



**Monitoring report form for CDM project activity  
(Version 06.0)**

*Complete this form in accordance with the instructions attached at the end of this form.*

**MONITORING REPORT**

<b>Title of the project activity</b>	India: Himachal Pradesh Reforestation Project - Improving Livelihoods and Watersheds
<b>UNFCCC reference number of the project activity</b>	4174
<b>Version number of the PDD applicable to this monitoring report</b>	07
<b>Version number of this monitoring report</b>	01
<b>Completion date of this monitoring report</b>	30/05/2018
<b>Monitoring period number</b>	2 <sup>nd</sup> Monitoring Period (01/01/2013 to 031/12/2017)
<b>Duration of this monitoring period</b>	5 years
<b>Monitoring report number for this monitoring report</b>	
<b>Project participants</b>	<p><b>India:</b> M/s HP Mid-Himalayan Watershed Development Project (MHWDP)</p> <p><b>Spain:</b> International Bank for Reconstruction and Development (IBRD) as trustee for the BioCarbon Fund (BioCF) Kingdom of Spain - Ministry of Agriculture, Food and Environment and Ministry of Economy and Competitiveness Zeroemissions Carbon Trust, S.A</p> <p><b>Switzerland:</b> Syngenta Foundation for Sustainable Agriculture</p> <p><b>Ireland:</b> Government of Ireland - Department of the Environment, Community and Local Government</p>
<b>Host Party</b>	India
<b>Sectoral scopes</b>	14 – Afforestation and Reforestation

<b>Applied methodologies and standardized baselines</b>	A/R ACM 0001 Version 03	
<b>Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period</b>	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
		145,829 tCO <sub>2</sub> e
<b>Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD</b>	438,641	

## SECTION A. Description of project activity

### A.1. General description of project activity

>> The A/R CDM project is being implemented in the Indian State of Himachal Pradesh. The state is located in the North-Western Himalayan region of India and has 12 districts, which are categorized into four agro-climatic zones, i.e., i) Siwalik hills, ii) Mid hills, iii) High hills and iv) Cold dry zone. The Project area lies in the mid and high Siwalik hills at an altitude ranging from 600 to 1,800 meters and covers 11 watershed divisions in 10 districts and is spread over the catchments of Ravi, Beas and Sutlej, major rivers of Northern India.

The A/R CDM project has been designed under the MHWDP Project. It has been developed and implemented through a series of consultations involving MHWDP and its stakeholder constituents namely, Forest Department (Government of Himachal Pradesh) local institutions, Gram Panchayats (GPs); and the International Bank for Reconstruction and Development as the trustee of the BioCarbon Fund. The project envisaged implementing A/R CDM activities on 4,003.07 ha of degraded lands in 420 land parcels of the watersheds spread over in 177 Gram Panchayats of Mid-Himalayan region but it could be implemented over 3215.69 ha of land in 292 land parcels in 139 Gram Panchayats.

The four guiding principles of the project are: (i) adoption of native and locally preferred tree species for reforestation, (ii) involvement of the local GPs and small and marginal farmers in reforestation activities to strengthen the ongoing watershed management interventions, (iii) facilitation of technical, financial and capacity development support from MHWDP for reforestation activities, and iv) distribution of carbon revenue to local institutions (GPs) and farmers.

The major objectives of the project are to:

- improve the productive potential of degraded land and watershed catchments by enhancing biomass production and carbon stocks on degraded land included in the project,
- sequester greenhouse gas (GHG) removals by sinks through reforestation on degraded forest, community and private lands, and
- contribute revenue to improve livelihoods and incomes of rural households residing in the watersheds covered under the project.

The project is expected to restore degraded land through reforestation activities and bring value addition to the activities undertaken for improving catchments as part of the MHWDP. The project is expected to provide multiple benefits to poor households through meeting their needs of small timber, firewood, minor forest produce, besides providing employment opportunities and revenue from the sale of certified emission reductions. The three reforestation models implemented in the project are outlined below.

- Restoration forestry: In this model, reforestation of degraded forestland is undertaken by planting 1,100 plants/ha of mostly native species. The restoration forestry aims to protect watersheds, conserve biodiversity, and regenerate native flora, and involves supplemental planting of native tree species on degraded high-altitude lands of selected GPs. Regenerated forests are expected to provide non-timber forest products to local communities and improve their livelihood opportunities. Out of a total projected area of 3,176.86 ha under this model 2,944.83 ha has been planted.
- Community forestry: This model is being undertaken for reforestation of degraded community lands (common land). The species included in this model are largely native species. The reforestation activity will lead to protection of watersheds, improvement in biomass required to meet the local community needs such as small timber, fuelwood, fodder and non-timber forest products. Out of a total projected area of 293.06 ha under this model, 225.04 ha has been planted.

- Farm forestry: Under this model, reforestation has been promoted on abandoned or long-term fallow private lands with the objective of providing fruits and fodder to private land owners. Through this model, in addition to protection of abandoned lands from soil erosion, land owners derive fuelwood non-timber products, and employment. Out of a total area of 533.15 ha under this model, 45.81 ha has been planted.
- The A/R CDM project contributes to sustainable development in the following ways:
  - Restoration of degraded forest land, degraded community land, and degraded and abandoned private land, which are subject to severe soil erosion and unsustainable land use practices.
  - Promotion of local community participation, particularly small and marginal farmers in plantation activities with multi-purpose species on degraded forestlands, degraded common lands, and private degraded lands.
  - Generation of employment through silvicultural activities such as nursery raising, site preparation, seedling transportation, planting, protection and maintenance of plantations. About 343 person days/ha of employment is expected to be generated during the project period
  - Promotion of biodiversity and environmental protection objectives through planting and protection of native tree species, reduction in risk of soil erosion and prevention of downstream siltation of water bodies.
  - Supply of multiple products to local communities.
  - Transfer of revenues accrued from the project to participating gram panchayats and individual farmers.

The progress of project implementation is as below.

- Start date of the project: 01 July 2006 - Progress of planting activities: from 2006 to 2012
- Registration of the project: 04 March 2011
- First monitoring period: 01 July 2006 to 31 December 2012
- Issuance of credits from the first periodic verification: 08 October 2013

The project will continue to be implemented and managed by the MHWD project authorities (Now Integrated Development Project for Source Sustainability and Climate Resilient Rain-fed Agriculture) till 2024 and subsequently by the State Forest Department. The Project Directorate will manage and transfer the carbon revenue to local stakeholders, i.e. panchayats and/or individual farmers. In addition to carbon revenue, the restoration, community and farm forestry activities will bring additional benefits such as land reclamation, increased biomass supply and livelihood opportunities to local communities.

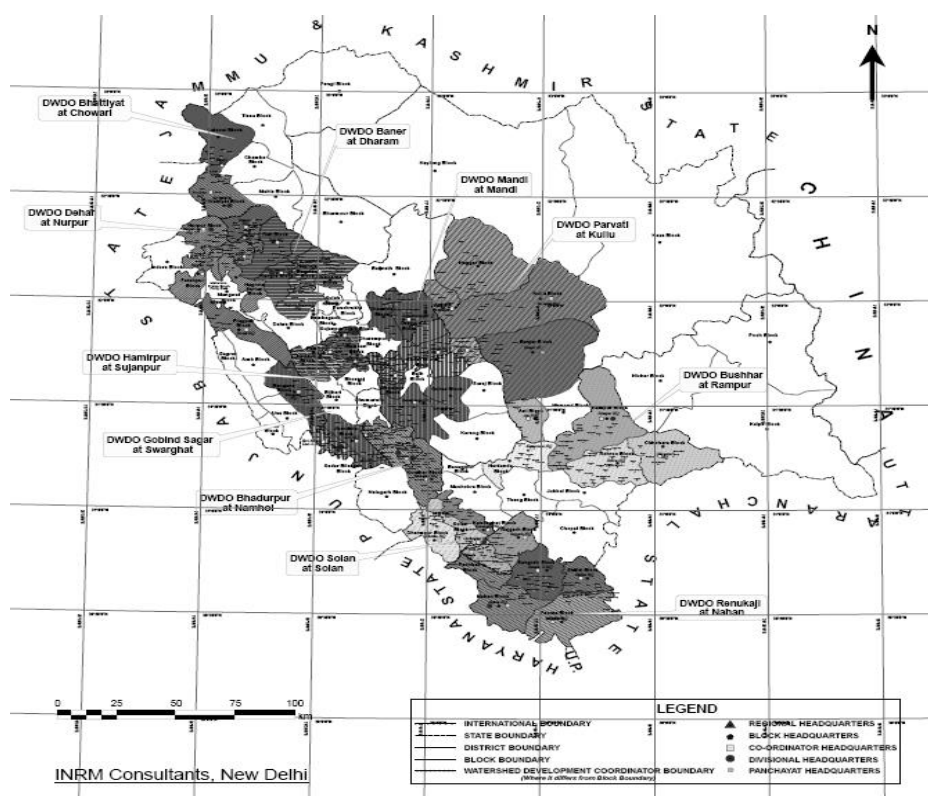
During the first monitoring period, the project has demonstrated the implementation of CDM project activities; developed institutional mechanisms for the sale of Certified Emission Reductions (CERs); promoted financial arrangements for restoration of degraded lands; and enabled participation of resource-poor farmers in the implementation of the project. Being the first of its kind, the project is expected to have significant demonstration effect in the country. The addition of Bio-carbon component to the watershed project of the HP through this CDM project has been a pioneering effort to demonstrate the climate change mitigation through watershed restoration activities.

