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Studies and Research Related to CDM Afforestation and Reforestation Project Activities

Kiyono Yoshiyuki
Department of Forest Vegetation, Forestry and Forest Products Research Institute
Matsunosato 1, Tsukuba, Ibaraki, 305-8687 Japan

Abstract
Many of tropical grasslands were originally forested. The history of direct or indirect biomass use by local people is connected with the conversion from forest to grassland. Afforestation and reforestation activities under the Clean development mechanism (CDM afforestation and reforestation) not only control vegetation, but also replace local people's land-use systems with different systems. The success of a project depends on whether it is managed and run properly in collaboration with local people, who are supposed to play the primary role. Japan is one of the countries most enthusiastically doing afforestation and reforestation research in tropical countries. The government has already funded many study projects. Because the CDM is meant to reduce CO_2 and other GHG emissions, it stands to reason that there is much research on silvicultural technologies and especially biomass growth; nevertheless, not enough work has been done on the socioeconomic impacts on local people, or on understanding leakage, and on the impacts on biodiversity. This lack is also found in the international discussion on CDM afforestation and reforestation.

1. Successional Sequence of Secondary Plant Communities Caused by Human Activities

Many of tropical grasslands were originally forested. The history of direct and indirect biomass use by local people is involved in transforming forest to grasslands.

Figure 1 illustrates the successional sequence of secondary plant communities caused by human activities in the tropical rainforest. This example from Kalimantan, Indonesia (Kiyono et al. 2003) is basically the same for other Southeast Asian countries and New Guinea. The vertical axis represents the height of plant community from 0 to 50m. The horizontal axis represents the time scale of human activities from 0 to about 300 years. When slash-and-burn agricultural fields are made in primary forest or selectively logged forest (type A), the forest that subsequently grows is a pioneer small-tree forest (type C) whose trees are no higher than about 5m on average (Fig. 2). If slash-and-burn use is repeated but the fallow period is comparatively long (10 years or more), the same type of vegetation will reappear. Each time the vegetation is burned off there will be more pyrophytic plants. Pyrophytic plants are plant species burn well, but regenerate after fire. Ultimately such places will become forests dominated by pyrophytic trees such as *Schima wallichii*, *Vitex pinnata* etc. This type of pyrophytic forest is named type B. If the fallow period is short (2 or 3 years), shrub communities will replace the small-tree forest (type D), and the same kind of vegetation will reappear even if slash-and-burn is repeated with short fallow periods. Because small-tree pioneer and shrub vegetations themselves have low productivity, they are frequently converted to other land use (type F; square in the middle of the figure), such as planted forest, rubber plantations, orchards, agricultural land, or other uses. If this type of vegetation is abandoned because of fires spreading

from other places, or because of price down of agricultural produce, grasslands claim the land (type E). This happens because naturally growing trees and shrubs are weeded out for crop management. Grasslands (type E) and shrub communities (type D) burn readily and are maintained because fires stop succession. Because the sprouts of fire-resistant woody plants also grow on such lands, type B forests will establish themselves if fires do not come for a decade, but because fires in fact do often spread over the land; shrub communities and grasslands are maintained. Vegetation on land targeted for CDM afforestation and reforestation projects is mainly shrub community and grasslands. Types D and E vegetation are often found in mosaic with each other. Because COP9 set the vegetation height of such targeted land at under 2 to 5 m, while the vegetation of other types A, B, and C grows to heights of 5 m or more (Fig. 2).

