CORDILLERA AZUL NATIONAL PARK REDD PROJECT

2012 CLIMATE MONITORING REPORT

FOR PERIOD AUGUST 8, 2008 – AUGUST 7, 2012

Document Prepared By

Centro de Conservación, Investigación y Manejo de Áreas Naturales – Cordillera Azul

Lima, Peru

under a Total Management Contract with

The National Service of State National Protected Areas - SERNANP

with technical assistance from

The Field Museum, Chicago, USA

and

TerraCarbon, LLC, Peoria, USA

Project Title	*Cordillera Azul National Park REDD Project*
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1. PROJECT DETAILS

1.1 Summary Description of Project

Cordillera Azul National Park (PNCAZ) REDD Project protects a large, intact expanse of lower-montane forest remaining in Peru. PNCAZ is the easternmost outlier of the Andes at this latitude and covers portions of seven provinces in four departments in Peru: San Martín, Ucayali, Huánuco, and Loreto. The project area is 1,351,963.85 hectares within the boundaries of PNCAZ owned by the government of Peru, by order of its designation as a national park. The park's buffer zone was officially recognized by the Peruvian government in a Supreme Decree establishing the park. In 2007 and 2011 the buffer zone was expanded by legislation, resulting in an area of 2,303,414.75 hectares.

Each mountain range in the park is a separate, uplifted block of mostly Jurassic and Cretaceous strata, which predominate in the northeastern Peruvian Andes south of the Marañon River. Most of these tilted blocks are oriented north and south, but some curve to run east and west. A distinctive geological feature, the Vivian formation consists of rows of flat, sloping triangles of rock up to 7 km broad at the base and 4 km along the ridge resembling giant zigzags. They are well developed and almost perfectly symmetrical in two areas of the park.

The possibility of non-contacted indigenous people from the Cacataibo group living in the southeast region of the park led to the establishment of a "strict protection zone" (Zona de Protección Estricta in Spanish) in the region that permits zero outside entry. Until these people come out of their own volition and request contact, the region remains closed to all entry or use.

There are no organized human communities within the project area. The one known dweller inside the park – a cattle rancher – does not have legal land tenure but has an agreement with SERNANP and CIMA that allowed him to remain on his land subject to the conditions discussed in PD Section 1.10.4. He has violated this agreement and MINAM began proceedings to have him legally removed as is described later in this document.

Most of the park-neighboring communities are on the west, along the Huallaga valley. Most Huallaga residents are *mestizo*. The only officially recognized indigenous population on the Huallaga side (with land titles as a "native community") is a small Quechua-Lamista community in the district of Chazuta. The Ucayali region on the park's eastern side differs dramatically from the west. The population is sparse and predominantly indigenous—principally Shipibo, with some Piro/Yine and Cacataibo groups—each group conserving its cultural identity and mother language.

The project area includes intact forests from the lowlands (at 300 meters) to mountain peaks (at 2,400 meters) and protects an eastern outlier of the Andes that has been isolated sufficiently long for massive speciation to occur. Scientists who conducted the Rapid Biological Inventory led by The Field Museum in 2000 estimated a total of 4000 – 6000 plant species in the park, with at least 12 probably new to science. (Alverson *et al*. 2001) In their three weeks in the field, the scientists observed 71 large mammal species including bush dogs, spectacled bears, 10 species of primates, and enormous herds of white-lipped peccaries. Bird diversity is extremely high, with more than 590 species already registered for the park and actual species richness probably exceeding 800 species. During the inventory, 58 species of amphibians and 26 of reptiles were registered, but these numbers are low because the inventory was conducted during the dry season when few species are calling and active. Inventories to date have confirmed 150 species of fish with total richness expected to be greater than 250 species.

The project area consists of 1,351,963.85 hectares within the park that belongs to the national government of Peru. Upon its formation in 2002, Centro de Conservación, Investigación, y Manejo de Áreas Naturales– Cordillera Azul (CIMA) voluntarily signed an agreement with the Peruvian government to support the management of the park. The agreement was renewed for one-to-two year terms until August 8, 2008 when CIMA and the Peruvian government signed a 20-year, full management contract. The 2008 management contract includes legal authorization for CIMA to use revenues from the sale of carbon credits from avoided deforestation for park activities for the 20-year term. CIMA is the only NGO with a contract with the Peruvian government for full management of the entire national park and buffer zone. CIMA and PNCAZ receive no or extremely limited funds from the government of Peru per the terms of the management contract, which further differentiates PNCAZ from other Peruvian national parks.

As a result of a funding crisis in 2007, CIMA and its technical advisor, The Field Museum, sought a more sustainable source of funding than the foundation and USAID funding that they had been receiving to date for park protection and land-use management activities. The two organizations decided to pursue a REDD project for PNCAZ because no alternative, sustainable financing was available and CIMA would have to cease all protection and management activities in the park and buffer zone. Two protocols were identified to develop and monitor the project: Verified Carbon Standard (VCS) and the Community, Climate and Biodiversity (CCB) protocol. Under VCS, the project is using VM0007 REDD Methodology Modules (REDD-MF) for unplanned frontier deforestation for carbon stock and avoided emissions assessment. The signing of the 20-year management contract in 2008 served as the start of the carbon project.

The project's primary objective is to prevent deforestation in PNCAZ by focusing on three main goals:

- Strengthening the protection strategy for the park.
- Using a participatory model to engage local communities and other stakeholders in the management and financial sustainability of the park.
- Building local capacity for sustainable land use and improving the quality of life in the buffer zone communities.

All project activities support these goals.

1.2 Sectoral Scope and Project Type

Project Scope 14: Agriculture, Forest and other Land Use (AFOLU)
Project Category: Reduction Emission from Deforestation and Degradation (REDD)
Type of Activity: Avoided unplanned Deforestation (AUDD)

1.3 Project Proponent

Project Proponent: Centro de Conservación, Investigación y Manejo de Áreas Naturales – Cordillera Azul (CIMA-Cordillera Azul)
Contact: Patricia I. Fernández-Dávila M.
Address: Calle José Gabriel Chariarse 420, San Antonio, Miraflores, Lima 18, Perú
Telephone Number: +51 1 2412291
Email Address: pfernandezdavila@cima.org.pe
Responsibilities: Coordinate and oversee all project activities including interactions with national, regional and local governments, communications and relationships with buffer zone communities, input and review of project documentation, data collection and project monitoring and mapping

1.4 Other Entities Involved in the Project

The following organizations assisted in development of the project documentation:

Additional Project Participant: The Field Museum
Contact: Debra Moskovits
Address: 1400 S. Lake Shore Drive, Chicago, IL 60605 USA
Telephone Number: +1 312 665 7431
Email Address: dmoskovits@fieldmuseum.org

Responsibilities: Provide technical, strategic and administrative support to all areas of the project as requested by CIMA

Additional Project Participant: TerraCarbon LLC
Contact: Scott Settelmyer
Address: 5901 N. Sheridan Road, Peoria, IL 61614 U.S.A.
Telephone Number: +1-309-693-9303
Email Address: scott.settelmyer@terracarbon.com
Responsibilities: Provide technical assistance in the application of REDD methodologies and development of portions of the project documentation

1.5 Project Start Date

The project start date is August 8, 2008.

1.6 Project Crediting Period

The project has a crediting period of 20 years, extending from August 8, 2008 to August 7, 2028.

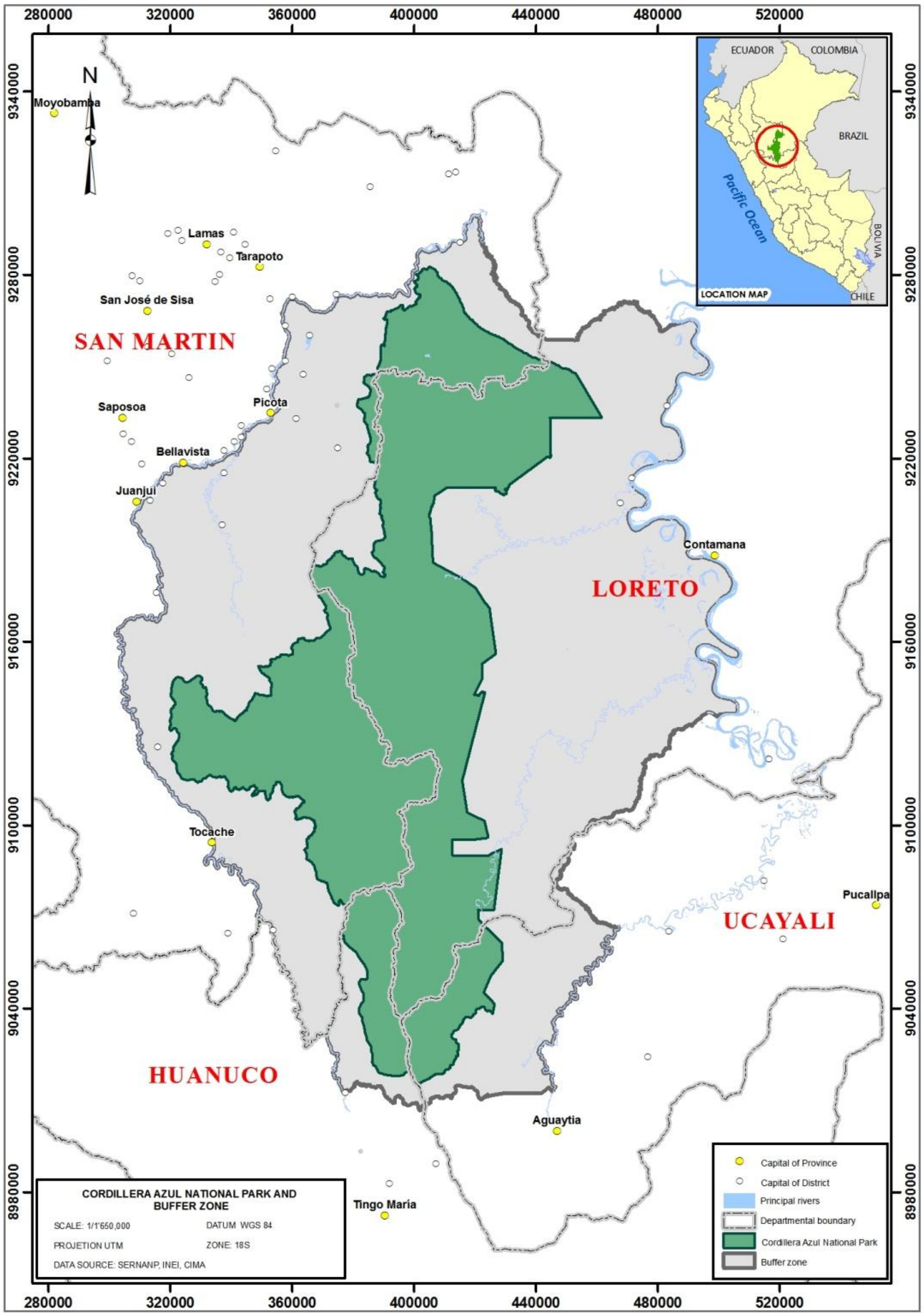
1.7 Project Location

The project consists of the area within the boundaries of Cordillera Azul National Park (PNCAZ) owned by the government of Peru. The limits of the park were defined in the official *Supreme Decree No. 031-2001-AG*, and lie between 06°29'13.3" - 08°54'07.5" south and 75°20'52.3" - 76°24'17.4" west. The park has an area of 1,353,190.85 hectares as defined in the Supreme Decree and an approximate perimeter of 974 km. A small amount of land within the park is privately owned, so the project area is 1,351,963.85 hectares and covers portions of seven provinces in four departments in the Republic of Peru, San Martín, Ucayali, Huánuco, and Loreto. Note that by mistake the supreme decree names only six provinces; however, subsequent documents for management of the area (the "master plans") name all seven provinces. Additional information regarding the private land owners is located in Section 1.10.4. Figure 1.2 is a map of the project area and buffer zone.

The park's buffer zone was provisionally delineated by the Peruvian government in the Resolución Jefatural Nº 314-2001-INRENA on 13 December 2001, covering 2,061,259.79 hectares. In June of 2007 INRENA passed a resolution (Resolución Jefatural Nº 144-2007-INRENA) amplifying the buffer zone to more than 2.3 million hectares and making official the limits proposed in the Plan Maestro 2003-2008 (Resolución Jefatural Nº 245-2004-INRENA). Finally, in 2011, through the Resolución Presidencial Nº 064-2011-SERNANP that approved the Plan Maestro 2011–2016 (SERNANP 2012), the buffer zone limits were adjusted once more, now to 2,303,414.75 hectares.

Figure 1.2: Project Map and Location in 2012

Map of PNCAZ/project area (shaded in green) and its buffer zone (shaded in grey). The project zone consists of the entire shaded area (project area and buffer zone). The inset shows the park's location in central Peru.



1.8 Title and Reference of Methodology

The methodology used to quantify the avoided emissions is the framework and component modules of the modular REDD methodology VM0007 REDD Methodology Modules Version 1.3 approved 20 November 2012.

This project uses the following modules and tools:

VM0007 REDD Methodology Module, REDD Methodology Framework (REDD-MF), version 1.3

CP-AB “VMD0001 Estimation of carbon stocks in the above- and belowground biomass in live tree and non-tree pools”, version 1.0

CP-D “VMD0002 Estimation of carbon stocks in the dead-wood pool”, v1.0

BL-UP “VMD0007 Estimation of baseline carbon stock changes and greenhouse gas emissions from unplanned deforestation”, version 3.1

LK-ASU “VMD0010 Estimation of emissions from activity shifting for avoided unplanned deforestation”, version 1.0

E-BB “VMD0013 Estimation of greenhouse gas emissions from biomass burning”, version 1.0

M-MON “VMD0015 Methods for monitoring of greenhouse gas emissions and removals” version 2.1

X -STR “VMD0016 Methods for stratification of the project area” version 1.0

X-UNC “VMD0017 Estimation of uncertainty for REDD project activities” version 2.0

T-ADD “VT0001 Tool for the Demonstration and Assessment of Additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) Project Activities”, version 3.0

T-BAR “Tool for AFOLU non-permanence risk analysis and buffer determination”, version 3.1

T-SIG CDM “Tool for testing significance of GHG emissions in A/R CDM project activities”, version 1.0

2 IMPLEMENTATION STATUS

2.1 IMPLEMENTATION STATUS OF THE PROJECT ACTIVITY

As discussed in the PD, one of the very first project activities conducted was regional meeting with the communities to determine their vision for the future and solicit their input in developing specific activities. Out of these workshops came a set of three goals and associated sub-goals and activities. These were included in the Plan Maestro for 2011 – 2016. Although not officially published until 2011, almost of these activities were begun between 2008 and 2011. All activities listed in the PD are either continued here or completed.

Goal 1: Strengthening the protection strategy for the park.

Sub-goal	Supporting Activities
Enhance the prevention of illegal activities within PNCAZ and ensure the recovery of degraded areas	1. Monitoring through satellite images 2. Development of a plan for patrols to prevent incursions and invaders in the park 3. Field visits to verify recovery of degraded areas 4. Maintenance of patrol infrastructure

Ensure resource use inside the park conforms to the Park zoning and the usage rules while respecting traditional uses by indigenous people and establishing consensus on appropriate uses with buffer zone communities	1. Review current approved uses for traditional communities 2. Monitor compliance with approved uses 3. Implementation of a plan for patrols to prevent activities not permitted inside the park
Strengthen the involvement of organizations, authorities and local people in the control and surveillance systems for the park and buffer zone	1. Conduct training with local organizations and authorities on security and surveillance issues 2. Promote dissemination of lessons learned and share experiences among groups 3. Evaluate the advantages and disadvantages of the current communal park guard system, and implement the recommendations from the evaluation

Goal 2: **Using a participatory model to engage local communities and other stakeholders in the management and financial sustainability of the park.**

Sub-goal	Project Activities
Strengthen the participatory management model for PNCAZ	1. Coordinated planning to ensure the park management team shares their work schedules and evaluate work plans together 2. Develop and promote mechanisms for ongoing communication among parties involved in managing PNCAZ 3. Present experiences to colleagues in large-scale events 4. Coordinate with the Comité de Gestión (CG) to develop and implement the Plan Maestro
Plan resources effectively to manage PNCAZ	1. Develop and implement a Plan de Control y Vigilancia, with proposed routes for park guards and locations of control posts 2. Implement the plan for the maintenance and management of infrastructure, property and equipment 3. Select, hire and strengthen capacities to ensure qualified personnel
Ensure there is a consolidated system of production, dissemination and exchange of information regarding PNCAZ and the buffer zone	1. Implement the communications strategy 2. Publish reports on activities of PNCAZ institutional actors involved in the protection of the park and buffer zone 3. Implement information campaigns by sector 4. Update web pages 5. Present the experience of participatory management in PNCAZ
Ensure the financial sustainability of PNCAZ through projects aimed at supporting the activities concerning the management of the park and its buffer zone	1. Design and implement REDD+ project at PNCAZ including the modelling and monitoring required 2. Establish a network of cooperating institutions interested in strengthening the park's management
Promote scientific research in the park and its buffer zone to obtain relevant information	1. Maintain updated databases and promote use of research results 2. Promote PNCAZ as an opportunity to develop

for decision making in the area	research through presenting results at conferences, workshops, and courses 3. Strengthen ties with academic institutions

Goal 3: **Building local capacity for sustainable land use and improving the quality of life in the buffer zone communities.**

Sub-goal	Project Activities
Promote participatory processes for zoning and land use plan development that use both technical and local knowledge to enhance understanding of larger-scale processes	1. Promote delimitation of population centers 2. Lead development of ecological and economic land-use zoning processes, using a participatory tool called Zonificación Participativa Comunal – ZPC
Promote economic activities for local people as part of land management processes	1. With communities, as a part of the Communal Strategic Plans, identify economic activities compatible with zoning 2. Provide linkages with larger-scale processes that develop in the buffer zone (meso and macro zoning)
Strengthen capacities of local people, authorities, local organizations and other actors in decision making aimed at the conservation and sustainable development, strengthening its cultural identity	1. Conduct environmental education programs in communities 2. Strengthen local organizational capacities 3. Develop plans for quality of life (Communal Strategic Plans) compatible with land use 4. Support development of conservation initiatives at local levels

All of these activities were conducted in the period August 2008 – August 2012, except for the following:

Goal 1: Sub-goal: Ensure resource use inside the park conforms to the Park zoning and the usage rules while respecting traditional uses by indigenous people and establishing consensus on appropriate uses with buffer zone communities
Activities:
1. Review current approved uses for traditional communities
2. Monitor compliance with approved uses

The review of current approved uses for traditional communities has not yet taken place. This will take place in 2013 or 2014 in conjunction with the buffer zone communities. The review will focus on whether the traditional uses currently approved continue to be appropriate or whether changes should be made.

