Project Specific or Performance-standard Baseline? Testing the alternatives for a forest carbon sequestration project

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Abstract

Several voluntary greenhouse gas (GHG) mitigation programs such as the DOE 1605(b), state, and private registries in the U.S., are now developing protocols for handling the many technical issues that arise in establishing project-based GHG mitigation accounting systems. One key technical issue is the establishment of a project baseline, which estimates the net GHG effects that would occur without the project. Baselines may be used to determine if project GHG reductions are additional to what would happen under business as usual.

Currently the World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD) are coordinating stakeholder development of a draft protocol for GHG project quantification methods that address key project technical issues consistently across sectors. This paper considers two baseline-setting approaches identified by WRI/WBCSD and evaluates their usefulness for evaluation of carbon sequestration in the agriculture, land use change, and forestry (AgLUCF). Given the spatially explicit nature of AgLUCF projects, the project-specific approach focuses on the characteristics of activities largely within project boundaries in determining the baseline. In contrast, the performance-standard uses regional information on the behavior of cohort groups to gauge what other landowners might do under conditions similar to the project.

We evaluate specific, though hypothetical, afforestation projects in the Lower Mississippi River Valley, USA, to “road test” the two baseline approaches considered in the WRI/WBCSD protocol. We identify data requirements, assess the pros and cons of each approach, and quantify the baseline and the difference in the potential GHG benefits generated under each approach.

1. Introduction

Policy alternatives to reduce the concentration of greenhouse gases (GHG) in the atmosphere include the development of sector- and location-specific GHG mitigation projects to offset emissions generated by other sources. Project-based approaches to GHG mitigation are gaining ground domestically in the U.S. through various voluntary programs, such as the registry of GHG emissions via Section 1605(b) of the Energy Policy Act of 1992, and GHG reduction commitments under the Chicago Climate Exchange. Moreover, initiatives such as Joint Implementation (Article 6) and the Clean Development Mechanism (CDM, Article 12) of the Kyoto Protocol have advanced project-based approaches to GHG mitigation at the international level. As a result, protocols are now being developed for handling the myriad technical issues that arise in establishing project-based accounting systems for GHG reductions.

One category of GHG offset activities that has received much attention is in terrestrial carbon sequestration in agriculture, land use change and forestry (AgLUCF). Many of the AgLUCF sequestration options have relatively low opportunity costs (McCarl and Schneider 2001), therefore only a small incentive may be necessary to favor their adoption. And AgLUCF activities are spatially dispersed changes in the way that land is allocated and managed. As a result, they often have ancillary effects on non-GHG environmental outcomes such as water and air quality, biodiversity, and aesthetics (Noble et al. 2000, Pattanayak et al. 2003). Taking all this together, policymakers have turned their attention to the AgLUCF sector as a potential source of mitigation projects with potentially low costs and high co-benefits.

The goal of many GHG policies is to reduce GHG emissions and ultimately reduce atmospheric concentrations of GHGs. This can occur by reducing the amount of GHGs emitted to the atmosphere and/or by increasing the amount of GHGs removed from the atmosphere through carbon sequestration. GHG policy has primarily focused on reducing emissions from large sources such as fossil fuel combustion in the production of energy. However, the notion of offsetting energy-based fossil fuel emissions by reducing net emissions from other sources and/or locations at a lower cost has gained some acceptance as an economically efficient alternative to narrowly defined emission reduction efforts. This has been called an “offset” approach to GHG mitigation.

In developing protocols for GHG mitigation projects that generate offset credits, it is important to recognize that a purchased offset credit may allow the buyer to emit a corresponding quantity of GHG. Therefore, for this offset system to offer a high level of environmental integrity, the exchange of an emission reduction or sequestration credit for an allowable emission increase should result in no net increase of GHG emissions. In other words, the terms of trade between debits and credits should be one-for-one.

The concept of project additionality arises, in GHG policy discussions (e.g., IPCC 2000) to identify the extent to which the associated amount of emission reduced or sequestered is additional to that which would occur without the project, or under business as usual (BAU) conditions. If offset crediting is granted for activities that would occur anyway in the baseline, then it is not effectively offsetting the emission that is allowed by the emitter generating the offset in the first place. So determining additionality from the baseline conditions or BAU is effectively an attempt to make sure the atmosphere is “made whole” by the credit exchange.

Two fundamentally different approaches to setting project baselines have evolved over time (e.g., IPCC, 2000). The first is essentially a bottom-up approach, wherein each project developer asserts a baseline based on the particular circumstances of the project. This is commonly referred to as a *project-specific* baseline. The alternative is a *top-down* approach, which uses more aggregate, regional information for the nation/sector/region in which the project is located to determine a likely baseline for the project in question. The top-down approach has also been called a *performance-standard* (WRI/WBCSD 2003), benchmarking (Hargrave et al. 1998), multi-project, or regional baseline.

Each approach has its advantages, but the bottom-up approach has been the dominant approach for the limited number of GHG mitigation projects that have been tested to date. However, the prospect of each project developing its own independent baseline raises questions about cost efficiency and consistency across projects. One reason for the dominance of bottom-up baselines to date may be the lack of a coordinated effort to date to evaluate methods and data for the top-down approach.

