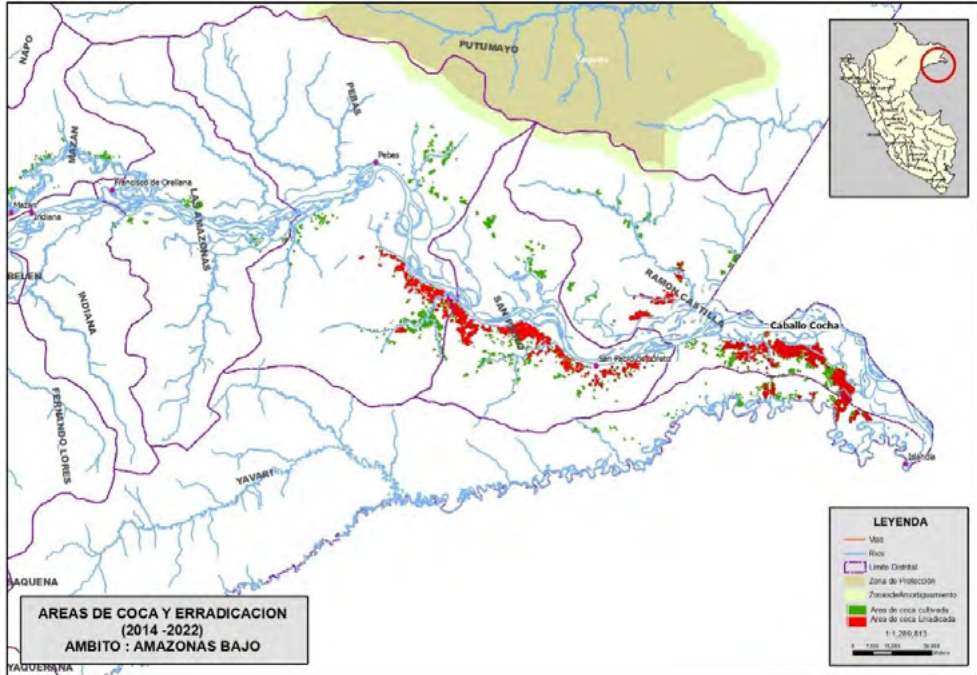
Table 10. Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	890	27%	1,337.00	40%
500 - 1000	372	38%	665.00	60%
1000 - 2000	622	56%	720.00	81%
2000 - 3000	485	71%	305.00	90%
3000 - 4000	356	81%	155.00	95%
4000 - 5000	228	88%	95.00	98%
5000 - 6000	128	92%	39.00	99%
6000 - 7000	111	95%	22.00	99%
7000 - 8000	54	97%	17.00	100%
8000 - 9000	47	98%		
9000 - 10000	42	99%		
MAS DE 10000	20	100%		
TOTAL	3,355		3,355	

- Shows a steady growth of coca areas: 843 ha in 2011 and 1,212 ha in 2022. There has been some slowing down due to intermittent eradication.
- DEVIDA reports a decreasing invasion in the buffer zones of the Bahuaja Sonene National Park.
- Criminal organizations continue to promote coca cultivation. The population rejects the presence of Peru’s National Police. There have been no Police stations installed in the area.
- Deforestation has been growing. For the 2001-2010 period, an average of 702 ha was deforested yearly for the 2011-2021 period, average yearly deforestation grew to 1,843 ha (an increase of 163%). 11,547 ha were deforested during the study period (2011-2021).
- Direct deforestation due to coca for the study period was 4,959 ha representing 24% of the total area’s deforestation, percentage-wise, the second highest in Peru.
- Deforestation associated with coca, considering a 300-meter buffer zone was 3,770 ha or 19% of total deforestation in the area. Combining both figures, 43% of the area’s deforestation is due to the growing of coca.

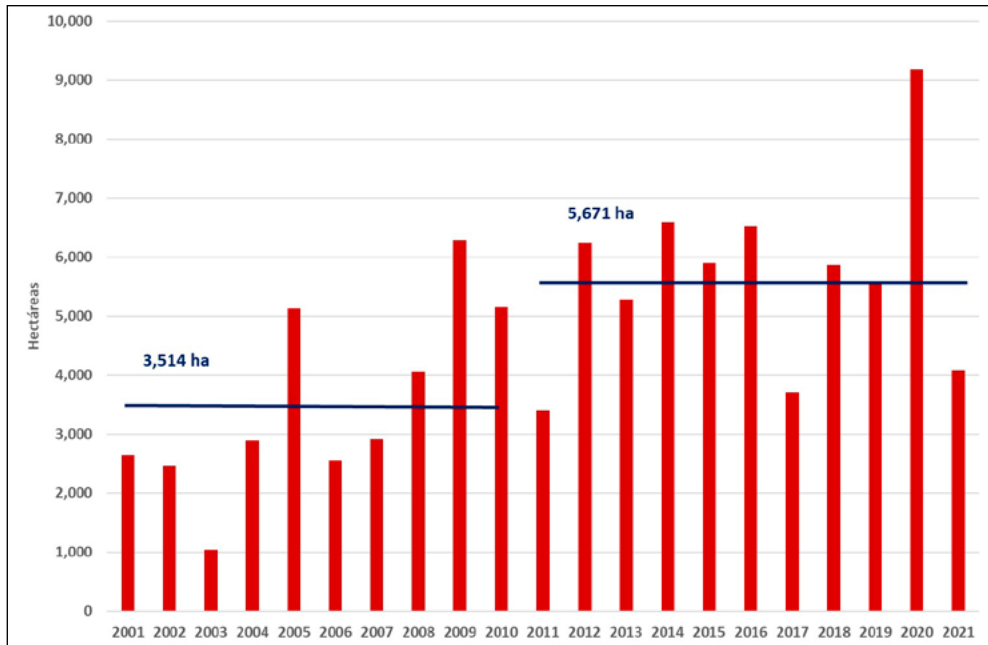
3.3. Bajo Amazonas

Map 3
Distribution of Cultivated and Eradicated Coca Areas in Bajo Amazonas
(2014-2022)



This study zone includes the districts of Ramon Castilla, Pebas, Yaravi and San Pablo of the Mariscal Ramon Castilla province in the department of Loreto. The area is linked to the Amazon and Yaraví main rivers.

Graph 5
Total deforested area in Bajo Amazonas (2001-2021)



Source: PNCBMCC.

Figure 3. Deforestation due to coca in Bajo Amazonas

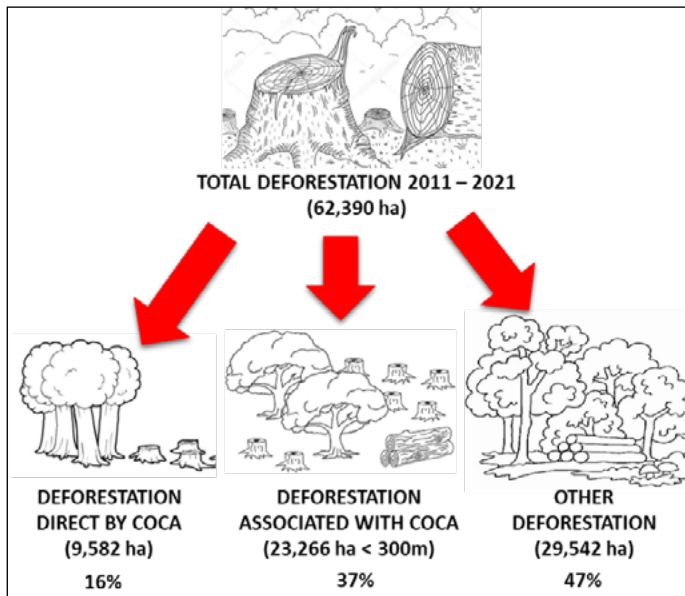


Table 11. Direct Coca Deforestation Bajo Amazonas

Año	ha
2011	581.32
2012	965.51
2013	1,057.39
2014	1,200.83
2015	936.60
2016	1,542.27
2017	980.64
2018	1,028.09
2019	728.74
2020	493.26
2021	67.60
TOTAL	9,582.24

Source: PNCBMCC.

Table 12. Deforestation Associated with Coca, Bajo Amazonas (2011-2021)

BUFFER	ha	%
100m	17,313	27.75%
200m	20,689	33.16%
300m	23,266	37.29%
400m	25,149	40.31%
500m	26,747	42.87%
1000m	32,536	52.15%

Due to lack of roads, rivers acquire an important role in where coca is established. Hydrographic characteristics of Bajo Amazonas, the lack of controls and eradication have allowed for 62% of plots being established within 3 km from the rivers.

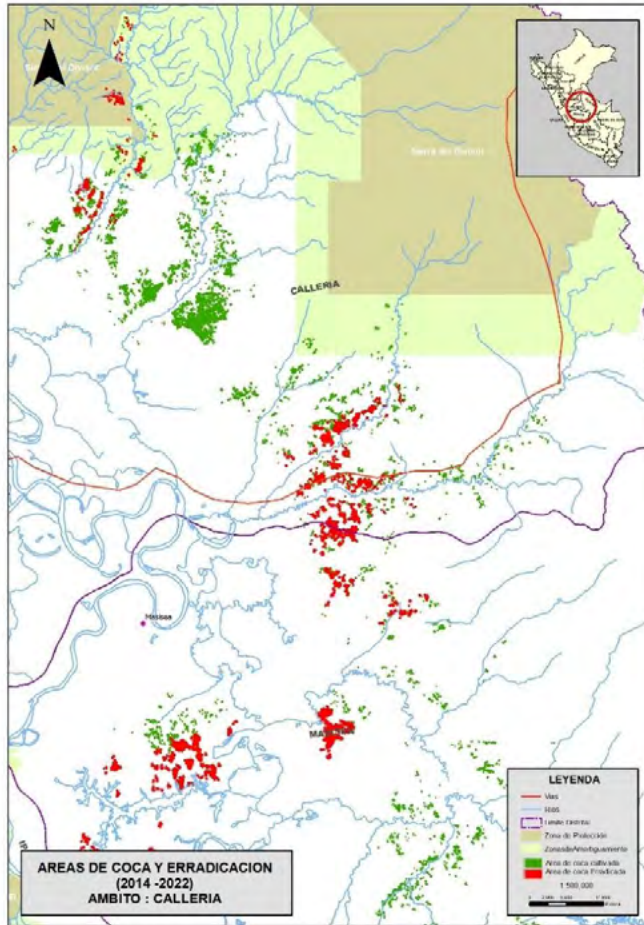
Table 13. Minimum Distance from Coca Plots to Rivers

RANGO DE DISTANCIA (m)	RÍOS	
	#	% ACUMULADO
0 - 500	558	7%
500 - 1000	969	20%
1000 - 2000	1,898	45%
2000 - 3000	1,340	62%
3000 - 4000	976	75%
4000 - 5000	692	84%
5000 - 6000	399	89%
6000 - 7000	242	92%
7000 - 8000	202	95%
8000 - 9000	159	97%
9000 - 10000	125	99%
MAS DE 10000	105	100%
TOTAL	7,665	

- Shows continuous growth of coca: 1,710 ha in 2011 to 8,725 ha in 2022. It is the third area with the largest coca growth of coca after the VRAEM and Calleria.
- Criminal organizations have promoted coca cultivation by involving the Ticuna indigenous communities.
- Eradication has been intermittent. There has been no eradication since 2019.
- Total deforestation in the area has been growing. For the 2001-2010 period, and average of 3,514 ha were deforested per year, in the 2011-2021 period, the yearly average increased to 5,671 ha (a 61% increase). During the 2011-2021 study period, a total of 62,390 ha was deforested.
- Direct deforestation attributed to coca for the study period (2011-2021) was 9,582 ha, representing 16% of the total deforestation in the area. Percentage-wise, the third highest in Peru.
- Deforestation associated with coca, considering a 300-meter buffer amounted to 23,266 ha or 37% of the area's total deforestation. Combining the two figures, 53% of the area's total deforestation can be attributed to the growing of coca, the second highest in Peru, similar to Aguaytia and Calleria.

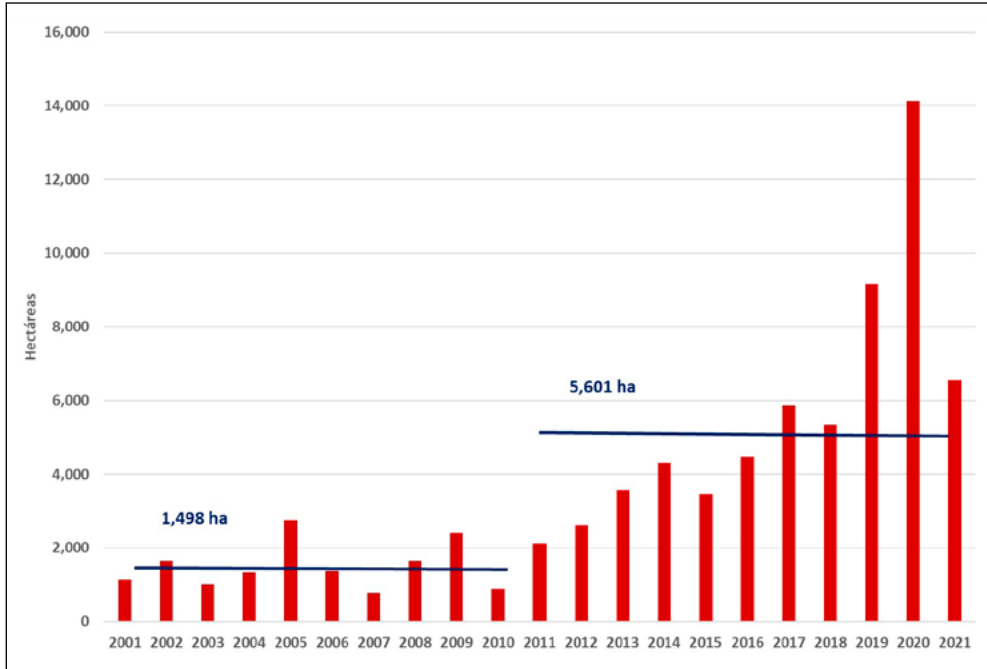
3.4 Callería

Map 4.
Distribution of Cultivated and Eradicated Coca Areas in Callería (2014-2022)



This study area considers the department of Ucayali and the Coronel Portillo province districts of Callería and Masisea. The area is linked to the main rivers Ucayali and Tamaya.

Graph 6
Total deforested area in Calleria (2001-2021)



Source: PNCBMCC.

