CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES (CDM-AR-PDD) Version 04

CONTENTS

Annexes

SECTION A. General description of the proposed A/R CDM project activity:

A.1. Title of the proposed A/R CDM project activity:

Title: Bagepalli CDM Reforestation Programme
Version: 7
Date: 1st April 2011

A.2. Description of the proposed A/R CDM project activity:

The purpose of the proposed A/R CDM project activity "Bagepalli CDM Reforestation Programme" is to implement a reforestation activity on the degraded agricultural land of 5 taluks of Chickballapur District of Karnataka, India. These lands are currently private uncultivable lands, fallow lands or marginal croplands belonging to farmers. They are all highly degraded. The majority of the lands are uncultivable or their productivity is very low due to scarcity of water resources and poor soil conditions for agriculture. The lands belong to the poorest farmers and agricultural labourers in the region who have had to make do with acquiring the worst kind of lands. Seasonal conditions have been the major factor causing fluctuation in the area under cultivation. The periodic drought and recurring scarcity have made any kind of land-based activity including agriculture very difficult.

The proposed reforestation activity on such degraded lands is of great promise. It will generate income to the marginal farmers, not only from the produce but mainly from the sale of carbon credits. The proposed project activity will thus play a vital role in poverty alleviation. The project is thus designed to create long-term secure income for marginal farmers in the Bagepalli, Chickballapur, Chintamani Gudibanda and Siddalaghatta taluks of Chickballapur District, as well as creating a lasting tree cover in the region. It will thus have beneficial effect beyond the project boundary in that there may be beneficial effect on the local micro-climate as well as on community and biodiversity.

Chickballapur District is a very dry region. The rainfall is scanty, and the nominal forest area is just 6.18% of the total area of the old Kolar district[1] (FSI, 2009)[2]. In practice many of the forests are also very degraded. The proposed project is essential for a District like Chickballapur. But the project proponents are not taking up any activities on Forest Department or Revenue lands belonging to the Government. The reforestation is only taking place on the marginal private lands of members of the Bagepalli Coolie Sangha organized by the Project Proponent, an NGO - Agricultural Development and Training Society (ADATS). ADATS[3] is working with 39,070 small and poor peasant families in 899 villages of the 5 taluks of Chickballapur district, Karnataka, in South India for the past 33 years. ADATS is a comprehensive rural development organisation working in the fields of Community Organisation, Adult Literacy, Children's Education, Community & Referral Health, Legal Aid & Aid Distress, Dry Land

[1] 6 taluks of former Kolar district have been separated and named Chickballapur district. Chickballapur district was carved out of Kolar district on 23rd August 2007 (http://chikballapur.nic.in/district_profile.html). The 6 taluks includes Gowribidanur, Gudibanda, Bagepalli, Chintamani, Siddalaghatta and Chickballapur taluks. Many of the discussions in the PDD are done for Kolar District, as statistics have been compiled for the formerly Kolar District, which is inclusive of the project area.

[2] Source: State of Forest Report, Forest Survey of India, Ministry of Environment and Forests, Government of India 2009. http://www.fsi.nic.in/sfr_2009.htm

[3] http://www.adats.com

Development, Agriculture, alternate Credit, Women's Programmes, etc. ADATS also work on issues of gender justice, secularism and democratisation. All these are efforts to empower the Coolie caste-class in village society, and build an authentic people's organisation, the Coolie Sangha, at the Village, Cluster and Taluk levels.

Apart from producing fruits, and some small amounts of firewood and fodder, the indirect benefits of the "Bagepalli CDM Reforestation Programme" will be by way of moisture conservation in the soil, prevention of soil erosion, improvement of soil fertility by the addition of organic manure, reduction of soil cutting due to run-off water from the hillocks, and maintenance of the regular flow of water in the streams.

The view of the project participant is that this A/R CDM project activity provides a substantial contribution to sustainable development.

- It will generate income and improve the environmental well-being of local marginal farmer families.
- It will improve soil and control water erosion: the production of litter and nutrient recycling enrich the soil with organic matter and essential nutrients, and the trees act as a barrier to water run-off and roots hold the soil in place.
- It will sequester carbon dioxide (CO_2) that can be measured, monitored and certified.
- It will decrease vulnerability to current climate change and climatic variability
- It will engage in capacity building through training and technical assistance.
- It will reforest 8933.34 hectare with local mixed species trees on degraded lands in 5 taluks of Chickballapur District namely Bagepalli, Chickballapur, Chintamani, Siddalaghatta and Gudibanda.
- It will monitor and assess the project's environmental and socio-economic impacts.
- It will sell Certified Emission Reductions (lCERs).

The A/R CDM project activity is proposed on marginal farmer's lands that have an average land holding of less than a hectare (0.72 ha). These farmers do not have the financial wherewithal to invest in planting activities and wait for several years for the financial benefits to accrue. Without the pre-project investment from carbon credits, it is not an economically feasible proposition. With the sales of carbon credit however, and with the collection of non-timber forest products (NTFPs), firewood and fodder, farmers will have enough benefits to make the A/R CDM project activity sustainable.

The species for planting were chosen by participating local families who selected local species[4] which are suited for the agro-climatic zone. The main species are *Mangifera indica*, *Anacardium occidentale*, and *Tamarindus indica*. Other species such as *Annona squamosa*, *Azadirachta indica*, *Ceiba pentandra*, *Leuceana leucocephala*, *Pongamia pinnata*, *Syzygium cummini and Zizypus jujuba* will be planted depending on their soil and water conditions and personal preferences. No Invasive Alien Species (IAS) or Genetically Modified Organisms (GMO) will be used.

A.3. Project participants:

Please list project participants and Party(ies) involved and provide contact information in Annex 1. Information shall be indicated using the following tabular format.

[4] http://www.worldagroforestry.org/Sites/TreeDBS/TreeDatabases.asp

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Indicate if the Party involved wishes to be considered as a project participant (Yes/No)
India (host)	Agricultural Development and Training Society (ADATS)	No

A.4. Description of location and boundaries of the A/R CDM project activity:

A.4.1. Location of the proposed A/R CDM project activity:

A.4.1.1. Host Party(ies):

India

A.4.1.2. Region/State/Province etc.:

Karnataka and Andhra Pradesh

A.4.1.3. City/Town/Community etc:

Bagepalli, Chickballapur, Chintamani, Gudibanda and Siddalaghatta Taluks[5] of Chickballapur District, Karnataka. 1 Village (Shastrolapalli) in Chilamathur Mandal[5] of Ananthapur District, Andhra Pradesh.

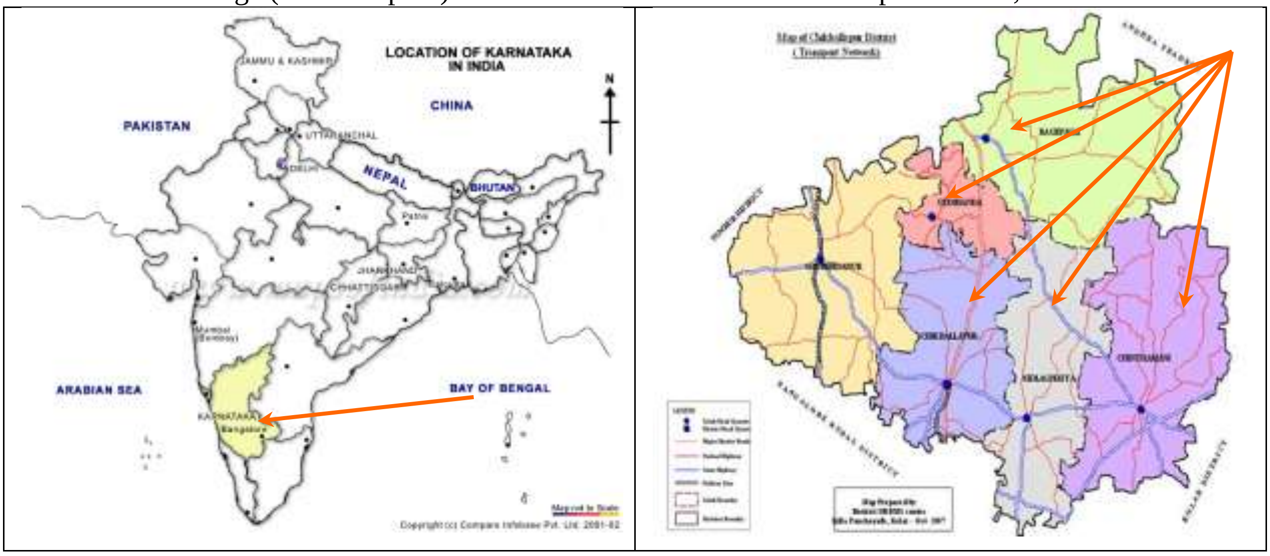

Figure A.4.1: Map showing Karnataka State and the 5 taluks in Chickballapur district where the project will be implemented.

[5] Taluk or Mandal consists of a city or town that serves as its headoffice, along with additional towns, and a number of villages. As an entity of local government, it exercises certain fiscal and administrative power over the villages and municipalities within its jurisdiction. It is the ultimate executive agency for land records and related administrative matters.

A.4.2 Detailed geographic delineation of the project boundary, including information allowing the unique identification(s) of the proposed A/R CDM project activity:

Geographical location: Chickballapur is the easternmost District of Karnataka. It is bounded in the north by Anantapur District of Andhra Pradesh, in the east by Anantapur, Chittoor and Cuddapah Districts of Andhra Pradesh and North Arcot District of Tamil Nadu, in the west by Bangalore Rural and Tumkur Districts of Karnataka and in the south by Chittoor District of Andhra Pradesh and Dharampuri District of Tamil Nadu. It is carved out of the old Kolar District and is situated between 12^{o} 46' and 13^{o} 58' north latitudes and between 77^{o} 21' and 78^{o} 35' east longitudes. Chickballapur District spans over a distance of about 84 kilometres from north to south and over roughly 67 km distance from east to west. The taluks are situated between the following latitudes and longitudes.

Taluk	Latitude	Longitude
Bagepalli	13°35' and 13°58' North	77°4' and 78°05' East
Chickballapur	13°2' and 31°39' North	77°33' and 77°5' East
Siddalaghatta	13°13' and 13°4' North	77°45' and 77°58' East
Gudibanda	13°36' and 13°47' North	77° 35' and 77°49' East
Chintamani	13°15' and 13°21' North	78° 51' and 78°1' East

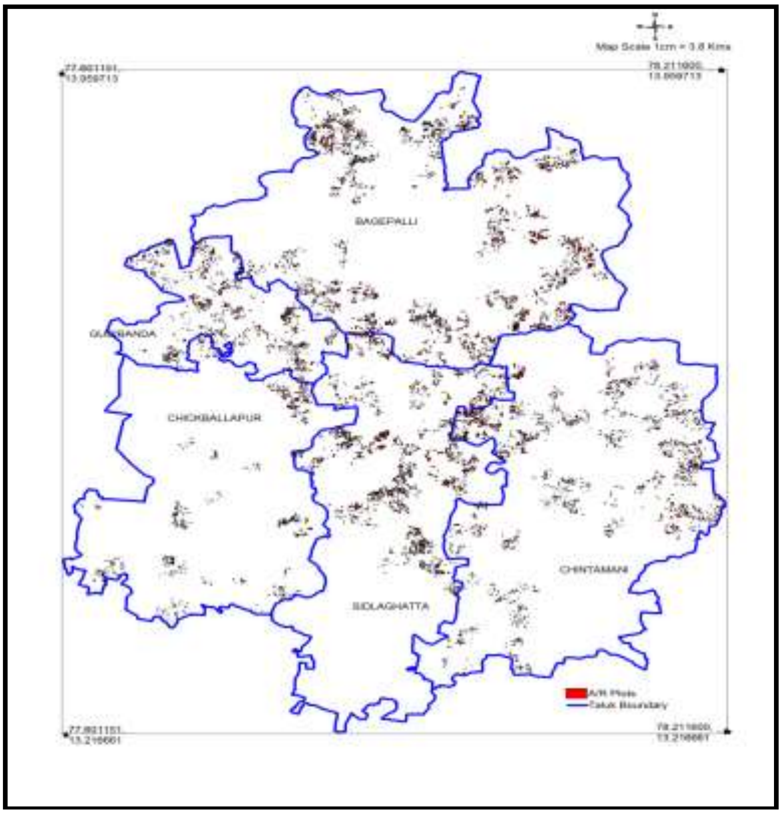

Fig A4.2: Project boundary of the A/R project

Project boundary: The project boundary is as set and shown in Fig A4.2. The A/R CDM project contains more than one discrete area of land as shown in Fig A4.2 in the 5 taluks and in some of the villages of neighbouring Anantapur taluk falling in Andhra Pradesh and Karnataka. The project will encompass 12,347 parcels of lands in 394 villages. In all, the A/R CDM project involves 8,107 families on 8933.34 hectare of land. The details of each parcel of land – unique geographical identification, the farmer's name, and the details of land are enclosed in Appendix 1. A summary of the details are as follows:

Table A4.1: Details of participating families in the A/R project activity

Taluk	Total Number of Village	Number of families	Number of Plots	Area (ha)
Bagepalli	122	2,659	4203	3071.76
Chickballapur	45	865	1349	670.97
Chintamani	107	2011	2907	2227.05
Gudibanda	49	907	1337	934.59
Siddalaghatta	70	1611	2497	1983.32
Chilamathur (AP State)	1	54	54	45.65
Total	**394**	**8,107**	**12,347**	**8933.34**

According to the Guidance on application of the definition of the project boundary to A/R CDM project activities, version 01, EB 44, the area of land for which control over the A/R CDM project activity is already established at validation should be at a minimum 2/3 (66%) of the total area of land planned for A/R CDM project activities. Accordingly the area that is currently under the control established at validation is 100% or **8,933.34** ha under the A/R project activity.

Applying AR-AM0004 version 4, EB 50, each discrete parcel of land has a unique geographical identification. The boundary is defined for each discrete parcel. The discrete parcels of lands are defined by polygons, and to make the boundary geographically verifiable and transparent, the GPS coordinate for corners of polygons are measured, recorded, archived and listed. Fig A.4.3A-E shows the boundary of each discrete area of plots for the 5 taluks of project boundary. Each discrete area of land is identified by a unique geographical identification, which is listed in Appendix 1. The boundary of each discrete plot is defined for each discrete area and does not include the areas in between these discrete parcels of land.

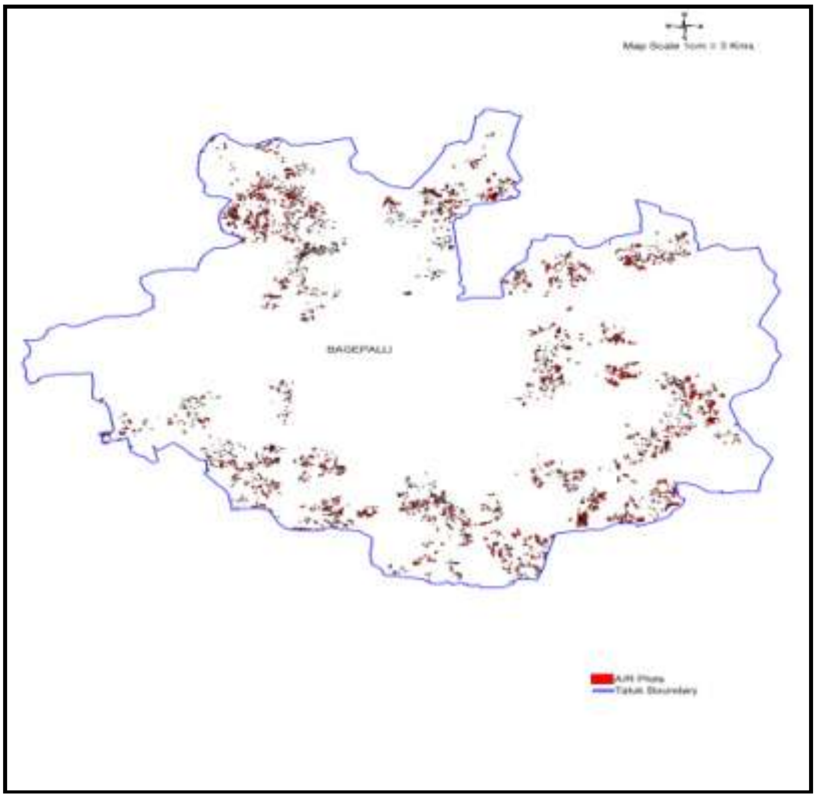

Fig A.4.3A: Map showing the boundary for each discrete area for Bagepalli Taluk

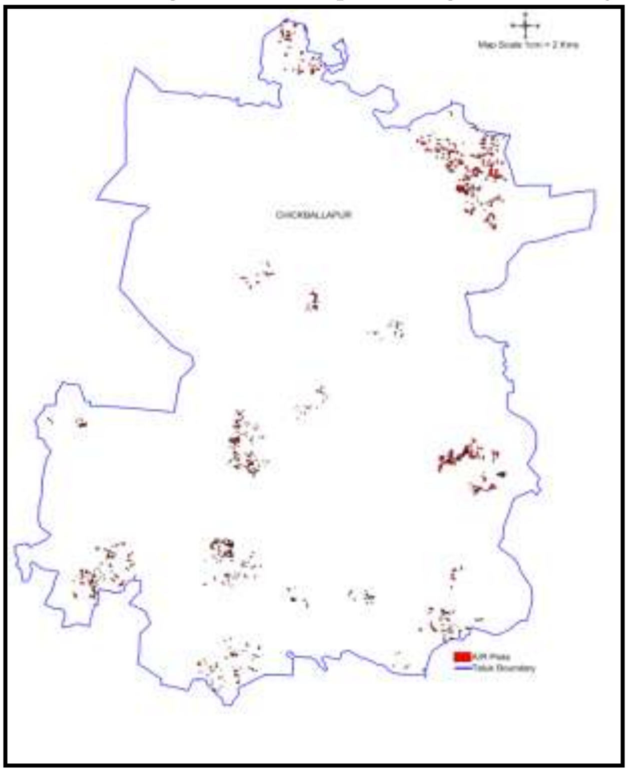

Fig A.4.3B: Map showing the boundary for each discrete area for Chickballapur Taluk

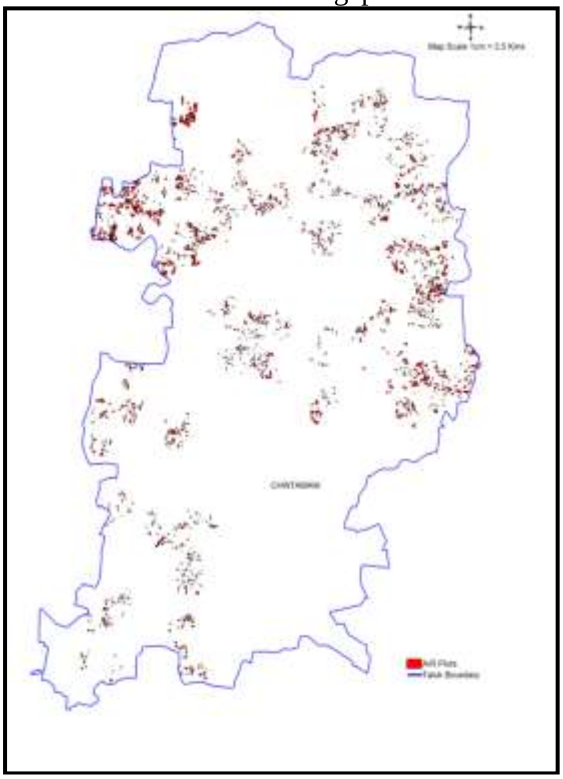

Fig A.4.3C: Map showing the boundary for each discrete area for Chintamani Taluk

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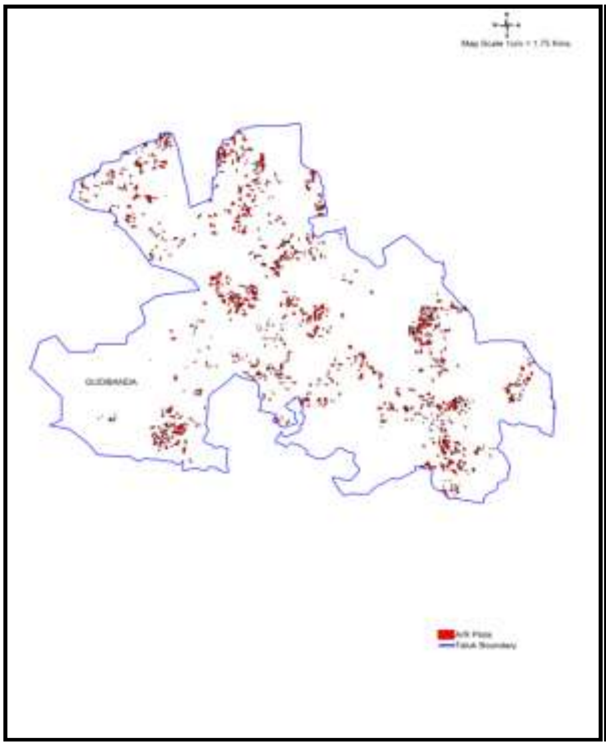

Fig A.4.3D: Map showing the boundary for each discrete area for Gudibanda Taluk

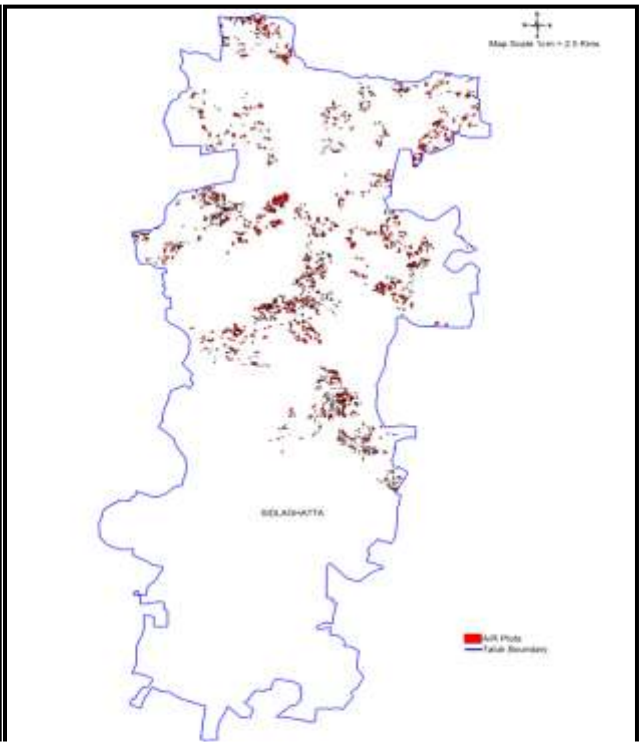

Fig A.4.3E: Map showing the boundary for each discrete area for Siddalaghatta Taluk

A.5. Technical description of the A/R CDM project activity:

A.5.1. Description of the present environmental conditions of the area planned for the proposed A/R CDM project activity, including a concise description of climate, hydrology, soils, ecosystems (including land use):

Climate: Chickballapur district has an agreeable climate. The year may be divided into four seasons. The dry season with clear bright weather is from December to February. The period from March to May constitutes the hot season and the south-west monsoon season is from June to about end of October. November is the retreating monsoon season. The average rainfall of the region is 786 mm and the maximum temperature of the district is 36° C and minimum is 16-18° C.

Table A.5.1: Average climate conditions in the taluks of project area

Taluk	Annual Rainfall* (mm)
Bagepalli	**679.2**
Chintamani	**690.1**
Chickballapur	**771.2**
Gudibanda	**808.3**
Siddalaghatta	**753.0**

*** - last 50 years average**

Hydrology and geology: There are no perennial rivers in the district. Most of these are small and carry water only during the rainy season. Three important rivers of the old Kolar District, namely, Palar, North

Pinakini or North Pennar and South Pinakini or South Pennar and several of their tributaries take their birth in the district and flow in different directions receiving the drainage of the intermediate tracts of the District. The project area consists of immense expanse of peninsular gneisses rocks (Fig A5.1). The schistose rocks in this region are poor aquifers and yield poor quality water in very less quantity. In the absence of major sources of water like rivers, the district depends heavily on groundwater. But the groundwater table has receded beyond 600 feet depth. This has resulted in failure of most tube wells and has led to high fluoride content in drinking water, causing bone, dental and other physical deformities (Raju *et al*., 2004)[6]. The main water source for cultivation is rain water. The district receives rains on an average for about 48 days in a year. Most of the crops are dependent on monsoons. Monsoon in this district is unpredictable because of which rainfall varies and leads to drought situation. So farmers have to depend on underground water for their cultivation. Again most of the tanks get water only from rain. The water table in the district has gone deep to around 650 feet because of scarcity of rain.

Soils: Based on surface soil texture (NBSS&LUP), the soils of Chickballapur district are divided into sandy, loamy, clayey and rocky (Fig A5.2). The red loamy region extends from south to north of the district comprising of Chickballapur and major parts of Siddalaghatta taluk. The water table in this type of soils is between 400 to 500 feet deep. The gravelly soil region is found in parts of Gudibanda and Chintamani taluks. The water table in these types of soils is between 500 to 600 feet deep. The clay loam soil is found in Chickballapur and parts of Siddalaghatta and Bagepalli taluk. Around Siddalaghatta, lateritic masses occur irregularly distributed in disconnected patches in the form of flat topped hills. The soils in Chickballapur district have a normal soil reaction and here and there they tend towards alkalinity. Due to land degradation many lands are uncultivable and may only improve after intensive soil treatment. The A/R CDM project activity will improve the soil by providing additional mulching material to the soil and providing shading, water retention capacity and prevention of soil erosion and surface soil runoff. As can be seen from the Fig A5.1, most of the areas in the proposed project area situated in Chickballapur are classified as severe problem soils.

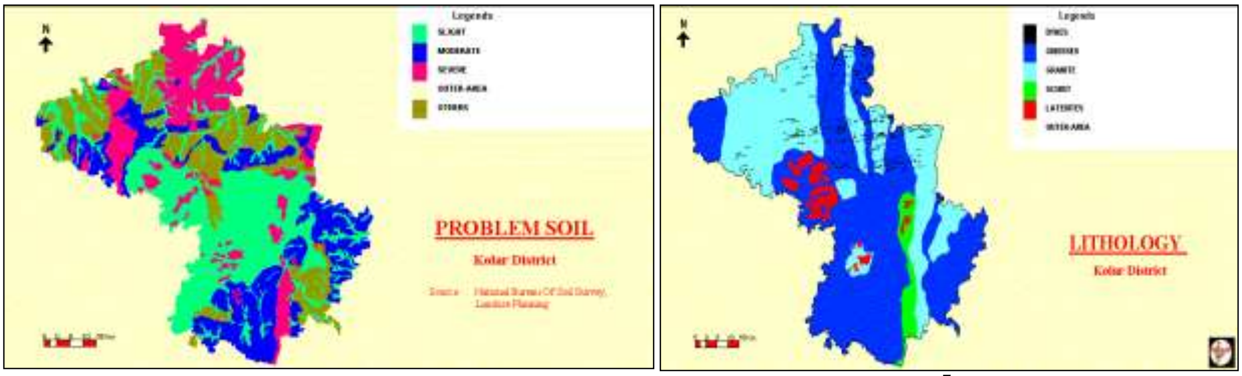

Fig A5.1: Soil condition and lithology of Kolar district.[7]

[6] K.V. Raju, N. Praveen, B.K. Anand,. 2004. Groundwater in Urban Market: Can it Sustain? A case study of Kolar city in south India. http://www.cerna.ensmp.fr/cerna_globalisation/Documents/Raju-paris.pdf

[7] Source: http://www.csre.iitb.ac.in/adi/maps/prob-s.gif; http://www.csre.iitb.ac.in/adi/maps/litholog.gif

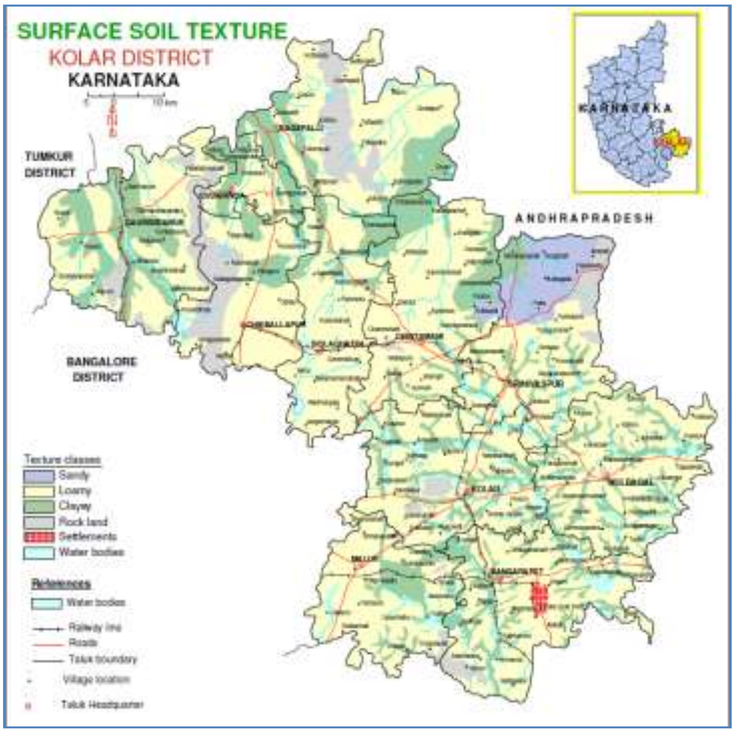

Fig A5.2: Surface soil texture status of Kolar district (source: NBSS&LUP)

Ecosystems

Composition of forests in the project area: The forests of Chickballapur are typical of the plain tracts of Karnataka. The stocking of the forests is poor. The trees are stunted and branchy, with diffused crown. The soil is poor and shallow and rains are scanty. Such conditions support only stunted growth. There are large extents of thorn forests. The forests have been heavily exploited in the past for extracting firewood and for manufacturing charcoal. Large extents of thorny, scrubby and deciduous forests were also cleared to plant mostly Eucalyptus hybrid under various schemes. The forests on inaccessible steep slopes, however, remain unworked. Even in the unexploited areas the vegetation is mostly stunted (Working plans, Kolar District, 2002).

Number of districts: 27 (area in km^2)

District	Geographical area	Very dense forest	Mod. dense forest	Open forest	Total	% of G.A.	Change*	Scrub
Kolar	8,223	0	59	449	508	6.18	-2	283

The satellite imagery of Kolar district (consisting also of Chickballapur district), shows that 6.18% of area is forests[2] (Fig A5.3). Of the geographic area of Kolar District, the area under dense forests (with canopy cover greater than 70%) is zero; moderately dense forests (canopy cover between 40-70%) accounts for 0.72%; open forest accounts for 5.46% (canopy cover between 40-10%) and scrub forests accounts for 3.44% (less than 10% canopy cover)[2].

Fig 7.13 : Forest cover map of Karnataka

Fig A5.3: Forest Cover map of Karnataka (Source: FSI, 2009)

The common species in the region are Chigare, Pachali, Bikke, Kakke, Kagli, Dindiga, Naviladi, Sandal, Devadari, Kukarthi, Honne, Hunal, Bevu, Honge, Jagalaganti, Alale, Jalari, Mathi etc. Small bamboo (Medri) is found growing in some of the areas in valleys. Big bamboo (Dowga) is seen along the banks of rivers and streams at some places. The undergrowth mostly consists of Lantana, Badabakka, Devavare, Uelachi, Bandarike, and various Grasses. The forest types recognized in Chickballapur district division as per the Working Plan of Kolar, the GIS map (KSRSAC – Fig A7.1) and classification of Champion and Seth (1968) are as under:

5A / C3: Southern Tropical Dry Mixed Deciduous Forests: In this type of forests, dry deciduous species occur and tend to become thorny with increased heavy grazing. Poor quality bamboos are present in some pockets. Grass is conspicuous, herbs are scattered and climbers are few. The approximate extent of such forest is around 20 % of total forest area of Kolar Forest Division. The most common and characteristic trees found are *Anogeissus latifolia (Dindiga), Terminalia tomentosa (Mathi), Chloroxylon swietenia (Hurugalu), Santalum album (Srigandha), Melia composita (Hebbevu), Acacia catechu (Katha), Hardwickia binata (Kamara), Cassia fistula (Kakke), Diospyros montana (Jagalaganthi), Diospyros melanoxylon (Thupra).*

5A / DS 1 Southern Tropical Dry Deciduous Forests: In this type low broken cover of shrubby growth of 1 to 3 metres in height, is found. The trees usually develop branches from the base. The grass occurs through out the tract. The approximate extent of such forest is around 45% of total forest area of Kolar Forest Division. The floristic composition are *Acacia leucophloea (Bilijali), Albizzia amara (Chigara, Thugali), Dalbergia paniculata (Nayibeete, Pachali), Azadiracta indica (Bevu), Euphorbia antiquorum*

(Pirukalli, Mundukalli), Pterolobium indicum (Badubukalu), Cassia fistula (Kakke), Lantana camara (Lantana), Opuntia dillenii (Papaskalli).

6A / C1 Southern Tropical Thorn Forests: These are low open forests with thorny, xerophytic species. *Acacia* species are characteristic of this type. The trees usually have short boles with low branching crowns. The lower canopy is made up of shrubs, mostly spiny and xerophytic. Climbers are few. The herbs and grass make up the lowest level. *Acacias* are met in combination with *Zizyphus* species and stunted *Anogeisus latifolia*. Patches of fleshy *Euphorbias* are not infrequent. The approximate extent of such forest is around 15% of total forest area of Kolar Forest Division. The floristic composition is *Acacia catechu* (Kaggali), *Acacia leucophloea* (Bilijali), *Acacia nilotica* (Jali), *Flacourtia indica* (Devadari), *Euphorbia nivulia*, *Chloroxylon swietenia* (Hurugalu), *Ixora arborea*, *Strychnos potatorum* (Chiligida, Chittadamara), *Cassia auriculata* (Thangadi), *Dodonea viscosa* (Kanagalu), etc.

6A / DS 1 Southern Thorn Scrub: In this type there is further degradation due to biotic and edaphic factors, resulting in the formation of almost thorny bush, with surviving trees seen here and there. Spiny, xerophytic climbers are met with. In further degraded areas grasses are more abundant. The approximate extent of such forest is around 20% of total forest area of Kolar Forest Division. The floristic composition is *Albizzia amara* (Chujjulu, Thugali), *Chloroxylon swietenia* (Hurugalu), *Wrightia tinctoria* (Hale), *Randia dumetorum* (Kare, Maggare), etc.

General condition of the forests: The rainfall being scanty and the rivers and streams remaining dry for a large part of the year, the area is for the most part, devoid of vegetation, and scarcity conditions are very common. Extensive plantations have been raised in the division since many years. However, because of relatively hostile conditions and inadequate post-planting cultural operations, indigenous species have generally not done well. Some of the exotic species introduced in these plantations such as Karpuradagida or Nilgirigida (*Eucalyptus* species), Ballari jali (*Prosopis juliflora*), Sime thangadi (*Cassia siamia*), Sisso (*Dalbergia sisso*) and Sarvemara (*Casuarina equisetifolia*) have fared better in relatively favourable sites.

Repeated illicit felling of plants and even of coppice shoots has rendered the forests of the district almost barren. The soil is exposed to sheet and gully erosion, except in the areas where coppice and bushy growth still survives. *Lantana* has spread gregariously over the area. The weed has now become the major source of fuel in the absence of better species. Xerophytic condition prevails with its characteristic species. Several pure patches of *Shorea talura* (Jalari) occur in some state forests, like that of Sambar kaval. *Buchanania angustifolia* (Maradi) predominates yielding an important minor forest produce (Working Plan, Kolar district, 2002).

Fauna: Owing to the absence of thick forests, there is not much cover for wild animals. Wild game is practically unknown in the district. In the Nandi hill ranges, occasional visitations of panthers are known. Black bucks and deer are found, though in small number, in the unfrequented parts, which have a little forest growth. In the hill slopes and valleys, several kinds of reptiles are found, cobras being very common. The district has no sanctuary or national park. The wild animals and birds found in the district are, The Indian Gerbill, Mongoose, Blackbuck, Blacknaped Hare, The Fourhorned Antelope, Palm squirrel, The Leopard, The Indian Wild Boar, Jackal, Indian Pangolin, Fox, Indian Otter, Jungle Cat, Ratel, Small Indian Civet, Slender Loris, The Common Palm civet, Porcupine, Striped Hyena, white tailed wood rat, Bonnet Macaque, Indian Bush Rat and Sloth bear.

A.5.2. Description of the presence, if any, of rare or endangered species and their habitats:

There are no records of endangered species in the project site. The baseline survey conducted in the project area comprising of 84% of the project area does not register any rare or endangered species, the ecosystem being agricultural lands. The project activity will be established in areas which are in states of degradation.

There is no presence of endangered or rare species which can be threatened or displaced by the establishment of the project activity. On the contrary, the reforestation of these degraded areas with tree stand models will benefit the species of fauna and flora, in comparison with the baseline cases. Changing the marginal agricultural lands to forestry models should improve the habitat in several ways. Banyan (Aala) or Peepal (Arali) are considered the keystone species. The updated list for India contains 483 species of animals listed as endangered or vulnerable.[8] The project activity being southern dry deciduous forest eco-region contains seventy-five species of mammal fauna, of which 7 are on the red List:

Hipposideros hypophyllus, or Kolar leaf-nosed bat.

It was previously listed as Vulnerable. Improved information since then has resulted in the species being upgraded to endangered status. This recently described endemic species requires urgent follow-up studies to determine its distribution, population status and threats to its survival. The species is known from only two localities in the Chickballapur District. Extent of occurrence and area of occupancy are estimated as < 5,000 km^2 and < 500 km^2, respectively. Available habitat has decreased in quality and area (by at least 20%) over the last six years due to deforestation and mining activity.

- The critically endangered Salim Ali fruit bat *Latidens salimalii* is a near-endemic species in the region.
- *Cuon alpinus* – the wild dog
- *Melursus ursinus* – the sloth bear
- *Tetracerus quadricornis* – Chousingha
- *Bos gaurus* – Gaur
- *Ratufa macruora* – grizzled giant squirrel

Loris lydekkerianus – Slender Loris, though not endangered, is rare. It was spotted in Malur, Kolar District in 1981. The Indian Star Tortoise *Geochelone elegans,* is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Schedule IV of the Indian Wildlife (Protection) Act 1972, making the trade of the species illegal.

The eco-region's bird fauna consists of about 260 species, of which two are near-endemic species. *Turdoides subrufus* Rufous babbler, and *Pycnonotus xantholaemus* Yellow-throated bulbul. The Yellow throated bulbul is on the vulnerable list.

Two species in this eco-region, the Indian Bustard (*Ardeotis nigriceps*) and Lesser Florican (*Eupodotis indica*), are globally threatened and warrant conservation attention.

Aquila clanga, or Greater Spotted Eagle, is endangered. It has been spotted in the area.

There is an endemic endangered plant species in the region listed on the Red List. It is:

[8] Export IUCN Red List August 1st 2007

- *Cycas Beddomei*, a medicinal plant, known from Cuddapah Hills in Andhra Pradesh State, north-west of Madras in eastern Peninsular India, and into Chickballapur District. Characteristically a species of dry, open hill slopes, in open grassy woodland or grassland.

A.5.3. Species and varieties selected for the proposed A/R CDM project activity:

The species for planting were chosen by participating local families who selected local species which are suited for this agro-climatic zone. The main species are *Mangifera Indica* (Mango), *Tamarindus indica* (Tamarind) and *Anacardium occidentale* (Cashew). Other economically important dry land trees such as *Azadirachta indica* (Neem), *Pongamia pinnata* (Kanniga), *Leuceana leucocephala* (Subabul), will be planted depending on their soil and water conditions and personal preferences.

Table A5.2: Species/Model selected for the A/R project

Species/Model	No. of Trees/ ha	Spacing
Model 1: Mango Model		
Mangifera indica	*256*	6 x 6 m
Pongamia pinnata	*45*	30.5 x 30.5 m
Zizypus jujuba	*45*	30.5 x 30.5 m
Syzygium spp	*45*	30.5 x 30.5 m
Leuceana leucocephala	*45*	30.5 x 30.5 m
Annona squamosa	*45*	30.5 x 30.5 m
Azadirachta indica	*20*	9 x 9 m
Ceiba pentandra	*20*	9 x 9 m
Total	***521***	
Model 2: Cashew Model		
Anacardium occidentale	*256*	6 x 6 m
Pongamia pinnata	*45*	30.5 x 30.5 m
Zizyphus jujuba	*45*	30.5 x 30.5 m
Syzygium spp	*45*	30.5 x 30.5 m
Leuceana leucocephala	*45*	30.5 x 30.5 m
Annona squamosa	*45*	30.5 x 30.5 m
Azadirachta indica	*20*	9 x 9 m
Ceiba pentandra	*20*	9 x 9 m
Total	***521***	
Model 3: Tamarind Model		
Tamarindus indica	*256*	6 x 6 m
Azadirachta indica	*20*	9 x 9 m
Ceiba pentandra	*20*	9 x 9 m
Total	***296***	

Mangifera Indica is the leading fruit crop of India and considered to be the king of fruits. Besides delicious taste, excellent flavour and attractive fragrance, it is rich in vitamin A&C. The tree is hardy in nature and requires comparatively low maintenance costs.

Climate: Mango can be grown under both tropical and sub-tropical climate from sea level to 1400 m altitude, provided there is no high humidity, rain or frost during the flowering period. Places with good rainfall and dry summer are ideal for mango cultivation. It is better to avoid areas with winds and cyclones which may cause flower and fruit shedding and breaking of branches.

Soil: Mango comes up on a wide range of soils from alluvial to laterite provided they are deep (minimum 6') and well drained. It prefers slightly acidic soils (pH 5.5 to 7.5)

Varieties: Recently some mango hybrids have been released for cultivation by different institutes / universities.

Mallika - It is a cross between Neelam and Dashehari variety. Fruits are medium sized cadmium coloured with good quality, reported to be a regular bearer.
Amrapali - It is a cross between Dashehari and Neelam variety. It is a dwarf vigorous type with regular and late bearing variety. It yields on an average 16 t/ha and about 1,600 plants can be accommodated in one ha.
Mangeera - It is a cross between Rumani and Neelam variety. It is a semi vigorous type with a regular bearing habit. Fruits are medium sized with light yellow coloured skin, firm and fibreless flesh and sweet to taste.
Ratna - It is a cross between Neelam and Alphonso variety. It is a regular bearer and free from spongy tissue. Fruits are medium sized with excellent quality. Flesh is firm and fibreless, deep orange in colour with high TSS (19-21 Brix).
Arka Aruna - It is a hybrid between Banganapalli and Alphonso variety with regular bearing habit and dwarf in stature. About 400 plants can be accommodated per hectare. Fruits are large sized (500-700 gm) with attractive skin colour. Pulp is fibreless, sweet to taste (20-22 Brix). Pulp percentage is 73 and the fruits are free from spongy tissue.
Arka Puneet - It is a regular and prolific bearing hybrid of the cross between Alphonso and the Banganapalli variety. Fruits are medium sized (220-250 gm) with attractive skin colour, having red blush. Pulp is free from fibre, pulp percentage being 70 percent. Fruits are sweet to taste (20-22 Brix) with good keeping quality and free from spongy tissue. It is a good variety for processing also.
Arka Anmol - It is a semi-vigorous plant type from the cross between Alphonso and Janardhan Pasand variety. It is also a regular bearing tree and free from spongy tissues. Fruits ripen to uniform yellow colour. Keeping quality of the fruit is very good and it is suitable for export. It has got excellent sugar and acid blend and fruits weigh on an average about 300 g.

Tamarindus indica belongs to Caesalpinoideae of the Leguminosae family, and is commonly referred to as Tamarind. The Tamarind tree is much loved throughout the semi-arid regions for its deep, cool shade and for its valuable pungent fruits. Less well known are its excellent leaf fodder and high quality timber. It can be grown on a wide range of soils, including slightly saline or alkaline; has a deep tap root and is drought-hardy. The species requires 500 mm annual rainfall to do well, but can be grown with 350 if watered for establishment. It propagates easily by direct sowing, seeding, cutting; it is frost-tender, and relatively slow-growing. The Tamarind is a large tree (height 30m, dbh 1.6m) with a spreading crown up to 12m in diameter. It is a light demander, and grows best in the open. It is deep rooted, wind-firm, very sensitive to frost, and seedlings and saplings require special protection. It is drought resistant, and starts flowering at the age of about 10 years. It is grown on the soils ranging from gravelly to deep alluvial, and thrives best in deep loam which provides optimum conditions for development of its long tap root. It tolerates slightly alkaline or saline soil, and tolerates temperatures up to 47^0 C but is very sensitive to frost and fire. It can be raised by direct sowing in lines behind the plough or in patches of $45cm^2$ dug 30cm deep. The depth of sowing should be about 1.5 cm.

Anacardium occidentale: It is a tree belonging to the family Anacardiaceae. It is widely grown in tropical climates for its cashew nuts and cashew apples. It is a small evergreen tree growing to 10-12m tall, with a short, often irregularly shaped trunk. The leaves are spirally arranged, leathery textured, elliptic to obovate, 4 to 22 cm long and 2 to 15 cm broad, with a smooth margin. The flowers are produced in a panicle or corymb up to 26 cm long, each flower small, pale green at first then turning reddish, with five slender, acute petals 7 to 15 mm long.

Other economically important dry land trees are also being planted. They are *Azadirachta indica (*Neem), *Annona squamosa*, *Pongamia pinnata* (Kanniga), *Syzygium cumini* (Jamun), *zizypus* sps, *Leuceana leucocephala and ceiba pentandra* in lesser numbers. All the participants will plant around 521 trees per hectare, with a typical plot of 1 hectare consisting of 256 trees of either Mango or Cashew at 6 x 6 m spacing with other species in the bund and field. Tamarind model will consist of 256 trees with Ceiba and Neem. The description of these species are as follows:

Syzygium cumini is in the Myrtaceae family and is sometimes referred to as Indian plum. It is high valued for its fruit and as a fodder tree, and produces strong, heavy timber. It grows in moist condition and tolerates water logging, but also survives and is productive, though may be stunted in semi-arid conditions on gravelly and stony sites. It is a large tree growing up to 30 metres in height and attaining 1.3 metres dbh. The tree inhabits a variety of soils from clayey to loamy sands, including swampy conditions. It is found under a wide range of sub tropical and tropical climates with temperature extremes of 2-45^0 C and mean annual rainfall of 500-5000 mm.

Planting will be through nursery raised seedlings or stumps. Fruits are produced in abundance every year. Ripe fruits are collected from the trees or swept from the ground in June to August. No pre-treatment is required for germination. In nursery beds sowing is done in June to July. The germination % of fresh seed is high i.e. 90%. Planting out of entire transplants is done in July to August of the following year. For stump planting the stumps are prepared from 2-3 old plants depending upon their growth. The growth of seedlings is slow during the first year and comparatively fast during the subsequent years. In farmers field it is often planted on bunds. In this case it acts as windbreak around orchards. Syzygium will be planted on bunds at a spacing of 8 m. Thus approximately 45 trees will be planted on bunds per hectare.