Slash-and-burn farmers live on shrub lands. The owners of abandoned agricultural fields live on grasslands. People who started fires live on shrub lands and grassland. They are one of the stakeholders in CDM afforestation and reforestation projects. CDM afforestation and

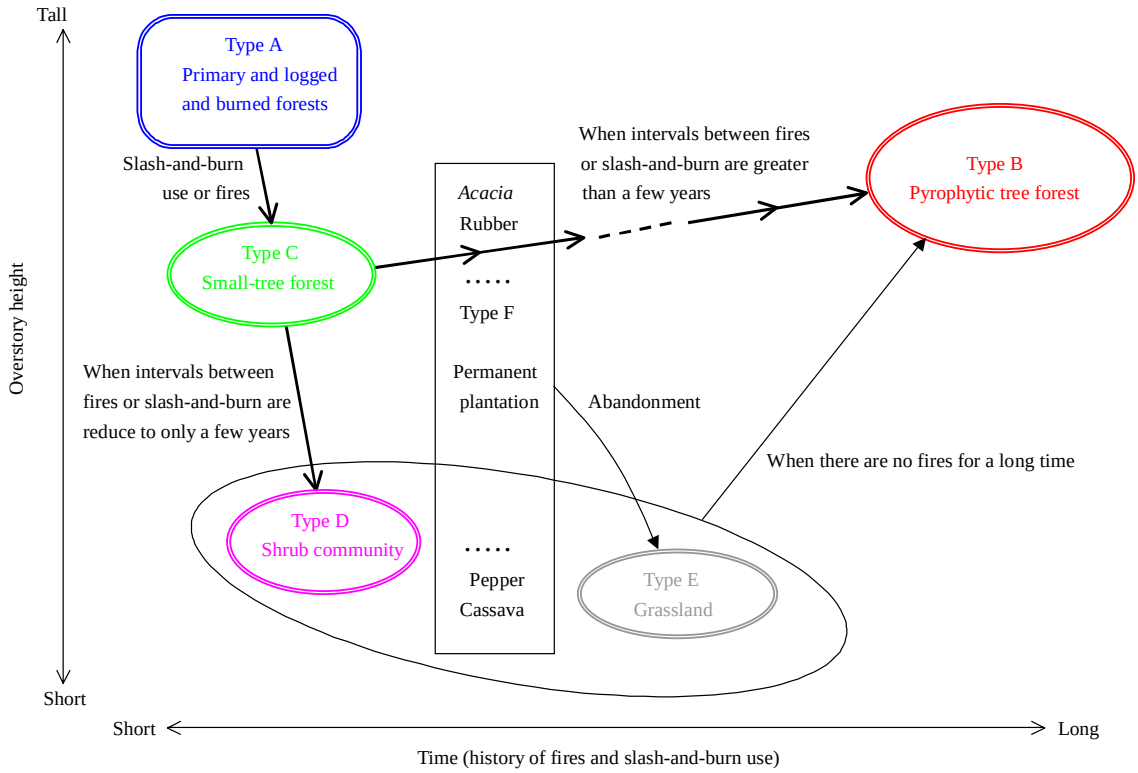

Fig. 1 Successional sequence of secondary plant communities in East Kalimantan, Indonesia (Kiyono et al. 2003, modified)

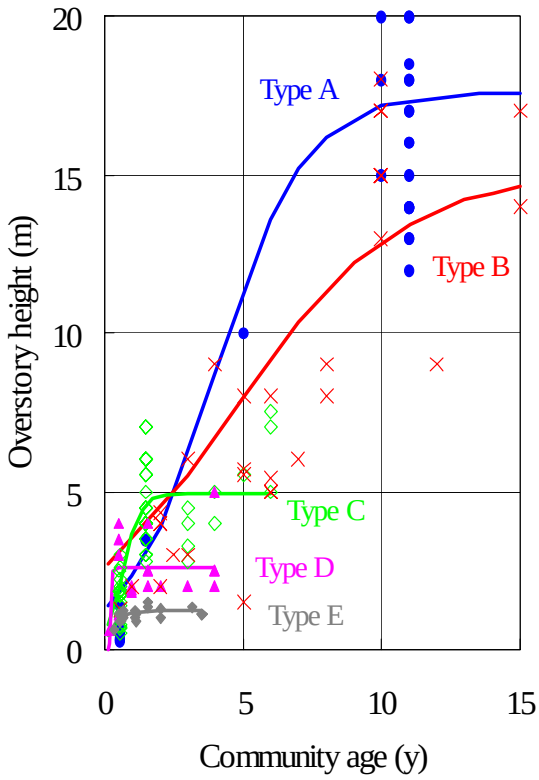

Fig. 2 Growth of mean overstory height in the secondary plant communities in East Kalimantan, Indonesia (Kiyono et al. 2003)

reforestation project not only control vegetation, but also replace local people's land-use systems with different systems. The success of a project depends on whether it is managed and run in collaboration with local people, who are supposed to play the primary role.

