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Application of Clean Development Mechanism to forest plantation projects and rural development in India

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ABSTRACT

This paper analyses the prospects for establishing afforestation and reforestation Clean Development Mechanism (CDM) projects in Karnataka State, India. Building on multidisciplinary fieldwork, the aim is to: (i) establish what type of plantations and forests that would best suit a forest-based project activity, considering global climate benefits and local sustainable development objectives; (ii) identify the parameters that are important for ensuring sustainable development at the local level and (iii) develop a transparent ranking tool for the assessment of possible forest-based project activities. Using equal weights for the ranking parameters and a 30-year time horizon, the ranking shows that plantations managed with the shortest rotation period (5 years) would be most suitable for forest-based project activities. However, the performance of individual forest-based project activities will depend on local conditions, which need to be reflected in the weighting procedure. Sensitivity analysis shows that when weights are varied, other forest types can become the preferred option. Based on a combination of the sensitivity analysis and results from the fieldwork, it can be concluded that successful implementation of forest-based project activities will require local participation and are likely to involve multiple forest products and environmental services demanded by the local community.

Introduction

The Clean Developing Mechanism (CDM) was established as one of the flexible mechanisms within the Kyoto Protocol and subsequent climate negotiations. CDM is based on the fact that greenhouse gas (GHGs) emissions lead to the same climate benefits regardless of where they occur. Defined in Article 12, the CDM provides for Annex I Parties (in essence industrialized countries) to implement projects hosted by non-Annex I Parties (in essence developing countries) that lead to emissions reductions and thus to climate benefits and a contribution to the ultimate objective of the Convention.[1]

Abbreviation: AGB, above ground biomass; BGB, below ground biomass; CDM, Clean Development Mechanism; CER, certified emission reductions; FAO, Forest and Agriculture Organization; GHG, greenhouse gases; IPCC, Intergovernmental Panel on Climate Change; LULUCF, land use land-use change and forestry; SBSTA, subsidiary body for scientific and technological advice; SOM, soil organic matter; UNEP, United Nation Environmental Programme; UNFCCC, United Nation Framework Convention on Climate Change.

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[1] "... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

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In return, the Annex I Parties obtain certified emission reductions (CERs) that can be used to meet their own emissions reduction commitments. One condition is that the CDM project activities are designed so that they assist the host Parties in achieving sustainable development. In addition, the investor will require that the CERs are generated in a cost-competitive way.

This study evaluates forest-based projects in India, based on a survey of the perceptions of the local villagers concerning different forest types and forest management. We also estimate the carbon stocks in above ground biomass (AGB) and soils in different land-use systems. The overall aim is to establish what kind of forest system that would be best suited for a CDM project activity, i.e. to the best extent meets the two objectives, local sustainable development and carbon sequestration. The empirical data comes from two villages in India, a country with great capacity and interest in CDM project activities; both with different experiences of plantations projects. The specific aims of this study are:

- Identification of plantations and forest types that will best suit a CDM project activity in terms of local sustainable development and climate benefits.
- Identification of parameters that are important to consider for ensuring sustainable development on the local level.
- Development of a transparent ranking tool for the assessment of possible CDM activities.

Even though we have used afforestation and reforestation (A/R) CDM as a possible case in this study, the overall scope of method and result can be applicable in a wider forest-based or carbon sequestration project implementation.

Background

Land use, land-use change and forestry under the Kyoto Protocol

Land use, land-use change and forestry (LULUCF) activities can provide a relatively cost-effective way of combating climate change, either by increasing the sinks of GHG from the atmosphere (e.g. by planting trees or managing forests), or by reducing emissions (e.g. by curbing deforestation) (Sathaye et al., 2001). An increase in forest cover will also have positive environmental effects on a degraded land area: an increase of soil organic matter (SOM) will enhance the fertility of the soil, and, with the exception of monocultures, there will also be an increased biodiversity. The forestry projects would also protect the land from further degradation (IPCC, 2000; Ravindranath & Sathaye, 2002).

