MANOA+ PROJECT

MONITORING REPORT OF GHG EMISSION REDUCTIONS FROM AVOIDING UNPLANNED DEFORESTATION IN

2013, 2014, 2015 AND 2016

Document Prepared By:

Biofílica Investimentos Ambientais S.A.

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1 PROJECT DETAILS

1.1 Summary Description of Project

Manoa REDD+ Project is a partnership between Biofílica and Grupo Triângulo, located at Manoa Farm, city of Cujubim, state of Rondônia, in an area of 74.038,7 hectares. Throughout its almost 30 years of history, Manoa has improved its management techniques, becoming a model of worldwide reference of forest exploration ally to with the conservation of nature.

The farm`s 73,000 hectares of forest demonstrates the pioneering in sustainable forest management, and are one of the few forest areas remaining in private area in the region, constantly threatened by invasions and timber theft. Manoa is of paramount importance in the landscape connectivity, as it is close to conservation units and provides shelter for several species.

Manoa Project will carry on the following actions to reduce deforestation and consequently reduce emissions:

- Forest protection and monitoring: remote monitoring and in local surveillance, along with the best sustainable forest management practices;
- Scientific research: monitoring of forest management impacts, follow-up and study of identified and/or endemic species, partnerships with educational and research institutions for the production and dissemination of knowledge;
- Local socioeconomic development: through its own training center, CEFLOM, the project provides trainings and capacitation in techniques aimed at encouraging sustainable development practices such as responsible forest management, agroforestry systems, low carbon agriculture, among others;
- Social empowerment: Strengthening and technical assistance for local producers' associations and environmental education interventions for the surrounding rural population and the municipality of Cujubim, aiming to strengthen small farmers, together with awareness of environmental issues, and consequent improvement in the quality of life of these people.

Climate Benefits:

Avoid the emission of 279.290 tons of CO2e per year or 8.378.697 tons of CO2e along 30 years of project. This corresponds to 22.118 hectares of avoided deforestation.

Community Benefits:

The main objectives of the project for the community include the training of local stakeholders on issues related to sustainable economic development and the valorization of forest resources; Support to the development of associations of small local rural producers aiming at the social empowerment of these

actors; And to members of neighboring associations of the project area and the young and university public of the state of Rondônia. These actions aim at improving the quality of life of this population, social empowerment, the strengthening of small farmers and the dissemination of practices of sustainable development in the region.

In the labor aspect of the property, it is expected the dissemination of knowledge about labor rights and rules to its employees and collaborators, environmental education workshops and the support in the training of skilled labor to operate in the supply chain of certified forest management and non-wood forest management.

Biodiversity Benefits:

Maintenance of forest coverage, preventing deforestation of approximately 12,000 hectares along 30 years of project. Conservation of 177 of flora and more than 360 fauna identified species. Out of these species, 12 are mammals and 9 are birds in some type of threat, according to IUCN. Maintenance of "ecological corridors" with Conservation Units of the state of Rondônia, reducing negative impacts of the region degradation.

Relevant Implementation Dates:

- Started in July 2013 continuously throughout the Project: political and stakeholder articulation;
- Started in 2014 and to continue throughout the Project lifetime: project's budget follows up;
- Annually since January 2013: Monitoring of deforestation and carbon emissions.
- First half of 2014: Survey and identification of local partners such as consultants, researchers and institutions to develop the project;
- July 2014: Inauguration event of CEFLOM with the 1stWorkshop of the REDD+ Project;
- Second half of 2014: Technical field studies and Environmental Assessment (Socioeconomic, Biodiversity, and Baseline);
- March, 2015: Carbon Stock estimation survey;
- March 2016: Preparation of the Project description document;

Total GHG emission reductions :

The total GHG emissions reductions generated in this monitoring period (01-January-2013 to 30-December-2016) are 541,077 tCO_2e.

1.2 Sectorial Scope and Project Type

Project Scope 14: Agriculture, Forest and other Land Use (AFOLU)

Project Category: Reduction Emission from Deforestation and Degradation

Type of Activity: Avoided Unplanned Deforestation (AUD)

Grouped Project: No

1.3 Project Proponents

Table 1 Identification and responsibility of Manoa REDD+ Project Proponents

ORGANIZATION	DESCRIPTION
Biofílica Investimentos Ambientais S.A (primarily responsible for the design and implementation of the project).	Biofílica Investimentos Ambientais is a Brazilian company that promotes the management of forest areas in the Amazon biome. The company was founded in 2008, striving to create pioneering alternatives and turn environmental conservation into an economically interesting activity for forest owners, communities, and investors. Biofílica's mission is to reduce deforestation and carbon emissions into the atmosphere, conserve biodiversity and water resources, and promote social inclusion and the development of communities that live in the Amazon biome. This mission is achieved by commercializing environmental services credits, by fostering and financing scientific research activities, and by developing sustainable business chains. **Responsibilities in the Project:** overall coordination of the socioeconomic and environmental diagnosis (DSEA), baseline studies and carbon stock; development and financing of PDD (Project Design Document); Remote monitoring of forest cover and implementation / coordination of additional actions aimed at reducing / mitigating greenhouse gas emissions (GHG); validation/verification and sale of credits; project co-management throughout its duration. **Contact Information** Plínio Ribeiro **Phone:** +55 (11) 3073-0430 **Email:** plinio@biofilica.com.br **Website:** www.biofilica.com.br

Triângulo Pisos e Paineis Ltda	Triângulo Pisos e Paineis is the owner of Manoa Farm, in the city of Cujubim, state of Rondônia, property in which Manoa REED+ Project is installed. Dedicated to wood industrialization since 1972, it strives to the responsible timber production, continuous product development, and forest protection with social responsibility. The company invests in the conservation of its native forests through responsible management. Project Responsibilities: Triângulo Pisos e Paineis Ltda. owns the land where the project will be implemented. Co-management and control of project activities. Contact Information: Douglas Granemman de Souza Phone: +55 (41) 2106-5113 Email: triangulo@triangulo.com.br Website: www.triangulo.com.br

1.4 Other Entities Involved in the Project

Table 2 Identification and responsibility of other entities involved in Manoa REDD+ Project.

ORGANIZATION	DESCRIPTION
Casa da Floresta Assessoria Ambiental Ltda.	Casa da Floresta Assessoria Ambiental is a company specialized in biodiversity and sustainability research. Casa da Floresta holds 15 years of experience in environmental consulting area, and is nationally recognized for conducting high level work, always meeting the needs of its clients, without forgetting its mission and maintaining the quality of its products and services. The company's team is dynamic and of innovative character, composed of forest engineers, agronomists, biologists, ecologists, geographers, and social workers that integrate a skilled team of researchers and specialists able to conduct activities and environmental assessments in the different biomes and terrestrial and water ecosystems in Brazil; thus, combining scientific knowledge with its clients' needs. **Responsibilities in the Project**: Development of characterization studies on the physical environment and biodiversity assessment of Manoa REDD+ Project area. **Contact Information:** Eng. Florestal Me. Klaus D. Barretto - Forest Engineer - Master's Degree Agrônoma Ma. Mônica C. de Brito - Agronomist Engineer - Master´s Degree **Phone:** +55 (19) 3433-7422 **Email: Elson Fernandes de Lima <elson@casadafloresta.com.br>** **Website:** www.casadafloresta.com.br **Technical skills:** Casa da Floresta holds borad experience in the development of

	flora and fauna monitoring programs, especially for compliance with farming and forest certification requirements, including Standard FSC® (Forest Stewardship Council - ProForest) and Standard RAS (Red de Agriculture Sostenible - Rainforest Alliance), which are two of the most demanding and well-established standards in these sectors. Based on great demand for certifications, emerged from initiatives such as REDD+ and technical standards for food safety and sustainability, its activities have also been used for other types of certifications, such as ISCC (International Sustainability & Carbon Certification).
Ecoporé - Guaporé Ecological Action	Ecoporé-Guaporé Ecological Action is an environmental non-profit association. Founded in June 1988 to legitimize its actions, which were developed against predatory timber exploitation, to fight illegal deforestation and invasion of Conservation Units. The association has executed projects aimed at environmental conservation and sustainability, in partnership with governmental and non-governmental institutions and traditional populations. **Responsibilities in the Project:** Development of Socioeconomic and Environmental Diagnostic in Manoa REDD + Project Region. Contact Information: Marcelo Ferronato Phone: +55 (69) 3224-7870 **E-mail**: ecopore@ecopore.org.br Website: www.ecopore.org.br
Florestal - Planejamento, Paisagismo e Consultoria Ltda	It was founded in 1986 in the Ariquemes, state of Rondônia. With 28 years of experience in the forestry industry in Rondônia, the entity is dedicated to the management and use of forest resources. In addition to conducting forest inventory activities and preparing Sustainable forest management plan and the Annual Operational Plan (PMFS)/ POA), the entity is also responsible for technical support during exploration activities of its clients´ management projects, carrying out refreshing courses in Reduced Impact Exploration and Training in Safety at Work . **Responsibilities in the Project:** Development of Manoa REED+ Project Forest Carbon Stock Estimate study. Contact Information: Eng. Fltal. Márcio José Lovatti - Forest Engineer Phone: +55 (69) 3535-4501 **E-mail:** florestal@florestalro.com.br Website: www.florestalro.com.br

HDOM Engenharia e Projetos Ambientais Ltda.	Founded in 2009 in the city of Manaus, state of Amazonas, Hdom Consultoria Ambiental is a dynamic and multidisciplinary consulting company specialized in providing a set of solutions in environmental education, biodiversity, and forestry. The company provides services throughout Brazil and abroad, always looking for support, developing with the client. **Responsibilities in the Project:** Manoa REED+ Project Baseline Development Contact Information: Mateus Bonadiman, M.Sc. Phone: +55 (92) 98128-3936 **E-mail**: mateus.bonadiman@hdom.com.br Website: www.hdom.com.br

1.5 Project Start Date

The Manoa REDD+ Project starting date is January 1st, 2013, the justification elaborated for the definition of the project start date is contained in the project description document.

1.6 Project Crediting Period

The crediting period is January 1st, 2013. The finish date will take place on December 31, 2042, completing the 30-year period.

1.7 Project Location

Manoa REDD+ Project is located at Manoa Farm, which territory covers an area of 73,038,7 hectares in the cities of Cujubim, Itapoã do Oeste, and Porto Velho, state of Rondônia state (**Erro! Fonte de referência não encontrada.**), Northern Brazil. The vertices of Manoa Farm are found in Table 1.