2. A Review of Studies and Research Related to CDM Afforestation and Reforestation

Japan is one of the countries most enthusiastic doing afforestation and reforestation research, and has performed many government-funded studies on tropical afforestation and reforestation. Table 1 shows the main studies performed since 1990s. The number of projects markedly increased since 1998.

"The Research Program of Reforestation of Tropical Forest" was commissioned by Forestry Agency and contracted by an association of many companies. This is continued for 10 years and developed technologies for forest rehabilitation and industrial forest plantation in the tropics.

The "Carbon Sink Project Promotion Study" was also supported by Forestry Agency. It is first full-fledged undertaking to assess the amount of CO_2 removals by forests. It is also investigated conservation-oriented ways to use timber, as in improving the yield of cut timber. Former Ministry of International Trade and Industry also made a project ("Basic Study for Facilitating the Introduction of New Energy Sources: A Study on the Assessment of CO_2 Fixing by Industrial Plantation") and assessed the CO_2 removals by industrial forests of mainly fast-growing trees.

Table 1 CDM afforestation and reforestation-related projects in Japan.

Project name	Supported party	Years	General Description	Silviculture	Carbon sink	Envi. impacts	Socioeconomic impacts	PDD	DOE	Capacity build.	Contracted party
Research program of reforestation of tropical forest	Forestry Agency	1991-2001	Technologies for forest rehabilitation and industrial forest plantation in the tropics	●							RETROF
Carbon sink project promotion study	Forestry Agency	1992-1996	Assessing CO2 removals by forest; conservative use of Forest Products		●						JIFPRO
Basic study for facilitating the introduction of new energy sources: A study on the assessment of CO2 fixing by industrial plantation	Ministry of International Trade and Industry	1998-1999	Assessing CO2 removals by industrial plantation		●						JOPP
Working group on baseline for CDM/JI project	Environment Ministry	1998-2000	Provide guidelines of PDD preparation					●			Pacific Consultants
Feasibility study on clean development mechanism	Environment Ministry	1999-	Feasibility studies of CDM/JI forestation projects; PDD preparation		●	●	●	●			GEP
Ecological impact assessment of tropical plantation forests on the environment	Forestry Agency	2000-2002	Environmental impacts of tropical planted forest using exotic fast-growing species	●	●	●					JOPP
Assessment on the potentiality of reforestation and afforestation activities in mitigating the climate change	Forestry Agency	2000-2004	Database of growth and forestation cost of planed forest using medium- and long-lived tree species	●	●						JIFPRO
Case study on validation and verification procedures of existing sink-oriented projects by DOEs	Forestry Agency	2001-2002	Provide case studies on validation and verification of AR-CDM projects by DOEs						●		JAFTA
Demonstration study on carbon fixing forest management in Indonesia	JICA	2001-2005	AIJ-expected project in Indonesia. Carbon credit; Charcoal technologies; cost accounting	●	●						
Project for developing technologies to promote AR-CDM	Forestry Agency	2001-2002	Analyses of AIJ forestry projects, assessing carbon sink and leakage, fertilizing technique	●	●		●				JIFPRO
Study of technological guidelines for JI, CDM afforestation and reforestation	Japan Paper Association	2002-	Information on CDM afforestation and reforestation; guidelines of PDD preparation					●			JOPP
Forestation basic data collection aiming at small scale afforestation/reforestation CDM in environmental planting	Forestry Agency	2003-2005	Small-scale AR-CDM projects in environmental planting. Simple methodologies for carbon credit, environmental and socioeconomic impacts, cost accounting		●	●	●				FFPRI
Project for studies on CDM-PDD guidelines	Forestry Agency	2003-2007	PDD examples for Asia, Africa, and Central and South Americas		●	●	●	●			JOPP
Baseline survey for afforestation and reforestation Clean development mechanism	Forestry Agency	2003-2007	Provide baseline maps for Asia, Africa, Central and South Americas	●							JOFCA
Capacity building program for AR-CDM Implementation	Forestry Agency	2003-2007	Train personnel involved in CDM afforestation and reforestation							●	JIFPRO