Changes might be made based on additional uses needed or to provide support for community established rules such as bans on hunting certain species. Monitoring with currently approved uses is ongoing but monitoring with any revised uses will not be able to take place until the revision occurs.

Goal 1: Sub-goal: Strengthen the involvement of organizations, authorities and local people in the control and surveillance systems for the park and buffer zone
Activity:
3. Evaluate the advantages and disadvantages of the current communal park guard system, and implement the recommendations from the evaluation

This is scheduled for 2013 and will be conducted in coordination with the Park Head.

Goal 2:Sub-goal: Strengthen the participatory management model for PNCAZ
Activity:
5. Coordinate with the Comité de Gestión (CG) to develop and implement the Plan Maestro

The CG has participated in the development of the Plan Maestro but has not yet been fully integrated into the implementation of the Plan Maestro. Not all members of the CG represent Primary Stakeholders, and therefore not all members have been equally trained regarding the REDD Project. The CG's role will continue to increase following the implementation of the Secondary Stakeholder Communication Plan. Once all primary and secondary stakeholders are introduced to the REDD project process and the project activities, the CG will be able to play a greater role as an organization.

All other activities have occurred during the timeframe of this monitoring period.

Summary of Park Protection Activities

The approach to park protection has not changed over the four year monitoring period. CIMA continues to implement the ICC, an integrated planning and monitoring tool that incorporates social, biological, institutional, and operational aspects to effectively manage and protect the park.

The system of park guard control posts and routes remains the same and is being maintained. The park guards' routes are defined but special patrols are done periodically in response to potential threats being reported. Feedback from park guards and CIMA has been used to improve and streamline the reporting system.

Park guards continue to document key species observed (sightings or tracks) during their patrols to monitor the project's impacts on biodiversity. Similarly park guards report any signs of illegal uses of the park found in the park or buffer zone.

Summary of Buffer Zone Activities

CIMA's work in the buffer zone has evolved over the monitoring period as CIMA was able to monitor the effectiveness of its activities and learn new techniques and participatory processes.

Based on its work in the region prior to the project's start in 2008, CIMA initially focused on five strategies for stabilizing land use and improving quality of life in the buffer zone: Environmental Awareness, Strengthening Organizations, Strengthening Technical Support for community efforts, Monitoring and Evaluation. During this time, CIMA developed a number of conservation agreements with communities in line with the customary and traditional uses in the region where communities committed to using their resources in a sustainable manner. These agreements also include commitments by local people to participate in supporting the protection of PNCAZ (park guards and control posts), and their own resources in the buffer zone (rural patrols, self-defense committees)

In 2009 and 2010, CIMA began a formal strategic planning effort with communities building on the efforts of the educational programs. Quality of Life plans specific to each community began to be developed allowing CIMA and the residents to better define the community's needs and future desires and identify how these related to the park's conservation and economic sustainability. These plans included setting objectives in three areas:

a. Strengthening local organizational capacities.
b. Technical assistance and improving coordination for sustainable productive economic activities compatible with land-use zoning in the individual community, as well as coordination between communities with similar activities and values to reduce deforestation in the buffer zone and consequently contribute to improving the local quality of life.
c. Consulting for communities to support their efforts to work with public or private institutions on local conservation, restoration or zoning projects.

In 2011, CIMA's leadership revised its strategy after a process of internal evaluation, developing an intervention model that would allow for more rapid implementation of these processes in critical areas. This model is based on the most successful participatory methodologies and tools CIMA had used previously and contains the following stages:

(1) Development of baseline (Asset Mapping, or MUF—for *Mapeo de Usos y Fortalezas*--used for the initial baseline or for update) and geographical baseline (Participatory Community Zoning) to inform the next steps,

(2) Development of Community Rules where the community produces and agrees to a set of rules of conduct in order to meet their traditional domestic and social needs while integrating conservation and protection of the land and its resources. The results are communal arrangements that achieve stability within populations and lead to concerted community planning.

(3) Development of a Quality of Life Plan

(4) Implementation of the Strategic Planning in each community.
CIMA guides and supports the communities through the process but the communities have an active role that grows with each step, resulting in local authorities and community organizations providing the leadership for ongoing activities.

Other Project Activities
In the fourth quarter of 2011 and first quarter of 2012, a new MUF was conducted to continue the process of updating information on the socioeconomic conditions of the communities and neighboring towns to PNCAZ. The information resulting from this MUF is being analyzed and compared to what was produced in the three previous ones conducted in 2003, 2005 and 2008, allowing us to have a clear idea of the current situation of the communities. This latest MUF was designed to simplify the information gathering process and continue to involve as many people from the communities as possible. As described in the PD, facilitators were from the local communities and focus groups were used to ensure the entire population was represented.

In 2012, social, biodiversity and climate monitoring events also took place. The results of these monitoring events will be disseminated to primary stakeholders and made available on CIMA's website as soon as the reports are verified.

In 2009, the cattle rancher inside the park expanded his operations in violation of the law and his agreement with CIMA and SERNANP to remain inside the park. This forced the Park Head and CIMA to develop a plan for his removal (Salazar 2009). In 2010, CIMA provided all requested documentation to a lawyer from the Peruvian Ministry of the Environment - MINAM (Oficio Nº 008-2010-SERNANP-PNCAZ, with a request from SERNANP to begin the judicial process) to have the rancher legally removed from the park. The legal paperwork was filed during the third quarter of 2011 and MINAM initiated the legal process of removing the cattle rancher, which continues to date. The *Juzgado Mixto de la Provincia de Bellavista* published notices in the official *El Peruano* newspaper and in the popular daily newspaper in San Martín. In 2012 the Juzgao Mixto appointed a lawyer (*curador procesal*) since the rancher had not appeared in court. The lawyer continues to work to remove the ranchers from PNCAZ. When he is removed, the rancher will be provided similar, suitable, already cleared land in the buffer zone for his use.

2.2 DEVIATIONS FROM THE MONITORING PLAN

A new classification technique was used to overcome sensor errors. These procedures are justified and detailed in Section 5.

2.3 GROUPED PROJECT CRITERIA

Not applicable.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Details on data and parameters available at validation are provided below.

Data Unit / Parameter:	$\Delta C_{BSL,PA,unplanned}$
Data unit:	$t\ CO_2$-e
Description:	Net CO_2 emissions in the baseline from unplanned deforestation in the project area
Source of data:	Derived in Section 3.1 of PD
Value applied:	6,744,812 $t\ CO_2$-e (2009-2012)
Justification of choice of data or description of measurement methods and procedures applied:	Derived and justified in Section 3 of PD in which baseline is set
Any comment:	

Data Unit / Parameter:	$\Delta C_{BSL,LK,unplanned}$
Data unit:	$t\ CO_2$-e
Description:	Net CO_2 emissions in the baseline from unplanned deforestation in the leakage belt
Source of data:	Derived in Section 3.1 and 3.2 of PD
Value applied:	35,228,882 $t\ CO_2$-e (2009-2012)
Justification of choice of data or description of measurement methods and procedures applied:	Derived and justified in Section 3 of PD in which baseline is set
Any comment:	

Data Unit / Parameter:	C_{OLB}
Data unit:	$t\ CO_2$-e ha^{-1}

Description:	Area-weighted average aboveground tree carbon stock for forests available for unplanned deforestation outside the Leakage Belt
Source of data:	2010 FAO FRA Peru Country Report
Value applied:	376.3 t CO_2-e ha^{-1}
Justification of choice of data or description of measurement methods and procedures applied:	Derived above in Section 3.3 of the Project Description
Any comment:	

Data Unit / Parameter:	C_{LB}
Data unit:	t CO_2-e ha^{-1}
Description:	Area weighted average aboveground tree carbon stock for forests available for unplanned deforestation inside the Leakage Belt
Source of data:	Stocks were derived by first delineating three high order forest classes from Natureserve (Josse et al 2007; and Ferreira et al 2007), humedales-vegetacion inundable and vegetacion de tierra firme (corresponding roughly with aguajal/alluvial forest and hill/mountain forest, respectively, from the project area) and anthropogenic forest. For each of the three classes, spatially-explicit aboveground biomass data were obtained from Saatchi et al 2009, from which an area-weighted mean live aboveground tree carbon stock was estimated.
Value applied:	358.8 t CO_2-e ha-1
Justification of choice of data or description of measurement methods and procedures applied:	Derived above in Section 3 of the Project Description
Any comment:	

Data Unit / Parameter:	*CF*

Data unit:	t C t d.m.$^{-1}$
Description:	Carbon fraction of dry matter in t C t^{-1} d.m.
Source of data:	default value of from IPCC 2006GL
Value applied:	0.47 t C t^{-1} d.m
Justification of choice of data or description of measurement methods and procedures applied:	As permitted by methodology VM0007 module CP-AB “Values from the literature (e.g. IPCC 2006 INV GLs AFOLU Chapter 4 Table 4.3) shall be used if available, otherwise default value of 0.47 t C t^{-1} d.m. can be used”
Any comment:	

Data Unit / Parameter:	*D:RAD*
Data unit:	Dimensionless
Description:	Ratio of DBH to plot radius, specific to prism Basal Area Factor (BAF) employed in point sampling

<table>
<tr><td>Source of data:</td><td>Avery, T.E. and H.E. Burkhart. 1994. Forest Measurements. Fourth Edition. McGraw Hill, Boston, Massachusetts, USA. 408 pp.</td></tr>
<tr><td>Value applied:</td><td><table>
<tr><td></td><td colspan="5">BAF gauge</td></tr>
<tr><td>ft^2/acre</td><td>5</td><td>10</td><td>15</td><td>20</td><td>40</td></tr>
<tr><td>m^2/ha</td><td>1.15</td><td>2.29</td><td>3.44</td><td>4.59</td><td>9.18</td></tr>
<tr><td>ratio dbh/plot radius</td><td>1:46.7</td><td>1:33</td><td>1:26.9</td><td>1:23.3</td><td>1:16.5</td></tr>
</table></td></tr>
<tr><td>Justification of choice of data or description of measurement methods and procedures applied:</td><td></td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

Data Unit / Parameter:	$f_j(X,Y)$
Data unit:	t d.m. tree^{-1}
Description:	Allometric equation for species *j* linking measured tree variable(s) to aboveground biomass of living trees, expressed as t d.m. tree^{-1}

Source of data:	Chave, J., Andalo, C., Brown, S., Cairns, M.A., Chambers, J.Q., Eamus, D., Folster, H., Fromard, F., Higuchi, N., Kira, T., Lescure, J.P., Nelson, B.W., Ogawa, B., Puig, H., Riera, B. and T. Yamakura. 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia 145:87-99. Freitas Alvarado, L., Otorola Acevedo, E., del Castillo Torres, D., Linares Bensimon, C., Martinez Davila, P. and G.A. Malca Salas. 2006. Servicios Ambientales De Almacenamiento Y Secuestro De Carbono Del Ecosistema Aguajal En La Reserva Nacional Pacaya Samiria, Loreto, Perú. Instituto de Investigaciones de la Amazonía Peruana. Documento Técnico Nº 29. Iquitos, Perú.
Value applied:	Detailed in PNCAZ 2009 forest inventory report
Justification of choice of data or description of measurement methods and procedures applied:	Both equations validated in PNCAZ 2009 forest inventory report
Any comment:	

Data Unit / Parameter:	*R*
Data unit:	t root d.m. t^{-1} shoot d.m.
Description:	Root to shoot ratio appropriate to species or forest type / biome; note that as defined here, root to shoot ratio is applied as belowground biomass per unit area:aboveground biomass per unit area (not on a per stem basis)

Source of data:	Cairns, M. A., S. Brown, E. H. Helmer, and G. A. Baumgardner. 1997. Root biomass allocation in the world's upland forests. Oecologia 111, 1-11. Freitas Alvarado, L., Otorola Acevedo, E., del Castillo Torres, D., Linares Bensimon, C., Martinez Davila, P. and G.A. Malca Salas. 2006. Servicios Ambientales De Almacenamiento Y Secuestro De Carbono Del Ecosistema Aguajal En La Reserva Nacional Pacaya Samiria, Loreto, Perú. Instituto de Investigaciones de la Amazonía Peruana. Documento Técnico Nº 29. Iquitos, Perú.
Value applied:	Detailed in PNCAZ 2009 forest inventory report
Justification of choice of data or description of measurement methods and procedures applied:	Note that rather than using a constant root to shoot ratio to estimate belowground biomass, belowground biomass was estimated using an allometric equation, where the relationship varies continuously with aboveground biomass. The equation is derived from 151 observations from a global dataset of upland forests. For *Mauritia flexuosa* root biomass (lowland palm swamps) a fixed root:total biomass ratio of 0.276 derived from in-country empirical data was used.
Any comment:	

Data Unit / Parameter:	D_{DWdc}
Data unit:	t d.m. m^{-3}
Description:	Mean wood density of dead wood in the density class (dc) – sound (1), intermediate (2), and rotten (3); t d.m. m^{-3}

Source of data:	Measured from dead wood samples, 30 from each decomposition class, collected in the project area. Density of dead wood was determined through sampling and laboratory analysis as follows. Discs were collected in the field and decomposition class and green volume determined as per standard protocols (Appendix 2). Discs were then transferred to a laboratory (Laboratorio de Análisis de Suelos del Instituto Nacional de Investigación Agraria, INIA) in Tarapoto and oven-dried at 80°C, conducting continuous weight measurements until reaching constant weight. The resulting dry weight was recorded and used to calculate dead wood density as oven-dry weight (g) / green volume (cm^3) for each sample.
Value applied:	Detailed in PNCAZ 2009 forest inventory report
Justification of choice of data or description of measurement methods and procedures applied:	Measurements follow procedures as outlined in methodology VM0007 module CP-D
Any comment:	

Data Unit / Parameter:	*Regional Forest Cover / Non-Forest Cover Benchmark Map*
Data unit:	ha
Description:	Map showing the location of forest land within the reference region at the beginning of the crediting period

Source of data:	Classified satellite imagery
Value applied:	3,271,261 ha (at beginning of first baseline period)
Justification of choice of data or description of measurement methods and procedures applied:	Detailed procedures provided below under monitoring plan description.
Any comment:	Updated every 10 years at baseline revision

Data Unit / Parameter:	*Project Forest Cover Benchmark Map*
Data unit:	ha
Description:	Map showing the location of forest land within the project area at the beginning of each monitoring period. If within the Project Area some forest land is cleared, the benchmark map must show the deforested areas at each monitoring event

Source of data:	Classified satellite imagery
Value applied:	1,350,951 ha (at beginning of monitoring period)
Justification of choice of data or description of measurement methods and procedures applied:	Detailed procedures provided below under monitoring plan description.
Any comment:	Updated at each monitoring/verification event

Data Unit / Parameter:	*Leakage Belt Forest Cover Benchmark Map*
Data unit:	ha
Description:	Map showing the location of forest land within the leakage belt area at the beginning of each monitoring period. Only applicable where leakage is to be monitored in a leakage belt

Source of data:	Classified satellite imagery
Value applied:	1,920,311 ha (at beginning of monitoring period)
Justification of choice of data or description of measurement methods and procedures applied:	Detailed procedures provided below under monitoring plan description.
Any comment:	Updated at each monitoring/verification event

Data Unit / Parameter:	$COMF_i$
Data unit:	dimensionless
Description:	combustion factor for stratum *i* (vegetation type)
Source of data:	default values in Table 2.6 of IPCC, 2006 (Annex 2)

Value applied:	Not applied, $A_{burn,i,t}$ = 0 for 2009-2012 monitoring period
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	

Data Unit / Parameter:	G_{gi}
Data unit:	g kg^{-1} dry matter burnt
Description:	Emission factor for stratum *i* for gas *g*,
Source of data:	Defaults in Volume 4, Chapter 2, of the IPCC 2006 Inventory Guidelines in table 2.5 (Annex 2: emission factors for various types of burning for CH_4 and N_2O).
Value applied:	Not applied, $A_{burn,i,t}$ = 0 for 2009-2012 monitoring period
Justification of choice of data or description of measurement methods and procedures applied:	
Any comment:	

3.2 Data and Parameters Monitored

Details on data and parameters monitored are provided below. Note that:

- *Where a parameter is calculated from a methodology equation (i.e. not raw data), the methodology module and equation number is specified and "Description of measurement methods and procedures to be applied" and "QA/QC procedures to be applied" are appropriately left blank*
- *To avoid repetition and maintain an economical use of space in the summary tables, "Description of measurement methods and procedures to be applied" and "QA/QC procedures to be applied" for monitored (not calculated) parameters reference detailed accounts of procedures provided in the monitoring plan description below.*

Data Unit / Parameter:	$\Delta C_{P,Def,i,t}$
Data unit:	t CO_2-e
Description:	Net carbon stock change as a result of deforestation in the project case in the project area in stratum *i* at time *t*
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Every $\leq$ 5 years
Value applied:	331,399.8 t CO_2-e (2009-2012, all strata)
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	Equation 3, VMD0015
Any comment:	

Data Unit / Parameter:	$\Delta C_{P,DefLB,i,t}$
Data unit:	t CO_2-e
Description:	Net carbon stock change as a result of deforestation in the project case in the leakage belt in stratum *i* at time *t*
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	

Frequency of monitoring/recording:	Every ≤ 5 years
Value applied:	26,133,592.5 t CO_2-e (2009-2012, all strata)
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	Equation 4, VMD0015
Any comment:	

Data Unit / Parameter:	$\Delta C_{P,DistPA,i,t}$
Data unit:	t CO_2-e
Description:	Net carbon stock change as a result of natural disturbance in the project case in the project area in stratum *i* at time *t*
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Every ≤ 5 years
Value applied:	0 t CO_2-e (2009-2012, all strata)
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	Equation 20, VMD0015
Any comment:	

Data Unit / Parameter:	$A_{DefPA,u,i,t}$
Data unit:	Ha
Description:	Area of recorded deforestation in the project area stratum *i* converted to land use *u* at time *t*
Source of data:	Monitored at each monitoring/verification event through analysis of classified satellite imagery
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description. Minimum Mapping Unit (MMU) of 0.81 ha, corresponding to 3 pixels by 3 pixels Landsat resolution (90m by 90m), providing closest conformance possible to 0.5 ha Peru DNA forest definition with Landsat.