The access to the area is made through BR-364 highway, Porto Velho-Ariquemes, covering about 140 km up to RO-205 highway, which connects the city of Cujubim through 50 km of dirt road.

The project zone is defined as the "region that encompasses the project area, in which the activities that directly affect the land and associated resources, including activities related to provision of subsistence alternatives and community development, are implemented" (CCBA), comprising the area of Manoa Farm, totaling 74.038,7 hectares.

Table 3 Geographic coordinates of Manoa Farm vertices.

Vetex	X coordinate	Y coordinate
V 01	62°31'59,243"W	8°59'45,312"S
V 02	62°51'4,501"W	9°0'0,117"S
V 03	62°51'4,595"W	8°56'10,852"S
V 04	62°50'5,834"W	8°54'38,506"S
V 05	62°48'19,203"W	8°50'26,109"S
V 06	62°47'35,825"W	8°52'15,333"S
V 07	62°45'50,68"W	8°50'41,41"S
V 08	62°47'12,746"W	8°48'33,748"S
V 09	62°43'58,219"W	8°39'39,696"S
V 10	62°40'38,687"W	8°40'54,938"S

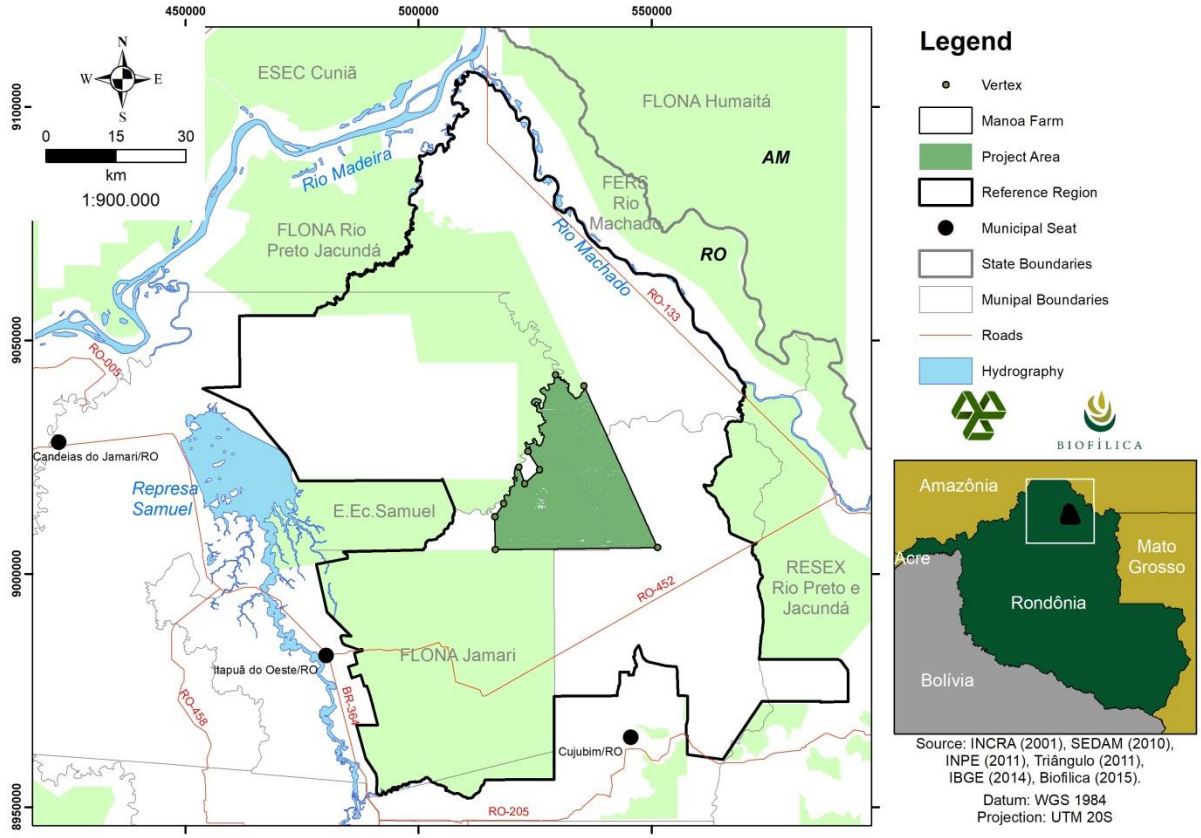

Figure 1. Manoa REDD+ project area location

1.8 Title and Reference of Methodology

Approved VCS Methodology VM0015 for Avoided Unplanned Deforestation, version 1.1.

1.9 Other Programs

REDD+ Manoa Project does not hold or wishes to generate any kind of environmental credit related to GHG emissions reduction or removals claimed within the VCS Program.

2 IMPLEMENTATION STATUS

2.1 Implementation Status of the Project Activity

The REDD+ activities are related to the greenhouse gas emission reduction by containing unplanned and illegal deforestation and social inclusion and local socioeconomic development (REDD+).

Below are described the activities that were performed during the Project's first period of verification (01 January 2013 – 31 December 2016).

REDD+ activities are under responsibility of Biofílica Investimentos Ambientais, Triângulo Pisos e Painéis Ltda, and started in 2013, with the first viability studies and the signing of the contract between Biofílica and Triângulo. The activities have been developed simultaneously, since the process of conception of the Project until the credit verification, and will be continued for all the Project's duration, through studies planning and execution, and prospection of buyers for Project's credits, ensuring the continuation of the Project. The activities of the REDD+ component implemented during the first monitoring period are shown in Table 4.

Table 4 Summary of the Manoa REDD+ Project main activities in the REDD+ activities component in this monitoring period.

Activity	Description	Status, applicable procedure and additional information regarding recording format
Planning Activities		
Survey of institutions and identification of partnerships	Survey and identification of local partners such as consultants, researchers and institutions to develop the project.	Concluded in 2014. See documents: Workshop I and Workshop II, Projeto REDD+ Manoa *Jul.2014-Nov.2014*.
Technical studies		
Socioeconomic and Environmental Diagnostic	Study developed together with the Ação Ecológica Guaporé-Ecoporé. The objective of the study was to characterize the project and surrounding areas in the socioeconomic context and to conduct a preliminary assessment of possible impacts of the project on local social-economic and environmental context, as well as suggest forward actions and monitoring measures for the project in this scope.	Concluded in February 2015. See document: *Relatório Diagnóstico Socioeconômico e Ambiental da região do Projeto REDD+ Fazenda Manoa – Cujubim*
Biodiversity and physical Assessment	Two studies developed together with Casa da Floresta Assessoria Ambiental. The objective of the first study was to identify and characterize the vertebrate flora and fauna of the region delimited as a Project Zone and assess the risks	Concluded in March 2015 See documents: *Avaliação da Biodiversidade - Projeto REDD+ Manoa and*

Activity	Description	Status, applicable procedure and additional information regarding recording format
	of impacts associated with biodiversity for the region which covers the REDD + Manoa Project, in addition to proposing a monitoring plan to generate guidelines for conservation. The objective of the second study was to characterize the physical aspects of the Manoa Farm and the Reference Region of the REDD + Manoa project, as well as a preliminary assessment of the risks of occurrence of impacts from anthropic activities and natural disasters that may affect forest cover and carbon stock.	*Caracterização do Meio Físico – Projeto REDD+ Manoa.*
Carbon stock estimate	Study developed in partnership with Florestal – Planejamento, Paisagismo e Consultoria Ltda. aiming to estimate the carbon stock contained in the different forest strata defined in Manoa Farm, through data collected in a sample forest inventory..	Concluded in March 2015. See document: *Estimativa do estoque de carbono florestal do projeto REDD+ na fazenda Manoa*
Determination of the baseline and the carbon credits generation potential	It was also developed in partnership with HDOM – Engenharia e Projetos Ambientais Ltda aiming to determine the project baseline and estimate the amount of REDD credits to be potentially generated by the project.	Concluded in February 2015. See document: *BASELINE_MANOA_2017_final*
Management and conception design activities		
Two workshops carried out with the partners and local consultants aiming to build the REDD+ Project approach.	Presentation of initial project design and alignment of expectations among stakeholders	Concluded in 2014. See documents: Workshop I and Workshop II, Projeto REDD+ Manoa *Jul.2014-Nov.2014*.
Articulation with partners to define project line action and proposed activities	Several meetings between project proponents, aiming to discuss the project planning and schedule.	Continuously throughout the Project lifetime. See documents: *Memoria Reuniões* and *Apresentação Proponentes*
Preparation of the Project description document	Detailed project description, with used methodology, proposed activities and impacts, and estimates avoided GHG emissions.	Concluded in August, 2016. See VCS Project Description: Manoa REDD+ Project

Activity	Description	Status, applicable procedure and additional information regarding recording format
Project's Financial Management		
Prospection of potential buyers of the Project's VCUs	In order to ensure the Project's longevity, Biofílica Investimentos Ambientais continuously searches for potential buyers of the VCUs to be generated by the Project. Such activities consist in participating in related events, relationship with potential buyers and sales representative.	Started in 2014 and to be continued throughout the Project duration. See document *Ata de Reunião de Conselho and Biofilica's folder*
Project's budget follow up	Income and expenses spreadsheet	Started in 2012 and to be continued throughout the Project lifetime. See document *Relatorio de Despesas Projeto REDD+ Resex Rio Preto Jacundá – Período de Monitoramento Oct. 2012-Oct.2015.*
Activities to prevent unplanned deforestation and monitoring of the forest cover		
Differentiated strategies in the forest management	Exploitation of forest management in remote areas like the north of the farm, and in other areas of greater risk.	From 2012 until 2015
Implementation of permanent surveillance	Restoration of houses of surveillance in strategic points of the area and placement of permanent vigilantes.	First quarter 2013. Continuously throughout the Project lifetime.
First interventions with local actors in the training center - CEFLOM	Training in certified forest management and environmental education	Started in 2015 and continuous throughout the project lifetime.
Monitoring of deforestation and emissions	Monitoring of deforestation ex post dynamics was monitored through satellite images, GIS analysis and annual deforestation reports.	Completed for 2013, 2014, 2015 and 2016. Continuously throughout the Project. See: *Boletim de Monitoramento Manoa 2013-16.*
Blockade of access roads in remote areas	Access roads in north of the farm were blocked after the logging activity to curb the entrance of invaders.	First half of 2015

Analysis of land-use and land cover change during the monitoring period

The analysis of land-use and land cover change during the monitoring period was carried out following the procedures described on the item 4.5 of the Project Description, though PRODES data. The

main activities carried out by the PRODES Project to monitor the Brazilian Amazon forest cover are presented hereafter.