The net anthropogenic GHG removals by sinks from the project at the end of first monitoring period (01/07/2006 to 31/12/2012) was 65,582 tCO<sub>2</sub>e. The net anthropogenic GHG removals by sinks at the end of second monitoring period (01/01/2013 to 21/12/2017) are estimated at 145,829 tCO<sub>2</sub>e,

The details of calculations of net anthropogenic GHG removals by sinks are presented in the ER calculation spreadsheet included as **Annex I** to the MR.

## A.2. Location of project activity

>> The project is located in the mid-altitude region of Himachal Pradesh, India at elevations ranging between 600 and 1,800 meters above mean sea level. The project area is spread over 420 land parcels in 177 gram panchayats (village councils) of 11 watershed divisions namely Nahan, Swarghat, Solan, Namhol, Kullu, Rampur, Mandi, Sujampur, Dharamshala, Nurpur and Chowari in Dharamshala and Bilaspur regions. The details of land parcels planted under this project are presented in **Annex II** to the MR. The Figure A.1 shows project area covering various districts of Himachal Pradesh.



**Figure A. 1:** Map of Himachal Pradesh with watershed divisions marked and selected divisions identified

## A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Party A (host Party) India	Private entity A Public entity A M/s HP Mid-Himalayan Watershed Development Project (MHWDP) ...	No

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Party B Spain	Private entity B- International Bank for Reconstruction and Development (IBRD) as trustee for the BioCarbon Fund (BioCF)  Public entity B Kingdom of Spain -Ministry of Agriculture, Food and Environment and Ministry of Economy and Competitiveness  Zeroemissions Carbon Trust, S.A ...	Yes
Switzerland	Syngenta Foundation for Sustainable Agriculture	No
Ireland	Government of Ireland - Department of the Environment, Community and Local Government	Yes

#### A.4. Reference to applied methodologies and standardized baselines

>>“Afforestation and Reforestation of degraded land” (AR-ACM0001, version 03).

The A/R methodological tools and guidelines applied at validation and verification of the project are noted below.

##### **A/R Methodological Tools**

- Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities (version 01)<sup>1</sup>
- Calculation of the number of sample plots for measurements within A/R CDM project Activities (version 02)<sup>2</sup>
- Tool for testing significance of GHG emissions in A/R CDM project activities (version 01)<sup>3</sup>
- Estimation of emissions from clearing, burning and decay of existing vegetation due to implementation of a CDM A/R project activity (version 03)<sup>4</sup>
- Tool for estimation of GHG emissions related to displacement of grazing activities in an A/R CDM project activity (version 02)<sup>5</sup>
- Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities (version 01)<sup>6</sup>
- Procedure to define the eligibility of land for afforestation and reforestation project activities (version 01)<sup>7</sup>.
- Procedure to determine when accounting of the soil organic carbon pool may be conservatively neglected in A/R CDM project activities (version 01)<sup>8</sup>

<sup>1</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-02-v1.pdf>

<sup>2</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.pdf>

<sup>3</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-04-v1.pdf>

<sup>4</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-08-v3.pdf>

<sup>5</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-09-v2.pdf>

<sup>6</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-13-v1.pdf>

<sup>7</sup> [https://cdm.unfccc.int/EB/022/eb22\\_repan16.pdf](https://cdm.unfccc.int/EB/022/eb22_repan16.pdf)

<sup>8</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-06-v1.pdf>

- Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities (version 04.2)<sup>9</sup>.
- Tool for estimation of changes in soil organic carbon stocks due to the implementation of A/R CDM Project Activities (version 01.1.0)<sup>10</sup>.
- Demonstration of Appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities (version 01.0.1)<sup>11</sup>.

### **EB Guidelines**

- Guidelines on accounting of specified types of changes in A/R CDM project activities from the description in registered project design documents (Version 02.0) (EB 66, Annex 24)<sup>12</sup>.
- Guidelines on application of specified versions of A/R CDM methodologies in verification of registered A/R CDM project activities (Version 01.1) (EB68, Annex 31)<sup>13</sup>.

### **A.5. Crediting period type and duration**

- >> The Project has adopted renewable crediting period. The first crediting period of 20 years, is renewable further for two additional 20-year crediting periods. The starting date of the first crediting period is 01/07/2006, which ends on 30/06/2026.

## **SECTION B. Implementation of project activity**

### **B.1. Description of implemented project activity**

>> Project has been implemented as a sub project of the Mid Himalayan Watershed Development Project (MHWDP) involving HP Forest Department and the local institutions i.e. Gram Panchayats through community user groups. The officials responsible for coordinating project implementation and organization of data/information/reporting of the project have been designated at various levels.

Out of the project area of 4,003.07 ha, a total of 3,215.69 ha area has been planted. The details of reforestation activities implemented in different project strata are presented in **Annex II** to the MR, and the summary is presented in Table B1 below.

The public entity implementing the project, HP Mid Himalayan Watershed Development Project (MHWDP) has control over all the project area. The MHWDP directly manages forest and community lands. The MHWDP has also signed sub-project agreements with the private land owners for implementing the project on private lands included in the project. A copy of sub-project agreements is also submitted as part of the supporting documentation to the MR.

**Table B.1: Project area planted during the first and second monitoring period and the project area that remained unplanted**

<sup>9</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-14-v4.1.pdf>

<sup>10</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-16-v1.1.0.pdf>

<sup>11</sup> <https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-18-v1.0.1.pdf>

<sup>12</sup> [https://cdm.unfccc.int/Reference/Guidclarif/ar/methAR\\_guid32.pdf](https://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid32.pdf)

<sup>13</sup> [https://cdm.unfccc.int/Reference/Guidclarif/ar/methAR\\_guid30.pdf](https://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid30.pdf)

	Project area planted (ha)	Remaining project area which could not be planted	Total project area (ha)
Restoration forestry (Degraded forestland)	2,944.83	232.03	3,176.86
Community forestry (Degraded community land)	225.04	68.02	291.36
Farm forestry (Degraded private land)	45.81	487.34	533.15
Total	3,215.69	787.38	4,003.07

The selection of species was based on their suitability to altitude, slope, topography, and site quality. Focus was on native species or species that are widely adapted to the location. Furthermore, among the suitable species, those with moderate to high growth rate of biomass and ability to provide multiple benefits to the community were selected.

The project includes degraded forestland, community land and private land categories, for which planting models – restoration forestry, community forestry and farm forestry, respectively were adopted, and based on altitude, each of the three models were further categorized into high, medium and low altitude. As a result, nine (9) project strata were identified in the registered PDD. As part of the ex post stratification, areas of the project strata that are not planted during the first monitoring period are grouped into a separate stratum. The details of ex post stratification are presented in the section D.3 on implementation of the sampling plan.

**Fencing:** was used to protect about 50 percent of the project area while the remaining area did not require fencing.

**Seed:** High quality seeds were selected from forest and plantation sources for raising seedlings. The seeds collected were tested for their germination ability and growth in the nurseries.

**Nursery Technology:** Decentralized nurseries were established in different watershed divisions and in Gram Panchayats, which reduced the transportation cost as well as vehicular emissions. Species were raised in nursery for a period of 12 to 18 months. All nursery activities were carried out using manual labour. The seedlings raised in nurseries were transported to planting sites. To ensure better survival of plants, nursery activities focused on developing sturdy and profuse root system for seedlings.

**Site preparation:** This involved clearing of weeds from an area of about 0.06 m<sup>2</sup> for each seedling and digging pits of 45x45x45cm. Clearance of vegetation was restricted to the area of pits (i.e. 0.06 m<sup>2</sup> per pit). The total area disturbed per hectare was insignificant at around 70 m<sup>2</sup>/ha (0.007% of area planted). This helped to protect the soil moisture and to avoid oxidation of soil organic matter. Slash and burn practice was not used in the project area to avoid the emissions of greenhouse gases. All land preparation activities were carried out using manual labour.

**Planting:** Planting was carried out during monsoon months (July-Aug) and Dec-Jan. The list of species planted in the project is presented in table B.2 below. The replacement planting was carried out to replace the failed seedlings during second to fifth year after planting. Seedlings were replanted depending on the mortality of the planted seedlings. The proportion of fast and slow growing species planted in the project approximates to that proposed in the Box A.5.2 of the registered PDD.