However, there are uncertainties regarding the methods for estimating GHG emissions and removals. Further, the *permanence* of carbon stocks created is an issue due to the potential reversibility of carbon benefits due to fire and unplanned harvesting. An attempt to deal with this problem has been the launching of two different CERs, one for long-term CERs (lCER) and one for temporary CERs (tCER) (UNFCCC, 2004a). The idea is basically to issue credits that have a defined lifetime and that has to be replaced if lost. Further, there have been worries that the inclusion of LULUCF activities under the CDM would undermine the environmental integrity of the Kyoto Protocol, and result in the reaping of "low hanging fruits" in developing countries and postponed actions for emission reduction in Annex 1 countries. Thus, LULUCF activities under the CDM have been a controversial issue during the global negotiations under United Nations Framework Convention on Climate Change.

In addition to genuine uncertainties connected to the difficulties in monitoring and verifying the climate benefits of LULUCF activities, there are several important issues that have to be addressed for satisfactory accounting of carbon credits from such projects. In order to establish *additionality* of the project, a *baseline* (i.e. a scenario depicting the development in the absence of the proposed project) must be set as a reference (Mendis & Openshaw, 2004). This is a difficult task since all eventual future scenarios in the absence of the project must be evaluated. This requires knowledge about the history in the specific area, the local socio-economic situation and wider economic trends, which may affect the future land use and carbon stocks. The risk of *leakage* must be minimized. Such leakage can occur if the project leads to local access to land, food, fuel and timber resources becoming restricted, forcing people to find needed supplies elsewhere. One basic principle is to take a debit for the lost carbon at the time of its occurrence, e.g. when abandonment of activities leading to carbon sequestration results in a loss of the stored carbon (Ravindranath & Sathaye, 2002). Finally, socio-economic and environmental impacts need to be addressed, including impacts on biodiversity and natural ecosystems (Boyd, May, Chang, & Veiga, 2007).

The rules for LULUCF activities that were agreed upon as part of the Marrakech Accords (COP7) also include specific regulations limiting the use of such activities to meet emission targets for the first commitment period. According to these regulations, only afforestation (planting of non-forested land) and reforestation (replanting of forest land) projects are eligible under the CDM (UNFCCC, 2001). Further, greenhouse gas removals from such projects may only be used to help meet emission targets up to 1% of an Annex 1 country's baseline for each year of the commitment period. The five carbon pools eligible within CDM is: AGB, below ground biomass (BGB), soil carbon, dead wood and litter.

The market for forestry CERs is still small with a limited supply and demand for credits. This is exemplified by only one registered A/R project today (March 2008) while there are 10 approved methodologies. The fact that there is only one registered project is a result of the complex methodological issues resulting in expensive procedures of validation and verification of the yet more complex crediting system. This complex process halter many project waiting to be registered.

The prospects for LULUCF activities in India

In India, estimates of the land classified as forest land ranges from 19% to 23% of the total area of 328.8 Mha (Ministry of Environment and Forests, 2004; Sathaye et al., 2001). This includes both natural forest and forest plantations. Forests are subjected to increasing pressure. However, India has succeeded relatively well in reducing the net deforestation rate (Ravindranath, Sudha, & Sandhya, 2001). This is mostly due to large afforestation programs. Plantations account for almost half of the forested land; giving a plantation area of 32.58 Mha, of which approximately 20% are planted with different acacia species. Estimates of the carbon stock in primary and logged forest in the humid tropics range from 192 to 276 tC/ha (IPCC, 2000). The estimated average carbon stock in the Indian ecosystems is 46 tC/ha (Haripriya, 2003). These figures include both AGB and BGB while our model figures consider AGB only.

Degraded land, in India called wasteland (Ravindranath & Hall, 1995), is often technically suitable for growing trees and can be regarded a promising land type to be used for LULUCF activities under the CDM. About 23% (75 million ha) of the Indian land area is considered wasteland. According to Sathaye et al. (2001) about 40% of this wasteland is considered available for forestation. The available area includes degraded forestland as well as pasture land, marginal cropland and other privately owned non-crop land categories (excluding the forest land and the area under roads, settlement, water bodies, sand, snow, etc.).