Frequency of monitoring/recording:	Every ≤ 5 years
Value applied:	642.4 ha (2009-2012, all strata, all land uses)
Monitoring equipment:	Image processing, classification and assessment work was conducted using IDRISI, Selva edition, Eastman, J.R., 2012. IDRISI Selva (Worcester, MA: Clark University). Some steps in accuracy assessment were conducted using: Arc GIS 10.0 ESRI 2011. ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description
Calculation method:	
Any comment:	

Data Unit / Parameter:	$A_{DefLB,u,i,t}$
Data unit:	Ha
Description:	Area of recorded deforestation in the leakage belt stratum *i* converted to land use *u* at time *t*
Source of data:	Monitored at each monitoring/verification event through analysis of classified satellite imagery
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description. Minimum Mapping Unit (MMU) of 0.81 ha, corresponding to3 pixels by 3pixels Landsat resolution (90m by 90m), providing closest conformance possible to 0.5 ha Peru DNA forest definition with Landsat.
Frequency of monitoring/recording:	Every ≤ 5 years
Value applied:	59,478.1 ha (2009-2012, all strata, all land uses)
Monitoring equipment:	Image processing, classification and assessment work was conducted using IDRISI, Selva edition, Eastman, J.R., 2012. IDRISI Selva (Worcester, MA: Clark University).

	Some steps in accuracy assessment were conducted using: Arc GIS 10.0 ESRI 2011. ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description
Calculation method:	
Any comment:	

Data Unit / Parameter:	$A_{DistPA,q,i,t}$
Data unit:	ha
Description:	Area impacted by natural disturbance in post-natural disturbance stratum *q* in stratum *i*, at time *t*
Source of data:	Monitored at each monitoring/verification event through analysis of classified satellite imagery
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description. Minimum Mapping Unit (MMU) of 0.81 ha, corresponding to3 pixels by 3 pixels Landsat resolution (90m by 90m), providing closest conformance possible to 0.5 ha Peru DNA forest definition with Landsat.
Frequency of monitoring/recording:	Every $\leq$ 5 years
Value applied:	32.6 ha (2009-2012, all strata, all land uses)
Monitoring equipment:	Image processing, classification and assessment work was conducted using IDRISI, Selva edition, Eastman, J.R., 2012. IDRISI Selva (Worcester, MA: Clark University). Some steps in accuracy assessment were conducted using: Arc GIS 10.0 ESRI 2011. ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description

Calculation method:	
Any comment:	

Data Unit / Parameter:	$C_{BSL,i}$
Data unit:	t CO_2-e ha^{-1}
Description:	Carbon stock in all pools in the baseline case in stratum *i*
Source of data:	Estimated from forest carbon inventory. For strata identified in the leakage belt from vegetation maps from Natureserve (Josse et al 2007), but not represented in the project area inventory, stock estimates specific to each stratum will be obtained from peer-reviewed values from Peru.
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description
Frequency of monitoring/recording:	Every $\leq$ 10 years. First re-measurement in 2018.
Value applied:	Detailed in PNCAZ 2009 forest inventory report
Monitoring equipment:	Detailed in PNCAZ 2009 forest inventory report
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description
Calculation method:	
Any comment:	

Data Unit / Parameter:	$C_{P,post,u,i}$
Data unit:	t CO_2-e ha^{-1}
Description:	Carbon stock in all pools in post-deforestation land use *u* in stratum *i*
Source of data:	Post deforestation carbon stocks are set as the historical area-weighted average carbon stock for pasture and cultivation land uses, derived from historical land use survey data and stocks estimates from regional studies in PD Section 3.
Description of measurement methods and procedures to be applied:	None
Frequency of monitoring/recording:	Every $\leq$ 10 years. Value to be re-assessed in 2018.

Value applied:	42.9 t CO_2-e ha^{-1}
Monitoring equipment:	none
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	

Data Unit / Parameter:	$C_{P,Dist,q,i}$
Data unit:	t CO_2-e ha^{-1}
Description:	Carbon stock in pools in post-natural disturbance strata *q* in stratum *i*
Source of data:	Conservatively assumed to be zero post disturbance
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	
Value applied:	0 t CO_2-e ha^{-1}
Monitoring equipment:	none
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	

Data Unit / Parameter:	$A_{DegW,i,t}$
Data unit:	Ha
Description:	Area potentially impacted by degradation processes in stratum *i*
Source of data:	Delineated based on survey results indicating general area of project potentially accessed and typical depth of penetration of illegal harvest activities from points of access
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Frequency of monitoring/recording:	Repeated each time the PRA indicates a potential for degradation. PRA conducted every $\leq$ 2 years

Value applied:	507,364.2 ha (accessible area patrolled by park guards)
Monitoring equipment:	
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Calculation method:	
Any comment:	

Data Unit / Parameter:	$C_{DegW,i,t}$
Data unit:	t CO_2-e
Description:	Biomass carbon of trees cut and removed through degradation process from plots measured in stratum *i* at time *t*
Source of data:	Estimated from diameter measurements of cut stumps in sample plots
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Frequency of monitoring/recording:	Every $\leq$ 5 years where surveys and limited sampling continue to indicate possibility of illegal logging in the project area
Value applied:	Not estimated for 2009-2012 monitoring period – potential impacts insignificant (assessed in Section 4 below)
Monitoring equipment:	
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Calculation method:	
Any comment:	

Data Unit / Parameter:	AP_i
Data unit:	Ha
Description:	Total area of degradation sample plots in stratum *i*
Source of data:	Calculated as 3% of $A_{DegW,i,t}$
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Frequency of monitoring/recording:	Every $\leq$ 5 years where surveys and limited sampling continue to indicate possibility of illegal

	logging in the project area
Value applied:	Sampling not carried out for 2009-2012 monitoring period – potential impacts insignificant (assessed in Section 4 below)
Monitoring equipment:	
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Calculation method:	
Any comment:	

Data Unit / Parameter:	$\Delta C_{P,DegW,i,t}$
Data unit:	t CO_2-e
Description:	Net carbon stock changes as a result of degradation in stratum *i* in the project area at time *t*
Source of data:	Calculated
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Every $\leq$ 5 years where surveys and limited sampling continue to indicate possibility of illegal logging in the project area
Value applied:	Not estimated for 2009-2012 monitoring period – potential impacts insignificant (assessed in Section 4 below)
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	Equation 8, VMD0015
Any comment:	

Data Unit / Parameter:	$PROP_{IMM}$
Data unit:	Proportion
Description:	Estimated proportion of baseline deforestation caused by immigrating population
Source of data:	Calculated based on results of survey of communities within 2 km of the PNCAZ boundary.
Description of measurement methods and	Detailed procedures provided below under

procedures to be applied:	monitoring plan description. Questions will be structured as: how long have you lived here and where did you come from prior? Immigrants are defined as someone who has lived in the area less than 5 years and came from an area outside the leakage belt. As there are sensitivities to assessing responsibility for deforestation in an interview context, the proportion of baseline deforestation caused by immigrating population will be assumed to be equal to the proportion of immigrants in the surrounding population.
Frequency of monitoring/recording:	Every $\leq$ 5 years
Value applied:	32.5%
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	

Data Unit / Parameter:	*MANFOR*
Data unit:	Ha
Description:	Total area of forests under active management nationally
Source of data:	Official data, peer reviewed publications and other verifiable sources
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Every $\leq$ 5 years
Value applied:	0
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	May be conservatively set to zero

Data Unit / Parameter:	*PROTFOR*
Data unit:	Ha
Description:	Total area of fully protected forests nationally
Source of data:	Official data, peer reviewed publications and other verifiable sources
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Every ≤ 5 years
Value applied:	0
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	May be conservatively set to zero A demonstration is required that areas will be protected against deforestation. Such a demonstration shall include either: 1. Designation as a UNESCO World Heritage Site, or 2. Management by an international NGO, or 3. Evidence that the government has immediately acted to evict any and all illegal squatters

Data Unit / Parameter:	*TOTFOR*
Data unit:	Ha
Description:	Total available national forest area
Source of data:	Official data, peer reviewed publications and other verifiable sources, including Peru FAO FRA reports, e.g. FAO. 2010. Global Forest Resources Assessment 2010, Peru Country Report. Forestry Department, Food and Agriculture Organization of the United Nations, Rome.
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Every ≤ 5 years
Value applied:	67,992,000 ha
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	

Data Unit / Parameter:	$PROP_{RES}$
Data unit:	Proportion
Description:	Estimated proportion of baseline deforestation caused by population that has been resident for ≥5 years
Source of data:	Calculated based on results of survey of communities within 2 km of the PNCAZ boundary.
Description of measurement methods and procedures to be applied:	Equals 1 - $PROP_{IMM}$ Detailed procedures provided under monitoring plan description below.
Frequency of monitoring/recording:	Every ≤ 5 years
Value applied:	67.5%

Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	

Data Unit / Parameter:	*N*
Data unit:	Dimensionless
Description:	Number of samples (i.e. clusters of 5 variable radius plots)
Source of data:	Detailed in PNCAZ 2009 forest inventory report
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording:	Every ≤ 10 years
Value applied:	64 clusters of 5 variable radius plots
Monitoring equipment:	N/A
QA/QC procedures to be applied:	
Calculation method:	Detailed in PNCAZ 2009 forest inventory report
Any comment:	

Data Unit / Parameter:	*DBH*
Data unit:	cm
Description:	Diameter at breast height of a tree in cm
Source of data:	Measured in the field
Description of measurement methods and procedures to be applied:	Detailed in PNCAZ 2009 forest inventory report
Frequency of monitoring/recording:	Every ≤ 10 years
Value applied:	Detailed in PNCAZ inventory analysis database and field data sheets

Monitoring equipment:	Detailed in PNCAZ 2009 forest inventory report
QA/QC procedures to be applied:	Detailed in PNCAZ 2009 forest inventory report and in description of monitoring plan below
Calculation method:	
Any comment:	

Data Unit / Parameter:	$Dia_{n,i,t}$
Data unit:	cm
Description:	Diameter of piece *n* of dead wood along the transect in stratum *i*, at time *t* in *cm*
Source of data:	Measured in the field
Description of measurement methods and procedures to be applied:	Detailed in PNCAZ 2009 forest inventory report
Frequency of monitoring/recording:	Every ≤ 10 years
Value applied:	Detailed in PNCAZ inventory analysis database and field data sheets
Monitoring equipment:	Detailed in PNCAZ 2009 forest inventory report
QA/QC procedures to be applied:	Detailed in PNCAZ 2009 forest inventory report and in description of monitoring plan below
Calculation method:	
Any comment:	

Data Unit / Parameter:	*BDia*
Data unit:	cm
Description:	Basal diameter of standing dead tree in cm
Source of data:	Measured in the field
Description of measurement methods and procedures to be applied:	Detailed in PNCAZ 2009 forest inventory report
Frequency of monitoring/recording:	Every ≤ 10 years
Value applied:	Detailed in PNCAZ inventory analysis database and field data sheets
Monitoring equipment:	Detailed in PNCAZ 2009 forest inventory report

QA/QC procedures to be applied:	Detailed in PNCAZ 2009 forest inventory report and in description of monitoring plan below
Calculation method:	
Any comment:	

Data Unit / Parameter:	TD_{SDW}
Data unit:	cm
Description:	Top diameter of standing dead tree in cm
Source of data:	
Description of measurement methods and procedures to be applied:	Not measured
Frequency of monitoring/recording:	
Value applied:	
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	Standing dead wood volume calculations assume volume of a paraboloid, i.e. volume = cross sectional area * height * ½ (no need for top diameter)

Data Unit / Parameter:	H_{SDW}
Data unit:	m
Description:	Height of standing dead tree in m
Source of data:	Measured in the field
Description of measurement methods and procedures to be applied:	Detailed in PNCAZ 2009 forest inventory report
Frequency of monitoring/recording:	Every $\leq$ 10 years
Value applied:	Detailed in PNCAZ inventory analysis database and field data sheets

Monitoring equipment:	Detailed in PNCAZ 2009 forest inventory report
QA/QC procedures to be applied:	Detailed in PNCAZ 2009 forest inventory report and in description of monitoring plan below
Calculation method:	
Any comment:	

Data Unit / Parameter:	*Project Forest Cover Monitoring Map*
Data unit:	ha
Description:	Map showing the location of forest land within the project area at the beginning of each monitoring period. (= updated *Project Forest Cover Benchmark Map)*
Source of data:	Classified satellite imagery
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Frequency of monitoring/recording:	Updated at each monitoring/verification event every ≤ 5 years
Value applied:	1,350,276 ha (at end of monitoring period)
Monitoring equipment:	Image processing, classification and assessment work was conducted using IDRISI, Selva edition, Eastman, J.R., 2012. IDRISI Selva (Worcester, MA: Clark University). Some steps in accuracy assessment were conducted using: Arc GIS 10.0 ESRI 2011. ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description.

Calculation method:	
Any comment:	

Data Unit / Parameter:	*Leakage Belt Forest Cover Monitoring Map*
Data unit:	
Description:	Map showing the location of forest land within the leakage belt area at the beginning of each monitoring period. (= updated *Leakage Belt Forest Cover Benchmark Map)*
Source of data:	Classified satellite imagery
Description of measurement methods and procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Frequency of monitoring/recording:	Updated at each monitoring/verification event every $\leq$ 5 years
Value applied:	1,860,832 ha (at end of monitoring period)
Monitoring equipment:	Image processing, classification and assessment work was conducted using IDRISI, Selva edition, Eastman, J.R., 2012. IDRISI Selva (Worcester, MA: Clark University). Some steps in accuracy assessment were conducted using: Arc GIS 10.0 ESRI 2011. ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.
QA/QC procedures to be applied:	Detailed procedures provided below under monitoring plan description.
Calculation method:	
Any comment:	

Data Unit / Parameter:	$A_{burn,i,t}$
Data unit:	ha
Description:	Area burnt in stratum *i* at time *t*
Source of data:	GPS coordinates and/or Remote Sensing data
Description of measurement methods and procedures to be applied:	Remote sensing analysis detailed below under monitoring plan description
Frequency of monitoring/recording:	Areas burnt shall be monitored at least every five years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied:	0 ha (2009-2012, all strata)
Monitoring equipment:	
QA/QC procedures to be applied:	
Calculation method:	
Any comment:	

3.3 Description of the Monitoring Plan

3.1.1 Revision of the baseline

The baseline as outlined here in the Project Description is valid for 10 years, through August 7 2018. The baseline will be revised every 10 years from the project start date.

3.1.2 Monitoring of actual carbon stock changes and greenhouse gas emissions

For accounting purposes the project conservatively assumes stable stocks and no biomass monitoring is conducted in areas potentially undergoing carbon stock enhancement, as permitted in the methodology monitoring module VMD0015, hence $\Delta C_{P,Enh,i,t}$ is set to 0.

Monitoring of actual emissions in the project area focuses on:

- Emissions due to deforestation and natural disturbance
- Emissions due to illegal degradation
- Emissions due to biomass burning

Procedures and responsibilities for monitoring each of the above sources of emissions are detailed below.

3.1.3 Emissions due to deforestation and natural disturbance

Forest cover change due to deforestation and natural disturbance is monitored through periodic assessment of classified satellite imagery covering the project area. Emissions ($ÄC_{P,Def,i,t}$ and $ÄC_{P,DistPA,i,t}$ for deforestation and natural disturbance, respectively) are estimated by multiplying area of forest loss detected ($A_{DefPA,u,i,t}$ and $A_{DistPA,q,i,t}$, for deforestation and natural disturbance, respectively) by average forest carbon stock per unit area (conservatively assuming $ÄC_{P,Dist,q,i,t}$ and $ÄC_{pools,Def,u,i,t} = C_{BSL,i}$). Stock estimates from the initial field inventory completed in 2009, are valid for 10 years (per VM0007), minimally through 2018. Post 2018, forest carbon stock estimates will be updated for any strata where deforestation or natural disturbance is detected.