Pre-processing

Images pre-processing procedures carried out by PRODES consist of the following steps (Câmara et al, 2006):

- Selection of images with less cloud coverage, shooting date closer to Amazon dry season and adequate radiometric quality;
- Georeferencing of the images with spatial resolution of 30 meters with topographic charts in a 1:100,000 scale and NASA images in MrSID orthorectified format.

Interpretation and classification

The satellite images classification method used by PRODES follows four main steps. The first is the generation of a spectral mixture model in which vegetation, soil and shadow components are identified; this technique is known as spectral linear mixture model and aims to estimate the percentage of vegetation, soil and shadow component for each pixel of the image. The second step is the application of the segmentation technique which identifies in the satellite image the spatially adjacent regions (segments) with similar spectral characteristics; after segmentation there is the individual classification of the segments to identify forest classes, non-forest vegetation and deforestation (anthropic vegetation). Finally, the classified segmentation result is submitted to an editing process, or classification audit, carried out by a specialist and finalizing with the creation of state mosaics.

Map accuracy assessment

PRODES mapping evaluation was carried out by comparison of each of the classes of the land-use and land-cover map (2013, 2014, 2015 and 2016) with a set of 100 points randomly distributed over the monitored area (Project Area and Leakage Belt). Reference data used come from the point obtained by visual interpretation of images from the sensor RapidEye with 5 meters of spatial resolution from July 2015, and with support from Google Earth imagens. The Figure 2 demonstrates the methodology adopted to carry out the accuracy assessment of the PRODES mapping

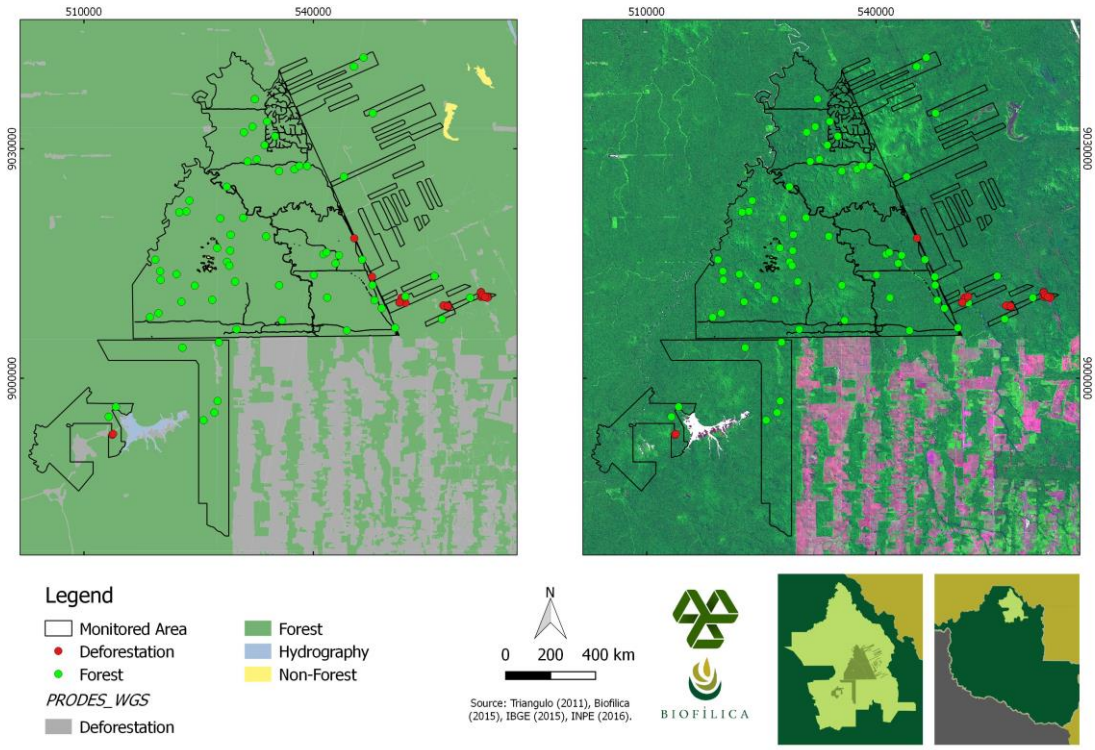

Figure 2 Map accuracy assessment

Having the reference points and the land-use and land-cover map of the monitoring period, it was possible to evaluate the performance of the monitoring process by analyzing the confusion matrix (Table 5) as per Congalton (1999). The overall accuracy of the monitoring process for the land-use classes at the monitored area presented values above 80%.

Table 5 Confusion matrix of the monitoring period

		Reference			
Classified		Forest	Deforestation	Total	User Acuracy %
	Forest	63	1	64	98%
	Deforestation	2	34	36	94%
	Total	65	35	100	

The confusion matrix was made based on a stratified random allocation of points with the aim to sample all the land use land change classes. A total of 100 points were used in the accuracy assessment, which is more the suggested in the Project Description, being 64 points randomly distributed in the Forest class and 36 poins randomly distributed in the Deforestation class.

Monitoring of leakage and management of non-permanence risk factors

The monitoring of leakage was realized through satellite images, allowing the mapping of the forest cover in the Leakage Belt, as described in section 4.3 of this document.

Regarding the non-permanence risk factors, the main risks are related to the Internal Risks, and they have been monitored as follows:

- Follow up of the project budget together with the continuous evaluation of the activities carried out with the purpose of guaranteeing the effectiveness and correct direction of the investments.
- Strengthening of communication among stakeholders in order to maintain the appropriate approach in the activities and to allow the reassessment of certain actions when necessary.
- Adequate registration of the activities carried out and improvement of the communication material aiming to guarantee a wide reach of the actions and benefits provided by the Project.

2.2 Deviations

2.2.1 Methodology Deviations

Not applicable.

2.2.2 Project Description Deviations

Not applicable.

2.3 Grouped Project

Not applicable.

3 DATA AND PARAMETERS

3.1 Data and Parameters Available at Validation

Data Unit / Parameter:	**Deforestation**
Data unit:	Hectare (ha)
Description:	Maps of forest coverage areas converted into non-forest areas.
Source of data:	Measured though data from PRODES/INPE project.
Value applied:	0,79%/year on average (2000-2012).
Purpose of the data:	For deforestation mapping and production of the Forest Cover Benchmark Map data from PRODES Digital (official Brazilian Amazon Forest deforestation satellite mapping) program were used. A total of 48 Landsat images were used during the analyzed period. The ISOSEG non-supervised classification method was used in the classification of the images to map forest classes, non-forest vegetation, hydrography and deforestation. • Determination of baseline scenario • Calculation of leakage
Any comment:	See documents: • *Câmara et al. 2006. Metodologia para o cálculo da taxa anual de desmatamento na Amazônia Legal* • *Determinação da Linha de Base e Dinâmica de Desmatamento para o projeto Manoa.*

Data Unit / Parameter:	**Ctot**
Data unit:	$tCO_2e\ ha^{-1}$
Description:	Average carbon stock per hectare in all carbon pools in the forest class used in the baseline scenario.
Source of data:	Calculated by allometric equations, expansion factors from literature and field measured data.
Value applied:	513 $tCO_2e\ ha^{-1}$
Purpose of the data:	• Calculation of baseline emissions • Calculation of project emissions

Any comment:	Above and under-ground biomass estimate was carried out using forest inventory data, allometric equations developed in areas similar to the project area (Nogueira, 2008 and Silva, 2007).

Data Unit / Parameter:	**DBH**
Data unit:	cm
Description:	Diameter at Breast Height (130 cm) for each tree with DBH equal or higher than 10 cm in each plot of the forest inventory.
Source of data:	Measured in the field by Hdom Engenharia e Projetos Ambientais Ltda.
Value applied:	See field measurements spreadsheet.
Purpose of the data:	• Calculation of baseline emissions • Calculation of project emissions
Any comment:	Manoa REDD+ Project's main variable for carbon stock estimate. VCS Methodology VM0015 requirement. Data from forest inventory collected less than 10 years ago from multiple plots at wide spatial distribution.

Data Unit / Parameter:	**BGB_{fw} = 0,0469xDAP^{2,4754}xfc_1** $\boldsymbol{AGB_{fw} = EXP(-1,716 + 2,413 x ln(DAP))}$
Data unit:	kg (biomass fresh weight)
Description:	Equation to convert DBH into biomass for trees with DBH equal to or higher than 10 cm.
Source of data:	1. Silva, 2007 2. Nogueira, 2008
Value applied:	BGB_{fw} = 0,0469xDAP^{2,4754}xfc_1 $AGB_{fw} = EXP(-1,716 + 2,413 x ln(DAP))$
Purpose of the data:	• Calculation of baseline emissions • Calculation of project emissions
Any comment:	Equation developed for forest with characteristics similar to the forests in the reference region.
Data Unit / Parameter:	**CF**
Data unit:	t
Description:	Carbon content in dry biomass

Source of data:	Nogueira, E.; Fearnside, P.; Nelson, B., et al., 2008. Estimates of forest biomass in the Brazilian Amazon: New allometric equations and adjustments to biomass from wood-volume inventories. Forest Ecology and Management, 256 (11), pp.1853-1867
Value applied:	0.485
Purpose of the data:	• Calculation of baseline emissions • Calculation of project emissions
Any comment:	Value found in scientific literature.

Data Unit / Parameter:	**44/12**
Data unit:	tCO_2e
Description:	Carbon mass to CO2e mass conversion factor.
Source of data:	From scientific literature: 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 AFOLU.
Value applied:	44/12
Purpose of the data:	• Calculation of baseline emissions • Calculation of project emissions
Any comment:	IPCC standard value

Data Unit / Parameter:	**Open area for management infrastructure**
Data unit:	Percent
Description:	Open area necessary for the forest management, like patios and roads.
Source of data:	Post exploratory report
Value applied:	1,6%
Purpose of the data:	Calculation of project emissions
Any comment:	Ex-post value validated with the support of post-exploratory reports provided by the Forest Management team.