Pongamia pinnata: Pongamia pinnata (L.) Pierre (Legununosae, subfamily Papilionoideae) is a medium sized tree that generally attains a height of about 8 m and a trunk diameter of more than 50 cm. It is often planted as an ornamental and shade tree. It is a preferred species for controlling soil erosion and binding sand dunes because of its dense network of lateral roots. Its root, bark, leaf, sap, and flower also have medicinal properties. The trunk is generally short with thick branches spreading into a dense hemispherical crown of dark green leaves. The bark is thin gray to grayish- brown, and yellow on the inside. The alternate, compound pinnate leaves consist of 5 or 7 leaflets which are arranged in 2 or 3 pairs, and a single terminal leaflet. Leaflets are 5-10 cm long, 4-6 cm wide, and pointed at the tip. Flowers, borne on racemes, are pink, light purple, or white. Pods are elliptical, 3-6 cm long and 2-3 cm wide, thick walled, and usually contain a single seed. Seeds are 10-20 cm long, fig oblong, and light brown in color. Native to humid and subtropical environments, pongamia is easily established by direct seeding or by planting nursery-raised seedlings or stump cuttings of 1-2 cm root-collar diameter. Propagation by branch cuttings and root suckers is also possible. Pongamia can grow on most soil types ranging from stony to sandy to clayey, including verticals. A thick yellow-orange to brown oil is extracted from seeds and is used as a fuel for cooking and lamps. The oil is also used as a lubricant, water-paint binder, pesticide, and in soap making and tanning industries. The oil is known to have value in folk medicine for the treatment of rheumatism, as well as human and animal skin diseases. Incorporation of leaves and the presscake into soils improves fertility. Dried leaves are used as an insect repellent in stored grains. The presscake, when applied to the soil, has pesticidal value, particularly against nematodes[9].

Zizypus jujuba: Belongs to the buckthorn family Rhamnaceae. It is a small deciduous tree or shrub reaching a height of 5–10 m, usually with thorny branches. The leaves are shiny-green, ovate-acute, 2–7-cm wide and 1–3-cm broad, with three conspicuous veins at the base, and a finely toothed margin. The flowers are small, 5-mm wide, with five inconspicuous yellowish-green petals. The fruit is an edible oval drupe 1.5–3-cm deep; when immature it is smooth-green, with the consistency and taste of an apple, maturing dark red to purplish-black and eventually wrinkled, looking like a small date. There is a single hard stone similar to an olive stone. The tree tolerates a wide range of temperatures and rainfall, though it requires hot summers and sufficient water for acceptable fruiting. Unlike most of the other species in the genus, it tolerates fairly cold winters, surviving temperatures down to about −15°C. This enables the jujube to grow in desert habitats, provided there is access to underground water through the summer. Virtually no temperature seems to be too high in summertime.

***Leuceana leucocephala* :** It belongs to Family Fabaceae of Mimoseae. It is a tree up to 18 m tall, forked when shrubby and branching strongly after coppicing, with greyish bark and prominent lenticels. Leaves bipinnate with 4-9 pairs of pinnae, variable in length up to 35 cm, with a large gland (up to 5 mm) at the base of the petiole; leaflets 11-22 pairs/pinna, 8-16 mm x 1-2 mm, acute. Flowers numerous, in globose heads with a diameter of 2-5 cm, stamens (10 per flower) and pistil 10 mm long, anthers pilose, dehiscing at dawn. Pod 14-26 cm x 1.5-2 cm, pendant, brown at maturity. Seeds 18-22 per pod , 6-10 mm long, brown. The plant grows on shallow limestone soils, coastal sands and seasonally dry, self-mulching vertisol soils of pH 7.0-8.5. Prefers subhumid and humid climates of 650-1,500 mm and up to 3,000 mm annual rainfall and tolerates up to 7 months dry season. Requires temperatures of 25-30ºC for optimum growth.

Annona squamosa: Annona squamosa a small well-branched tree that bears edible fruits called sugar-apple, species of the genus Annona and member of the family Annonaceae. It is a small, semi-deciduous, much branched small tree 3 metres to 8 metres tall with a broad, open crown or irregularly spreading branches and a short trunk, not buttressed at base. Branches with light brown bark and visible leaf scars, twigs become brown with light brown dots. Thin leaves occur singly, rounded at the base and pointed at the tip. Flowers are solitary or in short lateral clusters. Green outer petals, purplish at the base, oblong, inner petals reduced to minute scales or absent, very numerous stamens; crowded, white, ovary light green. The fruit has delicious whitish pulp, and is popular in tropical markets. Aggregate and soft fruits form from the numerous and loosely united pistils of a flower which become enlarged and mature into fruits which are distinct. The round or heart-shaped greenish yellow, ripened aggregate fruit is pendulous on a thickened stalk; with many round protuberances and covered with a powdery bloom. Fruits are formed of loosely cohering or almost free carpels. The pulp is white tinged yellow, edible and sweetly aromatic. Each carpel containing an oblong, shiny and smooth black, long seed.

***Azadirachta indica*:** Neem is a tree in the mahogany family Meliaceae and native to India, growing in tropical and semi-tropical regions. Neem is a fast-growing tree that can reach a height of 15–20 m. An evergreen tree, the branches are wide spread and the fairly dense crown is roundish or oval and may reach a diameter of 15–20 m. The trunk is relatively short and straight. The leaves are opposite, pinnate with dark green leaflets. Flowers are white and fragrant arranged axillary, normally in more-or-less drooping

[9] http://www.winrock.org/fnrm/factnet/factpub/FACTSH/P_pinnata.html

panicles. The inflorescences, which branch up to the third degree, bear from 150 to 250 flowers. An individual flower is protandrous and the fruit is a smooth, olive-like drupe.

The neem tree is noted for its drought resistance. Normally it thrives in areas with sub-arid to sub-humid conditions. Neem can grow in many different types of soil, but it thrives best on well drained deep and sandy soils. It is a typical tropical to subtropical tree and is a life-giving tree, especially for the dry coastal, southern districts of India. It is one of the very few shade-giving trees that thrive in the drought-prone areas. In India it is very common to see neem trees used for shade lining the streets or in most people's back yards.

In India, the tree is variously known as a 'Sacred Tree'. Products made from neem tree have been used in India for over two millennia for their medicinal properties and it is anthelmintic, antifungal, antidiabetic, antibacterial, antiviral, contraceptive and sedative. All parts of the tree have medicinal properties (seeds, leaves, flowers and bark) and are used for preparing many different medical preparations. Part of the Neem tree can be used as a spermicide. Neem oil is used for preparing cosmetics (soap, shampoo, balms and creams), and is useful for skin care. Besides its use in traditional Indian medicine, the neem tree is of great importance for its anti-desertification properties.

Ceiba pentandra**:** It is a tropical tree of the order Malvales and the family Malvaceae (previously separated in the family Bombacaceae). The tree is also known as Silk cotton or ceiba tree. The tree grows to 60-70 m tall and has a very substantial trunk up to 3 m in diameter with buttresses. The trunk and many of the larger branches are often (but not always) crowded with very large, robust simple thorns. The leaves are compound of 5 to 9 leaflets and palm like. Adult trees produce several hundred seed pods. The pods contain seeds surrounded by a fluffy, yellowish fibre that is a mix of lignin and cellulose. The fibre is light, very buoyant, resilient and resistant to water. The process of harvesting and separating the fibre is labour-intensive and manual. It is difficult to spin but is used as an alternative to fill in mattresses, pillows, upholstery, and stuffed toys and for insulation. The seeds produce an oil that is also used in soap and as fertilizer. The flowers are an important source of nectar and pollen for honeybees.

A.5.4. Technology to be employed by the proposed A/R CDM project activity:

Planting, weed control and fertilization will be applied in a similar manner in all tree stand models.

Establishment: Farmers will get vegetatively propagated, true to type plants from recognised local nurseries. Inarching, veneer grafting, side grafting and epicotyl grafting are the popular methods of propagation in mango, which will be implemented in the project.

Land Preparation: Land will be prepared by harrowing and levelling with a gentle slope for good drainage. It consists of elimination of herbaceous type vegetation, present at the sites to be planted, as it might eventually compete for nutrients and light. Pits will be dug of 3x3x3 ft for planting.

Water conservation: Tree crop agriculture is a huge challenge in semi-arid areas, due to limited availability and/or access to water. Especially the first three years of mango saplings are crucial. Root formation is this period is still rather small and efficient water uptake of water (hand) poured to the sapling is less than efficient and a large quantity of poured water never reaches the sapling. The loss of water is an expensive problem for farmers who are living on the poverty level of 1$/day. In the dry period the cost of water is already very high and on average the saplings need water on regular basis. Therefore an increased efficiency of use of hand poured water is needed, in order to increase the survival of the tree crops in the first three years.

Horticulture rockwool, which is used in greenhouses as alternative to soil for growing of agriculture produce, has this capability and will be used in the project area. The product is not toxic to plants and roots, and has the capability of water storage - whereby the excess of water which has not been absorbed by the plant is stored near the plant and stays available for the sapling during 3 – 4 days. By using this type of rockwool it will be feasible to increase the water efficiency for crops in these first three years. By planting perennial tree crops on rockwool, it is possible to lower risk and costs. After three years the plant will have grown enough roots to survive on its own.

A block of rock wool of 50x25x12 cm will be placed in the ground for each sapling. The block of rock wool will be filled with 15 litres of water. The mango trees will be planted directly on the blocks of rock wool. The watering regime that is followed is two pots (approximately 30 litres total) of water for each sapling, twice a week, for the seven dry months. Technically, putting in place the rock wool at the bottom of the planting pit is no problem. The pit just has to be dug out with an additional 15-20 cm to be able to put the rock wool slab in its proper position. The roots then grow through the rock wool and the rock wool will eventually disintegrate and become one with the inorganic soil.

Spacing and Plantation density: The plantation density or the number of trees per hectare is dependent on the spacing maintained for the species. The spacing for the mango saplings will be 6m x 6m. The spacing that will be maintained for each of the species in a hectare is given in Table A5.2.

Planting: The established seedling from the nursery to the beneficiary's property to be reforested will be made to the nearest passable site to the plot that is to be planted in varying capacity two-axle vehicles. The plant material will remain for shortest possible time at the unloading site, which should have available water, shade and protection to avoid possible damages caused by people and/or animals. In order to avoid mechanical damages and deterioration in the quality of the seedlings, they will be planted on the same day. Transportation from the unloading site to the planting point is done by the communities themselves by carrying them to their fields in wooden/iron plates used in the fields.

The planting process will be carried out in assistance with trained personnel. First, the pits will be filled with original soil mixed with 20-25 kg well decomposed Farm Yard Manure (FYM), 2.5 kg single super phosphate and 1 kg muriate of potash.

Healthy, straight growing grafts from reliable sources will be planted at the centre of pits along with the ball of the earth intact during rainy season in such a way that the roots are not expanded. Plants will be watered immediately after planting. In the initial one or two years, a stake is provided to make them grow straight. The procedure for planting is the following:

a) The rockwool is placed flat at the bottom of the pit horizontally.
b) The seedlings are grown in earthern pots. The bottom of the pot is cut open and removed.
c) The seedling is placed in the center of the pit, which is then filled with earth taken from the pit itself and uniformly pressing down on the four sides of the plant in order to eliminate any air bags.
d) The seedling is straightened up by hand, at the time of planting and two or three days later.

Training and pruning: About one meter from the base on the main trunk will be kept free from branching and the main stem will be allowed thereafter spaced at 20-25 cm apart in such a way that they grow in different directions. Branches which cross over/rub each other may be removed at pencil thickness.

Fertilizer application: The practice of fertilization consists of giving the soil and the trees nutrition, to attain chemical balance of the soil so that the trees will have everything they need in the right amount for an optimal development of their physiological functions and thus better productivity. 10-15 Kgs of organic manure per pit which includes slurry from biogas will be used as manure.

Replanting: Is the process by which dead trees are replaced in the various reforested lots. Replanting will be done using forest material of identical characteristics and conditions as that initially established and with the same planting techniques for all the dead seedlings in the first three years of planting.

Plant Protection: Mango is prone to damages by a large number of pests, diseases and disorders. 3.50 gms of Phorate 10% per plant and DAP (Diammonium Phosphate) will be added per pit to prevent the plants from the pests and to avoid decolouration of leaves. Neem oil will be sprayed (2ml of neem oil in 1 litre of water for each plant) as a natural pesticide.

Fencing: Fencing will be by planting Agave around on the bunds.

Harvesting and yield: Graft plants start bearing at the age of 3 - 4 years (10-20 fruits) to give optimum crop from 10-15th year which continues to increase upto the age of 40 years under good management.

The entry of cattle into the plots will be allowed after sufficient development to support the presence of cattle. Said moment will therefore depend on the development of each species at its establishment site, which will usually take about 3-4 years.

Post Harvest Management: Mangoes are generally packed in corrugated fibre board boxes 40 cm x 30 cm x 20cm in size. Fruits are packed in single layer 8 to 20 fruits per carton. The boxes should have sufficient number of air holes (about 8% of the surface area) to allow good ventilation. These activities will be organised jointly by the Village Coolie Sangha Units.

Table A5.3: Year of planting

Model	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
1	100.38	135.00	200.00	1,016.37	1,016.37	1,016.37	1,016.37	1,016.37	1,016.37	1,016.37	7,550.00
2	0.92	1.15		125.90	125.90	125.90	125.90	125.90	125.90	125.90	883.34
3	3.60			70.91	70.91	70.91	70.91	70.91	70.91	70.91	500.00
Total	**104.90**	**136.15**	**200.00**	**1,213.18**	**1,213.18**	**1,213.18**	**1,213.18**	**1,213.18**	**1,213.18**	**1,213.18**	**8,933.34**

Estimate of Biomass Volumes

The biomass volumes calculated by tree species and their respective participation in each of the strata shall be determined using existing biomass equations from scientific literature. In absence of biomass equations, the general equation from IPCC will be used.

The costs for planting are as follows:

Table A5.4: Costs per ha of planting.

ITEM	1st Year	2nd Year	3rd Year	Total
Cost of pitting, red earth and sand for 260 pits per hectare @ Rs 20	5,200			5,200
Cost of 260 saplings of Mango/Tamarind/Cashew per hectares @ Rs 60	15,600			15,600

Cost of 260 pieces of Rockwool per hectare family plot @ Rs 60	15,600			15,600
Cost of pitting, red earth and sand for an additional 250 pits per hectare @ Rs 20		5,000		5,000
Cost of 250 other species to be planted in the 2nd year @ Rs 40 per sapling		10,000		10,000
Cost of replacing 52 saplings per hectare family plot in the 2nd year		3,120		3,120
Cost of replacing 52 saplings per hectare family plot in the 3rd year			3,120	3,120
Cost of 2 prefab PVC Field Tanks of 6,500 litre capacity on each hectare @ Rs 7,500	15,000			15,000
Planting agave on the boundaries of each hectare @ Rs 500	1,000			1,000
Watering costs at Rs 6 per sapling per month x 7 summer months x 3 years	10,920	10,920	10,920	32,760
Total for 3 years	**63,320**	**29,040**	**14,040**	**106,400**

The technology to be employed consists of:

- Technically assessing the plot including soil type, water availability and interest and ability of the family to maintain the orchard
- Preparing the land including levelling, removing of boulders, bunding if necessary
- Making watering arrangements depending on water availability including placing of PCV field tanks in the fields and arranging for watering the plants for initial 3 years in summer months i.e. March-June (4 months) twice a week. Arrangement for payments for water sharing from bore wells will be done.
- Digging of 521/296 pits per hectare for mixed species planting depending on the model.
- Applying of farmyard manure and red sand to the pits
- Joint procurement of saplings along with other project participants
- Planting and maintenance
- Annual sapling replacement if necessary for 3 years
- Mapping the plot to be reforested: Using the GPS reading for each of the parcel of land, it will be integrated with GIS. Other details such as species planted, number of trees, year of planting, survival rate, permanent plots for each strata will be integrated. This will ensure transparency and aid in monitoring, verification and certification.
- Joint sale of CERs.
- Joint marketing of produce after 5-6 years of planting.

The environmentally safe and sound technologies and know-how which will be employed by the project are not being transferred to the host Party. The technology is indigenous and known to the A/R CDM project participant.

A.5.5. Transfer of technology/know-how, if applicable:

There is no transfer of technology know-how involved in this project.

A.5.6. Proposed measures to be implemented to minimize potential leakage:

Leakage (*LK*) represents the increase in GHGs emissions by sources which occurs outside the boundary of an A/R CDM project activity which is measurable and attributable to the A/R CDM project activity. According to the guidance provided by the Executive Board, leakage also includes the decrease in carbon stocks which occurs outside the boundary of an A/R CDM project activity which is measurable and attributable to the A/R CDM project activity (see EB 22, Annex 15).

There are three sources of the leakage covered by this methodology. Carbon stock decreases caused by displacement of pre-project agricultural crops, grazing and fuel-wood collection activities.

- There will not be any displacement of pre-project agricultural crops permanently or temporarily outside the project boundary. Forest Conservation Act, 1980 prevents any forest land conversion[10]. Thus there will not be conversion of forest land into agricultural lands. This is also supported by the fact that since 1980s' the land under agriculture and forests remained constant. Also, the Government of India has introduced the National Rural Employmnet Guarantee Act (NREGA)[11] for the rural communities. Under this act, the government provides at least 100 days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work to enhance livelihood security in rural areas. Thus, this scheme will address the livelihood issues of the family. Also nearly 60% of the families of the Coolie Sangha families will be planting only on half of their land holdings to continue agriculture for subsistence in the remaining lands.
- There will not be fuelwood collection activities as biogas for cooking and hot water bath is being provided to 23,500 families through 2 CDM Biogas projects in Chickballapur district. Of the 8107 families that are part of the Afforestation project, 2809 (34.65%) families have been provided biogas units. The remaining families will also be provided with either biogas units under the BCS Biogas CDM Project or Improved Cookstove.
- Leakage due to the displacement of animal grazing is zero as the number of animals allowed in the project area under the proposed A/R CDM project will be the same number of number of animals from the different livestock groups that are grazing in the project area under the baseline scenario after the initial 3-4 years of establishment. Based on the survey done, only in 50% area of the plots grazing of animals happens during summer, when there are no crops on the field. Since these are private lands and the participating families have absolute right over their lands, they have full control over their lands for the planned activities. Much pasture land is available near and outside the Project boundaries that can receive and maintain the cattle that are temporarily moved during planting. Thus, there will be an optimized use of the pasturage areas outside the project boundaries, which are sufficient to receive possible heads of cattle which might eventually leave the area under control of the project (Section E.5). There is no risk of deforestation outside the Project boundary due to cattle movements.
- Several villages are allowed free grazing of their cattle and sheep during grazing period in the forest area. There are other rights such as provision to draw water and removal of dry fuel and "Bade" grass free of cost on head loads for their bonafide purposes (Working Plan of Kolar, Karnataka Forest Department).
- There will not be any leakage with regard to carbon stock decreases caused by the increased use for fuelwood. The existing trees in the baseline will continue to exist and thus will not result in displacement of the activity outside the project boundary. Also after the initial years, there will be

[10] http://envfor.nic.in/legis/forest/forest2.html

[11] http://nrega.nic.in/Nrega_guidelinesEng.pdf

twigs and branches available from the project area, which would be more than that available in the baseline.

Though leakage is not anticipated, the following measures will be taken to minimize potential leakage.

- Workshops will be conducted to educate communities on energy conservation and prevention of land use conversion to fulfil the needs of grazing and fuelwood.
- Biogas will be provided under the BCS Biogas CDM Project.
- Alternatively, improved cookstoves will be provided to the communities to reduce fuelwood consumption.

A.6. Description of legal title to the land, current land tenure and rights to tCERs / lCERs issued for the proposed A/R CDM project activity:

Legal title to the land: The land category is private land. The legal title of the parcels of land is held with individual farmers. These farmers have legal title deeds to their lands with survey number. Copies of these *pahanis* are available with the Tahsildar. A copy of the pahanis for each parcel of land that is going to be planted is available at ADATS office

Current land tenure and rights: All the participating private farmers have absolute title to the land and enjoy all rights to the produce from the land.

Rights of access to the sequestered carbon: The individual families occupying or in any other way owning or managing their plot, will assign ADATS the right to manage the sequestered carbon on their behalf under legally binding carbon contracts. Under the carbon contract the individual family continues to hold the right to the carbon and will receive the exact full share of the proceeds of the sale of their lCERs.

A.7. Assessment of the eligibility of the land:

As per the methodology AR-AM0004 / Version 04, the eligibility of the land under the project activity should be assessed by following the latest version of the "Procedures to demonstrate the eligibility of lands for afforestation and reforestation CDM project activities" as approved by the Executive Board.

1(a). *Demonstrate that the land at the moment the project starts does not contain forest by providing transparent information.*

To comply with the definition of afforestation or reforestation and eligibility of the land, the present A/R CDM project activity provides evidence that the land within the planned project boundary is eligible as an A/R CDM project activity by demonstrating that the land at the moment the project starts is not a forest. This is done first by showing that the land is below the forest national threshold (crown cover, tree height and minimum land area) for forest definition under decisions 11/CP.7 and 19/CP.9 as communicated by the respective DNA.

As per the host party India, forests are defined as[12]

- a single minimum tree crown cover value of 15 per cent

[12] http://cdm.unfccc.int/DNA/ARDNA.html?CID=101

- a single minimum land area value of 0.05 hectare
- a single minimum tree height value of 2 metres

To demonstrate that the land at the moment the project starts does not contain forest by providing transparent information, two sources of evidence demonstrate that the current land use pattern on the lands under this A/R CDM project activity are not forests.

The first source is the recent 2006-07 land use maps for 5 taluks. For each of the taluk, the land use maps were overlaid on the project area. The source of these digitized satellite imagery maps is the Karnataka State Remote Sensing Application Centre and the following Land-Use thematic maps for Kolar district was used for analysis. The entire dataset was prepared at a scale of 1:50,000. The land-use, wasteland, and soil maps were derived from PAN+LISS III (final resolution of 5.8 m) merged data from IRS 1C/ ID satellite images. Thematic layers were generated through visual as well as digital classification. The GIS portion of the project and analysis was performed using MapInfo product (Version 9). Composite maps of the project area were prepared at taluk level. From the output, it can be seen that the project area is agricultural lands, marginal croplands, fallow lands, wastelands, degraded forest lands, scrub lands which has less than 10% crown cover and dried water bodies (A7.1A-E).

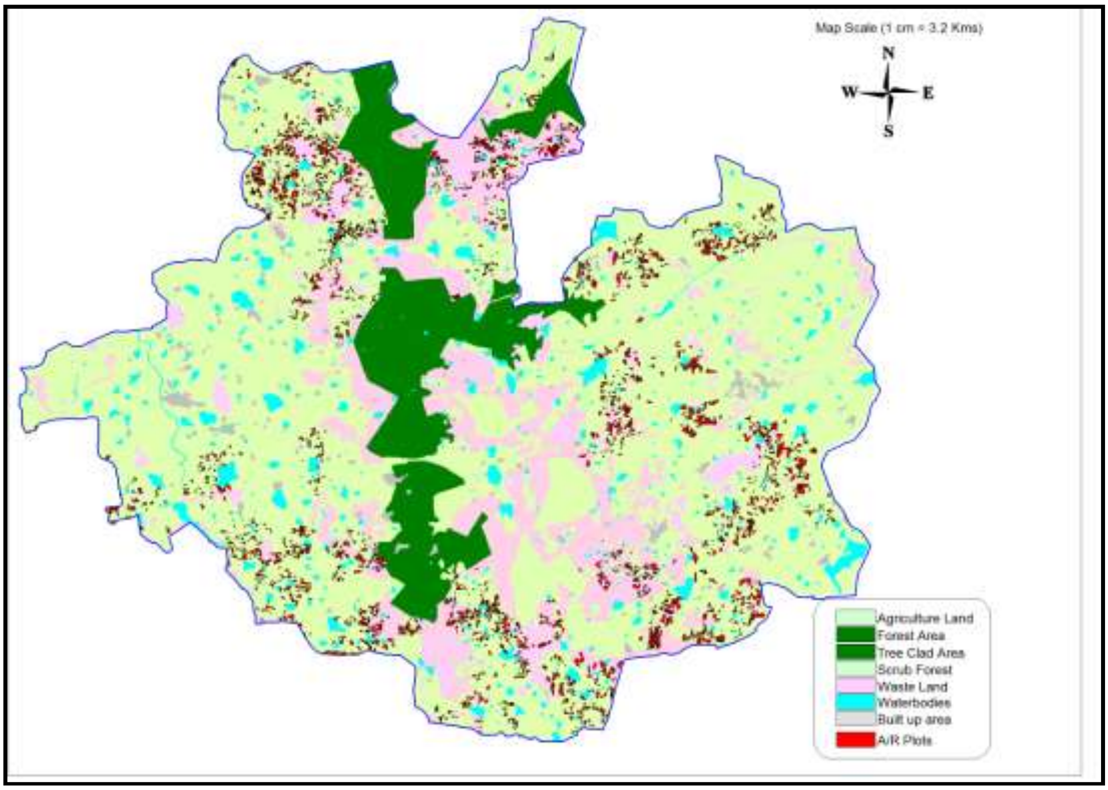

Fig A7.1A: Plots overlaid on Land use/land cover map of Bagepalli taluk of Chickballapur district in Karnataka for 2007

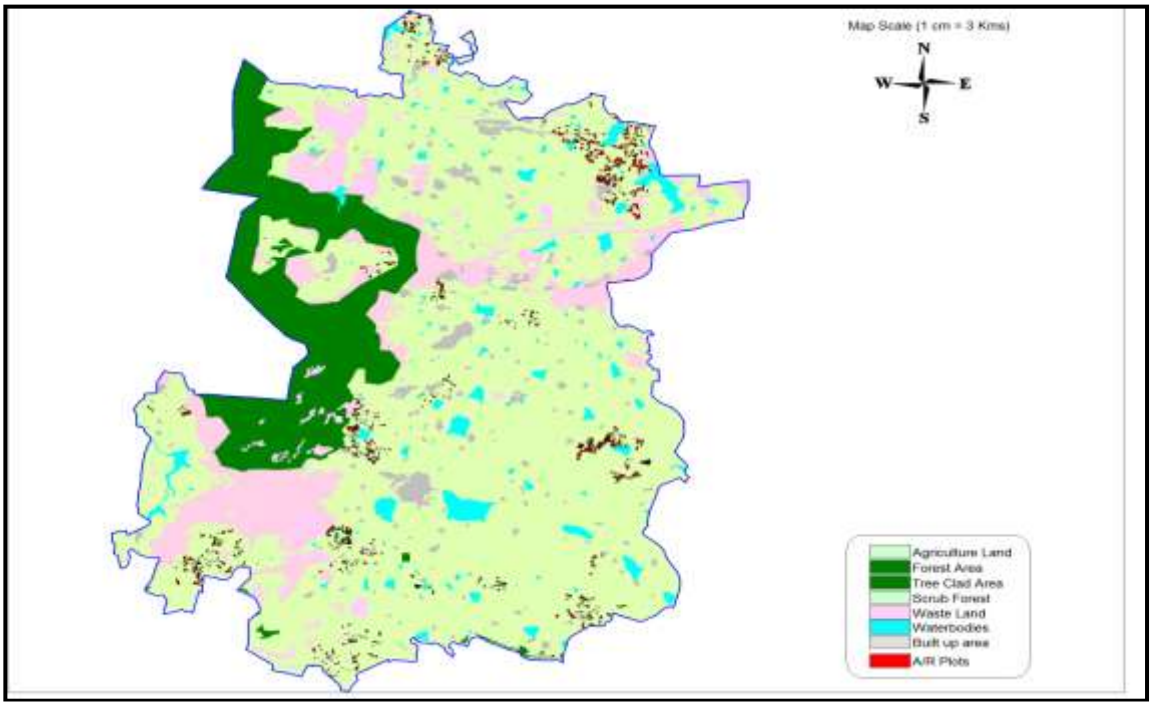

Fig A7.1B: Plots overlaid on Land use/land cover map of Chickballapur taluk of Chickballapur district in Karnataka for 2007

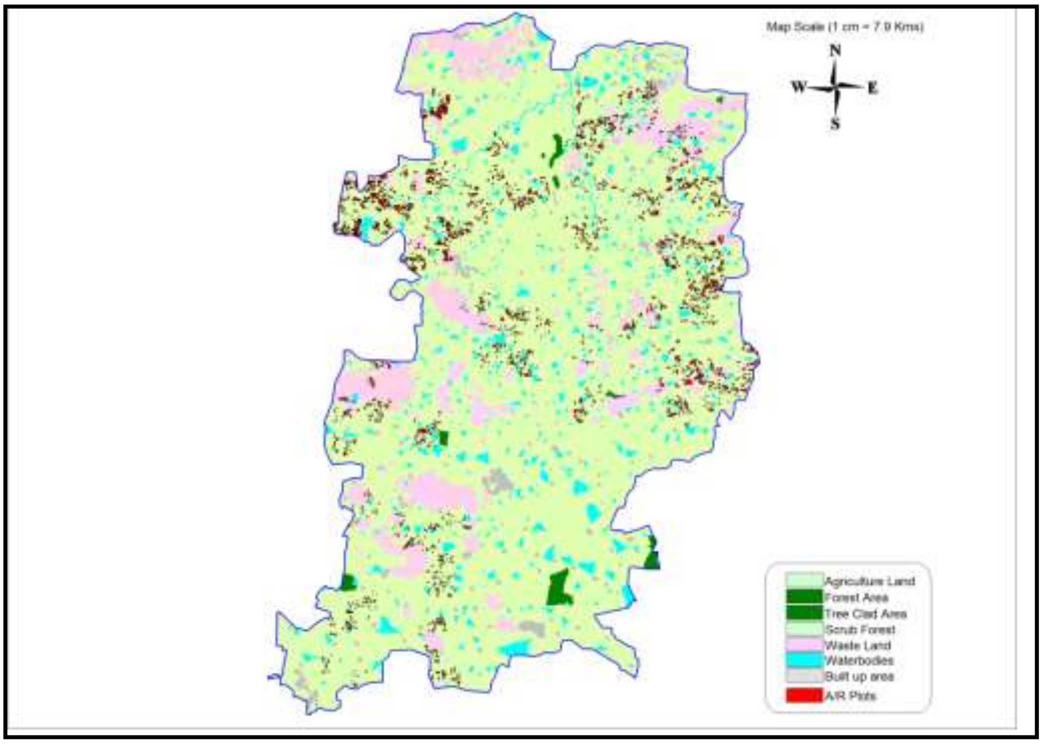

Fig A7.1C: Plots overlaid on Land use/land cover map of Chintamani taluk of Chickballapur district in Karnataka for 2007

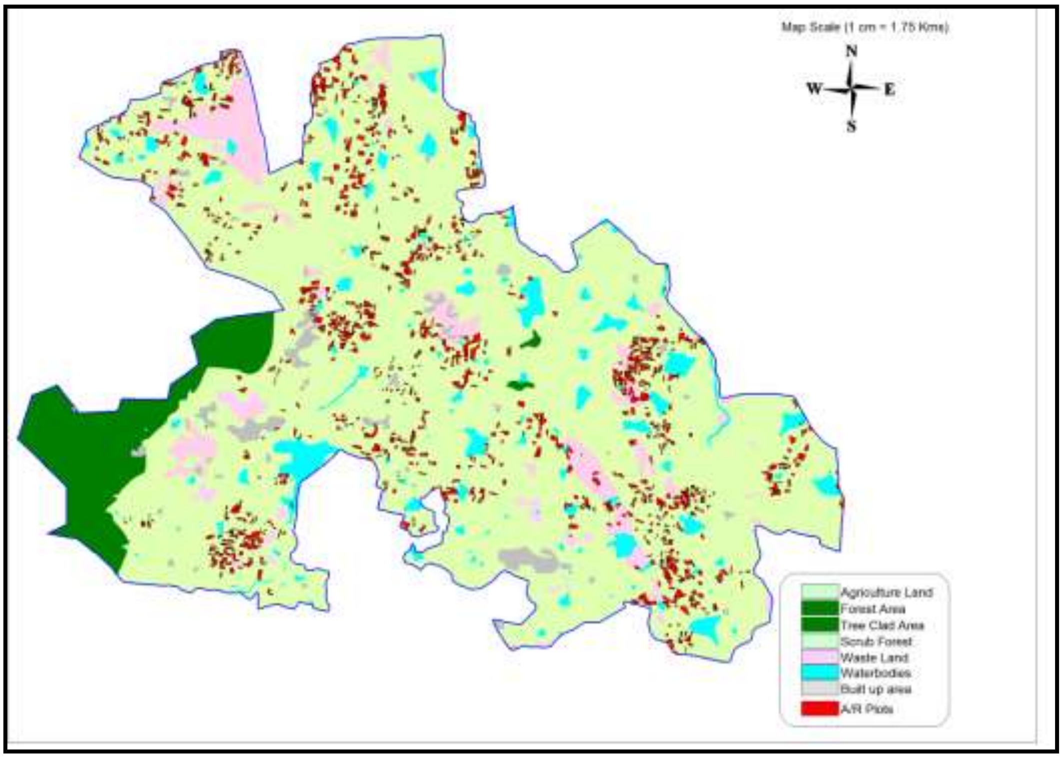

Fig A7.1D: Plots overlaid on Land use/land cover map of Gudibanda taluk of Chickballapur district in Karnataka for 2007

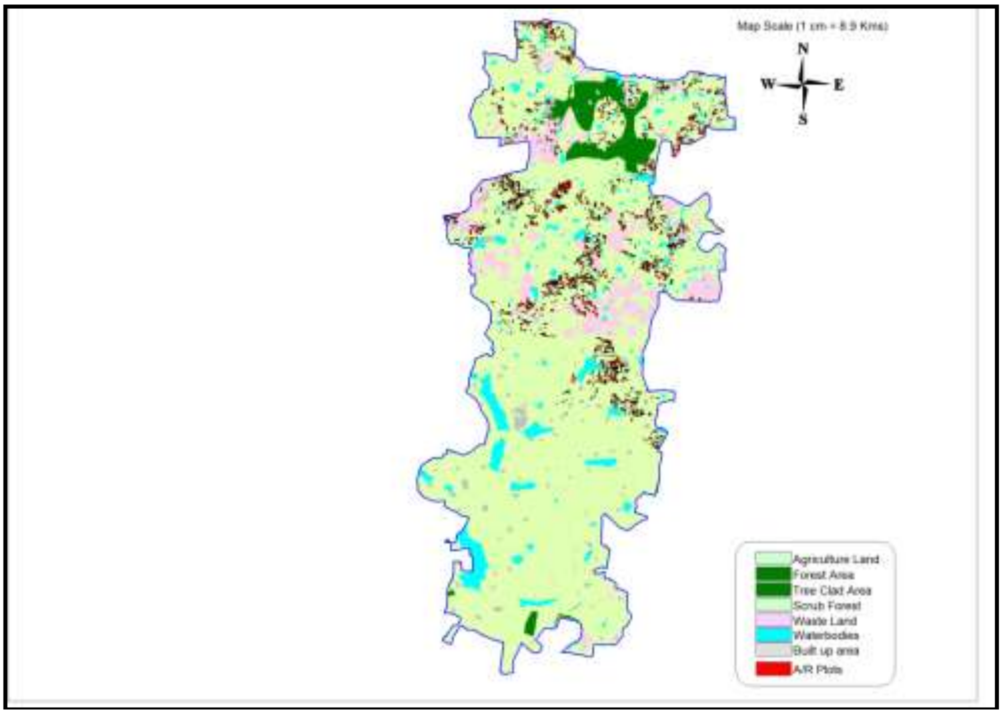

Fig A7.1E: Plots overlaid on Land use/land cover map of Siddalaghatta taluk of Chickballapur district in Karnataka for 2007

Secondly, the Dry Land Development Programme (DLDP) Database also acts as Participatory Rural Appraisal evidence. The lands which are being brought under the present A/R CDM project activity are degraded and were treated under a DLDP. Under the programme so far, 24,496 hectare of land has been treated. The local Participatory Rural Appraisal evidence based on the Dry Land Development Database thus also more than adequately confirms the GIS based evidence. Studies conducted also show that most of the areas are not very productive for agriculture (Fig A7.2). The baseline survey of nearly 84% of the land confirms the status of the lands as eligible.

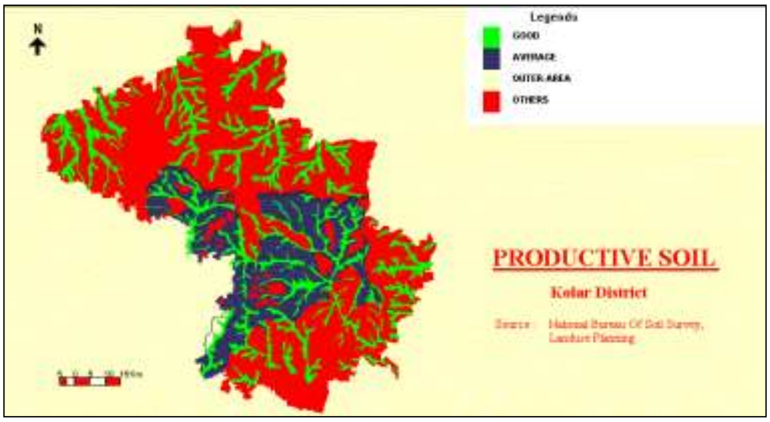

Fig A7.2: Status of land with regard to its agricultural productivity[13]

The initial objective of the Dry Land Development Programme is to enable agricultural labourers to cultivate their scattered patches of marginal land and become subsistence farmers. The further objective is to shift from subsistence to sustainable land use practices. The DLDP is a pluralistic programme comprising a whole range of indigenously conceived soil & water conservation measures. Each individual land owner decides on the type of labour input needed on each separate field. The collective output of the labour of 20-25 determined persons in a work gang converts the marginal lands into productive fields.

The Dry Land Development Programme works carried out for the last 5 years are as follows:

Description	**2002**	**2003**	**2004**	**2005**	**2006**	**Total**
Villages	260	354	326	255	229	464
Cleared Shrubs & Boulders (ha)	822.67	1193.52	1515.38	830.77	1106.07	5468.42
Built New Contour Bunds (mts)	1,96,834	3,27,499	2,35,934	2,49,923	1,48,225	11,58,414
Strengthened Existing Bunds (mts)	19,952	26,850	34,894	38,478	34,432	1,54,606
Built Field Bunds (mts)	32,750	68,713	51,703	27,538	48,363	2,29,067
Checked Ravine & Gully (Nos.)	234	1,323	435	410	348	2,750
Dug Diversion Channel (mts)	24,784	13,122	10,879	13,512	6,815	69,112
Built Retention Wall (mts)	17,236	34,958	38,805	38,775	15,235	1,45,009
Deepened Open Well (Nos.)	13	47	31	29	8	128
Dug Farm Pond (Nos)	17	10	36	12	-	75

[13] Source: NBSSLUP; http://www.csre.iitb.ac.in/adi/maps/prod-s.gif

Dug Pits for Trees (ha)	-	-	1.62	34.01	40.49	76.11
Built Cattle Wall (mts)	1,291	5,268	9,254	7,822	14,821	38,456
Built Path/Road (mts)	548	520	280	849	906	3,103
Wasted Work (ha)	77.33	8.50	5.26	1.62	50.20	142.91

ADATS implements DLDP from the 3rd or 4th year of Coolie Sangha formation. Labour capital is made available for each Coolie Sangha Unit (CSU) to collectively work on their patches of dry land for 100 days every year. These person-days are divided according to land holding and the condition of each patch of land. The entire CSU then descends on each holding to do various labour intensive works from March to June every year. They split themselves into work gangs and descended on each person's holding to do labour intensive works. One person from each Member family goes to work. Each land owner decides on the actual soil and water conservation work needed on her or his land. ADATS Staff give technical advice and monitor the actual works. After that, Accounts Staff pay DLDP wages to the actual persons who work on the lands - i.e. the land owner does not receive any direct monetary benefit.

Soil & water conservation works: For the first 3-4 years, land is cleared of pebbles and boulders, and Soil & Water Conservation Works like stone contour bunding, ravine and gully check, diversion channels, etc. are taken up. Shrubs and grasses are allowed to grow on them. These soil and water conservation works are once again implemented, after a gap of 2-3 years, in order to tackle the new contours of erosion that would, in the meantime, have chequered the terrain.

In this manner, over a period of about 8 years, all the Coolie lands are cleared, levelled and bunded. Rain water is retained, moisture in the soil is increased, and soil erosion prevented. The Dry Land Development Programme was started in 1986. Over the past 20 years (not every village implemented DLDP works every single year), Rs 78,074,896 worth of soil and water conservation works have been carried out on a total of 24,496 hectare of Coolie owned lands. The work carried out so far is as follows:

Work Done	Hectares	Value
1 year work done	5,555	6,174,528
2 years work done	6,651	14,786,029
3 years work done	5,196	17,325,846
4 years work done	3,130	13,913,320
5 years work done	1,959	10,885,604
6 years work done	1,086	7,244,569
7 years work done	549	4,273,868
8 years work done	245	2,177,081
9 years work done	88	882,852
10 years work done	33	364,257
11 years work done	4	46,941
	24,496	**Rs 78,074,896**

Land Survey: The established practice of Coolie Sangha is that as soon as a Coolie family joins the village CSU, all their landholdings are immediately surveyed and entered into the database. This data includes the extent of area, title in whose name the land stands, source of irrigation, gradient, quality of contour bunds, number of years of soil and water conservation works already carried out on the holding, and an estimate of the number of years of further work needed.

The DLDP also includes silt hauling onto coolie lands from the beds of irrigation tanks, compost making, seed treatment, promoting kitchen gardens, training women masons to build Smokeless *Chullas* (fuel efficient wood stoves), assisting sweeper women to set up vermicompost units to make manure from earthworms, and a host of other activities (http://www.adats.com).

From this it can be seen that land cover alone is sufficient to distinguish between forest and non-forest. Thus it can be seen that that proposed A/R CDM activity is on lands that are currently degraded land and not forests and that the land is below the forest national thresholds (crown cover, tree height and minimum land area) for forest definition under decisions 11/CP.7 and 19/CP.9 as communicated by the Indian DNA.

- This is also decisive evidence that the land is not temporarily unstocked as a result of human intervention such as harvesting or natural causes or is not covered by young natural stands or plantations which have yet to reach a crown density or tree height in accordance with national thresholds and which have the potential to revert to forest without human intervention. In addition, the title deed of the parcel of land of each of the farmer irrefutably provides evidence of the use of the land for agriculture. This also serves as evidence of ground based land cover information from the permits granted by the Land Records and Settlement Department, Government of Karnataka, declaring it as agricultural land and the owners (farmers) registers. Each parcel of land is registered with the land registrar (*Tahsildar*). Each plot of land has a survey number. Copies of these land registry documents (*pahanis*) are available at ADATS office.

1 (b) Demonstrate that the activity is a reforestation or afforestation project activity

The present proposed A/R CDM project is a reforestation activity. Reforestation is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989. For reforestation project activities, the A/R CDM project activities must demonstrate that on 31 December 1989, the land was below the forest national thresholds (crown cover, tree height and minimum land area) for forest definition under decision 11/CP.7 as communicated by the respective DNA. The project area of the proposed A/R CDM activity was overlaid on the 1989 satellite imagery maps. The source of these digitized satellite imagery maps is the Karnataka State Remote Sensing Application Centre. The land use maps were overlaid over the project area to show the exact land use/land cover of the project area. The land use/land cover map has three levels of classification. The elaborate or level 3 classification was considered. From the overlaid map, it can be seen that the plots fall on the land catgory/Land use of Agricultural land, Wasteland, scrub forests, which has less than 10% crown cover and dried water bodies. Scrub lands are defined as all forest lands with poor tree growth mainly of small or stunted trees having canopy density less than 10 percent[14]. Thus according to the definition of forests, these lands are eligible for A/R activity. Forest blanks and land without scrub are devoid of vegetation.

[14] http://www.fsi.nic.in/sfr_2009.htm

It can be seen that none of the parcels of land coming under the Bagepalli CDM reforestation programme are forested in 1989. The output for each of the taluk is provided in Fig A7.3A-E. As can be seen, none of the project area was forests during 1989. Thus the proposed project area is a reforestation activity.

