Introduction to the Methodology for Carbon Accounting of Bamboo Plantation Projects

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Abstract

This paper introduces the methodology for project level carbon sink of bamboo plantation and management. Carbon sequestration through bamboo plantation management is of significant importance in responding to climate change in the field of forestry in China. As a unique type of vegetation, bamboo plantation management is different from forest management, thus the available methodology for project level forest management carbon sequestration is not applicable for bamboo. In order to improve bamboo management for increased carbon credit, assessment and monitoring, ensure the certified carbon emission reduction (CCER) can be measureable, reportable and verifiable, and promote voluntary carbon emission scheme through bamboo plantation management for carbon credit, a new trial methodology for project level bamboo management carbon sequestration has been developed. This methodology includes applicability, baseline and carbon accounting methods.

Key words: Bamboo; carbon; methodology

Introduction

This paper briefly introduces the key principles and methods of the methodology developed by the International Network for Bamboo and Rattan (INBAR), Zhejiang A&F University (ZAFU) and the China Green Carbon Foundation (CGCF). The full methodology identifies the technical requirements when developing bamboo afforestation carbon projects, relating to its principles, conditions of applicability, project eligibility determination, selection of carbon pool, GHG emission sources, carbon leakage sources, baseline assumptions and investigation, project outlines, project monitoring plans, project carbon credit, etc, which can be referred to INBAR Working Paper No.73 (Zhou, G.M. et al. 2013).

1. Principles of methodological development

Bamboo plantations are unique forest resources that provide environmental and socio-economic benefits. In addition to increasing net carbon storage and therefore mitigating climate change, the local environmental and socio-economic benefits from the proposed project should be equal or better than the baseline assumptions, and should provide biodiversity protection, local employment, and additional income for participating farmers. The project should also improve the quality of life and living conditions for farmers, improve the eco-environment, increase the capacity for mitigating and adapting to climate change, and share benefits among stakeholders and project participants. Consequently, bamboo carbon projects should be conducive to building healthy and sustainable development for local communities.

The methodology is based on the tools, guidelines and procedures used in afforestation methodologies already available, issued by SFA (SFA 2008, 2010, 2011), and makes use of the tools, guidelines and procedures in related international carbon projects of the Clean Development Mechanism (CDM) (Clean Development Mechanism Methodology Booklet: Methodologies for Afforestation and Reforestation (A/R) CDM Project Activities) (UNFCCC 2010).

Principle of Conservatism: 'conservatism' refers to the approach towards estimating unknown variables, by which a conservative estimate of the project's effectiveness in sequestering carbon and generating credits will be obtained. For instance, the application of the principle of conservatism should result in an overestimation of carbon stock increases under the baseline assumptions, an underestimation of carbon stock increases resulting from the project, and finally an overestimation of carbon emissions caused by the project.

Transparency: this term is used in reference to the calculation methods and parameters used in the carbon accounting and monitoring. Apart from data which is of a commercially confidential nature, all other data and methods should be transparent, open to the public, and easily available.

Comparability: this term refers to the parameters used by the project for carbon accounting and monitoring being easily comparable with similar national and international projects. Detailed explanations should be given in cases where locally-generated data exceed the normal parameter scales of the IPCC or those of national level references.

Accuracy: The term relates to the adoption of necessary measures in carbon accounting and monitoring to refine the precision and accuracy of the carbon accounting and monitoring and to reduce uncertainty. An uncertainty analysis and related commentary in the monitoring report are required.

Principle of Cost Effectiveness: The cost of carbon accounting and monitoring is expected to naturally and exponentially increase with higher levels of accuracy and precision. Thus, when choosing carbon accounting and monitoring methods, extra consideration shall be given to cost-effectiveness, while due consideration is given to carbon accounting and monitoring accuracy. A rational balance shall be found between the accuracy and the cost of the carbon accounting and monitoring.

2. Applicability conditions

Land designated for the projects shall be suitable land for forestation, including non-forest land, sandy areas, and other suitable places, or those forest lands without stands, which have failed to regenerate to meet forestation standards, or certain limited non-forest land (such as agricultural land, and unused land.)