3.2 Data and Parameters Monitored

Data Unit / Parameter:	**Deforestation in the Project area and Leakage Belt**
Data unit:	Hectare (ha)
Description:	Forest coverage areas converted into non-forest areas inside the Manoa REDD+ Project area and leakage belt.
Source of data:	PRODES Project - Monitoring of the Brazilian Amazonian Forest by Satellite (INPE, 2016).
Description of measurement methods and procedures to be applied:	Monitoring of the forest cover in the monitored area was accomplished by overlaying PRODES vector data on the boundary of the REDD+ Manoa Project Area and the respective Leakage Belt. The polygons mapped as deforestation in the years of 2013 to 2016 were selected for quantification of the deforested area and subsequent field verification activities.
Frequency of monitoring/recording:	Annual
Value monitored:	Deforestation area identified within the Project Area (PA) and Leakage Belt (LK) for: 2015: 85,5 ha (LK) and 95,8 ha (LK);
Monitoring equipment:	Geographic information systems, digital processing program, and navigation GPS.
QA/QC procedures to be applied:	The minimum mapping unit is 1 ha. Cloud areas were visually analyzed with images collected by satellite Landsat 8 and provided by INPE or USGS, with spatial resolution of 30 m (2016/07/27; 2016/07/18). The accuracy assessment was performed by using RapidEye images, with spatial resolution of 5 m and with support from Google Earth images. The LU/LC assessment was higher than 80%.
Purpose of the data:	• Calculation of baseline emissions • Calculation of project emissions • Calculation of leakage
Calculation method:	Shapefile of areas detected as unplanned deforestation was used for updating the Shapefile of Forest Cover Benchmark Map by map algebra operations.

Any comment:	PRODES Digital project: http://www.dpi.inpe.br/prodesdigital/prodes.php Further information on QA/QC available in: • *Câmara et al. 2006. Metodologia para o cálculo da taxa anual de desmatamento na Amazônia Legal*

Data Unit / Parameter:	**Ctot**
Data unit:	$tCO_2e\ ha^{-1}$
Description:	Average carbon stock per hectare in all carbon pools in the Forest class used at baseline scenario.
Source of data:	Calculated by allometric equations, expansion factors from scientific literature, and data measured in the field by Hdom Engenharia e Projetos Ambientais Ltda.
Description of measurement methods and procedures to be applied:	Above-ground biomass estimate was carried out using forest inventory data, allometric equations developed in areas similar to the project area (Silva, 2007 and Nogueira, 2008).
Frequency of monitoring/recording:	Data collected in the forest inventory periods of up to 10 years in multiple installments.
Value monitored:	N/A
Monitoring equipment:	N/A
QA/QC procedures to be applied:	Further information on QA/QC available in: "Plano de Monitoramento do Estoque de Carbono – Projeto REDD+ Fazenda Manoa".
Purpose of the data:	• Calculation of baseline emissions • Calculation of project emissions • Calculation of leakage
Calculation method:	Comparison between total carbon stock average value contained in forest class used in the baseline scenario, according to *Estimativa do Estoque de Carbono Florestal do Projeto REDD+ Manoa*
Any comment:	Methodology VM0015 mandatory requirement for areas with logging. In this monitoring period not had carbon stock change due to planned logging activities in the project area.
Data Unit / Parameter:	**DBH**

Data unit:	cm
Description:	Diameter at Breast Height (130 cm) for each tree with DBH equal or higher than 10cm in each plot of the forest inventory.
Source of data:	Calculated from the circumference at breast height measured in the field by Florestal – Planejamento, Paisagismo e Consultoria Ltda.
Description of measurement methods and procedures to be applied:	DBH is calculated from the circumference at breast height (CBH) data of each monitored tree measured in the field.
Frequency of monitoring/recording:	Data collected in the forest inventory periods of up to 10 years in multiple installments.
Value monitored:	See field measurements spreadsheet.
Monitoring equipment:	Calculated from the circumference at breast height data measured in the field using a measuring tape.
QA/QC procedures to be applied:	Mandatory monitoring according to Methodology VM0015. Data coming from forest inventory collected in periods of up to 10 years from multiple plots.
Purpose of the data:	• Calculation of baseline emissions • Calculation of project emissions
Calculation method:	DBH is calculated from the circumference at breast height (CBH) data of each tree monitored measured in the field.
Any comment:	Main variable used to estimate changes in carbon stock on the Manoa REDD+ Project. In this monitoring period not had carbon stock change due to planned logging activities in the project area.

Data Unit / Parameter:	**Planned deforestation to Forest Management infrastructure**
Data unit:	Hectare (ha)
Description:	Map of forest cover areas converted into non-forest areas due to the construction of roads, trails and forest patios.
Source of data:	Remote sensing images, technical maps, and specific field cards to monitor the construction of forest management roads, trails and forest patios.

Description of measurement methods and procedures to be applied:	The monitoring of forest cover areas will be done by satellite images analysis, road, trails and forest patio construction maps, and field verification. In case planned deforestation occurs, the Forest Cover Benchmark Map will be updated by map algebra. The reduction in carbon stock in the Project area will be reported in the verification processes.
Frequency of monitoring/recording:	During the year of management of each UPA.
Value monitored:	N/A
Monitoring equipment:	Field card and geographic information system.
QA/QC procedures to be applied:	The mapping of planned deforestation areas for the implementation of Forest Management infrastructures will be carried out through high resolution images and field verification.
Purpose of the data:	Calculation of project emissions
Calculation method:	In case planned deforestation areas are detected the Forest Cover Benchmark Map will be updated by map algebra.
Any comment:	

Data Unit / Parameter:	**ΔCabBSLLKt**
Data unit:	tCO_2-e
Description:	Total carbon stock changes in the leakage belt area
Source of data:	Calculated.
Description of measurement methods and procedures to be applied:	• leakage prevention activities will be listed; • a map showing areas of intervention and type of intervention will be prepared; • areas where leakage prevention activities impact carbon stock will be identified; • non-forest classes existing within these areas in the baseline case will be identified; • carbon stocks will be measured on the identified classes or conservative literature estimates will be used; • carbon stock changes in the leakage management areas under the project scenario will be reported using table 30b of the VM0015;

	• net carbon stock changes that the leakage prevention measures cause during the fixed baseline period and, optionally, the project crediting period will be calculated; • results of the calculations will be reported in table 30.c of the VM0015.
Frequency of monitoring/recording:	To be determined depending on the activity
Value monitored:	46.269,5 ton CO_2e
Monitoring equipment:	To be determined depending on the activity
QA/QC procedures to be applied:	The accuracy assessment for the mapping of changes in land use in the Leakage Belt was performed by using RapidEye images, with spatial resolution of 5 m and with support from Google Earth images. The LU/LC assessment was higher than 80%.
Purpose of the data:	Calculation of leakage
Calculation method:	Evaluation of ex-post estimates in the Leak Belt in relation to the ex ante project estimate (Table 35 of VM0015).
Any comment:	N/A

Data Unit / Parameter:	**Harvest Damage Assessment**
Data unit:	M^3/ha
Description:	Evaluation performed by sampling in the UPAs during and after the harvesting operation.
Source of data:	Post-Exploratory Report.
Description of measurement methods and procedures to be applied:	See Sustainable Forest Management Plan.
Frequency of monitoring/recording:	Annual, after the end of the operations of each UPA.
Value monitored:	N/A
Monitoring equipment:	See Sustainable Forest Management Plan.
QA/QC procedures to be applied:	See section 8, item 8.1 of Project Description
Purpose of the data:	Assessment of changes in carbon stock due to damage from logging.
Calculation method:	See Sustainable Forest Management Plan.
Any comment:	Evaluation performed by sampling in the UPAs during and after the forest operation.

Data Unit / Parameter:	**Frequency of surveillance and patrol operations**
Data unit:	Number of operations per year
Description:	Record the number of surveillance operations carried out at the farm during the monitoring period.
Source of data:	Patrimonial Surveillance Reports
Description of measurement methods and procedures to be applied:	To be defined
Frequency of monitoring/recording:	Mensal
Value monitored:	N/A
Monitoring equipment:	N/A
QA/QC procedures to be applied:	To be defined
Purpose of the data:	Evaluation of the efficiency of surveillance operations
Calculation method:	N/A
Any comment:	The Patrimonial Surveillance Reports will be implemented from the validation of the project.

3.3 Description of the Monitoring Plan

Organizational structure, responsibilities and competencies

The REDD+ Project Monitoring Plan will cover three components: climate, community and biodiversity. At this first verification period, deforestation in the project area and leakage belt was monitored. As a proponent and partner implementer of the project, Biofílica coordinated the monitoring process during the first monitoring period. The climate aspects were monitored directly by the Biofílica team with support from Triângulo and Florestal.

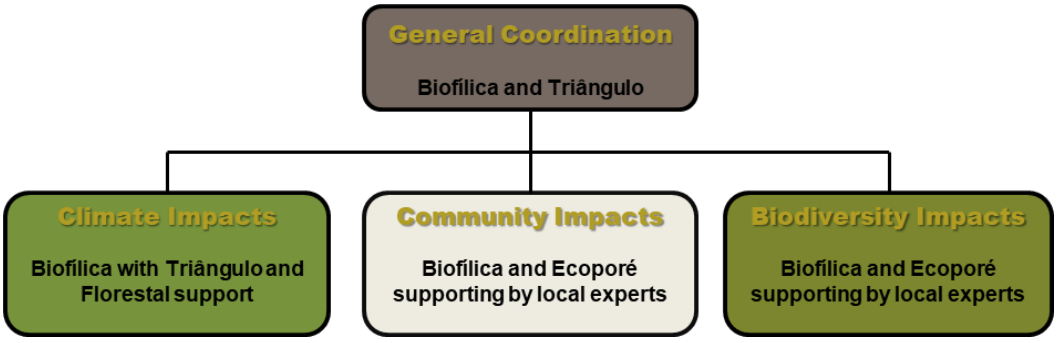

Figure 3 Organizational Structure of Monitoring Plan

Biofílica:

a) Responsibilities: general coordination of the socioeconomic and environmental assessment (DSEA) and baseline studies and carbon stock; PD (Project document) development and financing; credits validation/checking and trading; Project co-management throughout the Project lifetime; implementation of conservation activities; general coordination of monitoring activities and climate impacts monitoring.

b) Competencies: It has technical skills for monitoring activities with experts trained in GIS tools with full dedication to REDD+ projects.

Triângulo:

a) Responsibilities: Co-management of the implementation of conservation activities proposed by the project during its duration. Provide support in infrastructure and logistics for Biofílica and other professionals involved in the project. Provide any relevant data related to the forest management activity and the farm governance that are necessary for the good progress of the project.

b) Competencies: With extensive experience in Forest Management, Triângulo has been dedicated to the industrialization and responsible production of wood since 1972. The Forest Management at Manoa Farm began in 1997, acquiring the FSC certification seal in 2005, and today considered a reference in Brazil for quality and efficiency Of Management.