Environment Ministry set up the “Working Group on Baseline for CDM/JI (Joint Implementation) Project” at the same time to provide guidelines of PDD preparation, and then started another project (“Feasibility Study on Clean Development Mechanism”). It prepares examples of PDDs (project design documents) as feasibility studies of CDM/JI afforestation and reforestation projects). It estimates GHG removals by forest, and first deals with the environmental and socioeconomic impacts of CDM afforestation and reforestation projects.

The “Ecological Impact Assessment of Tropical Plantation Forests on the Environment” (Forestry Agency) took up the issue of environmental impacts by forestation using fast-growing exotic tree species, and assessed the environmental impacts of forestation with *Eucalyptus* spp. and other fast-growing species, including the impacts on nutrient, water, soil erosion, pests, biota, and carbon stocks. The “Assessment of Potentiality of Reforestation and Afforestation Activities in Mitigating Climate Change” (Forest Agency) is building a database of tree growth and cost of forestation by planting using medium- and long-rotation species in Thailand, Indonesia, Malaysia, and other countries.

Japan International Cooperation Agency (JICA) implements a project in Indonesia for the purpose of doing AIJ (Activities Implemented Jointly) forest management projects meant to increase carbon fixing. AIJ projects would precede CDM projects. This project is collecting ecosystem carbon data on forested land and baseline vegetations (the five carbon pools of aboveground biomass, belowground biomass, deadwood, litter, and soil), and on the development of technologies for increasing carbon sequestration by applying charcoal.

Accomplishment of the “ Project for Developing Technologies to Promote AR-CDM” (Forestry Agency) included case analyses of AIJ forestry projects, methodologies for assessing carbon

sequestration and leakage, and the development of technologies to increase carbon sequestration by applying fertilizer. This project was carried over by the “Forestation Basic Data Collection Aiming at Small Scale Afforestation/Reforestation CDM in Environmental Planting” (mentioned later). Last year (2003), the Forestry Agency did a second project to illustrate PDDs. This was its “Project for Studies on CDM-PDD Guidelines”. At the same time, the Forestry Agency began other projects whose purposes are training personnel involved in CDM afforestation and reforestation, and determining common baselines to be used over broad regions. These three newly started projects are meant for use in the Asia, Africa, and Central and South Americas regions.

An additional project was the “Case Study on Validation and Verification Procedures of Existing Sink-Oriented Projects by DOEs” (Forestry Agency), which provided case studies on validation, verification, and other ways to examine the adequacy of prepared PDDs by designated operational entities (DOEs).

Japanese government supports most of the projects, but paper industry (Japan Paper Association) is financing a project “Study of Technological Guidelines for JI, CDM Afforestation and Reforestation”. This is providing information on CDM afforestation and reforestation, and guidelines of PDD preparation.

Table 2 Fields of the CDM afforestation and reforestation-related projects.

Field	Number of projects
Silvicultural technologies	6
Carbon sink	9
Environmental impacts	4
Socioeconomic impacts	4
PDD (Project design document)	4
DOE (Designated operational Entity)	1
Capacity building	1

Overall, there are many projects dealing with silvicultural technologies and carbon sink, while projects for environmental and socioeconomic impacts are less (Table 2). They are conducted as a part of PDD preparation. There is one project dealing with DOEs and another project targeting on capacity building of personnel involved in CDM afforestation and reforestation.