**Table B.2: Species planted in project**



<i>Acacia catechu</i>	<i>Grewia optiva</i>
<i>Acacia nilotica</i>	<i>Lannea grandis</i>
<i>Albizia lebbek</i>	<i>Leucaena leucocephala</i>
<i>Albizia procera</i>	<i>Mallotus philippinensis</i>
<i>Albizia stipulata</i>	<i>Melia azadirachta</i>
<i>Alnus nitida</i>	<i>Myrica sculenta</i>
<i>Azadirachta indica</i>	<i>Olea glandulifera</i>
<i>Bambusa stricta</i>	<i>Pinus roxburghii</i>
<i>Bamboo</i>	<i>Pinus wallichiana</i>
<i>Bauhinia variegata</i>	<i>Populus ciliata</i>
<i>Bauhinia purpurea</i>	<i>Prunus padus</i>
<i>Butea monosperma</i>	<i>Punica Granatum</i>
<i>Bombax ceiba</i>	<i>Pyrus pashia</i>
<i>Cassia fistula</i>	<i>Quercus leucotrichophora</i>
<i>Cassia seameia</i>	<i>Robinia pseudoacacia</i>
<i>Cedrus deodara</i>	<i>Salix alba</i>
<i>Celtis australis</i>	<i>Syzygium cuminii</i>
<i>Dalbergia sissoo</i>	<i>Tectona Grandis</i>
<i>Dendrocalamus strictus</i>	<i>Terminalia arjuna</i>
<i>Emblica officinalis</i>	<i>Terminalia tomentosa</i>
<i>Engelhardtia colebrookiana</i>	<i>Toona ciliata</i>
<i>Ficus spp./Ficus roxburghii</i>	
<i>Flacourtia indica</i>	
<i>Grevillea robusta</i>	

**Fertilizer and manure application:** It was decided not to apply both organic and inorganic fertilizer to the plants.

**Species mix:** A wide range of species were used in planting to ensure that communities' requirements for timber and non-timber product supplies are met.

**Weeding and cultural operations:** Weeding was carried out manually to reduce competition for planted seedlings. Manual weeding was done twice a year for 5 years during September to February. Cultural operations did not result into disturbance of top soil.

**Tending, thinning operations:** The silvicultural operations were not carried out as the project is in the early stages of growth and establishment.

## B.2. Post-registration changes

### B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

>> None

### B.2.2. Corrections

>> None

**B.2.3. Changes to the start date of the crediting period**

&gt;&gt; None

**B.2.4. Inclusion of monitoring plan**

&gt;&gt; None

**B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools**

&gt;&gt; None

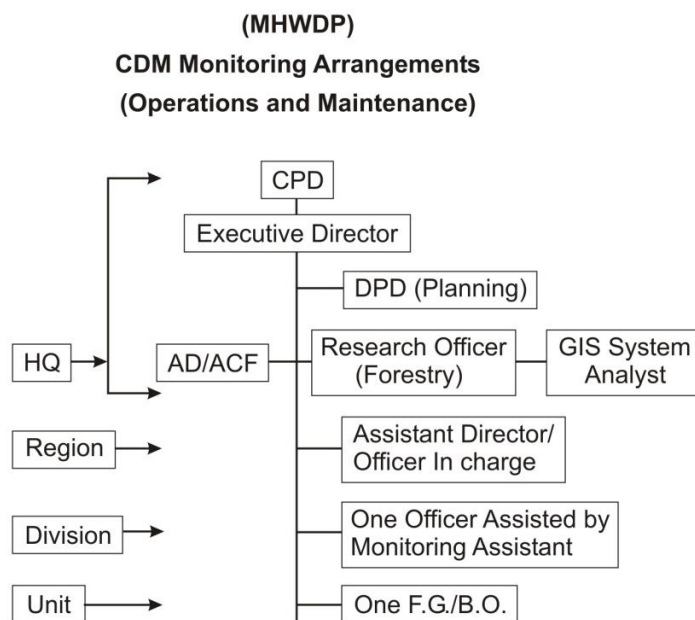
**B.2.6. Changes to project design**

&gt;&gt; None

**SECTION C. Description of monitoring system**

>> An effective monitoring system has been put in place through which periodic monitoring was carried out. The monitoring covered a range of parameters relevant for assessing the changes in GHG removals by sinks such as area planted, condition of land parcels, survival of seedlings, tree biomass growth, events occurring in the project area, status of contractual agreements with sub-project entities etc. Plantation Journals are being maintained and updated to reflect relevant information for each parcel.

The organization structure adopted for the project has facilitated successful conduct of project implementation and monitoring. The schematic overview of the organization structure for project monitoring is presented below.



&gt;&gt;

The types of parameters monitored in the project are noted below. The specific parameters monitored for calculation of actual GHG removals sinks are noted in the section D2.

**Area of the project:** The progress of planting in terms of the area planted and not planted in each stratum.

**Growth and survival of seedlings:** The survival of seedlings is checked through annual monitoring until seedling establishment.

**Geographical coordinates:** the Geographic coordinates of the project boundary checked as part of the monitoring.

**Participation of GPs/ community groups/private land owners:** Monitoring covers participation of agencies in implementing the project.

**Natural hazards:** Monitoring covers natural events such as fire etc. to assess the risk and implement preventive measures to address natural hazards.

Measurements were conducted between 01/09/2017 and 31/12/2017, crosschecks of field measurements were performed and errors if any were identified and corrected prior to 31/12/2017 as part of the QA/QC to ensure the accuracy of the measurements.

## SECTION D. Data and parameters

### D.1. Data and parameters fixed ex ante

*(Copy this table for each piece of data and parameter)*

<b>Data / Parameter:</b>	BEF <sub>2,j</sub>
<b>Unit:</b>	Dimensionless
<b>Description:</b>	Biomass expansion factor for conversion of stem biomass (including bark) to total above-ground tree biomass increment for species <i>j</i> ; dimensionless
<b>Source of data:</b>	Forest Survey of India (FSI) 1996: Volume Equations for India, Nepal and Bhutan, Ministry of Environment and Forests, Government of India; volume equations of species published in Journals and reports; and IPCC (2003) GPG LULUCF, Table 3A.1.10
<b>Value(s) applied:</b>	Value of species-wise BEF <sub>2,j</sub> is listed in the standard values worksheet of the ER calculation spreadsheet (Annex I to the Monitoring Report)
<b>Purpose of data:</b>	For conversion of stem biomass to above-ground tree biomass in the project.
<b>Additional comment:</b>	

<b>Data / Parameter:</b>	R <sub>j</sub>
<b>Unit:</b>	Dimensionless
<b>Description:</b>	Root-shoot ratio for tree species or group of species <i>j</i> / kg d.m.yr <sup>-1</sup> (kg d.m.yr <sup>-1</sup> ) <sup>-1</sup>
<b>Source of data:</b>	Root-shoot ratio of species published in journals and reports; and IPCC (2003) GPG LULUCF, Table 3A.1.8
<b>Value(s) applied:</b>	Value of species-wise root-shoot ratio (R <sub>j</sub> ) is listed in the standard values worksheet of the ER calculation spreadsheet (Annex I to the Monitoring Report)

Purpose of data:	For calculation of below ground tree biomass in the project.
Additional comment:	For species that have root-shoot ratio information published in journals and reports, those values were adopted; and for species that do not have published root-shoot ratio information, the root-shoot value for tropical and sub-tropical forest species, referenced in the IPCC (2003) GPG LULUCF, Table 3A.1.8 has been adopted. The information on sources of root-shoot ratio values of species in terms of published journals and reports has been included in the standard values worksheet of the excel sheet (Annex I to MR).

<b>Data / Parameter:</b>	$D_j$
Unit:	Dimensionless
Description:	Basic wood density for species $j$ / t d.m. $m^{-3}$
Source of data:	Basic wood density of species published in journals and reports; and IPCC (2003) GPG LULUCF, Table 3A.1.10
Value(s) applied:	Value of species-wise basic wood density ( $D_j$ ) is listed in the standard values worksheet of the ER calculation spreadsheet (Annex I to the Monitoring Report)
Purpose of data:	For conversion of volume in $m^3$ of wood to biomass in tonnes.
Additional comment:	The information on sources of basic wood density values of species in terms of published journals and reports has been included in the standard values worksheet of the excel sheet (Annex I to MR).

<b>Data / Parameter:</b>	$CF_j$
Unit:	Dimensionless
Description:	Carbon fraction of dry matter for species of type $j$ / t C $t^{-1}$ d.m.
Source of data:	IPCC (2003) GPG LULUCF
Value(s) applied:	0.5
Purpose of data:	For conversion of biomass to carbon
Additional comment:	

<b>Data / Parameter:</b>	<b>SOC (<math>\Delta C</math>)</b>
Unit:	t C/ha
Description:	Annual increase in SOC ( $\Delta C$ ) in C/ha
Source of data:	Tool for estimation of changes in soil organic carbon stocks due to the implementation of A/R CDM project activities, version 01.1.0; and approved spreadsheet for calculation of changes in soil organic carbon stocks (EB 60 Annex 12).
Value(s) applied:	0.51
Purpose of data:	To calculate the annual change in soil organic carbon pool
Additional comment:	The value of annual increment in SOC ( $\Delta C$ ) in C/ha has been calculated using the approved spreadsheet for calculation of changes in SOC (EB60, Annex 12).

<b>Data/Parameters:</b>	$t_{\text{(equilibrium)}}$
Unit:	years
Description:	Time in years required for increase in the soil organic carbon (SOC) to reach equilibrium
Source of data:	Tool for estimation of changes in soil organic carbon stocks due to the implementation of A/R CDM project activities, version 01.1.0 (EB 60 Annex 12).
Value(s) applied:	20
Purpose of data:	To calculate the annual change in soil organic carbon pool.
Additional comment:	

## D.2. Data and parameters monitored

(Copy this table for each data or parameter.)

(Copy this table for each piece of data and parameter.)