Ecoporé:

a) Responsibilities: Ecoporé was responsible for preparing the socioeconomic study of the project, which served as one of the bases for the elaboration of the project implementation plan. During the course of the project will be responsible for continuing the proposed activities in the social and environmental scope, under the coordination of Biofílica and with the support of local experts.

b) Competencies: Ecoporé was created in 1988 with the purpose of taking actions against the predatory exploitation of timber, combating illegal deforestation and the process of invasion of Conservation Units. From its experience, Ecoporé executed projects focused on environmental conservation and sustainability in partnership with governmental and non-governmental institutions and traditional populations.

Internal auditing performed

Internal Audit procedures were examinations and investigations, including compliance tests which allowed the internal auditor to obtain enough information to substantiate its findings and recommendations to the project management.

In its application, the following was considered:

a) inspection - verification of records and documents;

b) observation - monitoring process or procedure;

The evidences were sufficient, reliable, relevant and useful to provide solid basis for the conclusions and recommendations to the project coordination.

Internal audit staff with sufficient knowledge of techniques that require the use of information processing technology resources were hired in order to implement their own procedures or, if necessary, guide, supervise and review the work of experts.

Table 6 Internal audit Plan

Data/Parameter	Procedure	Unit	Source	Frequency	Responsible	Conformity
Income and expenses spreadsheet	Project's budget follow up	R$	Biofilica Investimentos Ambientais	Monthly	Project Coordinator	Yes
$AUDPA_{icl,t}$	Areas of unplanned deforestation in forest class in the project area	ha	Calculated through remote sensing images.	Quarterly	GIS Analyst	Yes
$APDPA_{icl,t}$	Areas of planned deforestation in forest class in the project area	ha	Calculated through remote sensing images, technical maps, and specific field cards.	Quarterly	GIS Analyst	Yes
$\Delta CPLdPA_t$	Total decrease in carbon stock due to planned logging activities in the Project Area	tCO_2-e	Calculated	Quarterly	GIS Analyst and Project Coordinator	Yes
$\Delta CUDdPA_t$	Total carbon stock decrease due to unavoided unplanned deforestation within the project area	tCO2-e	Calculated	Quarterly	GIS Analyst and Project Coordinator	Yes

Technical description of the monitoring tasks

The monitoring of the REDD+ activities aimed at avoiding unplanned deforestation through the social and conservation activities (increase in the frequency and comprehensiveness), the monitoring of the forest cover with satellite images and field survey, and social inclusion of the communities in the Manoa REDD+ Project area.

Table 7 Data collected to monitoring plan.

Data/Parameter	Description	Unit	Source	Frequency
Income and expenses spreadsheet	Project's budget follow up	R$	Biofilica Investimentos Ambientais	Annual
$AUDPA_{icl,t}$	Areas of unplanned deforestation in forest class *icl* at year *t* in the project area	ha	Calculated through remote sensing images.	Annual
$APDPA_{icl,t}$	Areas of planned deforestation in forest class *icl* at year *t* in the project area	ha	Calculated by means of the field survey of damages caused by forest management infrastructures.	Annual
$\Delta CPLdPA_t$	Total decrease in carbon stock due to planned logging activities at year *t* in the Project Area	tCO_2-e	Calculated	Annual

Table 8 Data collected to leakage monitoring.

Data/Parameter	Description	Unit	Source	Frequency
$ACPA_{icl,t}$	Annual area within the Project Area affected by catastrophic events in class *icl* at year *t*	ha	Calculated through remote sensing images.	Each time a catastrophic event occurs

Data/Parameter	Description	Unit	Source	Frequency
$\Delta CUCdPA_t$	Total decrease in carbon stock due to catastrophic events at year *t* in the Project Area	tCO_2-e	Calculated	Each time a catastrophic event occurs
$\Delta CUDdPA_t$	Total carbon stock decrease due to unavoided unplanned deforestation within the project area at year t.	tCO2-e	Calculated	Annual

Overview of data collection procedures

3.3.1 Monitoring of project implementation

The monitoring of the implementation was made by Biofílica. The implementation of REDD+ activities was monitored through physical-financial schedules, follow-up of performance and quality reports, maps of forest cover, meeting reports, deforestation reports, and other relevant documents.

3.3.2 Monitoring of land-use and land-cover changes

The monitoring of planned and unplanned deforestation was made through project area forest cover mapping using 30-meter or higher spatial resolution satellite images. The monitoring of the deforestation for implementation of forest management infrastructure was carried out through specific field cards for the construction of roads, trails and forest patios inside the project area, and the maps and satellite images containing information on forest cover areas converted into non-forest areas. In order to have more flexibility in the deforestation mapping process, different techniques of automatic classification and visual interpretation using field data and cartographic quality standards may be used when the technical team deems it necessary. Data on deforestation events was compared to baseline scenario. Emission reduction values for the monitored period was based on the comparison between forecasted and real deforestation.

Data acquisition:

For the mapping of forest cover and land use was used images from the satellite Landsat. The Landsat images used was with spatial resolution equal to 30 meters and spectral resolution between 0,45 to 2,35 *μm,* within the period of lower incidence of clouds and rain in the region. For the monitoring of forest cover in the monitored area all the satellite images covered the area between the following coordinates: 62°58'22,687"W 8°38'16,254"S; 62°24'28,259"W 8°37'53,073"S; 62°24'27,278"W 9°14'49,725"S and 62°58'59,814"W 9°14'32,53"S. All the data used to perform the monitoring, including maps in Shapefile and Geotiff format was provided by PRODES Digital of the National Institute for Space Research (INPE), the information provided by PRODES Digital can be accessed at www.obt.inpe.br/prodes. Support data from RapidEye was used to validate the PRODES mapping.

Pre-processing:

The main activities regarding pre-processing were carried out by PRODES. The procedures were the following:

- Selection of optical satellite images with less cloud coverage, shooting date closer to Amazon dry season and adequate radiometric quality;
- Georeferencing of the satellite images with topographic charts in a 1:100,000 scale or NASA images in MrSID orthorectified format;

- All data was in Datum WGS84 20S;
- Generation of a spectral mixture model to estimate the percentage of vegetation, soil and shadow component for each pixel of the image;
- Application of the segmentation technique which identifies in the satellite image the spatially adjacent regions (segments) with similar spectral characteristics;
- Classification the segments to identify forest classes, non-forest vegetation and deforestation.

Classification:

The methodology of classification adopted by PRODES Digital is made by using the multispectral images to transform values from digital numbers to scene component (vegetation, soil and shadow) through spectral mixture algorithm. The classification is performed, for every year since 2000, using the algorithm unsupervised ISOSEG with the acceptance threshold of 90% for the classes: forest, deforestation, non-forest vegetation, hydrography and cloud. These segmentation and classification algorithms can be applied using the programs Spring and TerraView (Câmara et al., 2006). In the case of this monitoring period was used de classification made for the years 2013, 2014, 2015 and 2016. For more information, access: obt.inpe.br/prodes/metodologia.

Post-processing:

The methodology of classification is programmed to avoid the cloud coverage by selection of optical satellite images with less cloud coverage and by estimating the areas deforested under cloud coverage. The areas remained within the cloud cover were validated by visual interpretation of additional images from Landsat 8 satellite.

Classification accuracy assessment:

PRODES mapping evaluation was carried out by comparison of each of the classes of the land-use and land-cover map (2013, 2014, 2015 and 2016) with a set of 100 points randomly distributed over the monitored area (Project Area and Leakage Belt). Reference data used come from the point obtained by visual interpretation of 5 meters resolution imagens from satelite RapidEye.

Having the reference points and the land-use and land-cover map of the monitoring period, it was possible to evaluate the performance of the monitoring process by analyzing the confusion matrix (Table 3) as per Congalton (1999). The overall accuracy of the monitoring process for the land-use classes at the monitored area presented values above 80%.

Additional Procedure Implemented

Additionally to the predicted procedure explained in the Project Description Section 2.4 and 2.5, all the identified deforestation Polygons will be checked in the field according with the following

procedure, developed after Project Validation and first verification. The deforestation polygons were not checked in the field at this first verification period because the lack of security in the area, however these activity is foreseen for the next project years.

For this monitoring period Biofílica Investimentos Ambientais generated an Annual Deforestation Bulletin (for 2013, 2014, 2015 and 2016). This Bulletin contained all the data, methodology applied and the results of Biofílica's analyses of PRODES data, for the corresponding year, within the Project Area and the Leakage Belt. Maps were generated with all the deforestation polygons of interest (those inside the perimeter of Project Area and Leakage Belt) and the polygons coordinates were set in a table. For the next monitored years Biofílica Investimentos Ambientais will generate these Bulletins annually with the PRODES data.

Quality control and quality assurance procedures:

Data from INPE / PRODES monitoring system are recognized as the official data of deforestation in the Brazilian Amazon, the PRODES system is internationally recognized as the main source of data regarding the change of land use in the Amazon. This system already has more than 25 years and has been constantly improved, since 2000 the system is fully digital and has 1 ha as a minimum mapping unit (GOFC-GOLD, 2011). PRODES system mainly uses Landsat satellite images in carrying out mapping with a resolution of 30 meters. The methodology of PRODES is specifically developed to map the Amazon rainforest, has image interpretation techniques and reducing the influence of clouds to the specific characteristics of the Amazon rainforest. Thus, in the case of mapping the Amazon rainforest, PRODES is the most accurate system available, details of PRODES monitoring methodology can be found at Camara, et al., 2006.

The original (raster) and processed (vector) digital data from satellite images, coordinates, technical maps, field photos and cards were stored by Biofílica Investimentos Ambientais throughout the project. Maps of infrastructure installation, satellite images and annual deforested areas reports are available to the verification body.

3.3.3 Monitoring changes in carbon stocks

Within Leakage Management Areas:

No areas were subject to planned carbon stock decrease in the leakage management areas in the project scenario.

Within the Project Area:

It is expected that ex ante carbon stock estimate for forest class does not change during baseline period. However, VCS Methodology VM0015 requires the monitoring of carbon stock in project area subjected to significant carbon stock decrease in the project scenario according to the ex ante

assessment due to controlled deforestation and planned harvest activities, or areas subjected to unplanned and significant carbon stock decrease in the project scenario.

Total carbon stock change due to unavoided unplanned deforestation within the project area is calculates the following way:

$$\Delta \mathrm{CUDdPA}_t = \sum_{y=1}^{t} \left(\sum_{icl=1}^{icl} AUDPA_{icl,y} * \Delta Ctot_{icl,t-y} - \sum_{fcl=1}^{fcl} AUDPA_{fcl,y} * \Delta Ctot_{fcl,t-y} \right)$$

Where:

ΔCUDdPAt Total carbon stock change due to unavoided unplanned deforestation within the project area at year t.