Figure 4. Deforestation due to coca in Callería

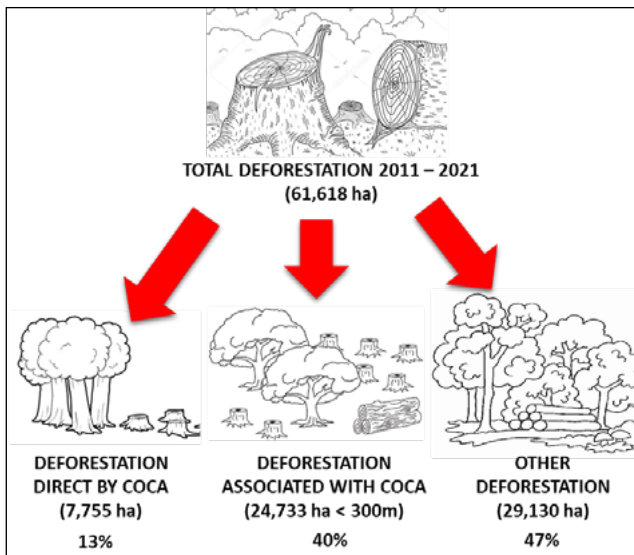


Table 14. Direct Coca Deforestation in Calleria

Año	ha
2011	117
2012	249
2013	610
2014	634
2015	696
2016	621
2017	913
2018	1,194
2019	2,257
2020	436
2021	29
TOTAL	7,755

Source: PNCBMCC.

Table 15. Deforestation Associated with Coca, Calleria (2011-2021)

BUFFER	ha	%
100m	19,550	31.73%
200m	22,712	36.86%
300m	24,733	40.14%
400m	26,339	42.75%
500m	27,738	45.02%
1000m	32,222	52.29%

Rivers play an important role in the establishment of coca areas. Hydrographic characteristics of the area and lack of control have resulted in 53% of the plots being installed within 3 km of the rivers.

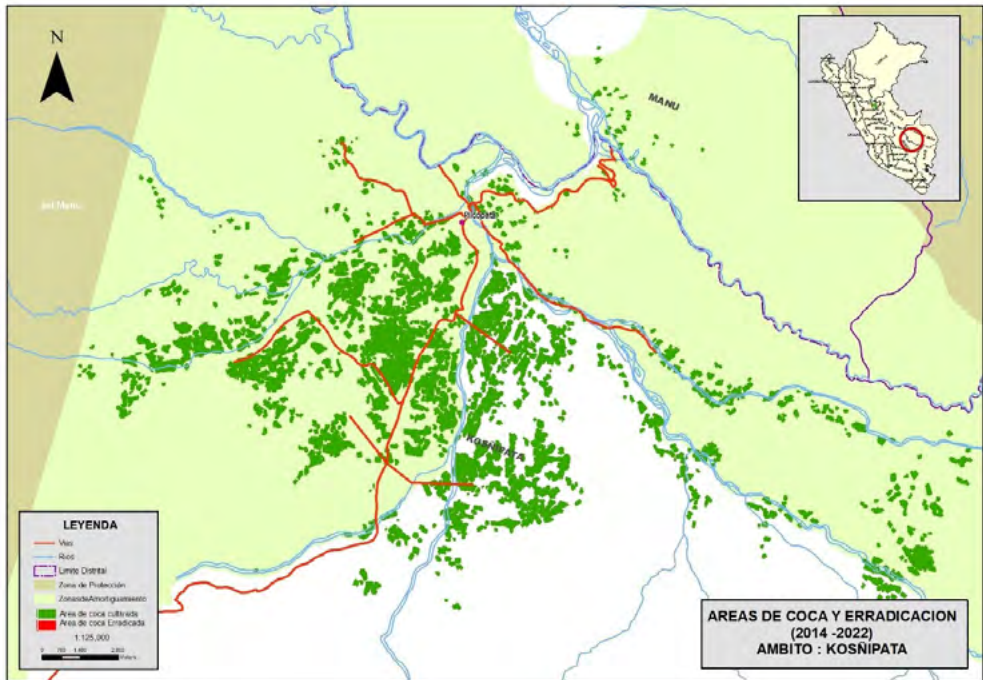
Table 16. Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500		0%	256	5%
500 - 1000	6	0%	506	15%
1000 - 2000	19	0%	1,140	36%
2000 - 3000	12	1%	866	53%
3000 - 4000	38	1%	560	64%
4000 - 5000	57	3%	491	73%
5000 - 6000	55	4%	360	80%
6000 - 7000	54	5%	279	85%
7000 - 8000	38	5%	144	88%
8000 - 9000	11	6%	111	90%
9000 - 10000	25	6%	108	92%
MAS DE 10000	4,907	100%	401	100%
TOTAL	5,222		5,222	

- Shows a sustained growth of coca areas: 231 ha in 2016 to 7,615 ha in 2022. During that six-year period, area grew 32-fold; the highest growth rate of coca cultivation in Peru.
- Since 2020, there is an increasing invasion of the buffer zone of Sierra del Divisor National Park.
- Criminal organizations have promoted coca cultivation with the migration of cocaleros from the VRAEM and Alto Huallaga as well as with local indigenous farmers and peasants.
- Total deforestation has been increasing. For the 2001-2010 average yearly deforestation amounted to 1,498 ha increasing to 5,601 ha for the 2011-2021 period (a 274% increase). During the study period (2011-2021), 61,618 ha were deforested.
- Direct coca deforestation in the 2011-2021 period amounted to 7,755 ha, representing 13% of the total deforestation in the area.
- Deforestation associated with coca, considering a 3000-meter buffer was 24,733 ha or 40% of the total deforestation in the area. Combining these two figures, 53% of the total deforestation in the area is due to coca; the second highest in Peru and similar to that Bajo Amazonas and Aguaytia.

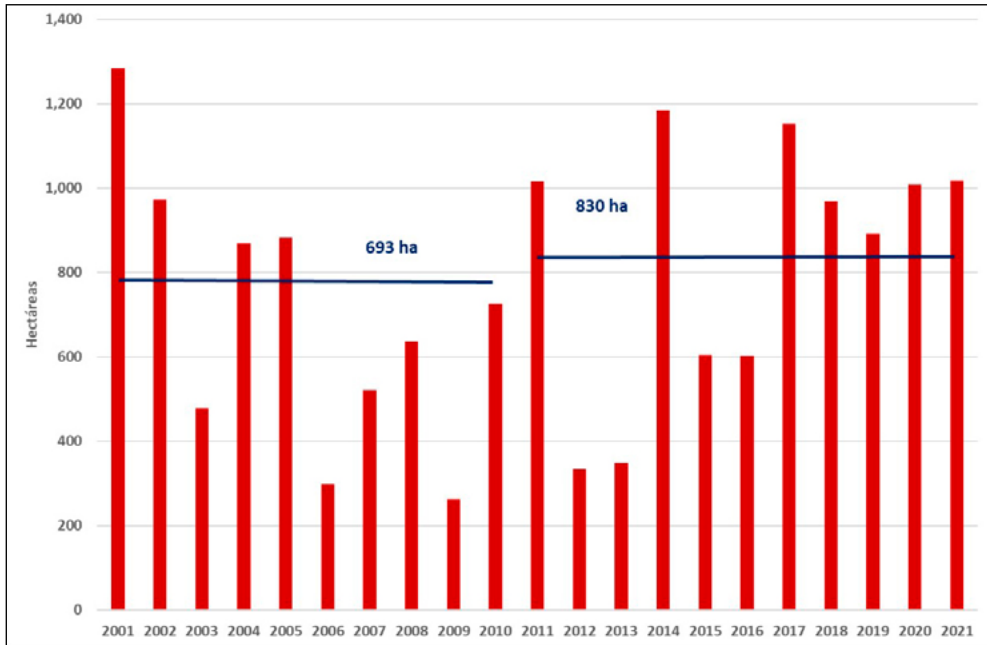
3.5 Kosñipata

Map 5
Distribution of Cultivated and Eradicated Coca Areas in Kosñipata
(2014-2022)



The zone includes the Kosñipata district of the Paucartambo province in the department of Cusco; and the Manu district of the Manu province in the department of Madre de Dios. The zone is linked to the main rivers Alto Madre de Dios, Pilcopata and Tono.

Graph 7
Total deforested area in Kosñipata (2001-2021)



Source: PNCBMCC.

Figure 5. Deforestation due to coca in Kosñipata

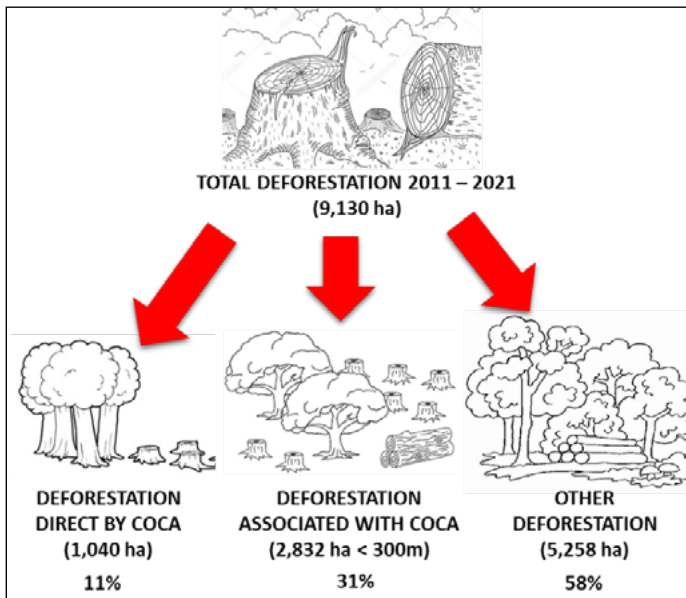


Table 17.
Direct Coca Deforestation, Kosñipata

Año	ha
2011	103
2012	44
2013	44
2014	128
2015	131
2016	81
2017	161
2018	205
2019	115
2020	21
2021	6
TOTAL	1,040

Source: PNCBMCC.

Table 18.
Deforestation Associated with Coca, Kosñipata (2011-2021)

BUFFER	ha	%
100m	2,144	23.48%
200m	2,514	27.54%
300m	2,832	31.02%
400m	3,018	33.06%
500m	3,222	35.29%
1000m	3,601	39.44%

Roads and rivers play an important role for the location of coca areas. Roads, and lack of controls and eradication have allowed for 80% of plots be established within 1 km from the roads.

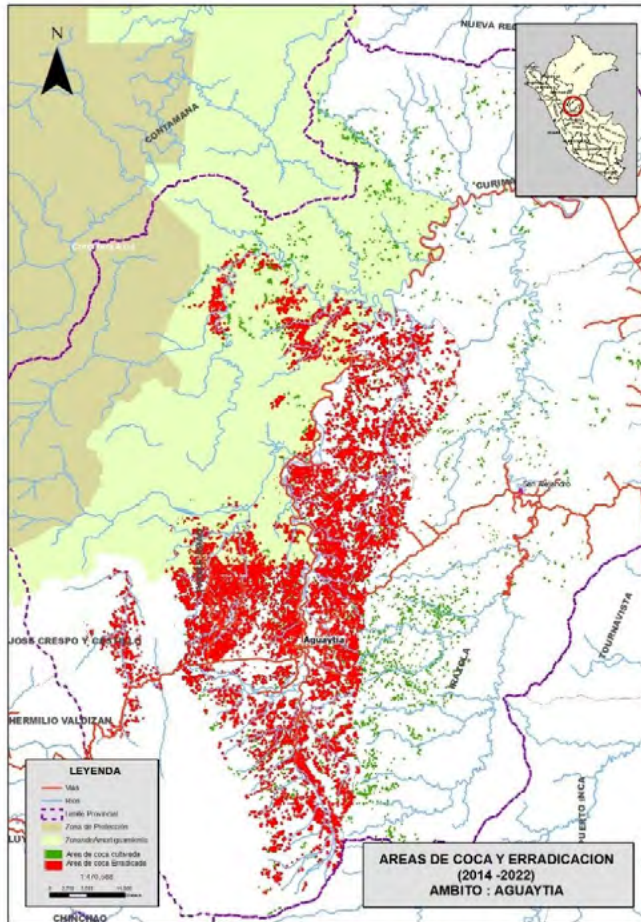
Table 19.
Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	676	64%	462	44%
500 - 1000	168	80%	201	63%
1000 - 2000	102	90%	237	86%
2000 - 3000	53	95%	107	96%
3000 - 4000	37	99%	42	100%
4000 - 5000	9	100%		
5000 - 6000	4	100%		
6000 - 7000				
7000 - 8000				
8000 - 9000				
9000 - 10000				
MAS DE 10000				
TOTAL	1,049		1,049	

- Maintains a sustained growth of coca areas: 670 in 2011 to 2,057 ha in 2022.
- DEVIDA reports an increasing invasion of the Communal Amaraeri Reserve.
- Criminal organizations have promoted the cultivation of coca with cocalero migrants from the VRAEM as well as local peasants.
- Deforestation has been growing. For the 2001-2010 period, annual average deforestation was 693 ha while for the 2011-2021 the annual average was 830 ha (a 20% growth). During the study period (2011-2021), 9,130 ha were deforested.
- Direct coca deforestation for the 2011-2021 period amounted to 1,040 ha which represented 11% of the total deforested area.
- Deforestation associated with coca considering a 300-meter buffer was 2,832 ha or 31% of the total deforestation in the area. The combination of these two figures indicates that 42% of the area's deforestation could be attributable to coca.