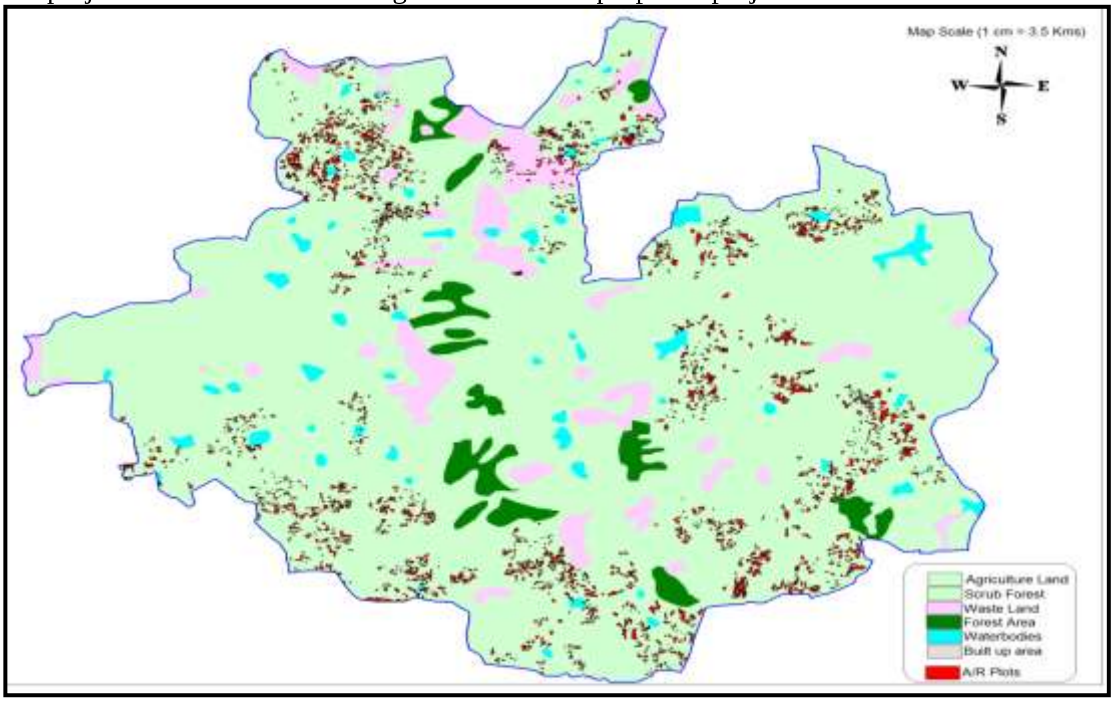

Fig A7.3A: Plots overlaid on Land use/land cover map of Bagepalli taluk of Chickballapur district in Karnataka for 1989

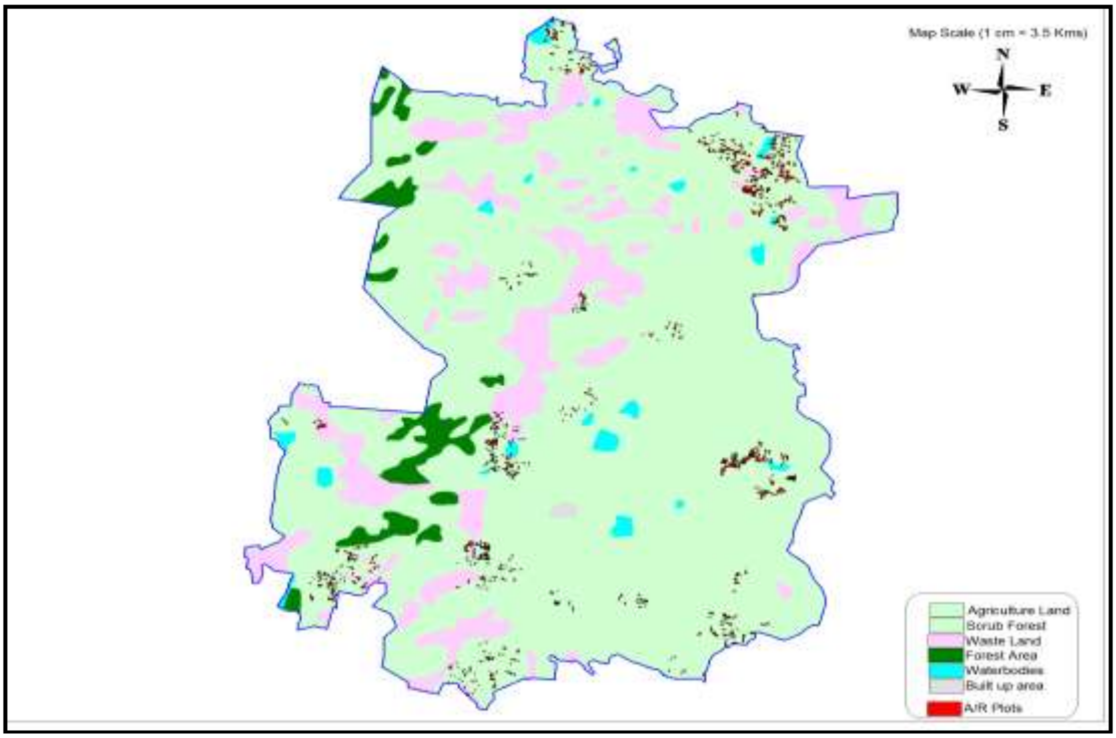

Fig A7.3B: Plots overlaid on Land use/land cover map of Chickballapur taluk of Chickballapur district in Karnataka for 1989

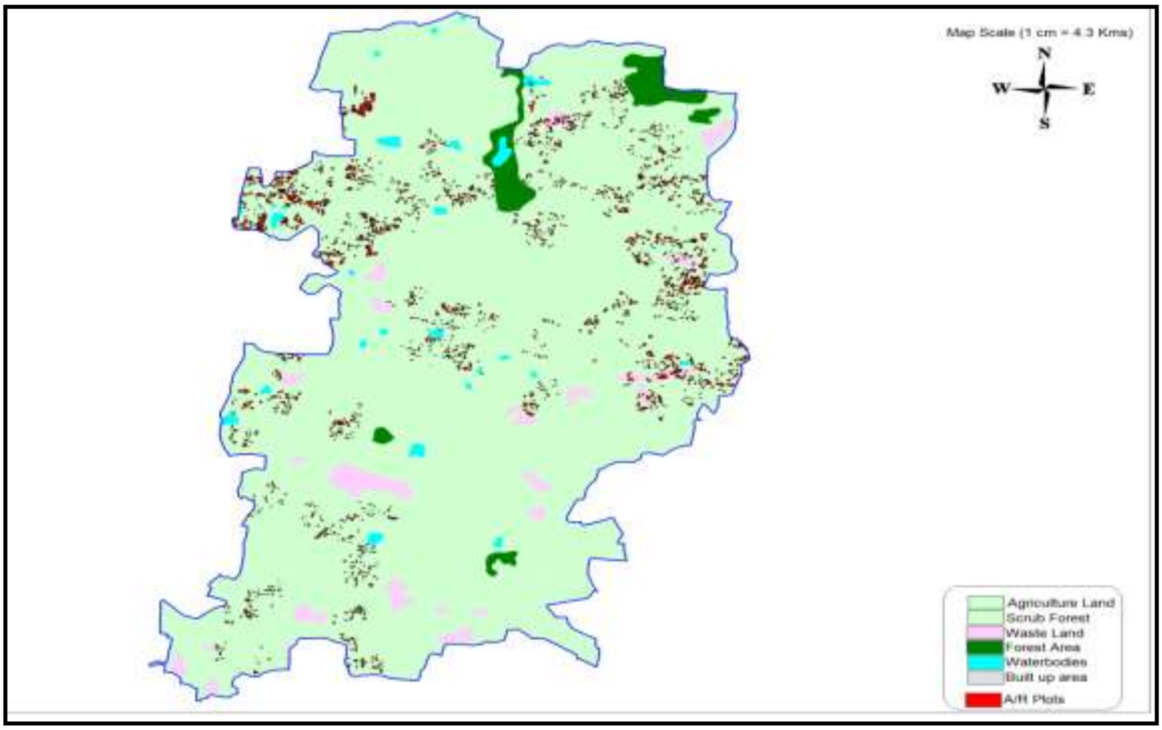

Fig A7.3C: Plots overlaid on Land use/land cover map of Chintamani taluk of Chickballapur district in Karnataka for 1989

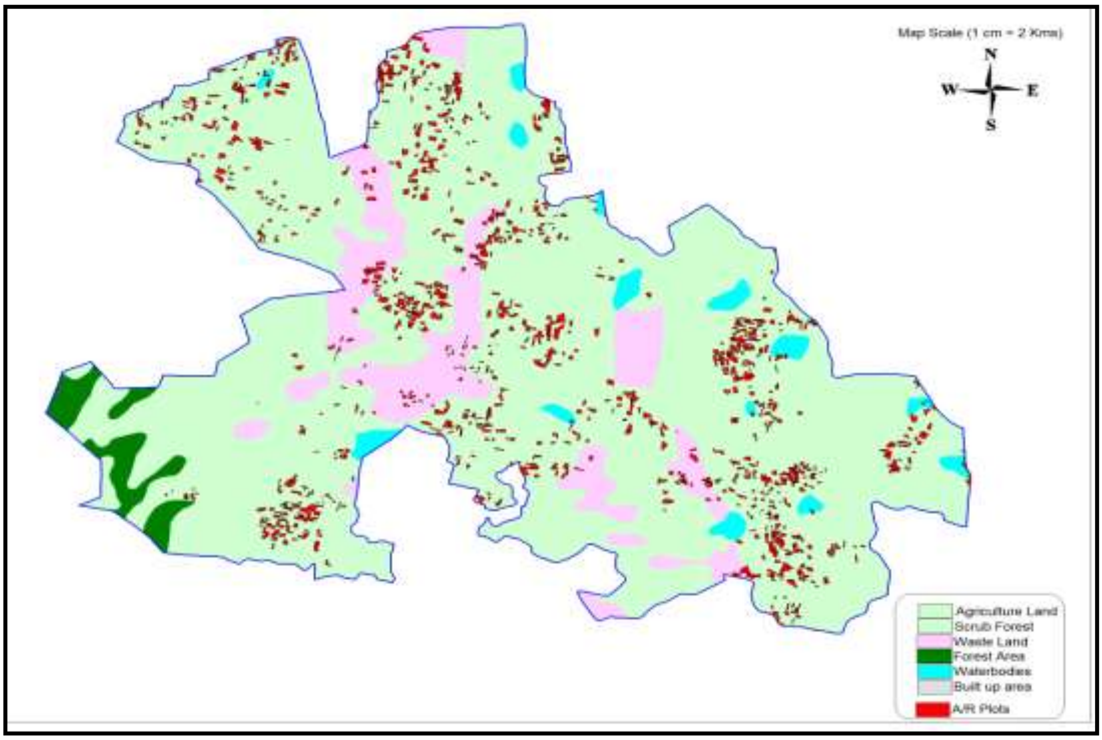

Fig A7.3D: Plots overlaid on Land use/land cover map of Gudibanda taluk of Chickballapur district in Karnataka for 1989

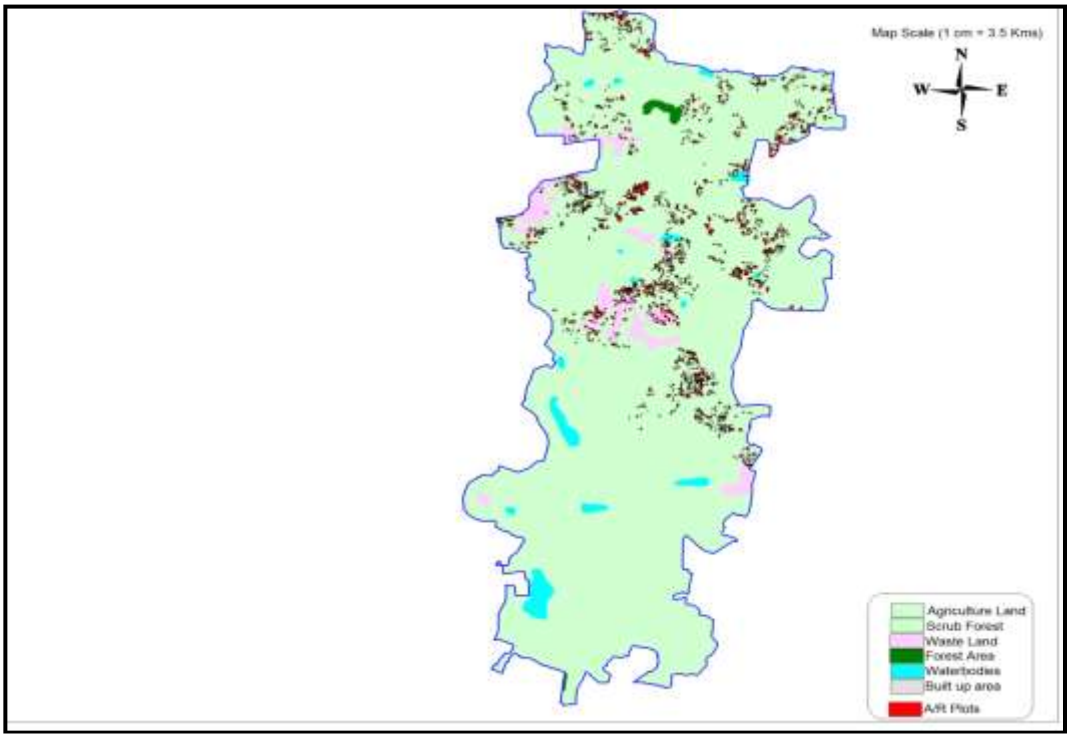

Fig A7.3E: Plots overlaid on Land use/land cover map of Siddalaghatta taluk of Chickballapur district in Karnataka for 1989

Dry Land Development Programme works going on since 1986 on these lands is also sufficient evidence to show that these lands were not forests during 1989 (Fig C2.3 below).

Thus the satellite imagery complemented by ground reference data is available to show beyond doubt that the proposed CDM A/R project area was not forests since 1989 till date.

Additional written testimony produced by following a participatory rural appraisal methodology is not required as this evidence provided is sufficient. Since DLDP has been carried out since 1986, this Database acts as written testimony to back up this evidence from the satellite imagery. Thus to summarize: To demonstrate that the A/R CDM project activity is a reforestation activity the verifiable information provided is as follows:

- These lands have been low productive marginal croplands, uncultivable and barren. Dryland Development is being carried out on these lands since 1986. These records are available at the ADATS office. The work done by ADATS in the 5 taluks of Chickballapur can also be seen at the website http://www.adats.com
- Each parcel of land to be afforested is the farmers' land and is registered with the land registrar (*Tahsildar*). Each plot of land has a survey number. Copies of these land registry documents (*pahanis*) are available at the taluk office. None of the plots are listed as being forest.

The integrated maps of land use and the project boundary as shown in Fig A7.1A-E and Fig 7.3A-E also show that these lands have *not been* forests currently and since 1989 respectively.

Thus it can be concluded that these lands have not been forests and are degraded drylands since 1989.

A.8. Approach for addressing non-permanence:

In accordance with paragraph 38 and section K of the CDM A/R modalities and procedures[15], the following approach is selected to address non-permanence of the A/R CDM activity: 'Issuance of lCERs for the net anthropogenic greenhouse gas removals by sinks achieved by the project activity during each verification period, in accordance with paragraphs 45–50 of the CDM A/R modalities and procedures in 'Decision -/CMP.1 - Modalities and procedures for afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol.'

A.9. Estimated amount of net anthropogenic GHG removals by sinks over the chosen crediting period:

Summary of results obtained in Sections C.7., D.1., and D.2.

Year	Estimation of baseline net GHG removals by sinks (tonnes of CO_2 e)	Estimation of actual net GHG removals by sinks (tonnes of CO_2 e)	Estimation of leakage (tonnes of CO_2 e)	Estimation of net anthropogenic GHG removals by sinks (tonnes of CO_2 e)
2008 (25th January 2008)	0	1,541	0	1,541
2009	0	5,126	0	5,126
2010	0	11,715	0	11,715
2011	0	35,837	0	35,837
2012	0	77,494	0	77,494
2013	0	136,686	0	136,686
2014	0	213,411	0	213,411
2015	0	307,670	0	307,670
2016	0	419,463	0	419,463
2017	0	548,791	0	548,791
2018	0	678,118	0	678,118
2019	0	807,445	0	807,445
2020	0	936,773	0	936,773
2021	0	1,066,100	0	1,066,100
2022	0	1,195,428	0	1,195,428
2023	0	1,324,755	0	1,324,755
2024	0	1,454,082	0	1,454,082
2025	0	1,583,410	0	1,583,410
2026	0	1,712,737	0	1,712,737
2027	0	1,842,065	0	1,842,065
Total (tonnes of CO_{2e})	**0**	1,842,065	0	1,842,065

[15] Decision -/CMP.1 - Modalities and procedures for afforestation and reforestation project activities under the clean development mechanism in the first commitment period of the Kyoto Protocol.

A.10. Public funding of the proposed A/R CDM project activity:

No public funding from parties included in Annex 1 is involved.

The cost of planting and protecting saplings on these dry lands is beyond the capacity of small and marginal farmers who are the primary stakeholders of this A/R CDM Project. A combination of NREGA wages, voluntary labour and carbon revenues through the forward sale of A/R CERs will meet these costs. Unfortunately, there are no very long term loans available for small and marginal farmers to avail.

SECTION B. Duration of the project activity / crediting period

B.1 Starting date of the proposed A/R CDM project activity and of the crediting period:

25th Jan 2008

B. 2. Expected operational lifetime of the proposed A/R CDM project activity:

100-y-0-m

B.3 Choice of crediting period:

B.3.1. Length of the renewable crediting period (in years and months), if selected:

20-y-0-m. The crediting period is 2 times renewable.

B.3.2. Length of the fixed crediting period (in years and months), if selected:

N/A

SECTION C. Application of an approved baseline and monitoring methodology

C.1. Title and reference of the approved baseline and monitoring methodology applied to the proposed A/R CDM project activity:

Approved afforestation and reforestation baseline and monitoring methodology AR-AM0004 “Reforestation or afforestation of land currently under agriculture use” Version 04, EB 50

Annex 13, Guidelines on conditions under which increase in GHG emissions related to displacement of pre-project grazing activities in A/R CDM project activity is insignificant, Version 01, EB 51.

Annex 14, Guidelines on conditions under which increase in GHG emissions attributable to displacement of pre-project crop cultivation activities in A/R CDM project activity is insignificant, Version 01, EB 51.

Annex 15, Clarifications regarding methodologies for Afforestation and Reforestation CDM project activities, EB 22.

Annex 16, Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant, Version 01, EB 46.

Annex 17, A/R Methodological Tool, Tool for the Demonstration and Assessment of Additionality in A/R CDM Project Activities, Version 02, EB 35.

Annex 18, Procedures to demonstrate the eligibility of lands for afforestation and reforestation CDM project activities, Version 01, EB 35.

Annex 19, Afforestation/reforestation in the baseline scenario, EB 24.

Annex 21, Guidelines on conditions under which GHG emissions from removal of existing vegetation due to site preparation are insignificant. EB 50.

Guidance on application of the definition of the project boundary to A/R CDM project activities, Version 01, EB 44.

C.2. Assessment of the applicability of the selected approved methodology to the proposed A/R CDM project activity and justification of the choice of the methodology:

The chosen methodology AR-AM0004 version 4 EB 50 is applicable to the proposed A/R CDM project activity for the following reasons:

- Afforestation or reforestation of degraded land, which is subject to further degradation or remains in a low carbon steady state, through assisted natural regeneration, tree planting, or control of pre-project grazing and fuel-wood collection activities (including in-site charcoal production);
    - Lands will be reforested by direct planting and seeding of multiple species such as *Mangifera Indica* (Mango), *Anacardium occidentale* (Cashew), *Tamarindus indica* (Tamarind), *Syzygium cumini*, *Pongamia pinnata*, *Zizypus jujuba*, *Syzygium spp, Leuceana leucocephala*, *Annona squamosa*, *Azadirachta indica and Ceiba pentandra*.
- The project activity can lead to a shift of pre-project activities outside the project boundary, e.g. a displacement of agriculture, grazing and/or fuel-wood collection activities, including charcoal production.
    - The project activity does not lead to a shift of pre-project activities outside the project boundary, i.e. the land under the proposed A/R CDM project activity can continue to provide at least the same amount of goods and services as in the absence of the project activity. The proposed project area is currently degraded lands providing very little or no goods and services. Any level of reforestation on this degraded land would lead to an increase in goods and services. There will be no change in right of access to the plots or other management changes which would bar families with the right to their own land from using any part of it. As none of the land is common land there is no chance of landless families being prevented from using the land and thus being deprived of the goods and services they are getting.

The conditions under which the methodology is applicable are:

Lands to be afforested or reforested are degraded and the lands are still degrading or remain in a low carbon steady state;

- The lands are in a state of low carbon steady state. As mentioned in section A.7, the lands which are being brought under the present A/R CDM project activity are degraded and were treated under the Dry Land Development Programm. As shown in Fig A5.1 and A7.2, studies conducted also show that most of the areas are problem soils and not very productive for agriculture. The initial objective of the Dry Land Development Programme is to enable agricultural labourers to cultivate their scattered patches of marginal land and become subsistence farmers. The further objective is to shift from subsistence to sustainable land use practices. The DLDP is a pluralistic programme comprising a whole range of indigenously conceived soil & water conservation measures. During initial years land was cleared of pebbles and boulders, and Soil & Water Conservation Works like stone contour bunding, ravine and gully check, diversion channels, etc. were taken up. Shrubs and grasses are allowed to grow on them. These soil and water conservation works are once again implemented, after a gap of 2-3 years, in order to tackle the new contours of erosion that would, in the meantime, have chequered the terrain.
- The National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) have done elaborate studies on the soil status of Kolar at 1:250,000 scale. The soil information so generated was published as district-wise maps (spatial data on land features and soil qualities). The soil mapping at 1:250,000 scale, in short, involved a 3-tier approach viz., satellite image data interpretation, field soil survey and laboratory investigations, and cartography and printing. Systematic interpretation of satellite imagery was carried out for preparing physiograhic map. Using available thematic information on geology and geomorphology as reference, Landsat images of 1:250,000 scale were interpreted to yield major physiographic divisions. Further subdivisions of physiography were delineated based on image characteristics such as color, tone, texture, pattern associations etc. The delineated boundaries were transferred on to topographic base of 1:250,000 scale. The scale adjusted physiographic maps were used for field soil survey operations. Field soil survey involved detailed study of soils to develop soil-physiographic relationships, random soil observations at different sites and observations at regular grid points. In all about 300 to 500 observations were made on each 1:250,000 scale topographic sheet. In the laboratories soil samples collected (horizon-wise) were analysed for basic physical and chemical properties such as particle size distribution, pH, EC, organic carbon, calcium carbonate, exchange properties, exchangeable cations etc. Based on the analysis of landforms/physiography, field soil survey, laboratory analysis and systematic correlation soil resource maps were generated.
- Thus the Soil Organic Carbon maps prepared for the distict (Fig C2.1), show that the project area comprising of Bagepalli, Gudibanda, Chickballapur, Chintamani and Siddalaghatta taluks of the recently formed Chickballapur district has very low Soil Organic Carbon status. The project area is in a state of low carbon state of less than 0.5% organic carbon.

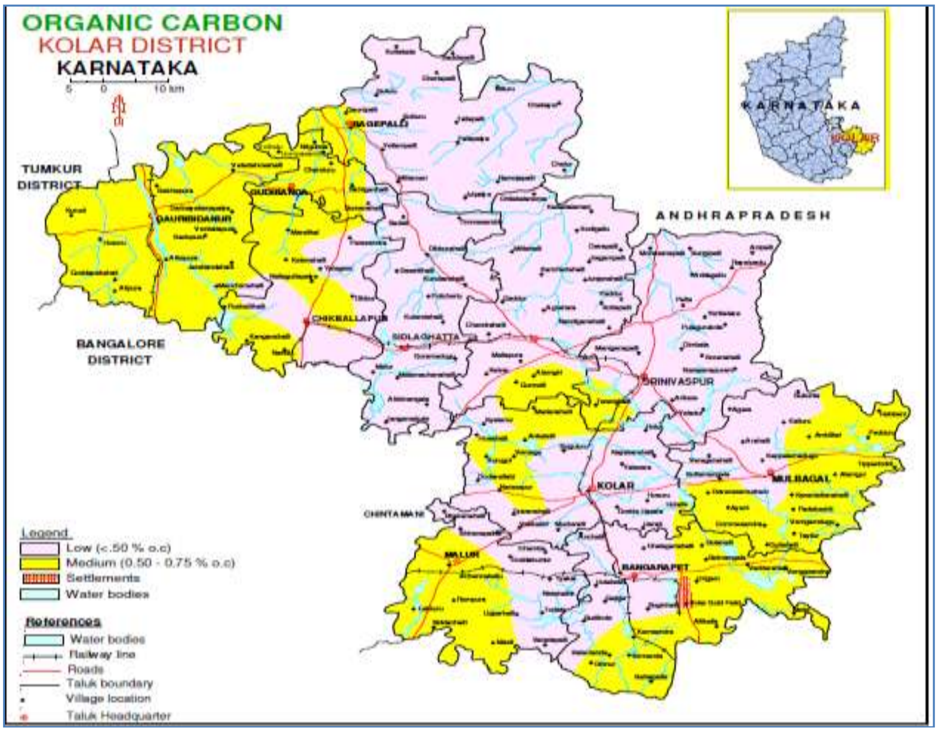

Fig C2.1: Soil organic carbon status of Kolar district (source: NBSS&LUP)

- *Site preparation does not cause significant longer-term net decreases of soil carbon stocks or increases of non-CO_2 emissions from soil;* Site preparation practices such as mechanical site preparation, biomass burning and soil scarification (surface soil displacement with civil engineering machinery such as a bulldozer for silvicultural site preparation) and tillage for afforestation/reforestation causes decrease in soil carbon stocks and may also affect non-CO_2 emissions and removals from soils[16]. Site preparation that will be followed does not include mechanical site preparation. No tractors, bulldozers or other mechanical devices will be used for site preparation such as levelling, digging pits, planting, etc. Neither do the farmers have the wherewithal to take up such activities nor are any discrete land so vast to take up such activities.

- The site preparation will not cause significant long-term net decrease of soil carbon stocks or increases in non-CO_2 emissions from soil. The only site preparation that has taken place on some of the crop lands are the Dry Land Development Programme, where the boulders are being removed and contour bunds prepared for soil and moisture conservation. The technical standards that will be followed for site preparation for planting (see section A.5.4) does not cause significant long-term net decreases of soil carbon stocks. The site preparation will ensure that the soils and their carbon stocks are not affected during site preparation.

[16] IPCC Good Practice Guidance for LULUCF, 2006. Chapter 3.2 Forest Land and 4.3 LULUCF PROJECTS, IPCC Good Practice Guidance for LULUCF, 2006.

- *Carbon stocks in soil organic carbon, litter and dead wood can be expected to further decrease due to soil erosion and human intervention or increase less in the absence of the project activity, relative to the project scenario;*
    - The project area has undergone severe soil erosion or is of rocky land and also has low soil organic carbon status. As can be seen by the study conducted by NBSS&LUP, the project area has undergone severe soil erosion.
    - The carbon stocks in soil organic carbon, litter and dead wood is likely to increase less in the absence of the project activity relative to the project activity. Long rotation species will be planted which will increase soil carbon, dead wood and litter stocks compared to the baseline scenario.
    - Environmental conditions and human-caused degradation do not permit the encroachment of natural forest vegetation. The project area is degraded dryland which has been taken up for development under a Dry Land Development Programme. The land is being treated by removing boulders and creating bunds for soil and water conservation (Fig C2.3). Other parameters which define degraded land are: low soil carbon, low organic content of soil, low standing biomass growth and lack of water retention on the land. All these conditions apply to the project area.
    - According to the State of Forest Report, Kolar District has 6.18% of geographic area under forests accounting for 50800 hectare. Of them, 87% constitute open forests, which have a crown cover between 10-40%. There has been a decrease in the forest area for Kolar district (for the period 2001-2007 –section C.5.1). Thus the environmental conditions and human-caused degradation of the parcels of land under this A/R CDM project activity do not permit natural regeneration or encroachment of natural vegetation. The plots are discrete parcels spread over vast expanse of land which will not permit natural regeneration or encroachment.

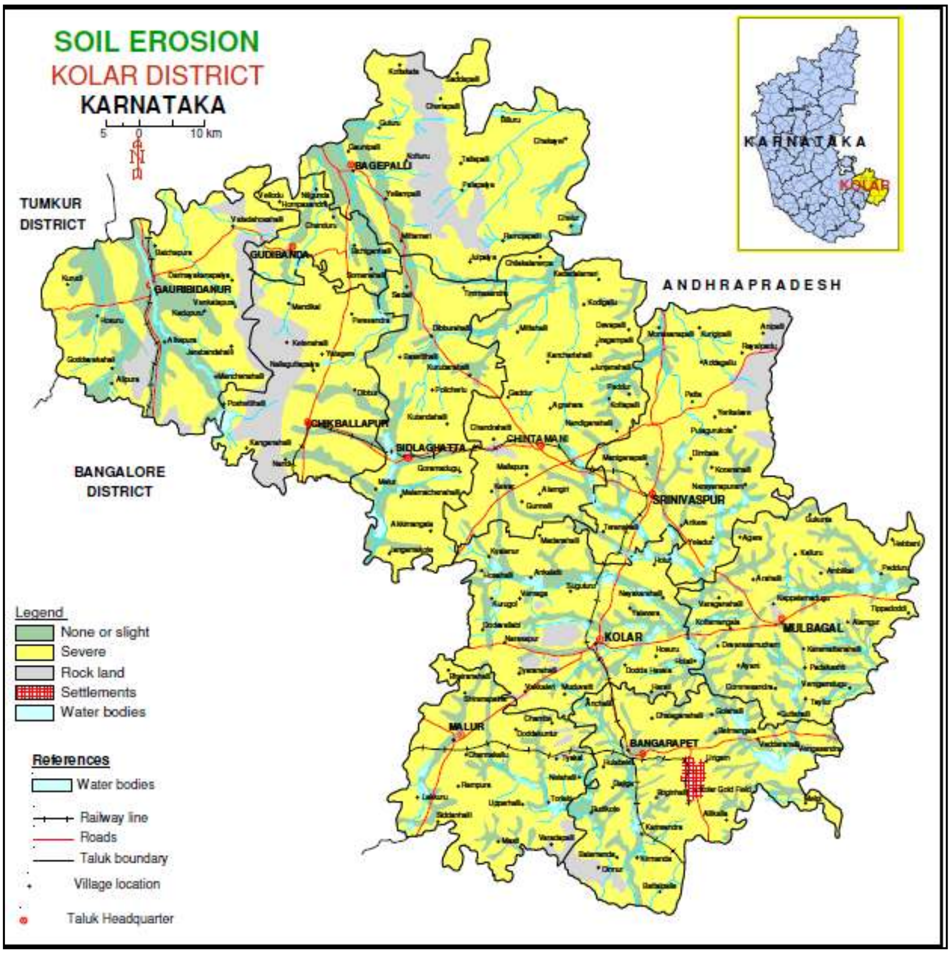

Fig C2.2: Soil erosion status of the project area (source: NBSS&LUP)

Fig C2.3: Dry land development work in the proposed A/R CDM project area

- *Flooding irrigation is not permitted*
    - Floor irrigation is not being done. In fact, there is scarcity of water. Thus large tanks are being provided in each farmer's land (Fig C2.4). These tanks are filled up with water for watering by hand for each of the seedlings planted. These conditions prevent irrigation by flooding.

Fig C2.4: Water tanks placed in the farmer's lands for hand watering the mango saplings

- *Soil drainage and disturbance are insignificant. Thus non CO_2-greenhouse gas emissions from these types of activities can be neglected;*
    - Available Water Capacity (AWC) of the soils is dependent upon the type of the clay mineral, texture, depth and gravel content and amount and distribution of rainfall. According to the survey done by NBSS&LUP, soils having medium retentive capacity occur extensively (55%), followed low rentative (25.5) capacity. Soils having very low AWC occur in substantial areas in the taluks of Chintamani, Bagepalli and Sidlaghatta Taluks. Nearly 90% of soils of Gudibanda taluks have medium retentive soils (Fig C2.5).

    - The area is a drought prone area and thus there will be no soil drainage and disturbance. Thus non CO_2-greenhouse gas emissions from these types of activities can be neglected;

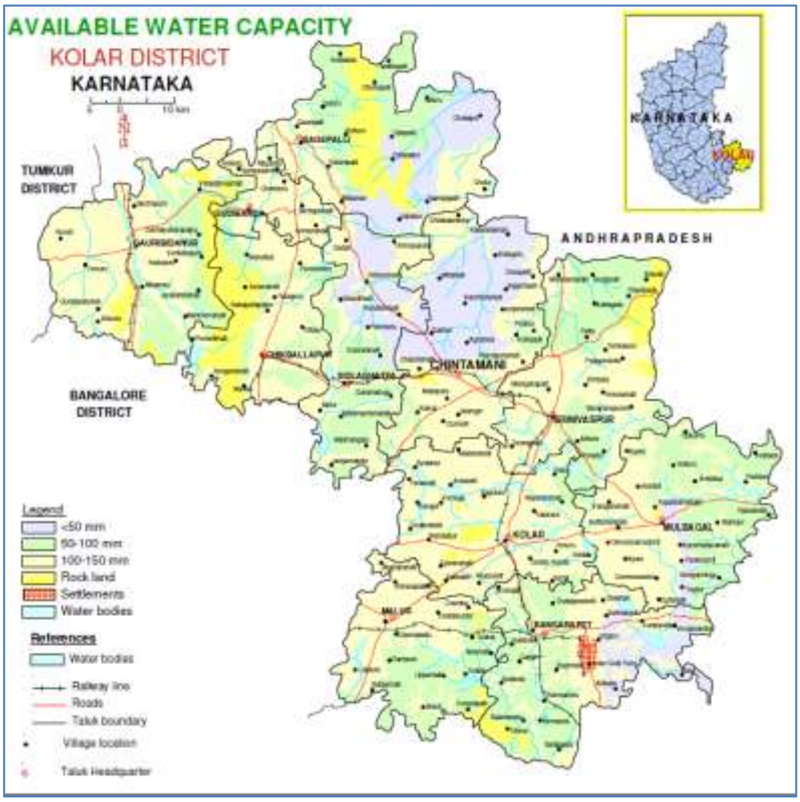

Fig C2.5: Available water capacity status of the project area (source: NBSS&LUP)

- *The A/R CDM project activity is implemented on land where there are no other on-going or planned A/R activities (no afforestation/reforestation in the baseline).*
    - There are no A/R activities ongoing on private lands as proposed for this A/R project activity as can be seen from the Karnataka Forest Department website: http://karnatakaforest.gov.in/English/projects_programmes/pro_css.htm.

C.3. Assessment of the selected carbon pools and emission sources of the approved methodology to the proposed CDM project activity:

The carbon sinks and gases considered according to AR-AM0004 Version 04 methodology is as shown below:

Table A: Selected carbon pools

Carbon Pools	Selected	Justification / Explanation
Above ground	Yes	Major carbon pool subjected to the project activity
Below ground	Yes	Major carbon pool subjected to the project activity
Dead wood	No	Conservative approach under applicability condition
Litter	No	Conservative approach under applicability condition
Soil Organic Carbon	No	Conservative approach under applicability condition

Table B: Gases considered from emissions by sources other than resulting from changes in carbon pools

Sources	Gas	Included/ excluded	Justification / Explanation
Burning of biomass	CO_2	No	However, carbon stock decreases due to burning are accounted as a carbon stock change. Also, not a source as biomass burning is not practiced in the project area
	CH_4	Yes	Deliberate burning of biomass is not practiced in the project area Included as a source due to possible unintentional fires
	N_2O	No	Not a source as: a. Potential emission is negligibly small; b. It is not practiced in the project area

C.4. Description of strata identified using the *ex ante* stratification:

Stratification for baseline net GHG removals by sinks

According to the methodology, it is sufficient to stratify according to area of major vegetation types because baseline removals for degraded (or degrading) land are expected to be small in comparison to project removals. As can be seen from Fig C4.1 and C4.2, the project area falls under the category having the length of growing period of 120-150 days and the soil organic carbon status is low (<0.5% o.c) to moderate (0.5-0.75% o.c), with major region having low Soil organic carbon status. The project areas are private agriculture lands with only a few trees on the bunds, which have been mostly planted. The various land use type based on Karnataka Remote Sensing Center was considered for baseline stratification. The major type is Agriculture land-Kharif Crop (summer crops), Rabi Crop (winter crops), Two crop area, Fallow land and horticulture species; Built Up area: rural, industrial/mine/quarry; Forest-Scrub forest (<10% crown cover); Wasteland-rocky, stony, gullied, shallow ravenous, scrub lands; Water bodies-dried and seasonal lakes, ponds, reservoirs, streams and tanks. The various land use of the plots based on Karnataka Remote Sensing Center for baseline stratification is as follows:

Land Use (Vegetation Type)	Area (ha)	% Area
Agriculture Land	7,656.14	85.7
Built Up Land	91.65	1.0
Scrub Forest (< 10% crown cover)	62.37	0.7
Wasteland	1,037.92	11.6
Waterbodies	85.26	1.0
Total	**8,933.34**	100.0

With regard to the vegetation found in the baseline survey, it is homogeneous with the dominance of few species on the bunds of plots. According to Champion and Seth classification and the remote sensing data, the vegetation type in this region is deciduous type. Thus a single stratification for the baseline net GHG removals by sinks has been considered.

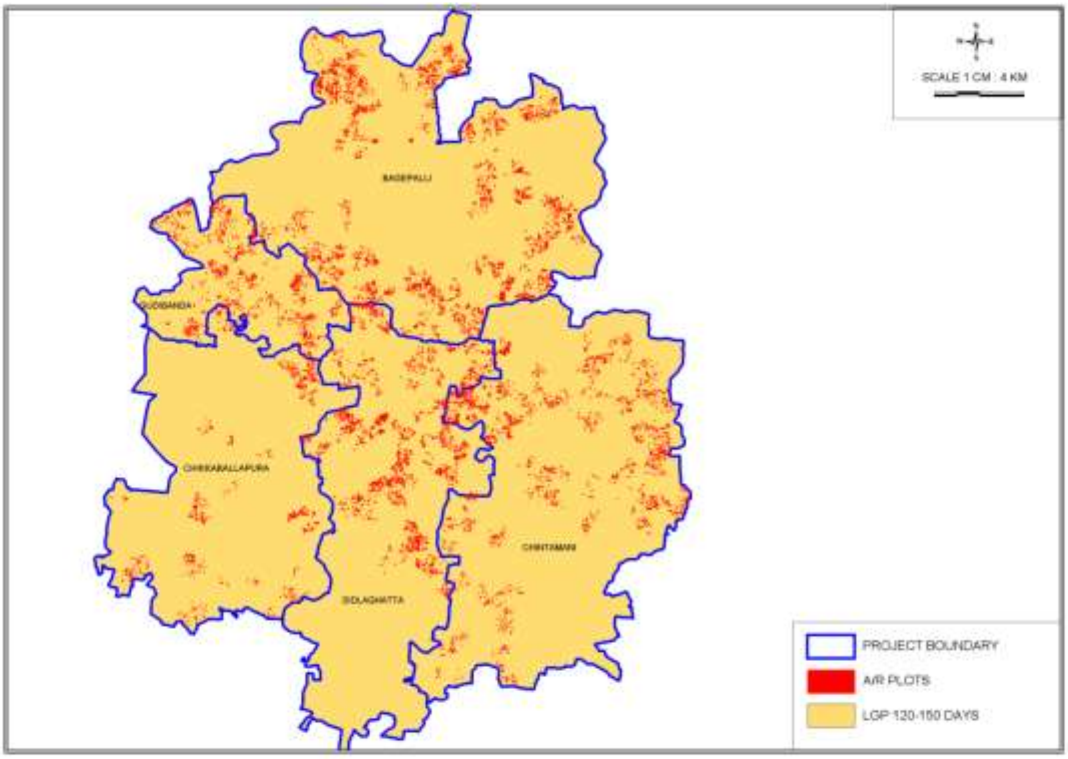

Fig C4.1: Length of growing period for the project area

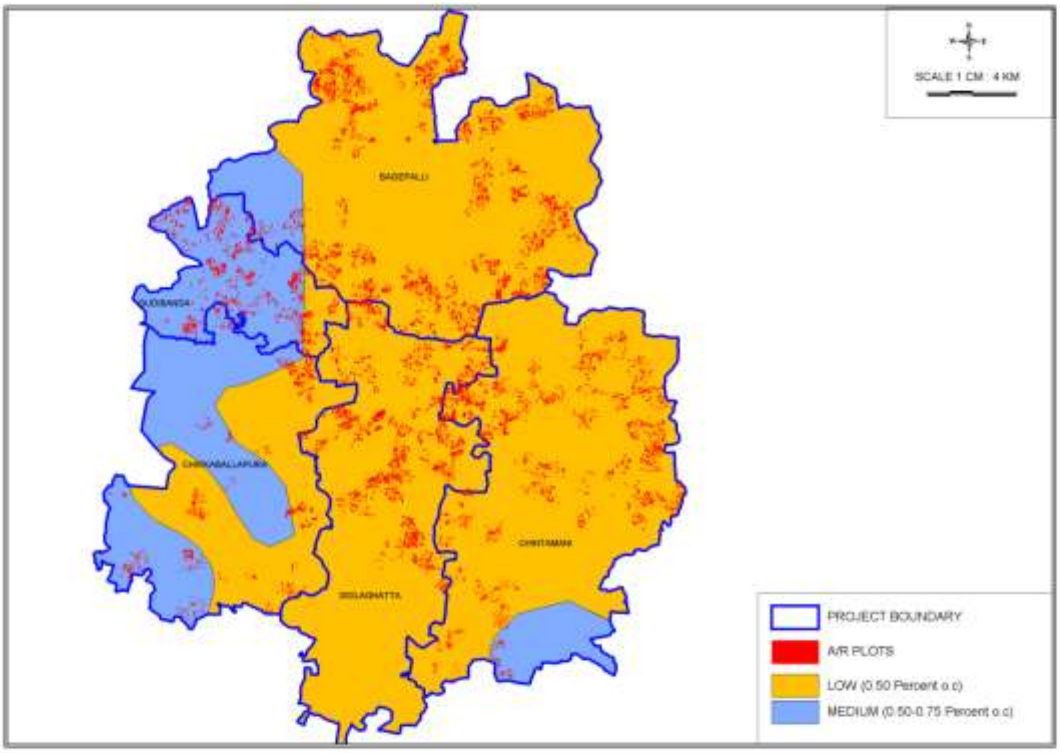

Fig C4.2: Soil Organic Carbon status for the project area

Stratification for actual net GHG removals by sinks.

The *ex ante* estimations will be based on the project planting/management plan. The *ex post* stratification will be based on the actual implementation of the project planting/management plan. Further subdivision of the project strata to represent spatial variation in the distribution of the baseline or the project biomass stocks/removals is not usually warranted. Though other factors impacting growth (e.g., soil type) might be useful for *ex post* stratification, their variability in the project area is not large. This is due to the fact that the area is low in soil organic carbon. There have not been any natural or anthropogenic impacts that will add variability to growth pattern in the project area to further have sub-stratification.

- The tree stand models defined in Section A.5.3 are: Mango, Cashew and Tamarind Stands. The planting regimes are defined in Section A.5.4 (Table A5.2). The distribution of the tree stand models in the eligible area is based on discussions with the land owners, and takes into account the following parameters, among others:
    - The economic activity and land use at the start of the project on each owner’s parcel, and the owner's interest in continuing with said productive activity.
    - The tree stand model is established within their unsustainable agricultural lands which is not yielding good economic returns
    - The distribution of the tree stand models results from decision made by landowners as to how to incorporate the forestry activities. The tree stand models permit the entry of cattle, in order not to displace grazing activity after the initial 3-4 years of establishment of saplings.
    - The proper environmental conditions for the establishment of each of the species.

Final *ex-post* stratification

All polygons which are part of the project strata are mapped using MapInfo and are available as Shape file form. The monitoring plan will include variables to be periodically verified *ex-post*, in order to detect the need for a possible additional stratification during the crediting period, if required based on factors impacting growth.

C.5. Identification of the baseline scenario:

C.5.1. Description of the application of the procedure to identify the most plausible baseline scenario (separately for each stratum defined in C.4.):

Step 1: *Demonstrate that the proposed A/R CDM project activity meets the conditions under which the proposed methodology is applicable, and that baseline approach 22(a) can be used.*

The applicability of the selected methodology (AR-AM0004 Version 04) was assessed and determined in Section C.2. The baseline scenario was developed under the baseline approach 22(a) of the Modalities and Procedures for the AR CDM project activity: changes in the carbon content due to the historic use of the soil in the project boundary.

Step 2: *Define the project boundary as described in Section II.2 above.*

The eligible areas for the project were determined using the tool “Procedures to define the eligibility of lands for afforestation and reforestation Project activities” (Section A.7). Starting from the areas identified as eligible and including those under written agreement with the interested owners, thereby establishing the areas that were under the control of the project participants, the project boundary was determined and an ex-ante stratification of same was developed (Section C.4).

Step 3: Analyze historical land use, local and sectoral land-use policies or regulations and land use alternatives.

(a) Analyse the historical and existing land-use/land-cover changes in the context of the socio-economic conditions prevailing within the boundary of the proposed A/R CDM project activity and identify key factors that influence the land-use/land-cover changes over time, using multiple sources of data including archives, maps or satellite images of land use/cover data prepared before 31.12.1989 (reforestation) or at least 50 years old (afforestation) and before the start of the proposed A/R CDM project activity, supplementary field investigation, land-owner interviews, as well as studies and data collected from other sources

The historical and existing land use/cover changes in their social-economic context are best observed by analyzing the Dry Land Development Programme records going back to 1986, looking at the satellite images of land use/cover from around 1989 and by drawing on the local knowledge of the project participants who have lived and worked in this area for 30 years and the Karnataka government Gazetteer for Kolar region, which is being documented regularly. The key factor that influences the land use/cover changes over time in this region is climate change. The project area is a semi arid drought prone region. The project area skirts the southern border of the Rayalaseema desert belt and shares the same language, culture and social structure, as also the stark poverty that afflicts southern Andhra Pradesh. The region receives an annual rainfall of around 780 mm and is facing imminent desertification, with severely degraded soils. The dust brown rocky terrain is severely undulating, with small hill ranges and outcrops that stud the topography. There is no mineral wealth and only a very thin and fragile soil cover. Slopes in the region are not terraced and rainfall is not retained. This is an even bigger problem than low precipitation and erratic, spatial showers. Soil erosion is a definite problem (Fig A5.1&C2.2) and the age-old network of small and large irrigation tanks is getting visibly choked.

As described in the Karnataka Gazetteer for Kolar for the year 1968[17], "the scanty rainfall and the rivers and streams being dry for most part of the year, the area is devoid of vegetation and scarcity conditions are very common. State owned forest areas such as state forests, plantations, reserve forests and village forests form only 10% of the district area as against the recommended national standard of 33.5%. Most of the state-owned forests are confined to hilly tracts, the intervening plains areas being brought under the plough. Due to the low rainfall and the soil being rocky, gravelly or very shallow, the vegetation is incapable of bearing better type of vegetation. The underlying rock being granitic-gneiss and low rainfall in the region, it is unfavourable for rich forest growth. Under such climatic and soil conditions, the vegetation is either dry deciduous or thorny scrub type. The growing stock is stunted, the forest canopy open and the vegetation is more or less xerophytic in nature. Many parts of the forest areas are not forests any more due to heavy working in the past for firewood and charcoal. As a result of the denudation which is due to over exploitation in the past, soil erosion is evident in many of the forest areas. Paucity of vegetatal cover, coupled with the absence of organic humus from the top soil, has been the main cause for the accelerated soil erosion. Soil conversation measures were taken up the Government of Karnataka by taking up contour-bunding, contour-trenching, gully-plugging and planting barren areas by trench and mound method".

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[17] http://gazetteer.kar.nic.in/dist_book.asp?pre_post=1&kan=2

As part of the efforts of the Project Participant, ADATS, the project area, underwent soil and water conservation works under the DLDP. These lands are currently either barren and uncultivable land, fallow land or marginal cropland. Basically climate change is causing rapid desertification. Soil degradation has occurred as erosion has increased continuously and no soil and water conservation works have really been able to stop it; soil organic matter content has decreased, and no natural encroachment of trees would occur as there are no on-site seed pools that may result in natural regeneration.

The existing land-uses of the project activity are degraded agricultural lands, which has very low Soil Organic Carbon status. As mentioned in Section A.7, the lands to be afforested or reforested are degraded and the lands are still degrading or remain in a low carbon steady state. The lands which are being brought under the present A/R CDM project activity were treated under a DLD Programm. Studies conducted also show that most of the areas are not very productive for agriculture (Fig A7.2). The initial objective of the Dry Land Development Programme is to enable agricultural labourers to cultivate their scattered patches of marginal land and become subsistence farmers. The further objective is to shift from subsistence to sustainable land use practices. The DLDP is a pluralistic programme comprising a whole range of indigenously conceived soil & water conservation measures. During initial years land was cleared of pebbles and boulders, and Soil & Water Conservation Works like stone contour bunding, ravine and gully check, diversion channels, etc. were taken up. Shrubs and grasses are allowed to grow on them. These soil and water conservation works are once again implemented, after a gap of 2-3 years, in order to tackle the new contours of erosion that would, in the meantime, have chequered the terrain.

The National Bureau of Soil Survey and Land Use Planning (NBSSLUP) have done elaborate studies on the soil status of Kolar. Soil Organic Carbon maps have been prepared for the distict. As can be seen from the map (Fig C2.1) , the project area comprising of Bagepalli, Gudibanda, Chickballapur, Chintamani and Siddalaghatta taluks of the recently formed Chickballapur district has very low Soil Organic Carbon status. The agricultural lands are in a state of low carbon state.

Based on the baseline study (section B), the density of naturally occurring trees in the region is <1 tree/ha. There are no external seed sources that may result in natural regeneration; and there is no possibility of seeds sprouting and the growth of young trees occurring. As DLDP has been going on since 1986, this provides the required evidence of supplementary surveys on the project areas as well as similar surrounding areas for two different years covering a minimum time period of ten years. There are no national and/or sectoral land-use policies or regulations that create policy driven market distortions which give comparative advantages to afforestation/reforestation activities and that have been adopted before 11 November 2001. As can be seen from Table C5.1, plantations in the taluks account for only 0.18-5% of the land use.