AUDPAicl,y Area of unplanned deforestation in the initial forest class icl at year t within the project area in the project scenario.

ΔCtoticl,Ac Carbon stock loss in the initial forest class icl at age of change Ac (# of years after LU/LC change).

AUDPAfcl,y Area of non-forest class fcl at time t within the project area post-unplanned deforestation in the project scenario.

ΔCtotfcl,Ac Carbon stock gain in the final non-forest class fcl at Age of change Ac (# of years after LU/LC change).

All reduction in carbon stock due to sustainable forest management activities was reported in this verification processes using Table 27 of the VCS methodology VM0015 version 1.1, or Table 12 of this document.

Quality control and quality assurance procedures:

3.3.4 Monitoring of non-CO_2 emissions from forest fires

Emissions due to biomass burning are not accounted in this project.

3.3.5 Monitoring impacts from natural disturbances and other catastrophic events

Decreases in carbon stocks and increases in GHG emissions due to natural disturbances or catastrophic events was controlled by monitoring the forest cover through satellite, using the same methods applied in monitoring the forest cover at the project area (section 1.1.2).

The main activities carried out by the project to collect and process data were:

- Selection of optical satellite images with less cloud cover, taken at times near the Amazonian dry season and with adequate radiometric quality;

- Georeferencing of satellite images with topographic charts in a 1:100.000 scale or NASA images in MrSID orthorectified format;
- Mapping the affected forest cover areas.

Emissions due to natural disturbance or catastrophic events will be estimated by multiplying the area of forest loss mapped by the average of forest carbon stock. During this monitoring period no significant reduction in carbon stock due to natural disturbance or catastrophic events were identified during the forest cover monitoring.

Data archiving

All data and reports of the Manoa REDD+ Project were stored by Biofílica Investimentos Ambientais in digital files throughout the project.

The original reports and field cards collected for the forest management activities were stored by Florestal – Planejamento, Paisagismo e Consultoria Ltda. Biofílica Investimentos Ambientais kept a copy of these documents filed in digital format throughout the project.

The compilation and announcement of the results of social activities were made through Biofílica Activities Report and Impacts Report periodically prepared and made available in digital format.

All documents related to the monitoring of Manoa REDD+ Project were put together in hard and/or virtual files, and made available to the verification body at each verification event.

Organization and responsibilities of the parties involved in all the above

All activities of monitoring are a responsibility of Biofílica Investimentos Ambientais, with support from Triângulo Pisos e Painéis Ltda.

3.3.6 Monitoring of Leakage:

Technical description of the monitoring tasks

Manoa REDD+ Project involved two monitoring activities of sources of leakage:

I. Monitoring of decrease in carbon stocks and/or increase in GHG emissions associated with leakage prevention measure if the project proponents implement activities such as tree planting, agricultural intensification, fertilization, fodder production and/or other measures to enhance cropland and grazing land areas. If these activities cause reductions in carbon stocks and/or increase in GHG emissions in leakage management areas, such carbon stock changes and/or GHG emissions would be estimated by Biofílica Investimentos Ambientais technical staff. During this monitoring period project proponents carried none of the interventions mentioned out. Therefore carbon stock changes and GHG emissions associated to leakage prevention activities were not accounted.

II. Biofílica Investimentos Ambientais performed the monitoring of forest cover in the Leakage Belt via satellite images to account for carbon stock decrease and increases in the GHG emissions due to leakage displacement.

Table 9 Data collected to leakage monitoring.

Data	Description	Unit	Source	Frequency
$\Delta CLPMLK_t$	Carbon stock decrease due to leakage prevention measures	tCO_2-e	Calculated	Annual
$ELPMLK_t$	Annual total increase in GHG emissions due to leakage prevention measures at year *t*	tCO_2-e	Calculated	Annual
$\Delta CBSLLK_t$	Total ex post carbon stock change at year t.	tCO2-e	Calculated	Annual

Overview of data collection procedures

3.3.6.1 Monitoring of changes in carbon stocks and GHG emissions associated to leakage prevention activities

The decrease in carbon stocks due to activities developed in Leakage Management areas are not expected, since no activity for improved farming techniques, or management of grazing areas that could alter carbon stocks and increase GHG emissions, as compared to the baseline scenario, has been planned for implementation. And such kinds of activities were not implemented during this monitoring period.

However, if it is decided that such activities are necessary, then, the ex ante carbon stock changes and GHG emissions associated to such activities would be estimated through step 8 of the VM0015 methodology, and, if meaningful, they would be monitored and data would be provided to the verification body at each verification event through tables 30b, 30c, 31, 32 and 33 of VM0015 methodology, version 1.1.

3.3.6.2 Monitoring of carbon stocks reduction and GHG emissions increase due to activity displacement leakage

Activity data for the Leakage Belt area was determined using the same methods applied to monitoring deforestation in the Project Area (section 1.2).

It was identified a deforestation even higher than expected for the baseline scenario within the Leakage Belt in two of the monitored years (2015 and 2016), representing an emission of 46.269,5 tCO_2e

Monitoring of increases in GHG emissions:

Emissions due to forest fires are not accounted in the baseline.

Quality control and quality assurance procedures

Monitoring of carbon stock changes and GHG emissions associated to leakage prevention activities:

- To be determined depending on the activity, if implemented.

Activity data for the Leakage Belt area was determined using the same methods applied to monitoring deforestation in the Project Area (section 1.2). If during the monitoring process a deforestation event higher than the expected for baseline scenario is identified in the Leakage Belt, and such deforestation is attributed to deforestation agents from the Project Area, the losses in carbon stock will be accounted for and reported using Table 22c and 21d of VM0015 approved methodology version 1.1.

Total carbon stock change due to unavoid unplanned deforestation within the leakage belt area is calculates the following way:

$$\Delta \mathrm{CBSLLK}_t = \sum_{y=1}^{t} \left(\sum_{icl=1}^{icl} AUDLK_{icl,y} * \Delta Ctot_{icl,t-y} - \sum_{fcl=1}^{fcl} AUDLK_{fcl,y} * \Delta Ctot_{fcl,t-y} \right)$$

Where:

ΔCBSLLKt Total carbon stock change due to unavoided unplanned deforestation within the leakage belt area at year t.

AUDLKicl,y Area of unplanned deforestation in forest class icl at year t within the leakage belt area in the project scenario.

ΔCtoticl,Ac Carbon stock loss in the initial forest class icl at age of change Ac (# of years after LU/LC change).

AUDLKfcl,y Area of non-forest class fcl at time t within the leakage belt area post-unplanned deforestation in the project scenario.

ΔCtotfcl,Ac Carbon stock gain in the final non-forest class fcl at Age of change Ac (# of years after LU/LC change).

Data archiving

The original reports and field cards were stored by Biofílica Investimentos Ambientais and keeped a copy of these documents filed in digital format throughout the project. The original (raster) and processed (vector) digital data from satellite images, coordinates, technical maps, field photos and cards

were stored by Biofílica Investimentos Ambientais throughout the project. Maps of annual deforested areas, satellite images and reports were available to the verification body at each verification event.

Organization and responsibilities of the parties involved in all the above

The all activities of monitoring of leakage are a responsibility of Biofílica Investimentos Ambientais.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

Estimation of annual areas of unplanned deforestation in the project area under the without project scenario has been implemented by applying the following four steps:

• Analysis of deforestation during the historic reference period (2000 – 2012).

• Estimation of the annual areas of unplanned baseline deforestation in the Reference Region (RR).

• Estimation of the annual areas of unplanned baseline deforestation in the Project Area (PA).

• Analysis of the ex-post scenario over the current monitoring period.

The entire process is detailed in the Manoa REDD+ Project Description. Results for the 2013 to 2016 monitoring period are presented in tables on the following pages.

Table 10 Carbon stocks per hectare of initial forest classes icl existing in the project area and leakage belt.

Initial forest class *icl*							
Name:	Forest						
ID_{icl}	1						
Average carbon stock per hectare + 90% CI							
Cab_{icl}		Cbb_{icl}		Cdw_{icl}		$Ctot_{icl}$	
C stock $tCO_2e\ ha^{-1}$	± 95% CI $tCO_2e\ ha^{-1}$	C stock $tCO_2e\ ha^{-1}$	± 95% CI $tCO_2e\ ha^{-1}$	C stock $tCO_2e\ ha^{-1}$	± 95% CI $tCO_2e\ ha^{-1}$	C stock $tCO_2e\ ha^{-1}$	± 95% CI $tCO_2e\ ha^{-1}$
436,4	10,0	76,6	1,8	-	-	513,0	11,7
tC ha-1	IC %	tC ha-1	IC %	tC ha-1	IC %	tC ha-1	IC %
119,0	2,3	20,9	2,3	0,0	0,0	139,9	2,3

Cab_{icl} = Carbon stock in aboveground biomass in stratum *i*; tCO_2-e/ha

Cbb_{icl} = Carbon stock in belowground biomass in stratum *i*; tCO_2-e/ha

Cdw_{icl} = Carbon stock in dead wood in stratum *i*; tCO_2-e/ha

Table 11 Annual areas of unplanned baseline deforestation in the Project Area for the 2013-2016 monitoring period.

Area establiseh after deforestation per zone within the project area		Total baseline deforestation in the project area	
IDz>	1		
Name>	Zone 1	$ABSLPA_t$	ABSLPA
Project year$_t$	ha	ha	ha
2013	198	198	198
2014	425	425	623
2015	469	469	1.092
2016	358	358	1.450

Table 12 Annual areas of unplanned baseline deforestation in the Leakage Belt for the 2013-2016 monitoring period

Area establiseh after deforestation per zone within the leakage belt		Total baseline deforestation in the leakage belt	
IDz>	1		
Name>	Zone 1	$ABSLLK_t$	ABSLLK
Project year$_t$	ha	ha	ha
2013	8	8	8
2014	108	108	116
2015	59	59	175
2016	16	16	191

For the calculations of the carbon stock changes of the baseline scenario was used the Method 1 described in the sections 6.1.2 and 6.1.3 of the Approved VCS Methodology VM0015. Total emissions in the baseline scenario for the years 2013, 2014, 2015 and 2016 were 86,638.4 tCO2e; 186,203.4 tCO2e; 205.965,3 tCO2e; and 157.957,0 tCO2e respectively as presented in Table 13.