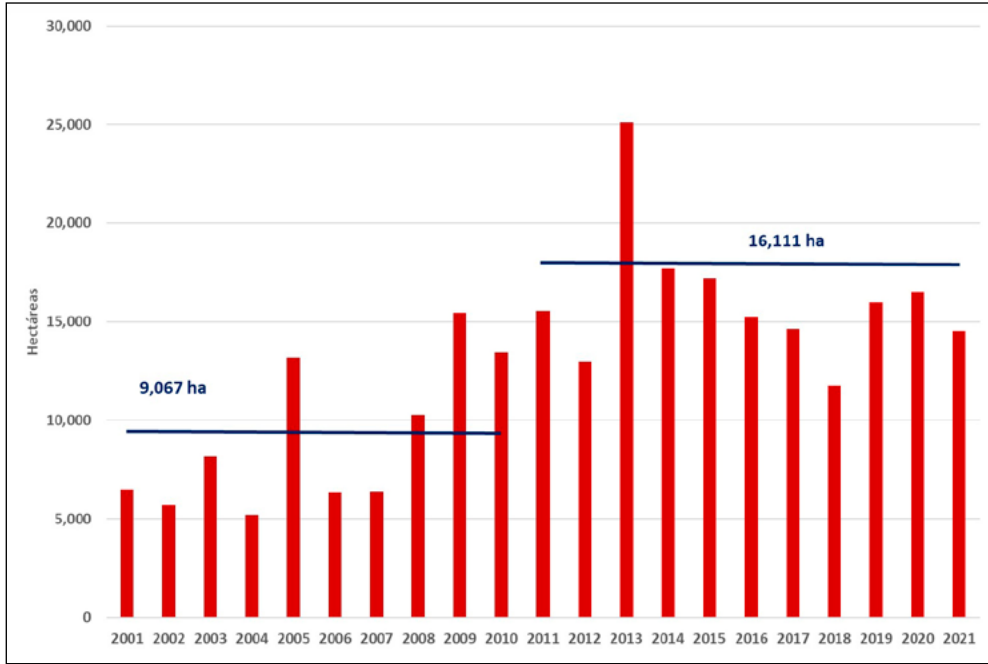
3.6 Aguaytía

Map 6.
Distribution of Cultivated and Eradicated Coca Areas in Aguaytia (2014-2022)



This zone includes the districts of Padre Abad, Irazola, Curimana, Neshuya, Alexander Von Humboldt, and Boqueron of the Padre Abad province in the Department of Ucayali. It also includes the Campoverde and Requena districts of the Coronel Portillo province in the same department. This area is linked to the Aguaytía river and various roads.

Graph 8
Total deforested area in Aguaytia (2001-2021)



Source: PNCBMCC.

Figure 6. Deforestation due to coca in Aguaytia

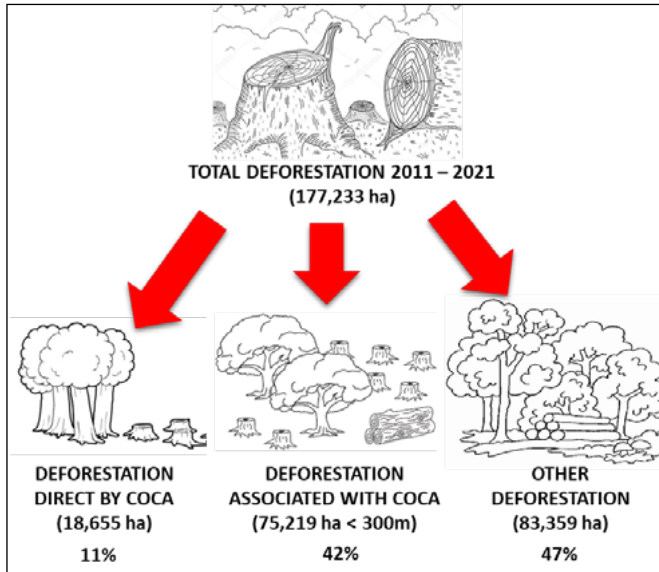


Table 20.
Direct Coca Deforestation, Aguaytia

Año	ha
2011	2,479
2012	1,380
2013	3,715
2014	2,441
2015	2,185
2016	1,385
2017	1,077
2018	961
2019	1,617
2020	999
2021	418
TOTAL	18,655

Source: PNCBMCC.

Table 21.
Deforestation Associated with Coca,
Aguaytia (2011-2021)

BUFFER	ha	%
100m	52,944	29.87%
200m	65,795	37.12%
300m	75,219	42.44%
400m	82,269	46.42%
500m	87,527	49.38%
1000m	106,022	59.82%

Roads and rivers play an important role when determining the location of coca areas. The road infrastructure and the rivers have allowed for 50% of the plots to be installed within 3 km of an access road or river

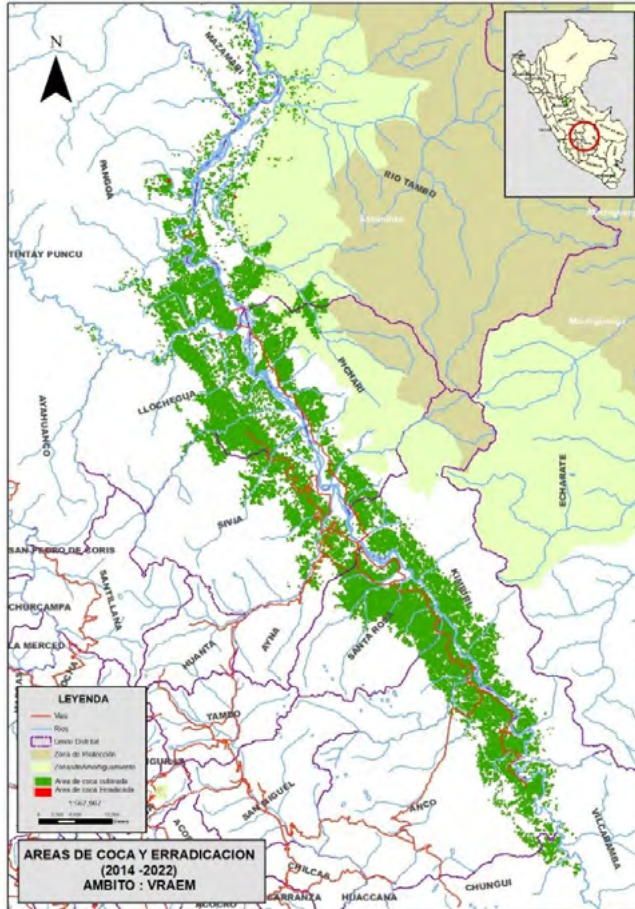
Table 22.
Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	3,983	13%	4,368	14%
500 - 1000	3,200	23%	3,003	24%
1000 - 2000	5,063	39%	5,636	42%
2000 - 3000	3,425	50%	4,736	57%
3000 - 4000	2,550	58%	3,867	69%
4000 - 5000	2,187	65%	3,120	79%
5000 - 6000	1,680	71%	2,278	86%
6000 - 7000	1,444	75%	1,677	92%
7000 - 8000	1,042	79%	1,070	95%
8000 - 9000	813	81%	751	97%
9000 - 10000	621	83%	369	99%
MAS DE 10000	5,286	100%	419	100%
TOTAL	31,294		31,294	

- Sustained growth of coca cultivation: 2,325 ha in 2011 to 3,914 ha in 2022.
- DEVIDA reports increased invasion in the buffer zone of the Cordillera Azul National Park.
- Criminal organizations promote coca cultivation with already established coccaleros in the area as well as local farmers even though eradication in the area has been permanent.
- Deforestation continues to grow. For the 2001-2010 period, the annual average deforestation was 9,067 ha and increased to 16,111 ha for the 2011-2021 period (78% increase). During the study period (2011-2021), 177,233 ha were deforested; the second largest area after the Pichis Palcazu Pachitea area.
- Direct deforestation from coca for the 2011-2021 period was 18,655 ha, representing 11% of the area's total deforestation. In absolute terms, deforestation due to coca in the area is the highest in Peru.
- Deforestation associated with coca considering a 300-meter buffer was 75,219 ha or 42% of the zone's total deforestation. Combining the two figures, 53% of the zone's total deforestation can be attributed to coca; percentage-wise the second highest in Peru similar to Bajo Amazonas and Calleria.

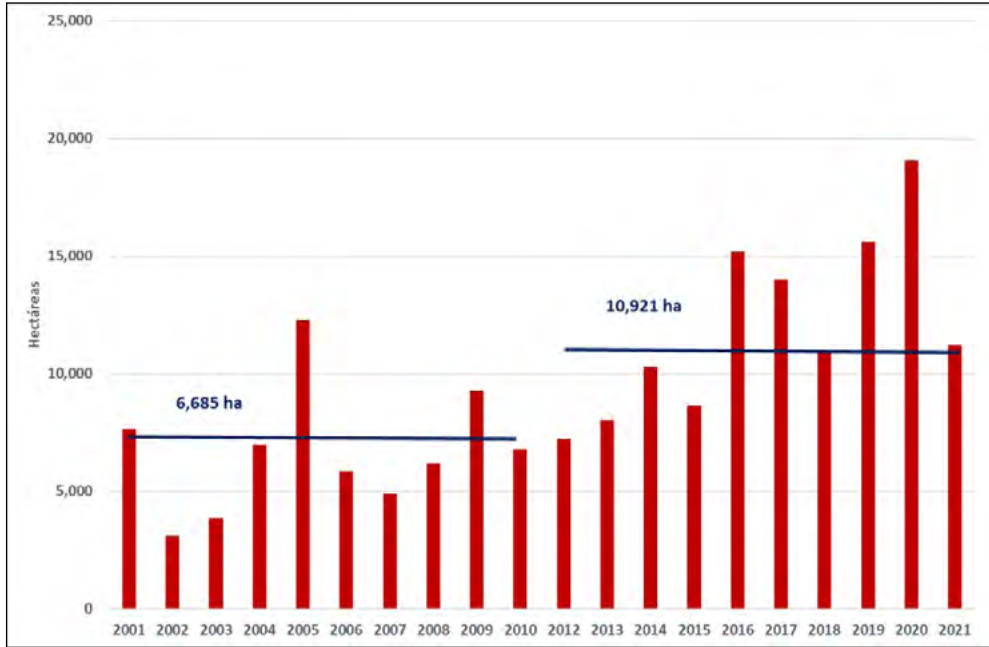
3.7 VRAEM

Map 7
Distribution of Cultivated and Eradicated Coca Areas in VRAEM
(2014-2022)



This zone includes the districts of Coriviali, Llaylla, Mazamari, Pangoa, Rio Tambo and Vizcatan del Ene of the Pangoa province in the department of Junin; the districts of Kimbiri, Cielo Punco, Manitea, Pichari, Union Ashaninka, Villa Kintiarina and Villa Virgen of the La Convencion province in the department of Cusco; and the Ayna, Samugari, Rio Magdalena Santa Rosa, Anchiway, Anco Union Progreso and Chungui districts of the Lamar province, and the Canayre, Llochegua and Silvia of the Huanta province in the department of Ayacucho. Valleys of the main rivers Apurimac, Ene and Mantaro are located in this zone.

Graph 9.
Total deforested area in VRAEM (2001-2021)



Source: PNCBMCC.

Figure 7. Deforestation due to Coca in VRAEM

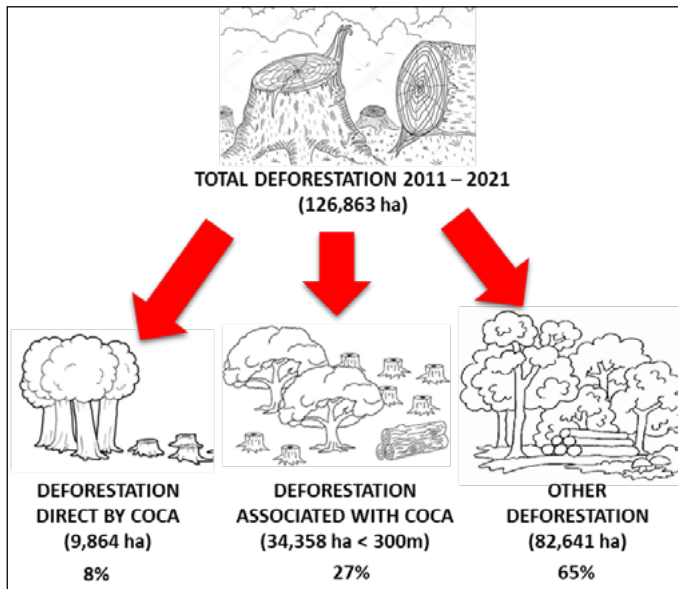


Table 23.
Direct Coca Deforestation, VRAEM

Año	ha
2011	706
2012	719
2013	1,066
2014	933
2015	904
2016	726
2017	2,492
2018	1,243
2019	801
2020	240
2021	34
TOTAL	9,864

Source: PNCBMCC.

Table 24.
Deforestation Associated with Coca,
VRAEM (2011-2021)

BUFFER	ha	%
100m	24,931	19.65%
200m	30,690	24.19%
300m	34,358	27.08%
400m	37,157	29.29%
500m	39,216	30.91%
1000m	45,732	36.05%

Roads are an important consideration when establishing coca plots. The complete lack of controls and eradication have allowed for 75% of plots be located within 1 km of roads; the shortest in Peru.

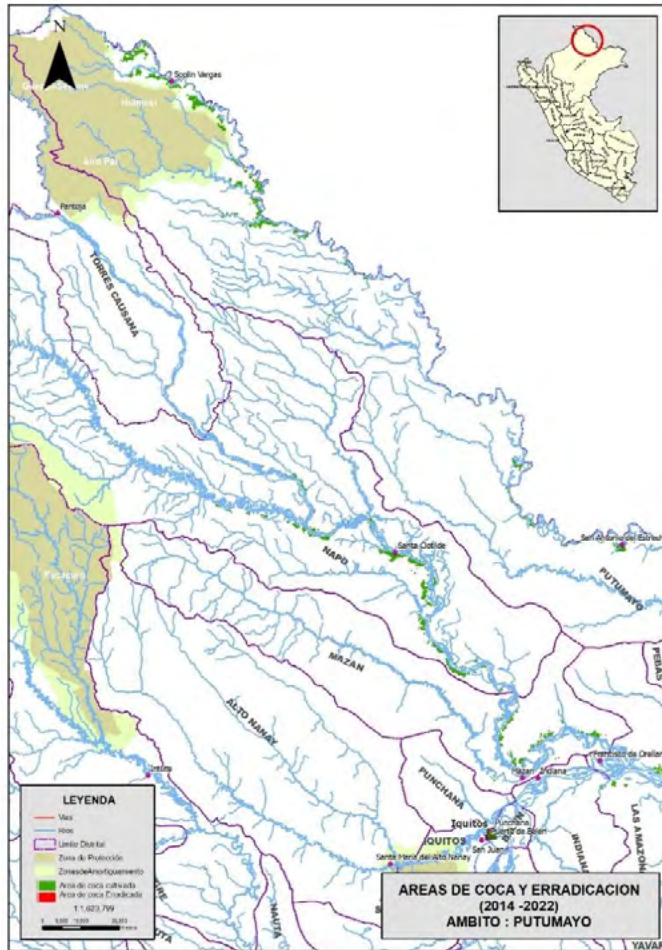
Table 25.
Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	9,937	56%	2,851	16%
500 - 1000	3,381	75%	2,895	32%
1000 - 2000	2,291	88%	4,753	59%
2000 - 3000	687	92%	3,064	76%
3000 - 4000	372	94%	1,867	87%
4000 - 5000	239	95%	1,186	94%
5000 - 6000	220	96%	689	97%
6000 - 7000	167	97%	325	99%
7000 - 8000	139	98%	91	100%
8000 - 9000	119	99%	16	100%
9000 - 10000	61	99%	10	100%
MAS DE 10000	139	100%	5	100%
TOTAL	17,752		17,752	

- Sustained growth of coca cultivation: 19,925 ha in 2011 to 35,709 in 2022. In absolute terms, this is the zone with the largest growth of coca cultivation;
- DEVIDA reports a growing invasion of the Ashaninka Communal Reserve buffer zone.
- Criminal organization have promoted coca cultivation with cocaleros established in the area for decades as well as with local farmers and engaging indigenous communities.
- Total deforestation has been increasing. Annual average deforestation for the 2001-2010 period was 6,685 ha and increased to 10,921 ha for the 2011-2021 period (63% increase). During this study's period (2011-2021), a total of 82,641 ha was deforested.
- Direct coca deforestation for the 2011-2021 period was 9,864 ha, representing 8% of the zone's total deforestation.
- Associated coca deforestation considering a 300-meter buffer was 34.358 ha or 27% the zone's total deforestation. If the two figures are combined, 35% of the zone's total deforestation can be attributed to coca.