In addition to biomass, atmospheric carbon can be sequestered as SOM. Apart from being a carbon sink, increased SOM leads to stabilized soil structure, reduced erosion risk, improved ability to store and transmit air and water and nutrients needed for the growth of plants and soil organisms. Thus, SOM increases leads to benefits in addition to the climate benefits arising from the carbon sequestration. For India, a mean value of soil carbon has been estimated to 79.8 tC/ha, while estimates from the study area are 90.5 tC/ha (Haripriya, 2003).

There exists several possibilities to increase the rate of carbon sequestration in SOM in the agricultural sector (Olsson & Ardö, 2002), including: (i) crop rotations that contribute more biomass to the soil, (ii) increased use of green fallow rotation, (iii) use of natural fertilizers (green manure) and (iv) erosion control. Erosion control and the saving of waste biomass on the ground can also be applied in the management of forests and plantations.

The study site

Karnataka, Uttar Kannada, Sirsi

The state of Karnataka is situated on the West Coast in southern India and the district of Uttar Kannada is located along the coast in the north (Fig. 1). The area was chosen because of the mixture of natural forest and plantations. The district has a high forest cover at about 75% of the total area of 10,291 km^2 with four categories of forest: tropical evergreen, semi evergreen, moist deciduous and dry deciduous. The mean annual precipitation is 2742 mm and is driven by the southwest monsoon during June to September. The forest division of Sirsi (Fig. 1) contains smaller villages with an agrarian population. Main crops are rice and areca nuts.

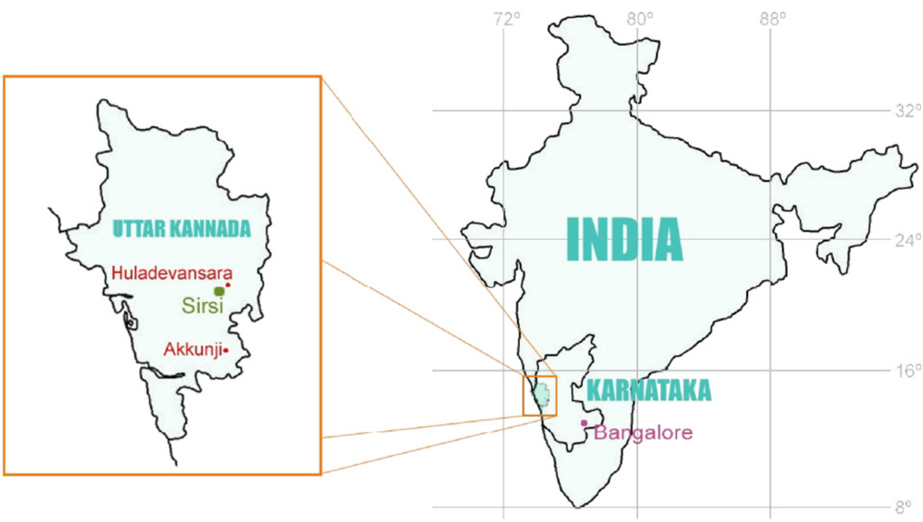

Fig. 1. Map of the study area: Karnataka state, Uttar Kannada District, Sirsi and the villages, Huladevansara and Akkunji used in this study.

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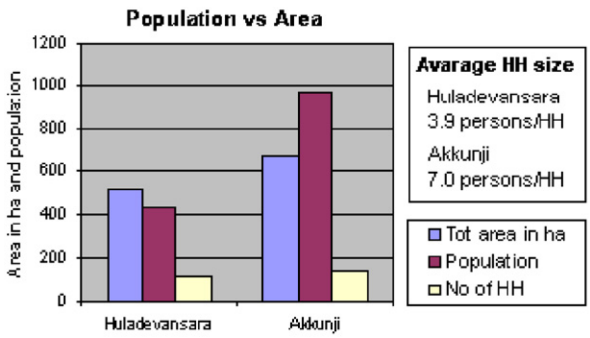

Fig. 2. Number of households, population and land is the two studied villages.