3.1.3.1 Monitoring changes in forest cover

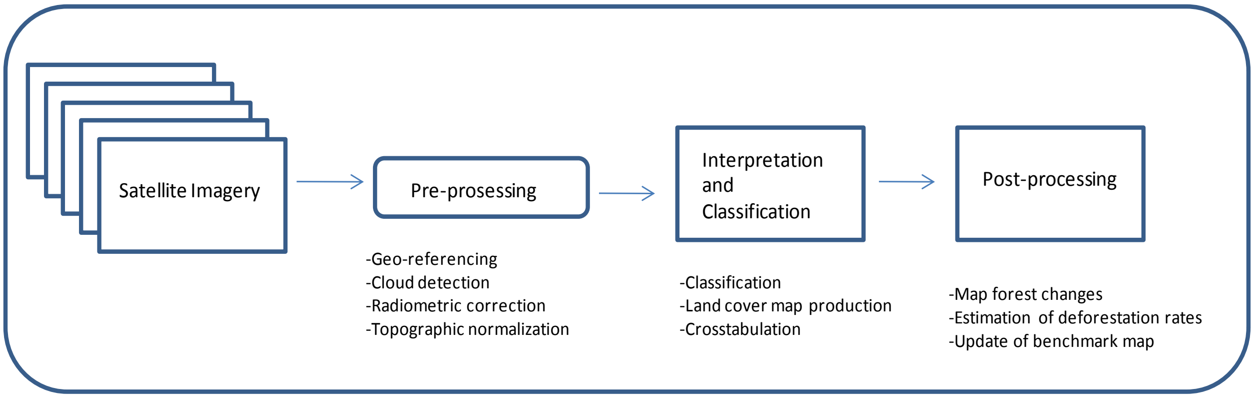
The project boundary, as set in the PD, will serve as the initial “forest cover benchmark map” against which changes in forest cover will assessed over the interval of the first monitoring period; the entire project area has been demonstrated to meet the forest definition at the beginning of the crediting period. For subsequent monitoring periods, change in forest cover will be assessed against the preceding classified forest cover map marking the beginning of the monitoring interval.

Data collection and analysis to determine forest cover change at each monitoring event will follow the procedures detailed below. The resulting classified image is compared with the preceding classified image (forest cover benchmark map marking the start of the monitoring interval) to detect forest cover change over the monitoring interval, and subsequently becomes the updated forest cover benchmark map for the next monitoring interval. Thus, the forest benchmark map is updated at each monitoring event. All changes in forest cover detected for the monitoring interval will be annualized (to produce estimates of ha for each year) by dividing the area by the number of years in the period.

For each monitoring/verification date, satellite imagery for that year will be acquired and interpreted to produce a classified forest cover map in which forest and non forest are distinguished. AMinimum Mapping Unit (MMU) of 0.81 ha, corresponding to 3pixels by 3 pixels Landsat resolution (90m by 90m) will be used throughout the duration of the project crediting period.

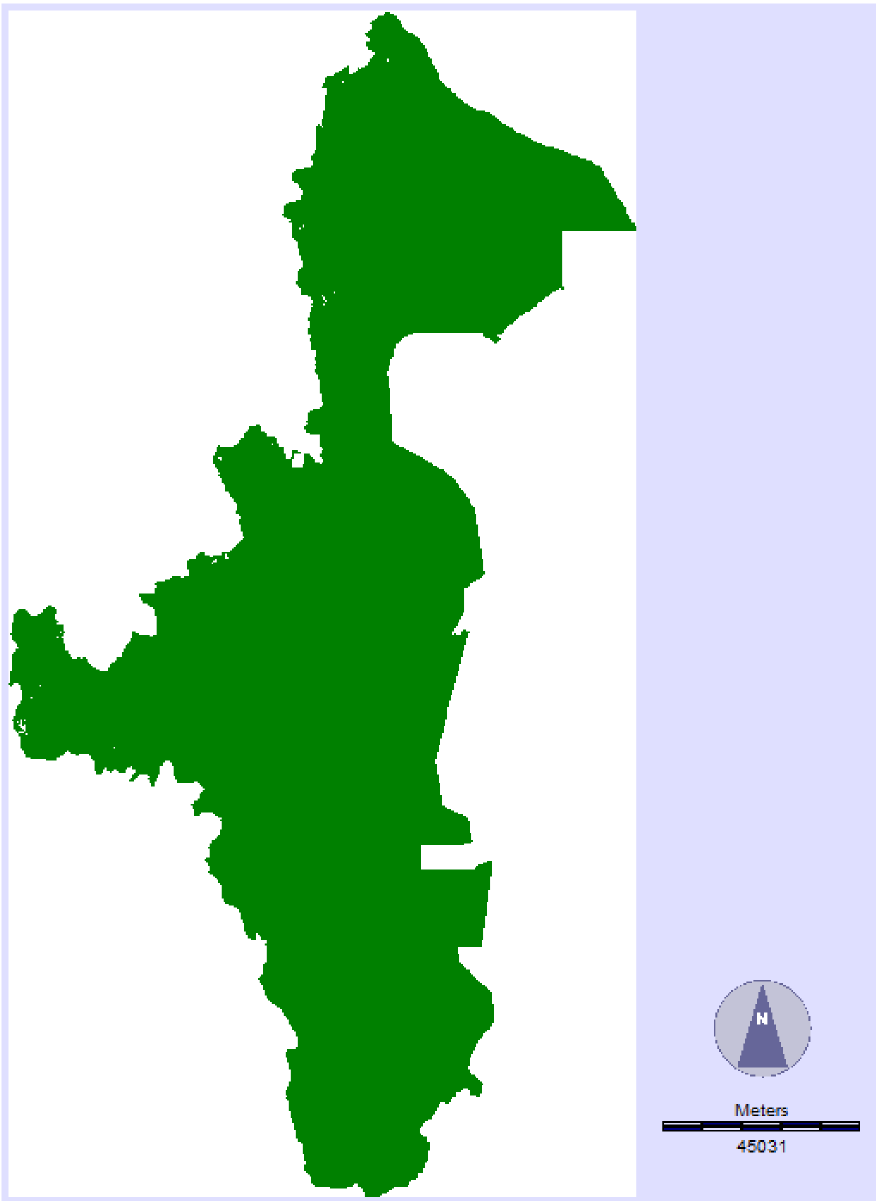
The general work flow for monitoring forest cover change is shown in Figure 3.1.

Figure 3.1: General workflow for monitoring of forest cover change in the project area and leakage belt



The forest cover benchmark map for the project start date in August 2008 (Figure 4.2) establishes the extent and location of forest and non-forest at the beginning of the crediting period and the first verification interval.

Figure 4.2: Forest cover benchmark map for project area, August 2008



Data collection and analysis to determine forest cover change at each monitoring event will follow the procedures detailed below. The resulting classified image is compared with the preceding forest cover benchmark map to detect forest cover change for the monitoring period, and becomes the updated forest cover benchmark map for the subsequent monitoring period. Thus, the forest benchmark map is updated at each monitoring event.

3.3.1.1 Data acquisition

To estimate the change of forest cover within the project area, the benchmark map generated at the previous monitoring event (or at project start August 2008 for the first monitoring event) will be compared with a newly-generated classified forest cover map for the monitoring date. The new forest cover map for the project area will comply with the following requirements.

Base satellite imagery will cover both the project area and leakage belt (i.e. monitoring of project area and leakage belt will use the same data source) and will be from a single year, though it may include a mosaic of scenes over several months. Landsat imagery has been used in historical analysis, and will likely be used in the future, but with the failure of Landsat 5 in 2011, and the sensor error with Landsat 7, a final determination of the which sensor will be used will hinge on the successful launch of the Landsat data continuity mission (LDCM) in early 2013. In the case that LDCM is not launched successfully, other medium resolution remotely sense data will be used that can calibrate to acceptable levels with the previous imagery.

Imagery will be 90% cloud free. To achieve 90% classified area, where possible, clouded areas will be classified on the basis of other data sources (e.g. ground surveys in the year of interest, radar, over-flights or classified imagery from a year subsequent to the monitored year).

Per module M-MON, "If the areas with 10% cloud cover in either date in question do not overlap exactly, then the rate [will] come from areas that were cloud free in both dates in question.... estimated in % per year. Then, a maximum possible forest cover map [will] be made for the most recent time period [i.e. monitoring date]. The historical rate in % [will] be multiplied by the maximum forest cover area at the start of the period for estimating the total area of deforestation during the [monitoring] period."

The following cartographic data has also been collected to aid in geo-referencing and delineation of project area and leakage belt (all projected in UTM WGS 84 Zone 18 S):

- Carta Nacional 1:1 000,000 IGN (Hojas 13L, 14K, 14L, 19M, 15J, 15K, 15L, 15M, 16J, 16K, 16L, 16M, 17J, 17K, 17L, 17M, 18K, 18L, 18M)
- Hidrografía y red vial - CIMA Cordillera Azul.
- Project area
- Leakage belt area

3.3.1.2 Pre-processing

As stated above Landsat moderate resolution imagery will be used preferentially. Landsat imagery is 30m multispectral data that is composed of 7 bands. One of these bands, band 6 is a thermal band, and is not used in image classification. The other 6 bands will be included in image analysis.

Collected imagery will be prepared for processing and analysis to ensure that the imagery displays and overlays accurately. The following pre-processing tasks will be conducted and are detailed below: geo-referencing, cloud and shadow removal. Each scene will be pre-processed and classified separately, eliminating need for radiometric corrections or topographic normalization where scenes must be mosaiced together.

The majority of Landsat imagery from USGS is obtained from EROS (Earth Resource Observation Systems) with multiple pre-processing steps completed. These processing steps are summarized below and more detail information can be found from NASA http://landsathandbook.gsfc.nasa.gov/level/.

The 1G product available to users is both radiometrically and geometrically corrected. The correction algorithms employed model the spacecraft and sensor using data generated by onboard computers during imaging events and ground control points and a digital elevation model are also used to improve the overall geometric fidelity. The geometric correction process utilizes both ground control points (GCP) and digital elevation models (DEM) to attain absolute geodetic accuracy. The WGS84 ellipsoid is employed as the Earth model for the Universal Transverse Mercator (UTM) coordinate transformation. Associated with the UTM projection is a unique set of projection parameters that flow from the USGS General Cartographic Transformation Package. The end result is a geometrically rectified product free from distortions related to the sensor (e.g. jitter, view angle effects), satellite (e.g. attitude deviations from nominal), and Earth (e.g. rotation, curvature, relief).
When using Level 1G processed imagery, pre-processing success must be confirmed, but frequently few extra pre-processing steps are necessary. The potential additional steps are detailed below.

Radiometric correction

Since change detection is conducted after classification, the only time radiometric correction is required is if severe atmospheric distortions are present in the only available imagery, or extreme topographic relief makes cloud shadows problematic. In these cases a haze reduction algorithm using a dark object subtraction may be used or a topographic normalization using a digital elevation model may be used.

Geo-referencing

For this procedure the August 2008 benchmark map will be used as a reference image from which all subsequent images will be geo-referenced. At least 7 well distributed ground control points (GCP) will be identified for the geo-referencing procedure. Each GCP will be known and recognizable in the source image and the reference image. A resampling operation using the nearest neighbor interpolation method, and a linear polynomial function will be used to ensure minimal distortion. The average geo-location error will not exceed 1 pixel. In the case that multiple images are mosaicked, a final image may be geo-referenced to ensure accurate location. In the case that imagery is obtained with geo-rectification conducted by the image producer or provider, secondary geo-referencing is not necessary.

Cloud and Shadow detection and removal

Detection of clouds and shadows will be accomplished through visual inspection or combining automated cloud identification techniques and visual inspection. An unsupervised clustering technique or a post classification assessment will be used to identify all areas affected by clouds and cloud shadow. Other imagery from with 12 months of the image date may be used to fill in these cloud areas.

3.3.1.3 Interpretation and classification

In this step, the scenes are interpreted by applying a classification algorithm to identify forest and non-forest categories. A two-step approach to classification will be used. In the first step, an unsupervised clustering algorithm technique will be used to classify each scene. Visual interpretation of clusters by an image analyst with knowledge of the land cover and/or with the assistance of high resolution imagery will be conducted to identify and then group all clusters into forest, non-forest, fire or fire scars, cloud and cloud-shadow and water classes. In the case of mixed classed, a second stage clustering may be employed on just the areas of confusion to see if clear classes may be identified. If clear categorization has been obtained (tested through the accuracy assessment) then step 2 can be skipped. If the classification accuracy using the unsupervised technique is not sufficient, or if the analyst prefers the use of supervised techniques, then a maximum likelihood algorithm will be used for supervised classification using samples of known areas selected for training areas (AOI, Areas of Interest) for a minimum of the following classes: "non-forest" ,"forest" “fire scars” “water”. A final land use map with 2 categories (forest and non-forest) will be created to assess forest loss against the previous benchmark map. In the case of fire evidence, as can be detected through the distinct spectral signature of burn scars, typically for > 18 months, or naturally shaped (as opposed to more typically geometrically shaped anthropogenic disturbance) patched of re-growth,or from field reports of fires that have been investigated and substantiated through remote sensing evidence, these areas will be maintained as a separate category to calculate parameter $A_{burn,i,t}$ and for estimation of biomass burning emissions using the module E-BB – calculated emissions from biomass burning will be incorporated in project accounting only where they are not determined to be insignificant applying T-SIG. As mentioned above, each scene will be classified separately.

The following guidelines will be taken into consideration for the imagery classification process.

Each scene will be classified separately using a hard classification method. The geospatial analyst performing the classification will take into consideration the variety of features in the scene and reference training sites representing a range of categories (from within forest and non-forest) sufficient to facilitate the identification of forested locations from locations with no forest. Special attention will be given to grasslands or herbaceous wetlands, and especially old fallows and shade crops like coffee (which can be confused with forest) to avoid classification errors. Where necessary, corrections to the supervised classification will be made from visual interpretation of imagery. Once the classified map is produced, categories will be merged into two categories for change assessment: forest and non-forest.

Following classification, classified scenes will then be joined to produce a final map that will be compared against the benchmark map.

Post classification

To ensure that the minimum forest definition is met the final classification will be filtered using a 3 by 3 mode filter. This will increase the MMU to 90m by 90 m to most closely meet the national forest definition. It will also improve any “speckle” in the classification due to small error.

3.3.1.4 Change detection

Post-classification change detection techniques will be implemented for identifying forest cover change.

Basic cross-tabulation techniques will be used to identify changes from forest to non-forest. Area data from the two maps (benchmark map at beginning of monitoring interval and newly-generated map for current monitoring year) will be cross-tabulated to identify locations that change from forest to non-forest during the monitoring period, which represent deforestation in the actual with-project case.

The project area has many extreme topographic features- Including very steep slopes, and areas at high elevation that have minimal tree cover. These areas were removed from the spatial modeling due to their inaccessibility, and will also be removed from the change detection analysis since any land cover change in these areas is due to non-anthropogenic sources. GIS files that delineate these masked areas are archived so that each analysis will maintain the same masks.

3.3.1.5 Quality Assurance/Quality Control

To ensure consistency and quality results, spatial analysts carrying out the imagery processing, interpretation, and change detection procedures will strictly adhere to the steps detailed above. All data sources and analytical procedures will be documented and archived (detailed under data archiving below).

Accuracy of the classification will be assessed by comparing the classification with ground truth points or samples of high resolution imagery (e.g. SPOT or Rapideye imagery). Any data collected from ground-truth points will be recorded (including GPS coordinates, identified land-use class, and supporting photographic evidence) and archived. Any sample points of high resolution imagery used to assess classification accuracy will also be archived. Samples used to assess classification accuracy should be well-distributed throughout the project area (as far as is possible considering availability of high resolution imagery and/or logistics of acquiring ground truth data), with a minimum sampling intensity of 50 points each for the forest and non forest classes.

Results of the accuracy assessment will be presented and analyzed in a matrix in the format elaborated in the example below, such that the following errors are presented:

- Overall classification accuracy
- Error of omission of each land-use category (forest and non-forest)
- Error of commission of each land-use category (forest and non-forest)

Table 3.1: Example accuracy assessment results

Land-use class as determined from ground-truth points	**Classification**		**Total**	**Accuracy (%)** ***User's accuracy*** ***(# correct/ row total)***	**Error of Commission (%)**
	Forest	**Non-forest**			
Forest (100)	95	5	100	95.0	5.0
Non-forest (100)	9	91	100	91.0	9.0

Total	104	96	200		
Accuracy (%) ***Producer's accuracy*** ***(# correct/ column total)***	91.3	94.8			
Error of Omission (%)	8.7	5.2			

The classification will only be used in the forest cover change detection step if the overall classification accuracy, calculated as the total number of correct samples/ the total number of samples, is equal to or exceeds 90%.

3.3.1.6 Data Archiving

All data sources and processing, classification and change detection procedures will be documented and stored in a dedicated long-term electronic archive maintained by CIMA at its main office in Lima as described in Section 3.3.8.

Information related to monitoring deforestation maintained in the archive will include:

- Base (raw) imagery used (specifying type, source, resolution, imagery date, acquisition date)
- Any cartographic data used to geo-reference the image (source, base data)
- Data used for training classification
- Definition of land cover classes assessed
- Documentation of software type and procedures applied (including all pre-processing steps and corrections, spectral bands used in final classifications, and classification methodologies and algorithms applied)
- Classified images
- Data used in accuracy assessment - ground-truth points (including GPS coordinates, identified land-use class, and supporting photographic evidence) and/or sample points of high resolution imagery
- Accuracy assessment matrix with minimally the following errors presented: overall classification accuracy, error of omission of each land-use category (forest and non-forest), and error of commission of each land-use category (forest and non-forest)

Data archived will be maintained through at least two years beyond the end of the project crediting period, through July 2030. Given the extended time frame and the pace of production of updated versions of software and new hardware for storing data, electronic files will be updated periodically or converted to a format accessible to future software applications, as needed.