<b>Data / Parameter:</b>	A
Unit:	ha
Description:	Total area of the project
Measured/ Calculated / Default:	Calculated
Source of data:	Project monitoring
Value(s) of monitored parameter:	4,003.07 ha
Monitoring equipment:	GPS and GIS
Measuring/ Reading/ Recording frequency:	Measured at the start of the project and thereafter at monitoring intervals prior to each verification.
Calculation method (if applicable):	Sum of all project strata
QA/QC procedures:	Checked during monitoring period
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

<b>Data / Parameter:</b>	$A_i$
Unit:	ha
Description:	Total area of stratum i
Measured/ Calculated / Default:	Measured
Source of data:	Project monitoring

Value(s) of monitored parameter:	<b>Area of strata planned for planting (ha)</b>				
		Forest	Community	Private	Total
	Low	976.21	125.33	232.06	
	Medium	969.75	66.90	221.43	
	High	1,230.90	100.83	79.66	
	Total	3,176.86	293.06	533.15	4,003.07
	<b>Area of strata planted up to 31.12.2017(ha)</b>				
		Forest	Community	Private	Total
	Low	931.56	107.69	16.95	
	Medium	876.73	56.66	22.79	
High	1,136.54	60.69	6.08		
Total	2,944.83	225.04	45.81	3,215.69	
Monitoring equipment:	GPS and GIS, compass, and cloth and metal measurement tape				
Measuring/ Reading/ Recording frequency:	Measured at the start of the project and thereafter at monitoring intervals corresponding to each verification				
Calculation method (if applicable):	NA				
QA/QC procedures:	Checked during monitoring period				
Purpose of data:	Calculation of actual net GHG removals by sinks				
Additional comment:					

<b>Data / Parameter:</b>	$A_{p,i}$
Unit:	ha
Description:	Area of sample plot p of stratum i
Measured/ Calculated / Default:	Measured
Source of data:	Project field measurement
Value(s) of monitored parameter:	500 m <sup>2</sup>
Monitoring equipment:	GPS and GIS, compass, and metal and cloth measurement tape
Measuring/ Reading/ Recording frequency:	Monitoring period corresponding to each periodic verification
Calculation method (if applicable):	NA
QA/QC procedures:	QA/QC procedure includes multiple levels: checks of sample plot measurement by field staff and by the staff of project monitoring unit
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

<b>Data / Parameter:</b>	Species, j
Unit:	Dimensionless
Description:	Species planted in the project strata
Measured/ Calculated / Default:	Measured
Source of data:	Project monitoring data. The species planted in the project are listed in Table B.2 of the section B.1 of this monitoring report.
Value(s) of monitored parameter:	NA
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	Monitoring until establishment of species
Calculation method (if applicable):	NA
QA/QC procedures:	Checks to ensure consistency in field records and project database
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	

<b>Data / Parameter:</b>	Survival
Unit:	Per cent
Description:	Survival of planted species
Measured/ Calculated / Default:	Measured
Source of data:	Project monitoring
Value(s) of monitored parameter:	53.44
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	Monitoring period corresponding to each periodic verification
Calculation method (if applicable):	Percent of planted seedlings surviving in the field
QA/QC procedures:	Survival assessment is conducted in the field by the staff of the project is checked randomly in the field. The project-monitoring unit also conducts checks.
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	Survival assessment is conducted at annual and periodic intervals. The information on survival is presented under the parameter, survival, in the section D. For planted areas, survival information is used to implement replacement planting activities during the years 2 to 5.

<b>Data / Parameter:</b>	DBH
Unit:	cm
Description:	Diameter at breast height (1.37m) of live trees
Measured/ Calculated / Default:	Measured
Source of data:	Measurement of trees on permanent sample plots
Value(s) of monitored parameter:	Values of DBH in cm recorded on sample plot measurement forms and transferred to ER calculation spreadsheet.
Monitoring equipment:	Calliper
Measuring/ Reading/ Recording frequency:	Monitoring period corresponding to each periodic verification
Calculation method (if applicable):	NA
QA/QC procedures:	Diameter measurements are randomly checked in the field e staff. The project monitoring unit also conducts checks
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	Measurement of diameter of trees above minimum <i>DBH</i> of 2 cm on permanent sample plots following forest inventory procedures. DBH measurements are conducted at 1.37 meters as per the national forestry inventory procedures in India.

<b>Data / Parameter:</b>	H
Unit:	Meters
Description:	Tree height
Measured/ Calculated / Default:	Measured
Source of data:	Measurement of trees on permanent sample plots
Value(s) of monitored parameter:	Tree height in meters is recorded on sample plot measurement forms and transferred to calculation spreadsheet
Monitoring equipment:	The tree height was measured with pole method in respect of smaller trees and Haga altimeter was used for trees having long bole. The pole method refers to direct measurement of tree height with the use of graduated wooden or metal or fiberglass pole by placing it near a tree. As part of calibration, pole height gradations and Haga altimeter were checked to ensure that the instruments are correctly calibrated and that there is no error in their measurements.
Measuring/ Reading/ Recording frequency:	Monitoring period corresponding to each periodic verification
Calculation method (if applicable):	NA



QA/QC procedures:	Height measurements are randomly checked during sample plot measurement to ensure accuracy of measured data.
Purpose of data:	Calculation of actual net GHG removals by sinks
Additional comment:	The pole method was found to be appropriate for measurement of tree seedlings and smaller trees, and Haga altimeter was appropriate for trees with long bole. Therefore, as part of the project monitoring, as the trees grow the pole method will be replaced by Haga altimeter for measurement of tree heights on the sample plots.

<b>Data / Parameter:</b>	t2, t1
Unit:	Years
Description:	Time in interval between measurements of sample plots
Measured/ Calculated / Default:	Measured
Source of data:	Project
Value(s) of monitored parameter:	5 years
Monitoring equipment:	NA
Measuring/ Reading/ Recording frequency:	Monitoring period corresponding to each periodic verification
Calculation method (if applicable):	NA
QA/QC procedures:	Checked as part of project monitoring
Purpose of data:	Calculation of carbon stock change between monitoring periods
Additional comment:	

<b>Data / Parameter:</b>	$A_{\text{BiomassBurn},t}$
Unit:	ha
Description:	Area affected in the biomass burn
Measured/ Calculated / Default:	Measured
Source of data:	Project monitoring
Value(s) of monitored parameter:	19.07 ha
Monitoring equipment:	Field survey/GPS
Measuring/ Reading/ Recording frequency:	Measured subsequent to the occurrence of a fire event
Calculation method (if applicable):	NA
QA/QC procedures:	Checked as part of project monitoring
Purpose of data:	Calculation of project emissions

Additional comment:	The methodology does not require estimation of emissions from natural fires. Therefore, area affected in natural fires was monitored but not considered in the estimation of project emissions.
---------------------	---

### D.3. Implementation of sampling plan

>> Sampling plan has been implemented as per the monitoring plan and described in the sub-sections below:

#### D.3.1 Ex post stratification:

In the registered PDD, ex ante stratification of the project activity was conducted based on the stand models proposed for implementation in three land use categories (restoration forestry; community forestry; and farm forestry on private degraded lands); in three altitudes ranges (low– 600 to 1,100 meters; medium–1,100 to 1,400 meters; and high – 1,400 to 1,800 meters) of the project, which translate into 9 project strata as summarized below.

- Restoration forestry: low, medium and high strata
- Community forestry: low, medium and high strata
- Farm forestry, : low, medium and high strata

Some areas of the project strata were not planted by the end of the first monitoring period. As a consequence, the ex post stratification was conducted at the end of the first monitoring period taking into account progress in the area planted in the project strata. In the ex post stratification, all unplanted areas of the project are grouped into a separate stratum, i.e. 10th stratum of the project. The details of stratification of the project are presented in the table D.1 and the stratification worksheet of the ER calculation sheet (Annex I to the Monitoring Report).

**Table D.1: Ex post stratification of the project**

Ex ante stratification (presented in the registered PDD)				Ex post stratification (at the end of the monitoring period)			
S. No	Stratum	Area (ha)	No. of sample plots	S. No	Stratum	Area (ha)	No. of sample plots
1	Forest_Low	976.20	35	1	Forest_Low	931.56	35
2	Forest_Medium	969.7	35	2	Forest_Medium	876.73	35
3	Forest_High	1230.9	45	3	Forest_High	1,136.54	45
4	Community_Low	125.3	14	4	Community_Low	107.69	14
5	Community_Medium	666.9	8	5	Community_Medium	56.66	8
6	Community_High	100.8	11	6	Community_High	60.69	10
7	Private_Low	232.1	9	7	Private_Low	16.95	2
8	Private_Medium	221.4	8	8	Private_Medium	22.79	2
9	Private_High	79.7	3	9	Private_High	6.08	1
				10	Area not planted	787.38	
	Total area	4,003.07	168		Total area	4,003.07	152

Out of the 168 sample plots proposed in the registered for monitoring and measurement of the carbon stock changes in the tree biomass, a total of 152 sample plots were laid out during the first monitoring period, which were also remeasured at the end of the second monitoring period in 2017. The difference in the proposed and actual number of sample plots laid out is due to the small area planted in the strata of the private land category.

#### D.3.2 Sampling design

As part of the sampling design, sampling units (grids in the land parcels of a stratum; and location of sample plots within a grid) were identified following statistical procedures.