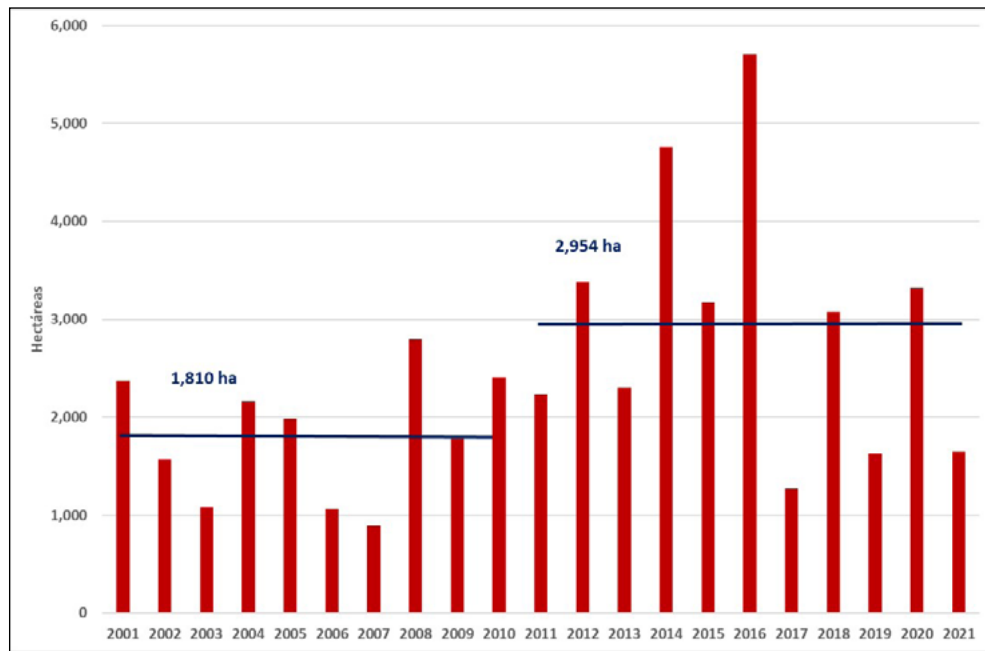
3.8 Putumayo

Map 8. Distribution of Cultivated and Eradicated Coca Areas in Putumayo (2014-2022)



This zone includes the districts of Indiana, Las Amazonas, Mazan, Napo and Punchana of the Maynas province; and the districts of Putumayo, Rosa Panduro and Teniente Manuel Clavero of the Putumayo province: both located in the department of Loreto. This zone is linked to main rivers of Putumayo and Napo.

Graph 10
Total deforested area in Putumayo (2001-2021)



Source: PNCBMCC.

Figure 8. Deforestation due to coca in Putumayo

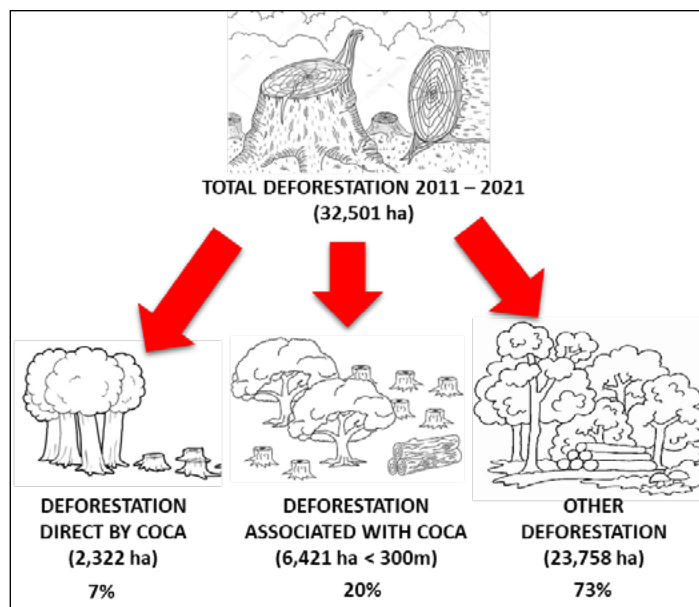


Table 26.
Direct Coca Deforestation, Putumayo

Año	ha
2011	98
2012	113
2013	201
2014	285
2015	210
2016	314
2017	169
2018	559
2019	129
2020	220
2021	26
TOTAL	2,322

Source: PNCBMCC.

Table 27.
Deforestation Associated
with Coca, Putumayo 2014-2022

BUFFER	ha	%
100m	4,621	14.22%
200m	5,680	17.48%
300m	6,421	19.76%
400m	6,981	21.48%
500m	7,460	22.95%
1000m	8,921	27.45%

Rivers are an important consideration when establishing coca plots. Hydrographic characteristics in Putumayo plus the lack of controls and eradication have allowed for 60% of the plots to be located within 1 km of the rivers.

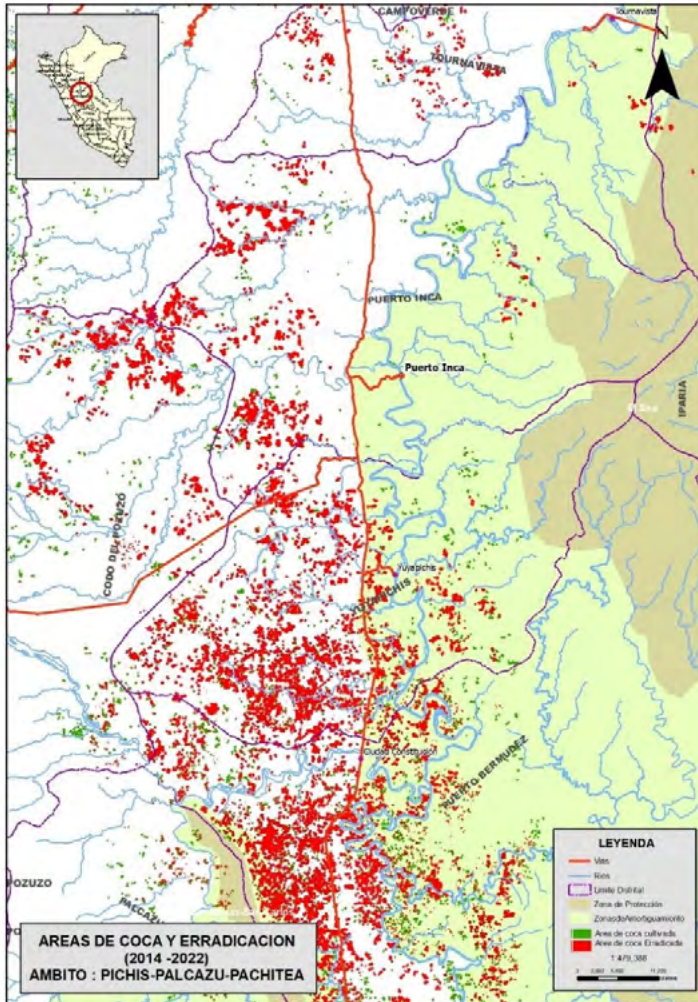
Table 28.
Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500		0%	1,336	33%
500 - 1000	1	0%	1,092	60%
1000 - 2000	1	0%	1,011	86%
2000 - 3000		0%	374	95%
3000 - 4000	2	0%	144	99%
4000 - 5000		0%	51	100%
5000 - 6000	2	0%	9	100%
6000 - 7000	9	0%		
7000 - 8000	30	1%		
8000 - 9000	38	2%		
9000 - 10000	17	2%		
MAS DE 10000	3,917	100%		
TOTAL	4,017		4,017	

- Small growth of coca cultivation: 1,540 ha in 2011 to 1,840 ha in 2022.
- DEVIDA has reported a growing invasion of the Huimaki Communal Reserve.
- Criminal organizations have promoted coca cultivation with migration of cocaleros from the Alto Huallaga as well as local farmers. Colombian criminal organizations are also promoting coca cultivation.
- Total deforestation has been increasing. Annual average deforestation for the 2001-2010 period was 1,810 ha and increased to 2,954 ha for the 2011-2021 period (63% growth). During this study's period (2011-2021) a total of 32,501 ha were deforested.
- Direct coca deforestation for the 2011-2021 period was 2,332 ha, representing 7% of the zone's total deforestation.
- Associated coca deforestation considering a 300-meter buffer was 6,421 ha or 20% the zone's total deforestation. If the two figures are combined, 27% of the zone's total deforestation can be attributed to coca.

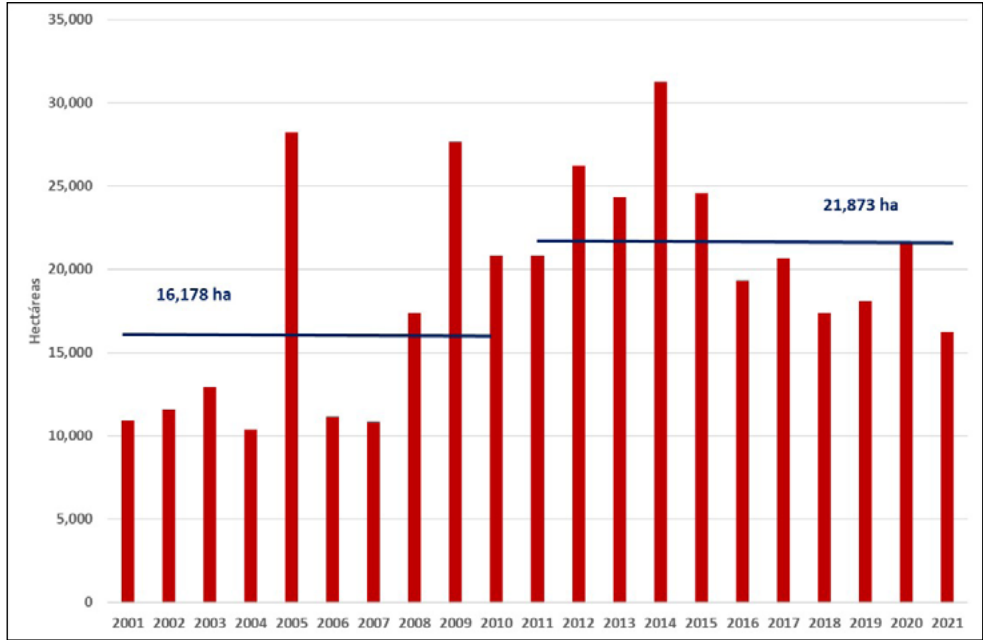
3.9 Pichis Palcazu Pachitea

Map 9.
Distribution of Cultivated and Eradicated Coca Areas in Pichis Palcazu Pachitea (2014-2022)



This zone includes the districts of Puerto Inca, Codo de Pozuzo, Tournavista, Honoria and Yuyapichis of the Puerto Inca Province in the department of Huanuco and the districts of Constitución, Puerto Bermudez and Palcazu in the Oxapampa province in the department of Pasco. This area is linked to the Pichis, Palcazu and Pachitea rivers.

Graph 11
Total deforested area in Pichis Palcazu Pachitea
(2001-2021)



Source: PNCBMCC.

Figure 9. Deforestation by coca in Pichis Palcazu Pachitea

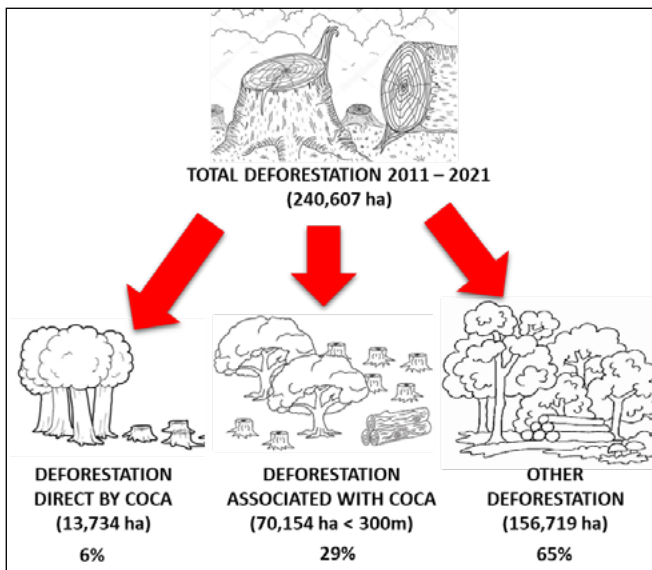


Table 29.
Direct Coca Deforestation,
Pichis Palcazu Pachitea

Año	ha
2011	2,036
2012	2,363
2013	1,353
2014	2,395
2015	1,351
2016	761
2017	892
2018	873
2019	888
2020	546
2021	276
TOTAL	13,734

Source: PNCBMCC.

Table 30. Deforestation Associated with Coca, Pichis Palcazu Pachitea (2011-2021)

BUFFER	ha	%
100m	46,658	19.39%
200m	59,286	24.64%
300m	70,154	29.16%
400m	78,583	32.66%
500m	86,629	36.00%
1000m	115,924	48.18%

Roads and rivers are an important consideration when establishing of coca plots. Hydrographic characteristics of Pichis Palcazu Pachitea plus lack of controls have allowed for 60% the plots to be located within 3 km of the rivers.