3.3.1.7 Updating forest carbon stock estimates

Forest carbon stock estimates used to calculate emissions from deforestation and natural disturbance will use estimates derived from field measurements less than or equal to 10 years old. In the event that any deforestation is discovered in the project area, forest carbon stock estimates older than 10 years will be updated for any strata where deforestation is detected. Initial above- and belowground biomass and dead wood stock estimates from the 2009 inventory are valid and treated as constant through 2018, after which they will be re-estimated from new field measurements.

To re-assess forest carbon stocks, twenty (20) point samples (four clusters of five points) will be randomly located in each forest strata and measured (following field protocols in Appendix 8) in 2018. Biomass will be estimated applying the allometric equations of Chave et al 2005 and otherwise maintain consistency with analytical procedures applied in the original 2009 inventory. For each strata, where the re-measured estimate of total forest biomass carbon (live and dead) is within the 90% confidence interval of the 2009 estimate, the 2009 stock estimate will continue to be used in the next 10 year baseline period. If the re-measured estimate is outside (i.e., greater than or less than) the 90% confidence interval of the 2009 estimate, then the 2018 stock estimate will be used in the next 10 year baseline period.

3.3.2 Quality Assurance /Quality Control and Data Archiving Procedures

The following steps will be taken to control for errors in field sampling and measurements and data analysis:

1. Field crews with prior training in forest inventory will carry out all field data collection and adhere to field measurement protocols outlined in PD Appendix 8. Pilot sample plots shall be measured before the initiation of formal measurements to train and appraise field crews and identify and correct any errors in field measurements. Field crew leaders will be responsible for ensuring that field protocols are followed to ensure accurate and consistent measurement. During the course of implementation, field crews were periodically apprised of measurement errors to assess progress. To ensure accurate measurements, the height of diameter at breast height (1.3 m) will be periodically re-assessed by personnel during the course of the inventory. Field crews will have fine scale forest strata maps for use in the field to precisely interpret strata/forest boundaries and identify potential areas of plot overlap.
2. Calibration of prisms will be confirmed prior to formal field measurements. All borderline trees will be measured and assessed against prism plot radius factor, which is standardized as distance to the centre of the tree: diameter at breast height.
3. An opportunistic sample of plots will be re-measured to assess measurement errors. Re-measurement for this purpose will be done by a different field crew. Measurement error will be assessed as 1/2 of the mean (absolute) percent difference between re-measured plot level biomass estimates (a valid assumption where teams are equally experienced and there are no systematic errors in measurement, which will also be appraised from the re-measurement results). Target measurement error is < 5%.
4. Field measurement data will be recorded on standard field data sheets (PD Appendix 8) and transferred to electronic media ("entrada de datos PNCAZ inventario.xls") following each return from the field. Original data sheets will be permanently archived at the CIMA office in Tarapoto and Lima, and the electronic database of all field measurements will be housed in the dedicated long-term electronic archive maintained on the CIMA server at its main office in Lima. The electronic database will also archive GIS coverages detailing forest and strata boundaries and plot locations.
5. Checks will be run for unusual (high or low) values to identify and correct any errors in recorded field data or transcription. Personnel involved in data analysis will consult with personnel involved in measurement to clarify any ambiguities in recorded field data.
6. For laboratory analysis of dead wood specific gravity, all balances for measuring dry weights will be calibrated against known weights prior to use. All calibration results will be documented and archived along with sample analysis results. 10% of samples will be re-analyzed/re-weighed to produce an error estimate

3.3.3 Emissions due to illegal degradation

Emissions due to illegal logging will be tracked by conducting MUF surveys in communities with access to the project area at least every three years. Communities surveyed will include, but not necessarily be limited to those listed in Table 3.2.

Table 3.2: Communities to be surveyed

Region de Referencia (distrito)	Centro Poblado
Huimbayoc	Pongo Isla
Huimbayoc	Pucallpa
Chazuta	Ricardo Palma
Chazuta	Callanayacu
Shamboyacu	Porvenir
Pampa Hermosa	Tahiti
Pampa Hermosa	Playa Hermosa
Alto Biavo	Los Cedros
Bajo Biavo	Selva Andina
Alto Biavo	Challual
Alto Biavo	Juanita
Padre Abad	Yamino
Contamana	La Cumbre

Surveys will produce information on wood consumers (fuel wood and wood for construction and charcoal production) in the surroundings areas, as well as general indications on the areas where wood is sourced from and maximum depth of penetration of harvest activities from access points.

In the event that any potential of illegal logging occurring in the project area is detected from the surveys (i.e. ≥ 10% of those interviewed/surveyed believe that degradation may be occurring within the project boundary), temporary sample plots will be allocated and measured in the area of the project indicated by the surveys as a potential source area for illegally-harvested wood. The potential degradation area within the project area ($A_{DegW,i}$) will be delineated based on survey results, incorporating general area information and maximum depth of penetration. Rectangular plots 10 meters by 1 kilometer (1 ha area) will be randomly or systematically allocated in the area, sufficient to produce a 1% sample of the area, and any recently-cut stumps or other indications of illegal harvest will be noted and recorded. Diameter at breast height, or diameter at height of cut, whichever is lower, of cut stumps will be measured.

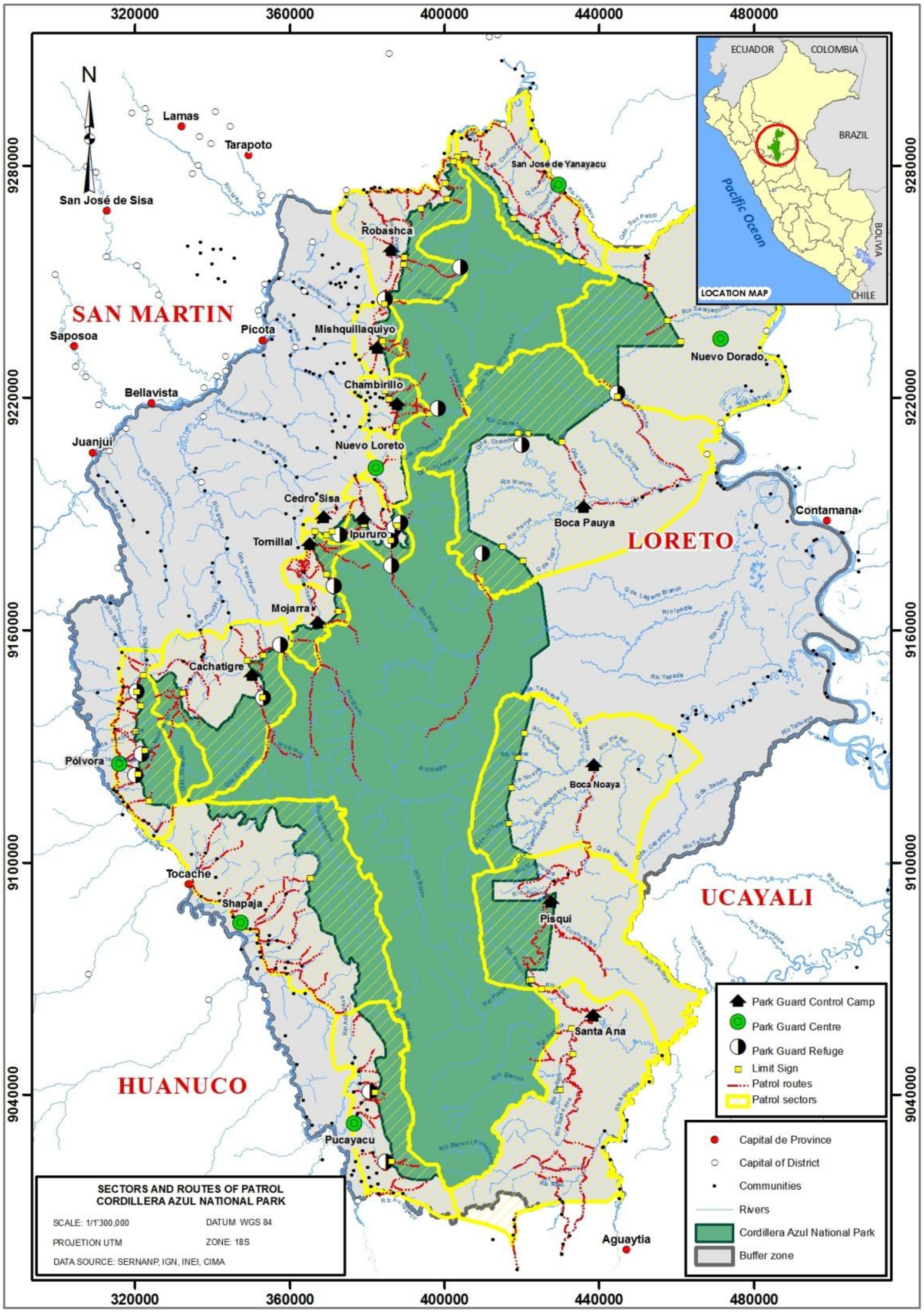
In the event that the sample plot assessment indicated that illegal logging is occurring in the area, supplemental plots will be allocated to achieve a 3% sample of the area. Biomass will be estimated from measured diameters (conservatively assuming that diameters of stumps cut below breast height are equivalent to diameter at breast height) applying the allometric equation of Chave et al 2005 and otherwise maintain consistency with analytical procedures applied in the original 2009 PNCAZ inventory. Emissions due to illegal logging (Ä$C_{P,DegW,i,t}$) are estimated by multiplying area ($A_{DegW,i}$) by average biomass carbon of trees cut and removed per unit area ($C_{DegW,i,t}$ / AP_i).

The more intensive 3% sample will be carried out once every 5 years where surveys and limited sampling continue to indicate possibility of illegal logging in the project area to produce an estimate of emissions resulting from illegal logging (Ä$C_{P,DegW,i}$). Estimates of emissions will be annualized (to produce estimates in t CO_2-e per year) by dividing the emission for the monitoring interval by the number of years in the interval.

The same quality assurance/quality control and archiving procedures as detailed above for updating estimates of forest carbon stocks will be adhered to in the field surveys of potential degradation areas.

Within the project area and area bordering the park (PNCAZ buffer zone), routine patrols will be carried out throughout the year by park guards. Patrols will identify, and resolve where possible, any illegal wood harvest taking place in the PNCAZ and project area. There are 18 control posts and park guard centers on or near the border of the project area, from which guards will be routinely fielded on patrol routes totaling 2,041 km distance (544.6 km within PNCAZ). The total area to be routinely patrolled is located closest to communities with potential access to the park (i.e. highest potential pressure area for illegal harvest) and totals 1,779,984.7 ha (507,364.2 ha within PNCAZ). The density of patrol trails in the monitored area within PNCAZ is 1 km per 10 km^2. The location of patrol areas and park control posts are shown in Map 3.1.

Map 3.1: Location of patrol areas and park control posts

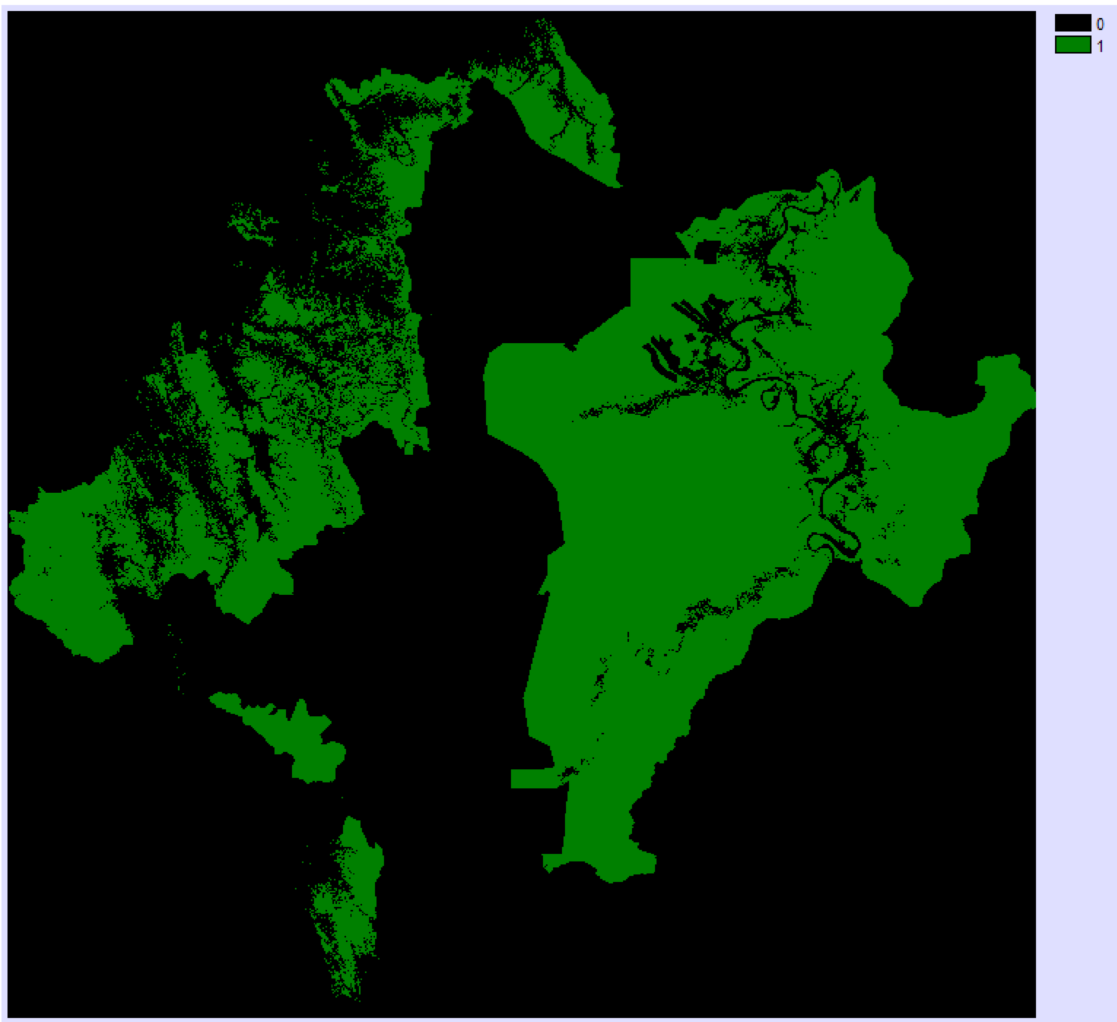


3.3.4 Monitoring of leakage carbon stock changes

Activity-shifting leakage in the leakage belt will be monitored by tracking forest cover change in the leakage belt (ADefLB,u,i,t), using classified satellite imagery produced following the same procedures outlined above in Section 3.2.1, referencing the 2008 forest cover benchmark map for the leakage belt (Figure 3.3). All changes in forest cover detected for the monitoring interval will be annualized (to produce estimates of ha for each year) by dividing the area by the number of years in the period.

Note that the leakage belt includes private inholdings and ineligible areas (without forest >10 years old) within PNCAZ as well as planned deforestation areas for oil palm production in the northeast. The initial area of forest in the leakage belt is 1,920,311 ha.

Figure 3.3: Benchmark map of forest cover in 2008 in the leakage belt



Parameter, $\Delta C_{pools,Def,u,i,t}$, is derived from estimates of $C_{BSL,i}$ (forest carbon stock in all pools in the baseline case in stratum *i*) from PNCAZ forest inventory measurements, or for strata identified in the leakage belt but not represented in the PNCAZ inventory from peer-reviewed regional literature sources, as for initial estimates derived in Section 3 above. Parameter, $C_{P,post,u,i}$ (carbon stock in all pools in post-deforestation land use *u* in stratum) is assigned as the historical area-weighted average carbon stock for the converted (non forest) baseline land-use(s), the initial estimate derived in PD Section 3. Stock estimates will be re-assessed every $\leq$ 10 years.

Monitored parameters will be entered into the table format below to complete calculations of activity shifting leakage occurring in the leakage belt in the with-project case ($\Delta C_{LK\text{-}ASU\text{-}LB}$).

Table 3.3: Calculation format for area subject to activity shifting leakage in the leakage belt

equation	Derived in PD Sections 3.1 and 3.3		Derived from forest inventory estimates	M-MON 4	LK-ASU 1
Year	$\Delta C_{BSL,LK,unplanned}$ t CO_2	$A_{DefLB,u,i,t}$ ha	$\Delta C_{pools,Def,u,i,t}$ t CO_2/ha	$\Delta C_{P,DefLB,i,t}$ t CO_2	$\Delta C_{LK\text{-}ASU\text{-}LB}$ t CO_2
2009	6,910,840.7				
2010	7,497,174.1				
2011	9,658,074.5				
Etc…	Etc...				

Activity shifting leakage outside the leakage belt will be tracked by monitoring deforestation in the project area ($A_{DefPA,i,t}$) and leakage belt ($A_{DefLB,i,t}$).

The value of parameter, $PROP_{IMM}$, 32.5%, as derived in PD Section 3.3, will be employed for the first five years of the project. Subsequently, the parameter, $PROP_{IMM}$, will be derived from the results of surveys conducted among neighboring communities every $\leq$ 5 years. The same communities identified above for assessing potential for illegal degradation in the project area will be surveyed to determine for each interviewee how long the person has lived there and where did they come from prior to moving to the area. As there are sensitivities to assessing responsibility for deforestation in an interview context, the proportion of baseline deforestation caused by immigrating population will be assumed to be equal to the proportion of immigrants in the surrounding population. Immigrants are defined as someone who has lived in the area less than 5 years and came from an area outside the leakage belt.