The 9 planted strata were included in the sampling design. The area not planted designated as 10<sup>th</sup> stratum of *ex post* stratification was not included in the sample frame as there is no carbon stock in these areas for measurement. Therefore, the sampling design includes the planted area of 9 project strata referred under the *ex post* stratification in Table D.1

The standard operating procedures for forest inventories recommended by the Forest Survey of India were adopted in the sampling design and in location of sample plots in the field. Stratified random sampling was followed for selecting the land parcels for location of sample plots, which is summarized below.

- All Parcels in strata were arranged sequentially in increasing order of the parcel area such that equal representation / weightage was given to each ha of land parcel in the project.
- The areas of land parcels were divided into 1 ha grids, resulting in each land parcel of the project is represented with equivalent number of 1 ha grids in each parcel.
- Random numbers were generated using three/four and five-digit table of random numbers, which were divided by the total number of 1 ha grids of a stratum (for example, 3742 (random number) /973 (number of 1 ha grids in a stratum, i.e. area of stratum).
- Digit number of remainder was identified as selected (for example, 3742/973 and the remainder is 823) grid for laying out the sample plot. This exercise was repeated till grids equivalent to the number of sample plots assessed as part of sample size estimation were selected in a stratum enabling random selection of the grids for locating sample plots.

### D.3.3 Sample size

Based on average growth rates of the species included in the project, a total of 168 sample plots were assessed in the registered PDD as per the procedure of the tool for “Calculation of the number of sample plots for measurements within A/R CDM project Activities, Version 02” for the assessment of changes in the carbon stock of the project during the monitoring period.

At the end of the first monitoring period, a total of 152 sample plots were laid out for measurement of carbon stock changes of the monitoring period. The number of sample plots lay out in the degraded forest land strata and degraded community land strata are same as those assessed for these strata in the registered PDD. The fewer number of sample plots in the degraded and abandoned private land strata (relative to those noted in the registered PDD) was due to the small proportion of area planted in the private land strata.

The list of sample plots along with their strata and location details are presented in **Annex I** (ER Calculation spreadsheet) of the Monitoring Report.

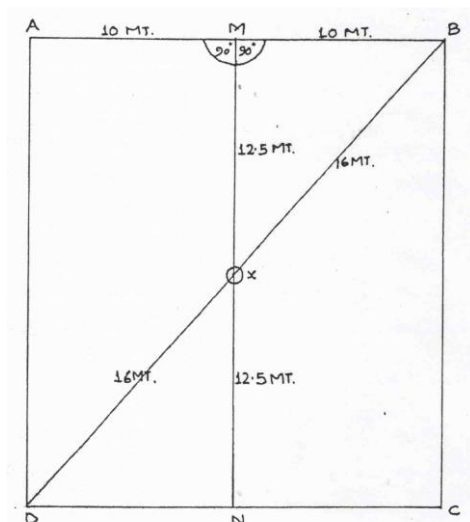
### D.3.4 Locating sampling plots

To avoid subjective choice in location of plots within a randomly selected grid, the permanent sample plots were located following systematic procedure. The rectangle sample plot of size 500 sq.mt (0.05 ha) in each selected land parcel grid was located based on the difference of the longitude and latitude intervals of the extreme points of a land parcel. The sample plot location in the field was accomplished with the help of a GPS and the GPS coordinates of each sample plot was recorded and archived. The list of sample plots along with GPS coordinates of latitude and longitude is included in the worksheet on list of sample plots in the ER calculation spreadsheet (Annex I to the Monitoring Report).

### D.3.5 Layout of sample plots

Detailed trainings were conducted to train field team members in the layout of the sample plots and in the conduct of tree biomass measurements on the sample plots. For the layout of the sample plots, the centre point of each sample plot was fixed with a peg and GPS co-ordinates were recorded. With the help of a rope, lines of 12.5 meters in the north – south direction on either sides of the centre point were marked, and perpendicular lines with respect to the end points of 12.5 meter lines were also marked. The 10 meters width either side of the centre point on perpendicular line was measured and the parallel and perpendicular lines were connected to establish a rectangle of size 25\*20 meters plot. The accuracy of the plot dimensions was also checked with diagonal method. The figure D.1 below illustrates the layout of sample plots in the land parcels of the project strata.

**Figure D.1: Diagram representing sample plot layout in the land parcels of project strata.**



### D.3.6 Calibration of the equipment used in measurement of sample plots.

The equipment used in the measurement of carbon stock on sample plots is listed below.

- Metal/cloth tapes for measuring distances
- Global Positioning System (GPS) for locating plots
- Plot center markers for marking plots
- Caliper measuring for tree diameter at breast height (dbh)
- Pole with graduated scale and Haga altimeter for measuring height of tree species

The equipment was calibrated prior to use in the field by following standard operating procedures of forest inventory to avoid errors in the measurement of carbon stock. The details of calibration of the equipment are presented in the Table D.2 below.

**Table D.2. Calibration record of the equipment**

Item	Name/Type/ serial number	Date of calibration	Uncertain y	Remarks
Metal/cloth tape for measuring distances	Commercial	16-08-2017	None	As per the procedures of forestry inventory
Global Positioning System (GPS) for locating sample plots	Garmin GPS 76	16-08-2017	+/- 3 to 6 meters	As per the procedures of the user manual
Caliper for measuring tree diameter	Vernier Caliper	16-08-2017	None	As per the procedures of forestry inventory
Pole for measuring	Commercial	16-08-2017	None	As per the procedures

Item	Name/Type/ serial number	Date of calibration	Uncertainty	Remarks
tree height				of forestry inventory
HAGA Altimeter	Commercial	16-08-2017	None	As per the procedures of forestry inventory

### D.3.7 Assessment of adequacy of the sample size

The sample size estimated in the registered PDD was based on average growth rates of tree species selected for planting in the project. During sample plot measurements it was observed that the growth rates of the tree species in the project were significantly below the average growth rates of tree species used for estimation of sample size in the registered PDD. The severely degraded status of lands in the project, including steep slopes of land parcels, and delayed planting schedule were major factors in the smaller than anticipated growth rates. During the measurements, it was observed that the DBH of tree species on several plots was below the minimum DBH threshold. The biomass of the plots with trees below minimum DBH threshold was considered zero for the monitoring period.

The biomass estimated from the sample plot measurements was assessed for compliance with 90/10 confidence/precision requirements. As per the "Guidelines on application of specified versions of A/R CDM methodologies in verification of registered A/R CDM project activities" (Version 01.1) (EB68, Annex31)<sup>14</sup>, the allowable error of  $\pm 10\%$  of the expected mean biomass carbon stock per plot in living trees was used for assessing the compliance with confidence/precision requirements.

The assessment showed that less than anticipated growth rates of tree species due to degraded status of lands, steep slopes of parcels, high variability in biomass growth rates, and several sample plots with trees smaller than the minimum DBH threshold were the factors in the biomass estimate of the project not meeting the 90/10 confidence/precision requirements.

It was not feasible to increase the sample size for the reasons of inclement weather and high costs associated with the lay out and measurement of additional sample plots on steep slopes and difficult geographic conditions of the project strata. In this context, the guidance of the A/R Methodological Tool (AR Tool 14) *Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities, version 04.2* was used to assess the uncertainty in the biomass estimate of the project.

As per the paragraph 22 of the AR Tool 14,

If uncertainty ( $u_{\Delta c}$ ) is greater than 10 per cent, then the project proponent may decide to either:

(a) Install additional sample plots; or

Increase in the number of sample plots to address the variability in the biomass estimate was considered. However, because of the inclement weather conditions and high costs associated with layout and measurement of additional sample plots on difficult geographic conditions of the project, it was not feasible to install additional sample plots for meeting the 90/10 confidence/precision requirements.

(b) Accept a deduction in the estimated change in carbon stocks of biomass.

Based on the equation 6 of the AR Tool 14, *Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities, version 04.2*, the uncertainty ( $u_{\Delta c}$ ) of 17.57% was assessed in the tree biomass estimate. The calculation of uncertainty is presented in

<sup>14</sup> [https://cdm.unfccc.int/Reference/Guidclarif/ar/methAR\\_guid30.pdf](https://cdm.unfccc.int/Reference/Guidclarif/ar/methAR_guid30.pdf)

the *Biomass\_AR Tool 14 V04.2 worksheet* of the ER calculation spreadsheet (Annex I to the MR). As this value is greater than 10%, per the guidance noted in the paragraph 22 and Appendix 2 of the AR tool 14, version 04.2, uncertainty associated with the tree biomass was estimated, and appropriate discount was applied to the project biomass to calculate the carbon stock change in the biomass of the project.

## SECTION E. Calculation of emission reductions or net anthropogenic removals

### E.1. Calculation of baseline emissions or baseline net removals

>> The *ex ante* baseline net GHG removals by sinks accounting for above and belowground biomass is insignificant and are considered **zero**. As per the PDD (para E3, page 74), the baseline carbon stock changes also need not be monitored during the project crediting period.