Table C5.1: Land use in the taluks of project area based on satellite imagery (%)

Taluk	Built-up	Agriculture	Plantation	Forest	Wasteland	Waterbody
Bagepalli	8.33	32.21	0.18	0.96	57.60	0.72
Chickballapur	2.82	49.16	2.42	4.78	39.47	1.36
Chintamani	5.65	47.74	0.56	0.12	45.60	0.33
Gudibanda	3.07	44.30	3.28	2.82	45.74	0.79
Siddalaghatta	5.05	47.64	5.23	0.70	41.08	0.31

Source: Mapping of fuel wood trees in Kolar district using remote sensing data and GIS. http://ces.iisc.ernet.in/energy/paper/fuelwood/fuelwood.html

No policies (implemented before 11 Nov 2001) significantly impact the project area, and therefore the baseline scenario is degraded land. The scenario “lands to be planted are degraded lands and will continue to degrade in absence of the project" is the most appropriate plausible baseline scenario. To ensure transparency regarding the condition of degraded lands, all information used in the analysis and demonstration is archived at the ADATS head office in Bagepalli.

- The boundary of each of the parcel of land of the proposed CDM A/R project was determined and represented by the following:
  - a) the survey number of the parcel of land. Copies of these land registry documents (*Pahanis*) have been provided by the local land registrar office (Tahsildar) to the farmers. Copies of these land registry documents (*Pahanis*) are available with the Tahsildar.
  - b) Each parcel of land has been given a unique reference number, which has the code of the village and the farmer. The shape files with the plots are available.
  - c) Field survey as part of DLDP was done to study soil conditions, gradient and erosion status of 100% of the lands. The gradient of the land and the bund condition is recorded for each parcel of the land.
- Sample surveys on representative land types were done which includes trees and shrubs, biomass stock sampling and soil type.
- These areas are degraded and are under different stages of DLDP. Ground survey shows that these lands are highly degraded and there is no possibility of natural encroachment. The soil conditions are hostile for natural regeneration. Currently these lands are barren uncultivated lands, fallow lands or marginal croplands. These lands have been non-forested since 1989.

(b) Show that historical and current land-use/land-cover change has led to progressive degradation of the land over time including a decrease or steady state at a reduced level of the carbon stocks in the carbon pools. Provide indicators of land degradation and carbon stock decrease/steady state that can be verified and sustain the choice of these indicators using appropriate and credible sources of information, such as scientific literature and studies or data collected in the project area or similar areas;

The historical degradation feature can be indicated by:

1. Vegetation degradation: A study was conducted by Ramachandra and Uttam[18] for Kolar district to study the change in land use patterns for Kolar district using digital change detection referenced to geo-registered multitemporal remote sensing data. It helps in identifying change between two (or more) dates that is uncharacterised of normal variation. Change detection is useful in many applications such as landuse changes, habitat fragmentation, rate of deforestation, coastal change, urban sprawl, and other cumulative changes through spatial and temporal analysis techniques such as GIS (Geographic Information System) and Remote Sensing along with digital image processing techniques. Comparison of the temporal data shows that builtup area has considerably increased in Chickballapur (14.56 %) showing urban sprawl in and around the center of the town at the road junction and the forest area has decreased by 6.36% between 1998 and 2002. At the district level (Kolar), based on Forest Survey of India[19] remote sensing assessment, there has been a decrease in forest area (Table C5.2). The region is devoid of dense forest vegetation.

As mentioned above in Step 3, the Gazetteer of Kolar records degradation of the region happening since 1960s in the region.

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[18] Ramachandra, T.V. and Uttam Kumar, 2004. Geographic Resources Decision Support System for land use, land cover dynamics analysis. Proceedings of the FOSS/GRASS Users Conference - Bangkok, Thailand, 12-14 September 2004.

[19] Forest Survey of India, http://www.fsi.org.in/

Table C5.2: Forest area of Kolar District (sq km)

Assessment Year	Geographic area	Very dense forest	Moderately dense forest	Open Forest	Total	% of Geographic area	Scrub
2007	8223	0	59	449	508	6.18	283
2005	8223	0	70	466	536	6.52	281
2003	8223	0	82	500	582	7.08	281
2001	8223	0	189	386	575	6.99	281

2. Soil degradation: The NBSS&LUP[20] made an assessment of the extent, type and severity of soil degradation in Karnataka. The type of soil degradation refers to the process that causes the degradation; the degree of degradation refers to the present state of degradation. The soil degradation status of Karnataka was assessed from the soil map having 121 soil units at association of soil families with phases. Each mapping unit was assessed for the kind, degree and extent of degradation. The severity class was worked out based on the degree and extent of degradation. The soil degradation status map is as shown in Fig C5.1. The project area has undergone moderate water erosion and physical deterioration. As mentioned in Section C.2, the project area has undergone soil erosion and has low Soil Organic Carbon status (Fig C2.1 and C2.2).

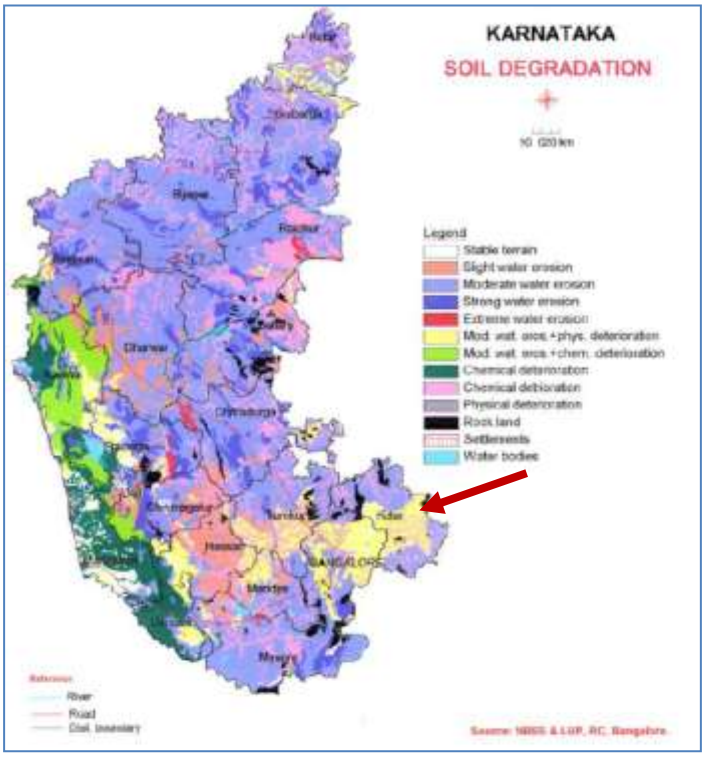

Fig C5.1: Status of soil degradation in Karnataka (Source: NBSS&LUP)

[20] Parisara, ENVIS Newsletter, Departmant of Forests, Ecology and Environment, Government of Karnataka. Special Issue – Technologies for combating desertification, Vol 2. No 2. 2006.

(c) Identify and briefly describe national, local and sectoral land-use policies or regulations adopted before 11 November 2001 that may influence land-use/land-cover change and demonstrate that they do not influence the areas of the proposed A/R CDM project activity (e.g., because the policy does not target this area, or because there are barriers to the policy implementation in this area, etc). If the policies (implemented before 11 November 2001) significantly impact the project area, then the baseline scenario cannot be 'degraded land' and this methodology cannot be used any further;

a) The National Forest Policy of India (1988) envisages 33% of land area under forest/ tree cover. In the approach paper of the Tenth Five Year Plan a monitorable target has been fixed to increase forest/tree cover to the extent of 25% by 2007 and 33% by 2012.
b) The Indian Constitution has been amended to include forestry under concurrent list. Article 48-A states "The State shall endeavour to protect and improve environment and safeguard the forests and wildlife of the country." Article 51- A (G) enshrined as fundamental duty of each citizen "to protect and improve the natural environment including forest, lakes, rivers and wildlife, and to have compassion for living creatures". Similarly 73rd and 74th amendments of the Constitution authorized Panchayats and Urban local bodies to promote social forestry and urban forestry and tree plantations on vacant lands.
c) The National Forest Policy 1988 was adopted with the objectives to: i. have a symbiotic relationship between the tribal and forest, and to associate the forest dwellers in protection, regeneration and development of forests as well as sharing of benefits, ii. promote/popularise non-wood forest products and development of medicinal plants and bamboos, iii). increase productivity through adoption of clonal forestry, application of biofertilizers, adoption of IPM system and efficient forest product development, processing, utilisation and marketing and iv. Carry out detailed investment studies, harmonisation of demand and supply of forest products, and environmental impact analysis to rationalize and improve utilisation.
d) The National Agriculture Policy 2000 was adopted with the following objectives:
   a. Areas of shifting cultivation will receive special attention for their sustainable management
   b. Integrated and holistic development of rainfed areas will be promoted by conservation of rainwater through vegetative measures on watershed basis and augmentation of biomass production through agro and farm forestry with the involvement of the watershed committee.
   c. Agroforestry and social forestry that are prime requisites for maintenance of ecological balance and augmentation of biomass production in the agricultural systems will receive a major thrust for efficient nutrient cycling, nitrogen fixation, organic matter addition and for improving drainage. Farmers will be encouraged to take up farm/agroforestry for higher income generation by evolving technology, extension and credit support and removing constraints to development of agro and farm forestry.
   d. Creation of National Wasteland Development Board to afforest 5 million hectares of wasteland every year. The National Afforestation and Ecodevelopment Board set up by the Ministry of Environment and Forests will regenerate degraded forest land.
   e. Formulation of a number of externally aided social forestry projects and their implementation in States.
   f. Concrete efforts are to be made to cover 15 million hectare of degraded forests under JFM (Joint Forest Management (JFM) vii. Private forestry development has to be encouraged by providing various inputs and legal & policy supports for increasing production and improving ecology and economy of the region.
   g. Around 43 m hectare of area is proposed to be covered under Greening programme in 10-year period as under
      i) 15 m hectare of degraded forest land to be covered under JFM.
      ii) 10 m hectare of irrigated area to be brought under commercial agroforestry

iii) 18 m hectare of rainfed area to be brought under subsistence agroforestry.
iv) Greening India Programme aims at achieving increased productivity, employment and income generation and food security to poverty stricken people.

Though there are a large number of policies, programmes and amendments to the Constitution for reforestation, implementation depends on the availability of funds. In India, the budgetary outlays under the forestry and wildlife sector in State Plans are around 1 per cent. This amount includes overseas development aid. The financial requirement for greening programme would be of the order of Rs.48,000 crores in 10 years. The annual requirement would be Rs. 4,800 crores against the current availability of Rs.1601 crores. There is shortage of funds to undertake such programmes. Additional funds requirement will have to be met from the plan budget of Central and State Governments and externally aided projects. It was envisaged that the external aid would come as an additional amount, but the domestic support was consequently reduced[21]. Thus funding for afforestation and reforestation is lacking in the country though there are ambitious policies and plans to cover a large area under tree cover[22,23]. Further, according to the Planning Commission of India, presently all investment in forestry sector is undertaken directly by the Government with negligible private sector participation in afforestation and tree planting. In order to meet the Eleventh Plan (2007-12) an investment of Rs. 4950 – Rs. 7260 crore will be required on annual basis compared to the investment of about Rs. 1600 crore per year at all levels, thus leading to continuing constraints in provision of additional fiscal resources for afforestation by the Centre and States[24]. The funds for afforestation and reforestation in Kolar region were allocated for planting on forest lands under the Joint Forest Management. On an average, annually, during 1991-2005, 500 hectare has been planted in the taluks. Funding for planting on farmers lands from the programmes are limited. The overseas funding from JBIC for planting on forest lands under the JFM programme has come to an end. There is no funding for planting activities in Chickballapur district under any of the schemes in the coming years. In addition, farmers do not get loans from banks for the purpose of reforestation activities as compared to agricultural activities. According to the mid term appraisal by the Planning Commission, the states have not been able to realize the full potential of this sector, particularly the poverty alleviation focus of the 1988 Indian Forest Policy. The strategy of the Forestry Sector should be two pronged – one, producing market oriented products on farms and two, protecting forests for environmental benefits and for sustaining the livelihood of the forest dwellers[25]. Lack of funds has been the major deterrent to the promotion of forestry activities. These activities listed above would be the only plausible alternative land uses including alternative future public or private activities on the degraded lands. There is no other similar A/R activity or any other feasible land development activities that would impact the proposed project area. The relevant national and sectoral land-use policies, listed above, and the land records, field surveys, data and feedback from stakeholders, already described above, all demonstrate that without the proposed A/R CDM project activity, the project area will not be reforested.

(d) Identify alternative land uses including alternative future public or private activities on the degraded lands including any similar A/R activity or any other feasible land development activities, that are not in

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[21]Source: http://planningcommission.nic.in/plans/planrel/fiveyr/10th/volume2/v2_ch9_1.pdf. Tenth five year plan 2002-07. Forests and Environment, Planning commission. Govt. of India.

[22] http://planningcommission.nic.in/plans/mta/midterm/english-pdf/chapter-14.pdf

[23] http://assets.wwfindia.org/downloads/economic_instruments_project__brief.pdf

[24] http://planningcommission.nic.in/aboutus/committee/wrkgrp11/wg11_forests.pdf

[25]Report of the task force on greening India for livelihood security and sustainable development. Planning Commission, Government of India, July 2001. http://planningcommission.nic.in/aboutus/taskforce/tk_green.pdf

contradiction with the identified local, national and/or sectoral land-use policies and regulations and that could be implemented within the boundary of the proposed A/R CDM project activity. In doing so, use land records, field surveys, data and feedback from stakeholders, and other appropriate sources;

The credible alternative land use scenarios to the proposed CDM project activity is
a) Continuation of the pre-project land use – marginal cultivation, fallow, barren lands;
b) Reforestation of the land within the project boundary performed without being registered as the A/R CDM project activity.

Being privately owned agricultural lands; there are no legal requirements for forestation of at least a part of the land within the project boundary of the proposed A/R CDM project.

a) Continuation of the pre-project land use:

The current area under barren cultivable land, fallow land and agriculture land accounts for 53% of the geographic area of the 5 taluks of project area[26] (Table C5.3).

Table C5.3: Land use of the 5 taluks of project area (ha)

	Geographical Area	Cultivable waste	Fallow Land	Net area sown	Total land holdings (ha)	Area under Mango Plantations (ha)
Bagepalli	90,009	453	8242	37424	44,756	600
Chickballapur	55,612	208	4452	20987	29,599	720
Chintamani	86,697	3,076	6283	38872	51,608	5191
Gudibanda	21,645	310	1960	12517	11,710	180
Shidlaghatta	63,811	751	16869	15959	35,855	1210
Total	317,774	4,798	37806	125759	173,528	7901

Source: Chickballapur district at a glance, 2008-09, Government of Karnataka.

b) Reforestation of the land within the project boundary performed without being registered as the A/R CDM project activity.

The observed forestation activities in the geographical area with similar socio-economic and ecological conditions to the proposed A/R CDM project activity was assessed by a study conducted by Ramachandra, 2007[27] for the year 1988-89. The study showed that plantations accounted for 7,002 ha of land for the relevant taluks of project area. Species level land analysis based on pixel level mapping (considering higher spatial resolution data) and spectral response pattern for each species show that Mango plantations accounted for 0.70% of the land area. During 2008, the area under mango accounts for 7901 ha or 2.48% of the land area[26] (Table C5.3). A change analysis performed based on two dates spanning over a period of four years using supervised classification showed an increasing trend (2.5 %) in unproductive waste land and decline in spatial extent of vegetated areas (5.33 %)[18]. The author concludes

[26] http://des.kar.nic.in/ptc/C.ballapur_DAG_08-09.pdf

[27] Ramachandra, T.V. Comparative assessment of techniques for bioresource monitoring using GIS and remote sensing. The ICFAI Journal of Environmental Sciences, Vol 1. No. 2. 2007.

that depletion of water bodies and large extent of barren land in the district is mainly due to lack of integrated watershed approaches and mismanagement of natural resources.

(e) Demonstrate that land-use/land-cover within the boundary of the proposed A/R CDM project activity would not change and/or lead to further degradation and carbon stock decrease in absence of the proposed project activity, e.g., by assessing the relative attractiveness of alternative land uses in terms of benefits to the local economy and communities' subsistence, consulting with stakeholders for existing and future land use, and identifying barriers for alternative land uses.

The land use alternatives identified by the communities are associated with the current agricultural land uses, barren cultivable land, fallow land and agriculture land. The attractiveness of the plausible alternative land uses in terms of the benefits to the project participants is very low indeed. This is evidenced by the fact that the agricultural labourer families who are participating in this A/R CDM project activity have to work on other people's lands as the land which they will be reforesting under this A/R CDM project activity is so degraded. Similar lands in the vicinity, which are not under Dry Land Development Programme, are simply left as degraded lands and are not cultivated or reforested. Based on land-use pattern of 2007-08, nearly 18% of the geographic area is non-agricultural land and another 11% is fallow land (i.e. 22% of agriculturable land). Based on stakeholder's interview, the only alternative to the project activity for the lands would be marginal agricultural cultivation. The crop productivities are low as these areas have low fertility and are dependent on rainfall. Uncertain rainfall and continuous droughts in the area is causing financial loses to these marginal farmers. The project areas would thus remain either as barren and uncultivable lands, or fallow or marginal croplands in the absence of the project activity. DLDP had low budget at its disposal which could not allow the land to be converted to alternative use.

The credible alternative land use scenarios to the proposed CDM project activity is a) Continuation of the pre-project land use – marginal cultivation, fallow, barren lands. The assessment of the attractiveness of plausible alternative land use in terms of benefits to the project participants (having consulted with stakeholders for existing and future land use, and identifying barriers for alternative land uses) is that similar lands, in the vicinity to the proposed project activity parcels of land, are not planned to be used for these alternative land uses. There are barriers which prevent the alternative land use. The two main issues identified by the communities are high investment costs and lack of funding for dry land agriculture. The Coolie families cannot absorb risks of arid land plantation management as isolated individuals and neither can they benefit from economics of scale. The proposed A/R CDM activity is different from the earlier social forestry programmes. The World Bank aided social forestry programme in the eighties had contributed to the supply of seedlings free of cost to farmers through decentralized nurseries for planting on their lands. In Southern and Eastern Kolar District, Eucalyptus was extensively planted on the mounds/ bunds as well as in the agricultural wastelands (Fig C5.2). In the Chickballapur district comprising the project area, the area covered was negligible as seen in Fig C5.2. Plantations account for 0.18-5% of the taluk area (Table C5.1). These programs were aided by overseas developmental agencies, while domestic funds for such programmes were minimal. A study by Shiva *et al.*, (1981)[28], concluded that the primary objective of social forestry had not been achieved. A survey of the various stakeholders for choice of species in the project area shows that they do not prefer Eucalyptus, as they opine that it will further deteriorate the lands. They prefer horticulture tree species.

[28] Shiva, V., Sharatchandra, H.C. & Bandyopadhyay, J. 1981. Social, Economic and Ecological Impact of Social Forestry in Kolar. Indian Institute of Management, Bangalore, India. http://www.odifpeg.org.uk/publications/greyliterature/socialforestry/shiva/ Shiva.pdf

PROJECT DESIGN DOCUMENT FORM
FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES (CDM-AR-PDD) - Version 04

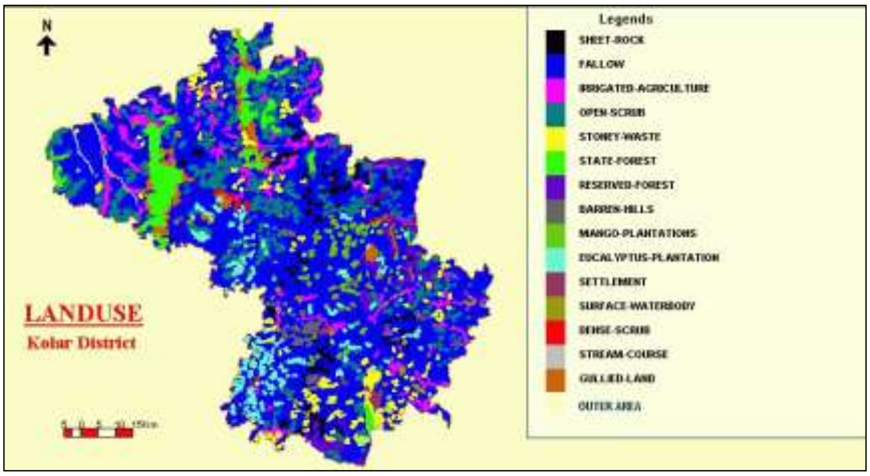

Fig C5.2: Land use map of Kolar district

Afforestation and reforestation was done under the externally aided JBIC programme, but limited to forest lands. The benefit of planting is to the Joint Forest Committees (JFMCs) and the forest department. Planting on degraded private lands are not being done. As mentioned above, even in the agroforestry model, only a few big farmers (with large land holding) were benefited while the marginal and poor farmers are not being benefited. The species planned for this proposed A/R CDM project activity are NTFP species which are indigenous to the region and will yield long-term benefit to the farmers. The scale of the A/R CDM project activity also means that some benefit may accrue to the local climate and ecological conditions, and precipitation in the local area may even increase. This scale of planting on private marginal lands has not been done before. Thus the proposed CDM is different from the forestry projects promoted by the forest department. Thus the project activity is different is the following ways:
- Reforestation under this A/R CDM project activity is on degraded agricultural lands belonging to marginal farmers and agricultural labourers in the 5 taluks of Chickballapur District. These taluks have worse soil conditions than Southern and Eastern taluks, and do not lend themselves to the programmes described above.
- The species are selected by the participating families and the emphasis is on NTFP and local species.
- The aim is to establish long rotation farm forests, and not engage in short rotation cash crop plantations.
- There will be greater biodiversity benefits from this A/R CDM project activity as bund planting and mixed species will contribute to creating small protected habitats for flora and fauna.

The CDM potential to support reforestation financially by providing a new and growing cash flow related to the accumulation of biomass and carbon stocks in reforestation projects has convinced many landowners to change land use towards forestry. If the carbon markets and lCER prices develop as hoped, and participating land owners perceive a fair market price for the carbon they have sequestered, A/R CDM will provide new incomes. In the medium term, if the tree stand models accumulate large amounts of carbon and the price of lCERs on the market is also high, the incomes from carbon sequestration may become very important, may offset opportunity costs for the use of the land, and may provide an important incentive for allowing the stands to grow and accumulate carbon.

Step 4: *Stratify the A/R CDM project area*

The project strata were defined in the stratification process *ex- ante* (Section C.4).

Step 5: *Determine the baseline land-use/land-cover scenario for each stratum.*

The baseline land-use/land-cover of the project area is uniform predominantly being private farmer's agricultural lands. From the baseline survey, 80% of the land are marginal croplands of Paddy, Finger millet, Sugarcane, Groundnut, horsegram, pigeon pea, Maize and Bengal gram., 14% is left barren and another 5% has fruits and vegetables grown on them. The analysis of the baseline uses of land demonstrate that 51% of the lands have undergone soil and water conservation works under the DLDP programme for 1-11 years period. Based on the baseline survey conducted on 7537 ha of land, the average tree density on the land with trees is 3.2 scattered trees per hectare in the project area. As previously mentioned, the degradation, erosion and compacting in the baseline scenarios, prevents the natural regeneration of these areas. The vegetation present in these areas and their economic uses in the absence of the project activity are not sufficient to permit natural regeneration processes of forest cover. If the project activity were not to occur, the historical uses and the economic determinants of land use would most probably result in a continuation of fallow land or marginal farming leading to further degradation of lands.

Analyse the possibility of self-encroachment of trees under the current conditions:

Survey and identification of trees growing on site; A study conducted by Ramachandra and Rao, 2005 shows that large part of standing biomass in Kolar region is human induced and not from naturally grown trees[29]. A baseline survey was conducted to assess the baseline land-use scenario in the project area. An analysis of trees in the baseline shows that planted species account for 93% of the trees, of which the dominant species are *Pongamia pinnata, Azadirachta indica, Eucalyptus, Tamarindus indica, Annona squamosa* and *cocus nucifera.*

The overall tree density of the project area is 3.27 trees/ha. Plot-wise, 47% and area-wise 37% have no trees (Stratum A) and remaining 53% of the plots or 63% of the land area have nearly 5.2 trees/ha (Stratum B). The average basal area in the baseline is 0.22±0.07 m^2/ha for the project area. at 95% confidence level. For Stratum B with trees, the basal area is 0.40±0.14 m^2/ha.

The proposed lands are croplands, barren or fallow lands with hardly any trees on these lands. There are no on-site or external seed pools/sources that may result in natural regeneration. Neither are there possibility of seed sprout and growth into trees with the potential height, crown cover and area crossing the threshold values used in the national definition of forest, under the current conditions. If the project activity were not to occur, the historical uses and the economic determinants of land use would most probably result in a continuation of the current land use.

C.5.2. Description of the identified baseline scenario (separately for each stratum defined in Section C.4.):

The various land use type based on Karnataka Remote Sensing Center was considered for baseline stratification. The major type is Agriculture land-Kharif Crop (summer crops), Rabi Crop (winter crops), Two crop area, Fallow land and horticulture species; Built Up area: rural, industrial/mine/quarry; Forest-Scrub forest (<10% crown cover); Wasteland-rocky, stony, gullied, shallow ravenous, scrub lands; Water

[29] Ramachandra, T.V and Rao, G.R 2005. Inventorying, mapping and monitoring of bioresources using GIS and remote sensing. Geospatial Technology for Developmental Planning SM.Ramasamy, CJ.Kumanan, KPalanivel and Bhoop Singh (eds). pp. 49 - 76, Allied Publications Pvt. Ltd., New Delhi, July 2005. http://wgbis.ces.iisc.ernet.in/energy/paper/Biores_using_RS_GIS/index.htm

bodies- dried and seasonal lakes, ponds, reservoirs, streams and tanks. The various land use of the plots based on Karnataka Remote Sensing Center for baseline stratification is as follows:

Taluk	Total No. of Plots		Total Identified Project Area (Ha)		% Area sampled
	Project	Sampled	Project	Sampled	
Agricultural Land	10,714	9,556	7,656.14	6,424.15	83.91
Built Up Area	134	125	91.65	78.37	85.51
Scrub Forest (<10% crown cover)	78	69	62.37	54.16	86.83
Wastelands	1,282	1,187	1,037.92	905.95	87.29
Waterbodies	139	126	85.26	74.85	87.79
Grand Total	**12,347**	11,063	**8,933.34**	7,537.49	84.37

With regard to the vegetation found in the baseline survey, it is homogeneous with the dominance of few species on the bunds of plots. According to Champion and Seth classification and the remote sensing data, the vegetation type in this region is deciduous type. Thus a single stratification for the baseline net GHG removals by sinks has been considered.

Stratum A: Baseline strata without trees or woody perennials

The project area with no trees or woody perennials on the cultivated area is 2791.08 ha of the 7537.49 ha or 37% of the sampled project area. These lands do not contain any trees or woody perennials on the bunds or on the cultivated lands. The details of stratum are as follows:

Land Use	**Area (ha)**	**No. of Plots**
Agricultural Land	2,331.67	4459
Built Up Area	35.77	66
Forest-Scrub Forest	32.73	45
Wastelands	366.01	591
Waterbodies	24.90	52
Grand Total	2,791.08	5213

Stratum B: Baseline strata with trees or woody perennials

This statum is constituted by numerous plots of land. It includes 5850 number of plots and 4746.41 ha of land with trees. These plots include a few scattered trees per hectare, and include species such as *Pongamia pinnata, Azadirachta indica, Prosopis juliflora, Eucalyptus sps, Tamarindus indica, Annona squamosa, cocus nucifera*, among others. In the survey carried out for stratum B, an average of 5.2 tree individuals per hectare was determined. In total, the amount of carbon contained in the baseline scenario is estimated at 0.43 tC/ha.

Plot-wise, 53% of the plots or 63% of the land area have nearly 5.2 trees/ha (Stratum B). The average basal area in the baseline is 0.22±0.07 m^2/ha for the project area at 95% confidence level. For Stratum B with trees, the basal area is 0.40±0.14 m^2/ha.

Land USe	Area (ha)	No. of Plots
Agricultural Land	4,092.48	5,097
Built Up Area	42.61	59
Forest-Scrub Forest	21.43	24
Wastelands	539.94	596
Waterbodies	49.96	74
Grand Total	**4,746.41**	**5,850**

An analysis of the species in the baseline shows that 93% of the trees have been planted and 7% of the trees are naturally regenerated. Nearly 80% of the trees will be retained during planting. The rest of 20% which will be cut during the project activity are species such as Eucalyptus, Teak and Prosophis juliflora, which even over wise would have been harvested.

C.6. Assessment and demonstration of additionality:

The assessment and demonstration of additionality are described using the document ***"Tool for Demonstration and Assessment of Additionality in A/R Project activities***" Version 02, issued by the CDM executive board at the United Nations, which shall be hereinafter referred to as the "Additionality Tool".

The proposed project area is a collection of parcels of degraded land owned by marginal private farmers in the 5 taluks of Chickballapur District. The Dry Land Development Programme has been in place since 1986. As can be seen in Fig A7.3A-E, these lands have not been forests since 1989 according to the definition of forests given by India. Also currently these lands are not forests as shown in Fig A7.1A-E . These lands are degraded private lands and no natural regeneration will take place.

The steps as outlined in the EB additionality tool[30] is followed to demonstrate that a proposed A/R CDM project activity is additional and not the baseline scenario, taking into account the conditions under which AR-AM0004 is applicable. The chosen approach is:

- STEP 0. Preliminary screening based on the starting date of the A/R project activity;
- STEP 1. Identification of alternative land use scenarios to the A/R project activity;
- STEP 2. Investment analysis to determine that the proposed project activity is not the most economically or financially attractive of the identified land use scenarios; or
- STEP 3. Barriers analysis; and
- STEP 4. Common practice analysis.

STEP 0: *Preliminary screening based on the starting date of the A/R project activity*

The PDD was submitted for validation before the starting date of the A/R project activity. The start date for the project activity is 25th Jan 2008. The evidence that the incentive from the planned sale of CERs was seriously considered in the decision to proceed with the project activity is evidenced by the fact that Host Country Approval for the project activity was obtained on 16th June 2006.

STEP 1: *Identification of alternative land use scenarios to the proposed A/R CDM project activity*

[30] (cdm.unfccc.int/EB/Meetings/016/eb16repan1.pdf)

Sub-step 1a. Identify credible alternative land use scenarios to the proposed CDM project activity

The credible alternative land use scenarios to the proposed CDM project activity is a) Continuation of the pre-project land use – marginal cultivation, fallow, barren lands; b) Reforestation of the land within the project boundary performed without being registered as the A/R CDM project activity.

Being privately owned agricultural lands, there are no legal requirements for forestation of at least a part of the land within the project boundary of the proposed A/R CDM project.

a) Continuation of the pre-project land use: The project area being a semi-arid drought prone region receiving an annual rainfall of 780 mm, is facing desertification and soil degradation. The region has rocky terrain which is severely undulating, with small hill ranges and outcrops. There is only a very thin and fragile soil cover. Slopes in the region are not terraced and rainfall is not retained due to which soil erosion is a severe problem in this area. The proposed project area has undergone soil and water conservation works under DLDP and the only alternative to this would be continued degradation of the land and continued barren conditions. Alternatively cropping could in some circumstances be taken up by the families. But neither DLDP nor marginal cropping is economically viable as the crop productivities are very low due to poor soil conditions and scarcity of water resources (Fig A5.1, C2.1, C2.2). There has been a decrease in agricultural and pasture land, and there has been an increase in fallow degraded land (Kolar land use statistics, 2005)[31]. Seasonal conditions and climate change have been the main factor for decrease in cultivation area. The periodic drought and the recurring scarcity conditions have reduced the cultivated areas (Table C6.1)

Table C6.1: Information on occurrence of droughts / floods in the Project area

Name of the Taluk	Occurrence of drought / floods	Year (Last 10 Years)	Severity M / S / VS	% Cropped area affected	Livestock Mortality (No. of animals)	% of farm families affected
Bagepalli	Drought	2002-03-04	VS	83	-	92
Chickballapur	Drought	2002-03-04	M	52	-	62
Chintamani	Drought	2002-03-04	S	67	-	71
Gudibanda	Drought	2002-03-04	VS	81	-	90
Sidlagatta	Drought	2002-03-04	S	63	-	71

Note: M – Mild S – Severe VS – Very severe (As per GOI / States parameter)
Source: Government of Karnataka, Department of Agriculture, Kolar

To reap better benefits, slightly richer farmers install submersible borewells and cultivate some lands, and like marginal farmers, they leave the degraded unproductive lands fallow. This has led to overall collapse of the water table and further decrease in acreage under cultivation. This is an indicator of increased degradation. A study was conducted by Ramachandra and Uttam[32] for Kolar district to study the change in land use patterns for Kolar district using digital change detection referenced to geo-registered multitemporal remote sensing data to identify change between 1998 and 2002 for landuse changes

[31] Chitraranjan, H. Kolar district Gazetteer, Karnataka Gazetteer, 2005
[32] Ramachandra, T.V. and Uttam Kumar, 2004. Geographic Resources Decision Support System for land use, land cover dynamics analysis. Proceedings of the FOSS/GRASS Users Conference - Bangkok, Thailand, 12-14 September 2004. http://wgbis.ces.iisc.ernet.in/energy/paper/grdss/index.htm

through spatial and temporal analysis techniques such as GIS (Geographic Information System) and Remote Sensing along with digital image processing techniques. The land use analyses indicate increase of non-vegetation area from 451752 ha. (54.84% in 1998) to 495238 ha (60.17% in 2002). The results also show a decrease in agriculture lands by about 8.21% from 28.34% in 1998 to 20.13% in 2002 and an increase in wasteland area.

Thus the lands to be reforested are severely degraded, with the vegetation indicators below thresholds for defining forests, and the lands are still degrading. As proved by the fact that DLDP works have to continue to be carried out on all these lands, these lands are economically unattractive as croplands. At the same time there is no financial wherewithal to take up alternatives. Thus the continuation of the current situation represents the only baseline alternative.

b) Reforestation of the land within the project boundary performed without being registered as the A/R CDM project activity.

The observed forestation activities in the geographical area with similar socio-economic and ecological conditions to the proposed A/R CDM project activity was assessed by a study conducted by Ramachandra, 2007[33] for the year 1988-89. The study showed that plantations accounted for 7,002 ha of land for the relevant taluks of project area. Species level land analysis based on pixel level mapping (considering higher spatial resolution data) and spectral response pattern for each species show that Eucalyptus occupy 2.44%, forest - 3.18% and mango 0.70% of the land area. Extrapolating this to the present, the area under the horticulture species - Mango and Tamarind, is very low. As seen from Table C5.3, the extent of these lands is still very low. Holistic decisions and scientific approaches are required for sustainable development of the region. The change analysis based on two dates, spanning over a period of four years using supervised classification, showed an increasing trend (2.5 %) in unproductive waste land and decline in spatial extent of vegetated areas (5.33 %)[18]. Depletion of water bodies and large extent of barren land in the district is mainly due to lack of integrated watershed approaches and mismanagement of natural resources.

Sub-step 1b. Consistency of credible land use scenarios with enforced mandatory applicable laws and regulations

a) Continuation of the pre-project land use – marginal cultivation, fallow, barren lands:

This activity is legal and complies with all national laws and regulations. The provision of basic minimum livelihood through granting of land title to agricultural labourers who have squatted the lands and obtained title to the land is legal and complies with all the national laws and regulations.

b) Reforestation of the land within the project boundary performed without being registered as the A/R CDM project activity: This activity is legal and complies with all national laws and regulations.

National policies and programmes were launched in India for afforestation and reforestation in India, of which social forestry and the Joint Forest Management (JFM) order of 1990 are the major activities. According to the 10th Five years plan for the forestry sector by the Planning Commission, Government of

[33] Ramachandra, T.V. Comparative assessment of techniques for bioresource monitoring using GIS and remote sensing. The ICFAI Journal of Environmental Sciences, Vol 1. No. 2. 2007.

India, the thrust for forestation especially on farm lands should be encouraged[34]. The following plans are suggested:

Promotion of forestry on private farmers' land: The National Forest Policy (1988) stressed that forest farming should be encouraged for meeting forest based industrial raw-material requirements. By avoiding duplication of species unhealthy competition may disappear between forestry and agroforestry sectors and farmers can start forest farming for their economic gains.

Poverty alleviation, tribal development and women's empowerment schemes to focus on private farm land: Forestry on agricultural lands has a potential to optimise production in the rainfed and semiarid regions. However, this has neither been stressed nor monitored in poverty alleviation, tribal development and women's empowerment schemes under implementation. Such programmes should be encouraged under the 10th five year plan.

Integrated watershed development programme: There is a serious problem of ecological deterioration in watershed areas. An integrated approach is needed for conserving, upgrading and using the natural resource base of land, water, plant, animal and human resources. Forestry on farm lands can play a dominant role in promoting livelihood opportunities and has to be taken up in the 10th five year plan.

These plans are not legally binding and meeting the goals and objectives of these programs depend on availability of funds. Funds from government have been limited for such programs. The national JFM program and social forestry concentrates on the forest areas rather than on such private degraded lands where the proposed A/R CDM activity takes place. Also the farmers face cash flow limitations, multiple risks and other problems to take it on their own. Thus the baseline scenario is entirely in compliance with applicable legal and regulatory requirements but at the same time the fact that the legal requirements are in place does not mean that enough is being done.

The outcome of sub-step 1b is that both the scenarios are credible land use scenarios.

Sub-step 1c. Selection of the baseline scenario:

The procedure to select and determine the most plausible baseline scenario is described in Section C.5.1.

STEP 3. Barriers analysis

I. Investment barriers

Similar activities as the CDM project activity in this region have only been implemented with the World Bank grants. Social forestry was undertaken by the Karnataka Forest Department since 1975-76, followed by the official social forestry programme by World Bank, which gained momentum by 1979-80. This is apparent from the growth during that year which showed that 300 million of free seedlings were distributed[35]. Thus the most successful and predominant element of social forestry has been based on individual farmers planting seedlings which were distributed free of cost.

[34] Report of the task force on greening India for livelihood security and sustainable development, Planning commission, Government of India, July-2001. http://planningcommission.nic.in/aboutus/taskforce/tk_green.pdf

[35] http://www.unu.edu/unupress/unupbooks/80a03e/80A03E09.htm

Lack of access to credit: No credit mechanisms are in place for farmers to make long term investment in plantation forestry on degraded and degrading lands by taking commercial loans from banks. As can be seen from Table A5.4 perennial trees cost Rs 1,06,400 per hectare to establish. Agricultural banks do not give loans for these project activities as the marginal farmers do not have any collateral security to offer. The gestation period for tree crops is so long that these kinds of loans are not attractive to banks. A study conducted by International Financial Corporation showed that farmers reported they would plant trees if there was sufficient financing available. Some local rural banks were willing to grant new loans only if buyback guarantees were provided and these guarantees did not materialize[36]. More so, financing programs to work with smallholders have not worked yet in India[37]. Agriculture is the main income source in the project area and with low productivity, the condition of most farmers borders on poverty. As a result they are not able to afford the high plantation costs particularly with the long gestation periods that forestry entails. The proposed A/R CDM project activity reduces the gestation period for economic returns through carbon credits and makes the project a more attractive economic proposition. The Project Proponent, an NGO, has taken up the proposed A/R CDM project activity with a view to promote tree planting on these lands and is bearing all project investigation and preparation costs as well as seedling costs and will also endeavour to help the project proponent raise money for raising plantation. This is being done only because it is a CDM project.

Annual cropping of marginal lands costs Rs 1,000-3,000 per hectare. This level of borrowing is available more readily from informal sources where collateral is not needed. Gestation periods are short and money that has been borrowed informally can be returned more quickly to the lender. The even more likely alternative of leaving the land in a degraded state costs nothing and is generally preferred. Local fund availability matches the baseline level of activity on highly degraded lands where people do not have time, skill or money to do more than just scratch the soil. Informal credit is enough to buy some millet for planting after some shallow scratching of the soil. Otherwise it is also simply left as wasteland.

II. Technological barriers

The local farmers do not have an easy access to either the planting material or planting technologies as forestry is not their usual occupation. A study was conducted by Government of Karnataka of Agriculture, Kolar and Directorate of Extension, University of Agricultural Sciences, Bangalore for Kolar region[38]. They have identified the gap in adoption of these technologies in the project area of which the major issues are lack of Organic Manure, Fertilizer application, Method of Fertilizer Application, Use of Micronutrients, Weed control, Land and Water Management. The reasons for these were identified as i. Lack of awareness, ii. Non availability of organic manure iii). Mango crop raised under Rainfed condition thus leading to lack of moisture iv). Lack of interest regarding use of recommended dose of fertilizers and v). Lack of adoption of intercultivation practices.

The study has recommended: i) Conduct of training programmes, ii) Grafting of improved, dwarf and high yielding varieties, iii). Training regarding soil and water management iv) Training regarding improved methods of compost preparation and v). Protective irrigations for increase in the yield.

These technological barriers as identified by a Third Party study for this region will be addressed through this CDM activity. The beneficiary families will get these facilities from the Project Proponent. ADATS

[36] www.ifc.org/ifcext/rmas.nsf/AttachmentsByTitle/.../BILTFarm.pdf

[37] https://www.devex.com/projects/india-farm-forestry-program-phase-i

[38] www.manage.gov.in/ExRef/SREP-KOLAR/SREP-KOLAR.doc

will have a management plan is place in consultation with Horticulturalists. This is being done only because of the commitment to promotion of CDM afforestation on such lands.

For the baseline marginal crops like millet and groundnut there is no lack of planting material. It is available from local markets. The infrastructure required in the baseline activity is family based. The activity can be carried out with family labour and there is no need for transport, technical and other inputs. Only technically proven and tried and tested crops are used – millet and groundnut on degraded lands are relatively pest-resistant and no additional technical support is required to get a marginal crop. Rest of the last is left as wasteland.

III. Barriers due to social conditions

There is no organization of local communities that is focused on tree planting and individual farmers are unable to successfully invite investments in tree planting on such lands and exploit commercial synergies with their other products and create new links to market on their own. Farmers have been constrained by lack of adequate technical knowhow regarding choice of species, planting pattern, quality of seedlings, harvesting practices and so on. A systematic approach towards providing farmers with the necessary information is lacking at present and so is coordination among the various agencies associated with farm forestry[39]. This also prevents them from overcoming technological barriers mentioned above. Now the interest in CDM and the benefits that are likely to flow from a CDM project has led to the involvement of Bagepalli Collie Sangha under the patronage of the project proponent - ADATS. Thus an important barrier to the tree planting on the project lands will be addressed through CDM.

For cropping on degraded land in individual parcels, no community organisation is required.

IV. Barriers due to local ecological conditions

Drought is a major barrier to the implementation of this project activity. Poor soil conditions and scarcity of water resources (Fig A5.1, C2.1, C2.2) is a major barrier. As shown in Table C6.1 drought occurs frequently in this region. The project area does not enjoy the full benefit of northeast monsoon and being cut off by the high Western Ghats. The rainfall from the southwest monsoon is also prevented, depriving of both the monsoons and subjected to recurring drought. The rainfall is not only scanty but also erratic in nature. The district is devoid of significant perennial surface water resources. The ground water potential is also assessed to be limited. The terrain has a high runoff due to less vegetation cover contributing to erosion of top productive soil layer[32]. Drought due to global climate change which causes increased desertification means that the proposed type of project activity has to overcome major barriers to see that the trees establish and flourish. Water arrangements will be made for each of the farmers' lands without water source to overcome this barrier as shown in section A5.4. Also rockwool will be provided to each of the seedlings to increase the rate of survival.

Though this barrier also affects marginal cropping on degraded lands too, it does not affect it as strongly, as the monetary loss in case of a drought is less.

STEP 4. ***Common practice analysis***

[39] http://www.compete-bioafrica.net/international/Annex4-2-4-COMPETE-032448-2ndReport-D4.1-India-Final.pdf

An analysis of the extent to which similar forestation activities have occurred in the geographic area of the project activity, shows that area under plantations accounted for 15.85% of the geographic region of Chickballapur taluk in 1998, dominated by Eucalyptus plantations[29] and was 6.11% of the geographic area of the district including Chickballapur taluk. These are predominantly Eucalyptus plantations implemented under the World Bank funded Social forestry programme and by the Karnataka Forest Department. As of 2004, only 2840 ha of land were under Mango plantations, which accounts for 0.36% of the geographic area[40]. Another study conducted by Ramachandra shows that the area under Mango plantations is 0.70% of geographic area during 2002[27]. The World Bank funding was available for the period 1984 to 1990. Later under the JBIC project, farm forestry was implemented from 1997 to 2005. Under this scheme, seedlings were distributed, which were for fuelwood, pulp for paper industries and poles with funding essentially for free distribution of seedlings.

Currently there are no programmes or policies to promote forestation activities of the kind proposed for the A/R Project activity. Even if present, these are limited to only the distribution of seedlings to the farmers and these are essentially Eucalyptus plantations. The subsidy is limited to only free distribution of seedlings. The other costs to overcome technical and social barriers as listed above needs to be addressed. This will be done by the project proponent and is essentially being done as it is a CDM project activity.

C.7. Estimation of the *ex ante* baseline net GHG removals by sinks:

Estimation of baseline net GHG removals by sinks

The calculation procedures proposed in AR-AM0004/Version 04 were used in order to estimate the baseline net removals by sinks (C_{BSL}). In this respect, the changes in the carbon contents of the existing scattered tree woody biomass were quantified, in order to determine these quantities in case it is necessary to consider their CO_2 contents at any point during the proposed crediting period.

$$C_{BSL} = \Delta C_{B,LB} \qquad \textbf{(2)}$$

where:

C_{BSL} Baseline net greenhouse gas removals by sinks; t CO_2-e

ΔC_{BLB} Baseline sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e

For estimation of ΔC_{BLB} (changes in living biomass carbon stocks in the baseline)

$$\Delta C_{BLB} = \sum_{t=1}^{t^*} \sum_{i=1}^{m_{BL}} \Delta C_{B,ikt} \qquad \textbf{(3)}$$

where:

ΔC_{BLB} Baseline sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e

$\Delta C_{B,ikt}$ Baseline annual carbon stock change in living biomass for stratum *i*, stand model *k*, time *t*; t CO_2-e. yr^{-1}

40 Nageshwara Rao, H.M. Ravishankar, Uday Raj and K. Nagajothi. Production estimation of horticultural crops using IRS-1D LISS-III Data. Journal of the Indian Society of Remote Sensing, Vol. 32, No. 4, 2004.

I 1, 2, 3, … m_{BL} baseline strata

K 1, 2, 3, … *K* stand model

T 1, 2, 3, …*t** years elapsed since the start of the A/R CDM project activity

$\Delta C_{B,ikt}$ has been set to 0 for stratum without trees.

A baseline survey was undertaken in the project area consisting of five taluks of Bagepalli, Chickballapur, Chintamani, Gudibanda and Siddalaghatta in Chickballapur District, Karnataka State. This region is a semi arid drought prone area with low, erratic and spatial rainfall. The dust brown rocky terrain is severely undulating, with small hill ranges and a very thin and fragile soil cover. The normal forest cover is just 6.18% of the total area of the old Kolar district (FSI, 2009). In practice many of the forests are themselves very degraded, the forests have been highly exploited. For the CDM project activity, private or farmers' lands are currently being considered for CDM for the reforestation activity which belongs to about 8107 Coolie families who own a total 9833.34 ha.The details of the participating families in the study area are shown in Table A4.1. Of these lands, 7537.49 ha of the land have been sampled to determine the baseline net GHG removals by sinks, which accounts for nearly 84.37% of the 8933.34 ha lands under the project area (Table C7.1).