Table 3.4: Calculation format for area subject to activity shifting leakage outside the leakage belt

equation		Derived in PD Section 3.1	LK-ASU 7			LK-ASU 8	LK-ASU 9	Derived in PD in Section 3.3	LK-ASU 11
Year	$PROP_{IMM}$	$A_{BSL,PA,unplanned,t}$ ha	$A_{LK\text{-}IMM,t}$ ha	$A_{DefPA,i,t}$ ha	$A_{DefLB,i,t}$ ha	$A_{LK\text{-}ACT\text{-}IMM,t}$ ha	$A_{LK\text{-}OLB,t}$ ha	$PROP_{CS}$	$\Delta C_{LK\text{-}ASU,OLB}$ t CO_2
2009	32.5%	4,256.82						1.049	
2010	32.5%	5,420.34						1.049	
2011	32.5%	3,216.33						1.049	
Etc…	Etc...	Etc.						Etc.	

3.3.5 Estimation of ex-post net carbon stock changes and greenhouse gas emissions.

Estimates of GHG credits eligible for issuance as VCU's will be calculated entering data into the table format below, where

Estimated GHG emission reduction credits =

Baseline emissions, fixed for 10 years at validation *minus*

Project emissions *minus*

Leakage *minus*

Non-permanence Risk Buffer withholding (calculated as a percent of net change in carbon stocks prior to deduction of leakage)

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Risk buffer (%)	Deductions for AFOLU pooled buffer account	Estimated net GHG emission reductions or removals (tCO2e)
2009	1,834,510.1					
2010	1,960,580.9					
2011	1,337,026.1					
Etc…						

3.3.6 Organization and Responsibilities

For all aspects of project monitoring, CIMA will ensure that data collection, processing, analysis, management and archiving are conducted in accordance with the monitoring plan.

Remote sensing image analysis is conducted by CIMA's GIS team periodically according to the procedures discussed in PD Appendix 4.

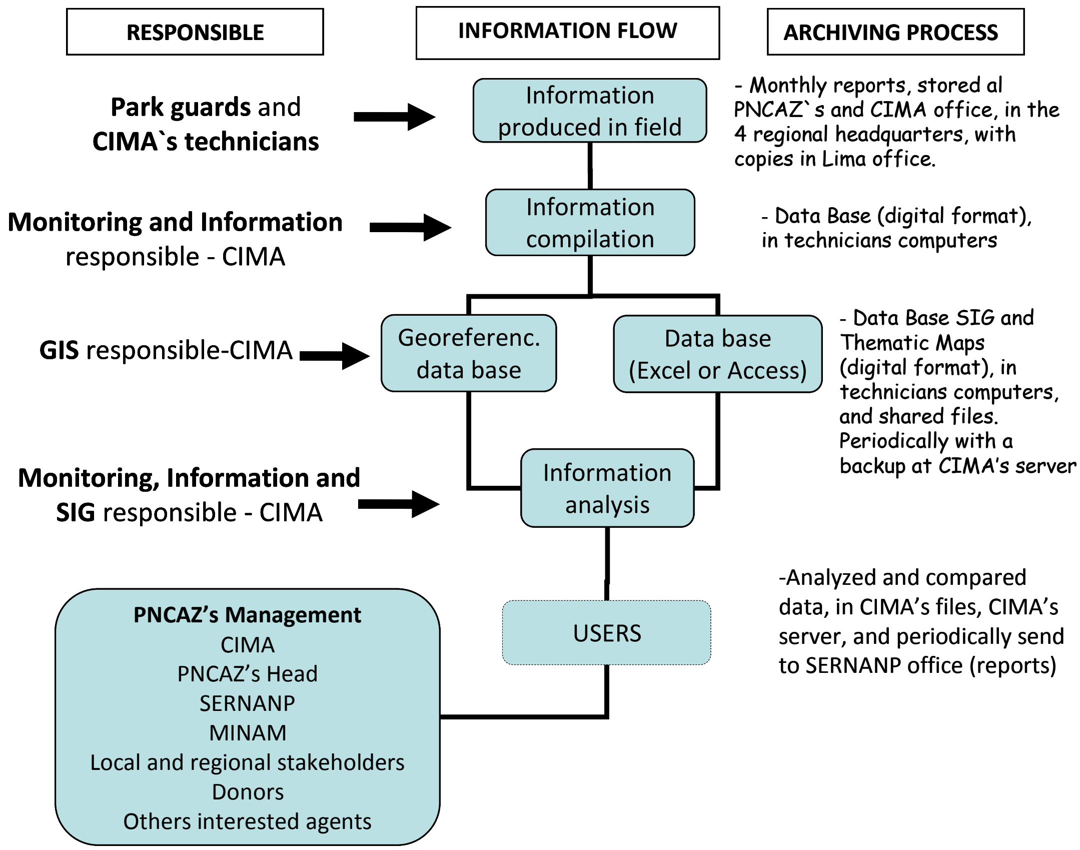
Field data is the result of CIMA technicians' trips and the park guards routine and special patrols as part of their planning activities. Technicians and park guards are the key personnel in the generation of information - threats, social and environmental aspects of PNCAZ and buffer zone – and are trained to ensure that they are aware of the importance of the data they are generating. They are the first link in the chain of information flow (Figure 3.4).

This data is recorded in the monthly reports of the technicians and park guards at the offices of the Head of PNCAZ and CIMA, and copies of the park guards' reports are send to CIMA office in Lima headquarters. This information is analyzed by the CIMA Information and Data Specialists to provide quarterly and annual technical reports to SERNANP (or donors) about the progress in PNCAZ's management activities, to report results and impacts of management to SERNANP, and for review by

CIMA Management as appropriate. This critical information is systematized and analyzed annually by the technical staff of CIMA.

Hard copies of all of the data is stored in Lima or Tarapoto. The most important information and data is converted to electronic format and placed on the server for sharing between the Lima and Tarapoto offices. This server is periodically backed up.

Figure 3.4: Data flow in CIMA



4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Baseline emissions for the project activities for project years 2009 to 2012, are summed in Table 4.1 below (derived from Section 3.1 of the VCS PD)

Table 4.1 : Calculation of baseline emissions

YEAR	$C_{TOT\ PA}$	$C_{TOT\ LB}$
2009	1,834,510.1	6,910,840.7
2010	1,960,580.9	7,497,174.1
2011	1,337,026.1	9,658,074.5
2012	1,612,694.5	11,162,792.9
total	6,744,811.6	35,228,882.2

Hereafter, the monitoring report uses the convention that the project year is the year at the end of the interval, i.e. project year 2009 is Aug 8 2008 to Aug 7 2009

4.2 Project Emissions

Project emissions from deforestation are calculated as the total area deforested multiplied by the emission per unit area.

Table 4.2.1: Parameters used to calculate *ΔCP,DefPA,i,t*

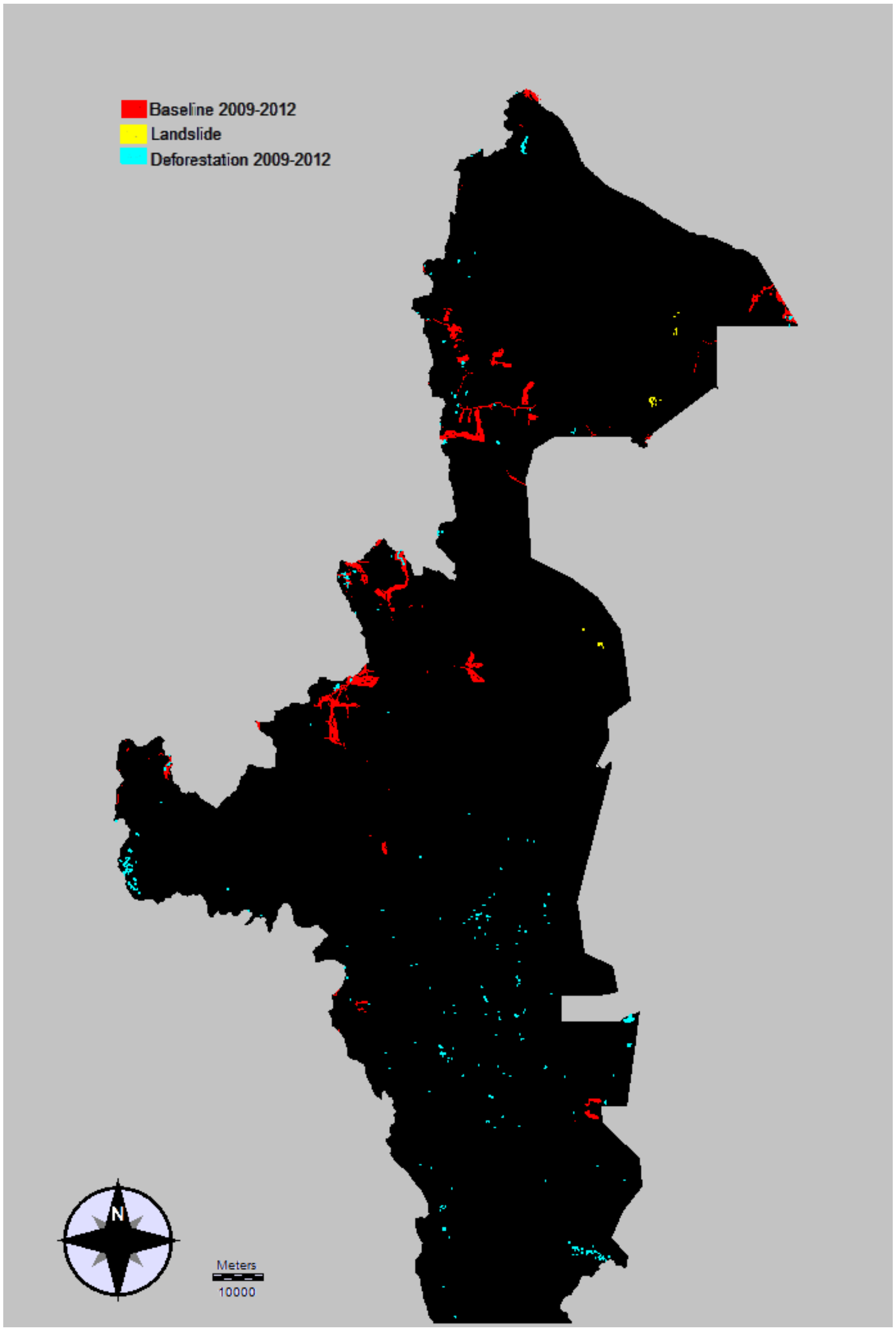
ADefPA,u,i,t (ha)	Area of recorded deforestation in the project area stratum *i* converted to land use *u* at time *t*; ha	Calculated in imagery analysis
ΔCpools,Def,u,i,t	Net carbon stock changes in all pools in the project case in land use *u* in stratum *i* at time *t*; t CO_2-e ha^{-1}	Calculated below

Landslides have occurred in the project area and have been delineated in the image classification from other deforestation using expert knowledge and identification of areas that are highly susceptible to these events. Some areas of deforestation detected in image classification may also be due to natural disturbance or classification error, but due to the inaccessibility of these remote areas they are conservatively included as deforestation.

Table 4.2.2: *ADefPA,u,i,t (ha)*

	ADefPA,u,i,t (ha)				
	Alluvial	Collinsos (Hill forest)	Montanosos	Humedales (Aguajal)	*TOTAL*
2009	*33.4*	*17.1*	*102.4*	*7.6*	*160.6*
2010	*33.4*	*17.1*	*102.4*	*7.6*	*160.6*
2011	*33.4*	*17.1*	*102.4*	*7.6*	*160.6*
2012	*33.4*	*17.1*	*102.4*	*7.6*	*160.6*
Total 2009-2012	**133.8**	**68.5**	**409.5**	**30.6**	**642.4**

Figure 4.1: Project land cover change and baseline projections 2009-2012



Calculation of emission per unit area is equal to the difference between the stocks before and after deforestation. There are no indications of any commercial wood products recovery associated with the forest clearance process.

Table 4.2.3: Parameters used to calculate *ΔCpools,Def,u,i,t*

Parameters used to calculate *ΔCpools,Def,u,i,t*			
Parameter	Description		value
CBSL,i	Carbon stock in all pools in the baseline case in stratum	Calculated in forest inventory (PD section 3)	
CP,post,u,I	Carbon stock in all pools in post-deforestation land use u in stratum i; t CO2-e ha-1	Historical area-weighted average carbon stock for the converted (non forest) baseline, cultivation and pasture (derived in PDD section 3)	41.3

Table 4.2.4: *ΔCP,DefPA,i,t*

	ΔCP,DefPA,i,t				Total
	Alluvial	Collinosos (Hill forest)	Montañosos	Humedales (Aguajal)	*ΔCP,DefPA,i,t*
2009	8,491.6	7,283.2	64,539.0	2,536.1	82,849.9
2010	8,491.6	7,283.2	64,539.0	2,536.1	82,849.9
2011	8,491.6	7,283.2	64,539.0	2,536.1	82,849.9
2012	8,491.6	7,283.2	64,539.0	2,536.1	82,849.9
Total 2009-2012	**33,966.3**	**29,133.0**	**258,156.1**	**10,144.4**	**331,399.8**

Monitoring areas undergoing natural disturbance

Risk of landslides resulting in reversals is low. Per module M-MON, “For unplanned deforestation the sum of $A_{DistPA,q,i,t}$ shall be equal to the area of overlap between the delineated area of the disturbance and the summed area of unplanned deforestation in the project area ($A_{BSL,PA,unplanned,t}$), summed to the year in which the disturbance occurred.” Thus emissions from natural disturbance that are accounted for are only those taking place in the area of projected deforestation in the baseline. Because the baseline incorporates topographic features (elevation) in the spatial modeling, which assign higher probabilities of deforestation in lower elevation and more level areas suitable for settlement and agriculture, risk of landslides (that tend to occur on higher elevation, steeper sites less suitable for settlement and agriculture) that produce reversals in project accounting is expected to be low.

Landslides have occurred in the project area and have been delineated in the image classification (Figure 4.1) However, there was no overlap between these areas and the summed area of unplanned deforestation in the project area ($A_{BSL,PA,unplanned,t}$), therefore no natural disturbance area is included in project accounting.

Monitoring biomass burning

In the classification process, no evidence of fire scars was detected. No fires were reported during the 2008-2012 period from other sources, including park guard patrols, and therefore $A_{burn,i,t}$ was 0. Also, areas of apparent anthropogenic deforestation in the project area from 2009-2012 are likely to be classification errors (642 ha / 1,350,950 ha = 0.05% of the monitored project area, well within the calculated classification error of 5%) as there is no corroborating ground evidence from park guard patrols, hence no slash and burn agriculture, and emissions from biomass burning, likely took place.

Monitoring illegal logging

The number of routine patrols carried out by PNCAZ park guards per year, and the findings of those patrols, are detailed in the table below.

Table 4.2.9: Park guard patrols in and around PNCAZ (source: Informe Anual al SERNANP).

Year	No. of patrols conducted	No. of infractions identified	Notes	Conservative estímate of area of impact*
2009	**340 routine** **2 special (periodic, more extensive)**	**0**		**0 ha, 0% of patrol area within PNCAZ**
2010	**298 routine** **7 special**	**3**	**infractions by loggers (very small areas of cuts, too small to be detected by Landsat imagery, i.e. <30m * 30 m, < 0.9 ha)**	**27 ha, 0.005% of patrol area within PNCAZ**
2011	**347 routine** **18 special**	**1**	**infractions by loggers (very small areas of cuts, too small to be detected by Landsat imagery, i.e. <30m * 30 m, < 0.9 ha)**	**9 ha, 0.002% of patrol area within PNCAZ**

2012 (Jan-May)	**119 routine** **20 special**	**2**	**infractions by loggers (very small areas of cuts, too small to be detected by Landsat imagery, i.e. <30m * 30 m, < 0.9 ha)**	**18 ha, 0.004% of patrol area within PNCAZ**

*total area patrolled = 507,364.2 ha, assumes each reported infraction represented an area of impact 0.9 ha and park guards only detect 10% of incidents of illegal logging in the patrolled area

Findings indicate that the impacts of illegal harvest in the project area, when they do occur, are insignificant at the project scale. Using conservative assumptions (1) that each reported infraction represented an area of impact 0.9 ha; in fact areas of cuts were much smaller, too small to have been detected by Landsat imagery, and (2) that park guards only detect 10% of incidents of illegal logging; illegal logging is likely to be concentrated along access routes which are travelled by the patrols), average annual area of illegal logging impacts (degradation) from 2009 to 2012 was 0.3% of the patrolled area. Because the patrolled area is the most accessible part of the project area in closest proximity to surrounding communities (Figure 3.3 above), it would be expected to have a higher incidence of illegal logging than the average incidence across the entire project area, and thus at the project scale, which includes more interior, less accessible areas, the annual area subject to degradation would not be expected to have exceeded that of the patrolled subsection from 2009 to 2012.

Net project emissions within the project area calculated in table 4.2.10.

Table 4.2.10: ΔCP (t CO2-e)

	ΔCP,DefPA,i,t	ΔCP,Deg,i,t	ΔCP,DistPA,i,t	ΔCP
2009	82,849.9	0	0	82,849.9
2010	82,849.9	0	0	82,849.9
2011	82,849.9	0	0	82,849.9
2012	82,849.9	0	0	82,849.9
Total 2009-2012	331,399.8	0	0	331,399.8

4.3 Leakage

Leakage monitored in the project case is related to activity shifting of local and immigrant agents.

Activity shifting from local agents (in the leakage belt) was tracked by monitoring deforestation and stock changes in the leakage belt from 2008 to 2012.

Table 4.3.2: Area deforested in the leakage belt from 2008 to 2012 *ADefLB,u,i,t* (ha)

	ADefLB,u,i,t (ha)			TOTAL
	Anthropogenic (forest)	Humedales – vegetación inundable	Vegetación de tierra firme	
2009	3,743.0	1,493.5	9,633.1	14,869.5
2010	3,743.0	1,493.5	9,633.1	14,869.5
2011	3,743.0	1,493.5	9,633.1	14,869.5
2012	3,743.0	1,493.5	9,633.1	14,869.5
Total 2009-2012	**14,972.0**	**5,973.8**	**38,532.3**	**59,478.1**

Emissions were calculated as the difference between stocks before and after deforestation, as for project emissions.