The land should be expected to remain in the original state or continue land degradation trends, with a carbon stock at a stable low level, in the absence of the project's afforestation activities.

The land conditions of the project should be suitable for bamboo growth.

The soil designated for the project should be composed of mineral matter, not organic soil; the project land does not include wetlands.

The project activities will not result in the displacement of households or villages.

No large-scale grazing activities are allowed within the project boundary under project criteria. The harvest of litter layer shall not be included in project protocol.

The project protocol should provide at least the same level of comprehensive socioeconomic and environmental benefits and effectiveness as that of the baseline, while the net carbon stock must be higher than that of the baseline.

3. Project eligibility

3.1 Land eligibility requirements

3.1.1 At the start of a project, positive proof that each plot of land included in the project activities shall conform to the following conditions:

The land shall be non-forested land since 2005, (inclusive of, but not limited to barren hills, non-designated forest land and land suitable for afforestation) or off-forest land (except for wetland and organic soil for rice).

The existing vegetation inside the plot does not meet any of the threshold parameters of the forest definition (i.e. the canopy cover maximum of 20%, the average tree height maximum 2 meters, the area less than 0.067 ha.)

The soil conditions of the project land should be suitable for bamboo growth, with projections of high carbon sequestration capacity. At the same time, afforestation can facilitate local forestry, social and economic development.

Clear and stable land tenure rights should exist, with land tenure certificates issued at or above the county level people's government and valid evidence of this.

3.1.2 Positive proofs of land use and the changes of land use for the project land since 2005.

In the case of a change in land use, where the land meets the above eligibility requirements since 2005, evidence is needed to demonstrate that the motivation of such a change was not the pursuit of the implementation of the project or emission credit generation.

3.1.3 The project owner or project implementer needs to provide one of the following proofs to verify the eligibility of the project land.

3.1.3.1 Aerial photos, satellite photos and other spatial data

3.1.3.2 A land use map, land coverage map, forest distribution map, or forest aspect map.

3.1.3.3 Site survey data of the project land and Participatory Rural Appraisal (PRA）, inclusive of survey methods and results.

3.1.3.4 Other written materials that verify the project land's eligibility, including certificates of tenure.

3.2 Project boundary requirements

3.2.1 Geographical boundary

3.2.1.1 Any afforestation project activity can be carried out on land plots of varying sizes. The size and boundaries of each plot must be specified.

3.2.1.2 The confirmation of the project geographical boundaries consists of ex-ante and continuous confirmation. Ex-ante confirmation aims at the study of land eligibility, project afforestation design and the estimation of project afforestation areas and carbon sequestration, while continuous confirmation will occur during the project monitoring activities. The precision of continuous confirmation should no less than that of ex-ante confirmation when determining the project geographical boundaries.

3.2.1.3 Ex-ante project boundary (project design boundary) may be determined by any of the following means

With a global positioning system (GPS, plane positioning accuracy of meters and above), using single-point positioning or differential GPS technology to directly measure inflection point coordinates of project site boundary.

Use land use/ land coverage map, forest distribution map and forest aspect map and high resolution geographical spatial data (satellite images, aerial photos) to directly read the geographical boundaries.

Sketching the project site boundary on a topographical map (scale ≥ 1:10000).

3.2.1.4 Continuous confirmation of the geographical boundaries suggested by using topographical map (scale ≥ 1:10000) or differential GPS technology or high resolution geographical spatial data to determine the actual project boundaries, with a tolerance of less than 5%. In case the functional boundary is outside of the project designated boundary, the functional boundary will prevail. The actual boundaries may exceed the project designed boundary due to bamboo's fast propagation. However, the areas outside the project designed boundary cannot be incorporated into accounting and monitoring.

3.2.2 Project time duration

3.2.2.1 The minimum project crediting period is 20 years and can be extended to 30 to 40 years, according to the demands of the carbon market, baseline re-design, and the character of bamboo growth.

3.2.2.2 Due to the nature of mature bamboo forest maintaining a stable biomass through shooting regeneration, selective harvesting can be carried out in line with the cost effectiveness principle.