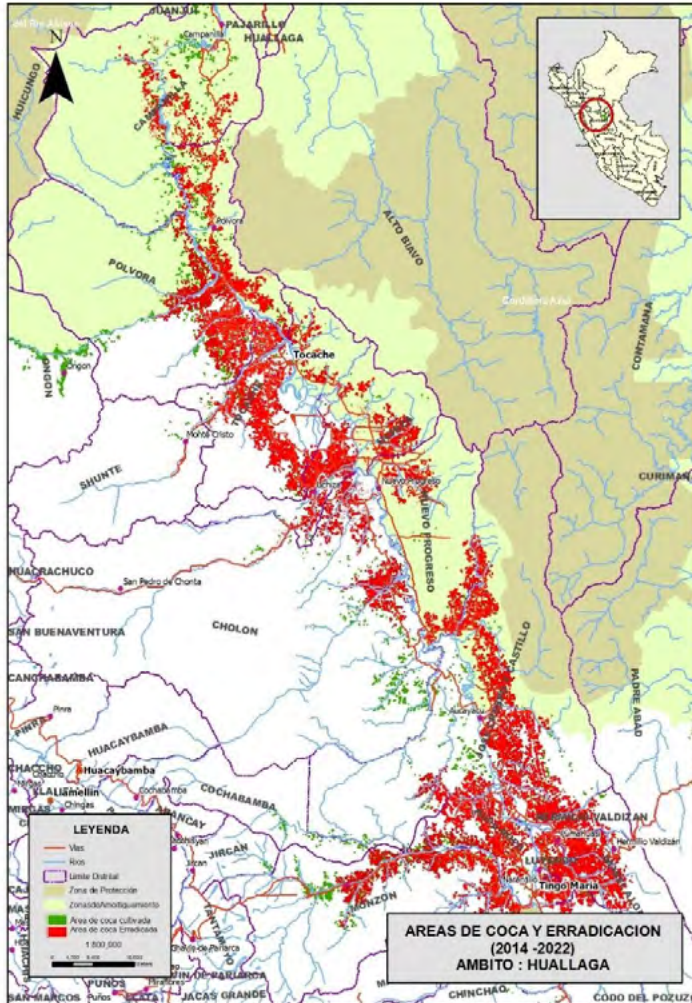
Table 31. Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	1,345	7%	2,383	12%
500 - 1000	1,534	15%	2,242	24%
1000 - 2000	2,707	29%	3,583	43%
2000 - 3000	2,153	40%	3,273	60%
3000 - 4000	1,845	50%	2,272	71%
4000 - 5000	1,521	58%	1,864	81%
5000 - 6000	1,493	65%	1,382	88%
6000 - 7000	1,353	73%	1,050	94%
7000 - 8000	1,234	79%	602	97%
8000 - 9000	946	84%	253	98%
9000 - 10000	780	88%	114	99%
MAS DE 10000	2,328	100%	221	100%
TOTAL	19,239		19,239	

- Sustained growth of coca cultivation: 3,734 ha in 2011 to 5,099 ha in 2022.
- DEVIDA reports increased invasion to the San Matias-San Carlos Protection Forest, the El Sira Communal Reserve and the Yanesha Communal Reserve.
- Criminal organizations have promoted coca cultivation with migration of cocaleros from the VRAEM and Alto Huallaga as well as local farmers.
- Total deforestation has been increasing. Annual average deforestation for the 2001-2010 period was 16,178 ha and increased to 21,873 ha for the 2011-2021 period (35% growth). During this study's period (2011-2021) a total of 240,607 ha were deforested; the highest in all of Peru.
- Direct coca deforestation for the 2011-2021 period was 9,864 ha, representing 8% of the zone's total deforestation.
- Direct coca deforestation for the 2011-2021 period was 13,734 ha, representing 6% of the zone's total deforestation. However, in absolute terms the highest due directly to coca after Aguaytia.

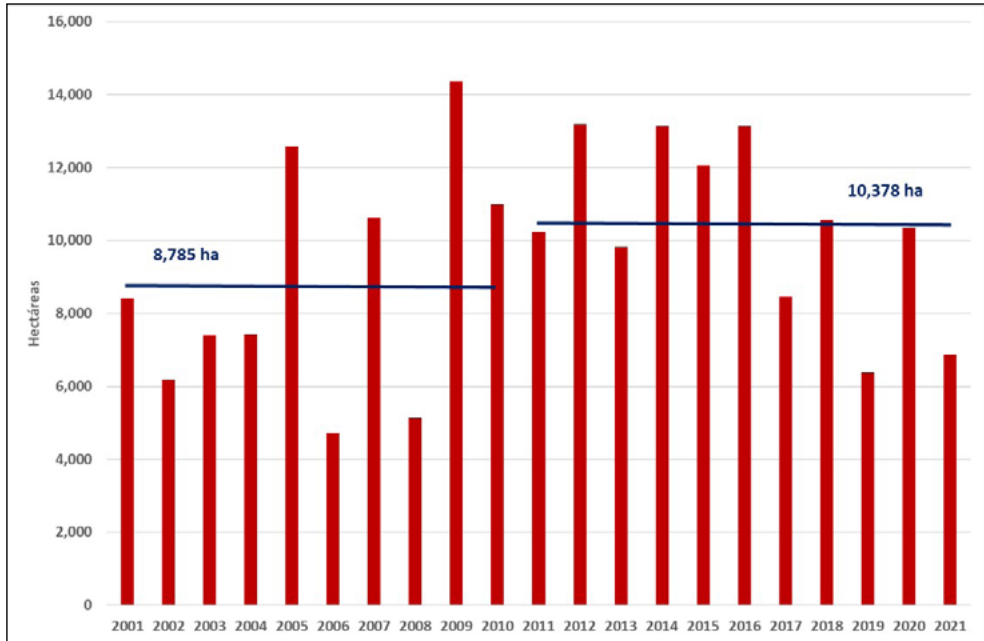
3.10 Huallaga

Map 10. Distribution of Cultivated and Eradicated Coca Areas in Huallaga (2014-2022)



This zone includes the districts of Juanjui, Campanilla, Huicungo and Pachiza of the Mariscal Caceres province; the Tocache, Polvora, Shunte, and Uchiza and Santa Lucia districts of the Tocache province in the department of San Martin; and the provinces of Huacaybamba, Marañón, Huamalíes and Leoncio Prado in the department of Huanuco. This zone is linked to the Huallaga and Monzon rivers.

Graph 12.
Total deforested area in Huallaga (2001-2021)



Source: PNCBMCC.

Figure 10. Deforestation due to coca in Huallaga

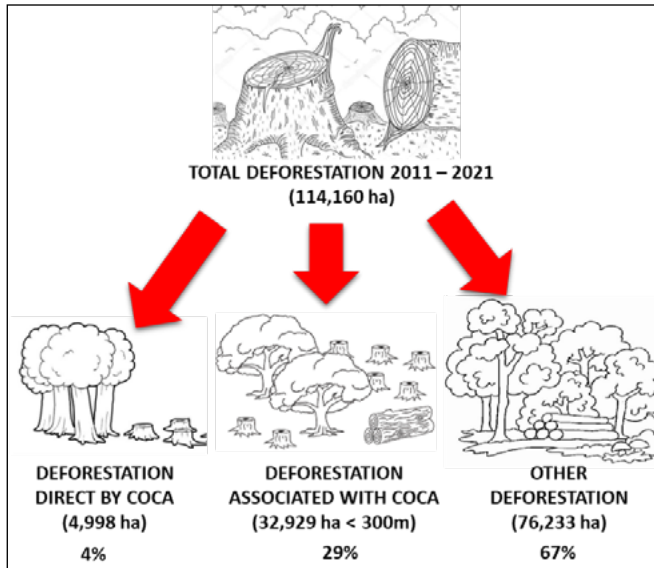


Tabla 32.
Direct Coca Deforestation, Huallaga

Año	ha
2011	566
2012	753
2013	514
2014	633
2015	595
2016	519
2017	445
2018	418
2019	241
2020	207
2021	109
TOTAL	4,998

Source: PNCBMCC.

Table 33. Deforestation Associated with Coca, Huallaga (2011-2021)

BUFFER	ha	%
100m	20,859	18.27%
200m	27,965	24.50%
300m	32,929	28.84%
400m	36,801	32.24%
500m	39,900	34.95%
1000m	50,607	44.33%

Roads and rivers are an important consideration when establishing of coca plots. The extensive road network has allowed for 57% of plots to be located within 1 km of a road.

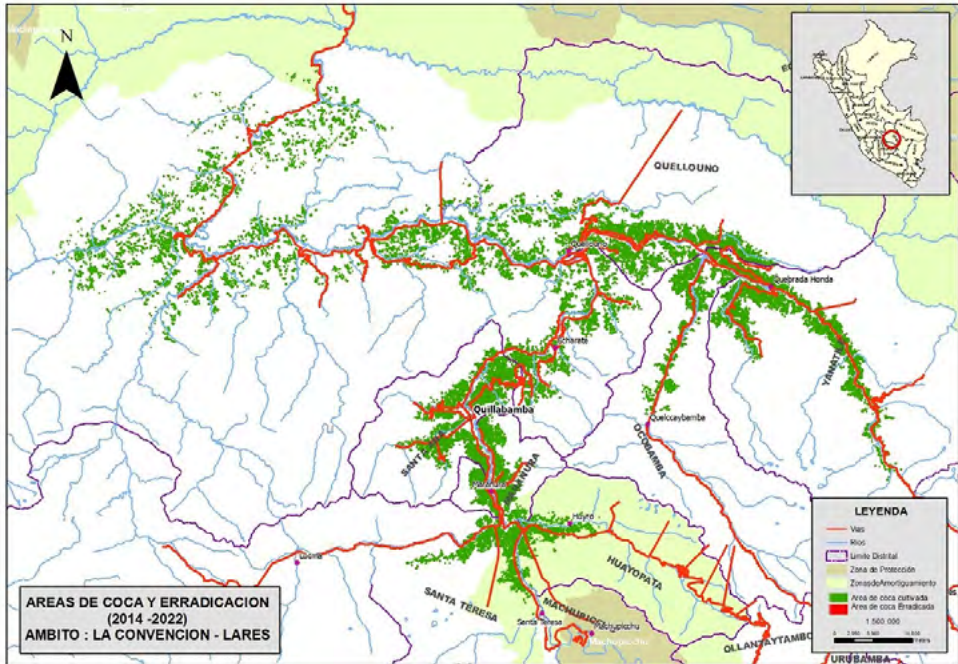
Table 34. Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	14,796	36%	6,164	15%
500 - 1000	8,704	57%	5,580	28%
1000 - 2000	8,536	77%	9,388	51%
2000 - 3000	3,310	85%	7,074	68%
3000 - 4000	1,598	89%	4,789	80%
4000 - 5000	817	91%	3,205	87%
5000 - 6000	584	92%	1,982	92%
6000 - 7000	520	94%	1,310	95%
7000 - 8000	410	95%	666	97%
8000 - 9000	294	95%	436	98%
9000 - 10000	365	96%	319	99%
MAS DE 10000	1,522	100%	543	100%
TOTAL	41,456		41,456	

- The zone showed a decrease of 78% in coca cultivation: 12,421 ha in 2011 to 2,683 in 2022. Permanent coca eradication and investments in alternative development are the major cause of this result.
- DEVIDA reports and increasing invasion of the Cordillera Azul and Rio Abiseo National Parks' buffer zones.
- Criminal organizations insist in promoting coca cultivation with already established cocaleros.
- Total deforestation has been increasing. Annual average deforestation for the 2001-2010 period was 8,785 ha and increased to 10,378 ha for the 2011-2021 period (18% growth). During this study's period (2011-2021) a total of 114,160 ha were deforested.
- Direct coca deforestation for the 2011-2021 period was 4,998 ha, representing 4% of the zone's total deforestation.
- Associated coca deforestation considering a 300-meter buffer was 32.929 ha or 29% the zone's total deforestation. If the two figures are combined, 35% of the zone's total deforestation can be attributed to coca.

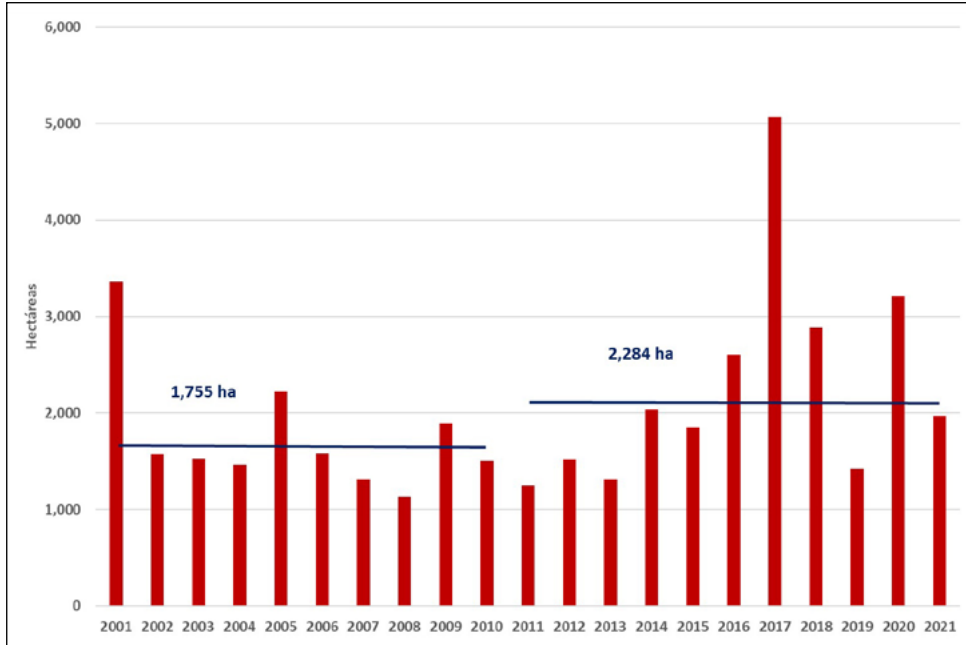
3.11 La Convención Lares

Map 11
Distribution of Cultivated and Eradicated Coca Areas
in La Convención Lares
(2014-2022)



This zone includes the districts of Santa Ana, Echarate, Huayopata, Marañón, Ocopampa, Quellouno, Santa Teresa, Vilcabamba and Kumpirushiato of the La Convención province in the department of Cusco. The zone is linked to the Vilcanota river.