Because the CDM is meant to reduce CO_2 and other GHG emissions, it stands to reason that there is much research on silvicultural technologies and especially biomass growth; nevertheless, not enough work has been done on the socioeconomic impacts on local people, or on understanding leakage, and on the impacts on biodiversity.

3. One of the first achievements of a FFPRI’s new project

Last year, Forestry Agency commissioned Forestry and Forest Products Research Institute (FFPRI) to do a project to research and collect information on small-scale CDM afforestation and reforestation projects in environmental planting.

COP9 defined that each small-scale CDM afforestation and reforestation project has having a maximum CO_2 removal of 8,000 t y^{-1} and procedures are simplified when there is the participation of low-income communities or individuals determined by the host party. Simple

measurement is necessary. This FFPRI's project targets to develop simple methodologies to calculate carbon credit; and to collect information on management systems, cost accounting, and environmental and socioeconomic impacts.

For small-scale environmental CDM afforestation and reforestation with medium- and long-lived tree species are planted and they are not necessarily clear-cut.

In the 1st year, the project selected a plantation forest on seasonally dry area in the Lombok Island, Indonesia. The project calculated carbon credit and conducted studies on environmental and socioeconomic impacts, with the cooperation of involved Indonesian agencies including Ministry of Forestry, as well as that of involved Japanese agencies such as Japan International Forestry Promotion and Cooperation Center (JIFPRO), JICA, and Institute for Global Environmental Strategies (IGES). The dry season lasts six months in the studied area.

Its vegetation includes some primary forest although it is converted to other land use such as slash-and-burn fields. There is much coppice forest recovering after logging, pasture having a long history of a few centuries (Monk et al. 1997), and slash-and-burn field. Even here forest will grow if there are no human impacts. But actually, logging, grazing, slash-and-burn agriculture, and fire by the local people maintain the vegetation in a non-forest state.