Table C7.1: Baseline sampling details

Project Details			Sampling details			
Taluk	Total Identified Project Area (Ha)	Total No. of Plots	Area covered		Plots surveyed	
			Ha	%	No.	(%)
Agricultural Land	7,656.14	10,714	6424.15	83.91	9556	89.19
Built Up Area	91.65	134	78.37	85.51	125	93.28
Scrub Forest	62.37	78	54.16	86.83	69	88.46
Wastelands	1,037.92	1,282	905.95	87.29	1187	92.59
Waterbodies	85.26	139	74.85	87.79	126	90.65
Total	**8,933.34**	**12,347**	**7537.49**	**84.37**	**11063**	**89.60**

The first stratification was done according to presence or absence of trees on the plots. This shows that 2,791 ha or 37% of the area surveyed is without trees and 4,746.60 ha or 63% of the area is under trees. Thus for the 8,936.46ha of project land, 3311.21 ha is without trees and 5625.25 ha has trees on them.

Table C7.2: Details of baseline stratum for the project area

Stratum	Baseline Area (Ha)	No. of Plots	% of Area
A - No trees	2791.07	5213	37
B - Trees	4746.40	5850	63
Total	7537.47	11063	100.00

Stratum A: Baseline strata without trees or woody perennials

Stratum A of project area with no trees in the baseline constitutes nearly 37% of the lands or 2791 ha.

For this strata,

a) No growing trees or woody perennials exists. This is evidenced by the baseline survey conducted. A study conducted by Ravindranath *et al*, 2005[41] also shows the baseline number of trees on farm forestry for Kolar region as zero.

(b) No trees or other woody perennials will start to grow at any time during the crediting period: Based on the baseline survey, the project has very no regenerating species.

Nearly 93% of the trees in the project area are planted and very few regenerating tree species are in the project area. For this stratum, the methodology conservatively assumes that baseline net greenhouse gas removals by sinks are zero:

$C_{BSL} = 0$ for all $t^* \leq t_{cp}$

C_{BSL} = Baseline net greenhouse gas removals by sinks; tCO_2-e
t^* Number of years elapsed since the start of the A/R project activity; yr
t_{cp} Year at which the first crediting period ends; yr

Stratum B: Trees in the baseline

The stratum B comprises of 63% of the lands. Thus of the project area of 8,933.34 ha, 5625.25 ha of land has trees in the baseline. The baseline net GHG removal by sinks is determined as follows:

For those strata with a few growing trees, $\Delta C_{B,ikt}$ was estimated using method 2 (stock change method) proposed in the AR-AM0004/Version 04. In addition, the CO_{2e} content in the shrub biomass was quantified. The procedures were applied to calculate the total carbon stock for the scattered trees during a twenty (20) year crediting period. Initially, the area (A_{ikt}), number of trees (nTR_{ijt}), carbon fraction (C_{fpre}) and Diameter at Breast Height (DBH) variables were determined. The DBH was used to determine the biomass with the help of volumetric or allometric equation which ever was available as species specific equations that will enable the determination of carbon stock in the aboveground component. In order to determine the number of individuals (nTR_{ijt}) and DBH for each strata of the base line, a series of field analyses were carried out.

Field measurements demonstrate that the number of scattered trees is small and that the criteria established by the national definition of forest for India are not met. These trees are there since the start of the project. With respect to the carbon fraction variable contained in the woody species of the strata CFj, a constant value of 0.5 suggested by the IPCC Good Practices Guidance (2006) was assumed. The method to calculate carbon capture by the aboveground biomass (CAB_{ijt}), (Equation 12, AR-AM0004/Version 04) indicates the need to use allometric functions which relate the living woody biomass of the trees or shrubs (dry matter ha^{-1}) with the diameter or height variables (DBHt, Ht).

[41] Ravindranath, N.H; Murthy, I.; Sudha, P.; Ramprasad, V.; Nagendra, M.; Sahana, C.; Srivathsa, K.; Khan, H. Methodological issues in forestry mitigation projects: a case study of Kolar district *Mitigation and Adaptation Strategies for Global Change*, Volume 12, Number 6, July 2007 , pp. 1077-1098

$$C_{AB,ijt} = A_{ikt} \cdot nTR_{ijt} \cdot CF_j \cdot f_j(DBH_t, H_t) \quad \textbf{(12)}$$

where:

$C_{AB,ijt}$	Carbon stock in above-ground biomass for stratum *i*, species *j*, at time *t;* t C
A_{ikt}	Area of stratum *i*, stand model *k*, at time *t*; hectare (ha)
nTR_{ijt}	Number of trees in stratum *i*, species *j*, at time *t*; dimensionless ha^{-1}
CFj	Carbon fraction for species *j*, t C (t d.m.)$^{-1}$
$f_i(DBH_t,H_t)$	Allometric equation linking above-ground biomass of living trees (d.m. ha^{-1}) to mean diameter at breast height (*DBH*) and possibly mean tree height (*H*) for species *j*; dimensionless

Allometric equations available in the scientific literature for trees were used as shown in Table 4 of Annex 3.

In the equation above, the values for nTRijt and DBH used in the estimations correspond to the average values determined in the field samples. The values for biomass obtained for the baseline scenarios are presented in Table C7.3.

Table C7.3: Number of individuals, average DBH, Height and Age of species in the baseline survey

Botanical Name	Average DBH (m)	Average Height (m)	Average Age (yrs)
Acacia auriculiformis	0.16	4.18	6.90
Achtas sapota	0.12	3.33	9.58
Albizia amara	0.24	7.52	10.10
Aleurites moluccana	0.16	5.00	11.35
Anacardium occidentale	0.18	4.03	10.00
Annona squamosa	0.11	3.66	8.42
Artocarpus integrifolia	0.34	7.34	17.65
Azadiractha indica	0.44	5.12	10.43
Bauhinia malabaria	0.16	4.73	9.81
Butea monosperma	0.23	4.81	12.16
Calotropis gigantea	0.25	4.74	14.00
Canthium parviflorum	0.13	4.13	7.75
Cassia auriculata	0.18	5.88	10.87
Channagiri	0.17	4.24	6.40
Citrus	0.21	4.24	8.67
Ceiba pentandra	0.33	6.84	11.60
Diospyros melanoxylon	0.28	6.26	11.71
Diospyros montana	0.25	3.96	8.00

Eucalyptus sps	0.18	6.72	8.61
Eugenia (Syzygium cumini)	0.28	5.42	11.68
Ficus bengalensis	0.76	7.38	16.35
Ficus religiosa	0.39	6.49	18.01
Glyricidia	0.04	3.96	4.00
Gossypium sps	0.36	8.01	16.31
Grevillea robusta	0.18	6.88	8.72
Holoptelea integrifolia	0.22	6.09	11.42
Leucaena leucocephala	0.26	7.86	10.17
Mangifera indica	0.23	4.98	12.55
Pongamia pinnata	0.19	4.61	10.46
Prosopis juliflora	0.19	5.00	10.66
Psidium guava	0.17	4.37	9.93
Punica granatum	0.13	3.55	6.40
Santalum album	0.09	3.20	10.00
Sapindus emarginatus	0.18	4.17	9.35
Tamarindus indica	0.39	7.17	19.80
Tectona grandis	0.18	6.52	10.58
Terminalia paniculata	0.14	4.90	11.22
Unknown1	0.17	6.49	8.25
Unknown2	0.40	9.67	13.47
Unknown3	0.22	4.86	8.91
Unknown4	0.23	5.75	13.00
Unknown5	0.21	5.33	12.21
Zizypus jujupa	0.24	4.90	10.11

The carbon stock in the belowground biomass is obtained by multiplying the expansion factor of the roots by the result of the carbon stock of the aboveground biomass (Equation 11, of the AR-AM0004/ Version 04).

The belowground biomass ($C_{BB,ijt}$) was calculated considering the GPG-IPCC (2006) value of 0.27 as the shoot:root ratio.

The sum of the two stocks in the aboveground and belowground compartments yields the total carbon by stratum C_{ijt} in the baseline and in the scattered trees, during each year of the crediting period considered (Equation 9, of AR-AM0004/ Version 04).

$C_{BB,ijt}$ = $C_{AB,ijt} . R_j$
C_{ikt} = $C_{AB,ijt} + C_{BB,ijt}$
$C_{BB,\ ijt}$ = Carbon stock in the belowground biomass for stratum i, species j, and time t; t C
$C_{AB,\ ijt}$ = Carbon stock in the aboveground biomass for stratum i, species j, and time t; t C
R_j = Root radius.

C_{ikt} = Carbon stock of the living biomass for stratum i, tree stand model k, time t; t C

Table C7.4 presents the values of accumulation of tC in the baseline strata. The carbon increase over time (ΔC_{ijt}) is assumed to be the ratio between the total carbon change over a time interval (known through age of the tree), multiplied by the constant 44/12. (Equation 8 of AR-AM0004/ Version 04).

$$\Delta C_{ikt} = \frac{C_{ikt2} - C_{ikt1}}{T} \cdot \frac{44}{12} \tag{8}$$

Where:
ΔC_{ikt} = Change in annual carbon stock (t C) of the biomass for stratum i, tree stand model k, time t.
C_{ikt2} = Carbon stock of the living biomass for stratum i, tree stand model k, time t=t2
C = Carbon stock of the living biomass for stratum i, tree stand model k, time t=t1
T = Number of years between t1 and t2

The baseline (ΔC_{ijt}) is calculated with the total of the carbon increases for stratum B

Table C7.4: Average biomass/tree, Number of trees/ha and carbon stock in Above ground biomass and below ground biomass and the change in annual carbon stock for Stratum B with trees.

Botanical Name	Biomass (t) fi(DBHt,Ht)*BEF	No. of trees/ha (nTR_{ijt})	Carbon Stock in AGB ($C_{AB,jt}$)	Carbon stock in BGB ($C_{BB,jt}$)
Acacia auriculiformis	0.04	0.006	0.59	0.15
Achtas sapota	0.04	0.005	0.44	0.11
Albizia amara	0.08	0.091	16.26	4.23
Aleurites moluccana	0.07	0.008	1.38	0.36
Anacardium occidentale	0.21	0.006	3.10	0.81
Annona squamosa	0.07	0.082	14.60	3.80
Artocarpus integrifolia	0.70	0.054	89.95	23.39
Azadiractha indica	0.25	1.205	717.68	186.60
Bauhinia malabaria	0.11	0.033	8.71	2.26
Butea monosperma	0.11	0.036	9.61	2.50
Calotropis gigantea	0.21	0.003	1.38	0.36
Canthium parviflorum	0.06	0.013	1.74	0.45
Cassia auriculata	0.11	0.013	3.38	0.88
Ceiba pentandra	1.14	0.003	7.39	1.92
Channagiri	0.13	0.005	1.59	0.41
Citrus	0.16	0.005	1.79	0.47
Diospyros melanoxylon	0.15	0.009	3.00	0.78
Diospyros montana	0.07	0.000	0.03	0.01
Eucalyptus sps	0.13	0.244	75.29	19.58
Ficus bengalensis	1.26	0.017	52.45	13.64
Ficus religiosa	0.20	0.102	47.42	12.33
Glyricidia	0.08	0.000	0.04	0.01
Gossypium sps	0.53	0.011	13.37	3.48

Grevillea robusta	0.10	0.043	10.36	2.69
Holoptelea integrifolia	0.15	0.050	17.81	4.63
Leucaena leucocephala	0.17	0.003	1.00	0.26
Mangifera indica	0.10	0.113	27.34	7.11
Pongamia pinnata	0.13	1.565	470.86	122.42
Prosopis juliflora	0.17	0.542	223.28	58.05
Psidium guava	0.13	0.014	4.19	1.09
Punica granatum	0.11	0.001	0.38	0.10
Santalum album	0.10	0.003	0.60	0.16
Sapindus emarginatus	0.10	0.005	1.31	0.34
Syzygium cumini	0.16	0.117	45.57	11.85
Tamarindus indica	1.22	0.627	1810.95	470.85
Tectona grandis	0.05	0.024	2.95	0.77
Terminalia paniculata	0.19	0.003	1.41	0.37
Unknown1	0.16	0.002	0.64	0.17
Unknown2	0.73	0.004	7.34	1.91
Unknown3	0.18	0.013	5.89	1.53
Unknown4	0.09	0.057	12.78	3.32
Unknown5	0.18	0.057	24.94	6.48
Zizypus jujupa	0.05	0.003	0.41	0.11

Following the guidance contained in paragraph 35 in the report of the EB 42 meeting the living biomass does not contain the biomass of herbaceous vegetation.

In this methodology equation 2 is used to estimate baseline net greenhouse gas removals by sinks for the period of time elapsed between project start ($t=1$) and the year $t=t^*$, t^* being the year for which baseline net greenhouse gas removals by sinks are estimated. The change in carbon stocks for the stratum B is about 0.42 tCO_2/ha.

Following the procedures described in EB 46 Annex 16, *(Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant),* it was determined that the change in carbon stocks of live woody vegetation that exists within this A/R CDM project boundary prior to the project ("the existing woody vegetation"), and that would have occurred in the absence of this A/R CDM project activity, are insignificant and therefore shall be accounted for as zero. An analysis done to estimate the average stocking of existing trees within the area compared to the final stocking of trees to be established by the A/R project activity showed that in stratum B, the number of trees in the baseline per hectare is 5.2. This constitutes about 1.022% of the trees that will be planted under the project activity. Thus it is less than 2% and insignificant (Table C7.5).

Also the existing trees within the area that are allowed to remain, are not expected to be impacted by A/R project activities, and shall be excluded from estimates of project net GHG removals by sinks.

Table C7.5: Determination of percent of baseline trees vis-a-vis project trees that will be planted in Stratum B of the project activity

Model	Total	Stratum A (ha)	Stratum B (ha)	No. of Trees in the Baseline of Stratum B	No. of Trees to be Planted in Stratum B
1 (521 trees)	7,550.00	2,795.71	4,754.29	26,693	24,76,984
2 (521 trees/ha)	883.34	327.10	556.25	2,889	2,89,804
3 (296 trees/ha)	500.00	185.15	314.85	1,635	93,197
Total	8,936.46	3,307.95	5,625.39	29,217	28,59,985

Trees/Ha in Stratum B	5.2
Total Baseline trees in Stratum B	24,652
Trees that will be planted in Stratum B	28,59,985
% of baseline trees to the trees that will be planted in A/R project	**1.022**

A study of shrub vegetation in the project shows that approximately 0.09 t/ha is the shrub biomass. The most common species of shrub vegetation is Lantana camara, Prosophis juliflora and Dodonea viscosa. Lantana camara and Prosphis juliflora is commonly used as fuelwood species. Many of the population meet its cooking and heating energy requirement from shrubs and weeds like Lantana camara and prosophis juliflora[42]. The project area being a fuelwood scare region wherein nearly 78% of the fuelwood being used is non-renewable[42], shrubs are a constant source of fuelwood for the rural communities. A study done by Indian Wood Science and Technology (IWST) for Kolar also shows that dependence on farm forestry and trees on roadside, bunds and marginal land for fuelwood was the highest[43]. Thus the growth conditions of the shrub species are expected to decline in the baseline scenario. This is evidenced by the low shrub vegetation status in the project area. Also land degradation will not allow a steady increase in the shrub vegetation due to continuous harvesting for fuelwood purposes. According to guidance Annex 16, of EB 46, on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant, the change in carbon stocks of existing woody vegetation sinks may be accounted as zero for an area of land within the project boundary.

Thus the annual estimation of baseline net anthropogenic GHG removals by sinks is set to zero (Table C7.6).

The numerical values and sources of data used in calculation for estimation of ex-ante baseline net GHG removals as follows:

[42] Ramachandra, T.V. Mapping of fuelwood trees using geoinformatics. Renewable and Sustainable Energy Reviews 14 (2010) 642–654

[43] www.icfre.org/UserFiles/File/annual_report-2004-05/.../chap_3.pdf

Data/Parameter:	$\Delta C_{B,ikt}$ for stratum without trees
Description/Unit:	Baseline annual carbon stock change in living biomass for stratum *i*, stand model *k*, time *t*; t CO_2-e. yr^{-1}
Value applied:	0
Source of data:	Baseline survey
Justification of choice/ Measurement procedures (if any):	The project area has been stratified into a) Stratum A: Baseline strata without trees or woody perennials and Stratum B: Trees in the baseline. For Stratum A without trees, the baseline annual carbon stock change is zero.
Any comment:	

Data/Parameter:	$C_{AB,ijt}$
Description/Unit:	Carbon stock in above-ground biomass for stratum B, species *j*, at time *t;* t C
Value applied:	See Table C7.4
Source of data:	Calculated using Biomass equations
Justification of choice/ Measurement procedures (if any):	Average girth and height of each of the species in every plot was measured. Applying biomass equations and BEF, biomass was calculated. Multiplied by 0.5 to derive tC of biomass.
Any comment:	

Data/Parameter:	A_{ikt}
Description/Unit:	Area of stratum with trees, stand model *k*, at time *t*; hectare (ha)
Value applied:	5,625.39
Source of data:	Field Survey
Justification of choice/ Measurement procedures (if any):	
Any comment:	

Data/Parameter:	nTR_{ijt}
Description/Unit:	Number of trees in stratum *i*, species *j*, at time *t*; dimensionless ha^{-1}
Value applied:	See Table C7.4
Source of data:	Field Survey
Justification of choice/ Measurement procedures (if any):	The total number of trees of species j, in Stratum with trees was divided by the area with trees (5,625.39) to arrive at the number of tress/ha
Any comment:	

Data/Parameter:	*CFj*
Description/Unit:	Carbon fraction for species *j*, t C (t d.m.)$^{-1}$
Value applied:	0.5
Source of data:	IPCC default value
Justification of choice/	

Measurement procedures (if any):	
Any comment:	

Data/Parameter:	$f_j(DBH_t,H_t)$
Description/Unit:	Allometric equation linking above-ground biomass of living trees (d.m. ha^{-1}) to mean diameter at breast height (*DBH*) and possibly mean tree height (*H*) for species *j*; dimensionless
Value applied:	See Table C7.4
Source of data:	From literature: See Table 4, Annex 3 for the allometric equation applied
Justification of choice/ Measurement procedures (if any):	Based on methodology, the allometric equations were used linking above ground biomass with mean diameter and tree height for the stratum B, with trees of the project area.
Any comment:	

Data/Parameter:	R_j
Description/Unit:	Root radius.
Value applied:	0.27
Source of data:	IPCC Good Practice Guidance, 2006
Justification of choice/ Measurement procedures (if any):	To estimate the below ground biomass based on above ground biomass value
Any comment:	

Data/Parameter:	$C_{BB,ijt}$
Description/Unit:	Carbon stock in the belowground biomass for stratum i, species j, and time t; t C
Value applied:	See Table C7.4
Source of data:	$C_{AB,ijt} . R_j$
Justification of choice/ Measurement procedures (if any):	Calculated according to the methodology
Any comment:	

Data/Parameter:	C_{ikt}
Description/Unit:	Carbon stock of the living biomass for stratum with trees
Value applied:	4054.35
Source of data:	$C_{AB,ijt} + C_{BB,ijt}$
Justification of choice/ Measurement procedures (if any):	According to the methodology
Any comment:	

Data/Parameter:	ΔC_{ikt}
Description/Unit:	Change in annual carbon stock (t C) of the biomass for stratum i, tree stand model k, time t.

Value applied:	0
Source of data:	Field Studies; see Table C7.5
Justification of choice/ Measurement procedures (if any):	Following the procedures described in EB 46 Annex 16, *(Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant)*, it was determined that the change in carbon stocks of live woody vegetation that exists within this A/R CDM project boundary prior to the project ("the existing woody vegetation"), and that would have occurred in the absence of this A/R CDM project activity, are insignificant and therefore shall be accounted for as zero.
Any comment:	

Table C7.6: Annual estimation of baseline net anthropogenic GHG removals by sinks (tCO_{2e}).

Please present final results of your calculations using the following tabular format.	
Year	**Annual estimation of baseline net anthropogenic GHG removals by sinks in tonnes of CO_2e**
2008	0
2009	0
2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
2016	0
2017	0
2018	0
2019	0
2020	0
2011	0
2012	0
2013	0
2014	0
2015	0
2016	0
2017	0
Total estimated baseline net GHG removals by sinks (tonnes of CO_{2e})	0
Total number of crediting years	20
Annual average over the crediting period of estimated baseline net GHG removals by sinks (tonnes of $CO_{2\ e}$)	0

C.8. Date of completion of the baseline study and the name of person(s)/entity(ies) determining the baseline:

10th July 2010
Agricultural Development & Training Society
Bagepalli, Chickballapur District,
Karnataka

Dr. Sudha Padmanabha
Fair Climate Network
19/1, Alexandria Street,
Richmond Town,
Bangalore – 560 025
Karnataka

SECTION D. Estimation of *ex ante* actual net GHG removals by sinks, leakage and estimated amount of net anthropogenic GHG removals by sinks over the chosen crediting period

D.1. Estimate of the *ex ante* actual net GHG removals by sinks:

The actual net GHG removals by sinks is the sum of verifiable changes in carbon stocks, minus the increase in emissions of the GHGs measured in units of CO_2 equivalent by the sources that are increased as an attributable result of the implementation of the proposed A/R CDM project activity within the project boundary. The actual net GHG removals by sinks within the project scope (C_{ACTUAL}) will be determined using equation 13 of methodology AR-AM0004/Version 04.

$$C_{ACTUAL} = \Delta C_{P,LB} - GHG_E \qquad \textbf{(13)}$$

where:

C_{ACTUAL} Actual net greenhouse gas removals by sinks; t CO_2-e

$\Delta C_{P,LB}$ Sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e

GHG_E Sum of the increases in GHG emissions by sources within the project boundary as a result of the implementation of an A/R CDM project activity; t CO_2-e

Estimation of actual $\Delta C_{P,LB}$ (changes in living biomass carbon stocks in the project scenario)

The changes in living biomass stocks in the project is determined as follows:

$$\Delta C_{P,LB} = \Delta C_{P,LB_T} - E_{biomasslos} \qquad \textbf{(14)}$$

where:

$\Delta C_{P,LB}$ Sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e

$\Delta C_{P,LB\ T}$ Sum of the changes in living tree biomass carbon stocks (above- and below-ground); t CO_2-e

$E_{biomassloss}$ Decrease in the carbon stock in the living biomass carbon pools of non-tree woody vegetation in the year of site preparation, up to time *t**; t CO_2-e

Treatment of pre-existing vegetation

In accordance with methodology AR-AM0004/Version 04, as shown in section C.7:

- the living biomass is not significant (< 2% of the anticipated actual net GHG removals by sinks).

- Based on baseline survey, on nearly 12.57% of the area or 14.85% of the plots, species such as Eucalyptus, Teak and Prosophis will be cut before planting. Clearance of Eucalyptus, Teak and Prosopis juliflora in the proposed project area is a common occurrence. Eucalyptus and Teak are grown for the poles and are harvested with rotation period of 6-8 years, while prosophis is cut for use as fuelwood which coppices. Based on Annex 21 on "Guidelines on conditions under which GHG emissions from removal of existing vegetation due to site preparation are insignificant", EB 50, the emissions from removal of these trees are insignificant. This is due to the fact that Eucalyptus and Teak would have been removed after the rotation period which is usually 6-8 years.

- Also the existing trees within the area that are allowed to remain, are not expected to be impacted by A/R project activities, and shall be excluded from estimates of project net GHG removals by sinks.

Carbon stock changes in the living biomass of pre-existing non-tree and tree vegetation are not included in the *ex-ante* calculation of actual carbon stock changes, regardless if the pre-existing non-tree and tree vegetation is left standing or is harvested.

Burning of pre-existing vegetation for land preparation before planting is not a practice in the project area. For that reason, the dispersed trees present in the baseline scenario will not be quantified in the estimations of the net anthropogenic removals of the project.

Thus $E_{biomassloss} = 0$

Determination of $\Delta C_{P,LB\,T}$

The methodology and equations used for estimating *ex-ante* actual changes in the living biomass carbon stocks are similar to the ones used for the estimation of baseline changes in the living biomass carbon stocks.

(a) There will be no harvesting of trees as they are predominantly fruit yielding trees.

(b) The project strata will be based on type of baseline stratum where activity takes place, stand model and possibly cohorts of the same stand model based on year of plantations.

The sum of changes in the carbon stored in living tree biomass compartments in the project scenario ($\Delta C_{P,LBT}$) will be determined, following the guidelines established by AR-AM0004/ Version 04. First of all, the necessary information to apply Equation (16) of the mentioned methodology will be established.

$$\Delta C_{P,LB_T} = \sum_{t=1}^{t^*} \sum_{i=1}^{m_{BL}} \sum_{k=1}^{K_P} \Delta C_{P,LB,ikt} \qquad \textbf{(16)}$$

where:

$\Delta C_{P,LB}$ Sum of the changes in living biomass carbon stocks in the project scenario (above- and below-ground); t CO_2-e

$\Delta C_{LB,ikt}$ Annual carbon stock change in living biomass for stratum *i*, stand model *k*, time *t*; t CO_2-e yr^{-1}

i 1, 2, 3, ... m_{BL} strata in the baseline

k 1, 2, 3, … *K* stand models in the project scenario

t 1, 2, 3, ...*t** years elapsed since the start of the A/R project activity

Following is a description of the procedures that will be used to obtain the necessary variables:

The annual planting regimes are determined for each tree stand model (A_{ikt}), during the crediting period (Table A5.3).

For tree stand models, existing volume equations which have been established by Forest Survey of India and from other scientific literature will be used. The species, volume models considered, their parameters, as well as the sources from which the information was obtained, are noted in Table D1.1.

Table D1.1: Equations to determine the biomass of the planted species.

Species/Model	**Volume Equations**	***Source***
Mangifera indica	Y=exp[-2.289+2.649 *ln (DBH) - 0.021 *(ln(DBH))^2; Y = kg; DBH in cms	Annex 4A.1, IPCC GPG, 2006[44]
Pongamia pinnata	Y= 0.0494+0.4568*DBH^2*H; Y in Kg, H and DBH in decimeters	Chaturvedi and Behl, 1996[45]
Zizypus jujupa	V=-0.002557+0.260114D^{2}H; D (metres) and H (metres)	FSI, 1996[46]
Syzygium cumini	V=0.0238+0.41681D^{2}H	FSI, 1996[46]
Leucaena leucocephala	Y = 0.5 (DBH^2) x HT X SG; HT=Height; SG=Specific gravity; Y in Kg, DBH in cm, H (m)	Dubley and Fownes, 1991[47]
Annona squamosa	Y=exp[-2.289+2.649 *ln (DBH) - 0.021 *(ln(DBH))^2; Y = kg; DBH in cms	Annex 4A.1, IPCC GPG, 2006[44]
Azadiractha indica	Y=19.2224+238.5245D^{2}H; Y= (kg/tree)	Shailaja and Sudha, 1997[48]
Ceiba pentandra	V=0.0589+0.000956D^2; D is cm	FSI, 1996[46]
Anacardium occidentale	Y=exp[-2.289+2.649 *ln (DBH) - 0.021 *(ln(DBH))^2; Y = kg; DBH in cms	Annex 4A.1, IPCC GPG, 2006[44]

[44] IPCC Good Practice Guidance for LULUCF, Chapter 4: Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.

[45] A.N. Chaturvedi and H.M. Behl(1996), Biomass production trials on sodic site, Indian Forester, June

[46] FSI (1996) Volume Equations for Forests of India, Nepal and Bhutan, Forest Survey of India, Ministry of Environment and Forests, Government of India, 1996

[47] Dubley, N.S. and Fownes, J.H. Preliminary biomass equation for eight species of fast-growing tropical trees. Journal of Tropical Forest Science 5(1):68:73

[48] Shailaja Ravindranath and Sudha Premnath. 1997, Biomass Studies. Field Methods for Monitoring Biomass. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

Tamarindus indica	Y=exp[-2.289+2.649 *ln (DBH) - 0.021 *(ln(DBH))^2; Y = kg; DBH in cms	Annex 4A.1, IPCC GPG, 2006[44]

Subsequently, equations 10 of AR-AM0004/ Version 04 will be applied in order to determine the biomass based on the expansion factors or equation 12 of allometric equation will be used directly.

For species of *Mangifera indica, Annona squamosa, Anacardium occidentale* and *Tamarindus indica*, the allometric equations given by IPCC for tropical moist hardwoods is applied due to lack of biomass equations for these horticultural species. During verification if any local or species specific equation is available, it will be used for biomass calculations.

$$C_{AB,ijt} = A_{ijt} \cdot V_{ijt} \cdot D_j \cdot BEF_{2,j} \qquad \textbf{(10)}$$

$$C_{AB,ijt} = A_{ikt} \cdot nTR_{ijt} \cdot CF_j \cdot f_j(DBH_t, H_t) \qquad \textbf{(12)}$$

where:

$C_{AB,ijt}$	Carbon stock in above-ground biomass for stratum *i*, species *j*, at time *t;* t C
A_{ikt}	Area of stratum *i*, stand model *k*, at time *t*; hectare (ha)
nTR_{ijt}	Number of trees in stratum *i*, species *j*, at time *t*; dimensionless ha^{-1}
CFj	Carbon fraction for species *j*, t C (t d.m.)$^{-1}$
$f_i(DBH_t,H_t)$	Allometric equation linking above-ground biomass of living trees (d.m. ha^{-1}) to mean diameter at breast height (*DBH*) and possibly mean tree height (*H*) for species *j*; dimensionless

The variables and equations selected to carry out the estimations of *ex-ante*, were selected giving priority to the information on the basis of the following hierarchy as specified in the methodology:

- Existing local and species specific;
- National and species specific (e.g. from national GHG inventory);
- Species specific from neighboring countries with similar conditions;
- Globally species specific (e.g. GPG-LULUCF).

The expansion factors will be calculated through the incorporation of expansion factor values by type of forest found in the Table (3A.1.10) of the IPCC-GPG. The tree stand model volumes will be established by TARAM, based on the combination of the groups of species used (Section A.5.3). The density of the wood is incorporated primarily from JTDA, 1984, based on Indian database as shown below.

Table D1.2: Wood density of species selected for the A/R project activity

Species/Model	***Wood Density***	***Reference***
Mangifera indica	0.588	JTDA (Ind) Vol.30(4) Oct 1984[49]
Pongamia glabra	0.609	
Zizypus jujuba	0.597	

[49] JTDA 1985. Specific gravity of Indian Timbers. Journal of the Timber Development Association (India). Vol.30(4) Oct 1984

Syzygium jambolana	0.636	
Azadirachta indica	0.693	
Ceiba pentandra	0.273	
Tamarindus indica	0.747	
Leuceana leucocephala	0.649	
Annona squamosa	0.800	Average wood density, Source: Forest Survey of India (FSI, 1996)[50]
Anacardium occidentale	0.5	Wood Density Database, World Agroforestry Centre[51]

For each stratum, the carbon content in the aboveground and belowground biomass, total carbon and carbon increase for species over time are determined; applying the equations previously used for the baseline strata for the existing species. Using equations 8, 9, 10, 11 or 12 of AR-AM0004/ Version 04.

The volumes of each tree stand model will be expressed according to the variables defined in equation 21 of AR-AM0004/Version 04: V_{ikt1}, commercial volume; Mf_{ikt}, mortality factor; $I_{v,ijT}$, annual increase in commercial volume; H_{ijT}, commercial volume harvested annually; FG_{ijT}, annual volume wood fuel harvested; T, number of years between times t2 and t1.

$$V_{ikt2} = V_{ikt1} \cdot (1 - Mf_{ikT}) + \sum_{j=1}^{J_k} (I_{v,ijT} - H_{ijT} - FG_{ijT}) \cdot T \quad \textbf{(21)}$$

$$Mf_{ikT} = \left(\frac{Adist_{ikT}}{A_{ikT}} \right) \quad \textbf{(22)}$$

where:

V_{ikt1} Average merchantable volume of stratum *i*, stand model *k*, at time $t = t_1$; $m^3\ ha^{-1}$

V_{ikt2} Average merchantable volume of stratum *i*, stand model *k*, at time $t = t_2$; $m^3\ ha^{-1}$

Mf_{ikT} Mortality factor = percentage of V_{ikt1} died during the period *T*; dimensionless

$I_{v,ijT}$ Average annual net increment in merchantable volume for stratum *i*, species *j* during the period *T*; $m^3\ ha^{-1}\ yr^{-1}$

H_{ijT} Average annually harvested merchantable volume for stratum *i*, species *j*, during the period *T*; $m^3\ ha^{-1}\ yr^{-1}$

FG_{ijT} Average annual volume of fuel wood harvested for stratum *i*, species *j*, during the period *T*; $m^3\ ha^{-1}\ yr^{-1}$

[50] FSI, 1996. Fuelwood, timber and fodder from forests of India: Demand and Supply of Fuelwood, Timber and Fodder in India. Forest Survey of India, MoEF, Govt. of India.

[51] http://www.worldagroforestry.org/sea/Products/AFDbases/WD/Index.htm

T Number of years between times t_2 and t_1 $(T = t_2 - t_1)$

$Adist_{ijT}$ Average annual area affected by disturbances for stratum *i*, species *j*, during the period *T*; ha yr^{-1}

A_{ijT} Average annual area for stratum *i*, species *j*, during the period *T*; ha yr^{-1}

j 1,2,3…J_k tree species in stand model *k*

There will be no harvest and mortality factor will be addressed by replanting during the first three years after planting.

In each tree stand model, the mean annual increment was obtained based on field survey (Table D1.3A-C). This is in concurrence with the MAI values given in the IPCC Good Practice Guidance. According to the Good Practice Guidance of LULUCF, 2006 (Table 3A.1.6), the average annual aboveground biomass increment (t/ha/yr) for tropical/sub-tropical forest plantations (other than Eucalyptus) in Asia for dry region (rainfall < 1000 mm) is in the ranges from 1.2 – 11.7 t/ha/yr, with an average of 6.45. Accordingly, for the project area, the calculated MAI for Model I is 6.45, model II is 6.45 and model III is 2.30 t/ha/yr.

Table D1.3A: Above ground biomass of tree species in stand Model 1 – Mangifera indica stand

Stand age	Above ground biomass of Tree species in stand Model 1 (t d.m. ha^{-1}) – 521 trees/ha							
	Mangifera indica	*Pongamia glabra*	*Zizyphus jujuba*	*Leuceana leucocephala*	*Azadirachta indica*	*Ceiba pentandra*	*Syzygium cummini*	*Annona squamosa*
1	3.89	0.33	0.25	0.74	0.13	0.06	0.65	0.40
2	7.78	0.66	0.50	1.48	0.26	0.12	1.30	0.80
3	11.67	0.99	0.75	2.22	0.39	0.18	1.95	1.20
4	15.56	1.32	1.00	2.96	0.52	0.24	2.60	1.60
5	19.45	1.65	1.25	3.70	0.65	0.30	3.25	2.00
6	23.34	1.98	1.50	4.44	0.78	0.36	3.90	2.40
7	27.23	2.31	1.75	5.18	0.91	0.42	4.55	2.80
8	31.12	2.64	2.00	5.92	1.04	0.48	5.20	3.20
9	35.01	2.97	2.25	6.66	1.17	0.54	5.85	3.60
10	38.90	3.30	2.50	7.40	1.30	0.60	6.50	4.00
11	42.79	3.63	2.75	8.14	1.43	0.66	7.15	4.40
12	46.68	3.96	3.00	8.88	1.56	0.72	7.80	4.80
13	50.57	4.29	3.25	9.62	1.69	0.78	8.45	5.20
14	54.46	4.62	3.50	10.36	1.82	0.84	9.10	5.60
15	58.35	4.95	3.75	11.10	1.95	0.90	9.75	6.00
16	62.24	5.28	4.00	11.84	2.08	0.96	10.40	6.40
17	66.13	5.61	4.25	12.58	2.21	1.02	11.05	6.80
18	70.02	5.94	4.50	13.32	2.34	1.08	11.70	7.20
19	73.91	6.27	4.75	14.06	2.47	1.14	12.35	7.60
20	77.80	6.60	5.00	14.80	2.60	1.20	13.00	8.00

Table D1.3B: Above ground biomass of tree species in stand Model 2 – Anacardium occidentale stand

Stand age	**Above ground biomass of Tree species in stand Model 2** (t d.m. ha^{-1}) – **521 trees/ha**							
	Anacardium occidentale	*Pongamia glabra*	*Zizypus jujuba*	*Leuceana leucocephala*	*Annona squamosa*	*Azadirachta indica*	*Ceiba pentandra*	*Syzygium cummini*
1	3.89	0.33	0.25	0.74	0.13	0.06	0.65	0.40
2	7.78	0.66	0.50	1.48	0.26	0.12	1.30	0.80
3	11.67	0.99	0.75	2.22	0.39	0.18	1.95	1.20
4	15.56	1.32	1.00	2.96	0.52	0.24	2.60	1.60
5	19.45	1.65	1.25	3.70	0.65	0.30	3.25	2.00
6	23.34	1.98	1.50	4.44	0.78	0.36	3.90	2.40
7	27.23	2.31	1.75	5.18	0.91	0.42	4.55	2.80
8	31.12	2.64	2.00	5.92	1.04	0.48	5.20	3.20
9	35.01	2.97	2.25	6.66	1.17	0.54	5.85	3.60
10	38.90	3.30	2.50	7.40	1.30	0.60	6.50	4.00
11	42.79	3.63	2.75	8.14	1.43	0.66	7.15	4.40
12	46.68	3.96	3.00	8.88	1.56	0.72	7.80	4.80
13	50.57	4.29	3.25	9.62	1.69	0.78	8.45	5.20
14	54.46	4.62	3.50	10.36	1.82	0.84	9.10	5.60
15	58.35	4.95	3.75	11.10	1.95	0.90	9.75	6.00
16	62.24	5.28	4.00	11.84	2.08	0.96	10.40	6.40
17	66.13	5.61	4.25	12.58	2.21	1.02	11.05	6.80
18	70.02	5.94	4.50	13.32	2.34	1.08	11.70	7.20
19	73.91	6.27	4.75	14.06	2.47	1.14	12.35	7.60
20	77.80	6.60	5.00	14.80	2.60	1.20	13.00	8.00

Table D1.3C: Above ground biomass of tree species in stand Model 3 – Tamarindus indica stand

Stand age	Above ground biomass of Tree species in stand Model 3 (t d.m. ha^{-1}) – **296 trees/ha**		
	Tamarindus indica	*Azadirachta indica*	*Ceiba pentandra*
1	2.11	0.13	0.06
2	4.22	0.26	0.12
3	6.33	0.39	0.18
4	8.44	0.52	0.24
5	10.55	0.65	0.30
6	12.66	0.77	0.35
7	14.77	0.90	0.41
8	16.88	1.03	0.47
9	18.99	1.16	0.53
10	21.10	1.29	0.59
11	23.21	1.42	0.65
12	25.32	1.55	0.71
13	27.43	1.68	0.77
14	29.54	1.81	0.83
15	31.65	1.94	0.89

16	33.76	2.06	0.94
17	35.87	2.19	1.00
18	37.98	2.32	1.06
19	40.09	2.45	1.12
20	42.20	2.58	1.18

The loss of living biomass ($E_{biomassloss}$) in the carbon reservoirs of the nonwooded vegetation needs to be determined through equation 15 of AR-AM0004/Version 04, using the area (A_{ikt}), pre-existing biomass ($B_{pre,ikt}$) and carbon fraction (CF_{pre}) variables. Since the pre-existing biomass is insignificant.

$E_{biomassloss} = 0$

Finally, the sum of changes in the carbon stored in the living tree biomass compartments ($\Delta C_{P,LB}$), will be determined by subtracting $E_{biomassloss}$ from the total by amounts, applying Equation (14) of AR AM0004/Version 04.

Since $E_{biomass} = 0$

$$\Delta C_{P,LB} = \Delta C_{P,LB_T}$$

Table D1.4: Carbon stocks in living biomass (tCO_2e)

Project year	Stand Model 1		Stand Model 2		Stand Model 3	
	cumulative CO_2e removal		cumulative CO_2e removal		cumulative CO_2e removal	
	above-ground biomass carbon pool	below-ground biomass carbon pool	above-ground biomass carbon pool	below-ground biomass carbon pool	above-ground biomass carbon pool	below-ground biomass carbon pool
1	1,187.0	320.5	10.9	2.9	15.2	4.1
2	3,970.4	1,072.0	35.4	9.5	30.4	8.2
3	9,118.7	2,462.1	59.8	16.2	45.5	12.3
4	26,285.7	7,097.1	1,573.0	424.7	359.7	97.1
5	55,471.3	14,977.3	4,574.9	1,235.2	973.0	262.7
6	96,675.6	26,102.4	9,065.6	2,447.7	1,885.2	509.0
7	149,898.5	40,472.6	15,044.9	4,062.1	3,096.5	836.0
8	215,140.0	58,087.8	22,513.0	6,078.5	4,606.8	1,243.8
9	292,400.1	78,948.0	31,469.8	8,496.8	6,416.1	1,732.3
10	381,678.8	103,053.3	41,915.3	11,317.1	8,524.4	2,301.6
11	470,957.6	127,158.5	52,360.8	14,137.4	10,632.7	2,870.8
12	560,236.3	151,263.8	62,806.3	16,957.7	12,741.1	3,440.1
13	649,515.1	175,369.1	73,251.9	19,778.0	14,849.4	4,009.3
14	738,793.8	199,474.3	83,697.4	22,598.3	16,957.7	4,578.6
15	828,072.6	223,579.6	94,142.9	25,418.6	19,066.1	5,147.8
16	917,351.3	247,684.9	104,588.4	28,238.9	21,174.4	5,717.1
17	1,006,630.1	271,790.1	115,033.9	31,059.2	23,282.7	6,286.3

18	1,095,908.8	295,895.4	125,479.4	33,879.4	25,391.1	6,855.6
19	1,185,187.6	320,000.6	135,924.9	36,699.7	27,499.4	7,424.8
20	1,274,466.3	344,105.9	146,370.4	39,520.0	29,607.7	7,994.1

b. Estimation of the increase in GHG Emissions as a result of the project implementation; GHG_E

The AR-CDM activity may increase the GHG emissions in particular of CO_2, CH_4 and N_2O.

Emissions of greenhouse gases by biomass burning are from site preparation (slash and burn activity).

The project activity does not involve biomass burning from site preparation due to slash and burn activity. It is not a practice of biomass burning during site preparation in this region. Also site preparation does not involve biomass burning on field[52]. Thus estimate of the increase in GHG emissions as a result of the project implementation is not considered (Table D1.5).

Table D1.5: Increase in GHG emissions by sources

Year	Emissions by $E_{biomassburn}$ tCO_{2e}	Total GHG emissions tCO_{2e}
2008 (January 25th 2008)	0	0
2009	0	0
2010	0	0
2011	0	0
2012	0	0
2013	0	0
2014	0	0
2015	0	0
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0
2021	0	0
2022	0	0
2023	0	0
2024	0	0
2025	0	0
2026	0	0
2027	0	0
Total	0	0

The *ex-ante* estimation of annual and cumulative actual net GHG removals by sinks is given in Table D1.6

[52] http://shanthap.tripod.com/mb1.htm#land

Table D1.6: Ex ante estimation of annual and cumulative actual net greenhouse gas removals by sinks

Project year	Carbon stock change in A/R living biomass				C_{ACTUAL}	
	Above-ground biomass carbon pool		Below-ground biomass carbon pool		Actual net greenhouse gas removals by sinks	
	annual $tCO_2e\ yr^{-1}$	cumulative tCO_2e	annual $tCO_2e\ yr^{-1}$	cumulative tCO_2e	annual $tCO_2e\ yr^{-1}$	cumulative tCO_2e
year	**$tCO_2e\ yr^{-1}$**	**tCO_2e**	**$tCO_2e\ yr^{-1}$**	**tCO_2e**	**$tCO_2e\ yr^{-1}$**	**tCO_2e**
1	1,213.05	1,213.05	327.52	327.52	1,540.58	1,540.58
2	2,823.03	4,036.08	762.22	1,089.74	3,585.24	5,125.82
3	5,188.03	9,224.11	1,400.77	2,490.51	6,588.79	11,714.61
4	18,994.39	28,218.50	5,128.49	7,618.99	24,122.88	35,837.49
5	32,800.76	61,019.26	8,856.21	16,475.20	41,656.97	77,494.46
6	46,607.13	107,626.39	12,583.92	29,059.12	59,191.05	136,685.51
7	60,413.49	168,039.88	16,311.64	45,370.77	76,725.14	213,410.65
8	74,219.86	242,259.74	20,039.36	65,410.13	94,259.22	307,669.87
9	88,026.23	330,285.97	23,767.08	89,177.21	111,793.31	419,463.18
10	101,832.60	432,118.57	27,494.80	116,672.01	129,327.40	548,790.58
11	101,832.60	533,951.16	27,494.80	144,166.81	129,327.40	678,117.97
12	101,832.60	635,783.76	27,494.80	171,661.61	129,327.40	807,445.37
13	101,832.60	737,616.35	27,494.80	199,156.41	129,327.40	936,772.77
14	101,832.60	839,448.95	27,494.80	226,651.22	129,327.40	1,066,100.16
15	101,832.60	941,281.54	27,494.80	254,146.02	129,327.40	1,195,427.56
16	101,832.60	1,043,114.14	27,494.80	281,640.82	129,327.40	1,324,754.95
17	101,832.60	1,144,946.73	27,494.80	309,135.62	129,327.40	1,454,082.35
18	101,832.60	1,246,779.33	27,494.80	336,630.42	129,327.40	1,583,409.75
19	101,832.60	1,348,611.92	27,494.80	364,125.22	129,327.40	1,712,737.14
20	101,832.60	1,450,444.52	27,494.80	3,91,620.02	129,327.40	1,842,064.54

The *ex-ante* estimates of actual net GHG removals by sinks (C_{ACTUAL}), are shown in Table D1.7.