Table 4.3.3: Emissions from deforestation in the leakage belt from 2008 to 2012 *ΔCP,DefLB,i,t* (t CO2e)

	ΔCP,DefLB,i,t			Total *ΔCP,DefLB,i,t*
	Anthropogenic (forest)	Humedales – vegetación inundable	Vegetación de tierra firme	
2009	1,673,484.8	841,317.5	4,018,595.8	6,533,398.1
2010	1,673,484.8	841,317.5	4,018,595.8	6,533,398.1
2011	1,673,484.8	841,317.5	4,018,595.8	6,533,398.1
2012	1,673,484.8	841,317.5	4,018,595.8	6,533,398.1
Total 2009-2012	**6,693,939.2**	**3,365,270.1**	**16,074,383.2**	**26,133,592.5**

The net greenhouse gas emission in the project case for the leakage belt, parameter *ΔCP,LB*, is equal to the sum of stock changes dues to deforestation through 2012, equal to 26,133,592.5 t CO2e. Estimated annual emissions in the leakage belt from 2009 to through 2012 were 6,533,398.1 t CO2e (=26,039,546 / 4).

Calculations of activity shifting leakage occurring in the leakage belt in the with-project case ($\Delta C_{LK\text{-}ASU\text{-}LB}$) are consolidated in Table 4.3.4 below.

Table 4.3.4: Calculations of area subject to activity shifting leakage in the leakage belt

equation	Derived in PD Sections 3.1 and 3.3		Derived from forest inventory estimates	M-MON 4	LK-ASU 1
Year	$\Delta C_{BSL,LK,unplanned}$ t CO_2	$A_{DefLB,u,i,t}$ ha	$\Delta C_{pools,Def,u,i,t}$ t CO_2/ha	$\Delta C_{P,DefLB,i,t}$ t CO_2	$\Delta C_{LK\text{-}ASU\text{-}LB}$ t CO_2
2009	6,910,840.74	14,869.5	Varies by strata	6,509,886.5	-377,442.6
2010	7,497,174.15	14,869.5	Varies by strata	6,509,886.5	-963,776.0
2011	9,658,074.47	14,869.5	Varies by strata	6,509,886.5	-3,124,676.3
2012	11,162,792.89	14,869.5	Varies by strata	6,509,886.5	-4,629,394.8
Total 2009-2012	35,228,882.25	59,478.1		26,039,546.0	- 9,095,289.75

Emissions from deforestation in the leakage belt were less than the projected emissions from deforestation in the leakage belt, and thus no leakage from activity shifting within the leakage belt is accounted.

Activity shifting leakage outside the leakage belt was tracked by monitoring deforestation in the project area ($A_{DefPA,i,t}$) and leakage belt ($A_{DefLB,i,t}$). Leakage outside of the leakage belt has not occurred as calculated in table 4.3.5 below. As stated in Module LK-ASU if parameter ALK-OLB,t < 0 Leakage outside the Leakage Belt has not occurred. If leakage outside the Leakage Belt has not occurred:

$\Delta C_{LK-ASU,OLB} = 0$.

Table 4.3.5: Emissions calculations for activity shifting leakage outside the leakage belt

equation		Derived in PD Section 3.1	LK-ASU 7			LK-ASU 8	LK-ASU 9	Derived in PD in Section 3.3	LK-ASU 10
Year	$PROP_{IMM}$	$A_{BSL,PA,unplanned,t}$ ha	$A_{LK\text{-}IMM,t}$ ha	$A_{DefPA,i,t}$ ha	$A_{DefLB,i,t}$ ha	$A_{LK\text{-}ACT\text{-}IMM,t}$ ha	$A_{LK\text{-}OLB,t}$ ha	$PROP_{CS}$	$\Delta C_{LK\text{-}ASU,OLB}$ t CO_2
2009	32.50%	4256.8	1,383.5	160.6	14,869.5	4,884.8	-3,501.3	1.049	0
2010	32.50%	5420.3	1,761.6	160.6	14,869.5	4,884.8	-3,123.2	1.049	0
2011	32.50%	3216.3	1,045.3	160.6	14,869.5	4,884.8	-3,839.5	1.049	0
2012	32.50%	3818.2	1,240.9	160.6	14,869.5	4,884.8	-3,643.9	1.049	0
Total 2009-2012		16711.7	5,431.3	642.4	59,478.1	19,539.2	-14,107.9		0

4.4 Summary of GHG Emission Reductions and Removals

Uncertainty

Deductions for uncertainty in carbon stock estimates and baseline deforestation projections were calculated applying module X-UNC.

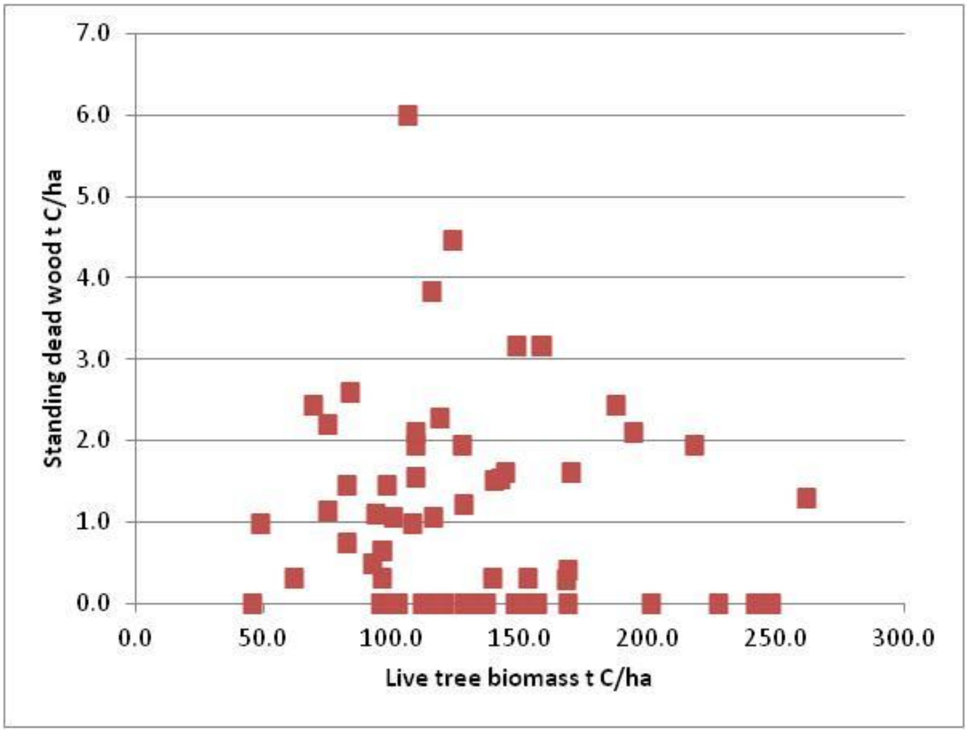
Total error in stock estimates (including live and dead above and belowground biomass C) from the 2009 PNCAZ forest inventory was +/-7.5% of the mean at the 95% confidence level (Table 4.4.1).

Table 4.4.1: Overall forest carbon density (live and dead above and belowground biomass C) estimate and statistics, derived in "Forest biomass carbon inventory of the Parque Nacional Cordillera Azul (PNCAZ)" (Shoch et al 2009).

Mean Forest Carbon Density (t C/ha)	151.0
Standard Error (t C/ha)	5.68
90% Confidence Interval (t C/ha)	9.5
95% Confidence Interval (t C/ha)	11.4
90% Confidence Interval as percentage of mean	6.3%
95% Confidence Interval as percentage of mean	7.5%

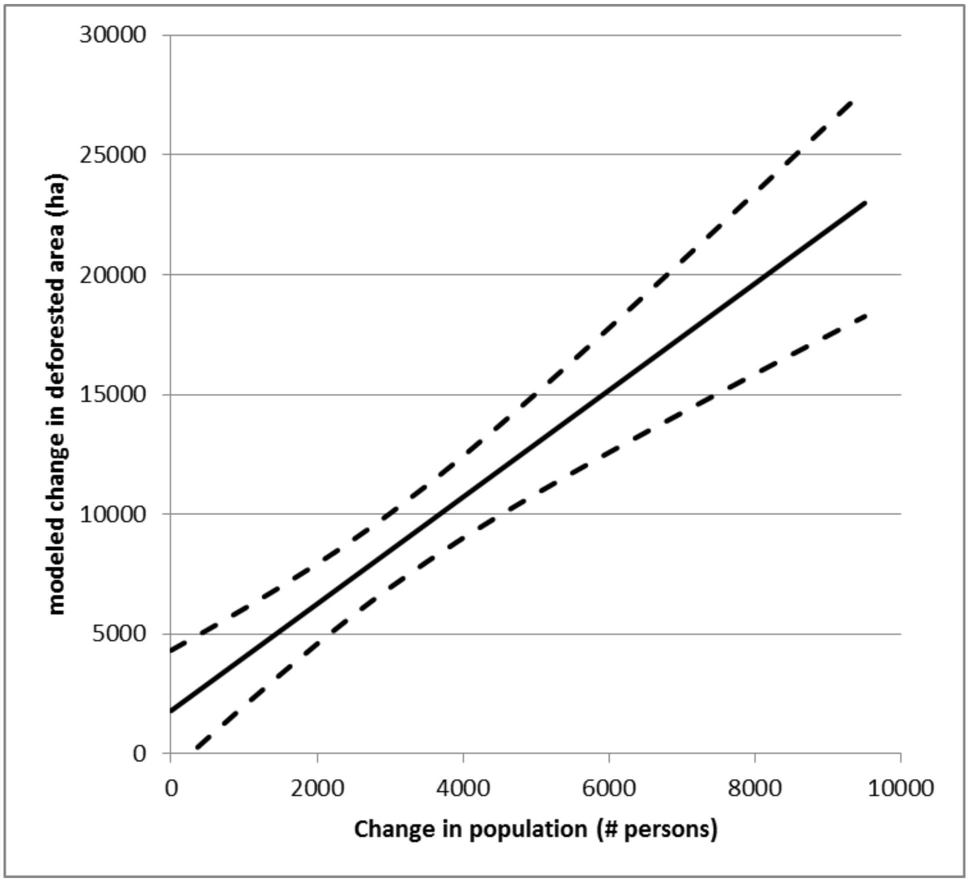
Note that error was not propagated across pools, because error propagation formulas require independence among component sources of error. This assumption often does not hold for aboveground biomass and dead wood, which are often inversely correlated (Figure 4.4.1), and instead pools are summed and composite errors estimated at the strata level, then propagated across strata.

Figure 4.4.1: Standing dead wood plotted against live tree biomass (n = 64, data from 2009 PNCAZ forest inventory), demonstrating apparent inverse correlation between live tree biomass and maximum standing dead wood.



Uncertainty in baseline deforestation projections was assessed referencing the 95% confidence interval of the regression model (Figure 4.4.2).

Figure 4.4.2:. 95% confidence interval (dashed lines) of predicted deforestation rate.



Only RRD subset 2 contributes to overall uncertainty. RRD subset 1, Huimbayoc, has a baseline rate of zero, thus its contribution to total uncertainty is zero. Calculations are detailed in Table 4.4.2 below.

Table 4.4.2. Summary of uncertainty calculations.

X-UNC eq #	5	Derived in PD Section 3	Regression model	1	3	6	10	11
year	$Uncertainty_{BSL,SS}$	total population change	modeled deforestation (ha)	$Uncertainty_{BSL,RATE,t}$	$Uncertainty_{BSL,RATE,t*}$	$Uncertainty_{BSL,t*}$	$C_{REDD\_ERROR,t*}$	*Adjustment factor applied to* $C_{REDD,t*}$
2009	7.5%	9733	23504	21%	21%	22%	22%	93%
2010	7.5%	11125	26610	22%	15%	17%	17%	98%
2011	7.5%	12754	30243	23%	13%	15%	15%	100%
2012	7.5%	14665	34506	24%	11%	14%	14%	100%

The final adjustment factor in Table 4.4.2 above is applied to parameter $C_{REDD,t}$, cumulative total net GHG emission reductions at time *t*, to produce parameter $Adjusted\_C_{REDD,t}$, cumulative total net GHG emission reductions at time *t* adjusted to account for uncertainty.

Summary of net emission reduction calculations

Estimates of GHG credits eligible for issuance as VCU's are found in the table below, where

Estimated GHG emission reduction credits =

Baseline emissions, fixed for 10 years at validation *minus*

Project emissions *minus*

Leakage *minus*

Non-permanence Risk Buffer withholding (calculated as a percent of net change in carbon stocks prior to deduction of leakage)

Years	Estimated baseline emissions or removals (tCO2e)	Estimated project emissions or removals (tCO2e)	Estimated leakage emissions (tCO2e)	Risk buffer (%)	Deductions for AFOLU pooled buffer account	Estimated net GHG emission reductions or removals VCU_t (tCO2e)*
Aug 8, 2008 – Aug 7, 2009	1,834,510	82,850	0	10%	175,166	1,576,494
Aug 8, 2009 – Aug 7, 2010	1,960,581	82,850	0	10%	187,773	1,689,958
Aug 8, 2010 – Aug 7, 2011	1,337,026	82,850	0	10%	125,418	1,128,758
Aug 8, 2011 – Aug 7, 2012	1,612,694	82,850	0	10%	152,984	1,376,860
Total Aug 8, 2008-Aug 7, 2012	6,744,812	331,400	0		641,341	5,772,071

* note that calculation of $VCU_{t,}$ number of Verified Carbon Units at time *t*, incorporates adjustments for uncertainty, per modules X-UNC and REDD-MF assessed against cumulative total net GHG emission reductions through each time *t* (to produce parameter $Adjusted\_\ C_{REDD,t}$), from which incremental $VCU_{t's}$ were calculated.

5. ADDITIONAL INFORMATION

Interpretation and classification of imagery

Landsat imagery
The Landsat program has provided the longest temporal archive of moderate resolution satellite imagery available, and as of 2008 USGS made all of this data freely available to all users. The combination of frequent data capture, moderate resolution (30m) and accessibility have made Landsat data the most widely used satellite platform for land cover change analysis.

On May 31, 2003 the Scan Line Corrector (SLC) in the ETM+ instrument failed on Landsat 7. The SLC consists of a pair of small mirrors that rotate about an axis in tandem with the motion of the main ETM+ scan mirror. The purpose of the SLC is to compensate for the forward motion (along-track) of the spacecraft so that the resulting scans are aligned parallel to each other. Without the effects of the SLC, the instrument images the Earth in a "zig-zag" fashion, resulting in some areas that are imaged twice and others that are not imaged at all. The net effect is that approximately one-fourth of the data in a Landsat 7 scene is missing when acquired without a functional SLC. Therefore all Landsat 7 imagery from post-2003 imagery was first has data gaps.

As a result the older platform, Landsat 5, was used more frequently. Landsat 5 had a critical instrument error in November 2011 which resulted in the suspension of all imagery acquisition. Since late 2011, the only available Landsat imagery is Landsat 7 sensor with the SLC-error. Therefor to conduct a monitoring event for 2012 required a modification of the original classification procedures to compensate for the scan line error which is detailed below.

Although this does not constitute a change in platform since Landsat platforms are cross-calibrated, it requires a change to the original classification procedure to overcome the data gap problems. As stated in the module M-MON , if the same remotely sensed spatial data source used in baseline development is no longer available (e.g. due to satellites or sensors going out of service) an alternate source may be used. The classification method selected to overcome this data gap is based on common good practice in the remote sensing field and is dependent on available resources.

To overcome the data gaps all available 2012 images from the reference region were combined through a post-classification concatenation procedure. For each Landsat path/ row in the reference region all images with useable (cloud free) data was obtained from USGS Glovis. Figure 5.1 shows the location of each scene and Table 5.1 shows the collection of images that were used in the final classification.

Figure 5.1: Landsat path/row location

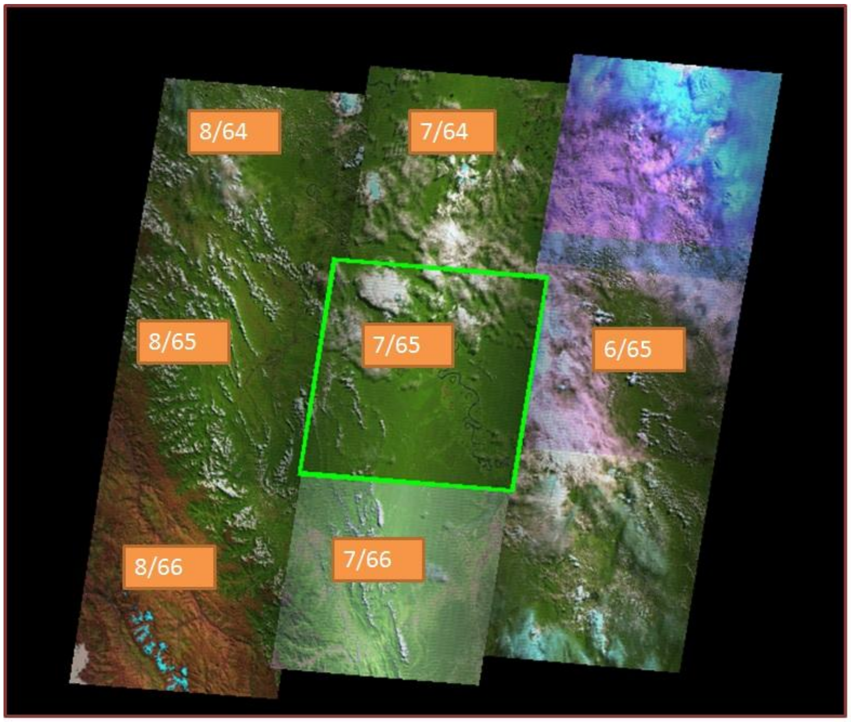


Table 5.1: Images that were used in the final classification

Path	Row	Date	Cloud cover
6	65	8/1/2012	41%
		6/14/2012	32%
		3/26/2012	11%
		1/22/2012	26%
6	66	8/1/2012	44%
7	64	8/8/2012	14%
		7/23/2012	2%
		6/21/2012	38%
		5/4/2012	43%
		4/2/2012	72%
7	65	8/8/2012	7%
		7/23/2012	23%
		6/21/202	4%
		5/4/2012	10%
		4/2/2012	42%
7	66	8/8/2012	14%
		7/23/2012	2%

		6/21/2012	38%
		5/4/2012	59%
		4/2/2012	25%
8	64	8/15/2012	54%
		7/30/2012	10%
		7/14/2012	31%
		6/12/2012	14%
		2/21/2012	13%
8	65	8/15/2012	45%
		7/30/2012	21%
		7/14/2012	15%
		6/12/2012	16%
		5/11/2012	26%
		2/12/2012	62%
8	66	7/14/2012	12%

Pre-processing
When using Lansat 7 ETM + data, imagery can be obtained from EROS (Earth Resource Observation Systems) with multiple pre-processing steps completed. These processing steps are summarized below and more detail information can be found from NASA http://landsathandbook.gsfc.nasa.gov/level/.