Monitoring and verification will be performed every 5-10 years, and monitoring should be carried out after the selective harvesting

3.3 Additionality requirements

3.3.1 The project implementing entity is required to prove and elaborate on how the proposed management activities provide additionality, based on environmental, financial, technical and politic perspectives; the important aspects described below should be chiefly addressed:

How the project net carbon sequestration exceeds the expected change of carbon stock under the baseline assumptions, and thus positively contributes to climate change mitigation.

The project must prove that the existing financial and technical obstacles, in the absence of funding and technical support provided by the project, would cause the plot to remain in its existing state of land use for a prolonged period of time.

In terms of geographic nature and policy, the project must prove that the existing natural regeneration obstacles, in the absence of governmental forestation and reforestation plans, and the policy support provided by the project, would cause the land to remain in its existing state of land use or land degradation, thus leading to low carbon stocking and difficulty in increasing the carbon stock for a prolonged period of time.

3.4 Risk management requirements

3.4.1 A basic project risk management assessment shall be performed, associated with the Project's actions and plans, in order to abate the risks involved. For instance, the risk of non-permanence of carbon credit targets caused by the large area of bamboo gregarious flowering, fire, pest and snow damage, should be delineated, and a mitigation plan to reduce the lost by these risks should be produced.

3.4.2 An operational period of longer than 20 years requires justification and proof that the listed goal are achievable, especially in consideration of the stability of land tenure status, and the operational and financial viability of the project owner or implementing entity.

4. Selection of Carbon pool, GHG emission sources and leakage sources

4.1 Selection of Carbon pool

4.1.1 According to normal international practices and reflecting bamboo's special growth characteristics and the principles of conservatism, precision, and cost-effectiveness, and the applicability of this methodology, only two out of six carbon pools (namely above-ground biomass (AGB), below-ground biomass (BGB), litter, death wood (DW), soil organic matter (SOM), harvested bamboo product (HB)), have been selected for accounting and monitoring. The two carbon pools selected are namely AGB and BGB. Litter, dead wood (DW), and soil organic matter (SOM) could be neglected for their minor contribution to the project's net carbon sequestration and lesser (potential) emissions.

4.1.2 In exceptional circumstances, if it cannot be proven whether it is consistent with conservative principles when changes in soil organic matter are ignored; that is, whether or not implementation of the project causes soil disturbance significantly greater than in the baseline plot, resulting in a greater negative impact on changes in soil organic matter, then the soil organic matter carbon pool needs to be measured and monitored.

4.1.3 Harvested bamboo product (HBP), is an important carbon pool for the bamboo carbon forestation project. However, the current international climate negotiations have not yet reached a recognized measurement, monitoring, verification methodology for harvested forest product carbon storage. Existing domestic methodology research on HBP carbon storage measurement, monitoring, and verification is not yet mature and lacks systematic structure. Therefore, HBP will be not considered and included in this methodology until research parameters achieve maturity.

4.2 GHG emission sources

4.2.1 Fertilizing: the direct N_2O emitted from organic fertilizer and nitrogen fertilizer in the process of bamboo planting and silviculture.

4.2.2 Emissions from forest fires: emissions of GHGs (including CO_2, CH_4, N_2O) from any forest fires during the project period.

4.2.3 Emissions from nitrogen-fixing vegetation and forage production, as well as the movements and manure of livestock are considered negligible.

4.3 GHG leakage sources

4.3.1 Leakage from transportation vehicles: CO_2 emission from fossil fuel combustion vehicles used in the shipment of seedlings, fertilizer and bamboo products.

4.3.2 In accordance with the applicable conditions given, there is no applicable GHG leakage caused by fuel wood harvesting, farming, or grazing activities outside of project boundaries.

5. Baseline investigation

5.1 Survey of the baseline scenario

Descriptions and survey are required regarding the project land plots. These would discuss their past and current surface vegetation, land use, and human activities. Measuring the carbon stock changes of the project designated areas prior to the proposed bamboo carbon afforestation activities is required. Surveying methodologies using stratification are recommended in meeting the accuracy and cost- minimization requirements.

5.2 Baseline stratification

The following factors will be considered in terms of project land use and the condition of existing vegetation for sampling stratification purposes:

(1) Whether there exist scattered standing trees on the land; and the dominant tree species and their ages.