Table D1.7: *Ex-ante* estimates of actual net GHG removals by sinks

Year	**Emissions by $E_{biomassburn}$ tCO_{2e}**	**Actual net greenhouse gas removals by sinks annual ($tCO_2e\ yr^{-1}$)**	**Estimation of actual net GHG removals by sinks cumulative ($tCO_{2\ e}$)**
2008 (January 25th 2008)	0	1,541	1,541
2009	0	5,126	5,126
2010	0	11,715	11,715
2011	0	35,837	35,837
2012	0	77,494	77,494
2013	0	136,686	136,686
2014	0	213,411	213,411
2015	0	307,670	307,670
2016	0	419,463	419,463
2017	0	548,791	548,791
2018	0	678,118	678,118
2019	0	807,445	807,445

2020	0	936,773	936,773
2021	0	1,066,100	1,066,100
2022	0	1,195,428	1,195,428
2023	0	1,324,755	1,324,755
2024	0	1,454,082	1,454,082
2025	0	1,583,410	1,583,410
2026	0	1,712,737	1,712,737
2027	0	1,842,065	1,842,065
Total accumulated (tonnes of CO_{2e})	0	1,842,065	1,842,065

Total net anthropogenic greenhouse gas removal by sinks (tCO_2e)	**1,842,065**
Average net anthropogenic greenhouse gas removal by sinks over the crediting period ($tCO_2e\ yr^{-1}$)	**92,103.2**
Average net anthropogenic greenhouse gas removal by sinks per hectare and year ($tCO_2e\ yr^{-1}\ ha^{-}$)	**10.31**

Data/Parameter:	$E_{biomassloss}$
Description/Unit:	Decrease in the carbon stock in the living biomass carbon pools of non-tree woody vegetation in the year of site preparation, up to time *t**; t CO_2-e
Value applied:	0
Source of data:	Field Survey
Justification of choice/ Measurement procedures (if any):	In accordance with methodology AR-AM0004/Version 04, as shown in section C.7, the living biomass is not significant (< 2% of the anticipated actual net GHG removals by sinks).
Any comment:	

Data/Parameter:	A_{ikt}
Description/Unit:	Area of stratum *i*, stand model *k*, at time *t*; hectare (ha)
Value applied:	See Table A5.3
Source of data:	Based on GPS readings and GIS calculations
Justification of choice/ Measurement procedures (if any):	The area calculations for each parcel of planted land based on GIS area calculations
Any comment:	

Data/Parameter:	nTR_{ijt}
Description/Unit:	Number of trees in stratum *i*, species *j*, at time *t*; dimensionless ha^{-1}
Value applied:	See Table A5.2
Source of data:	Field Data
Justification of choice/ Measurement procedures (if any):	Based on number of trees planted on each of the parcel of land.
Any comment:	

Data/Parameter:	*CFj*
Description/Unit:	Carbon fraction for species *j*, t C (t d.m.)$^{-1}$
Value applied:	0.5
Source of data:	IPCC default value
Justification of choice/ Measurement procedures (if any):	
Any comment:	

Data/Parameter:	$f_j(DBH_t,H_t)$
Description/Unit:	Allometric equation linking above-ground biomass of living trees (d.m. ha^{-1}) to mean diameter at breast height (*DBH*) and possibly mean tree height (*H*) for species *j*; dimensionless
Value applied:	
Source of data:	Calculated using allometric equations given in Table D1.1 for the project area, considering trees in the baseline. Also substantiated by secondary source information. From literature: See Table D1.3
Justification of choice/ Measurement procedures (if any):	Based on methodology, the allometric equations were used linking above ground biomass with mean diameter and tree height for the stratum B, with trees of the project area.
Any comment:	

Data/Parameter:	R_j
Description/Unit:	Root radius.
Value applied:	0.27
Source of data:	IPCC Good Practice Guidance, 2006
Justification of choice/ Measurement procedures (if any):	To estimate the below ground biomass based on above ground biomass value
Any comment:	

Data/Parameter:	GHG_E
Description/Unit:	Sum of the increases in GHG emissions by sources within the project boundary as a result of the implementation of an A/R CDM project activity; t CO_2-e
Value applied:	0
Source of data:	Field Data
Justification of choice/ Measurement procedures (if any):	The project activity does not involve biomass burning from site preparation due to slash and burn activity. It is not a practice of biomass burning during site preparation in this region. Also site preparation does not involve biomass burning on field. Thus estimate of the increase in GHG emissions as a result of the project implementation

	is not considered
Any comment:	

Data/Parameter:	$C_{AB,ijt}$
Description/Unit:	Carbon stock in above-ground biomass for stratum B, species *j*, at time *t;* t C
Value applied:	Model 1 – 3.225; Model II – 3.225; Model III – 1.15
Source of data:	Based on field data and IPCC GPG, 2006
Justification of choice/ Measurement procedures (if any):	Average girth and height of each of the species in every plot was measured. Applying biomass equations and BEF, biomass was calculated. Multiplied by 0.5 to derive tC of biomass.
Any comment:	

Data/Parameter:	$C_{BB,ijt}$
Description/Unit:	Carbon stock in the belowground biomass for stratum i, species j, and time t; t C
Value applied:	$C_{AB,ijt} . R_j$
Source of data:	Methodology
Justification of choice/ Measurement procedures (if any):	Calculated according to the methodology
Any comment:	

D.2. Estimate of the *ex ante* leakage:

According to the methodology AR-AM0004 version 4, three sources of the leakage covered are carbon stock decreases caused by displacement of pre-project agricultural crops, grazing and fuel-wood collection activities;

$$LK = LK_{ActivityDisplacement}$$

$$LK_{Activitydisplacement} = LK_{conversion} + LK_{fuelwood} \quad \textbf{(28)}$$

where:

$LK_{ActivityDisplacement}$ Leakage due to activity displacement; t CO_2-e

$LK_{conversion}$ Leakage due to conversion of forest to non-forest; t CO_2-e

$LK_{fuel\text{-}wood}$ Leakage due to the displacement of fuel-wood collection; t CO_2-e

$$LK_{conversion} = LK_{conv-graz} + LK_{conv-crop} \quad \textbf{(29)}$$

where:

$LK_{conv\text{-}graz}$ Leakage resulting from the conversion for grazing

$LK_{conv\text{-}crop}$ Leakage resulting from the conversion for cropland

Estimation of $LK_{conv\text{-}graz}$ (Leakage due to conversion of land to grazing land)

The baseline survey to estimate the pattern of grazing in the project area shows that grazing is practiced only on 50% of the project lands. Even on these lands, grazing is only during summers for 3-4 months, when crops are not grown.

Summer Grazing	No. of Land Parcels	Area (ha)	% of Area
Area under grazing	3,829.60	5,605.00	50.79
No grazing	3,711.01	5,543.00	49.21
Grand Total	7,540.60	11,148.00	100.00

In the project area, grazing, fodder collection and stall feeding of livestock are practiced. The approach adopted for estimating leakage is as follows:

- The total livestock population belonging to different livestock groups was obtained through survey in the sample villages
- The number and percentage of different livestock groups grazing in different land categories selected for the project was obtained through the survey
- Leakage due to the displacement of animal grazing is set as zero due to the following reasons:
    - Grass productivity after fencing and protection under A/R activity is projected to increase. Case studies of grass productivity of grazing lands in different parts of India indicate that mixed tree plantations shown that grass productivity can be higher in mixed tree plantations compared to open degraded lands[53] (Ravindranath and Hall, 2002). Thus under the project activity, the grass productivity increases as the soil quality improves. Thus after the initial four years, the project area will be open for grazing.
    - Nearly 60% of the families are willing to plant only on half of their holdings. Thus another half of the croplands is still available for summer grazing for their own livestock. The villagers are allowed free grazing of their cattle and sheep during grazing period and cut grass in the forest area. (Working Plan of Kolar, Karnataka Forest Department).
    - According to Annex 13, EB51, "*Guidelines on conditions under which increase in GHG emissions related to displacement of pre-project grazing activities in A/R CDM project activity is insignificant"*, if the total number of animals expected to be displaced is more than 40 LSU, and the n-40 LSU (where: "n" is the total number of animals, expressed in LSU, which are expected to be displaced) are displaced to existing grasslands with the carrying capacity that allows for accommodation of the displaced animals during the entire period of displacement.
        - A study was conducted by Chandel and Malhotra (2006) to understand the carrying capacity of semi-arid region in India. The carrying capacity (1.024/ha) is far more than the existing status (0.96/ha). Thus there is enough for additional 65 livestock units (LU/1000 ha) in the semi-arid region of India, under which the

[53] Ravindranath, N.H. and D.O. Hall. 2002. Biomass, Energy and Environment. A developing country perspective from India. Oxford University Press.

project area falls. A study by Ramachandra[54] for Kolar shows that the average livestock density is just 0.81/ha.

Thus accordingly, leakage due to displacement of animal grazing will be set to zero.

Estimation of $LK_{conv\text{-}crop}$ (Leakage due to conversion of land to crop land, based on area of conversion)

- According to Annex 14, EB51, Guidelines on conditions under which increase in GHG emissions attributable to displacement of pre-project crop cultivation activities in A/R CDM project activity is insignificant if the total area subjected to pre-project crop cultivation activities expected to be displaced is more than 5% of the entire A/R CDM project activity or more than 50 ha, and the n-a ha (where “n” is the area in ha expected to be displaced and “a” is 5% of the total project area or 50 ha) are displaced to existing cropland (i.e., area subjected to pre-project crop cultivation activities) managed in an extensive way subjected to an extensive management hence, allowing for increase of production without increasing their area (e.g., via improving crop rotation or change in the length of production/fallow periods).
    - Of the 8933.34 has of project area, 7656.14 ha is agricultural land (Table C7.1).
    - Thus n = 7656.14 ha; a = 5% of 7656.14 = 382.81 ha and n-a = 7273.33 ha
- Firstly, there will not be any displacement of pre-project agricultural crops permanently or temporarily outside the project boundary. Forest Conservation Act, 1980 prevents any forest land conversion[55]. Thus there will not be conversion of forest land into agricultural lands. This is also supported by the fact that the land under agriculture and forests have reduced in Kolar district[18].
- Also, the Government of India has introduced the National Rural Employment Guarantee Act (NREGA)[56] for the rural communities. Under this act, the government provides at least 100 days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work to enhance livelihood security in rural. Thus, this scheme will address the livelihood issues of the family.
- Nearly 60% of the families are willing to plant only on half of their holdings. There is still land available for subsistence farming for the family. Thus according to Annex 14 of EB51, there will be area under the control of the beneficiaries that will still be available for extensive cropping.

Estimation of LK fuel-wood (Leakage due to displacement of fuel-wood collection)

- According to Annex 15, EB 22, Clarifications regarding methodologies for Afforestation and Reforestation CDM project activities, “In the case of fuelwood collection or similar activities outside the project boundary, only the gathered volume of wood that is non-renewable shall be considered as an emission by sources if forests are not significantly degraded due to this activity. The equation (Eq. 3.2.8) for fuelwood gathering as outlined in IPCC GPG (2003) could be applied in combination with household surveys or Participatory Rural Appraisal (PRA). In the case that forests are significantly degraded, accounting rule 1 applies. “Not significantly degraded” means, that the extracted volume results in emissions which are between 2% and 5 %

[54] Ramachandra, T.V. 2008. Geographical Information system approach for regional biogas potential assessment. Research Journal of Environmental Sciences 2(3):170-184.

[55] http://envfor.nic.in/legis/forest/forest2.html,

[56] http://nrega.nic.in/Nrega_guidelinesEng.pdf

of net actual GHG removals by sinks. If the extracted wood volume results in emissions which are below 2% of the net actual GHG removals by sinks, this type of leakage can be ignored.

According to Equation 3.2.8

Annual Carbon loss due to fuelwood gathering

$L_{fuelwood} = FG * D * BEF_2 * CF$

Where:

$L_{fuelwood}$	=	Annual carbon loss due to fuelwood gathering, tonnes C. yr^{-1}
FG	=	Annual volume of fuelwood gathering, $m^3\ yr^{-1}$
D	=	Basic wood density, tonnes d.m. m^{-3} Table 3A.1.9
BEF_2	=	Biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark), dimensionless; Table 3A.1.10
CF	=	Carbon fraction of dry matter (default = 0.5), tonnes C (tonne d.m.)$^{-1}$

A study was conducted for Kolar District by Ravindranath *et al*, 2007[41] to estimate leakage based on PRA exercise as well as household survey where the quantity of fuelwood and poles/small timber currently extracted from community grazing land, degraded forestland and farmlands for the project were quantified. The fuelwood displacement due to the project activity is 10 kgs/ha/yr.

FG = 0.01 t/ha/yr or 89.33 t/yr for the project area (@10 kg/ha/yr)
BEF_2 = 1.3 from Table 3A.1.10 of the IPCC
CF = 0.5 default value
D is not considered as FG is estimated in weight.

$L_{fuelwood}$ = 89.33 t/yr * 1.3 * 0.5 = 58.07 tC/yr

The average net actual GHG removals by sinks for the project area accounts to 10.31 tCO_{2e}/yr or 2.82 tC/yr. Thus for the project area of 8933.34 ha, the net actual GHG removals by sinks is 25164.68 tC/yr. Thus $L_{fuelwood}$ accounts to 0.23% of the net actual GHG removals by sinks. Conservatively, it is assumed that 100% is non-renewable.

- Since the extracted wood volume results in emissions below 2% of the net actual GHG removals by sinks, this type of leakage is ignored.
- In addition, there will not be fuelwood collection activities as biogas for cooking and hot water bath is being provided to 23,500 families through 2 CDM Biogas projects in Chickballapur district. Thus the pressure for fuelwood in the project area has reduced drastically.
- There villagers are also allowed removal of dry fuel free of cost on head loads for their bonafide purposes (working plan of Kolar, Karnataka Forest Department).
- Also the baseline trees in the project area will continue to remain even after planting, thus providing the same services as in the baseline.

Taking into account the above, leakage due to activity displacement is set to zero.

Year	**Estimation of leakage (tonnes of CO_{2e})**
2008 (January 25th 2008)	0
2009	0

2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
2016	0
2017	0
2018	0
2019	0
2020	0
2021	0
2022	0
2023	0
2024	0
2025	0
2026	0
2027	0
Total (tonnes of CO_2e)	0

SECTION E. Monitoring plan

E.1. Monitoring of the project implementation:

Application of the approved methodology AR-AM 0004 ver 04 "Reforestation of Land Currently Under Agricultural Use"

E.1.1. Monitoring of forest establishment and management:

a. Monitoring the boundary of the proposed A/R CDM project activity

In Chickballapur district of Karnataka, 8933.34 ha meeting the land eligibility criteria for reforestation were identified. The project proposal seeks to establish these lands during the first crediting period. All the parcels of land are duly identified and mapped (Fig A4.1). The field survey was carried out using Global Positioning Systems (GPS) and will be differentiated by stratum, species and year of planting. All data obtained were downloaded and analyzed in the MapInfo platform (MapInfo Version 9), to generate the maps of areas under control of the project participants, to be able to monitor them over time. The activities that allow for proper management and monitoring of the project areas are:

- Review of all project boundaries to assess possible reforestation activities under way, site by site.
- Georeferencing (latitude and longitude) of each polygon by species and stratum, which is part of the CDM project, making use of the GPS.
- Periodic verification that the project boundaries correspond to the boundaries enunciated in section A and is consistent with the eligibility analysis.
- There will be periodic verifications of the project area boundaries, during the crediting period. If the boundaries present changes within this period due to natural (pests, diseases, fire, etc.) or anthropogenic damages (harvests or deforestation), these areas will be located and determined, making the relevant assessment of the carbon loss. These areas will be treated as different strata from those initially established. The modified boundaries will be reported to the DOE during the subsequent verification, the deforested lands will be excluded from the project and the lCERs issued for these areas will be deducted.
- Similarly, the areas where planting fails, or the use of the land changes, will be documented.
- Analysis of the field information obtained using a GIS system (MapInfo), calculating the areas incorporated by tree stand model and year of planting, and those affected by disturbances will be carried out.

The survey of the areas will be carried out in accordance with the procedures established in Annex 4. Any information collected will be incorporated into the customized ADATS InfoNeeds system, in order to coordinate the forest project planning. The data and variables to be used to monitor the project boundary are shown in the Table E1.1 below:

Table E1.1: Variable used in monitoring the project boundary

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)	Recording frequency	Number of data points / Other measure of number of collected data.	Comment
E1.1.1.	Stratum ID	Stratification map	c	Periodically	100% of the project area	Identification of project strata; includes strata with different conditions from those initially established for the project
E1.1.2	Polygon of the areas incorporated into the project. GPS coordiates	Latitude and Longitude	m	Continuously and validation every 5 years	100% of the area	Validated every 5 years in the monitoring periods. Formed by latitude and longitude coordinates of each polygon constituting the project; includes the areas affected by natural or human disturbances
E1.1.3	A_{ikt}	Hectare	c	5 years	100%	Total area at time t. The area of the project boundary will be measured and documented. Project boundary maps and corresponding documents will be made available at the time of monitoring. Correspond to the sum total of areas under control (E.1.1.2) in period T (monitoring times).
E1.1.4.	A_T	Hectare	c	Every 5 years	100% of the area	Total area at time t. The area of the project boundary will be measured and documented. Project boundary maps and corresponding documents will be made available at the time of monitoring. Correspond to the sum total of areas under control (E.1.1.2) in period T (monitoring times).
E1.1.5	$Adist_{ikt}$	Hectare	c	Annually	100% of the affected area	Areas altered by natural (fires, pests and diseases, etc.) or human (harvests and deforestation) conditions, for stratum i, in tree stand model k, in time t.
E1.1.6	$Adist_{ikT}$	Hectare	c	5 years	100% of the affected area	Average areas altered by natural (fires, pests and diseases, etc.) or human (harvests are deforestation) conditions, for stratum i, in tree stand model k, during period T.

b. Monitoring of forest establishment

According to the methodology, and in order to ensure that the planting quality conforms to the practice described in AR-CDM-PDD Section A and is well implemented, the following monitoring activities shall be conducted, throughout the forest establishment stage, by stratum and species and for the compartments considered.

- Confirm that site and soil preparations are implemented based on the practices documented in PDD (Sect A).
- Survival checking. Sample plots will be laid to check the survival rate of trees. These will be recorded and record maintained at the ADATS office.
    - The initial survival rate of planted trees three months after the planting.
    - Replanting shall be conducted to complete 100% of the area during the initial three years;
    - Final checking will be after three years of planting;

A standardized protocol will be developed, which guarantees the proper quantification of survival during the establishment period

- Verification of tree stand maintenance, e.g; weeding checking: check and confirm that the weeding practice is implemented as described in the PDD;
- Survey and check that species and planting for each stratum are in line with the PDD. Changes of planted species will be justified and promptly reported to the DOE, identifying the stratum to which they belong, planted area and time of planting.
- Document and justify any other deviation from the planned forest establishment, proposed in section A of the PDD.

The necessary variables to monitor the establishment of the forest models are presented in Table E1.2.

Table E1.2 Variables used in the monitoring of the project establishment.

ID number[57]	**Data variable**	**Data unit**	**Measured (m), calculated (c) estimated (e) or default (d)**[58]	**Recording frequency**	**Number of data points / Other measure of number of collected data.**	**Comment**
E1.2.1.	Cohert ID	Alpha numeric	Defined	Continuously	100%	Each stratum and tree stand model established by compartment, is associated with a single alpha numeric identifier.
E 1.2.2	Location	Grid/geopgraphical units	m		100%	Using GPS to locate geographical coordinates of the compartment boundary included in the project.
E 1.2.3	A_{ikt}	Hectare	c	Continuously	100%	Polygons of the areas planted during time t, for stratum i, in tree stand model k. Calculated with the information obtained through E.1.2.1
E 1.2.4.	Site Preparation	Hectare	m	At the start of the establishment	100% of all planted areas	Area intervened for the establishment of the tree stands.
E 1.2.5	Species choice in each stratum		Defined	Annually	100%	Type of species actually planted in the areas under control.
E 1.2.6	Check for survival Ij,k	Trees/ha	m,c	Three months after planting and a final check during the third year	100% of the survival monitoring plots	The quantity of survival in each monitoring plot is measured and calculated per hectare unit established, for stratum i, of species j, in tree stand model k.
E 1.2.7	Date of planting	Alpha numeric	m	Start of each planting	100%	Date of planting of each Lot

[57] Please provide ID number for cross-referencing in the PDD.

[58] Please provide full reference to data source.

c. Monitoring of Forest Management. In order to guarantee the quality of the planting and confirm that the forestry activities described in section A are well implemented, procedures would be set up that lead to the gathering of all information on the establishment activities carried out until the first monitoring, such as:

- **Cleaning and site preparation measures**: date, location, area, biomass removed and other measures undertaken.
- **Planting:** date, location, area, tree species.
- **Fertilization:** Species, location, amount and type of fertilizer applied, etc., is monitored to ensure that planting procedures are correctly followed and to ensure the success of the plantation. However, version 4 of the methodology does not take into account these emissions.
- **Cleanings:** date, place, area intervened
- **Coppicing:** Will not be practiced. If coppicing takes place on any of the plots, the date, location, area, tree species, volumes or biomass removed will be recorded.
- **Clearings:** date, type of clearing, density, places, species and biomass extracted if any.
- **Harvesting:** This is not a practice, as all the species are horticulture species. However, date, location, area, tree species, volumes or biomass removed if any, will be documents for any parcel of land under project activity.
- Verification and confirmation that if any area is harvested, it will be replanted or reseeded by direct planting, immediately after being used.
- Monitoring of the disturbances caused in the forest plantations, whether natural (fire, falling due to winds, diseases and pests, etc,) or through human action (deforestation, etc): date, location, area (GPS coordinates and remote sensing), tree species, type of disturbance, biomass lost, implemented corrective measures, changes in the boundary of strata and stand models.

The data used to monitor forest management are shown below in Table E1.3.:

Table E1.3: Data for monitoring forest management

ID number	Data variable	Data unit	Measured (m), calculated (c) estimated (e) or default (d)[59]	Recording frequency	Number of data points / Other measure of number of collected data.	Comment
E.1.3.1	Area Cleaning$_{i,j,t}$	Hectare	m		100%	Area subject to cleaning for the establishment of tree stand models by stratum and species, during a time t.
E.1.3.2	Area planting$_{(i),j,t}$	Hectare	m		100%	The areas are measured before planting the seedlings in the areas under control of the project, for stratum i, species j, during time t.
E.1.3.3	Area fertilized	Ha/yr	c	annually	100%	-
E1.3.4	Amount of synthetic fertilizer N applied per unit area	Kg N/ha/yr	m	annually	100%	-
E.1.3.5	Area weeded	Ha/yr	c	1st—4th year	100%	The cleanings will be carried out in different intensities during the first four years of establishment of the tree stand.
E.1.3.6	Area Coppicing	ha yr-1	c	annually	100%	Coppicing is not practiced in the project area. If coppicing takes place, will be differentiated by tree stand model, species, degree of development of the trees during time t.
E.1.3.7	Biomass removed in the coppicing	T d.m.ha-1	c	annually	100%	Biomass extracted in each coppicing, calculated for each stratum and species.
E.1.3.8	Thinning	Ha/yr	M,e	annually	100%	There will be no thinning. If thinning takes place, the areas subjected to thinnings will be estimated for each stratum and

[59] Please provide full reference to data source.

						species.
E.1.3.9	Biomass removed in the thinning	T d.m.ha-1	c	annually	100%	Biomass extracted due to thinning will not take place. If any, will be calculated for each stratum and species.
E.1.3.10	Area harvested	Hectare	c	annually	100%	There will be no harvesting as the species are horticulture species. If harvesting happens, the areas harvested estimated by model, stratum and species will be identified.
E.1.3.11	Volume harvested	M3/ha/yr	c	annually	100%	There will be no harvesting as it is a long rotation horticultural species. If harvesting takes place, the volume of biomass will be estimated.
E.1.3.12	Biomass harvested	Tdm/ha/yr	c	annually	100%	If biomass harvested, will be calculated as of E.1.2.1, for each stratum, species and during time t.
E.1.3.13	Area replanted	Ha/yr	m	annually	100%	The quantity of re-planted areas is evaluated, after the final harvest, in each stratum and for each species, according to the forest management program.
E.1.3.14	Area disturbed	Hectare	M	Annually	100%	The areas affected are measured using a GPS (geographical coordinates), identifying the type of disturbance, by stratum and species.
E.1.3.15	Biomass loss	Tdm/ha/yr	C	Annually	100%	Biomass loss as a consequence of disturbances in the plantations for stratum i, species j, during time t.

d. Monitoring of delivery of lCERs to landowners

The Project Participants will distribute the income from the sale of the lCERs to the landowners in accordance to the established contracts signed with them. The monitoring procedure for delivery of the lCERs is detailed in Annex 4, the Monitoring Plan.

The information and documentation related to the distribution and delivery of lCERs shall be saved in physical and digital formats and will be periodically verified and cross checked with the reports from the reforestation activities.

Before each verification, the Project manager will carry out a revision of the status of the participation contracts for each plot of land included in the project. The manager will provide the verifier with a list of all contracts and their status, either active or inactive, prior to initiation of the verification. Those contracts which are not up to date will be updated before the verification.

E.1.2. If required by the selected approved methodology, describe or provide reference to, SOPs and quality control/quality assurance (QA/QC) procedures applied.

The QC procedures will be designed to provide routine and consistent checks to ensure data integrity, correctness, and completeness; identify and address errors and omissions; document and archive inventory material and record all QC activities.

To ensure the net anthropogenic GHG removals by sinks to be measured and monitored precisely, credibly, verifiably and transparently, a quality assurance and quality control (QA/QC) procedure shall be implemented, including (1) collection of reliable field measurement; (2) verification of methods used to collect field data; (3) verification of data entry and analysis techniques; and (4) data maintenance and archiving. If after implementing the QA/QC plan it is found that the targeted precision level is not met, then additional field measurements will to be conducted until the targeted precision level is achieved.

Reliable field measurements

Persons involving in the field measurement work will be fully trained in the field data collection and data analyses.

Standard Operating Procedures (SOPs) for each step of the field measurements will be developed and adhered to at all times. These SOPs should detail all phases of the field measurements and will contain provisions for documentation for verification purposes, so that measurements are comparable over time and can be checked and repeated in a consistent fashion.

To ensure the collection of reliable field data,

- ✓ Field-team members shall be fully aware of all procedures and the importance of collecting data as accurately as possible;
- ✓ Field teams shall install test plots if needed in the field and measure all pertinent components using the SOPs;
- ✓ Field measurements shall be checked by a qualified person to correct any errors in techniques;
- ✓ A document that shows that these steps have been followed shall be presented as a part of the project documents. The document will list all names of the field team and the project leader will certify that the team is trained;
- ✓ Any new staff is adequately trained.

Verification of field data collection

To verify that plots have been installed and the measurements taken correctly, 10-20% of plots shall be randomly selected and re-measured independently. Key re-measurement elements include the location of plots, DBH and tree height. The re-measurement data shall be compared with the original measurement data. Any deviation between measurement and re-measurement below 5% will be considered tolerable and any error above 5% shall be corrected and recorded. Any errors discovered should be expressed as a percentage of all plots that have been rechecked to provide an estimate of the measurement error.

Uncertainty assessment

The uncertainty in each species in each stratum can be estimated from re-measurement of randomly selected plots and/or from the measurement of replicate plots. Uncertainties will be estimated and expressed as half the 95% confidence interval width divided by the estimated value, i.e.,

$$Us = \frac{1}{2}\frac{(95\%.confidence.level.\mathrm{int}\,erval.width}{\mu}.100$$

Where
µ = mean value
ó = standard deviation

$$Uc = \frac{\sqrt{(U_{s1}.C_{s1})^2 + (U_{s2}.C_{s12})^2 + ...+(U_{sn}.C_{sn})^2}}{\left|C_{s1} + C_{S2} + ...C_{sn}\right|}$$

Where
U_c = combined percentage uncertainty of sub-stratum, %
C_{si} = mean carbon stock of species i in the sub-stratum

The stratum and total percentage uncertainties are further combined in the same way as above.

Verification of data entry and analysis

Reliable estimation of carbon stock in pools requires proper entry of data into the data analyses spreadsheets. To minimize the possible errors in this process, the entry of both field data and laboratory data shall be reviewed using expert judgment and, where necessary, comparison with independent data to ensure that the data are realistic. Communication between all personnel involved in measuring and analyzing data should be used to resolve any apparent anomalies before the final analysis of the monitoring data is completed. If there are any problems with the monitoring plot data that cannot be resolved, the plot should not be used in the analysis.

To guarantee that the steps to estimate the net removals generated by the project are well developed in the monitoring processes, the TARAM tool, in its most recent version, will be used. This tool provides consistency to the estimates based on the information gathered in the monitoring stages.

Data maintenance and archiving

Because of the long-term nature of the A/R CDM project activity, data shall be archived and maintained safely. Data archiving shall take both electronic and paper forms, and copies of all data shall be achieved. All electronic data and reports shall also be copied on durable media such as CDs and copies of the CDs are stored in multiple locations. The archives shall include:

Copies of all original field measurement data, laboratory data, data analysis spreadsheet;

- ✓ Estimates of the carbon stock changes in all pools and non-CO_2 GHG and corresponding calculation spreadsheets;
- ✓ GIS products;
- ✓ Copies of the measuring and monitoring reports.

Table E1.5. Verification and checklist recommended by AR-AM0004/Version 04 to guarantee the quality of the information gathered and its management.

QC activity	Procedures
Check that assumptions and criteria for the selection of activity data, emission factors and other estimation parameters are documented	• Cross-check descriptions of activity data, emission factors and other estimation parameters with information on source and sink categories and ensure that these are properly recorded and archived
Check for transcription errors in data input and reference	• Confirm that bibliographical data references are properly cited in the internal documentation; • Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for transcription errors
Check that emissions and removals are calculated correctly	• Reproduce a representative sample of emission or removal calculations; • Selectively mimic complex model calculations with abbreviated calculations to judge relative accuracy
Check that parameter and units are correctly recorded and that appropriate conversion factors are used	• Check that units are properly labeled in calculation sheets; • Check that units are correctly carried through from beginning to end of calculations; • Check that conversion factors are correct; • Check that temporal and spatial adjustment factors are used correctly
Check the integrity of database files	• Confirm that the appropriate data processing steps are correctly represented in the database; • Confirm that data relationships are correctly represented in the database; • Ensure that data fields are properly labeled and have the correct design specifications; • Ensure that adequate documentation of database and model structure and operation are archived
Check for consistency in data between categories	• Identify parameters (e.g., activity data, and constants) that are common to multiple categories of sources and sinks, and confirm that there is consistency in the values used for these parameters in the emissions calculations
Check that the movement of inventory data among processing steps is correct	• Check that emission and removal data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries; • Check that emission and removal data are correctly transcribed between different intermediate products

QC activity	Procedures
Check that uncertainties in emissions and removals are estimated or calculated correctly	• Check that qualifications of individuals providing expert judgment for uncertainty estimates are appropriate; • Check that qualifications, assumptions and expert judgments are recorded. Check that calculated uncertainties are complete and calculated correctly; • If necessary, duplicate error calculations on a small sample of the probability distributions used by Monte Carlo analyses
Undertake review of internal documentation	• Check that there is detailed internal documentation to support the estimates and enable reproduction of the emission and removal and uncertainty estimates; • Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review; • Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation
Check time series consistency	• Check for temporal consistency in time series input data for each category of sources and sinks; • Check for consistency in the algorithm/method used for calculations throughout the time series
Undertake completeness checks	• Confirm that estimates are reported for all categories of sources and sinks and for all years; • Check that known data gaps that may result in incomplete emissions estimates are documented and treated in a conservative way
Compare estimates to previous estimates	• For each category, current inventory estimates should be compared to previous estimates, if available. If there are significant changes or departures from expected trends, re-check estimates and explain the difference

E.2. Sampling design and stratification

Stratification of the areas will correspond to the guidelines established by AR-AM0004/Version 04, and consists of a first stratification (Section C.4) based on the existing natural conditions, land use history and type of existing vegetation, in addition to factors such as status of soil due to degree of anthropogenic pressure, which is determined in the reference scenario. But other final factors that will be considered for the stratification will be the differences in the estimated sinks for each tree stand model as the project develops. The number and boundaries of the strata defined *ex ante* using the methodology procedure outlined in Section II.2 may change during the crediting period (*ex post*). For this reason, strata will be monitored periodically. If a change in the number and area of the project strata occurs, the sampling framework will be adjusted accordingly through the following procedure for monitoring strata and the sampling framework.

Monitoring of strata

The *ex-ante* stratification is the combination of the baseline strata with the proposed tree stand models. The database of the information obtained from the parameters for the *ex-ante* stratification will be entered into the geographical information system (MapInfo) and in the ADATS InfoNeeds Database, and the maps corresponding to said analysis will be generated. A re-stratification is proposed according to the results obtained in the first monitoring of the project, as a function of the carbon sinks and disturbances identified, taking into account the following elements:

1) The results of biomass accumulation
2) Planting dates
3) Forestry treatments carried out and/or productivity attained by the various planting models present in the project.
4) Unexpected disturbance occurring during the crediting period (e.g; fire, pest or disease outbreaks)

The information required for the stratification process will be determined to present the lowest possible number of strata that will facilitate the evaluation of the project. As determined by the methodology, strata that are considered as presenting similar conditions in terms of biomass accumulation, planting models, activities, etc., reflected in the results of the first monitoring, will be unified in order to reduce the number of strata. This will be geo-referenced and spatial database shall be updated periodically capturing the following if any:

- Unexpected disturbances occurring during the crediting period (e.g. due to fire, pests or disease outbreaks), affecting differently different parts of an originally homogeneous stratum or stand;

- Forest management (cleaning, planting, re-replanting and harvesting, if any) may be implemented at different intensities, dates and spatial locations than mentioned in the PDD, as there will be no harvesting and thinning.

- Eligible land areas as defined in the AR-CDM-PDD not yet under the control of the project participant at the start of the project activity have become under the control of the project participants (see Section II)

- Two different strata may be similar enough to allow their merging into one stratum.

Monitoring of strata and stand boundaries shall be done using a Geographical Information System (GIS), which allows for integrating data from different sources (including GPS coordinates and remote sensing data). Subsequent to the changes estimated in the re-stratification, a report on said changes will be presented to the DOE for verification.

Sampling framework

The sampling framework, includes sample size, plot size, plot shape and plot location.

Definition of the sample size and allocation among strata

Permanent sampling plots will be used for sampling over time to measure and monitor changes in carbon stocks. It will be ensured that the permanent plots will be treated in the same way as other lands within the project boundary, e.g., during site and soil preparation, weeding, fertilization, watering, thinning, etc., and will not be destroyed over the monitoring interval. The staff involved in management activities will not be aware of the location of monitoring plots. Local markers will not be used for identification of the plots.

The size of sample will be estimated using one of the methods described below as specified in AR-AM0004 Ver. 04:

The parameters required are as follows:

A Total size of all strata (A), e.g. the total project area; ha

A_i Size of each stratum (= $\sum_{t=1}^{tcr}\sum_{k}^{K_P} A_{ikt}$ where *tcr* is the end of the crediting period); ha

k 1, 2, 3, … $K_P$stand models in the project scenario

A_{ikt} Area of stratum *i*, stand model *k*, time *t*; ha

AP Sample plot size; ha

st_i Standard deviation for each stratum *i*; dimensionless

C_i Cost of establishment of a sample plot for each stratum *i;* e.g. US$

Q Approximate average value of the estimated quantity *Q*, (e.g. wood volume); e.g. m^3 ha^{-1}

DLP Desired level of precision (e.g. 10%); dimensionless

Then:

$$N = \frac{A}{AP} \;\; ; N_i = \frac{A_i}{AP} \;\; ; \;\; E = Q \cdot DLP \qquad \textbf{(57)}$$

where:

N Maximum possible number of sample plots in the project area

N_i Maximum possible number of sample plots in stratum *i*

E Allowable error

With the above information, the sample size (number of sample plots to be established and measured) will be estimated as follows since costs will be constant for all strata,

$$n = \frac{\left[\sum_{i=1}^{m_{PS}} N_i \cdot st_i\right]^2}{\left(N \cdot \frac{E}{z_{\alpha/2}}\right)^2 + \sum_{i=1}^{m_{PS}} N_i \cdot (st_i)^2} \qquad \textbf{(60)}$$

$$n_i = \frac{\sum_{h=1}^{m_{PS}} N_i \cdot st_i}{\left(N \cdot \frac{E}{z_{\alpha/2}}\right)^2 + \sum_{i=1}^{m_{PS}} N_i \cdot (st_i)^2} \cdot N_i \cdot st_i \qquad \textbf{(61)}$$

In order to determine sample size, an equal cost for the establishment of plots of land in each stratum is assumed. For the three models, pre-project mean annual increments of species were used to determine the standing biomass (Table E2.1). The biomass increment was estimated using volume equation, wood density and number of trees per ha.

Table E2.1: MAI and Standard deviation for the stand models

Botanical Name	MAI/Per Ha	StdDev of MAI/Per Ha
Anacardium occidentale	6.8	3.8
Mangifera indica	6.8	4.2
Tamarindus indica	2.1	1.6

The calculations on number of sample plots were made entering the information and the equations into the Winrock Sampling Calculator Software. Tables E2.2 present the intermediate results of the calculations obtained for the number of plots of land to be established and Table E2.3 details all plots of land and sample quantity for each stratum.

Table E2.2: Intermediate results of the sample plot calculations

Required error and confidence level	
e - level of error (%)	10.0%
Error level (decimal)	0.1
Z(1-a) - Confidence level	95.0%
Sample statistic Z(1-a)	1.96
Total project area size Ha)	8933.34

Stratum Name	Ai Area (ha)	Mean Increment Ct/ha (tones)	Standard Deviation (tonesC/ha)	Plot Size (ha)
Mango Plantations	7550.00	3.4	2.1	0.06
Cashew Plantations	883.34	3.4	1.9	0.06
Tamarind Plantations	500.oo	1.05	0.8	0.06

Intermediate calculations	
N = sum N_h	148889
Weighted Mean C (t/ha)	3.2684702
Weighted Plot Size (ha)	0.06
Weighted SD	2.0074626
Weighted Total Variance	4.1198877

An additional 15% of plots is added to the intermediate estimation values to support the loss of plots which may occur over time. Table E2.3 includes the forgoing considerations and indicates the number of plots per model.

Table E2.3: Estimation of the sample size by stratum for the project area

Stratum Name	Plot Quantity	Rounded Plot Quantity
Mango Plantations	127.99	**148**

Cashew Plantations	13.55	**16**
Tamarind Plantations	3.23	**4**
Total Number of Plots		**168**

It is possible to reasonably modify the sample size after the first monitoring event based on the actual variation of the carbon stocks determined from taking the *n* samples. After the first monitoring, the sample size will be reassessed. In case the permitted error is not obtained, the initial sample size is will be recalculated, with the information updated in the field. The information in each monitoring shall likewise be assessed. All calculations will be recorded and filed, in such a way that they can be easily verified.

Sample plot size

The plot area has a major influence on the sampling intensity and time and resources spent in the field measurements. The area of a plot depends on the stand density. Therefore, increasing the plot area decreases the variability between two samples. According to Freese (1962),[60] the relationship between coefficient of variation and plot area can be denoted as follows:

$$CV_2^{\ 2} = \quad CV_1^{\ 2} \cdot \sqrt{\frac{a_1}{a_2}} \qquad \textbf{(59)}$$

where a_1 and a_2 represent different sample plot areas and their corresponding coefficient of variation (*CV*).

Thus, by increasing the sample plot area, variation among plots can be reduced permitting the use of small sample size at the same precision level. According to the Good Practice Guidance of LULUCF, in general, it is recommended to use a single plot varying between 100 m^2 (for densely planted stand of 1,000 trees/ha or more) and 600 m^2 (for sparsely planted stand of multi-purpose trees) in area for even-sized stands. Accordingly, in the project area, rectangular or circular plots of land with an area of 600 m^2 will be established in all stand models. Within them, all trees with a diameter equal to or greater than 2.5 cm would be measured. In case should it become necessary to change the size of the sampling units, the size of the plots of land may fluctuate between 600 and 1,000 m^2. This size interval is considered cost-effective according to the proposed tree stand models. The size variation is determined by factors such as: stratum, species, planting system or even by variations in the A/R productive models under CDM.

Plot location

The distribution of the sampling units will follow a stratified random pattern. This is to avoid subjective choice of plot locations (plot centers, plot reference points, movement of plot centers to more ‘convenient’ positions) and the permanent sample plots shall be located systematically with a random start, which is considered good practice in IPCC GPG-LULUCF. This will be accomplished with the help of a GPS in the field. The GPS coordinate, administrative location, stratum and stand, series number of each plots shall be recorded and archived. Also, it will be ensured that the sampling plots are as evenly distributed as possible.

[60] Freese, F. 1962. Elementary Forest Sampling. USDA Handbook 232. GPO Washington, DC. 91 pp.

Monitoring frequency

Monitoring interval depends on the variability in carbon stocks and the rate of carbon accumulation, i.e., the growth rate of trees as of living biomass. The verification and certification shall be carried out every five years after the first verification until the end of the crediting period. However, to reduce the monitoring cost, the monitoring intervals shall coincide with verification time, i.e., five years of interval. The first monitoring time will be done taking into account:

- The growth rate of trees and the financial needs of the project activity,
- Since there will be no harvesting events, the issue of time of monitoring and subsequent verification and certification with peaks in carbon stocks based is not applicable.

Measuring and estimating carbon stock changes over time

The growth of individual trees on plots shall be measured at each monitoring event. Pre-existing (baseline) trees will not be measured and accounted for. Although non-tree vegetation such as herbaceous plants, grasses, and shrubs can occur, usually with biomass less than 10 percent, there is also non-tree vegetation on degraded lands and the baseline scenario has assumed the zero stock change for this non-tree biomass. Therefore, tree and non-tree vegetation will not be measured and accounted. This is consistent with the assumption proposed in the baseline scenario (subsection C.7 of this document), and this position is in accordance with EB 46 Annex 16 (*Guidance on conditions under which the change in carbon stocks in existing live woody vegetation are insignificant*) where the change in the carbon content is assumed as zero for this type of vegetation Even if the initial site preparation results in a removal of non-tree biomass, there is no risk to over-estimate the removals. The carbon stock changes in living biomass on each plot are then estimated through Biomass Expansion Factors (BEF) method or allometric equations method.

Monitoring GHG emissions by sources increased as results of the A/R CDM project activity

An A/R CDM project activity may increase GHG emissions, in particular CO_2, CH_4 and N_2O due to biomass burning for site preparation (slash and burn activity). Since in the project activity, slash and burn activity is not involved, it is not required.

E.3. Monitoring of the baseline net GHG removals by sinks, if required by the selected approved methodology:

It is deemed that the net changes in carbon contents present in the sinks considered are equal to zero in the scenario of baseline net GHG removals, due to the fact that the lands included within the project boundaries are marginal agriculture/barren lands and are devoid of forest cover (under the definition of forest considered for the Indian DNA). In addition, the history of land use indicates that the baseline net GHG removals will remain constant over time (zero) with the actual uses of these lands in the baseline cases.

Furthermore, methodology AR-AM0004/Version 04 does not require the monitoring of baseline scenario during the crediting period. However, since a renewable crediting period is chosen, relevant data necessary for determining the renewed baseline, including net greenhouse gas removals by sinks during the crediting period, shall be collected and archived to determine whether the baseline approach and baseline scenario are still valid or have to be updated. These include:

- National, local and sectoral policies that may influence land use in the absence of the proposed A/R CDM project activity;
- Technical progresses that may change the baseline approach and baseline scenario;
- Climate conditions and other environmental factors that may change to such a degree as to significantly change the successional and disturbance processes or species composition, resulting in, e.g., improved climate conditions and/or available seed source would make the natural regeneration possible that is not expected to occur for the current baseline scenario;
- Significant changes of political, social and economic situation, making baseline approach and the projection of baseline scenario unreasonable;
- Existing barriers that may be removed
- Market that may change the alternative land use, e.g., significant price rising of wood and non-woody products would make the degraded land economically attractive in the absence of the proposed A/R CDM project activity;

The carbon stock changes in the baseline scenario will be estimated by measuring carbon stock in the above-ground biomass on control plots at the end of the crediting period. The control plots shall be established outside the project boundary and serve as proxy and accurately reflect the development of the degraded lands in the absence of the project activity.

Table E3.1: Data to be collected and archived for the estimation of baseline net GHG removals by sinks

ID number	Data Variable	Source of data	Data Unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.3.01	National, local and sectoral policies that may influence land use in the absence of the proposed A/R CDM project activity	Various	n.a.	Collected	Start and end of the crediting period	As complete as possible	Will not be monitored, will be revalidated for the second accreditation period
2.3.02	Natural and anthropogenic factors influencing land use, land cover and natural regeneration	Various	n.a.	Collected	Start and end of the crediting period	As complete as possible	Will not be monitored, will be revalidated for the second accreditation period
2.3.03	Stratum ID	Stratification map	Alpha numeric		20 years	100%	Stratum identification for baseline scenario checking
2.3.04	Carbon stock in above-ground biomass at the end of the crediting period	Calculated based on baseline plot measurement	t CO_2-e. yr^{-1}	c	End of the crediting period	100% of baseline plots	Calculated based on baseline plot measurement for different strata/sub-strata
2.3.05	Carbon stock in above-ground biomass at the start of the crediting period	Calculated based on baseline plot measurement	t CO_2-e. yr^{-1}	c	Start of the crediting period	100% of baseline plots	Calculated based on baseline plot measurement for different strata/sub-strata
2.3.06	Baseline carbon stock change in above-ground biomass	Calculated	t CO_2-e. yr^{-1}	c	20 years	100%	Calculated

E.4. Monitoring of the actual net GHG removals by sinks:

To estimate the changes in the carbon content under the CDM project activity, the steps defined by methodology AR-AM0004/Version 04, according to the strata, species and tree stand models defined in section A will be followed. The sinks considered for their quantification are limited to the stocks present in the above and below-ground biomass. The soil, dead leaves and dead wood (or detritus) compartments, are not considered in the carbon content estimates, according to the methodology employed. The calculations will be performed periodically according to the monitoring plan. Therefore

$$C_{ACTUAL} = \Delta C_{LB} - GHG_E \qquad \textbf{(63)}$$

where:

C_{ACTUAL} Actual net greenhouse gas removals by sinks; t CO_2-e

ΔC_{LB} Sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e

GHG_E Sum of the increases in GHG emissions by sources within the project boundary as a result of the implementation of an A/R CDM project activity; t CO_2-e

To estimate actual net greenhouse gas removal by sinks for the period of time elapsed between project start (*t=1*) and the year *t=t**, *t** being the year for which actual net greenhouse gas removals by sinks are estimated, the 'stock change' method will be used to determine annual or periodical values.

$$\Delta C_{P,LB} = \Delta C_{P,LB_T} - E_{biomasslos} \qquad \textbf{(64)}$$

where:

$\Delta C_{P,LB}$ Sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e

$\Delta C_{P,LB\,T}$ Sum of the changes in living tree biomass carbon stocks (above- and below-ground); t CO_2-e

$E_{biomassloss}$ Decrease in the carbon stock in the living biomass carbon pools of non-tree vegetation in the year of site preparation, up to time *t**; t CO_2-e (as per equation 15)

E.4.1. Data to be collected in order to monitor the verifiable changes in carbon stock in the carbon pools within the project boundary resulting from the proposed A/R CDM project activity:

Estimation of changes in the carbon stocks

The verifiable changes in carbon stock equal to the carbon stock changes in above-ground biomass and below-ground biomass within the project boundary, will be estimated using the following methods and equations

$$\Delta C_{P,LB_T} = \sum_{t=1}^{t*} \sum_{i=1}^{S_{ps}} \sum_{k=1}^{K} \Delta C_{P,ikt} \qquad \textbf{(65)}$$

where:

$\Delta C_{P,LB}$ Sum of the changes in living biomass carbon stocks (above- and below-ground); t CO_2-e

$\Delta C_{P,ikt}$ Annual carbon stock change in living biomass for stratum *i*, stand model *k*, time *t;* t CO_2-e yr^{-1}

i 1, 2, 3, ... S_{ps} strata of the project activity

k 1, 2, 3, … *K* stand models

t 1, 2, 3, ...*t** years elapsed since the start of the A/R project activity

and

$$\Delta C_{P,ikt} = (\Delta C_{AB,ikt} + \Delta C_{BB,ikt}) \cdot \frac{44}{12} \quad \textbf{(66)}$$

where:

$\Delta C_{P,ikt}$ Annual carbon stock change in living biomass for stratum *i*, stand model *k*, time *t;* t CO_2-e. yr^{-1}

$\Delta C_{AB,ikt}$ Annual carbon stock change in above-ground biomass for stratum *i*, stand model *k*, time *t;* t C yr^{-1}

$\Delta C_{BB,ikt}$ Annual carbon stock change in below-ground biomass for stratum *i*, stand model *k*, time *t;* t C yr^{-1}

The mean change in carbon stocks in above-ground biomass and below-ground biomass per unit area will be estimated based on field measurements on permanent plots using the Volumetric equations and Biomass Expansion Factors (BEF) or Allometric Equations method depending on the equations adopted for the species. As shown in Table D1.1, for few species, the BEF method and for a few species the allometric equations will be used as available from literature.