Graph 13
Total deforested area in La Convención Lares
(2001-2021)



Source: PNCBMCC.

Figure 11. Deforestation due to coca in La Convención Lares

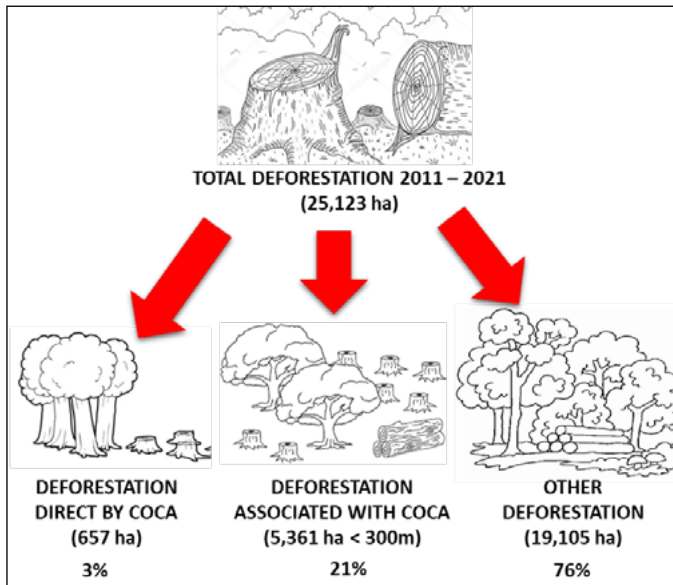


Table 35.
Direct Coca Deforestation, La Convencion Lares

Año	ha
2011	13
2012	27
2013	30
2014	83
2015	85
2016	88
2017	236
2018	50
2019	15
2020	21
2021	8
TOTAL	657

Source: PNCBMCC.

Table 36. Deforestation Associated with Coca, La Convencion Lares (2011-2021)

BUFFER	ha	%
100m	2,995	11.92%
200m	4,363	17.37%
300m	5,361	21.34%
400m	6,144	24.45%
500m	6,727	26.78%
1000m	8,491	33.80%

Roads and rivers are an important consideration when establishing of coca plots. Road infrastructure has allowed for almost 100% of plots being installed within 2 km of a road. La Convencion is the zone with the highest legal coca production.

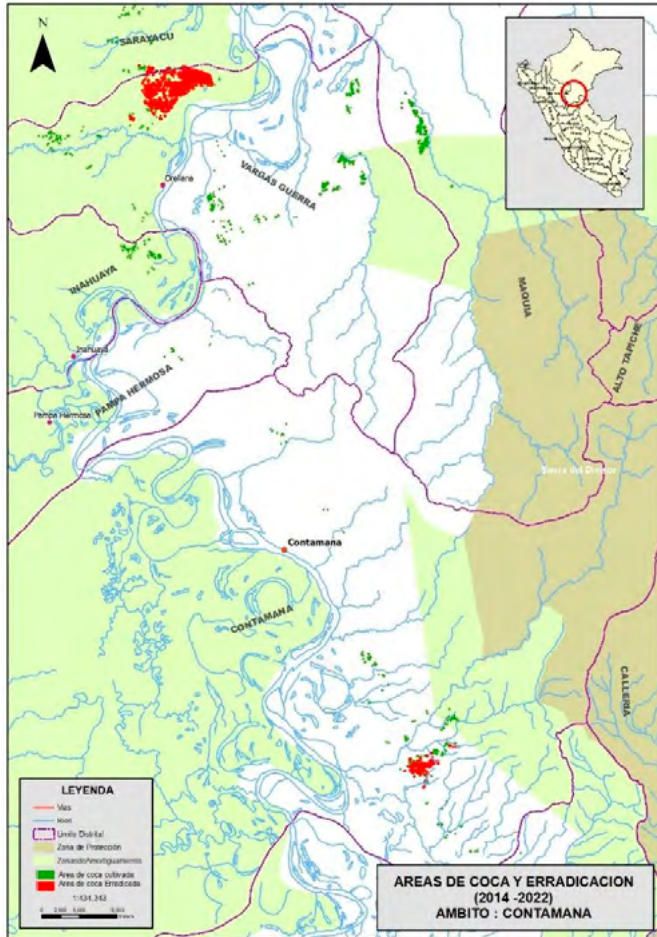
Table 37. Minimum distance from coca plots to roads and rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	11,080	75%	4,455	30%
500 - 1000	2,437	91%	3,384	53%
1000 - 2000	1,080	99%	4,027	80%
2000 - 3000	181	100%	1,883	93%
3000 - 4000	30	100%	648	97%
4000 - 5000		100%	253	99%
5000 - 6000	3	100%	83	99%
6000 - 7000			59	100%
7000 - 8000			12	100%
8000 - 9000			7	100%
9000 - 10000				
MAS DE 10000				
TOTAL	14,811		14,811	

- A 66% decrease in coca cultivation was reported: 13,090 ha in 2011 to 4,400 in 2022. This situation is likely due to heavy investments of local municipalities from the mining canon providing labor opportunities with higher paying wages than those in agriculture.
- DEVIDA reports invasions in the buffer zone of the Historic Sanctuary of Machupicchu.
- Total deforestation has been increasing. Annual average deforestation for the 2001-2010 period was 1,755 ha and increased to 2,284 ha for the 2011-2021 period (30% growth). During this study's period (2011-2021) a total of 25,123 ha were deforested.
- Direct coca deforestation for the 2011-2021 period was 657 ha, representing 3% of the zone's total deforestation.
- Associated coca deforestation considering a 300-meter buffer was 5,361 ha or 21% the zone's total deforestation. If the two figures are combined, 24% of the zone's total deforestation can be attributed to coca.

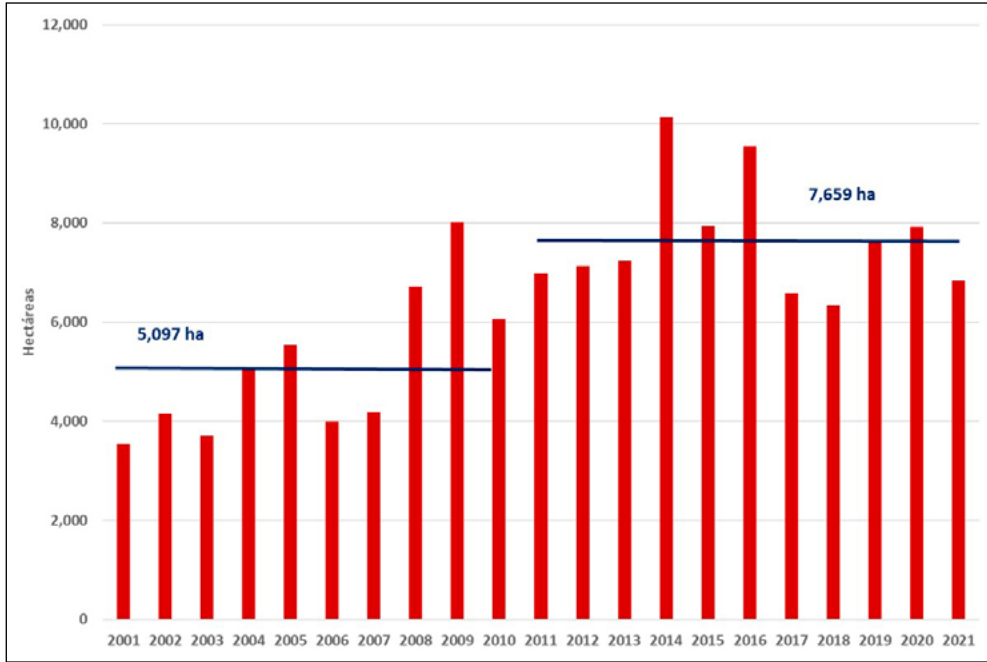
3.12 Contamana

Map 12. Distribution of Cultivated and Eradicated Coca Areas in Contamana (2014-2022)



This zone includes the district of Maquia of the Requena province in the department Loreto; and the districts of Contamana, Inahuaya, Padre Márquez, Pampa Hermosa, Sarayacu and Vargas Guerra of the Ucayali province in Loreto. The zone is linked to the Ucayali River.

Graph 14
Total deforested area in Contamana (2001-2021)



Source: PNCBMCC.

Figure 12. Deforestation due to coca in Contamana

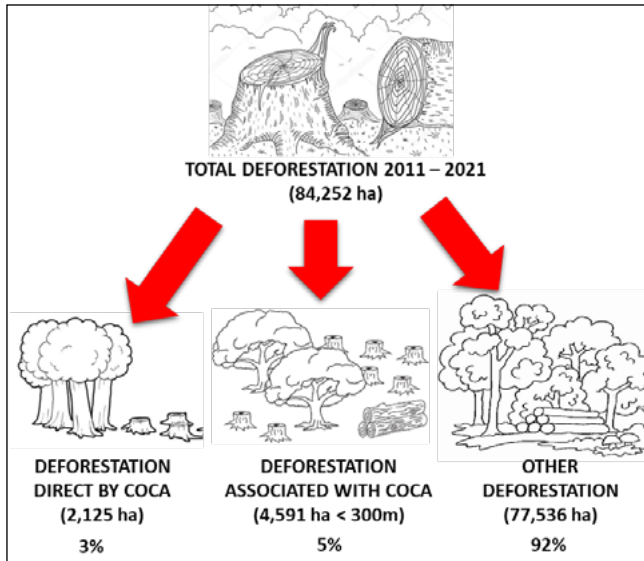


Table 38.
Direct Coca Deforestation, Contamana

Año	ha
2011	51
2012	114
2013	444
2014	437
2015	198
2016	164
2017	168
2018	125
2019	389
2020	31
2021	6
TOTAL	2,125

Source: PNCBMCC.

Table 39. Deforestation Associated with Coca, Contamana (2011-2021)

BUFFER	ha	%
100m	3,346	3.97%
200m	3,994	4.74%
300m	4,591	5.45%
400m	5,148	6.11%
500m	5,605	6.65%
1000m	7,413	8.80%

Hydrographic characteristics of Contamana are used by the narcotraffickers. The lack of controls and eradication have allowed for 67% of plots be located within 3 km of the rivers.

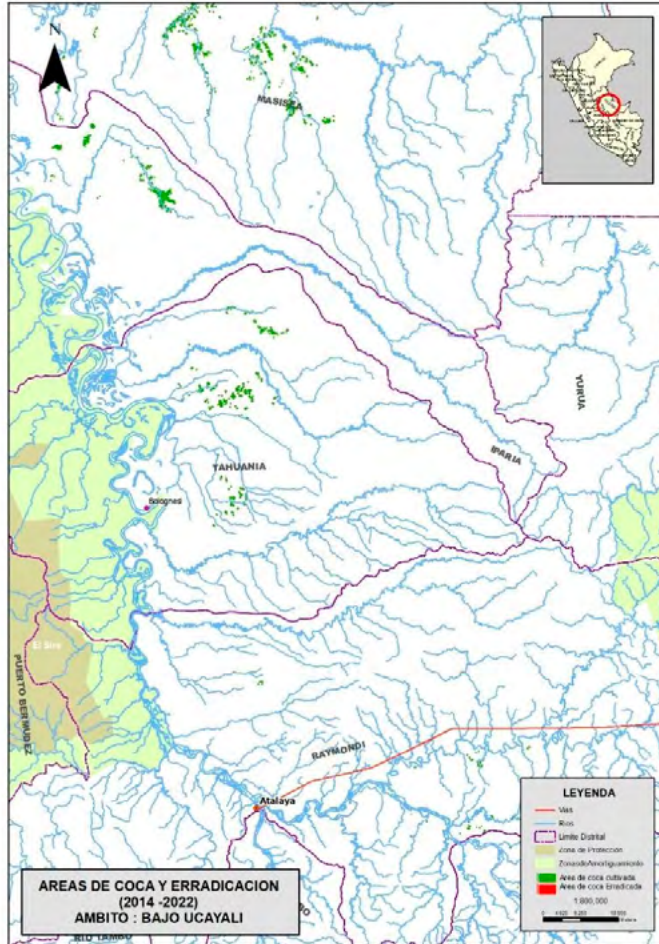
Table 40. Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	RÍOS	
	#	% ACUMULADO
0 - 500	99	9%
500 - 1000	150	22%
1000 - 2000	298	47%
2000 - 3000	226	67%
3000 - 4000	147	80%
4000 - 5000	93	88%
5000 - 6000	67	94%
6000 - 7000	40	97%
7000 - 8000	28	100%
8000 - 9000	3	100%
9000 - 10000		100%
MAS DE 10000	2	100%
TOTAL	1,153	

- Sustained growth of coca cultivation: only 47 ha in 2012 to 1,403 in 2022. A 29-fold increase.
- There is a growing invasion of buffer zones of the Cordillera Azul and Sierra del Divisor National Parks.
- Criminal organizations have promoted coca cultivation with the migration of cocaleros from Alto Huallaga and local farmers.
- Total deforestation has been increasing. Annual average deforestation for the 2001-2010 period was 5,097 ha and increased to 7,659 ha for the 2011-2021 period (50% growth). During this study's period (2011-2021) a total of 84,252 ha were deforested.
- Direct coca deforestation for the 2011-2021 period was 2,125 ha, representing 3% of the zone's total deforestation.
- Associated coca deforestation considering a 300-meter buffer was 4,591 ha or 5% the zone's total deforestation. If the two figures are combined, 8% of the zone's total deforestation can be attributed to coca.