Forests and plantations in the villages

Two villages were included in this study: Huladevansara and Akkunji (Fig. 1). The villages were chosen because of their different experiences of plantations and their accessibility to natural forest. Three forest types were included in the assessment; natural forest and plantations with 5- and 10-year rotation periods. The natural forest is owned by the Forest Department but can be used by the village for non-timber forest products. The plantations are dominated by acacia (*Acacia aculiformis*) in short rotations and belong to the Forest Department. The soils in the natural forest are fertile and the plantations were established in more or less degraded forest areas. Cattle grazing and collection of dry leaves are allowed in both land uses.

The population in Akkunji is twice the size of the Huladevansara population (Fig. 2), while the village land size is somewhat similar in the two villages. The per capita land availability is consequently much lower in Akkunji than Huladevansara. The average household sizes also differ: Akkunji have seven persons per household while Huladevansara have four persons per household. These differences are important when discussing forest/plantation needs and pressures.

Data and methods

Fieldwork

Mapping

Existing village maps were used. The maps date back to the 1860s and have been rewritten continuously over the years. Based on land-use information from the maps, information from key-informants and walk-abouts with farmers, information of present day land use was obtained, according to methods by Bernard (1995). Through digitalization of the maps and analyses in geographical information system, the extent of the different land use was calculated.

Biomass

To get AGB data in natural forest and in homogeneous acacia plantations of two different ages, 5- and 10-year old, field quadrate method was used collecting data on number of stems and girth (Ravindranath & Ostwald, 2008). The 50 × 40 m plots were chosen randomly. Basal area/ha (BA) was calculated and used to estimate the amount of carbon from:

$$C_{AGB} = (50.66 + 6.52\mathrm{BA}) \times \frac{0.85}{2} \quad (1)$$

The numerator gives the dry matter weight of biomass, calculated from the BA using regression coefficients from Ravindranath, Murali, and Malhortra (2000) and accounting for a moisture content of air dry wood at 15% (FAO, 1983). The denominator arises from that half of the dry matter in biomass consists of carbon. The formula is general for Indian forest and holds limitations since crown size and height is not considered.

Soil sampling

Five evenly spread soil samples from top soil to 30 cm depth, as suggested by the IPCC (2003), were taken from the same biomass quadrates. Composite samples of 200 g from each quadrate gave mean values for each forest category. Soil carbon was analyzed using the Walkley-Black method (Hesse, 1971).

Interviews

Three types of interview methods were used, all with the assistance of an interpreter; several informal interviews for general information, two key informants for local information to distinguish relevance of further investigation, and 30 questionnaires for personal information regarding forest and plantation to be analyzed quantitatively. The last methods used three general groups to get village representation; farmers with privileged forest land,[2] rice farmers and landless villagers.

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Data processing and analysis

Assessment of yearly biomass carbon increments

The climate benefits due to carbon sequestration in AGB and soils in the different forest systems were assessed based on a 50-year perspective. For the acacia plantations we used our empirical field data for 5- and 10-year-old plantations, where the 5-year plantation are clearcut and replanted every 5 years, and for 10-year plantations a thinning practice every 5 years, clearcut and replanted every 10 years. Annual increment for primary forest stated by the IPCC is 1.75 tC/ha/yr (IPCC, 2000). According to Sathaye et al. (2001) figures ranging from 0.8 to 3.0 tC/ha/yr are acceptable for regenerated tropical forest. We used the mean value of this range, i.e. 1.9 tC/ha, as an annual increment for natural forest. The increment was assumed to proceed during the whole monitoring period of 50 years.

Since an A/R CDM project activities cannot include the use of the harvested wood within the system boundary, an assessment using project's boundary cannot consider the effects of different land use options in combination with different carbon storage times in wood products and/or fossil fuel substitution patterns. This result in a limited climate benefit modelling for CDM projects but is not a limiting factor for our assessment.