(2) The height and the coverage of the non-timber vegetation; in particular, the species and the coverage of shrub vegetation.

5.3 Baseline carbon stock change

5.3.1 The tools defined in the “Guidelines for Carbon Accounting and Monitoring of Afforestation Projects” (SFA 2011) shall be adopted in estimating the baseline carbon stock changes. The following presumptions will be adopted for making the estimates, in the order of applicability and based on cost-effectiveness principles:

5.3.1.1 The change of the AGB and BGB for non-timber vegetation (the original small bamboo groves and other shrubs) is zero;

5.3.1.2The change of litter carbon is zero;

5.3.1.3The change of soil organic carbon is zero

5.3.2 When the woody vegetation/timber (scattered trees) exist in the baseline plot, random sampling methods should be adopted to assess the plot and to measure every scattered tree's species, age, diameter at breast height, and tree height. Use correlate related species' growth curves (individual volume, volume), using biomass expansion factors at different times, to calculate AGB and BGB carbon stock of scattered trees.

5.3.3 When the baseline vegetation/timber (single-standing trees) mature (i.e. reach a stable status), the change of baseline carbon stock is zero.

5.3.4 In the case the height of the baseline bamboo vegetation reaches 2 meters with 2 centimeters of DBH or over, but the areas is less than one mu (0.067ha.) and bamboo coverage rate is less than 20%, it is assumed that the changes of AGB and BGB for this scattered bamboo vegetation is zero.

6. Project guidelines

6.1 Project carbon stratification

According to project afforestation and management technique models (afforestation timing, bamboo species used, planting density, cutting plan and intensity), the ex-ante stratification models used, and according to actual afforestation circumstances and monitoring results, appropriate adjustment of the plan is allowed, i.e. adjustments can be made to the ex-post stratification.

6.2 Project carbon stock changes

6.2.1 The project carbon stock variation from soil organic carbon can be treated as negligible when making the accounting estimate. Although in general, the overall trend of soil organic carbon storage of non-standing forest, barren land, and non-forest land defined in the methodology for bamboo plantations will increase in the longer cycle (crediting period).

6.2.2 The carbon stock changes are equal to the carbon stock changes of the bamboo plantation biomass (AGB & BGB), minus the carbon stock decrease in the original vegetation biomass caused by the project.

6.2.3 The AGB of the bamboo plantation is composed of bamboo culm, bamboo branches, and bamboo leaves, while BGB is composed of bamboo stumps, bamboo roost and bamboo rhizomes.

6.2.4 The estimation of the bamboo plantation carbon stock changes (AGB and BGB) will be carried out in two stages.

6.2.4.1 Bamboo plantation development until maturity (1-9 years for large DBH scattered bamboo stands；1-5 years for small DBH scattered bamboo stands；1-5years for clustered bamboo stands；1-6 years for mixed bamboo stands).

6.2.4.2 Stable stage of a mature bamboo plantation (the 10^{th} year and onwards for large DBH scattered bamboo stands；the 6^{th} year and onwards for small DBH scattered bamboo stands；the 6^{th} year and onwards for clustered bamboo stands；the 7^{th} year and onwards for Mixed bamboo stands.)

6.2.5 Bamboo plantation development stages (1) Scattered bamboo species: the carbon stock changes of AGB will be calculated according to the standing bamboo culm change equation (culms and age) and the single bamboo biomass allometric equation (biomass and age). (2) Clustered bamboo species: the carbon stock changes of AGB will be calculated according to bamboo afforestation cluster density, average bamboo cluster culms change equation (culms and age) and the single culm biomass allometric equation (biomass and age) (See Appendix C for biomass equation of main bamboo afforestation species).

6.2.6 If there are no models and parameters provided in this methodology for other regions or other bamboo species, it is a priority for the project owner, or the measurement and monitoring unit, to choose appropriate models and parameters suitable for local conditions. If there are no local applicable models and parameters in place, models and parameters for similar regions and bamboo species should be selected and used after verification, in accordance with relevant professional approaches, to develop the new model applicable for the local area.