In this paper we evaluate both approaches as options in a baseline-setting framework below then apply them to quantify the baseline for a hypothetical afforestation carbon sequestration project in the lower Mississippi Valley, USA. The purpose of the direct comparison is to determine the applicability of each approach to one of the more commonly proposed forms of sequestration activity in the U.S. In particular, we want to determine whether pre-existing natural resource data sets can be used to develop top-down performance-standards with some degree of spatial refinement appropriate to project-level application. The paper concludes with some inferences drawn from the analysis, and suggestions for more research into areas that will inform baseline development.

2. Additionality and Baselines in Current Project-based Programs

Several GHG project-based reporting programs have evolved in the U.S. and abroad. Table 1 lists some of these programs and provides a brief synopsis of their requirements for demonstrating additionality and the baseline approaches referenced. Foremost on the domestic front in the U.S. is the voluntary GHG registry set up under Section 1605(b) of the Energy Policy Act of 1992. Reporting guidelines were initially established in 1994, but they are currently being revised during 2003-04. However, much of the focus in the draft revised guidelines is on entity-level, rather than project-level reporting. Project reporting does not have an additionality requirement, though reporters are encouraged to identify a reference case to represent baseline conditions. Other than that, relatively little attention is paid to the issues of additionality and baselines in the 1605(b) guidelines.

Another relevant program in the U.S. is the Chicago Climate Exchange (CCX), a four-year pilot demonstration program that enables GHG emissions reduction agreements and trades among the exchange's voluntary participants. Participants in the CCX agree to reduce GHGs from some base-year level and are allowed to meet these voluntary commitments, if they choose, by purchasing offset credits from AgLUCF carbon sequestration projects. The CCX does not have an explicit mandate for additionality and appears to address this implicitly by heavily discounting the credits assigned to a carbon offset project below what they believe is actually being sequestered on the ground (Walsh 2004).

Table 1. How Different Emerging GHG Project Reporting Programs are Addressing Baselines and Additionality

Program	Requirements for Demonstrating Additionality	Baseline Approaches Referenced
Domestic U.S		
Section 1605(b) of the Energy Policy Act of 1992 (2003-04 draft revisions)	Demonstration of additionality is not required for project-level reporting.	Subjective identification of baseline reference case suggested for projects. Entity reporting uses historic baseline (e.g., 1987-90).
Chicago Climate Exchange (CCX)	None	None
Climate Trust	Projects must demonstrate additionality to receive credits.	Project-specific baselines submitted by project developers
International		
Kyoto Protocol Articles 6 (JI) and 12 (CDM)	Project GHG effects must be additional to what would occur under baseline conditions in order for credits to be exchanged under Articles 6 and 12.	Guidance is given in Para 48 of the Marrakesh Accord (2001), which addresses both project-specific and standard-type baselines. Baseline methodologies are subject to review and approval by governing body.
WRI/WBCSD Draft Greenhouse Gas Protocol: Project Quantification Standard.	Draft states "if a project is to be used as an offset or a credit, the procedures to select a baseline scenario must address additionality and demonstrate that the project itself is not the baseline scenario."	Three options identified: • Project specific • Performance-standards • Retrofit standards

The Climate Trust is an independent organization, based in Oregon, that assembles funds from different sources to develop GHG offset projects. The Climate Trust's actions are largely driven to enable cost-effective implementation of the state of Oregon's first-in-the-nation legislation to control the emissions of carbon dioxide. The Climate Trust guidelines clearly state that project emission reductions (sequestration) must be additional to BAU for crediting purposes. The baselines used to determine additionality are project-specific, in that the baselines are asserted by project developers and are subject to review and acceptance by the Climate Trust. In addition to the Oregon program, there are other state programs and initiatives peppered throughout the U.S.

that have project-based components to them (e.g., New Hampshire and Wisconsin) but their requirements for additionality and baselines vary.[1]

Moving to an international perspective, the dominant system worldwide for project-level reporting requirements is the Kyoto Protocol, although the U.S. and some other countries are not a party to the Protocol. Emission commitments can be offset in part by project-based reductions in either Annex I countries (the Joint Implementation (JI) provisions of Article 6) or non-Annex I countries (the Clean Development Mechanism (CDM) of Article 12). In either case, additionality is a strict requirement for project credits. The Protocol does not prescribe methods for developing baselines, however, paragraph 48 of the Marrakesh Accord to the Kyoto Protocol (UNFCCC 2002) includes the following language about what is permissible for project baselines.

> *In choosing a baseline methodology for a project activity, project participants shall select from among the following approaches the one deemed most appropriate for the project activity, taking into account any guidance by the executive board, and justify the appropriateness of their choice:*
>
> > *(a) Existing actual or historical emissions, as applicable; or*
> >
> > *(b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment; or*
> >
> > *(c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.*

This guidance seemingly allows bottom-up and top-down approaches.