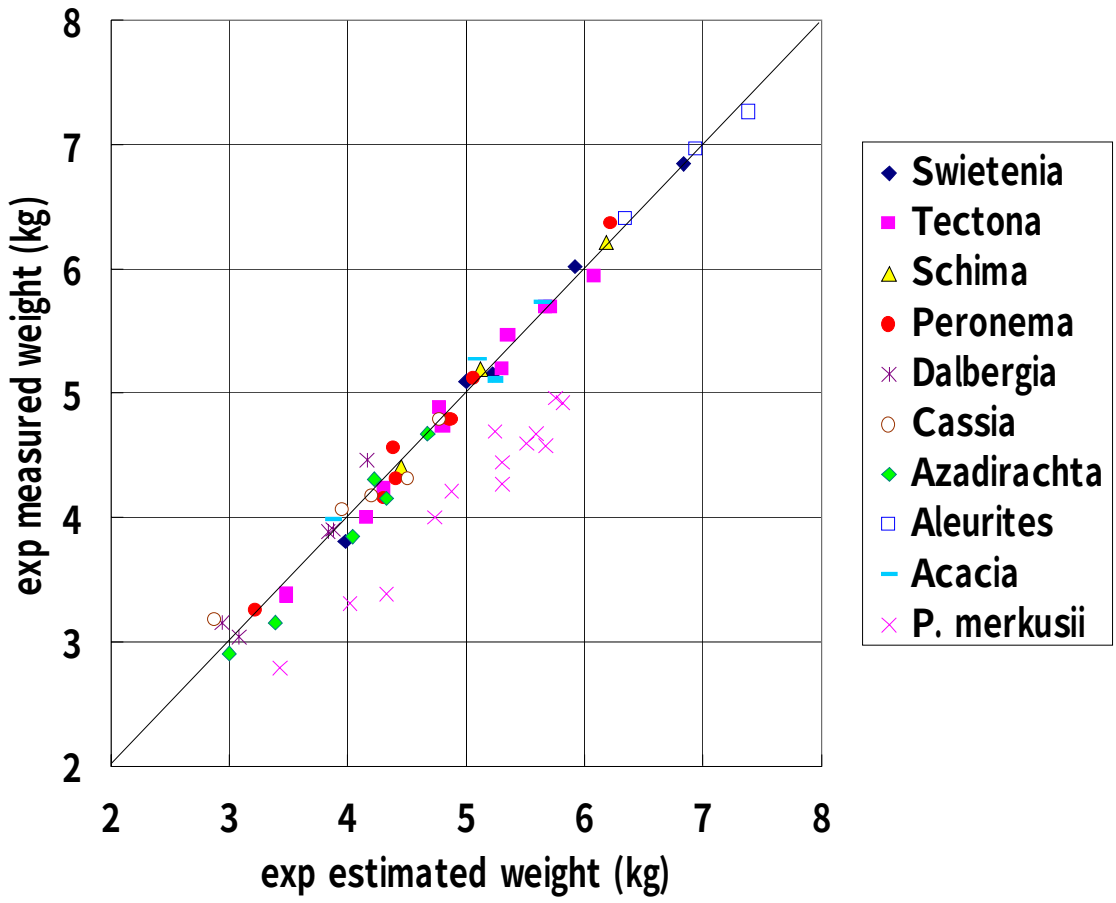

Fig. 3 Measured and estimated tree biomass of evergreen broad-leaved trees (Kiyono et al. 2004, data sources: Morikawa 2002; Gintings et al. 2003; Morikawa 2003a; b; JICA unpublished)

Probably under these conditions, tree planting was started by Ministry of Forestry in 1996. Medium- and long-live tree species were planted. They are *Dalbergia latifolia*, *Cassia siamea*, *and Melia azedarach* etc. In the planted forest, inter cropping was carried out.

One of the project's first achievements was developing methodologies for estimating carbon credit. The project obtained the following equation for biomass estimation with broad applicability for medium- and long-lived hardwood species (Kiyono et al. 2004, Fig. 3).

$$\text{Tree biomass} = 0.0167 \times \text{dbh}^{2.46} \times \text{Basic density}^{0.322} \quad (R^2=0.986)$$

Tree biomass data of Morikawa (2002; 2003a; b), Gintings et al. (2003), and JICA (unpublished) were used to determine parameters. If the hardwood tree species and diameter are known, this one equation will provide tree weight. Also, it looks as if the project will soon be able to release a method for estimating carbon stock changes in baseline and leakage. Using these methodologies and according to the definition of COP9, the project calculated carbon credit and obtained interesting results. "If non-forest vegetation is maintained because of agriculture and other activities by local people, and that as a result of the project, 100% of the activities by local people inside the project boundary have leakage outside the project boundary, then carbon credit is negative." This means that unless local people participate in a project on their own initiative and minimize their pre-project activities, that project may not succeed."

The conclusion of the methodology for estimating carbon credit, which was one of the FFPRI project's first achievements, is that "project success depends on whether projects are properly managed and run in collaboration with local people, who are supposed to play the primary role".

I therefore think it will be important to better our understanding of local people's socioeconomic matters. Good understanding will allow accurate predictions of CDM afforestation and reforestation project's socioeconomic impacts on local people, minimize leakage with fair management systems, and help projects succeed.

About biodiversity, there is little information(Sabarnurdin et al. 1998; Tomich et al. 1998; Bernhard-Reversat 2001). Conservation of endangered species and primary vegetation species and the problem of alien species, including GMOs, will be major challenges.

The foregoing review has concerned mainly Japan's achievements, but similar achievements turn up international CDM discussions. International bodies such as Food and Agriculture Organization of the United Nations (FAO) (Brown 1997), International Centre for Research in Agroforestry (ICRAF) (Tomich et al. 1998), International Tropical Timber Organization (ITTO) (2002), and Center for International Forestry Research (CI-FOR) (Muhtaman et al. 2000; Cossalter and Pye-Smith 2003), as well as organizations in other countries are also working in this area, but as far as one can tell from the results of recent CDM-related conferences in Taiwan (Taiwan Forestry Research Institute (2002)), Canberra (Booth 2003), Manila (Conference working committees 2003), and other places, their information differs little from that of Japan.

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