Ranking procedure

LULUCF projects have a broad range of environmental and socio-economic impacts that need to be taken into account when assessing the suitability for the CDM. The dual—and potentially conflicting—set of objectives in the definition of CDM adds an extra challenge: the design of a LULUCF-based CDM project activities may become a process of balancing disparate objectives of the parties involved (i.e. the objective of local sustainable development may require a project design that is different from the one maximizing cost-efficiency in CERs generation). This balancing process will be unique for each CDM project activity.

Here, we suggest a simple and transparent ranking procedure as a tool for processing the collected data in an integrated analysis of suitability of possible CDM project activities from the perspective of sustainable development and climate benefit. The ranking system is developed and applied on the studied forests and plantations. The procedure can of course be adapted for the evaluation of other candidate LULUCF activities under the CDM as well as of CDM project activities in general. Worth mentioning is that we have used parameters that were available from our study. Other parameters that could be relevant in a similar situation are issues such as other carbon pools, employment effects, social and community development, equity of returns and leakage.

To enable the ranking, a certain time frame has to be set, i.e. crediting period. The options for LULUCF based CDM project activities are either: (1) a maximum of 20 years which may be renewed up to two times, i.e. 60 years, if a Designated Operational Entity confirms that the original baseline is still valid or (2) a maximum of 30 years (UNFCCC, 2004b). The original baseline will be valid for the whole crediting period regardless of changes that may affect the additionality (UNEP, 2004). Here, the ranking was done considering a 30-year crediting period based on the maximum carbon stored during this time.

In the ranking, the parameters AGB carbon and soil carbon were chosen to exemplify carbon sequestration and therefore climate benefits and acceptance from villagers and land availability were chosen as sustainable development parameters. These parameters are not direct sustainable criteria but function as the basis for several sustainability co-benefits such as a financial flow to the project area, employment and development in infrastructure (Berndes, Börjesson, Ostwald, & Palm, 2008). Acceptance from villagers was used as one parameter which had already been revealed in the interviews as important for local sustainable development.[3] These two parameters are closely interlinked as a large acceptance will open up the possibility for larger areas planted. These parameters were assigned a ranking value of low (1), medium (2) and high (3) (for a full description of the weighing of these parameters see Appendix).

The assessment is based on the data collected for the two villages as well as AGB carbon from our increment model taken at 30 years. The AGB carbon values used for the ranking are 57 tC/ha for natural forest, 65 tC/ha for the plantation with a 5-year rotation and 70 tC/ha for the plantation with a 10-year rotation as found in Fig. 4.

Results

Fieldwork

The mapping exercise showed very little change over the past 100 years. Changes that were found included divided fields caused by partial conversion from rice to areca nut plantations, and encroachment in forest land due to agriculture and tree logging, and construction of water tanks.

[2] Forest land with user-rights belonging to a specific farmer who owns an areca garden.

[3] Rasul, Thapa, and Zoebisch (2004) show that sustainable land-use systems such as agroforestry, commercial plantation and horticulture evolve and flourish in areas where support and facilities were favourable. They suggest secure land tenure (available land) and necessary institutional support as an incitement for farmers to shift to an economically and environmentally suitable land use.

AGB and soil carbon analyses show that the natural forest has the highest AGB and hence carbon density (see Table 1). Worth noticing is that soil carbon in the 5-year old acacia plantation is higher than in the 10-year old, indicating a decline in soil carbon from the former land use, i.e. natural degraded forest, to a lower soil carbon stock under acacia plantations. However, the difference in carbon stock between the two plantations is probably too large to be affected by time only (IPCC, 2000), which indicates that the unknown land use history could have an influence. We found twice the number of stems in the 5-year plantation compared to the 10-year plantation. The decline in trees in the acacia plantations over time indicates thinning practice.

The total carbon stock figure for natural forest is however lower than earlier assessments on primary and logged forest at margins of the humid tropics (192–276 tC/ha) (IPCC, 2000). The variation in AGB carbon (65–117 tC/ha) of the different forest/plantation types is larger than that seen in the soil carbon (40–56 tC/ha).