### E.2. Calculation of project emissions or actual net removals

#### >> Estimation of changes in the carbon stocks

The verifiable changes in the carbon stock in tree above-ground biomass and below-ground biomass within the project boundary are estimated as per the equations of the AR ACM0001 Version 03 referenced below.

$$\Delta C_p = \sum_{t=1}^{t^*} \Delta C_t * \frac{44}{12} * 1year - E_{BiomassLoss} \quad \text{Equation (13) of AR ACM0001 Version 03}$$

where:

$\Delta C_p$	Sum of the changes in carbon pools in above-ground and below-ground tree biomass, and soil organic carbon in the project scenario; t CO <sub>2</sub> -e
$\Delta C_t$	Annual change in carbon stock in above-ground and below-ground tree biomass, and soil organic carbon pools for year $t$ ; t C yr <sup>-1</sup>
$E_{BiomassLoss}$	Increase in CO <sub>2</sub> emissions from loss of existing woody biomass due to site-preparation (including burning), and/or to competition from forest (or other vegetation) planted as part of the A/R CDM project activity; t CO <sub>2</sub> -e
$t$	1, 2, 3, ... $t^*$ years elapsed since the start of the A/R project activity; yr
44/12	Ratio of molecular weights of CO <sub>2</sub> and carbon; t CO <sub>2</sub> -e (t C) <sup>-1</sup>

$\Delta C_t$  has been estimated using the following equation:

$$\Delta C_t = \sum_{i=1}^{M_{PS}} (\Delta C_{AG,i,t} + \Delta C_{BG,i,t} + \Delta C_{DW,i,t} + \Delta C_{LI,i,t} + \Delta C_{SOC,i,t}) \quad \text{Equation (14) of AR ACM0001 Version 03}$$

1. where:

$\Delta C_t$	Annual change in carbon stock in all carbon pools for year $t$ ; t C yr <sup>-1</sup>
$\Delta C_{AG,i,t}$	Annual carbon stock change in above-ground biomass of trees for stratum $i$ , (possibly average over a monitoring period); t C yr <sup>-1</sup>
$\Delta C_{BG,i,t}$	Annual carbon stock change in below-ground biomass of trees for stratum $i$ , (possibly average over a monitoring period); t C yr <sup>-1</sup>
$\Delta C_{DW,i,t}$	Annual change in the dead wood carbon pool in stratum $i$ ; t C yr <sup>-1</sup> (per the registered PDD, this pool is excluded from project monitoring and accounting)
$\Delta C_{LI,i,t}$	Annual change in the litter carbon pool in stratum $i$ ; t C yr <sup>-1</sup> (per the registered PDD, this pool is excluded from project monitoring and accounting)

$\Delta C_{SOC,i,t}$	Annual carbon stock change in the soil organic carbon pool for stratum $i$ , time $t$ , t C yr <sup>-1</sup>
$i$	1, 2, 3, ... $M_{PS}$ strata in the project scenario
$t$	1, 2, 3, ... $t^*$ years elapsed since the start of the A/R CDM project activity

Changes in the deadwood and litter carbon pools that are excluded from monitoring and accounting are set equal to zero.

### ***Aboveground and Belowground Tree Biomass***

The carbon stock change in above-ground and below-ground tree biomass per unit area was estimated on the basis of field measurements in permanent sample plots. For this purpose, Biomass Expansion Factors (*BEF*) method has been used. The

The methodology AR ACM0001, version 03; and AR Methodological Tool 14, version 04.2 follow similar steps in the estimation of carbon changes of above ground and below tree biomass. While the notations used for some variables used in the estimation of carbon stock changes in biomass under the AR ACM0001, version 03 methodology; and AR Methodological Tool 14, version 04.2 are different. As the AR Tool 14, version 04.2 has been approved recently and it incorporates provisions for addressing uncertainty in carbon stock estimates of the aboveground and below ground biomass pools, the AR Tool 14, version 04.2 has been adopted to estimate the changes in carbon changes of above ground biomass and below tree biomass in the ER calculations spreadsheet (Annex I to the MR).

**Step 1:** Measurements of diameter at breast height (*DBH*, at typically 1.37 m above-ground level), and height (*H*), of the trees above minimum *DBH* of 2 cm were conducted on the permanent sample plots

**Step 2:** Stem volume of trees was estimated based on volume equations

Majority of the species adopted in the project are native species. The volume equations of species proposed for planting were included as an Annex to the registered PDD. Subsequent to the registration of the project, EB approved A/R Methodological Tool "*Demonstrating appropriateness of volume equations for estimation of aboveground tree biomass in A/R CDM project activities* (EB67, Annex 24)", According to the paragraph 5 of the tool; the volume equations applied to the project context should meet at least one of the three following criteria.

- (a) The equation is used in the national forest inventory, or the national GHG inventory of the host Party;
- (b) The equation has been used in commercial forestry sector of the host Party for 10 years or more;
- (c) The equation was derived from a data set of at least 30 sample trees, and the value of coefficient of determination ( $R^2$ ) was not less than 0.85.

During the monitoring period, the volume equations proposed in the project were checked for their compliance with the criteria of the paragraph 5 of the A/R Methodological Tool. It was assessed that major proportion of volume equations of species included in the registered PDD have been adopted in the national forest inventory and published in the official publication, *Volume Equations of for India, Nepal and Bhutan* by the Forest Survey of India, a national institution under the Ministry of Environment and Forests, Government of India; and a nodal agency for forest inventory in India. Therefore, most volume equations listed in the registered PDD confirm to the criteria (a), paragraph 5 of the AR Tool noted above. It was noticed that some volume equations listed in the registered PDD produce erroneous volume estimates. Moreover, during project implementation, additional species were planted in the project or species that had low survival were replaced with other species that were not listed in the registered PDD. In such cases, the volume equations of tree species confirming to the criteria (a), paragraph 5 of the AR Tool and listed in the official publication, *Volume Equations of for India, Nepal and Bhutan* were adopted. For species that did

not have species specific published volume equations, the volume equations of the rest of the species category in the official publication, *Volume Equations of for India, Nepal and Bhutan* were adopted. The updated volume equations listed in the standard values worksheet of the ER calculation sheet (Annex I to the MR) comply with the criteria (a) of the paragraph 5 of the AR Tool noted above.

The above procedures ensure that the volume equations adopted for the project comply with the guidelines of the AR methodological tool on the appropriateness of volume equations in the project.

**Step 3:** Application of *BEF* to convert the stem volume into total above ground tree volume.

The BEF values of species proposed for planting were included in the registered PDD. During the project implementation some planted species that did not survive were replaced with other suitable species. Consequently, for the species that did not have species specific BEF values, the average BEF of the rest of the species planted in the project was adopted. The BEF of the project species is listed in the standard values worksheet of the ER calculation sheet (Annex I to the MR).

**Step 4:** The above ground tree volume converted into biomass by multiplying with basic wood density.

The wood density values of species proposed for planting were included in the registered PDD. During the project implementation some planted species that did not survive were replaced with other suitable species. Consequently, for the species that did not have species specific wood density values, the average wood density of the rest of the species planted in the project was adopted. The wood density of the project species is listed in the standard values worksheet of the ER calculation sheet (Annex I to the MR).

$B_{TREE\_l,j,i,p,i} = V_j(x_{1,l}, x_{2,l}, x_{3,l}, \dots) * D_j * BEF_{2,j} * (1 + R_j)$  Equation (5) Appendix 1, AR Tool 14 Version 04.2

where:

$B_{TREE\_l,j,p,i}$	Biomass of tree <i>l</i> of species <i>j</i> in sample plot <i>p</i> of stratum <i>i</i> ; t d.m.
$V_j(x_{1,j}, x_{2,j}, x_{3,j}, \dots)$	Stem volume of tree <i>l</i> of species <i>j</i> in sample plot <i>p</i> of stratum <i>i</i> , estimated from the tree dimension(s) as entry data into a volume table or volume equation; m <sup>3</sup>
$D_j$	Wood density (over-bark) of tree species <i>j</i> ; t d.m. m-3
$BEF_{2,j}$	Biomass expansion factor for conversion of stem biomass to above-ground tree biomass for species <i>j</i> ; dimensionless
$1+R_j$	Root-shoot ratio for tree species <i>j</i> ; dimensionless

The calculations of aboveground and belowground tree biomass are presented in the worksheet on tree biomass of the ER calculation spreadsheet (Annex I to the MR).

**Step 5:** Estimation of change in carbon stock in trees between two points in time – As per the section 6.2, paragraphs 19 and 20 of the AR Tool 14, version 04.2, estimation of change in carbon stock by re-measurement of sample plots uses the below equations.

$$\Delta C_{TREE} = \frac{44}{12} * CF_{TREE} * \Delta B_{TREE} \quad \text{Equation (3) AR Tool 14 Version 04.2}$$

$$\Delta B_{TREE} = A * \Delta b_{TREE} \quad \text{Equation (4) AR Tool 14 Version 04.2}$$



$$\Delta b_{TREE} = \sum_{i=1}^M w_i * \Delta b_{TREE,i}$$

Equation (5) AR Tool 14 Version 04.2

$$u_{\Delta C} = \frac{t_{VAL} * \sqrt{\sum_{i=1}^M w_i^2 * \sum_{i=1}^M w_i^2 * \frac{s_{\Delta,i}^2}{n_i}}}{\Delta b_{TREE}}$$

Equation (6) AR Tool 14 Version 04.2

where:

$\Delta C_{TREE}$  Change in carbon stock in trees between two successive measurements; t CO<sub>2</sub>e

$CF_j$  Carbon fraction of tree biomass; t C (t d.m.)<sup>-1</sup> (IPCC default value = 0.5 t C t.d.m)

$\Delta B_{TREE}$  Change in tree biomass within the biomass estimation strata; t d.m. (The change in tree biomass  $\Delta B_{TREE}$  refers to  $B_{TREE}$  for the first monitoring period as the tree biomass attributable prior to the start of the project is zero).