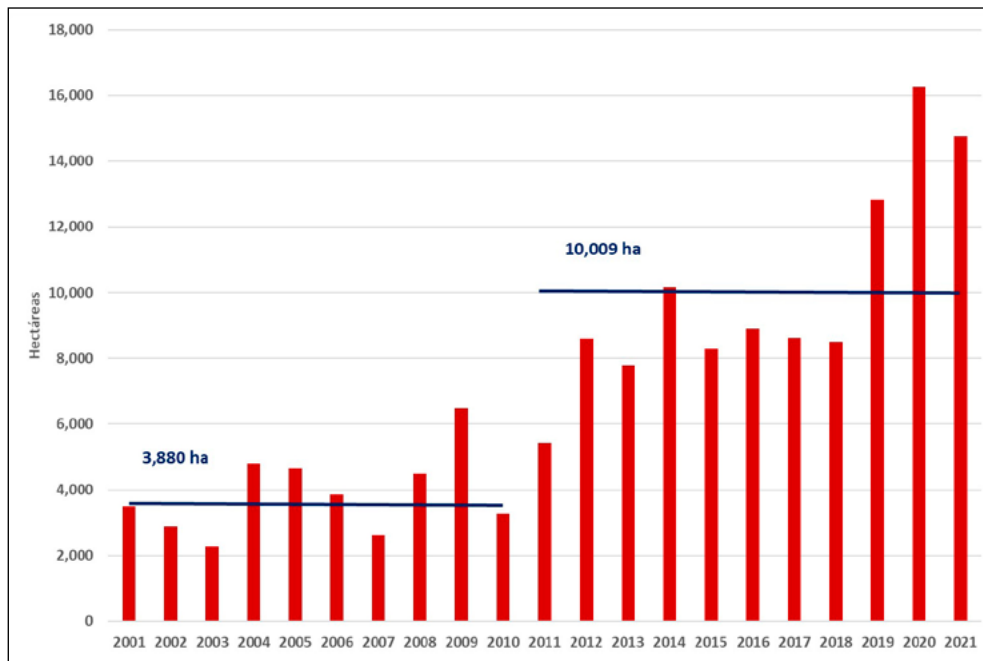
3.13 Bajo Ucayali

Map 13. Distribution of Cultivated and Eradicated Coca Areas in Bajo Ucayali (2014-2022)



This zone includes the district of Iparai of the Coronel Portillo province; the districts of Raimondi, Sepahua, and Tahuania of the Atalla province in the department of Ucayali. The zone is linked to the Ucayali and Urubamba rivers.

Graph 15
Total deforested area in Bajo Ucayali (2001-2021)



Source: PNCBMCC.

Figure 13. Deforestation due to coca in Bajo Ucayali

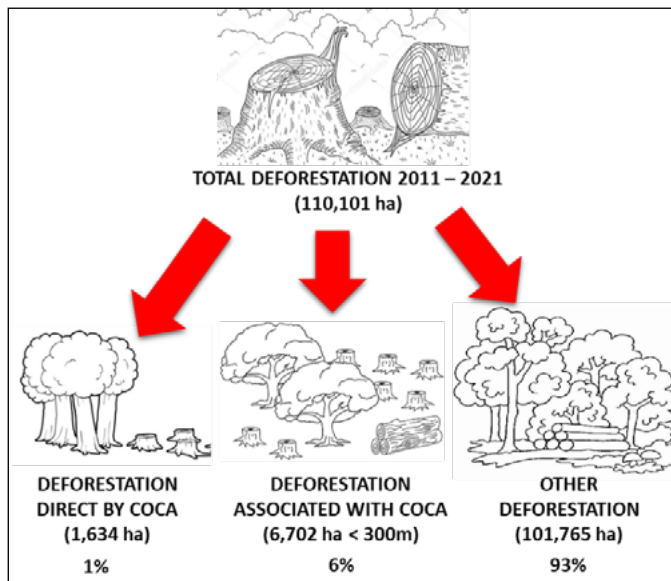


Table 41.
Direct Coca Deforestation, Bajo Ucayali

Año	ha
2011	16
2012	5
2013	11
2014	32
2015	50
2016	61
2017	152
2018	369
2019	824
2020	112
2021	3
TOTAL	1,634

Source: PNCBMCC.

Table 42. Deforestation Associated with Coca, Bajo Ucayali (2011-2021)

BUFFER	ha	%
100m	4,693	4.26%
200m	5,611	5.10%
300m	6,702	6.09%
400m	7,385	6.71%
500m	8,044	7.31%
1000m	10,854	9.86%

Rivers are an important consideration when establishing of coca plots. Hydrographic characteristics of Bajo Ucayali and the lack of controls and eradication have allowed for 60% of plots be located within 5 km from rivers.

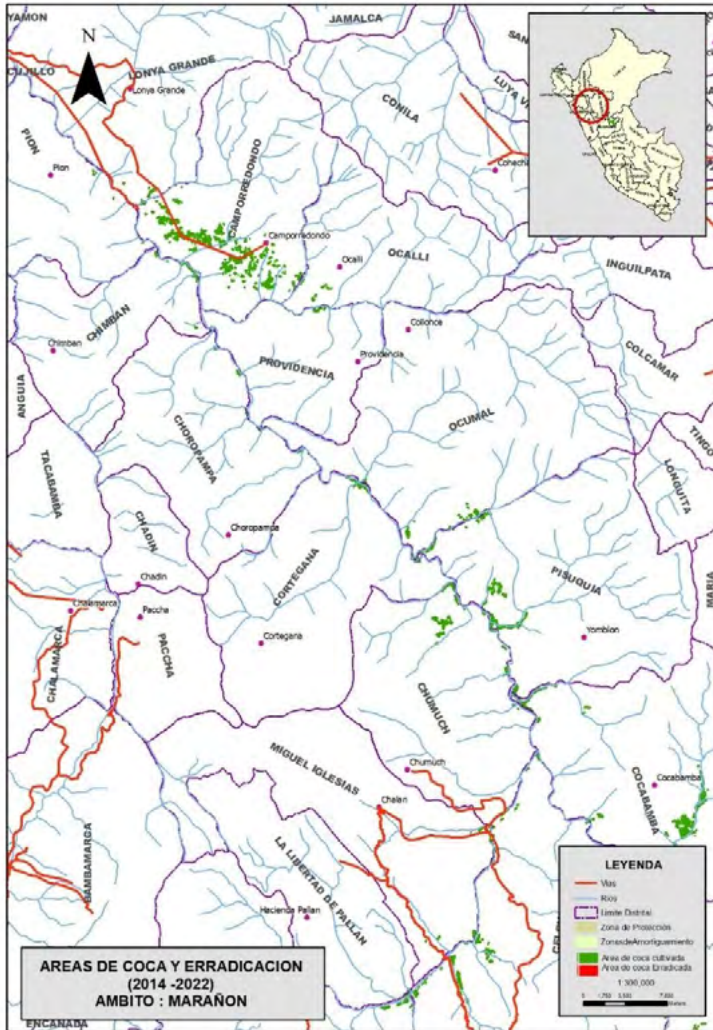
Table 43. Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	10	1%	55	8%
500 - 1000	27	6%	25	12%
1000 - 2000	43	12%	52	20%
2000 - 3000	74	23%	49	27%
3000 - 4000	62	32%	111	44%
4000 - 5000	21	35%	110	60%
5000 - 6000	22	39%	82	72%
6000 - 7000	9	40%	59	81%
7000 - 8000	15	42%	26	85%
8000 - 9000	19	45%	13	87%
9000 - 10000	1	45%	18	90%
MAS DE 10000	365	100%	68	100%
TOTAL	668		668	

- Growth of coca cultivation: 1,659 ha in 2021 a 2,735 in 2022.
- Criminal organizations have promoted coca cultivation with the migration of cocaleros from VRAEM and Alto Huallaga, and with local farmers.
- Total deforestation has been increasing. Annual average deforestation for the 2001-2010 period was 3,880 ha and increased to 10,008 ha for the 2011-2021 period (30% growth). During this study's period (2011-2021) a total of 110,765 ha were deforested.
- Direct coca deforestation for the 2011-2021 period was 1,634 ha, representing 1% of the zone's total deforestation.
- Associated coca deforestation considering a 300-meter buffer was 6,702 ha or 6% the zone's total deforestation. If the two figures are combined, 7% of the zone's total deforestation can be attributed to coca.

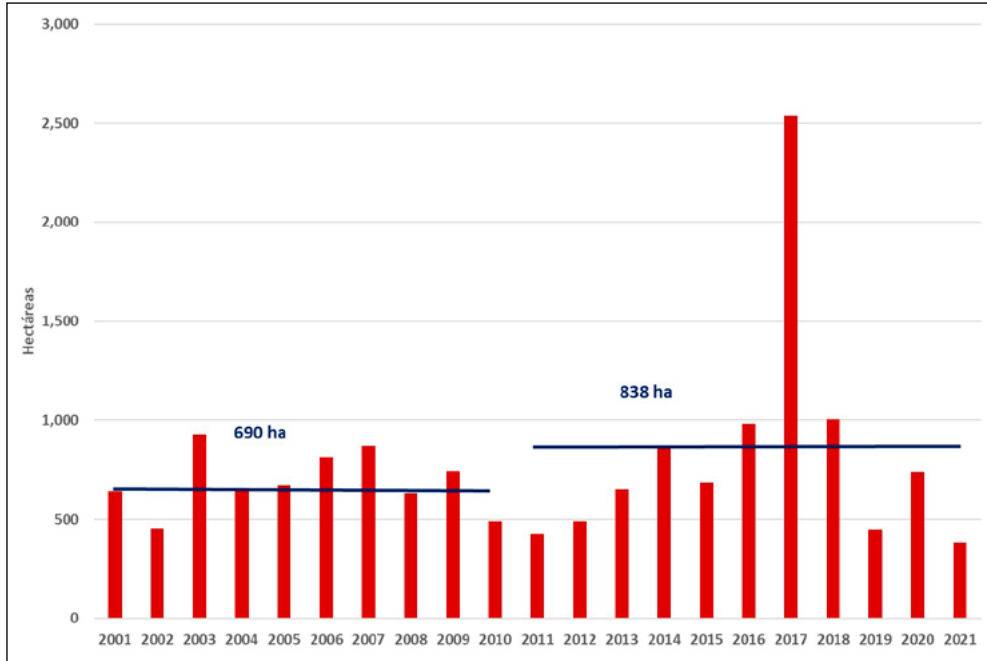
3.14. Marañón

Map 14.
Distribution of Cultivated and Eradicated Coca Areas in Marañón
(2014-2022)



This zone includes the Patatez district of the Patatez province, the provinces of Bolívar and Sánchez Carrion in the department of La Libertad; the provinces of Luya and Uctubamba in the department of Amazonas; and the provinces of Celendin, Chota and San Marcos in the department of Cajamarca. The zone is linked to the Marañón river.

Graph 16
Total deforested area in Marañon (2001-2021)



Source: PNCBMCC.

Figure 14. Deforestation due to coca in Marañon

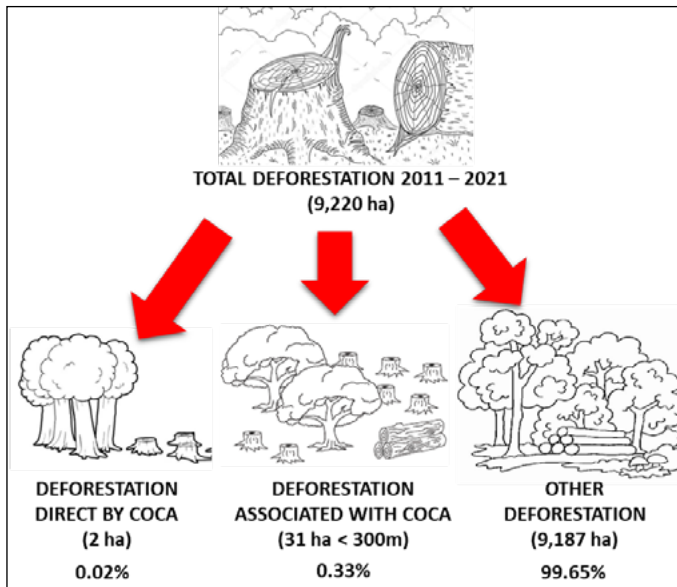


Table 44.
Direct Coca Deforestation, Marañon

Año	ha
2011	0.02
2012	0.47
2013	0.03
2014	0.01
2015	0.48
2016	0.68
2017	0.09
2018	
2019	
2020	
2021	
TOTAL	2

Source: PNCBMCC.

Table 45. Deforestation Associated with Coca, Marañon (2011-2021)

BUFFER	ha	%
100m	13	0.15%
200m	22	0.24%
300m	31	0.33%
400m	38	0.41%
500m	41	0.45%
1000m	66	0.72%

Rivers are an important consideration when establishing of coca plots. Hydrographic characteristics of Marañon, and the lack of controls and eradication have allowed for 62% of the pots being located within 1 km from the rivers.

Table 46. Minimum Distance from Coca Plots to Roads and Rivers

RANGO DE DISTANCIA (m)	VÍAS		RÍOS	
	#	% ACUM.	#	% ACUM.
0 - 500	517	27%	1,017	53%
500 - 1000	126	34%	162	62%
1000 - 2000	166	42%	230	74%
2000 - 3000	215	54%	183	84%
3000 - 4000	201	64%	112	89%
4000 - 5000	178	74%	113	95%
5000 - 6000	84	78%	84	100%
6000 - 7000	97	83%	5	100%
7000 - 8000	40	85%		
8000 - 9000	32	87%		
9000 - 10000	42	89%		
MAS DE 10000	208	100%		
TOTAL	1,906		1,906	

- Sustained growth of coca cultivation: 1,200 ha in 2011 to 1,560 ha in 2022
- DEVIDA reports invasion of the Rio Abiseo's National Park buffer zone.
- Criminal organizations have promoted coca cultivation with established cocaleros as well as with local farmers.
- Total deforestation has been increasing. Annual average deforestation for the 2001-2010 period was 690 ha and increased to 838 ha for the 2011-2021 period (21% growth). During this study's period (2011-2021) a total of 9,220 ha were deforested.
- Direct coca deforestation for the 2011-2021 period was 2 ha, representing 0.02% of the zone's total deforestation.
- Associated coca deforestation considering a 300-meter buffer was 31 ha or 0.33% the zone's total deforestation. If the two figures are combined, 0.35 % of the zone's total deforestation can be attributed to coca.

CHAPTER IV

OTHER ENVIRONMENTAL IMPACTS OF COCA CULTIVATION AND THE PRODUCTION OF COCAINE RELATED DRUGS

4.1. Contamination of soils and water bodies

Throughout the entire production of the coca leaf and the subsequent stages for cocaine and related drug production, in addition to deforestation, other detrimental environmental effects are also being caused.

Table 47
Environmental Impacts of Coca Cultivation and Drug Production

Burning for land preparation
Decreases the quality of soil organic matter
CO2 emissions and their adverse effects on climate and health
Damage to watersheds
Negative effects on biodiversity
Burning of more than 380 MT of biomass per hectare
Soil contamination by agrochemicals: Soils not suitable for agricultural production require large amounts of chemical fertilizers
High fertilizer use affects the normal functioning of microorganisms
Decreases natural fertility of already poor soils due to nutrient extraction
Enhances desertification in drier areas
Propensity for landslides due to soil erosion in sloping areas
Contamination of water resources: Due to the proximity of coca leaf processing facilities to water currents
Increase in the load of suspended solids in the lentic and lotic systems surrounding the processing areas
Contamination with precursor chemical residues and damage to aquatic microorganisms and fish populations
Water pollution and adverse effects on the diet and health of populations

Fuente: Policía Nacional de Colombia – Dirección Antinarcoóticos (2014).