From the questionnaires a general view concerning lack of timber for construction purposes was obtained. The group that had access to the privileged forest land received more forest products from privileged forest land compared to the natural forest, which can be explained by the geographical closeness of the privileged forest land compared to the natural forest and by the fact that the privileged forest land users have access to forest products unlike the natural or reserve forests. Plantations were used for grazing, collection of dry leaves, which can explain part of the low soil carbon in the acacia plantations (Table 1).

The number of products available to the farmers from the different forest types shows that all forest sources are used, although natural forest to a larger extent than privileged forest land (only used by the holders). Least products were taken from the plantations. Acacia plantations do not provide multiple products. A large part of the informants (47%) state that the government benefits more from the plantations than the villagers, while only 7% expressed this opinion for natural forest. The negative attitudes towards plantations are exemplified by the following quotations from respondents.

> Plantations brings problem to the ground water
> I don't like monocultures, they are not beneficial for local species and the biodiversity
> Monocultures benefit smugglers
> We don't need plantations. There is enough natural forest in this area

However, the majority of respondents agreed that all forest resources, including plantations, were beneficial for the village. Thus, the attitudes towards forests among villagers are positive but certain resistance was found against the plantations. This was mainly found in situations were the plantations were raised and managed by the Forest Department with no or little involvement of or user-rights to the village community similar to that found in Latin America (Boyd et al., 2007). Also in Nigeria Odihi (2003) found that government bodies does not consider the needs and demands of the local people in an afforestation programme. This ignorance results in major deforestation of the area. Odihi shows further that the success in a plantation project needs both the confidence and the participation of the people that work the land. Involvement and acceptance of the local people, supported by clear modalities on user-rights and revenue sharing, would be the crucial for a CDM project activity and its success and hence sustainable development.

Data processing and analysis

Based on the data given in Table 1 and the above quotations from respondents, natural forest regeneration appears to be the most attractive CDM project activity, both when considering the long term potential for carbon sequestration and local sustainable development. However, the presentation of the carbon dynamics over a 50-year period in Fig. 3 provides additional perspectives. It is clear from Fig. 3 that plantations sequester more carbon per year than natural forests, which in this case is modelled as natural regeneration with an initial carbon stock of 0 tC/ha. It is also clear that each time the plantation is harvested and the wood products are sold, the export of the wood to outside the CDM project boundary will lead to biomass carbon losses from the CDM project activity similar in size as the carbon gained during plantation growth.

The two plantation options may also differ when it comes to the economic performance and the local sustainable development objective. For example, the 5-year plantation may generate a larger accumulated climate benefit over time (depending on how the wood products are used, an issue for future CDM development). But it is also subject to larger costs than the 10-year plantation, since it will include additional labour managing the plantation. On the other hand, the additional labour requirements are beneficial in a CDM context, since employment generation as a rule is regarded positive for the local population. The choice of a plantation with a 5-year rotation could also be positive in terms of flexibility since

Table 1
Above ground biomass and soil carbon in the three different forest/plantation types

	Natural forest	Acacia 10 years	Acacia 5 years
AGB[a] carbon (tC/ha/yr)	117	70	65
Soil carbon (tC/ha/yr)	56	40	51
Total stock (tC/ha/yr)	173	110	116

[a] Above ground biomass.

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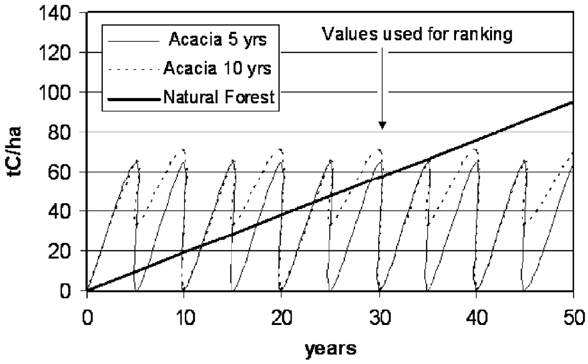

Fig. 3. Modelled sequestration potential from the studied natural forest plantation systems under the different rotation schemes; 10 years and 5 years. The 10-year rotation system practiced thinning on the 5th year, hence a dip in carbon content.