$A$  Sum of areas of the biomass estimation strata; ha

$\Delta b_{TREE}$  Mean change in tree biomass per hectare within the biomass estimation strata; t.d.m. ha<sup>-1</sup>

$w_i$  Ratio of the area of stratum  $i$  to the sum of areas of biomass estimation strata (i.e.  $\wedge$ ); dimensionless

$\Delta b_{TREE,i}$  Mean change in carbon stock per hectare in tree biomass in stratum  $i$ ; t d.m. ha<sup>-1</sup>  
Uncertainty in

$u_{\Delta C}$  Uncertainty in  $\Delta C_{TREE}$

$t_{VAL}$  Two-sided Student's  $t$ -value for a confidence level of 90 per cent and degrees of freedom equal to  $n - M$ , where  $n$  is total number of sample plots within the tree biomass estimation strata, and  $M$  is the total number of tree biomass estimation strata

$s_{\Delta,i}^2$  Variance of mean change in tree biomass per hectare in stratum  $i$ ; (t d.m. ha<sup>-1</sup>)<sup>2</sup>

$n_i$  Number of sample plots, in stratum  $i$ , in which tree biomass was re-measured

The ER calculation spreadsheet (Annex I to the MR) presents the details of this step in the worksheet, Biomass\_AR Tool14, Version 04.2.

**Step 6:** As per the paragraph 21 AR Tool 14, version 04.2, mean change in tree biomass per hectare in a stratum and the associated variance estimated per the equations below.

$$\Delta b_{TREE,i} = \frac{\sum_{p=1}^{n_i} \Delta b_{TREE,p,i}}{n_i}$$

Equation (7) AR Tool 14, Version 04.2

$$s_{\Delta,i}^2 = \frac{n_i * \sum_{p=1}^{n_i} \Delta b_{TREE,p,i}^2 - (\sum_{p=1}^{n_i} \Delta b_{TREE,p,i})^2}{n_i * (n_i - 1)}$$

Equation (8) AR Tool 14, Version 04.2

where:

$\Delta b_{TREE}$  Mean change in tree biomass per hectare in stratum  $i$ ; t d.m. ha<sup>-1</sup> .

$\Delta bTREE_{p,i}$	Change in tree biomass per hectare in plot $p$ in stratum $i$ ; t d.m. ha-1
$s^2_{\Delta,i}$	Variance of mean change in tree biomass per hectare in stratum $i$ ; (t d.m. ha-1) <sup>2</sup>
$n_i$	Number of sample plots, in stratum $i$ , in which tree biomass was re-measured

**Step 7:** As per the paragraph 22, AR Tool 14, version 04.2, if uncertainty estimated using equation (6) is greater than 10 per cent, the project biomass estimate is made conservative by applying uncertainty discount as per the procedure laid out in Appendix 2 of AR Tool 14. The ER calculation spreadsheet (Annex I to the MR) presents the details of this step in the worksheet, Biomass\_AR Tool14, Version 04.2.

In the Biomass AR Tool 14 V04.2 worksheet of the ER calculation spreadsheet (Annex I to the MR), the  $u_{\Delta c}$  calculated as per the equation 6, AR Tool 14, version 04.2 was 19.17% (column Y13). As per the Table 1, Appendix 2, AR Tool 14, version 04.2, if the uncertainty is between  $15 < U \leq 20$ , a discount of 50% of the standard deviation of the biomass per ha has to be applied to calculate the uncertainty value.

Accordingly, discount for uncertainty is calculated for each stratum and the project. The calculation of discount for uncertainty in the GHG removals by sinks for the project is presented below.

Discount for uncertainty in GHG removals by sinks for the project in CO<sub>2</sub>e

= 50% of the weighted standard deviation of the biomass (t.d.m/ha)\* project area (sum of area of project strata) \*(44/12).

= 6745.41 t CO<sub>2</sub>e (column AE13 of the Biomass AR Tool 14 V04.2 worksheet of the ER calculation spreadsheet (Annex I to the MR))

**Step 8:** The change in carbon stock of trees in CO<sub>2</sub>e for the monitoring period ( $\Delta CTREE$ ) is calculated by subtracting the discount for uncertainty (column AF13 of the Biomass AR Tool 14 V04.2 worksheet of the ER calculation spreadsheet (Annex I to the MR))

### Soil Organic Carbon

The rate of change in SOC stock in project scenario was estimated as per the latest version of *A/R Methodological Tool - Tool for estimation of changes in soil organic carbon stocks due to the implementation of A/R CDM project activities*, version 01.1.0 (EB 60 Annex 12). The parameters used for calculation of carbon stock changes in soil organic carbon are presented in the approved spreadsheet of the AR Tool on SOC, version 01.1.0.

Considering that the published information on climate and soil type of project area was not available, expert opinion was sought on the climate and soil type information applicable to the project area. In this context, the expert noted below was consulted.

Dr. K.S. Kapoor, Senior Scientist and Head, Soil and Biodiversity Division, Himachal Pradesh Forest Research Institute, Conifer Campus, Panthghati, Shimla, Himachal Pradesh 171 009

Based on the expert opinion, the project area was categorized as corresponding to the warm temperate moist climate, and with sandy soils. (soils of Shiwalik hills and mid Himalayan degraded slopes are sandy and have soil low carbon status). The SOC<sub>Ref</sub> value corresponding to the warm temperate moist/sandy soils in the Table 3 of the AR tool 16, version 1.1.0 was adopted for the reference SOC stocks of the lands included in the project.

The project complies with all the applicability conditions of the tool as described below.

(a) The areas of the project to which this tool is applied:

- (i) Do not fall into wetland category: None of the project areas fall in the category wetlands.
- The areas of the project do not fall into the category of wetland. This has been confirmed by the information from cadastre and field visits conducted during project design, implementation, and site visits during validation and verification.
- (ii) Do not contain organic soils as defined in Annex A: glossary of the IPCC GPG LULUCF 2003:
- The project soils are not organic soils and comply with the requirements 1 and 2 of the glossary of IPCC GPG LULUCF 2003.
- (iii) Are not subject to any of the land management practices and application of inputs as listed in the Tables 1 and 2;
- The project soils are not subjected to management practices and input applications listed in Table 1 of the "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" (Version 01.1.0).
- (b) The A/R CDM project activity meets the following conditions:
- (i) Litter remains on site and is not removed in the A/R CDM project activity;
- Litter is accumulated throughout the period of forest establishment and growth and remains undisturbed in the project area during entire rotation period of the forest.
- (ii) Soil disturbance attributable to the A/R CDM project activity is:
- In accordance with appropriate soil conservation practices;
    - Soil disturbance from site preparation in the project activity is as per the land management and soil conservation practices of the Government of Himachal Pradesh.
    - There is a limited soil disturbance from site preparation in the project activity and the site disturbance is not repeated within 20 year period.

$$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i} \quad \text{Equation (1) AR Tool\_SOC , Version 01.1.0}$$

where:

$SOC_{INITIAL,i}$	SOC stock at the beginning of the A/R CDM project activity in stratum $i$ of the areas of land; t C ha <sup>-1</sup>
$SOC_{REF,i}$	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation. normally forest) by climate region and soil type applicable to stratum $i$ of the areas of land; t C ha <sup>-1</sup>
$f_{LU,i}$	Relative stock change factor for baseline land-use in stratum $i$ ; the land use factor of grassland is adopted as the lands under the baseline are degraded lands and pastures. As per A/R Methodological Tool - <i>Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities</i> , Table 6, Annex 12, EB60, land use factor of 1.0 is applied.
$f_{MG,i}$	Relative stock change factor for management regime, dimensionless; as per A/R Methodological Tool - <i>Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities</i> , Table 6, Annex 12, EB60; the management factor of 0.7 for severely degraded lands is applied.
$f_{IN,i}$	Relative stock change factor for baseline inputs in stratum $i$ of the areas of land; dimensionless. No inputs are used in the baseline, therefore as per A/R Methodological Tool - <i>Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities</i> , Table 6, the input factor of 1.0 is applied.

$i = 1, 2, 3, \dots$  strata of project, dimensionless.