6.2.7 If there is available an actual measurement model for BGB, it can be used for BGB or carbon stock estimation. Otherwise, BGB or carbon stock can be calculated on the basis of crown/root ratio of different bamboo species. (See Table 1 for Crown/Root ratios of main bamboo afforestation species).

6.2.8 After the development of bamboo forest, a stable stage occurs for a mature bamboo plantation. Due to the special nature of bamboo growth, bamboo shoots emerge and expand; meanwhile, selective cutting, taking out selected shoots and old bamboo culms should be applied, and thus, the existing above-ground biomass will be in a relatively stable and dynamic balance. Consequently, the change of bamboo biomass (AGB and BGB) carbon stock will be considered as zero when selective harvesting takes place after plantation maturity.

6.2.9 Bamboo selective cutting basically only removes the above-ground parts (bamboo culms, bamboo branches, and bamboo leaves), while the below-ground parts (bamboo stumps, roots and rhizomes) is still retained in the forest. So bamboo ground biomass carbon stocks will continue to increase. When bamboo forest reaches a stable phase, the yearly below-ground biomass carbon stock changes will be based on the annual selective cutting of above-ground biomass (or average selective cutting numbers of bamboo culms) and through ratio calculation of below-ground biomass and above-ground biomass for the bamboo species. The annual selective cutting above-ground biomass equals to ABG of stabilized bamboo forest divided by mature ages T for selective cutting (similar to the tree forest rotation cycle).

6.2.10 It is assumed that under project guidelines, scattered trees (excluding bamboo) and non-timber vegetation within the project boundaries all disappear during land preparation. The estimation of the original vegetation biomass decreases can be done by using the tools from the "Guidelines for Carbon Accounting and Monitoring for Afforestation Projects" by the SFA.

6.2.11 Harvested bamboo products' carbon stock

This category refers to the carbon stored in bamboo culms or bamboo products after mature culms are harvested within the project boundaries and within the crediting period (20 years). Based on the features of bamboo growth, cutting and regeneration, as well as the bamboo production after maturity, there will be a part of the carbon stock of bamboo AGB which will be regularly transferred into the bamboo products pool. Thus, the carbon stock in the bamboo products can be regarded as one of the project's carbon pool. However, it is not covered in the present methodology due to insufficient current knowledge about bamboo product applications, losses during production and the unknown course of product degradation and release of carbon into the atmosphere.

6.3 Project GHG emissions and leakage

6.3.1 Direct N_2O emission will be calculated on the basis of the amount of fertilizer used in the project design.

6.3.2 Emission from non-CO_2 GHG (CH_4 and N_2O) caused by forest fires cannot be estimated ex-ante.

6.3.3 The project GHG emissions will be calculated on the basis of the project afforestation design, which details the quantities of the bamboo plants and fertilizer used and annual cutting of bamboo, in addition to CO_2 emissions calculated on the basis of distance and means of transportation.

6.3.4 The project GHG emissions will be estimated by using the tools in the SFA specified "Guidelines for Carbon Accounting and Monitoring for Afforestation Projects". (See Appendix A for detailed accounting tools)

6.4 Project net carbon

The actual net carbon stock produced by the project will be: the change of the project carbon stock Minus the increased GHG emission from the project activities Minus The baseline carbon stock change Minus the leakage out of project boundary caused by project activities.

Reference

1. SFA. 2011. Guidance on Carbon Accounting and Monitoring of Afforestation Projects. The State Forestry Administration of China.

2. SFA. 2008. Guidelines on Carbon Afforestation, Beijing: China Forestry Publishing House.

3. SFA. 2010. Technique Regulations of Carbon Afforestation, The State Forestry Administration of China.

4. UNFCCC. 2010. Clean Development Mechanism Methodology Booklet: Methodologies for Afforestation and Reforestation (A/R) CDM Project Activities. UNFCCC.

5. Zhou G.M.; Shi Y.J.; Lou Y.P.; Li J.L.; Kuehl Y.; Chen J.H.; Ma G.Q.; He Y.Y.; Wang X.M, and Yu T.F. 2013. Methodology for Carbon Accounting and Monitoring of Bamboo Afforestation Projects in China. INBAR Working Paper No. 73.