Table 2
Ranking of suitability of forest project implementation

Parameters	Villages					
	NF		10 yrs		5 yrs	
	A	H	A	H	A	H
C sequestration i.e. climate benefits						
C AGB[a]	M	M	M	M	M	M
C soil	M	M	L	L	M	M
Local sustainable development						
Acceptance	H	H	M	L	M	L
Land availability	H	L	H	L	H	L
Total	10	8	8	5	9	6
w/o C AGB	8	6	6	3	7	4
w/o C soil	8	6	7	4	7	4
w/o Acceptance	7	5	6	4	7	5
w/o Land availability	7	7	5	4	6	5

NF, natural forest; 10 yrs, 10-year plantation; 5 yrs, 5-year plantation; A, Akkunji; H, Huladevansara; L, low (1); M, medium (2); H, high (3); w/o, without. For parameterization, see Appendix.

[a] Above ground biomass.

the crediting period is short and the risks following a long rotation projects are less. If the soil carbon is taken into consideration, the 10-year plantation would be more beneficial since the soil would be less disturbed leading to a larger accumulation of soil carbon (Olsson & Ardö, 2002).

From the ranking it is clear that the natural forest is ranked high both in terms of climate benefits and sustainable development, higher than the plantations in some cases. However, a mature natural forest would never exist in a 30-year time frame with the present modalities for CDM (Table 2). However, with a slow A/R CDM development and with a global increased concern regarding avoided deforestation, the issue of natural forest and its benefits are worth pointing out. Conserving natural forest and functional plantations are interlinked (e.g. found by Köhlin & Ostwald, 2001). Plantation is a more likely CDM alternative and will be discussed from hereon. According to our result based on the four parameters (AGB carbon, soil carbon, acceptance and land availability), the 5-year rotation plantation in Akkunji is the most suitable project for CDM. This is due to high AGB carbon and high land availability. The least suitable project type would be the 10-year rotation plantation in Huladevansara. This is due to low soil carbon, low acceptance and low land availability.

The proposed method can preferably be used on any implementation initiative that would like to assess sustainable local development and carbon sequestration potential. Hence, its strength in flexibility and transparency is not limited to A/R CDM projects.

When different parameters are excluded the variations in local condition becomes visible. This will help pinpointing the differences, which can show great importance when it comes to choosing the area for a project. In this case the exclusion of parameters shows the effect of land availability. Akkunji has a high availability, while Huladevansara has little available land for a plantation. Such local variations will be of great importance for parameterization of the appropriate variables in a possible bundling scenario for A/R CDM project activities (UNFCCC, 2004a).

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Discussion

One of the reasons behind earlier land use changes, which were stated by farmers, was maximization of returns from farm work. Sections of the traditional land area used for rice have been converted into areca nut plantations, due to a higher profit from areca nuts production. Thus, farmers with access to land will change to the practice that gives the highest return. This indicates that potential CDM project activities that will result in direct financial benefits to the land users are likely to be accepted on the local level.

The results generated from this study are site specific. Two variables of particular importance are: (i) the local populations' need of forests and forest products and (ii) land availability. In this area, the forest cover is in general high and thus raising new forest resource is less desired than what is the case in many other parts of the Karnataka State, although there is a large difference between the two studied villages. Land availability in the study area is also low compared to eastern Karnataka, making A/R CDM establishment less attractive. However, land availability is not necessarily associated with the presence of wasteland alone since degraded forest, still classified as forest, and unsuccessful plantation areas might be locally available.

Data gathered from another location would most likely bring about other variable that could be important for the ranking procedure. To explore these crucial factors to sustain forest initiatives such as A/R CDM projects, a great meta-study of a larger number of cases would have to be assessed. This is a recommendation for future research.