The values  $SOC_{REF,i}$ ,  $f_{LU,i}$ ,  $f_{MG,i}$ , and  $f_{IN,i}$  are taken from the Table 3 and Table 6 of AR Tool. The climate regime applicable to the project is warm temperate moist as per the IPCC climate zones<sup>15</sup> and soils of  $SOC_{REF}$  stock for mineral soil corresponding to sandy soils in Table 3 of AR Tool has been adopted.

$$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i}$$

$$SOC_{INITIAL,i} = 34 * 1.0 * 0.7 * 1.0$$

$$= 23.8 \text{ t C ha}^{-1}$$

There has been less than 10% site disturbance due to site preparation activities. Therefore, as per the paragraph 9 of the tool, equation 2 of A/R Methodological Tool, the soil carbon loss is zero.

$$SOC_{loss,i} = 0 \quad \text{Equation (3) AR Tool _SOC, Version 01.1.0}$$

where:

$SOC_{loss,i}$  = Loss of SOC caused by soil disturbance attributable to the A/R CDM project activity, in stratum  $i$  of the areas of land; t C ha<sup>-1</sup>

$i = 1, 2, 3, \dots$  strata of the project, dimensionless

The rate of change in SOC stock in project scenario until the steady-state SOC content is reached is estimated as follows:

$$dSOC_{t,i} = 0 \quad \text{for } t < t_{\text{prep},i} \quad \text{Equation (4) AR Tool _SOC, Version 01.1.0}$$

$$dSOC_{t,i} = \frac{SOC_{LOSS,i}}{1 \text{ year}} \quad \text{for } t = t_{\text{prep},i} \quad \text{Equation (5) AR Tool , Version 01.1.0}$$

$$dSOC_{t,i} = \frac{SOC_{REF,i} - (SOC_{INITIAL,i} - SOC_{LOSS,i})}{20} \quad \text{for } t_{\text{prep},i} < t \leq t_{\text{prep},i} + 20 \quad \text{Equation (6) AR Tool _SOC, Version 01.1.0}$$

where:

$dSOC$  Rate of change in SOC stock in stratum  $i$  of the areas of land in year  $t$ , t C ha<sup>-1</sup>yr<sup>-1</sup>

<sup>15</sup> [http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4\\_Volume4/V4\\_03\\_Ch3\\_Representation.pdf](http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_03_Ch3_Representation.pdf)

Approved spreadsheet to facilitate the calculation of changes in soil organic carbon showing IPCC major climate zones, Annex to A/R Methodological Tool - *Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities*

$t_{PREP,i}$	The year in which first soil disturbance takes place in stratum $i$ of the areas of land
$SOC_{LOSS,i}$	Loss of SOC caused by soil disturbance attributable the A/R CDM project activity in stratum $i$ of the areas of land; t C ha <sup>-1</sup>
$SOC_{REF,i}$	Reference SOC stock corresponding to the reference condition in native lands (i.e. non-degraded, unimproved lands under native vegetation, normally forest) by climate region and soil type applicable to stratum $i$ of the areas of land; t C ha <sup>-1</sup>
$SOC_{INITIAL,i}$	SOC stock at the beginning of the A/R CDM project activity in stratum $i$ of the areas of land; t C ha <sup>-1</sup>
$i$	1, 2, 3, ... strata of project, dimensionless
$t$	1, 2, 3, ... years elapsed since the start of the A/R CDM project activity

$$dSOC_{loss,i} = \frac{34 - (23.8 - 0)}{20} = 0.51$$

As per the tool, the rate of change of SOC stock is 0.51 t C ha<sup>-1</sup> yr<sup>-1</sup>

$t_{equilibrium}$  = Time period in years for increase in SOC to reach equilibrium. The A/R tool adopted 20 years as the  $t_{equilibrium}$

The change in SOC stock for all the strata of the areas of land, in year  $t$ , is calculated as:

$$dSOC_{i,t} = \frac{44}{12} * \sum_i A_i * dSOC_{i,t} * 1year$$

Equation (8) AR Tool \_SOC, Version 01.1.0

where:

$\Delta SOC_{i,t}$	= Change in SOC stock in areas of land meeting the applicability conditions of this tool, in year $t$ ; t CO <sub>2</sub> e
$A_i$	= The area of stratum $i$ of the areas of land; ha
$dSOC_{t,i}$	= The rate of change in SOC stocks in stratum $i$ of the areas of land; t C ha <sup>-1</sup> yr <sup>-1</sup>
$i$	= 1, 2, 3, ... strata of project, dimensionless.

The ER calculation spreadsheet (Annex I to the MR) presents the details of carbon stock changes in the Soil Organic Carbon in the worksheet, \_Soil Carbon.

### Actual Net GHG Removals by Sinks

The actual net GHG removals by sinks of the project in terms of CO<sub>2</sub>e corresponding to the equation 13 of AR ACM0001, version 03 includes the carbon stock change in aboveground biomass and belowground biomass; and soil organic carbon.

The calculations of carbon stock changes in the aboveground and below ground biomass adjusted for uncertainty correspond to the equations of the AR Tool 14, Version 04.2; and calculation of carbon stock changes in soil organic carbon conducted correspond to the equations of AR Tool for estimation of carbon stock changes in SOC , Version 01.1.0.

The calculation of actual net GHG removals by sinks of the project is presented in the worksheet - Actual Net GHG Removals – in the ER calculation spreadsheet (Annex I to the MR).

#### E.2.1 Project emissions

The project did not use biomass burning in site preparation. During project implementation few isolated fire events were identified and measures were implemented to control them.

The emissions related natural fires events are insignificant and the methodology does not foresee their estimation. Therefore, the project emissions related to natural fire events are ignored in the calculation of actual net GHG removals by sinks. Area affected in the fire events was replanted during the subsequent planting period. The table below shows the details of fire affected parcels:

**Table E2: Detail of fire Events occurred during the monitoring period 01-01-13 to 31-12-17**

Sr. No.	Name of Division	Name of Gram Panchyat	Parcel ID	Area effected (Ha)	Remarks
1	Kullu	Kotla	KL048F1	1.00	
2		Chong	KL026F1	0.40	
3		Aut	KL048F1	0.30	
4		Gahar	KL007F2	0.80	
5	Nahan	Mahipur	NH006C3	2.94	
6	Nahan	Nehar Swar	NH008C1	1.68	
7	Namhol	Rajpura	NM004F1	0.92	
8	Solan	Sadiyana	SL033C4	1.23	
9	Solan	Thor Niwar	SL039C1	3.00	
10	Solan	Poudhna	SL027C2	3.00	
11	Swarghat	Rod Jamon	SG039F5 to F8	2.2	
12	Swarghat	DABAT	SG038F1 to F3	1.6	
	<b>Total</b>			<b>19.07</b>	

### E.3. Calculation of leakage emissions

>> The potential sources of leakage relevant to A/R CDM project was assessed based on the guidance presented in the latest version of the A/R Methodological Tool, "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activity (Version 01)".

As per the guidance of the above A/R Tool, the project is not subject to leakage emissions attributable to displacement of pre-project for the following reasons.

- (a) There has been no pre-project agricultural activity in the areas included in the project, which confirms that there is no displacement of agricultural activities.
- (b) The grass/fodder production in the project is greater than the grass production in the baseline, which clarifies that if the planned AR-CDM project activity produces more grass or fodder than the base activity, leakage due to conversion of land for grazing need not be accounted (page 68, Section D2 of PDD).

The A/R CDM project has also implemented the following measures to minimize potential leakage from the grazing:

- Grass production under the A/R CDM project is estimated to be twice the pre-project grass production<sup>16</sup>.
- Local communities are permitted to harvest and stall feed the livestock
- Under the watershed development project, there are activities that promote stall feeding to avoid grazing

<sup>16</sup> Integrated Watershed Development Project, Kandi Final Report; and monitoring and evaluation report of the Integrated Watershed Development Project (Hills)-II in Himachal Pradesh.

- Under the watershed project the farmers are encouraged to shift to high yielding or crossbred cows, which are stall-fed, thereby avoiding the need for their grazing.

$$LK = 0$$

Therefore, leakage emissions associated with the project are assessed to be **zero**.

#### E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO <sub>2</sub> e)	Project GHG emissions or actual net GHG removals (t CO <sub>2</sub> e)	Leakage GHG emissions (t CO <sub>2</sub> e)	GHG emission reductions or net anthropogenic GHG removals (t CO <sub>2</sub> e)		
				Before 01/01/2013	From 01/01/2013	Total amount
<b>Total</b>	0	145,829	0		145,829	145,829

#### E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO <sub>2</sub> e)	Amount estimated ex ante (t CO <sub>2</sub> e)
145,829	438,641

#### E.6. Remarks on increase in achieved emission reductions

>> During the monitoring period, growth rates of the tree species in the project have been observed to be significantly below the average growth rates of tree species in the registered PDD. The severely degraded status of lands in the project, steep slopes of land parcels and dependency of plantation areas on natural rains resulted in low survival rate of plantations. Against projected coverage of 4003.07 ha, the actual area tackled remained 3215.69 ha which contributed to smaller than anticipated carbon stock. Also a few species show slower rate of growth in initial stages under unfavourable conditions, resulting in low amount of carbon stock accumulation and the resulting GHG removals by sinks relative to the values estimated ex ante in the registered PDD.

## Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> <li>• Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN);</li> <li>• Make editorial improvements.</li> </ul>
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> <li>• Include provisions related to delayed submission of a monitoring plan;</li> <li>• Provisions related to the Host Party;</li> <li>• Remove reference to programme of activities;</li> <li>• Overall editorial improvement.</li> </ul>
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> <li>• Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0));</li> <li>• Include provisions related to standardized baselines;</li> <li>• Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1;</li> <li>• Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>;</li> <li>• Editorial improvement.</li> </ul>
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory		
Document Type: Form		
Business Function: Issuance		
Keywords: monitoring report		