As defined in the methodology, the following 5 steps will be followed:

BEF Method

Step 1: The diameter at breast height (DBH, at 1.3 m above-ground) and preferably height of all the trees in the permanent sample plots will be measured above a minimum DBH of 2.5 cm being an arid region.

Step 2: The volume of the commercial component of trees will be estimated based on locally derived equations. The sum for all trees within a plot will be expressed as volume per unit area (e.g., m^3/ha).

Step 3: Choose BEF and root-shoot ratio: The BEF shoot ratio given by the GPG IPCC LULUCF for tropical forests (1.3) will be used. The default value for root-shoot ratio of 0.27 will be used for root-shoot ratio.

Step 4: Converting the volume of the commercial component of trees into carbon stock in above-ground biomass and below-ground biomass via basic wood density, BEF root-shoot ratio and carbon fraction as follows:

$$MC_{AB,ijt} = MV_{ijt} \cdot D_j \cdot BEF_j \cdot CF_j \quad \textbf{(67)}$$

$$MC_{BB,ijt} = MC_{AB,ijt} \cdot R_j \quad \textbf{(68)}$$

where:

$MC_{AB,ijt}$	Mean carbon stock in above-ground biomass per unit area for stratum *i*, species *j*, time *t;* t C ha^{-1}
$MC_{BB,ijt}$	Mean carbon stock in below-ground biomass per unit area for stratum *i*, species *j*, time *t;* t C ha^{-1}
MV_{ijt}	Mean merchantable volume per unit area for stratum *i*, species *j*, time *t;* m^3 ha^{-1}
D_j	Volume-weighted average wood density; t d.m. m^{-3} merchantable volume
BEF_j	Biomass expansion factor for conversion of biomass of merchantable volume to above-ground biomass; dimensionless
CF_j	Carbon fraction; IPCC default value = 0.5; t C (t d.m.)$^{-1}$
R_j	Root-shoot ratio; dimensionless

Step 5*:* The total carbon stock in living biomass for stratum *i*, species *j*, time *t* is calculated from the area for stratum *i*, species *j*, time *t* and the mean carbon stocks in above-ground biomass and below-ground biomass per unit area, as follows:

$$C_{AB,ikt} = A_{ikt} \cdot MC_{AB,ikt} \quad \textbf{(69)}$$

$$C_{BB,ikt} = A_{ikt} \cdot MC_{BB,ikt} \quad \textbf{(70)}$$

where:

$\Delta C_{AB,ijt}$	Annual carbon stock change in above-ground biomass for stratum *i,* species *j*, time *t;* t C yr^{-1}
$\Delta C_{BB,ijt}$	Annual carbon stock change in below-ground biomass for stratum *i,* species *j*, time *t;* t C yr^{-1}
A_{ijt}	Area of stratum *i*, species *j*, at time *t*; hectare (ha)
$MC_{AB,ijt}$	Mean carbon stock in above-ground biomass per unit area for stratum *i,* species *j*, time *t;* t C ha^{-1}
$MC_{BB,ijt}$	Mean carbon stock in below-ground biomass per unit area for stratum *i,* species *j*, time *t;* t C ha^{-1}

Step 6*:* The change in carbon stock in living biomass over time is given by:

$$\Delta C_{AB,ikt} = \frac{\sum_{j=1}^{J} (C_{AB,ikt_2} - C_{AB,ikt_1})}{T} \quad \textbf{(71)}$$

$$\Delta C_{BB,ikt} = \frac{\sum_{j=1}^{J} (C_{BB,ikt_2} - C_{BB,ikt_1})}{T} \quad \textbf{(72)}$$

where:

$\Delta C_{AB,ikt}$	Annual carbon stock change in above-ground biomass for stratum *i,* stand model *k*, time *t;* t C yr^{-1}

$\Delta C_{BB,ikt}$	Annual carbon stock change in below-ground biomass for stratum *i*, stand model *k*, time *t;* t C yr^{-1}
$C_{AB,ijt2}$	Carbon stock in above-ground biomass for stratum *i*, species *j*, calculated at time $t = t_2$; t C
$C_{AB,ijt1}$	Carbon stock in above-ground biomass for stratum *i*, species *j*, calculated at time $t = t_1$; t C
$C_{BB,ijt2}$	Carbon stock in below-ground biomass for stratum *i*, species *j*, calculated at time $t = t_2$; t C
$C_{BB,ijt1}$	Carbon stock in below-ground biomass for stratum *i*, species *j*, calculated at time $t = t_1$; t C
T	Number of years between monitoring time t_2 and t_1 ($T = t_2 - t_1$); years
j	Species *j* (*J* = total number of species)

Allometric method

Step 1: Measurement will be taken of the diameter at breast height (DBH, at 1.3 m above ground) and possibly, depending on the form of the equation, height of all the trees in the permanent sample plots above a minimum DBH of 2.5 cm. When first measured all trees will be tagged to permit the tracking of individual trees in plots through time.

Where a tree has died, been harvested or cannot be found then the biomass at time t_2 should be made equal to zero to give the requisite deduction.

Step 2: Choice or establishment of appropriate allometric equations.

$$TB_{ABj} = f_j(DBH, H) \qquad \textbf{(73)}$$

where:

TB_{ABj}	Above-ground biomass of a tree; kg tree^{-1}
$f_j(DBH,H)$	An allometric equation for species *j* linking above-ground tree biomass (kg tree^{-1}) to diameter at breast height (*DBH*) and possibly tree height (*H*) measured in plots for stratum *i*, species *j*, time *t*

The allometric equations are mostly local-derived and species-specific (Table D1.1). When allometric equations are not available, the default equations given for biome-wide database, such as those in Annex 4A.2, Tables 4.A.1 and 4.A.2 of IPCC GPG LULUCF, is being used (Table D1.1). In case species specific equations are available at the time of monitoring, it will be chosen over the default values adopted for some of the species.

Step 3: Estimation will be done of the carbon stock in above-ground biomass per tree using selected allometric equations applied to the tree measurements in Step 1

$$TC_{ABj} = TB_{ABj} \cdot CF_j \qquad \textbf{(74)}$$

where:

TC_{AB}	Carbon stock in above-ground biomass per tree; kg C tree^{-1}

TB_{ABj}	Above-ground biomass of a tree of species *j*; kg tree^{-1}
CF	Carbon fraction (IPCC default value = 0.5); t C (t d.m.)$^{-1}$

Step 4: Increment of above-ground biomass carbon accumulation at the tree level: Will be calculated by subtracting the biomass carbon at time 2 from the biomass carbon at time 1 for each tree.

$$\Delta TC_{ABjT} = TC_{ABj,t2} - TC_{ABj,t1} \quad \textbf{(75)}$$

where:

ΔTC_{ABjT}	Carbon stock change in above-ground biomass per tree of species *j* between two monitoring events; kg C tree^{-1}
$\Delta TC_{ABj,t2}$	Carbon stock change in above-ground biomass per tree of species *j* at monitoring event t_2; kg C tree^{-1}
$\Delta TC_{ABj,t1}$	Carbon stock change in above-ground biomass per tree of species *j* at monitoring event t_1; kg C tree^{-1}

Step 5: Calculation of the increment in above-ground biomass carbon per plot on a per area basis: Will be calculated by summing the change in biomass carbon per tree within each plot and multiplying by a plot expansion factor which is proportional to the area of the measurement plot. This is divided by 1,000 to convert from kg to t.

$$\Delta PC_{ABikT} = \frac{XF \cdot \sum_{tr=1}^{TR} \Delta TC_{ABjT,tr}}{1000} \quad \textbf{(76)}$$

$$XF = \frac{10{,}000}{AP} \quad \textbf{(77)}$$

where:

$\Delta PC_{AB,ijT}$	Plot level carbon stock change in above ground biomass in stratum *i*, species *j*, between two monitoring events; t C ha^{-1}
ΔTC_{ABjT}	Carbon stock change in above-ground biomass per tree of species *j* between two monitoring events; kg C tree^{-1}
XF	Plot expansion factor from per plot values to per hectare values
AP	Plot area; m^2
tr	Tree (*TR* = total number of trees in the plot)

Step 6*:* Calculation of mean carbon stock change within each stratum: Will be calculated by averaging across plots in a stratum or stand:

$$\Delta MC_{ABikT} = \frac{\sum_{pl=1}^{PL_{ik}} \sum_{j}^{J} \Delta PC_{ABikT,pl}}{PL_{ik}} \quad \textbf{(78)}$$

where:

ΔMC_{ABikT} Mean carbon stock change in above-ground biomass in stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1}.

ΔPC_{ABijT} Plot level mean carbon stock change in above-ground biomass in stratum *i*, species *j*, between two monitoring events; t C ha^{-1}.

pl Plot number in stratum *i*, species *j*; dimensionless

PL_{ik} Total number of plots in stratum *i*, stand model *k*; dimensionless

j Species *j* (*J* = total number of species)

Step 7: Estimate carbon stock in below-ground biomass: This will be done by using root-shoot ratios to the above-ground carbon stock and apply Steps 4 and 5 described above to below-ground biomass.

$$TC_{BBj} = TC_{ABj} \cdot R_j \qquad \textbf{(79)}$$

$$\Delta TC_{BBjT} = TC_{BBj,t2} - TC_{BBj,t1} \qquad \textbf{(80)}$$

$$\Delta PC_{BB,ikT} = \frac{XF \cdot \sum_{tr=1}^{TR} \Delta TC_{BBjT}}{1000} \qquad \textbf{(81)}$$

$$\Delta MC_{BB,ikT} = \frac{\sum_{pl=1}^{PL_{ik}} \Delta PC_{BBikT,pl}}{PL_{ik}} \qquad \textbf{(82)}$$

where:

TC_{BBj} Carbon stock in below-ground biomass per tree of species *j*; kg C tree^{-1}

TC_{ABj} Carbon stock in above-ground biomass per tree of species *j* as calculated in Step 1; kg C tree^{-1}

R_j Root-shoot ratio appropriate to increments for species *j*; dimensionless

ΔTC_{BBjT} Carbon stock change in below-ground biomass per tree of species *j* between two monitoring events; kg C tree^{-1}

$\Delta PC_{BB,\ ijT}$ Plot level carbon stock change in below-ground biomass of species *j* between two monitoring events; t C ha^{-1}

XF Plot expansion factor from per plot values to per hectare values (see equation 77); dimensionless

tr Tree (*TR* = total number of trees in the plot)

ΔMC_{BBikT} Mean carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1}

ΔPC_{BBikT} Plot level carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1} *pl* = plot number in stratum *i*, stand model *k*; dimensionless

PL_{ik} Total number of plots in stratum *i*, stand model *k*; dimensionless

Step 8: Calculation of the annual carbon stock change will be by dividing the carbon changes between two monitoring events by the number of years between monitoring events.

$$\Delta MC_{ABikt} = \frac{\Delta MC_{ABikT}}{T} \qquad \textbf{(83)}$$

$$\Delta MC_{BBikt} = \frac{\Delta MC_{BBikT}}{T} \qquad \textbf{(84)}$$

where:

$\Delta MC_{AB,ikt}$ Annual mean carbon stock change in above-ground biomass for stratum *i*, stand model *k*, at year *t*; t C ha^{-1} yr^{-1}

$\Delta MC_{BB,ikt}$ Annual mean carbon stock change in below-ground biomass for stratum *i*, stand model *k*, at year *t*; t C ha^{-1} yr^{-1}

ΔMC_{ABikT} Mean carbon stock change in above-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1} yr^{-1}

ΔMC_{BBikT} Mean carbon stock change in below-ground biomass for stratum *i*, stand model *k*, between two monitoring events; t C ha^{-1} yr^{-1}

T Number of years between two monitoring events which in this methodology is 5 years

Step 9*:* The annual carbon stock change in living biomass for each stratum *i*, species *j*, stand model *k*, at time *t* is calculated from the area of each stratum *i*, species *j*, stand model *k*, at time *t* and the annual mean carbon stock change in above-ground biomass and below-ground biomass per unit area, given by:

$$\Delta C_{AB,ikt} = A_{ikt} \cdot \Delta MC_{AB,ikt} \qquad \textbf{(85)}$$

$$\Delta C_{BB,ikt} = A_{ikt} \cdot \Delta MC_{BB,ikt} \qquad \textbf{(86)}$$

where:

A_{ikt} Area of stratum *i*, stand model *k*, at time *t*; hectare (ha)

$\Delta C_{AB,ikt}$ Changes in carbon stock in above-ground biomass for stratum *i*, stand model *k*, at time *t*; t C yr^{-1}

$\Delta C_{BB,ikt}$ Changes in carbon stock in below-ground biomass for stratum *i*, stand model *k*, at time *t*; t C yr^{-1}

$\Delta MC_{AB,ikt}$ Annual mean carbon stock change in above-ground biomass for stratum *i*, stand model *k*, at year *t*; t C ha^{-1} yr^{-1}

$\Delta MC_{BB,ikt}$ Annual mean carbon stock change in below-ground biomass for stratum *i*, stand model *k*, at year *t*; t C ha^{-1} yr^{-1}

Table E4.1: Data to be collected and archived for actual net GHG removals by sinks

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.01	*DLP*	Desired level of precision (e.g. 10%)		%	Defined	Before the start of the project	100%	For the purpose of QA/QC and measuring and monitoring precision control
2.1.2.02	PBB_{ikt}	Average proportion of biomass burnt for stratum *i*, stand model *k*, time *t*	Measured after slash and burn	Dimensionless	m	Annually	100%	NA. Will not be measured as it is not a practice in the project area.
2.1.1.03	PL_{ID}	Sample plot ID (1, 2, 3, … pl, …)	Project and plot map, GIS	Alpha numeric	Defined	Before the start of the project	100%	Numeric series ID will be assigned to each permanent sample plot
2.1.1.04	PL_{ik}	Total number of plots in stratum *i*, stand model *k*	Field measurement	Dimensionless	m	5-year	100%	The values of total parcels will be redefined in accordance with the results obtained in ensuing monitoring activities
2.1.1.05	R_j	Root-shoot ratio	IPCC, GPG, 2006	Dimensionless	e	5 year	100% of sampling plots	Default values from the IPCC
2.1.1.06	*16/12*	Ratio of molecular weights of CH_4 and carbon;	Universal constant	Dimensionless	Universal constant			
2.1.1.07	*44/12*	Ratio of molecular weights of carbon and CO_2; dimensionless	Universal constant	Dimensionless	Universal constant			
2.1.1.08	*44/28*	Ratio of molecular weights of N_2O and nitrogen; dimensionless	Universal constant	Dimensionless	Universal constant			

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.09		Confidence level (e.g. 90%)	AR-CDM-PDD	%	Defined	Before the start of the project	100%	For the purpose of QA/QC and measuring and monitoring precision control
2.1.1.10	A	Total size of all strata (A), e.g. the total project area	GIS or/and GPS	Hectares	m	Before the start of the project and adjusted thereafter every 5-year	100%	Total of project area in accordance with the GIS database of the project
2.1.1.11	A_i	Area of each stratum	GIS or/and GPS	Hectares	m	Before the start of the project and adjusted thereafter every 5-year	100%	Participation of the area in each stratum
2.1.1.13	A_{ikt}	Area of stratum *i*, stand model *k*, at time *t*;	GIS or/and GPS	Hectares	m	Yearly	100%	Measured for different strata and stands
2.1.1.14	A_{B,ikt_sb}	Area of slash and burn in stratum *i*, stand model *k*, at time *t*	Measurement	Hectares	m	Yearly	100%	Not practiced in the project area and will not be monitored
2.1.1.15	*AP*	Sample plot area	Field measurement	m^2	m	5-year	100%	In accordance with that established in the monitoring plan
2.1.1.16	*BEF*	Biomass expansion factor (BEF)	IPCC GPG LULUCF	Dimensionless	e	5 year	100% of sampling plots	IPCC default in LULUCF GPG 2006
2.1.1.17	B_{ijt}	Average above-ground bio-mass stock before burning for stratum *i*, species *j*, time *t*	Field measurement	t d.m. ha^{-1}	m	Before burning	Sample plots	Not practiced in the project area and will not be monitored

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.18	*N/C ratio*	Nitrogen/carbon ratio	Literature	Dimensionless	e	Once per species or group of species		IPCC default value (0.01) is used if no appropriate value
2.1.1.19	$C_{AB,ijt}$	Carbon stock in above-ground biomass for stratum *i*, species *j*, time *t*	Calculations	t C	c	5-year	100%	
2.1.1.20	C_{ACTUAL}	Actual net greenhouse gas removals by sinks;	Calculations	t CO_2-e.	c	5-year	100%	
2.1.1.21	$C_{BB,ijt}$	Carbon stock in below-ground biomass for stratum *i*, species *j*, time *t*	Calculations	t C	c	5-year	100%	
2.1.1.22	*CE*	Average biomass combustion efficiency	GPG LULUCF, National inventory	Dimensionless	e	Before the start of the project	100%	IPCC default value (0.5) is used if no appropriate value
2.1.1.23	*CF*	Carbon fraction	IPCC value	t C (t d.m.)$^{-1}$	e	Once per crediting period		IPCC default = 0.5
2.1.1.24	CF_j	Carbon fraction of species *j*	GPG for LULUCF IPCC	t C (t d.m.)$^{-2}$	e	Once per species	100% of species or species group	IPCC default = 0.5
2.1.1.25	C_i	Cost of establishment of a sample plot for each stratum *i*	Measurement	US$ or local currency	m	5-years	100%	NA. It is considered a cost equal to establishment of monitoring parcels, due to close proximity between areas of the project.
2.1.1.28	*DBH*	Diameter at breast height of living trees	Plot measurement	cm (living)	m	5 year	100% trees in plots	Measuring at each monitoring time per sampling method
2.1.1.29	D_j	Wood density of species *j*	Local-derived, national inventory, IPCC GPG LULUCF	t d.m. m^{-3}	e	5 year	100% of sampling plots	Local-derived and species-specific value have the priority

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.30	D	Average wood density	Local-derived, national inventory, IPCC GPG LULUCF	t d.m. m^{-3}	e	5 year	100% of sampling plots	Local-derived and species-specific value have the priority
2.1.1.31	E	Allowable error	Calculations	Depends on the variable calculated	c	5-year	100% of the variables	Is established in accordance with the variable to be monitored and is applicable to all the variables considered.
2.1.1.32	$E_{BiomassBurn}$	Increase in GHG emission as a result of biomass burning within the project boundary	Calculations	t CO_2-e.	c	5-year	100%	NA. Will not be measured as it is not a practice in the project area.
2.1.1.33	$E_{BiomassBurn, CH4}$	CH_4 emission from biomass burning in slash and burn	Calculations	t CO_2-e.	c	5-year	100%	NA. Will not be measured as it is not a practice in the project area.
2.1.1.34	$E_{BiomassBurn, N2O}$	N_2O emission from biomass burning in slash and burn	Calculations	t CO_2-e.	c	5-year	100%	NA. Will not be measured as it is not a practice in the project area.
2.1.1.35	$E_{BiomassBurn,CO2}$	CO_2 emission from biomass burning in slash and burn	Calculations	t CO_2-e.	c	5-year	100%	NA. Will not be measured as it is not a practice in the project area.
2.1.1.40	ER_{N20}	Emission ratio for N_2O	Literature	Dimensionless	e	Yearly		(IPCC default = 0.007)
2.1.1.41	ER_{CH4}	Emission ratio for CH_4	Literature	Dimensionless	e	Yearly		(IPCC default = 0.012)
2.1.1.42	$f_j(DBH,H)$	Allometric equation for species *j* linking above-ground tree biomass (kg $tree^{-1}$) to diameter at breast height (DBH) and possibly tree height (H) measured in plots for stratum *i*, species *j*, time *t*	Literature and/or field measurements	kg $tree^{-1}$	m-e-c	Once per species	for all major species or group of species	Use local/global equations validated for local conditions

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.46	GHG_E	Increase in GHG emission as a result of the implementation of the proposed A/R CDM project activity within the project boundary	Calculations	t CO_2-e	c	5-year	100%	
2.1.1.47	GWP_{CH4}	Global Warming Potential for CH_4	IPCC literature - EB decisions		e	Once per commitment period		(IPCC default = 21)
2.1.1.48	GWP_{N2O}	Global Warming Potential for N_2O	IPCC literature - EB decisions		e	Once per commitment period		(IPCC default = 310)
2.1.1.49	H_{ijt}	Annually harvested volume and fuel wood for stratum *i*, species *j*, at time *t*	Harvesting statistics	m^3	c	Annually	100% stands	No harvesting takes place. If any will be recorded.
2.1.1.50	i_{ID}	Stratum *i*D (1, 2, 3, … m_{SP} project scenario (*ex post*) strata)	Stand map, GIS	Alpha numeric	Defined	At stand establishment	100%	Each stand has a particular year *to* be planted under each stratum
2.1.1.51	ID_{ikt}	Stand ID	Stand map, GIS	Alpha numeric	Defined	At stand establishment	100%	Each stand has a particular year *to* be planted under each stratum
2.1.1.52	*lat/long*	Plot location	Project and plot map and GPS locating, GIS		m	5 years	100%	Using GPS to locate before start of the project and at time of each field measurement
2.1.1.53	$MC_{AB,ijt}$	Mean carbon stock in above-ground biomass per unit area for stratum *i*, species *j*, time *t*	Calculations	t C ha^{-1}	c	5-year	100%	
2.1.1.54	$MC_{BB,ijt}$	Mean carbon stock in below-ground biomass per unit area for stratum *i*, species *j*, time *t*	Calculations	t C ha^{-1}	c	5-year	100%	

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.55	MV_{ijt}	Mean merchantable volume per unit area for stratum *i*, species *j*, time *t*		$m^3\ ha^{-1}$	m^3	5 year	100% of sampling plots	Calculated from 2.1.1.13 and possibly 2.1.1.15 using local-derived equations, or directly measured by field instrument
2.1.1.56	N	Maximum possible number of sample plots in the project area	Calculations	Dimensionless	c	5-years	100%	Will be re-evaluated in the first monitoring period to determine changes in the number of established parcels
2.1.1.57	n	Sample size (total number of sample plots required) in the project area	Calculations	Dimensionless	c	5-years	100%	
2.1.1.58	N_i	Maximum possible number of sample plots in stratum *i*	Calculations	Dimensionless	c	Before the start of the project and adjusted thereafter every 5-year	100%	
2.1.1.59	n_i	Sample size for stratum *i*	Calculations	Dimensionless	c	Before the start of the project and adjusted thereafter every 5-year	100%	Calculated for each stratum
2.1.1.64	nTR_{PLikt}	Number of trees in the sample plot	Plot measurement	Number	m	5 years	100% trees in plots	Counted in plot measurement
2.1.1.66	DLP	Desired level of precision (e.g. 10%)		%	Defined	Before the start of the project	100%	For the purpose of QA/QC and measuring and monitoring precision control
2.1.1.69	PL_{ID}	Sample plot ID (1, 2, 3, … pl, …)	Project and plot map, GIS	Alpha numeric	Defined	Before the start of the project	100%	Numeric series ID will be assigned to each permanent sample plot

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.70	PL_{ik}	Total number of plots in stratum *i*, stand model *k*	Field measurement	Dimensionless	m	5-year	100%	
2.1.1.71	R_j	Root-shoot ratio	Local-derived, national inventory	Dimensionless	e	5 year	100% of sampling plots	Local-derived and species-specific value have the priority
2.1.1.72	st_i	Standard deviation for each stratum *i*; dimensionless			e	At each monitoring event	100%	Used for estimating numbers of sample plots of each stratum and stand, as necessary
2.1.1.73	TB_{ABj}	Above-ground biomass of a tree	Calculations	kg dry matter $tree^{-1}$	c	5-year	100%	
2.1.1.74	TC_{ABj}	Carbon stock in above-ground biomass per tree of species *j*	Calculations	kg C $tree^{-1}$	c	5-year	100%	
2.1.1.75	tID	Age of plantation (1, 2, 3, … years)	GIS	year	m	At stand establishment	100%	Counted since the planted year
2.1.1.76	tr_{ID}	Tree ID (1, 2, 3, … tr … TR = total number of trees in the plot)	Field measurement	Dimensionless	m	5-year	100%	
2.1.1.77	XF	Plot expansion factor from per plot values to per hectare values)	Calculations	Dimensionless	c	5-year	100%	
2.1.1.78	$z_{\alpha/2}$	Value of the statistic z (normal probability density function), for $\alpha = 0.1$ (implying a 90% confidence level)	Statistic book	Dimensionless	m	5-years	0%	
2.1.1.79	$\Delta C_{AB,ijt}$	Annual carbon stock change in above-ground biomass for stratum *i*, species *j*, time *t*;	Calculations	t C yr^{-1}	c	5-year	100%	

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.80	$\Delta C_{AB,ikt}$	Annual carbon stock change in above-ground biomass for stratum *i*, stand model *k*, time *t*;	Calculations	t C yr^{-1}	c	5-year	100%	
2.1.1.81	$\Delta C_{BB,ijt}$	Annual carbon stock change in below-ground biomass for stratum *i*, species *j*, time *t*;	Calculations	t C yr^{-1}	c	5-year	100%	
2.1.1.82	$\Delta C_{BB,ikt}$	Annual carbon stock change in below-ground biomass for stratum *i*, stand model *k*, time *t*;	Calculations	t C yr^{-1}	c	5-year	100%	
2.1.1.83	$\Delta C_{LB,ikt}$	Annual carbon stock change in living biomass for stratum *i*, stand model *k*, time *t*	Calculations	t CO_2-e. yr^{-1}	c	5-year	100%	
2.1.1.84	$\Delta C_{P,LB}$	Sum of the changes in living biomass carbon stocks (above- and below-ground)	Calculations	t CO_2-e	c	5-year	100%	
2.1.1.85	ΔMC_{ABikT}	Mean carbons stock change in above-ground biomass stratum *i*, stand model *k*, between two monitoring events	Calculations	t C ha^{-1}	c	5-year	100%	
2.1.1.86	ΔMC_{ABikt}	Mean carbons stock change in above-ground biomass stratum *i*, stand model *k*, between two monitoring events	Calculations	t C ha^{-1}	c	5-year	100%	

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
2.1.1.87	$\Delta MC_{BB,ikt}$	Mean carbons stock change in below-ground biomass stratum *i*, stand model *k*	Calculations	t C ha^{-1}	c	5-year	100%	
2.1.1.88	ΔMC_{BBikT}	Mean carbons stock change in below-ground biomass stratum *i*, stand model *k*, between two monitoring events	Calculations	t C ha^{-1}	c	5-year	100%	
2.1.1.89	$\Delta PC_{AB,ijT}$	Plot level mean carbon stock change in above-ground biomass ins stratum *i*, species *j* between two monitoring events	Calculations	t C ha^{-1}	c	5-year	100%	
2.1.1.90	$\Delta PC_{BB,ijT}$	Plot level mean carbon stock change in above-ground biomass in stratum *i*, species *j* between two monitoring events	Calculations	t C ha^{-1}	c	5-year	100%	
2.1.1.91	ΔTC_{ABjt}	Carbon stock change in above-ground biomass per tree of species *j* in year *t*	Calculations	kg C tree^{-1}	c	5-year	100%	
2.1.1.92	ΔTC_{ABjT}	Carbon stock change in above-ground biomass per tree of species *j* between two monitoring events	Calculations	kg C tree^{-1}	c	5-year	100%	
2.1.1.93	ΔTC_{BBjt}	Carbon stock change in below-ground biomass per tree of species *j* in year *t*	Calculations	kg C tree^{-1}	c	5-year	100%	
2.1.1.94	ΔTC_{BBjT}	Carbon stock change in below-ground biomass per tree of species *j* between two monitoring events	Calculations	kg C tree^{-1}	c	5-year	100%	

E.4.2. Data to be collected in order to monitor the GHG emissions by the sources, measured in units of CO_2 equivalent, that are increased as a result of the implementation of the proposed A/R CDM project activity within the project boundary:

Estimation of the increase in emissions

The increase in GHG emission as a result of the implementation of the proposed A/R CDM project activity within the project boundary is due to biomass burning due to slash and burning. In the project area, biomass burning is not a practice.

E.5. Leakage:

Leakage represents the increase in GHG emissions by sources which occurs outside the boundary of an A/R CDM project activity which is measurably attributable to the A/R CDM project activity.

Leakage represents an increase in GHG emissions by emitting sources in areas located outside the project boundary, as a result of the implementation of A/R-CDM activities. This leakage must be measurable and quantifiable. The Bagepalli Reforestation project does not promote the displacement of agricultural and pasturage activities carried on in the areas where tree planting is anticipated to take place. The project only anticipates the temporary displacement of pasturage activities in negligible or insignificant quantities. Summer grazing happens for only 3 months and takes place only in 50% of the lands. The displacement is further reduced as nearly 60% of the farmers will be planting only on half of their land holding, wherein the other lands in their custody will continue to provide the requirements. After 3-4 years of establishment, the grass productivity will be higher than in the baseline scenario, providing more than that in the baseline. The agricultural activities carried on will be as explained in section D.2,

In fact what is termed "negative leakage" will occur. This is because some of the proposed A/R CDM project area is presently under soil and water conservation, under the dryland development programme by ADATS. Most of the land used for reforestation is degraded and uncultivable private farm land unfit for productive cultivation. The economical unattractive land currently does not support agriculture, grazing, and is not a major source for fuelwood. PRA exercises at village level show that nearby forests and common lands are the main sources of fuelwood. As a result of the project there will be a huge increase in on-farm fuelwood. Biogas is being promoted in a massive scale (23,500 Numbers) due to the presence of 2 biogas CDM projects. Also since the existing baseline trees will be retained, it will continue to provide the existing services. Participating farmers and probably others too will be able to collect fuel form within the project boundary without compromising the growth of the trees established under the proposed A/R CDM project activity. The collection will be restricted to dead wood and branches. Thus, as the result of the proposed A/R CDM project activity, local farmers will in fact have fallen twigs and branches as fuelwood and will not have to collect fuelwood on lands outside the project boundary.

E.5.1. If applicable, please describe the data and information that will be collected in order to monitor leakage of the proposed A/R CDM project activity:

Table E5.1: Data to be collected and archived for leakage

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
3.1.01	*44/12*	Ration of molecular weights of carbon and CO_2; dimensionless	Universal constant	Dimensionless	Universal constant			
3.1.02	aLK_{NGL}	Average leakage due to conversion of non-grassland to grassland per displaced animal in *NGL* areas	AR-CDM-PDD	t CO_2 -e. animal^{-1}	c - e	*Ex ante* in AR-CDM-PDD	SFR_{NGL}	NA. No leakage and not estimated
3.1.03	aLK_{XGL}	Average leakage due to conversion of non-grassland to grassland per displaced animal in *XGL* areas	AR-CDM-PDD	t CO_2 -e. animal^{-1}	c - e	*Ex ante* in AR-CDM-PDD		NA. No leakage and not estimated
3.1.05	BEF_2	Biomass expansion factor (BEF)	Local-derived, national inventory, IPCC GPG LULUCF	Dimensionless	e	5 year	100% of sampling plots	Local-derived and species-specific value have the priority (IPCC default in LULUCF GPG 2003, Table 3A.1.10)
3.1.06	*C*	Community index (*C*=total number of communities)		Dimensionless	Defined	Years 0, 1 and 5		NA. No leakage and not estimated

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
3.1.07	CF_j	Carbon fraction of dry matter of species *j*	Literature, own studies	t C (t d.m.)$^{-1}$	e	Once per species or group of species	100%	Local/national data or IPCC default (= 0.5)
3.1.08	CS_i	Locally derived carbon stock of identified lands (including all five eligible carbon pools) of stratum *i*	Field measurement	t CO_2-e. ha^{-1}	m	Years 0, 1 and 5		NA. No leakage and not estimated
3.1.09	$\overline{CS}$	Locally derived average carbon stock of unidentified lands (including all five eligible carbon pools)	Field measurement	t CO_2-e. ha^{-1}	m	Years 0, 1 and 5		NA. No leakage and not estimated
3.1.11	*Dj*	Wood density of species *j*	Local-derived, national inventory, IPCC GPG LULUCF	t d.m. m^{-3}	e	5 year	100% of sampling plots	Locally derived and species-specific value have the priority
3.1.12	dNa_{EGLt}	Number of animals displaced in *EGL* areas at time *t*	Calculations	Dimensionless	c	Yearly	100%	NA. No leakage and not estimated
3.1.13	dNa_{NGLt}	Number of animals displaced in *NGL* areas at time *t* – as estimated in Step 4	Calculations	Dimensionless	c	Yearly	100%	NA. No leakage and not estimated
3.1.14	dNa_{XGLt}	number of animals displaced in *XGL* areas at time *t* – as estimated in Step 4	Calculations	Dimensionless	c	Yearly	100%	NA. No leakage and not estimated

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
3.1.17	$FG_{AR,t}$	Volume of fuel-wood gathered in the project area according to monitoring results	Field sampling	$m^3\ yr^{-1}$	m	Yearly	SFR_{PAfw}	NA. No leakage and not estimated
3.1.18	FG_{BL}	Average pre-project annual volume of fuel-wood gathering in the project area – estimated *ex ante* and specified in the AR-CDM-PDD	AR-CDM-PDD	$m^3\ yr^{-1}$	c - e	*Ex ante* in AR-CDM-PDD		NA. No leakage and not estimated
3.1.19	$FG_{NGL,t}$	Monitored volume of fuel-wood gathering in *NGL* areas and supplied to pre-project fuel-wood collectors and/or charcoal producers – as per Step 2	Field measurements	$m^3\ yr^{-1}$	m	Yearly	SFR_{NGL}	Will not be monitored as leakage not considered
3.1.20	$FG_{outside,t}$	Volume of fuel-wood gathering displaced outside the project area at year *t* – as per Step 1	Calculations	$m^3\ yr^{-1}$	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.21	FG_t	Volume of fuel-wood gathering displaced in unidentified areas	Calculations	$m^3\ yr^{-1}$	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.24	*hh*	Household index (*Hh*=total number of households)			Defined	Years 0, 1 and 5		Will not be monitored as leakage not considered
3.1.25	*I*	Strata index (*S*=total number of strata)		Dimensionless	Defined	Years 0, 1 and 5		Will not be monitored as leakage not considered

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
3.1.26	IAC_{hi}	Identifiable areas converted by household *hh* in stratum *I*	Field measurement	ha	m	Years 0, 1 and 5	10% or at least 30 households	Will not be monitored as leakage not considered
3.1.27	IAC_{hci}	Identifiable areas converted of stratum *i*, by household *hh* in community *c*	Field measurement	ha	m	Years 0, 1 and 5	10% or at least 30 households	Will not be monitored as leakage not considered
3.1.29	LK	Total project leakage	Calculations	t CO_2-e.	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.30	$LK_{fuel\text{-}wood}$	Leakage due to the displacement of fuel-wood collection	Calculations	t CO_2-e.	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.31	$LK_{ActivityDisplacement}$	Leakage due to activity displacement	Calculations	t CO_2-e.	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.32	$LK_{conversion}$	Leakage due to conversion of forest to non-forest; t CO_2-e.	Calculations	t CO_2-e.	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.33	$LK_{conv\text{-}graz}$	Leakage resulting from the conversion for grazing	Calculations	t CO_2-e.	c	Yearly		Will not be monitored as leakage not considered
3.1.34	$LK_{conv\text{-}crop}$	Leakage resulting from the conversion for cropland	Calculation	t CO_2-e.	c	Years 0, 1 and 5	10% or at least 30 households or 10% of communities (or at least 10), 10% of households per community or at least 10	Will not be monitored as leakage not considered

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
3.1.35	$LK_{conv\text{-}crop,c}$	Leakage due to conversion of land to cropland attributable to displacement (activity shifting) in community c	Calculation	t CO_2-e.	c	Years 0, 1 and 5	10% of communities (or at least 10), 10% of households per community or at least 10	Will not be monitored as leakage not considered
3.1.37	LK_{NGL}	Leakage due to conversion of non-grassland to grassland in NGL areas	Calculations	t CO_2-e.	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.42	LK_{XGL}	Leakage due to conversion of non-grassland to grassland in *XGL* areas	Calculations	t CO_2-e.	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.43	$Na_{AR,t}$	Monitored number of animals present in the project area at year *t*	Field measurements	Dimensionless	m	Yearly	SFR_{PAga}	Will not be monitored as leakage not considered
3.1.44	Na_{BL}	Eex *ante* estimated pre-project number of animals from the different livestock groups that would be grazing in the project area under the baseline scenario	AR-CDM-PDD	Dimensionless	e	*Ex ante* in AR-CDM-PDD	SFR_{PAga}	Will not be monitored as leakage not considered
3.1.45	$Na_{EGL,t}$	Number of animals present in the sampled *EGL* areas at time *t*	Field measurements	Dimensionless	m	Yearly	SFR_{EGL}	Will not be monitored as leakage not considered
3.1.46	$Na_{EGL,t=1}$	Number of animals present in the sampled *EGL* areas at time *t*=1, as specified in the AR-CDM-PDD	AR-CDM-PDD	Dimensionless	c - e	*Ex ante* in AR-CDM-PDD		Will not be monitored as leakage not considered

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
3.1.47	$Na_{NGL,t}$	Number of animals present in the sampled *NGL* areas at time *t*	Field measurements	Dimensionless	m	Yearly	SFR_{NGL}	Will not be monitored as leakage not considered
3.1.48	$Na_{NGL,t=1}$	Number of animals present in the sampled NGL areas at time *t*=1, as specified in the AR-CDM-PDD	AR-CDM-PDD	Dimensionless	c - e	*Ex ante* in AR-CDM-PDD		Will not be monitored as leakage not considered
3.1.49	$Na_{outside,t}$	Number of animals displaced outside the project area at year *t*	Calculations	Dimensionless	c	Yearly	100%	Will not be monitored as leakage not considered
3.1.52	*SF*	Sampling factor of household *hh*	Calculations	Dimensionless	c	Years 0, 1 and 5	10% or at least 30 households	Will not be monitored as leakage not considered
3.1.53	SF_c	Sampling factor of household *c*	Calculations	Dimensionless	c	Years 0, 1 and 5	10% or at least 30 households	Will not be monitored as leakage not considered
3.1.54	SFR_{EGL}	Fraction of sampled *EGL* areas sampled with respect to total	CDM-AR-PDD	Dimensionless	Defined using statistical criteria	*Ex ante* in AR-CDM-PDD		Will not be monitored as leakage not considered
3.1.55	SFR_{NGL}	Fraction of sampled *NGL* areas sampled with respect to total	CDM-AR-PDD	Dimensionless	Defined using statistical criteria	*Ex ante* in AR-CDM-PDD		Will not be monitored as leakage not considered
3.1.56	SFR_P	Fraction of sampled project areas sampled fencing posts	CDM-AR-PDD	Dimensionless	Defined using statistical criteria	*Ex ante* in AR-CDM-PDD		Will not be monitored as leakage not considered

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
3.1.57	SFR_{PAfw}	Fraction of sampled project areas sampled for fuel-wood collection	CDM-AR-PDD	Dimensionless	Defined using statistical criteria	*Ex ante* in AR-CDM-PDD		Will not be monitored as leakage not considered
3.1.58	SFR_{PAga}	Fraction of sampled project areas sampled for grazing animals	CDM-AR-PDD	Dimensionless	Defined using statistical criteria	*Ex ante* in AR-CDM-PDD		Will not be monitored as leakage not considered
3.1.59	*SHH*	Sampled households, number of households	Field measurement	Dimensionless	Defined	Year 0	10% or at least 30 households	Will not be monitored as leakage not considered
3.1.60	SHH_c	Sampled households in community *c*	Field measurement	Dimensionless	Defined	Year 0	10% of communities (or at least 10), 10% of households per community or at least 10	Will not be monitored as leakage not considered
3.1.61	*TACP*	Total area of land on which pre-project activities were displaced due to project activities	Field measurement	ha	m	Year 0	10% or at least 30 households	Will not be monitored as leakage not considered
3.1.62	$TACP_c$	Total area of cropland planted that is owned by community *c*	Field measurement	ha	m	Year 0	10% of communities (or at least 10), 10% of households per community or at least 10	Will not be monitored as leakage not considered
3.1.63	$TACP_h$	Total area of cropland planted that is owned by household *hh*	Field measurement	ha	m	Year 0	10% or at least 30 households	Will not be monitored as leakage not considered

ID number	Data Variable		Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Proportion of data monitored	Comment
3.1.64	*TNHH*	Total number of households using project lands in baseline	Field measurement	Dimensionless	Defined	Year 0	10% or at least 30 households	Will not be monitored as leakage not considered
3.1.65	$TNHH_c$	Total number of households inc community *c* using project lands in baseline	Field measurement	Dimensionless	Defined	Year 0	10% of communities (or at least 10), 10% of households per community or at least 10	Will not be monitored as leakage not considered

E.5.2. Specify the procedures for the periodic review of implementation of activities and measures to minimize leakage, if required by the selected approved methodology:

In case of displacement of the grazing and agricultural activities, as well as firewood collection from the tree stands, no leakage is expected to occur due to the project implementation strategies, as mentioned below.

Grazing and plantation activity

Cattle will be rotated towards large low-density grazing areas, endeavouring to remain below the optimal occupation for the regional conditions. In this respect, as demonstrated in Section D.2., outside the project boundary, there are adequate areas to carry out this rotation without having to resort to a change of land cover, or to the elimination of tree vegetation. Subsequently, the cattle will be gradually incorporated into the plantation area when the trees are sufficiently developed to support their presence. Therefore, there will be no displacement of this activity due to the project implementation.

Fuelwood collection

There will be no leakage as the baseline trees will continue to be there. Also the establishment of 23,500 biogas units in these 5 taluks under 2 CDM projects has decreased the pressure on not only the existing lands but also on the forests. As of now, 2801 (34.61%) of the families have been provided biogas units under the two CDM Biogas Projects. Under the ongoing, BCS Biogas CDM Project, biogas will be provided to as many families under this project. Periodic review will be conducted to ensure that as many families are provided with biogas units. In addition, improved cookstoves will also be provided. Periodic review will be conducted to assess the extent of biogas units and improved cookstoves that will be provided to the families.

E.6. Provide any additional quality control (QC) and quality assurance (QA) procedures undertaken for data monitored not included in section E.1.3:

Data *(Indicate ID number)*	**Uncertainty level of data (High/Medium/Low)**	**Explain QA/QC procedures planned for these data, or why such procedures are not necessary.**
4.1.1.01 Plot location	Low	Random plot verification using GPS to ensure the consistent measuring and monitoring of carbon stock change over time
4.1.1.02 tree species	Low	Random verification over the project area to ensure each tree species is correctly measured
4.1.1.03 age of plantation	Low	Random verification over the project area to ensure the area in terms of plantation age is correctly measured
4.1.1.04 number of trees	Low	Random plot verification
4.1.1.5 diameter at breast height (DBH)	Low	Random plot verification
4.1.1.6 tree height	Low	Random plot verification
4.1.1.7 Merchantable volume	Low	All allometric equations used to calculate this data will be verified

4.1.1.8 wood density	Low	Data that divert significantly from IPCC default value will be verified
4.1.1.9 Biomass expansion factor (BEF)	Low	Data that divert significantly from IPCC default value will be verified
4.1.1.10 Carbon fraction	Low	Data that divert significantly from IPCC default value will be verified
4.1.1.11 Root-shoot ratio	Low	Data that divert significantly from IPCC default value will be verified

E.7. Please describe the operational and management structure(s) that the project operator will implement in order to monitor actual GHG removals by sinks and any leakage generated by the proposed A/R CDM project activity:

A. The Project Director of ADATS will be responsible for coordinating the Programme;

B. The project implementation is based on the Coolie Sangha Units (CSU) in each village. These CSUs are non-governmental organizations consisting of members of the public owning small parcels of marginal degraded lands who have joined the CSUs and are implementing reforestation on their degraded lands. The main role of the CSUs is to manage the reforestation activity in their villages and clusters in close cooperation with ADATS. The CSUs have in the past implemented the Dry Land Development Programme (DLDP) and have management systems in place for coordinating the Bagepalli CDM Reforestation Programme work. The CSUs are organized formally at village levels, with CSU management through the federal Coolie Sangha structure in each talk. The CSUs are part of the federal structure of the Bagepalli Coolie Sangha which is officially registered, and is overseen by elected members.

C. The CSUs will be responsible for:

- planting, tending of the trees
- annual reporting of tree counts
- doing the first survival monitoring
- dissemination of information on project implementation and best practices to all CSUs
- coordination with all involved parties on project financing and supervision.
- managing day to day activities of the project implementation, coordination of the project monitoring plan, including verification and reporting.
- implementation of the Emission Monitoring Plan (EMP) and annual monitoring of the project progress and measure the impact of project activities against the baseline survey undertaken during project preparation.
- systematic analysis of the project activities and the results of the monitoring activities, which will be fed back into the implementation process.
- sustainability of the project reforestation activities through strengthening of the forestry management practices;
- project co-ordination and knowledge management of project activities.
- inventory and mapping of every sector with the use of GPS and GIS;
- supervision of project stipulations, plantation technique and technologies.
- establishment of polygons and methodologies concerning the necessary measurements within the project area.
- carrying out of project monitoring at initial phase, and after that in year V, X and XV;
- verification of inventories of plantations;

- preparation of annual reports;
- formulation of recommendations for re-addressing and improvements of works (reparation, maintenance, assurance of integrity etc.);
- preparation of recommendations concerning the management of new created forests;
- preparing and carrying out workshops and training within the project.

Any activity data and monitoring and measuring data will be reported to and archived in the ADATS offices in both electronic and paper copy.

E. District forestry offices will provide technical instruction and support on reforestation and forest management.
F. An expert team will be established if any technical issues will arise, conducting checking and verification of measured and monitored data.
G. Leakage will not be monitored.

E.8. Name of person(s)/entity(ies) applying the monitoring plan:

Ram Esteves, Project Director, Agricultural Development and Training Society Bagepalli 561207, Chickballapur District, Karnataka, India.

The entity is the project participant listed in Annex 1.