> The 1G product available to users is both radiometrically and geometrically corrected. The correction algorithms employed model the spacecraft and sensor using data generated by onboard computers during imaging events and ground control points and a digital elevation model are also used to improve the overall geometric fidelity. The geometric correction process utilizes both ground control points (GCP) and digital elevation models (DEM) to attain absolute geodetic accuracy. The WGS84 ellipsoid is employed as the Earth model for the Universal Transverse Mercator (UTM) coordinate transformation. Associated with the UTM projection is a unique set of projection parameters that flow from the USGS General Cartographic Transformation Package. The end result is a geometrically rectified product free from distortions related to the sensor (e.g. jitter, view angle effects), satellite (e.g. attitude deviations from nominal), and Earth (e.g. rotation, curvature, relief).

When using Level 1G processed imagery, geometric accuracy should be confirmed, but extra geo-referencing steps are unnecessary.

Processing
Each image was processed using a hard classification technique. Using an unsupervised clustering technique all useable data were identified. Through this process, pixels are grouped according to their spectral similarities and are then identified to land cover classes. Therefor pixels with no data due to scan line errors can be removed, as well as areas that are not usable due to cloud coverage or cloud shadow. For each image, the remaining data is processed to identify all forest and non-forest clusters. Using known areas of forest, these cluster groups are identified and clumped. The same process is conducted for non-forest clusters. Since the non-forest category also includes categories that can be difficult to separate, such as agroforestry, secondary forests, swamps and mountain areas that have illumination variability, a secondary classification step was used in cases when forest and non-forest could not be distinguished. Clusters for all classes that included potential confusion and seperability challenges were isolated. These areas were processed again through a secondary cluster analysis focused only on these categories, and resulted in further dividing confusion classes. Through careful inspection of these new finely distinguished clusters, areas of non-forest were distinguished. This

secondary classification was done for the best image available for each area (path/row). All areas that were identified as non-forest through this process (agriculture & re-growth) were then aggregated. In a final processing step all forest and non-forest groups from each image are then combined.

Post- processing
After all areas of usable 2012 data were distinguished into forest and non-forest, a mode filtering procedure was used to align the classification as closely as possible with the Peruvian DNA forest definition. A 3 pixel by 3 pixel filter was used which increases the minimum mapping unit to 0.81 ha. (90m by 90m). Then previous classification work from 2010 was used to improve classification of non-forest were incorporated.

The result of this classification procedure is shown in figure 5.2. 93% of the reference region is classified with only 7% remaining with no data due to cloud coverage or scan-line errors (Table 5.2).

Figure 5.2: 2012 Classification for full reference region

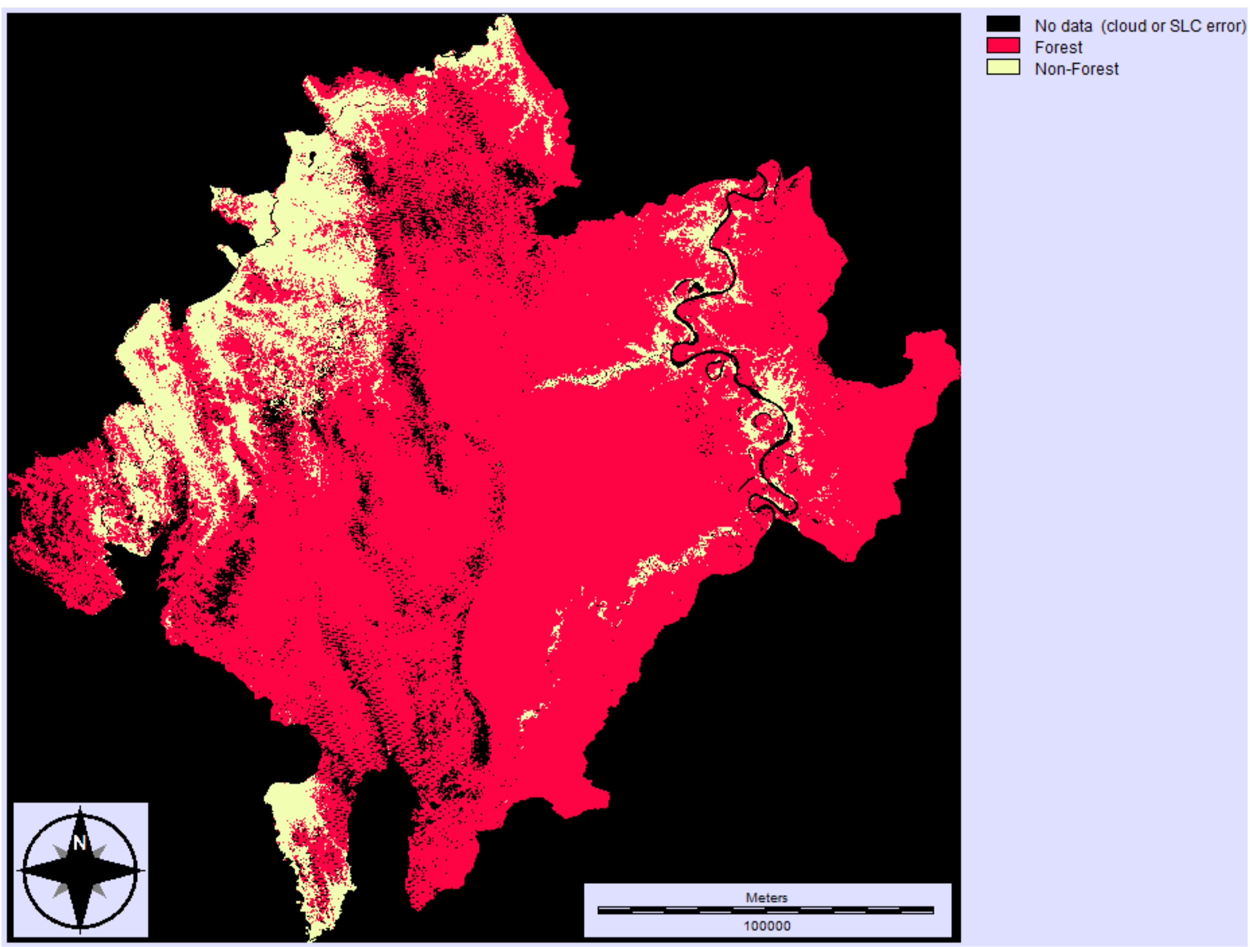


Table 5.2: Classification area

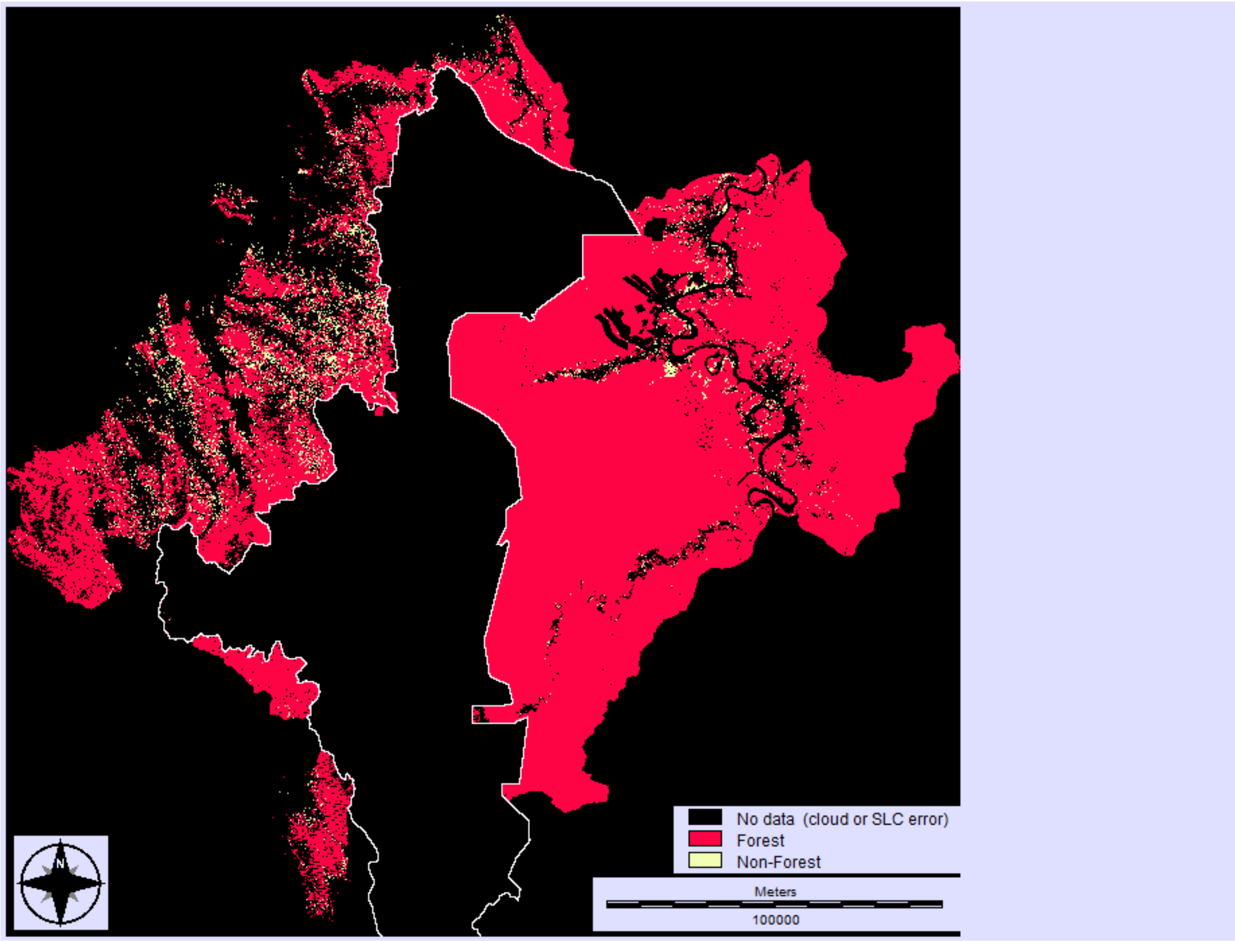
Forest	2,827,984.32
Non-Forest	524,089.53
Total area classified	3,352,073.85
	92.92%
total area of RR	3,607,419.24

Analysis of the total cloud cover in the year 2008 and 2012 show that less than 10% of the region is obscured by clouds for both years combined (Table 5.3).

Table 5.3: Cloud obscured total area

CLOUD COVER ANALYSIS		ha	% of area
Clouded in 2008		16966.26	0.47%
	Area that is clouded in 2008 & 2012	*8628.12*	
	Area this is only clouded in 2008	*8338.14*	
Area of missing data (cloud SLC error) in 2012		255313.71	
Cloud cover total for both dates		263651.85	7.31%

Figure 5.3: 2012 Land cover map for Leakage belt. Previous deforestation and exclusions are masked



Quality Assurance/Quality Control

To ensure consistency and quality results, all data sources and analytical procedures are documented and archived (detailed under data archiving above).

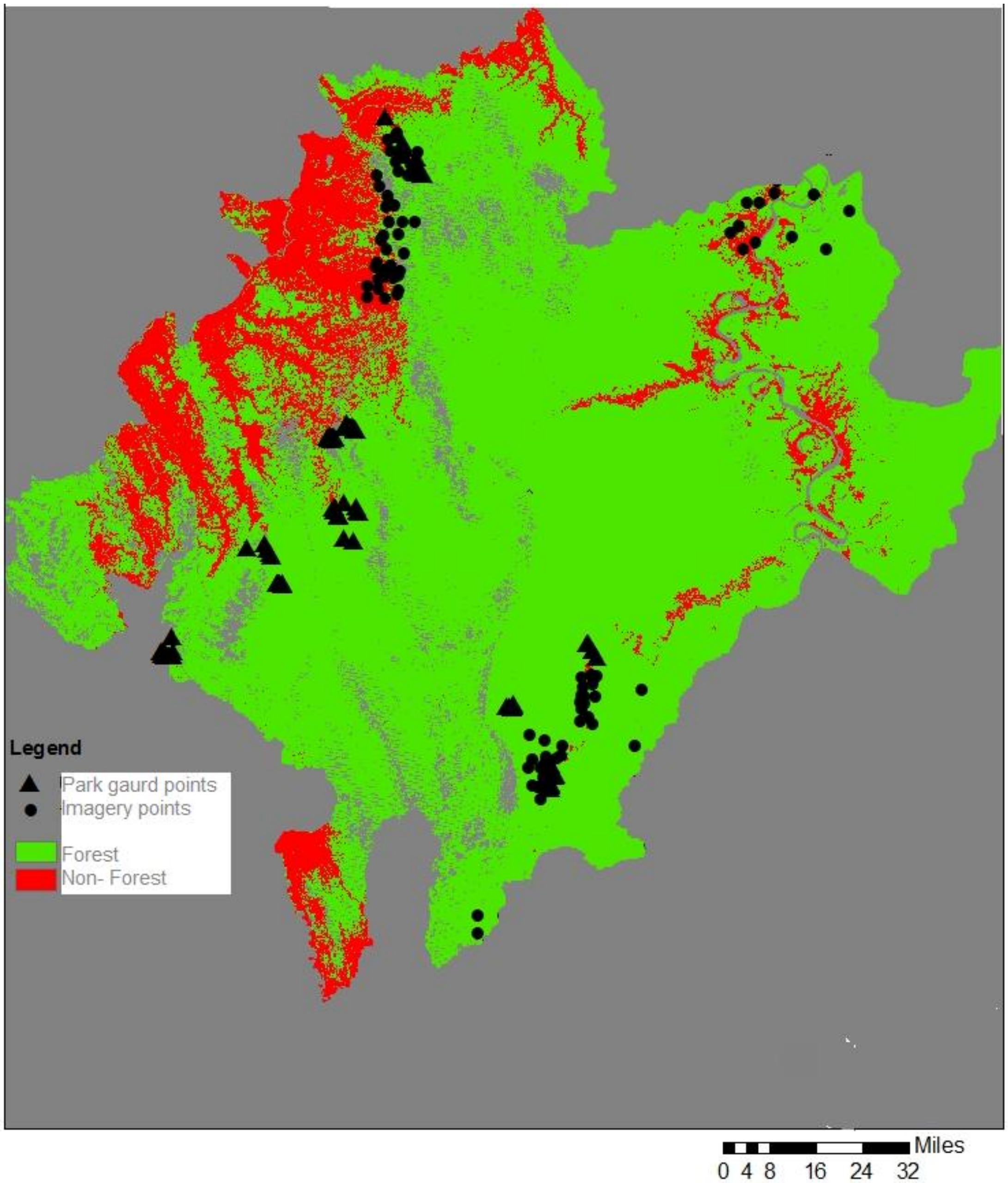
Accuracy of the classification was assessed by comparing the classification with ground truth points and samples of high resolution imagery (Quickbird imagery 5m resolution available on Bing maps). All data collected from ground-truth points are recorded (including GPS coordinates and identified land-use class) and archived. Any sample points of high resolution imagery used to assess classification accuracy are also archived. Samples used to assess classification accuracy are well-distributed throughout the project area (as far as is possible considering availability of high resolution imagery and/or logistics of acquiring ground truth data), with a minimum sampling intensity of 50 points each for the forest and non-forest classes. Distribution of all points is shown in figure 5.4.

Overall classification accuracy was 94.97%. Results of the accuracy assessment are in table 5.4.

Table 5.4 Classification accuracy assessment 2012

Land-use class as determined from ground-truth points	Classification		Total	Accuracy (%) *User's accuracy* *(# correct/ row total)*	Error of Commission (%)
	Forest	Non-forest			
Forest 140	131	9	140	93.57%	6.43%
Non-forest 59	1	58	59	98.31%	1.69%
Total	132	67	199		
Accuracy (%) ***Producer's accuracy*** ***(# correct/ column total)***	99.24%	86.57%		**Overall classification accuracy (correct/ total points)**	
Error of Omission (%)	0.76%	13.43%		94.97%	

Figure 5.4: Accuracy assessment points



New benchmark maps were created for 2012 for the project area (Figure 5.6) and leakage belt (Figure 5.7).

Figure 5.6: *Project Forest Cover Benchmark Map 2012*

Figure 5.7: *Leakage Belt Forest Cover Monitoring Map 2012*