4.2. Contamination due to use of agrochemicals and precursor chemicals for drug production

The use of harmful chemicals occurs in all phases of drug production. For the production of the coca leaf, agrochemicals are used in order to avoid pests and plant diseases, weeding of invasive plants, and fertilization. For the extraction

of cocaine related drugs, that takes place mainly in the same areas of coca cultivation, a host of harmful precursor chemicals are used.

In Colombia, various calculations have been made in this regard. The National Narcotics Directorate and Narcotic Affairs section has calculated that 98.7% of coca growers use insecticides and pesticides, 92.5% use chemical fertilizers and 95.5% use herbicides. For the two phases, it was calculated that for each hectare of coca for conversion to cocaine, 471 gallons of liquid precursor chemicals and 1,297 kg of solid precursor chemicals are used, totaling approximately 3,071 kg of chemical inputs. (National Police of Colombia - Anti-Narcotics Directorate, 2014).

Table 48
Use of Chemicals per hectare for Coca Cultivation and Drug Production in Colombia

Phase	Cantidad	Insumo
Coca cultivation	1.6 gl	herbicides
	1.1 gl	Insecticide
	6.0 kg	Fungicide
	2.0 gl	foliar fertilizer
	709.6 kg	NPK fertilizer
Cocaine manufacturing	581.3 kg	solid chemicals
	466.1 gl	liquid chemicals
Total	471 gl	liquid chemicals
	1,297 kg	solid chemicals

Source: Colombian National Police – Anti-Narcotics Directorate (2014).

In the case of Peru, UNODC (2010) published a brief Analytical Report detailing the use of agrochemicals in coca production to increase productivity. The main inputs used were identified and it was estimated that 700,000 liters of agrochemicals, not including fertilizers, were used for coca crops. At present, there is no estimate of the use of chemicals in the coca cultivation phase. However, it is very likely that it is a similar situation to that of Colombia, where there is massive use of agrochemicals to improve the productivity of the crop.

There are also no official estimates on the use of precursor chemicals for drug manufacturing. Meza & Antezana (2008), calculated, with information from 2004, a usage of 108 kg of precursor chemicals for the production of one kilogram of cocaine. A use of 31,012 t of precursor chemicals was calculated for

the estimated production of 288 t of cocaine. It is estimated that during the 2011-2021 study period around 4,800 t of cocaine would have been produced in Peru, in which case, 518,400 t of precursor chemicals would have been used and dumped in the soil and water of the Amazon basin.

In drug processing, maceration pits are mostly used. Precursor chemicals and coca leaves are placed in these pits in order to extract the alkaloids. After the extraction, coca leaves, impregnated with chemicals, are discarded and thrown onto the land. This waste, known as detritus, is highly polluting. The detritus not only contaminates the adjacent soils, but is also transferred by rain and water currents to other areas and bodies of water. More than 1,200,000 t (1.2 million tons) of detritus have been released into the environment in the period 2011-2021.

Once the Government of Peru has updated the coca to cocaine conversion ratio, as well as the current use of chemicals, it is feasible to quantify the effect it is having in each of the affected territories. In this way, it will be possible to inform and sensitize the populations and authorities about the environmental risks to which they are exposed.

4.3. The Carbon Footprint of Cocaine

The only measurement on the carbon footprint for the production of cocaine was carried out by Barrera-Ramirez, Prado & Solheim (2019). The measurement was made from origin to the production of cocaine (from cradle -to- gate). Two measurements are presented, the first without considering the change in land use, and it was estimated at 590 kgCO₂eq for the production of 1 kg of cocaine. If there was also a change in land use, CO₂ emissions would rise to between 4-6 tons of CO₂eq per kg of cocaine. This study has been carried out for Colombia in the Catatumbo and Putumayo areas.

UNODC (2022b) estimated that if 1,982 tons of cocaine were produced globally in 2020, and with a carbon footprint measurement of 4,500 kgCO₂eq per 1 kg of cocaine, total emissions for that year would have been 8.9 million tons of CO₂eq, equivalent to the emission of 1.9 million gasoline cars running for a whole year or the consumption of 3.3 billion liters of fuel.

It is necessary to carry out similar studies in Peru, but in any case, some approximations can be drawn in this regard. Carnegie (2014) developed a methodology that could facilitate an estimate of the carbon stocks of the forest soils being deforested by coca. With Aerial LiDAR (Light Detection and Ranging) technology, they have developed carbon density maps on the ground to estimate ACD (Above Carbon Density) with a resolution of 1 hectare.

SERFOR (2019) in its National Forest and Wildlife Inventory - First Panel (INFFS), calculated the aerial biomass content for the Selva Baja ecozone, a value of 295.41 t/ha; and, in relation to the carbon content, a value of 138.84 t C/ha. These results do not present emission factors themselves, that is, they are carbon stocks expressed in tons of biomass or carbon and not in tons of CO₂ equivalent per hectare (t CO₂e/ha). Other studies mentioned in the INFFS are in the following table 49:

Table 49
Studies of aerial biomass calculations in the Selva Baja of Peru

Authors	Geographic area	Estimation: t C/ha
Málaga et al (2014)	Selva Baja	116.4 t C/ha
Managed Forest EIRL (2013)	Ucayali	136.65 t C/ha
García y Del Castillo (2013)	Forest of “pacaes” in Ucayali	122.11 t C/ha
Mamani-Condori (2012)	Forest of “pacaes” in Madre de Dios	165.63 t C/ha
Paucar y Cjuro (2015)	High-terrace Forest in Inambari, Madre de Dios	188.39 t C/ha

Source: SERFOR (2019).

A first approximation of the impact of deforestation due to coca crops in the 2011-2021 period, taking a 300 m buffer, was quantified at 385,122 ha deforested. If a range of 120 – 140 t C/ha of affected aerial biomass is taken, an impact between 46.2 and 53.9 million t C/ha can be estimated.

These calculations must be deepened to sensitize public opinion and national, regional and local authorities, as well as the international community. The quantifications of the impacts on CO₂ emissions and the economic valuation of the ecosystem services for the storage and sequestration of carbon can help mobilize financial resources to avoid or mitigate the effects on climate change.

4.4. Coca cultivation and other illegal activities, and related crimes

As indicated, where there is deforestation associated with coca growing, a buffer of 300 m has been established as a reasonable approximation of the “spearhead” effect previously described. But there are also other activities related to drug trafficking that promote coca cultivation and drug manufacturing. AIDES-EP (2014) indicates that there is likely close cooperation between illegal loggers and drug traffickers, where loggers harvest commercial trees in areas drug traffickers have selected for coca planting. A field study in the triple border of Peru, Colombia and Brazil indicated that the workers of these loggers are in-

volved in seasonal work in the cultivation of coca, as the logging activity is also seasonal (ILO, 2018).

In addition, criminal organizations involved in drug trafficking generate large illicit profits; they seek to launder these funds through investments in diverse “licit” activities that can impact deforestation, including developed agricultural activities in the area.

These same criminal organizations also invest illegal financial resources from drug trafficking in other illegal activities, including the one with the greatest impact on deforestation: illegal gold mining in the Amazon rivers. These illegal activities share the same scenarios and logistical channels to move their products, as reported by Valdés, Basombrío & Vera (2019)¹.

¹ See also Valdés, Basombrío & Vera (2020).

V. CONCLUSIONS

1. Total deforestation in the Peruvian Amazon has gone from an average of 105,221 hectares (ha) per year in the decade from 2001 to 2010, to 158,438 ha in the following decade (2011 to 2020), a more than 50% growth. Both legal and illegal economic activities are responsible for this level of deforestation.
2. Illicit coca has a strong presence in the Amazon and the magnitude and dispersion of the crop constitute a very important factor in Amazon deforestation. This situation has deteriorated during the last decade and study period 2011-2021.
3. Drug trafficking has prompted the adaptation of coca to ever-lower elevations, where biodiversity is greater and more fragile, in the Selva Baja in eastern Amazonia. 71% of the growth of illicit coca cultivation areas in the last 20 years occurred at less than 400 meters above sea level.
4. Drug trafficking has managed to increase the productivity of coca through the selection of more suitable varieties, as well as the use of agrochemicals and intensive cultivation practices. This situation causes greater contamination and soil degradation, greater rotation of areas, and greater deforestation.
5. Drug trafficking organizations act as very effective agricultural promotion agents, select areas for the installation of new crops, organize the relocation of coca growers, provide adequate seeds, facilitate technical assistance for the management of nurseries and for planting and cultivation, and advance financing for the acquisition of agrochemicals (pesticides, herbicides) and fertilizers. Finally, drug traffickers collect the harvest and pay in cash with prices higher than those of legal crops.
6. For the study period of 2011-2021 and in the geographical areas of study, Deforestation by Direct Coca (DDC) cultivation was 83,232 ha, which corresponds to 7.6% of Total Deforestation in Coca-growing Areas (TDCA) or 4.8% of Total Deforestation in the Peruvian Amazon (TDPA). For Deforestation by Direct Coca + Deforestation Associated with Coca (DAC), if a buffer of 100 m away from coca plots is assumed, accumulated deforestation is 296,297 ha, which corresponds to 27% of TDCA or 17.2% of the TDPA. If a buffer of 500 m is assumed, the accumulated deforestation is 438,250 ha corresponding to 40% of the TDCA or 25.4% of the TDPA.

7. An average buffer of 300 m has been used, so it can be concluded with a certain level of confidence that the deforestation caused by coca leaf crops in Peru, between the years 2011-2021, was 385,122 hectares, which represents 35.1% of Total Deforestation in Coca-growing Areas, and 22.4% of Total Deforestation in the Peruvian Amazon.
8. A first approximation of the impact of deforestation by coca crops in the 2011-2021 period, taking a 300 m buffer, was quantified at 385,122 ha deforested. If a range of 120 – 140 t C/ha of affected aerial biomass is taken, a total impact between 46.2 and 53.9 million t C/ha can be estimated.
9. Inambari - Tambopata, in Puno, has the highest relative incidence of deforestation. Deforestation by Direct Coca explains 26.0% of their deforestation while deforestation by direct coca + a 300-meter buffer would explain 76.7% of their deforestation.
10. San Gaban, also in Puno, is the area with the second highest relative incidence. Deforestation by Direct Coca explains 24.5% of their deforestation and if the area associated with only 300 meters of buffer is included, it rises to 43%.
11. Bajo Amazonas, in Loreto, is the area with the third highest relative incidence. Deforestation by Direct Coca explains 15.4% of their deforestation and if the area associated with only 300 meters of buffer is included, it rises to 52.6%.
12. Callería, in Ucayali, is the fourth area with the highest incidence. Deforestation by Direct Coca explains 12.6% of their deforestation and if the area associated with only 300 meters of buffer is included, it rises to 52.7%.
13. Aguaytía, also in Ucayali, in absolute terms is where the impact of deforestation has been the greatest. Deforestation by Direct Coca was 18,655 ha or 10.5% of their deforestation and if the area associated with only 300 meters of buffer is included, it rises to 53%.
14. There is not enough attention by the Government at its national, regional and local levels to prevent the advance of illicit coca cultivation and its effect on deforestation.
15. There are information and technological tools to establish a detection or early warning system for deforestation due to illicit coca cultivation.

VI. RECOMMENDATIONS

1. Further studies on deforestation due to illicit coca cultivation, identifying the factors that affect the various areas of coca production, are required. Authorities at all levels of government must participate in this effort. Deforestation due to coca is a cross-cutting issue that includes: DEVIDA, Ministry of the Environment, Ministry of Agrarian Development, Ministry of the Interior, Public Ministry, SERNANP, SERFOR, Regional and Local Governments.
2. Estimate the impacts of deforestation on the carbon stock through the carbon density maps in the soil with the methodologies developed by the Ministry of the Environment with the support of Carnegie (2014). These calculations will make it possible to sensitize public opinion, national, regional and local authorities, as well as the international community. The quantifications of the impacts on CO₂ emissions and the economic valuation of the ecosystem services for the storage and sequestration of carbon can help mobilize financial resources to avoid or mitigate the effects on climate change.
3. Design, budget and implement a National Action Plan to avoid deforestation by coca cultivation. Due to the complexity of the problem, the current situation requires comprehensive action by the Government to prevent the advance of illicit coca into new forest areas.
4. Establish or strengthen inter-institutional coordination spaces to implement actions against deforestation due to illicit coca cultivation, especially linking the efforts and Action Plans through the Regional Environmental Commissions of the Regional Governments.
5. Dismantle criminal drug trafficking organizations that promote the expansion of illicit coca cultivation, which results in deforestation. Work should be coordinated between the National Police and the Public Ministry.
6. Establish an early warning mechanism for early detection of areas deforested by coca cultivation. With satellite images and field monitoring, it is feasible to establish an effective mechanism that allows early intervention by the National Police and the Public Ministry.
7. Promote Forest Surveillance mechanisms with Native Communities for early follow-up and prevention of invasions and deforestation by drug trafficking organizations. Involve civil society in this effort.

8. Recover areas deforested and degraded through coca cultivation with reforestation programs or the installation of alternative crops with sustainable technologies (Climate Smart Agriculture).
9. Increase the resources of DEVIDA's PIRDAIS Budget Program for the reforestation of deforested and degraded areas.
10. Increase resources allocated to the Comprehensive Anti-Drug Management Budget Program – GIECOD - to finance intelligence, investigation, supervision, and control actions related to criminal drug trafficking organizations in deforested areas.
11. Conduct studies on the use of agrochemicals by coca growers. CORAH, through its field work, can collect and systematize information on the chemicals and containers found, for a first approach to the analysis of this issue.
12. Realizar estudios del uso de agroquímicos por parte de los cocaleros. La labor de campo del CORAH puede levantar y sistematizar información sobre los químicos y envases encontrados, para una primera aproximación al análisis de este tema.
13. A través de DEVIDA identificar recursos de cooperación internacional o de fondos multilaterales con esquemas de Pagos por Resultados (Mecanismos REDD+), como el DCI con Noruega y Alemania. Potenciar mecanismos financieros para la conservación de bosques y reforestación.
14. Fortalecer la labor que DEVIDA viene desarrollando con SERNANP y SERFOR para la conservación de bosques, reducción de la deforestación y restauración de ecosistemas y tierras forestales degradadas.

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