Table 13 Total net baseline carbon stock change in baseline scenario in the Project Area (table 21b.VM0015).

Carbon stock changes per initial forest class *icl*		Total carbon stock change of initial forest class in the project area	
ID_{icl}>	1	$\Delta CBSLPA_{icl,t}$	$\Delta CBSLPA_{icl}$
Name>	Forest	annual	cumulative
Project Year *t*	tCO_2-e	tCO_2-e	tCO_2-e
2013	87.917,9	87.917,9	87.917,9
2014	190.229,2	190.229,2	278.147,1
2015	213.021,9	213.021,9	491.169,0
2016	167.327,0	167.327,0	658.496,0

Carbon stock changes per post-deforestation zone z		Total carbon stock change of post-deforestation zones in the project area	
ID_{iz}>	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$
Name>	Zone 1	annual	cumulative
Project Year *t*	tCO_2-e	tCO_2-e	tCO_2-e
2013	1279,5	1.279,5	1.279,5
2014	4025,9	4.025,9	5.305,4
2015	7056,6	7.056,6	12.361,9
2016	9370,0	9.370,0	21.731,9

Total net carbon stock change of the project area	
$\Delta CBSLPA_{t}$	$\Delta CBSLPA$
annual	cumulative
tCO_2-e	tCO_2-e
86.638,4	86.638,4
186.203,4	272.841,7
205.965,3	478.807,1
157.957,0	636.764,1

4.2 Project Emissions

Emissions due to planned deforestation

Emissions associated to planned deforestation were developed in the Project area from 01 January 2013 to 31 December 2016. Total emissions related to planned deforestation is 49.414,7 tCO2e. This value was estimated based on the results of the post-exploratory reports of the UPAs 07; 04; and 06, explored during the monitoring period.

Table 14 Carbon stock decrease due to planned deforestation in the project area (Table25.a.VM0015).

Project Year *t*	Areas of planned deforestation x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned deforestation	
	ID_{cl} =	1	annual	cummulative
	$APDPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CPDdPA_{t}$	$\Delta CPDdPA$
	ha	$tCO_2e\ ha^{-1}$	tCO_2e	tCO_2e
2013	22	513,0	11.219,5	11.219,5
2014	22	513,0	11.219,5	22.439,0
2015	28	513,0	14.290,8	36.729,7
2016	25	513,0	12.685,0	49.414,7

Emissions due to planned logging activities

There were no emissions associated to planned logging activities were developed in Project Area 01 January 2013 to 31 December 2016. All logging activities were executed in order to obtain long-lived wood products.

Table 15 Carbon stock decrease due to planned logging activities in the Project Area (Table 25.b.VM0015).

Project Year *t*	Areas of planned logging activities x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned logging activities	
	ID_{cl} =	1	annual	cummulative
	$APLPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CPLdPA_t$	$\Delta CPLdPA$
	ha	$tCO_2e\ ha^{-1}$	tCO_2e	tCO_2e
2013	0	0,0	0,0	0,0
2014	0	0,0	0,0	0,0
2015	0	0,0	0,0	0,0
2016	0	0,0	0,0	0,0

Emissions due to planned fuel-wood and charcoal activities

No emissions associated to planned fuel-wood and charcoal activities were developed in the Project Area.

Table 16 Carbon stock decrease due to planned fuel-wood collection and charcoal production in the Project Area (Table 25.c.VM0015).

Project Year *t*	Areas of planned fuel-wood & charcoal activities x Carbon stock change (decrease) in the project area		Total carbon stock decrease due to planned fuel-wood and charcoal activities	
	ID_{cl} =	1	annual	cummulative
	$APFPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CPFdPA_t$	$\Delta CPFdPA$
	ha	$tCO_2e\ ha^{-1}$	tCO_2e	tCO_2e
2013	0	0,0	0,0	0,0
2014	0	0,0	0,0	0,0
2015	0	0,0	0,0	0,0
2016	0	0,0	0,0	0,0

Removals due to carbon stock increase of planned activities

Carbon stock increase due to planned activities in areas that would be deforested in the baseline case was omitted.

Table 17 Total ex post carbon stock decrease due to planned activities (Table 25.d.VM0015).

Project Year t	Total carbon stock decrease due to planned deforestation		Total carbon stock decrease due to planned logging activities		Total carbon stock decrease due to planned fuel-wood and charcoal activities		Total carbon stock decrease due to planned activities	
	annual $\Delta CPDdPA_t$ tCO_2e	cumulative $\Delta CPDdPA$ tCO_2e	annual $\Delta CPLdPA_t$ tCO_2e	cumulative $\Delta CPLdPA$ tCO_2e	annual $\Delta CPFdPA_t$ tCO_2e	cumulative $\Delta CPFdPA$ tCO_2e	annual $\Delta CPAdPA_t$ tCO_2e	cumulative $\Delta CPAdPA$ tCO_2e
2013	11.219,5	11.219,5	0,0	0,0	0,0	0,0	11.219,5	11.219,5
2014	11.219,5	22.439,0	0,0	0,0	0,0	0,0	11.219,5	22.439,0
2015	14.290,8	36.729,7	0,0	0,0	0,0	0,0	14.290,8	36.729,7
2016	12.685,0	49.414,7	0,0	0,0	0,0	0,0	12.685,0	49.414,7

Total ex post carbon stock decrease in the Project area

No carbon stock decrease associated to Project activities has occurred in the Project Area from 01 January 2013 to 31 December 2016.

Emissions due to unavoidable unplanned deforestation

No unplanned deforestation was identified in the Project Area during this monitoring period. Therefore, no emissions related to unplanned deforestation were counted in the REDD+ Manoa Project Area during this monitoring period. (2013/14/15/16)

Table 18 Observed annual areas of unplanned deforestation under the project scenario in the project area for the 2013-2016 monitoring period.

Area establiseh after deforestation per zone within the project area		Total monitored deforestation in the project area	
IDz>	1		
Name>	Zone 1	Annual	Cumulative
Project year$_t$	ha	ha	ha
2013	0	0	0
2014	0	0	0
2015	0	0	0
2016	0	0	0

Emissions due to forest fires and catastrophic events

No emissions associated to forest fires and catastrophic events have occurred in the Project area 01 January 2013 to 31 December 2016.

Table 19 Carbon stock decrease due to forest fires in the Project Area (Table 25.e.VM0015).

Project Year *t*	Areas affected by forest fires x Carbon stock change (decrease)		Total carbon stock decrease due to forest fires	
	ID_{cl} =	1	annual	cummulative
	$AUFPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CUFdPA_t$	$\Delta CUFdPA$
	ha	$tCO_2e\ ha^{-1}$	tCO_2e	tCO_2e
2013	0	0,0	0,0	0,0
2014	0	0,0	0,0	0,0
2015	0	0,0	0,0	0,0
2016	0	0,0	0,0	0,0

Table 20 Carbon stock decrease due to catastrophic events in the Project Area (Table 25.f.VM0015).

Project Year *t*	Areas affected by catastrophic events x Carbon stock change (decrease)		Total carbon stock decrease due to catastrophic events	
	ID_{cl} =	1	annual	cummulative
	$ACPA_{icl,t}$	$Ctot_{icl,t}$	$\Delta CUCdPA_t$	$\Delta CUCdPA$
	ha	$tCO_2e\ ha^{-1}$	tCO_2e	tCO_2e
2013	0	0,0	0,0	0,0
2014	0	0,0	0,0	0,0
2015	0	0,0	0,0	0,0
2016	0	0,0	0,0	0,0

Table 21 Carbon stock decrease due to forest fires and catastrophic events (Table 25.g.VM0015).

Project Year *t*	Total carbon stock decrease due to forest fires		Total carbon stock decrease due to catastrophic events		Total carbon stock decrease due to forest fires and catastrophic events	
	annual	cummulative	annual	cummulative	annual	cummulative
	$\Delta CUFdPA_t$	$\Delta CUFdPA$	$\Delta CUCdPA_t$	$\Delta CUCdPA$	$\Delta CFCdPA_t$	$\Delta CFCdPA$
	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e	tCO_2e
2013	0	0,0	0,0	0,0	0,0	0,0
2014	0	0,0	0,0	0,0	0,0	0,0
2015	0	0,0	0,0	0,0	0,0	0,0
2016	0	0,0	0,0	0,0	0,0	0,0

Ex post estimated net carbon stock change in the Project area

The calculation of the ex-post estimated net carbon stock change in the project area uses the same method described in the sections 6.1.2 and 6.1.3 of the Approved VCS Methodology VM0015, considering at this time the changes observed in the current monitoring period.

Table 22 Ex-post carbon stock change in the project area (Table 21.b.2 of VCS VM0015)

Carbon stock changes per initial forest class *icl*		Total carbon stock change of initial forest class in the project area	
ID_{icl}>	1	$\Delta CBSLPA_{icl,t}$	$\Delta CBSLPA_{icl}$
Name>	Forest	annual	cumulative
Project Year *t*	tCO_2-e	tCO_2-e	tCO_2-e
2013	0,0	0,0	0,0
2014	0,0	0,0	0,0
2015	0,0	0,0	0,0
2016	0,0	0,0	0,0

Carbon stock changes per post-deforestation zone z		Total carbon stock change of post-deforestation zones in the project area	
ID_{iz}>	1	$\Delta CBSLPA_{z,t}$	$\Delta CBSLPA_{z}$
Name>	Zone 1	annual	cumulative
Project Year *t*	tCO_2-e	tCO_2-e	tCO_2-e
2013	0,0	0,0	0,0
2014	0,0	0,0	0,0
2015	0,0	0,0	0,0
2016	0,0	0,0	0,0

Total net carbon stock change of the project area	
$\Delta CBSLPA_t$	$\Delta CBSLPA$
annual	cumulative
tCO_2-e	tCO_2-e
0,0	0,0
0,0	0,0
0,0	0,0
0,0	0,0

Total ex post estimated carbon stock change in Project area under the Project scenario in this monitoring period is presented in Table 23.

Table 23 Net carbon stock chance in the Project Area under the Project scenario (Table 27 VM0015).