SECTION F. Environmental impacts of the proposed A/R CDM project activity:

F.1. Documentation on the analysis of the environmental impacts, including impacts on biodiversity and natural ecosystems, and impacts outside the project boundary of the proposed A/R CDM project activity:

- Afforestation and reforestation activities can have negative impacts on biodiversity, if taken up in forest ecosystems with already existing biodiversity value. Conversely, if planting is being promoted on land that is degraded or with no trees, it will have a positive impact on biodiversity.
- Trees have a longer growing season, more foliage and deeper roots than crops. Runoff from forested catchments is therefore generally lower than from those other land uses[61]. Properly planned and managed, plantation development can contribute to more sustainable land use in rural areas by providing substantial environmental, social and economic benefits with little impact on water availability[61]. According to an overview article on impact of plantation on water[62], afforestation activities on downstream effects on water resources security and river ecosystem health are generally likely to be small unless the area afforested is large. The project activity is of an average of 0.72 ha in 12,347 discrete plots. Thus it is not a continuous planting block to impact groundwater. In some cases, afforestation may increase groundwater recharge and low flows due to improved infiltration. Depending on the level of degradation of agricultural land, well designed, located and managed forestry can reduce the volume of sediment, nutrients and salt volumes transported into river systems. Afforestation may reduce shallow land slides and local ‘flash’ floods. Afforestation may influence precipitation patterns at local to regional scales by changing surface-atmosphere transfers of heat and moisture. According to IIstedt *et al*., 2007[63], based on meta analysis of many studies, afforestation on agriculture land increases infiltration capacity approximately three-folds (95% confidence interval: 2.4–4.7). Soil water infiltration influences groundwater recharge and potential top soil loss by erosion, as well as the partitioning of runoff into slow flow and quick flow.
- Forestry on degraded lands without any trees on them has a positive impact on biodiversity, regeneration of vegetative cover through leading to soil and water conservation and protection of watersheds, and increased supply of biomass, which is essential as sustainable development issues of mitigation projects.
- Among the many environmental services they provide, the most critical places are soil conservation i.e. protection against erosion and maintenance of fertility, shelter against wind and shade.
- Decreases vulnerability to current climate change and climatic variability
- Forestry on these degraded lands will enrich the soil by fixing nitrogen, improve drainage, promote efficient nutrient cycling, opportunity to optimise land productivity and diversity in output to meet domestic needs and improving economy of farmers.
- The project area is devoid of trees in most on the parcels of lands. A few parcels of land have trees on the bunds which are mature and these trees will not be uprooted. Thus the disturbance to soil will be limited.
- The species proposed are native to the region.

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[61] http://www.acera.unimelb.edu.au/materials/brochures/SDM-PlantationsWater.pdf

[62] Overview, Planted forests and water in perspective. Forest Ecology and Management 251 (2007) 1–9.

[63] Ulrik Ilstedt, Anders Malmer, Elke Verbeeten, Daniel Murdiyarso. The effect of afforestation on water infiltration in the tropics: A systematic review and meta-analysis. Forest Ecology and Management 251 (2007) 45–51

- Since the planting will be done is discrete parcels of land, fire and pests are not a serious threat. Most forest fires in plantations are caused by arson; only a few by lightning or encroachment of fires from neighbouring land. It is more often due to poor community relationships than any inherent shortcoming with forest plantations[64]. Pests and diseases occur when there is extensive planting of one species, large-scale planting programmes and exotics are used[65]. This project activity is of many small discrete plots with planting of native species.

F.2. If any negative impact is considered significant by the project participants or the host Party, a statement that project participants have undertaken an environmental impact assessment, in accordance with the procedures required by the host Party, including conclusions and all references to support documentation:

No significant negative impacts have been envisaged by the project activity. The project has received host country approval by the Indian National CDM Authority, hosted by the Ministry of Environment and Forests.

F.3. Description of planned monitoring and remedial measures to address significant impacts referred to in section F.2. above:

Not required as no significant impacts are projected.

SECTION G. Socio-economic impacts of the proposed A/R CDM project activity:

G.1. Documentation on the analysis of the major socio-economic impacts, including impacts outside the project boundary of the proposed A/R CDM project activity:

In a semi-arid, water scarce, poverty stricken region like this, the CDM A/R project activity which pays families to work on their land is extremely necessary, in fact life saving. It is a global environmental service activity which also generates substantial local benefits in terms of employment and income, and natural resource conservation.

Social impact

Local Communities of the project area are small and poor peasant families (landed or landless agricultural labourers who do not themselves employ wage labour) are the members of village Coolie Sangha Units (CSUs). The project expects to improve the living conditions of the local communities and the populations outside the direct area of influence of the project. The project will generate efficient land use systems than the current production models. The land tenure will remain as privately owned land by the famers who will be beneficiary of the project activity and the lCERs from their land. Employment will be created as a consequence of the many actual and future productive activities. Food production will not be affected, as these lands are of low agriculture productivity. Also over the years, the trend has been a decrease in agricultural area and increase in fallow lands. Also there has been an increased trend in migration of rural communities to urban areas for job opportunities. Thus this project activity will provide economic returns to the future generations. The project activity will not impact any of the cultural and religious sites as it is being done on privately owned discrete lands averaging 0.72 ha/beneficiary. The project activity will not impact fuelwood or NTFP collection outside the project boundary. The access to

[64] http://www.fao.org/docrep/004/ac122e/ac122e03.htm

[65] http://www.cifor.cgiar.org/publications/pdf_files/Books/Nair.pdf

community property resources for available fuelwood and NTFP will continue for all the households in the village.

Job creation
The major sources of employment in the region are agriculture, dairy, sericulture and floriculture. Farmers are totally dependent upon borewell water for irrigation and drinking. All forestry sector activities are labour-intensive and create rural employment in establishing, protecting and maintaining trees and also provide diverse biomass products. Thus, activities aimed at carbon sink creation or enhancement and in turn forest conservation and regeneration of degraded forests and non-forests will lead to improvement of the livelihoods. Given the social conditions that have historically characterized the region, the project will attract resources to invigorate the local economy. The project will have a positive impact on jobs and economic revenues by generating work for the local communities in planting activities. The proposed CDM A/R activity will provide employment at the time of initiation of the project when various activities such as land preparation, pitting, nursery raising, transportation of seedlings and actual planting occurs, and is paid for through the CDM A/R project activity.

Further, the CDM A/R project activity increases the supply of biomass such as fuelwood to families to meet their biomass requirements. In the proposed project, which is multi-component including promotion of fruit orchards on a large-scale, biodiversity will be enhanced. Further, these fruit tree species with varied gestation periods and end-use would provide not only economic returns at different time periods but also in a sustained manner, as fruit orchards yield over many decades, albeit with variations in yield.

The proposed CDM activity will generate income and minimise risks in cropping enterprises. It provides long term investment opportunity, diversified land use, tree cropping and best option for the marginal farmers. This can generate diversified on-farm employment, Non Timber Forest Produce (NTFP) and ensure raw-material supply to forest based industries. It is a potential technology for commercial farming, improving degraded and polluted sites, an opportunity for stabilizing fragile ecosystems and also a forestry system for arid and semi-arid zones.

Education
The local communities would be provided training and education processes that will ensure the maintenance of plantations and the sustainability of the project. These processes will increase the knowledge and transfer of forest technology to the rural communities in the area of influence of the project. An environmental education process will be generated among the youth population of the rural area to prepare them for sustainable forest development.

Community Development
The project activity will strengthen and support the community organization Bagepalli Collie Sangha for self-management and participation in projects generated by reforestation activities. The project activity will further strengthen the community organization of Bagepalli Coolie Sangha, by consolidating as an important social structure who will find a space for social, cultural and economic participation.

Economic impact
The non-timber forest produce (NTFP) from mango and tamarind plantations have a good market locally, nationally and internationally, which will promote economic activities. At the regional economy level, the project will have an impact on the GDP, adding new resources to the economic flow from the production and marketing of primary and transformed forest products and the sale of lCERs resulting from the project activity. At the family level, new revenues will be generated from the implementation of forest systems in the properties of producers involved in the project and their participation in the sale of lCERs.

In the absence of CDM revenues, the forestry activities in the region do not offer significant income in comparison to the alternatives existing in the baseline scenarios.

G.2. If any negative impact is considered significant by the project participants or the host Party, a statement that project participants have undertaken a socio-economic impact assessment, in accordance with the procedures required by the host Party, including conclusions and all references to supporting documentation:

No negative impact is considered due to the implementation of the proposed A/R CDM project activity.

G.3. Description of planned monitoring and remedial measures to address significant impacts referred to in section G.2 above:

None are required.

SECTION H. Stakeholders' comments:

H.1. Brief description of how comments by local stakeholders have been invited and compiled:

There has been 12 years of discussion, pilot project, participatory decision-making etc in this region. The pilot activities for this project were the first reforestation project activity to receive approval from the Government of India as an AIJ project in 1996. Local stakeholders include the local village councils or Gram Panchayats and the farmers. Secondary data was obtained from Gram Panchayats regarding the land holding of different farmers within the villages chosen in all the 5 taluks of Kolar. Families were interviewed as to their interest in the scheme. A PRA exercise was also conducted in all the villages by ADATS to explore the interest of families and the extent of land they wanted to dedicate for the CDM A/R project activity. The farmers or the owners of these lands were interviewed using a questionnaire to elucidate their interest in planting, the species choice, the extent of land they were inclined to dedicate and species for bund and block planting, for implementation of the A/R CDM project. In addition, 5 stakeholders meetings were conducted at ADATS office. This meeting was attended by local policy makers and government officials from all the taluks (Panchayat, Taluk, Zilla and District members), Mahila members of BCS, Coolie Sangha members and CDM consultant. Thus, a list of species to be promoted, the proportion of the species to be promoted and the phasing of the activity was worked out based on the stakeholder's comments.

H.2. Summary of the comments received:

A participatory approach was adopted to identify the area for afforestation and species choice through group meetings at cluster level comprising of 5-6 villages. Discussions were also held of the planting arrangement, tending to the seedlings, fertilizer application and maintenance of the plantations. A detailed stakeholder report was prepared based on these meetings. Analyses of the comments are as follows:

- ADATS has the organisational capacity but needs separate efficient staff to take care of the CDM project. There is a need for increased management capacity and time discipline for the project activity
- Good management practices are needed at the village level for 5 summer months to ensure that seedlings survive during the first three years. Sufficient rainwater harvesting & stocking works needs to be done in the plots for water retention.

- Market research needs to be carried out and the information disseminated to all the CSU members
- Dry Land Horticulture Project has been under discussion for a long time. Coolie Sangha have unity & discipline and are able to make long term plans for the communities. The opportunity of CDM revenues allows us to take this project proposition seriously. The positive pilot project experience has given the confidence to the Coolie Sangha members to take up the project activity.
- Choice of tree variety is critical. Success will hinge around choice of variety due to the nature of tree crops (we will realise a mistake only after 6-7 years later, when the trees fail to fruit properly).
- Technical issues of soil must be balanced with Member families' interest to grow trees. Only serious cultivators stay with the village CSUs.

H.3. Report on how due account was taken of any comments received:

During discussion participants welcomed the idea of reforestation on degraded private lands given that the region is dry, semi-arid and with low tree cover. Families are interested in promoting fruit orchards as it will be a source of additional income and are less subject to the vagaries of weather compared to annual crops.

There are also many local NGO records and government strategy papers which present an overall strategic view of how Chickballapur District agriculture needs to shift to dry land horticulture. The ADATS pilot project elicited enough and more comments over the last 10 years from participating families as to why and how the Bagepalli CDM Afforestation project can be taken forward for the benefit of all.

The concern that most of the farmers expressed was watering of plants during the establishment phase in the initial 3 years. Based on the experience of the AIJ project in this region, the communities requested for watering facilities during the initial years after planting.

A CDM team will be established to take care of the A/R CDM project. ADATS has 12 year long association with KYOTO activists. Also ADATS and Bagepalli Coolie Sangha have 2 registered CDM projects. Thus ADATS has the capacity to organize a good team of horticulturalists, CDM experts, soil experts to give technical advice for the project activity on pests and diseases, fertilization, preparation of tree produce for market, including quality control, grading, etc., secure best advice on primary production, including preservation of perishable produce and value addition – exploration of opportunities for educated youth or youth groups with technical and institutional support. Efforts will be made to use technical and government resources to improve rainwater harvesting and departmental advice for intelligent use of water.

Strict selection procedures will be followed for family selection. Assess landholding, family capability and past performance to select participating families. The Dry Land Horticulture Project shall be implemented by a coherent and disciplined collective instrumentality within the Coolie Sangha. In view of long gestation nature of tree crops, saplings for planting shall be purchased only from reliable sources.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROPOSED A/R CDM PROJECT ACTIVITY

Organization:	Agricultural Development and Training Society (ADATS)
Street/P.O.Box:	ADATS Campus
Building:	
City:	Bagepalli
State/Region:	Karnataka
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Country:	India
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E-Mail:	ram@adats.com
URL:	www.adats.com
Represented by:	
Title:	Project Director
Salutation:	Mr
Last Name:	Esteves
Middle Name:	-
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No funding will be diverted from the Official Development Assistance.

Annex 3

BASELINE INFORMATION

A baseline survey was undertaken in the project area consisting of five taluks of Bagepalli, Chickballapur, Chintamani, Gudibanda and Sidlaghatta in Chickballapur District, Karnataka State in Southern India. This region is a semi arid drought prone area with low, erratic and spatial rainfall. The dust brown rocky terrain is severely undulating, with small hill ranges and a very thin and fragile soil cover. The normal forest cover is just 6.18% of the total area of the old Kolar district (FSI, 2009). In practice many of the forests are themselves very degraded, the forests have been highly exploited.

Historical changes in covers and uses of the land

The historical and existing land use/cover changes in their social-economic context is best understood by studying the Gazetteer of Kolar region, which gives detailed description of the historic land use/land cover, the land treatment undertaken by the project proponent in the project area and the local knowledge of the project participants and looking at the satellite imagery of land use/cover and other studies conducted periodically for the region.

As described in the Karnataka Gazetteer for Kolar for the year 1968[66], "the scanty rainfall and the rivers and streams being dry for most part of the year, the area is devoid of vegetation and scarcity conditions are very common. State owned forest areas such as state forests, plantations, reserve forests and village forests form only 10% of the district area as against the recommended national standard of 33.5%. Most of the state-owned forests are confined to hilly tracts, the intervening plains areas being bround under the plough. Due to the low rainfall and the soil being rocky, gravelly or very shallow, the vegetation is incapable of bearing better type of vegetation. The underlying rock being granitic-gneiss and low rainfall in the region, it is unfavourable for rich forest growth. Under such climatic and soil conditions, the vegetation is either dry deciduous or thorny scrub type. The growing stock is stunted, the forest canopy open and the vegetation is more or less xerophytic in nature. Many parts of the forest areas are not forests any more due to heavy working in the past for firewood and charcoal. As a result of the denudation which is due to over exploitation in the past, soil erosion is evident in many of the forest areas. Paucity of vegetatal cover, coupled with the absence of organic humus from the top soil, has been the main cause for the accelerated soil erosion. Soil conversation measures were taken up the Government of Karnataka by taking up contour-bunding, contour-trenching, gully-plugging and planting barren areas by trench and mound method".

The key factor that influences the land use/cover changes over time in this region is climate change. The project area is a semi arid drought prone region. The project area skirts the southern border of the Rayalaseema desert belt and shares the same language, culture and social structure, as also the stark poverty that afflicts southern Andhra Pradesh. The region receives an annual rainfall of around 650 mm and is facing imminent desertification, with severely degraded soils. The dust brown rocky terrain is severely undulating, with small hill ranges and outcrops that stud the topography. There is no mineral wealth and only a very thin and fragile soil cover. Slopes in the region are not terraced and rainfall is not retained. This is an even bigger problem than low precipitation and erratic, spatial showers. Soil erosion is a definite problem (Fig A5.1&C2.2) and the age-old network of small and large irrigation tanks is getting visibly choked.

[66] http://gazetteer.kar.nic.in/dist_book.asp?pre_post=1&kan=2

As part of the efforts of the Project Participant, ADATS, the project area, underwent soil and water conservation works under the DLDP. These lands are currently either barren and uncultivable land, fallow land or marginal cropland. Basically climate change is causing rapid desertification. Soil degradation has occurred as erosion has increased continuously and no soil and water conservation works have really been able to stop it; soil organic matter content has decreased, and no natural encroachment of trees would occur as there are no on-site seed pools that may result in natural regeneration.

The existing land-use of the project activity is degraded agricultural lands, which has very low SOC. As mentioned in Section A.7, the lands to be afforested or reforested are degraded and the lands are still degrading or remain in a low carbon steady state. The lands which are being brought under the present A/R CDM project activity were treated under a DLD Programm. Studies conducted also show that most of the areas are not very productive for agriculture (Fig A7.2). The initial objective of the Dry Land Development Programme is to enable agricultural labourers to cultivate their scattered patches of marginal land and become subsistence farmers. The further objective is to shift from subsistence to sustainable land use practices. The DLDP is a pluralistic programme comprising a whole range of indigenously conceived soil & water conservation measures. During initial years land was cleared of pebbles and boulders, and Soil & Water Conservation Works like stone contour bunding, ravine and gully check, diversion channels, etc. were taken up. Shrubs and grasses are allowed to grow on them. These soil and water conservation works are once again implemented, after a gap of 2-3 years, in order to tackle the new contours of erosion that would, in the meantime, have chequered the terrain.

The National Bureau of Soil Survey and Land Use Planning (NBSSLUP) have done elaborate studies on the soil status of Kolar. Soil Organic Carbon maps have been prepared for the distict. As can be seen from the map (Fig C2.1) , the project area comprising of Bagepalli, Gudibanda, Chickballapur, Chintamani and Siddalaghatta taluks of the recently formed Chickballapur district has very low Soil Organic Carbon status. The agricultural lands are in a state of low carbon state.

Baseline field studies

For the CDM project activity, private or farmers' lands are currently being considered for CDM for the reforestation activity, which belongs to about 8,107 Coolie families who own a total 8933.34 ha.

The details of the Participating Families in the study area are as follows:

Table 1: Details of participations families in the study area

Landholding (hectares)	% of families
0.5-1	80
1-1.5	12
1.5-2	5
>2	3

These marginal farmers cannot grow anything other than local cereals and millets and rain is the only hope for their income hence forth they want to switch over from risky and timely-rain dependent field crops to hardy tree crops and under such condition the proposed reforestation project would be a great boon for them. And these farmers are not so financially sound to invest on planting activities and should wait for several years for the financial benefits to accrue.

Field Studies

A questionnaire was prepared consisting of pertinent questions related to the investigation. On this basis, the data collection sheet was prepared, field tested and finalized.

Of the study area of 8933.34 hectares, area sampled for the study was 84.37% of the project area. The total plots sampled for the project area is 11,063 (Table C7.1). The baseline survey was conducted during 2008-2010.

The details of the baseline survey are as follows:

Table 2: Sampling details of the survey

Project Details			Sampling details			
			Area covered		Plots surveyed	
Taluk	**Total Identified Project Area (Ha)**	**Total No. of Plots**	**Ha**	**%**	No.	**(%)**
Agricultural Land	7,656.14	10,714	6424.15	83.91	9556	89.19
Built Up Area	91.65	134	78.37	85.51	125	93.28
Scrub Forest	62.37	78	54.16	86.83	69	88.46
Wastelands	1,037.92	1,282	905.95	87.29	1187	92.59
Waterbodies	85.26	139	74.85	87.79	126	90.65
Total	**8,933.34**	**12,347**	**7537.49**	**84.37**	**11063**	**89.60**

The primary data was collected from a subset of the project area. The details of the plots are as follows:

- Plots chosen for the study are part of the CDM reforestation activity. The land details showing unique ID of the plot i.e. land survey number (Phani no.) and land details such as Dry land Development programme (DLDP) work done, land use, etc. were collected.

TABLE 3: Vegetation parameters monitored

Parameter	Surveyed
Tree Species	- Species name - Number of species in the selected plots
Above ground Biomass of trees	- Species name - Number of species in the selected plots - Average GBH of each species in a plot - Average Height of each species in a plot
Shrub Biomass	- Plot of 1m x 1m in the randomly selected plots - Wet weight - Dry weight

The carbon pool chosen for the estimation of the total carbon stock are above ground biomass and below ground biomass. Though litter, soil organic carbon and dead wood contribute to the carbon pool of a forestry project, they were not considered as reforestation is being carried on degraded lands and these pools are insignificant.

The vegetation parameters monitored are as shown in Table 3.

- All the species in the plots were identified with the help of local communities. The species names were recorded in Kannada/Telugu and botanical names.
- All the trees belonging to each of the plots sampled were noted down and their average girth at breast height (GBH) was measured at 130 cms from the ground using a measuring tape for trees above 10 cms.
- The height of all the trees were measured and recorded.
- Height of the tree below 3 m height were measured and the height of the taller trees was visually estimated.
- Details regarding the land such as village ID number, survey No. of the farmers land, land area, soil type, age of the tree, placement of the tree (bund or field) and uses of the trees were collected. Details of retention of the tree after the CDM reforestation activity was also recorded. The current dependence of the farmer on the land for firewood, thaching, and grazing, etc. was also recorded.
- The shrub biomass was also estimated. A plot of 1m x 1m was laid, biomass in that area harvested and the wet weight and dry weight noted.
- All the grass and shrub biomass present within the non-tree quadrat were clipped and harvested. The fresh weight of the harvested biomass was taken. Dry weight of the biomass was estimated by taking a small quantity and drying it in an oven. The dry biomass expressed as dry tones is extrapolated to per ha from the sample area

Data entry was done into the InfoNeeds of the ADATS database and data analysis was done in Microsoft excel. The methodology followed for data analysis is described below.

Estimation of above ground biomass

Aboveground biomass was estimated using volumetric or allometric equations. Equations to estimate volume or biomass of trees are developed for various species based on the DBH and height of the tree. Limited literatures are available on the equations for estimating the above-ground biomass stocks for tree species occurring in India (Murali *et al.*, 2002). One of the sources of equations is the report published by Forest Survey of India (FSI, 1996) for Indian species, wherein species specific volumetric equations have been developed. These equations were used to estimate the volume of trees using DBH (D) and height (H) data. In the absence of species specific equations, general equations were used. The equations are listed in the Table below.

Table 4: Volumetric or biomass equations of trees species

Species	Volume/Biomass equations	Reference[67]
Acacia auriculiformis	$V=0.187693-2.825587D+0.054763DH+12.16477D^2-0.004788/D$	FSI, 1996
Achtas sapota	$V=(0.079+0.41491\ D^2H)$	FSI, 1996
Albizia amara	$V=0.009134+0.17315D^2H$	FSI, 1996
Anacardium occidentale	Y=exp[-2.289+2.649 *ln (DBH) - 0.021 *(ln(DBH))2; Y = kg; DBH in cms	Annex 4A.1, IPCC GPG, 200644
Annona squamosa	Y=exp[-2.289+2.649 *ln (DBH) - 0.021 *(ln(DBH))2; Y = kg; DBH in cms	Annex 4A.1, IPCC GPG, 200644
Artocarpus integrifolia	$V=0.076-1.319D+11.370\ D^2$	FSI, 1996
Azadiractha indica	Y=19.2224+238.5245D2H; Y= (kg/tree)	Shailaja and Sudha, 1997
Cassia auriculata	$V=0.05159-0.53331D+3.46016D^2+ 10.18473D^3$	FSI, 1996
Ceiba pentandra	V=0.0589+0.000956D2; D is cm	FSI, 1996
Diospyros melanoxylon	$V=- 0.013104+0.365321D^2H$	FSI, 1996
Diospyros Montana	$V=-0.013104+0.365321D^2H$	FSI, 1996
Eucalyptus sps	$V=0.02894-0.89284D+8.72416D^2$	FSI, 1996
Ficus bengalensis	$\sqrt{V}=0.03629+3.95389D-0.84421\sqrt{D}$	FSI, 1996
Ficus religiosa	$V=0.0153+0.3856D^2H$	FSI, 1996
Leucaena leucocephala	Y = 0.5 (DBH2) x HT X SG; HT=Height; SG=Specific gravity; Y in Kg, DBH in cm, H (m)	Dubley and Fownes, 1991[68]
Mangifera indica	Y=exp[-2.289+2.649 *ln (DBH) - 0.021 *(ln(DBH))2; Y = kg; DBH in cms	Annex 4A.1, IPCC GPG, 2006[69]

[67] FSI (1996) *Volume Equations for Forests of India, Nepal and Bhutan*, *Forest Survey of India*, Ministry of Environment and Forests, Government of India, 1996.

[68] Dubley, N.S. and Fownes, J.H. Preliminary biomass equation for eight species of fast-growning tropical trees. Journal of Tropical Forest Science 5(1):68:73

Pongamia pinnata	Y= 0.0494+0.4568*DBH2*H; Y in Kg (fresh weight), H and DBH in decimeters	Chaturvedi and Behl, 1996[70]
Syzygium cumini	V=0.0238+0.41681D2H	FSI, 199646
Tamarindus indica	Y=exp[-2.289+2.649 *ln (DBH) - 0.021 *(ln(DBH))2; Y = kg; DBH in cms	Annex 4A.1, IPCC GPG, 200644
Tectona grandis	V=-0.001384+0.363126D^2H	FSI, 1995
Terminalia paniculata	V=0.131-1.87132D+9.47861D2	FSI, 1996
Zizyphus jujupa	V=-0.002557+0.260114D^2H	FSI, 1996
Zizyphus xylopyra	V=-0.002557+0.260114D^2H	FSI, 1996
Zizypus jujupa	V=-0.002557+0.260114D2H;	FSI, 1996
General Equation for tropical forests of Karnataka	V=(0.079+0.41491 D^2H)	FSI, 1996

[69] IPCC Good Practice Guidance for LULUCF, Chapter 4: Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.
[70] A.N. Chaturvedi and H.M. Behl(1996), Biomass production trials on sodic site, Indian Forester, June

Wood Density

The volume (m^3) of tree was converted to biomass (tonnes) using species-specific wood density values (Table 5). The source of data for wood density was:

- JTDA, 1985: Specific gravity of Indian Timbers. Journal of the Timber Development Association (India). Vol.30(4) Oct 1984
- IPCC's Good Practice Guidance for Land Use**,** Land-Use Change and Forestry (Source:http://www.ipccnggip.iges.or.jp/public/gpglulucf/gpglulucf_files/Chp3/Anx_3A_1_Data_Tables.pdf)
- Agroforestry tree database of The International Council for Research in Agroforestry ICRAF.(Source:http://www.worldagroforestry.org/sea/products/AFDbases/WD/asps/DisplayDetail.asp?SpeclD=11)
- A value of 800 kg/m^3 was considered (FSI, 1996) for trees whose species-specific wood densities were not found.

Table 5; Wood density for tree species

Botanical Name	**Wood Density (t/cum)**	**Source**
Acacia auriculiformis	0.65	World Agroforestry Centre
Acacia melanoxylon	0.563	JTDA, 1985
Achras sapota	0.31	World Agroforestry Centre
Albizia amara	0.7	IPCC GPG, Table 3A.1.9-2
Aleurites moluccana	0.43	IPCC GPG, Table 3A.1.9-2
Anacardium occidentale	0.5	World Agroforestry Centre
Annona squamosa	0.6	World Agroforestry Centre
Artocarpus integrifolia	0.58	IPCC GPG, Table 3A.1.9-2
Azadiractha indica	0.693	JTDA, 1985
Bauhinia malabaria	0.67	IPCC GPG, Table 3A.1.9-2
Butea monosperma	0.465	JTDA, 1985
Calotropis gigantea	0.8	FSI, 1996
Canthium parviflorum	0.42	IPCC GPG, Table 3A.1.9-2
Cassia auriculata	0.697	JTDA, 1985 for C.siamea
Citrus sps	0.8	FSI, 1996
Diospyros melanoxylon	0.678	JTDA, 1985
Diospyros montana	0.663	JTDA, 1985
Eucalyptus sps	0.713	JTDA, 1985
Syzygium cumini	0.636	JTDA, 1985
Ficus bengalensis	0.39	IPCC GPG, Table 3A.1.9-2
Ficus religiosa	0.385	JTDA, 1985
Glyricidia	0.75	World Agroforestry Centre
Grevillea robusta	0.472	JTDA, 1985

Holoptelea integrifolia	0.592	JTDA, 1985 for C.siamea
Leucaena leucocephala	0.649	JTDA, 1985
Mangifera indica	0.588	JTDA, 1985
Moringa oleifera	0.299	JTDA, 1985
Pongamia pinnata	0.609	JTDA, 1985
Prosopis juliflora	0.85	JTDA, 1985
Psidium guava	0.75	World Agroforestry Centre
Santalum album	0.87	World Agroforestry Centre
Sapindus emarginatus	0.58	IPCC GPG, Table 3A.1.9-2
Tamarindus indica	0.747	JTDA, 1985
Tectona grandis	0.5	JTDA, 1985
Terminalia paniculata	0.638	JTDA, 1985
Zizyphus xylopyra	0.597	JTDA, 1985
Zizypus jujupa	0.597	JTDA, 1985
Average density for wood	0.8	FSI, 1996

Estimation of below ground biomass

Below ground biomass was estimated using the default value of 0.27 from IPCC's good Practice Guidance for Land Use, Land-Use Change and Forestry for Tropical Forests.

Estimation of shrub biomass

A total of 21 shrub quadrates were laid to estimate the shrub biomass. Half of the dry biomass weight was taken as carbon and converted to CO_2.

Estimation of total carbon stock

The estimation of carbon stock was done as follows:

- The total biomass was obtained by adding the AGB and the BGB in tonnes.
- The total t carbon/ha present in the study area was estimated by multiplying with 0.5. (Based on the IPCC good practice guidance, 50% of biomass is taken as the carbon of biomass)
- The t carbon/ha was multiplied with 3.66 (44/12) to obtain tCO_2/ha in the study area.

Annex 4

MONITORING PLAN

The monitoring plan is according to the selected methodology (AR-AM0004/ Version 04), which includes the monitoring of the following:

- Project boundary. Includes the monitoring of all project areas in which activities are carried out, specifying the strata and their geographical location. The areas will be periodically monitored with a view to detecting changes in the physical limits of the project or variations in the strata established to the start of same.
- Forestry activities, such as the establishment of the tree stands and forest management. This section highlights the plant material selection, for the establishment of plantations in addition to the removal of biomass associated with thinnings, coppicing, and weed elimination. Though thinning and coppicing is not foreseen as they are horticultural species, if any, will be recorded. The application of fertilizers will likewise be monitored, with special emphasis on the specific requirements of the proposed tree stand models, during the crediting period.
- GHG emissions and removals within the project scope. This includes the net GHG removals by selected sinks and variations in the carbon contents present in the above- and below-ground biomass, in addition to the GHG emissions as a consequence of the project activities if any (i.e. coppicing and thinnings, among other things).
- Leakage. The eligible project area is characterized by the presence of summer grazing during 3-4 months in an year in about 50% of the lands. There is sufficient land for grazing outside the project area. There will not be any displacement of agriculture and fuelwood in the project area. Thus leakage will not be monitored.
- Quality of the information. Verification for optimization of control and quality of the information gathered. This comprises a control plan in the gathering, filing, verification and internal auditing of the resulting information, guaranteeing the integrity of the data accumulated for each monitoring period and throughout the execution of the proposed project activity.

1. Monitoring of baseline removals

The changes in carbon stocks in areas without tree cover is assumed to be zero, given that they are constant over time, even for the established crediting period. A period of 20 years has been set for the proposed activity, with two renewals of 20 years each. Therefore, the changes in the carbon contents of the baseline scenario do not need to be monitored during the first crediting period (given that the accepted approximation of baseline 22(a) assumes the continuation of the carbon contents within the project boundary at the time of its validation). For subsequent periods, satellite information or aerial photographs would be used to verify the possible changes that might occur in the baseline (IPCC 2003).

2. Monitoring of the total A/R CDM project activity behaviour.

2.1 Monitoring of the boundary of the proposed AR CDM project activity

The project boundary includes 8933.34 hectares.

The eligible areas are located in sites scattered in Chickballapur district. (Section A4.2). Fig A4.2 highlights the large number of parcels that will be covered by the project activity.

2.2 Procedure for incorporation of properties into the project:

The areas under control of the project participants, incorporated through written agreements with the landowners, are geographically located within the project boundary, in Chickballapur district. The agreements are carried out in accordance with the interests and preferences of the participating families, the requirements for participation stipulated by ADATS and CDM regulations.

The steps for inclusion of land areas into the project for introducing the tree stand models are as follows:

1. The staff of ADATS conducts an on-site visit to the interested participating families of Coolie Sangha to establish trees on their lands and briefs them of the project operation scheme.
2. The participating family provides ADATS staff with documentation (Clear Title of the land or Phani) to prove his/her ownership and possession of the lands where the project is to be carried out.
3. ADATS look into the documents of the land title submitted by the family, in order to guarantee that there are no legal problems and the development of the plantation can be assured during the expected duration of the project.
4. When the ADATS staff has determined that the property has legal viability, the participating family and the ADATS staff will carry out a field study of the property and they define, according to technical biophysical, social, environmental and economic criteria, along with the landowner preferences, the areas allocated to the tree stand model and the species to be used.
5. The ADATS personnel will measure the lot intended for the establishment of the tree stands, carrying out using the Global Positioning System (GPS).
6. A Forest Establishment and Management Plan will be prepared in which the methodology and activities to be carried on during the planting activity are set out. This will be done according to the guidelines for each tree stand model to which the project activity corresponds to.
7. In order to begin the field project activities, the participating family of the property must sign a letter of intent and subsequently legalize his association with ADATS by signing an Agreement. This document will stipulate the duties and commitments of each of the parties involved in the forestry project and are likewise considered binding documents.
8. Once all of the foregoing has been legalized, the planting process will began and the areas georeferenced with the Global Positioning System (GPS) are considered areas under control, and are entered into the ADATS InfoNeeds and Geographical Information System.

All project areas are verified against the eligible areas described in the baseline.

2.3 Monitoring of the forest establishment

The plantation quality and survival indexes will be monitored by the entity in charge of providing technical advice for the implementation of this project. Soil preparation activities will also be monitored, so as to verify that the designed plan is carried out. All relevant information to the forest establishment must detail aspects such as:
- Site preparation: In the tree stands involved and for the areas under control, land preparation is carried out as described in the PDD and the information regarding the tasks will be monitored, verified and collected which serves to monitor the establishment and management of the forest tree stands, in which the activities carried out in the properties incorporated into the project, as well as the date on which these are carried out, are

specified wherever possible. The pre-existing scattered trees in the eligible areas for the establishment of forest tree stands will not be eliminated.
- Verification of species and strata: The tree stands involved in the project will be verified with respect to the species and strata pre-defined in the PDD and will be stored in the project database, according to the tree stand model to which they belong (Table A5.2). These tree stand models make reference to the strata defined in the *ex-ante* phase.
- Survival: This is quantified in the field through a sampling in temporary survival plots of land, with an area of 250 m^2. Survival monitoring is carried out approximately three months after the planting of the lots. Any seedling that is dead will be replanted with the same species, seeking to maintain the lots homogeneous for the next three years. The seedlings that will be replaced will be recorded with regard to the year so that the age will be established for carbon calculations. The estimate is made through a simple count of the individuals within each plot, their vitality state, determining the density of live individuals and finally comparing it to the initial density of establishment. Given that there is continuous planting on the plots; mortality evaluation must be permanent during the establishment period, gathering the necessary survival information in each plot.

2.4 Forest management monitoring

Clearings, thinning and harvesting will not be a practice in the project area. But plots will be monitored so as to guarantee the application of correct practices. Thus, assurance is obtained that unsustainable forest use practices are avoided and correct growth of the plantations is monitored, according to the established standards. Fertilization will be monitored to ensure that the activities and procedures are carried out correctly to ensure the well-being of the plantation, but version 4 of the methodology does not require that emissions from this source be counted. The presence of anomalies, such as fires, diseases or disturbances and the technical recommendations for plantation management will be documented and reported promptly, to be kept in the files. If there are any losses of planted areas, these will not be considered within the quantification of net removals of the project. They will only be reincorporated if the anomaly is mitigated, through the replanting of the lots, for which the establishment procedures detailed above will be followed. The information on establishment and forest management activities will be recorded on scheduled forms. These forms will be kept in the filing system for each participating family. Whenever possible, the information thus collected will be taken to digital filing systems for its management and preservation. All of the forest management actions and situations will be supported with their date of occurrence, location, area, species, volume or biomass removed or characteristics of applied inputs. The minimum preservation time of the information shall be till the end crediting period.

3. Monitoring of actual net removals by sinks and data acquisition

The monitoring of this component will be carried out through permanent plots of land, in which the dynamic growth process of the plantation is assessed, thereby estimating the carbon contents present in the above- and below- ground tree biomass of the project. The follow-up of the monitoring plots permits an evaluation of the correspondence of the planted species against those proposed in the project, in addition to the planting densities.

The plot establishment and dendrometric variable measurement will be followed to estimate the volumetric increases in each tree stand. Said information will serve as input to validate the volumetric equations by species, or to reformulate new equations that enable the more real modelling of the volume attained by the species planted for the project area. Following is a description of some of the most important parameters to be monitored:

4. Stratification

The defined strata will be stored on physical and digital format in a database which shows, for each polygon, plot of land or property, the species, area, identification of the lot, planting date, etc.

Monitoring of the strata

The areas of the previously defined strata will be periodically monitored in accordance with the criteria established in the monitoring of the project scope, attempting to identify change parameters in the initially established areas, and promoting the unification of strata considered dissimilar in the *ex ante* phase. A restratification may be carried out before the first monitoring, as a result of the progress of the plantation, based on the parameters such as age, stand model, carbon capture variation, cost effectiveness in the monitoring process, disturbances (fires, pests and diseases, etc.). Some of the changes in the parameters defined above, such as carbon capture, will only be detected after the development of the first monitoring. After the first monitoring, the stratification would be reassessed, according to the changes detected in the project boundary, reforested areas, actual years of establishment and/or variations in carbon contents by strata, which may be grouped together or associated by similar carbon contents, by their change dynamics or by their spatial variation.

Monitoring of changes in carbon contents

The monitoring proposal will make use of permanent sampling plots to evaluate changes in the carbon content present in the aboveground and belowground biomass within the project scope. The sample size for each stratum will be established in a cost-effective manner, complying with an accuracy level equal to ± 10% of the mean and with a 95% confidence level (the details of the initial stratification are shown in section E.2.).

Sample size determination

In order to determine sample size, the tool established by the Executive Board for Climate Change (UNFCCC) will be followed[71]. Within the calculations, an equal cost for the establishment of plots of land in each stratum is assumed. The calculations will be made entering the information and the equations into Microsoft Excel software.

5. Sampling procedure in the monitoring of carbon contents in the aboveground biomass.

The sampling procedure details the quantity of area to be sampled and the number of plots of land which must be established by tree stand model or stratum. The procedures for estimation and sampling distribution are in keeping with what is described in the methodology (AR-AM0004/ Version 04). The dispersed trees that do not form part of the project activity will be clearly identified, coded and marked with paint or permanent tags. The information related to these will be registered in the monitoring plan and they will not be considered in the calculations of net anthropogenic carbon sequestration by the Project activity. These marked dispersed trees will be checked to ensure that they are not affected by the project activity over time.

Aboveground biomass of trees

Trees are woody perennial plants having a single, usually elongated main stem with few or no branches on its lower part. Plants belonging to a tree species will be considered for measurement in tree quadrats, if the height of the plant is over 1.5 m and with a DBH of >2.5cm

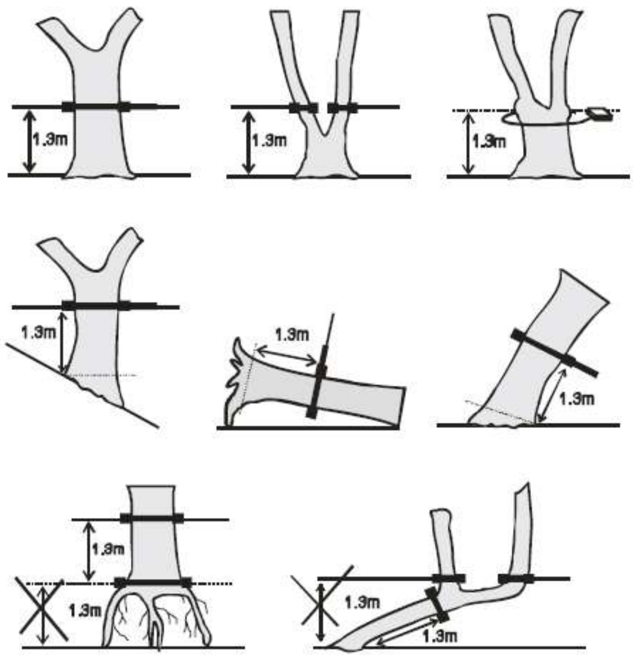
[71] http://cdm.unfccc.int/EB/031/eb31_repan15.pdf : Methodological Tool. Calculation of the number of simple plots for measurements within A/R CDM Project activities. Ver. 01.

Parameters to be measured include species, number of stems, DBH, height, dead and standing tree and extent of damage to the tree.

DBH will be measured by a measuring tape or a calliper and a marker. DBH is measured using the following procedure:

- Mark 130 cm above ground on tree trunk
- Place the callipers/tape at 130 cm
- Measure and record the DBH or GBH in cm
- If a tree has multiple shoots count and measure GBH/DBH for all shoots
- If the tree is large normally girth is measured using a measuring tape
- If the tree is young and has girth lesser than the prescribed, measure DBH using a slide calliper

A tree could have multiple and/or crooked shapes, could be slanting, and could be on a sloping hill. Measurement technique for irregularly shaped trees and under different land conditions is illustrated in the following figure.



Tree height normally refers to total tree height defined as the vertical distance from the ground level to the upper most point. Tree height is also often referred to as the merchantable height, since many allometric equations are derived for this height. Height will be measured based on the biomass equation requirement. Height is measured for all the tree stems for which DBH is measured. Trees <3 meters will be measured using a graduated height stick, by holding a stick against the side of the tree. Clinometer is one of the instruments used for measuring the height of the trees. Mark out a horizontal distance of 10 meters from the tree from where the tree can be viewed using a clinometer, if necessary increase the horizontal distance by moving away from the tree beyond 10 meters. If the tree plot is located on a steep slope, view the tree from across the slope to obtain the horizontal distance. Sighting the tree through the clinometer, align the centre line with the base of the tree (ground level on the upside slope) and record the reading on the percent scale (base angle %). Next aim the clinometer to the top of the tree and record the reading on a percentage scale. Calculate the height using the equation.

Aboveground biomass would be estimated using biomass estimation equations for the dominant species raised in the stand models. These equations are available. The following steps would be adopted for estimating above ground biomass:

- Select the biomass equation relevant to the region, plantation species and age of the stand
- Tabulate and enter the tree number, DBH and height (H) data into a computer data analysis package such as Microsoft Excel for each sample plot
- Enter the biomass equation in the data file or worksheet for estimating the weight of the individual tree (kg/tree) for a given DBH and Height
- Estimate and add the weight of each tree derived using the DBH values from the sample plot selected
- Add up the values of total weight of the trees in each of the sample plot to obtain the total weight of all the trees in the sample plots selected for the land category, reforestation model and stratum
- Extrapolate the biomass of trees from the sampled area to per hectare (tonnes/ha)
- The biomass equations provide volume (in m^3) estimates. These will be converted to biomass by multiplying the volume by the wood density of the tree species.

Belowground biomass will be estimated using the IPCC default value of 0.27 of aboveground biomass.

Total biomass carbon stock per hectare will be estimated by adding the aboveground and belowground biomass values calculated for each species belonging to the stand model.

The biomass values estimated per hectare for each stand model will be converted to tonnes of carbon per hectare using the IPCC default value of 0.5.

Data recording and compilation

Data recording formats for tree in sample plots will be used. These formats are largely for use in the field. The data entered in these formats in the field would be verified and entered into a database for analysis. Some of the following precautions and steps would be followed to ensure correct recording in the field and its compilation in a computer for obtaining accurate estimates of the biomass are as follows:

- Use of the appropriate data entry format for trees
- Ensure to enter the location name, date, plot number, vegetation type and name of the field investigator
- Enter and verify the GPS readings of the plots
- Enter and verify the units of height and DBH
- Ensure all the relevant data recording cells in the formats are entered, before departing from the field location
- Verify the data recording formats as quickly as possible, after returning from the field, for any corrections or conversion of traditional units of measurement to the standard units such as metric system
- Codify if any entry requires the use of codes, by converting the qualitative information using the codes
- Develop a user friendly data entry system for computer analysis and for archiving of data
- Verify all the data entered and store in the database

6. Monitoring of GHG emissions

6.1 Monitoring of leakage

Activity shifting: The potential activity displacements options due to the implementation of project activities include:
- Conversion of land for cropping
- Conversion of land for grazing
- Shifting of fuelwood collection activities

Conversion of land for cropping In the proposed A/R CDM project, no conversion of land to cropland is likely to occur due to the existing laws and regulations of the country. Currently no conversion is occurring. Therefore emissions from conversion of land for cropping purposes, is not likely to occur. Thus this activity will not be monitored over the crediting period.

Conversion of land for grazing Conversion of land outside the project boundary is unlikely as explained above is leakage section. Grass production is projected to increase in the planted area. The participating families have control over their lands and thus will be able to graze their animals or harvest grass and feed to the livestock. Thus this will not be monitored over the crediting period.

Fuelwood collection: This will also not be monitored as the biogas programme being implemented in Chickballapur region will decrease the fuelwood pressure on these families. In fact, under the project scenario, fallen twigs and branches would be available in more quantity than in the baseline scenario after a few years.

7. Monitoring the delivery of Certificates of Emission Reduction (lCERs)

End User Agreements signed between participating families and ADATS categorically state that 100% of project revenues from the sale of lCERs will be fully distributed to the participating families. ADATS will not hold back a single Rupee by way of service charge, or profit, or return on investment, or commission, or any manner whatsoever.

Since the project have a large number of parcels, landowners have to be assigned lCERs in an open and transparent manner that accurately corresponds to sinks created. Technical personnel in charge of monitoring will estimate carbon capture, leaks and emissions based on established species, age of tree stands, tree stand model(s), tree stand growth and baseline stratum(s). This detailed information will allow them to determine the quantity of lCERs to be apportioned to each parcel, and become the basis for a *pro rata* sharing.

The project database will record and store the above information. Before verification is undertaken, this database with information on landowners and the quantity of lCERs appropriated to each parcel, will be updated.

Prior to initiation of a verification exercise, ADATS will provide the verifier with a list of all contracts and their status, indicating whether they are active or inactive. Those contracts which are not updated will not be considered as areas under control of the project participants. Such parcels will be excluded from the project boundary.

Revenues from the sale of issued lCERs will be disbursed in a transparent and verifiable manner.

PROJECT DESIGN DOCUMENT FORM
FOR AFFORESTATION AND REFORESTATION PROJECT ACTIVITIES (CDM-AR-PDD) - Version 04

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History of the document

Version	Date	Nature of revision
04	EB35, Annex 20 19 October 2007	• Restructuring of section A; • Section “Monitoring of forest establishment and management” replaces sections: “Monitoring of the project boundary”, and “Monitoring of forest management”; • Introduced a new section allowing for explicit description of SOPs and quality control/quality assurance (QA/QC) procedures if required by the selected approved methodology; • Change in design of the section “Monitoring of the baseline net GHG removals by sinks” allowing for more efficient presentation of data.
03	EB26, Annex 19 29 September 2006	Revisions in different sections to reflect equivalent forms used by the Meth Panel and assist in making more transparent the selection of an approved methodology for a proposed A/R CDM project activity.
02	EB23, Annex 15a/b 24 February 2006	Inclusion of a section on the assessment of the eligibility of land and the Sampling design and stratification during monitoring
01	EB15, Annex 6 03 September 2004	Initial adoption