The ranking exercise considers four parameters that are central from a CDM project perspective. However, for a successful CDM project implementation there will be more factors that will be of importance, such as increased job opportunities and barriers related to lack of technical competence, as mentioned above. Here, it is also relevant to mention co-benefits that can be associated with a project, dealing with impact on economy, environment and social aspects (Berndes et al., 2008). Those co-benefits are considered in this paper by using the parameter of local acceptance but could be separated into individual components to ensure specific attention in a ranking exercise. Furthermore, a ranking within a widened system, e.g. considering the effects of different uses of the harvested wood, could change the picture.

This study illustrates the sometimes conflicting aims in the CDM objectives, i.e. the climate benefit and the sustainable development. The ranking exercise provides a tool which considers parameters of relevance in an objective manner, while at the same time showing that the effect varies from different types of forest projects at local level.

However, the implication of this type of assessment integrating multiple local specific issues into a flexible and transparent ranking tool can be a way forward for any forest and land sequestration proposal within the scope of international climate negotiations, particularly the post-Kyoto setup.

Conclusions

Based on the results of the ranking exercise, a visualization of the relation between sustainable development and climate benefits can be made (Fig. 4). From this, the following conclusions can be noted:

- Natural forests are the most preferred forest resource in both villages, when sustainable development parameters are considered.
- Fulfilment of the sustainable development criteria is to a higher extent associated with finding the right village than finding the right forest type for a CDM project activity.

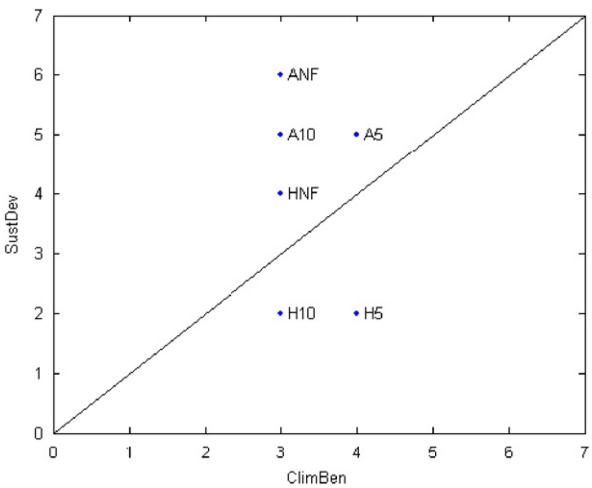

Fig. 4. Conceptual position, in terms of local sustainable development and climate benefit, of the possible projects based on the data from our ranking exercise in Table 2. NF, natural forest; 10, 10-year plantation; 5, 5-year plantation; A, Akkunji; B, Huladevansara.

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- The 5-year rotation is consistently ranked higher than the 10-year rotation.
- The proposed ranking tool proved to be flexible and transparent for assessing local sustainable development and carbon sequestration potential. Hence, it is not limited to only A/R CDM projects.

One recommendation that can be made based on these observations is a two-step procedure. Initially, in order to ensure sustainable development, carefully select a village having land available for forest activities and also an adequate forest resource need. After that, CDM project activities can focus on maximizing the climate benefits, preferably associated with multiple co-benefits.

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Appendix. Ranking parameters

Sustainable development

- Land availability
  (1) No land
  (2) Land available for alternate land use
  (3) Available wasteland and degraded forestland
- Acceptance
  (1) Majority of negative views on plantations
  (2) Mixed views on plantations
  (3) Majority of positive views on plantations

Climate benefit

- AGB carbon[4]
  (1) <55 tC/ha
  (2) 55–125 tC/ha
  (3) >125 tC/ha
- Soil carbon[5]
  (1) <50 tC/ha
  (2) 50–110 tC/ha
  (3) >110 tC/ha

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[4] Mean calculated from study data, Haripriya (2003) and IPCC (2000) ± 35 tC/ha, 73% of total biomass gives AGB (IPCC, 2003).
[5] Mean figures taken from Haripriya (2003) ± 30 tC/ha.

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