Project Year t	Total carbon stock decrease due to planned activities		Total carbon stock increase due to planned activities		Total carbon stock decrease due to fires and catastrophic events		Total carbon stock increase due to fires and catastrophic events		Total carbon stock change in the project case	
	annual $\Delta CPAdPA_t$ tCO_2e	cumulative $\Delta CPAdPA$ tCO_2e	annual $\Delta CPAiPA_t$ tCO_2e	cumulative $\Delta CPAiPA$ tCO_2e	annual $\Delta CUDdPA_t$ tCO_2e	cumulative $\Delta CUDdPA$ tCO_2e	annual $\Delta CPSPA_t$ tCO_2e	cumulative $\Delta CPSPA$ tCO_2e	annual $\Delta CPSPA_t$ tCO_2e	cumulative $\Delta CPSPA$ tCO_2e
2013	11.219	11.219	0,0	0,0	0,0	0,0	0,0	0,0	11.219	11.219
2014	11.219	22.439	0,0	0,0	0,0	0,0	0,0	0,0	11.219	22.439
2015	14.291	36.730	0,0	0,0	0,0	0,0	0,0	0,0	14.291	36.730
2016	12.685	49.415	0,0	0,0	0,0	0,0	0,0	0,0	12.685	49.415

Non-CO_2 emissions from forest fires

Not subject to monitoring and accounting.

4.3 Leakage

One source of leakage was monitored: leakage due to displacement activity. Leakage due to displacement activity was monitored by mapping forest cover change in the leakage belt. As defined in the VCS Methodology VM0015, deforestation above the baseline in the leakage belt area will be considered activity displacement leakage. Activity data for the leakage belt area was determined using the same methods applied to deforestation mapping in the Project area.

Table 24 Ex-ante Baseline carbon stock change in the leakage belt area (Table 21.c of VCS VM0015)

Carbon stock changes per initial forest class *icl*		Total carbon stock change of initial forest class in the leakage belt area		Carbon stock changes per post-deforestation zone z		Total carbon stock change of post-deforestation zones in leakage belt area		Total net carbon stock change of the leakage belt area	
ID_{icl}>	1	$\Delta CBSLLK_{icl,t}$	$\Delta CBSLLK_{icl}$	ID_{iz}>	1	$\Delta CBSLLK_{z,t}$	$\Delta CBSLLK_{z}$	$\Delta CBSLLK_{t}$	$\Delta CBSLLK$
Name>	Forest	annual	cumulative	Name>	Zone 1	annual	cumulative	annual	cumulative
Project Year *t*	tCO_2-e	tCO_2-e	tCO_2-e	Project Year *t*	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e
2013	3.552,2	3.552,2	3.552,2	2013	51,7	51,7	51,7	3.500,5	3.500,5
2014	48.016,5	48.016,5	51.568,7	2014	749,6	749,6	801,3	47.266,9	50.767,4
2015	27.086,3	27.086,3	78.655,0	2015	1.130,9	1.130,9	1.932,2	25.955,4	76.722,8
2016	8.444,9	8.444,9	87.099,9	2016	1.234,3	1.234,3	3.166,4	7.210,7	83.933,5

Table 25 Ex-post observed carbon stock change in the leakage belt area (Table 21.c.2 of VCS VM0015)

Carbon stock changes per initial forest class *icl*		Total carbon stock change of initial forest class in the leakage belt area		Carbon stock changes per post-deforestation zone z		Total carbon stock change of post-deforestation zones in leakage belt area		Total net carbon stock change of the leakage belt area	
ID_{icl}>	1	$\Delta CBSLLK_{icl,t}$	$\Delta CBSLLK_{icl}$	ID_{iz}>	1	$\Delta CBSLLK_{z,t}$	$\Delta CBSLLK_{z}$	$\Delta CBSLLK_{t}$	$\Delta CBSLLK$
Name>	Forest	annual	cumulative	Name>	Zone 1	annual	cumulative	annual	cumulative
Project Year *t*	tCO_2-e	tCO_2-e	tCO_2-e	Project Year *t*	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e	tCO_2-e
2013	0,0	0,0	0,0	2013	0,0	0,0	0,0	0,0	0,0
2014	0,0	0,0	0,0	2014	0,0	0,0	0,0	0,0	0,0
2015	37.966,8	37.966,8	37.966,8	2015	552,5	552,5	552,5	37.414,3	37.414,3
2016	43.192,9	43.192,9	81.159,7	2016	1.171,6	1.171,6	1.724,1	42.021,3	79.435,6

Total *ex post* estimated leakage

Ex post total net carbon stock changes in the leakage belt due to displacement of activity in this monitoring period are presented in Table 26. The Leakage was calculated as the difference between the ex post and ex ante assessment. In this case, as result, the value of the carbon stock change within the Fixed Baseline Period in 2013 and 2014 is lower than zero (<0), so the ex post leakage was set to zero in this years as recommended by the section 1.2 – Monitoring of Leakage, of VCS VM0015.

In the years 2015 and 2016, ex-post leakage was identified, the total ex post leakage was 11.458,9 for 2015 and 34.810,6 for 2016.

Table 26 Total net ex ante and ex post baseline carbon stock change in the leakage belt.

Total ex ante net carbon stock change of the leakage belt area		Total ex post net carbon stock change of the leakage belt area		Total ex-post Leakage	
ΔCBSLLKt	ΔCBSLLK	ΔCBSLLKt	ΔCBSLLK	ΔCBSLLKt	ΔCBSLLK
annual	cumulative	annual	cumulative	annual	cumulative
tCO2-e	tCO2-e	tCO2-e	tCO2-e	tCO_2-e	tCO_2-e
3.500,5	3.500,5	0,0	0,0	0,0	0,0
47.266,9	50.767,4	0,0	0,0	0,0	0,0
25.955,4	76.722,8	37.414,3	37.414,3	11.458,9	11.458,9
7.210,7	83.933,5	42.021,3	79.435,6	34.810,6	46.269,5

4.4 Net GHG Emission Reductions and Removals

The net anthropogenic GHG emissions reductions were calculated following the equation 19, equation 20 and equation 21 of VCS VM0015 version 1.1. The risk factor used to calculate VCS buffer credits (VBC) is 10%, as calculated in Non-permanence Risk Report. The calculated *ex post* GHG emissions reductions are presented in Table 27.

Table 27 Ex post estimated net anthropogenic GHG emission reductions and Verified Carbon Units (Table 36 of VCS VM0015).

Project Year t	Baseline carbon stock changes		Ex post project carbon stock changes		Ex post leakage carbon stock changes		Ex post net anthropogenic GHG emission reductions		Ex post VCUs tradable		Ex post buffer credits	
	annual $\Delta CBSLPA_t$ tCO_2-e	cumulative $\Delta CBSLPA$ tCO_2-e	annual $\Delta CPSPA_t$ tCO_2e	cumulative $\Delta CPSPA$ tCO_2e	annual ΔCLK_t tCO_2e	cumulative ΔCLK tCO_2e	annual $\Delta REDD_t$ tCO_2e	cumulative $\Delta REDD$ tCO_2e	annual VCU_t tCO_2e	cumulative VCU tCO_2e	annual VCB_t tCO_2e	cumulative VCB tCO_2e
01 jan 2013 to 31 dec 2013	86.638	86.638	11.219	11.219	0	0	75.418	75.418	67.877	67.877	7.541	7.541
01 jan 2014 to 31 dec 2014	186.203	272.842	11.219	22.439	0	0	174.983	250.401	157.485	225.362	17.498	25.039
01 jan 2015 to 01 dec 2015	205.965	478.807	14.738	37.177	11.459	11.459	180.215	430.616	161.048	386.410	19.167	44.206
01 jan 2016 to 31 dec 2016	157.957	636.764	13.312	50.489	34.811	46.270	110.461	541.077	95.934	482.344	14.527	58.733

5 APPENDIX

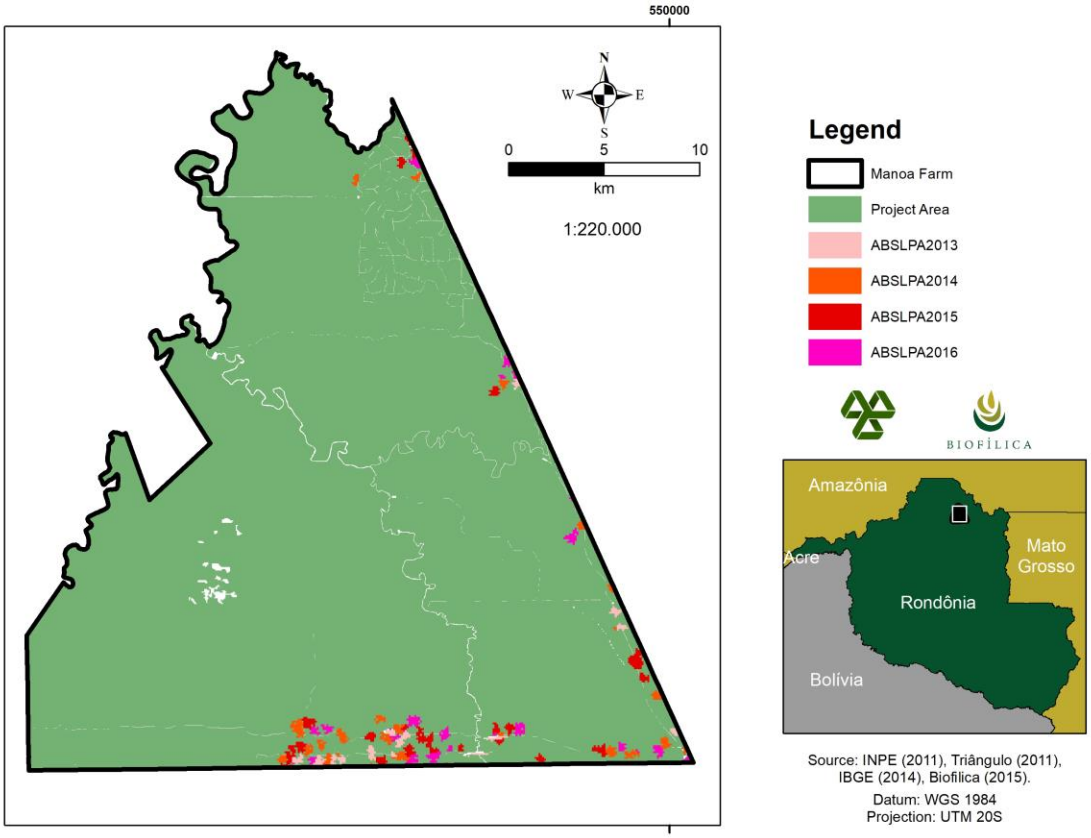

Figure 4. Map showing cumulative areas credited within the Project Area.

Digital files used for the mapping (satellite images, shapefiles and GPS points) were presented to verification team as evidence of monitoring land-use and land-cover within the project area and leakage belt area.