Recognizing the emergence of competing project-based programs for GHG mitigation, the World Resources Institute (WRI) and the World Business Council on Sustainable Development (WBCSD) have engaged in a joint effort to provide guidance and consistency on project-level accounting across these different types of programs. The WRI/WBCSD Project protocol process outlines different approaches to project quantification in general, and baseline-setting in particular. The GHG protocol being developed by WRI/WBCSD clearly states that projects being considered for use as an offset or for the generation of credits, result in reductions that are additional to what would have occurred absent the project. The protocol then outlines three approaches to selecting the baseline, each with specific steps to ensure that the project being evaluated is in addition to the baseline conditions.

The program descriptions in Table 1 suggest no consensus on either additionality or baseline methods in the various systems. Nonetheless, a few patterns emerge. Those programs that are more prescriptive (e.g., Kyoto and Climate Trust) do require additionality and do provide some guidance on what they expect from a baseline. These baseline expectations, by design, stop short of prescribing specific methods. The WRI/WBCSD protocol aspires to harmonize across these programs as much as possible and establish a consistent framework for reporting. The WRI/WBCSD and Kyoto approaches recognize the dichotomy of bottom-up and top-down approaches and hold

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[1]This discussion of domestic, state and international GHG mitigation programs benefited from material posted on the web by Christopher Loreti of Battelle, Robyn Camp of the California Registry, and Michael Gibbs of ICF Consulting (www.climateregistry.org/docs/EVENTS/GHGRegistries_Compared.pdf).

open the possibility that either approach can be followed under the appropriate circumstances.

In the sections that follow we apply the draft WRI/WBCSD framework for baseline-setting to an afforestation case study in the lower Mississippi Valley, USA. The WRI/WBCSD approach is chosen for several reasons: (1) it addresses both the project-specific and the top-down performance-standard approaches, (2) it attempts to establish a consistent reporting framework across various candidate project-based programs, and (3) it is one of the more fully developed draft guidance's at this point. The 1605(b) draft revisions at the date of writing are not yet public or sufficiently detailed to allow similar comparison. Through applying this approach to our case study we identify advantages and shortcomings of the protocol's baseline setting approaches.

3. The WRI/WBCSD Project Quantification Protocol

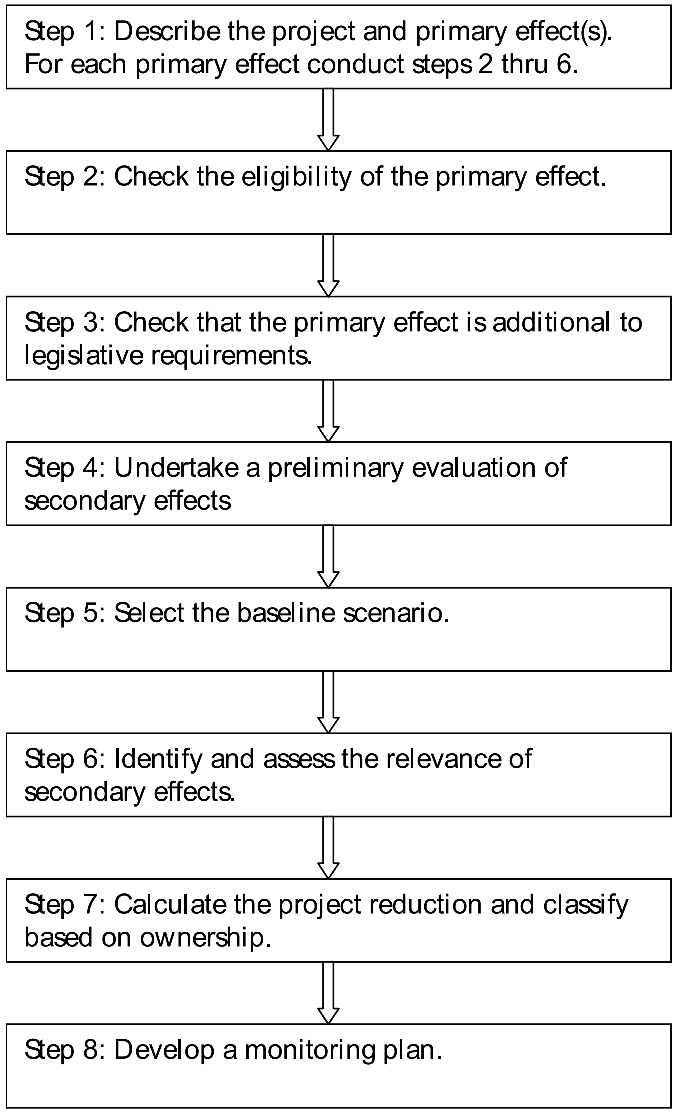
As indicated above, the WRI and WBCSD are together developing a protocol or methodological guidance for the quantification of GHG mitigation projects. The underlying goal of this process is to harmonize project accounting methods across different sectors and institutional settings. Baseline development is just one part of the project quantification process, but it is an important and technically challenging component.

The Project Quantification Process

WRI/WBCSD describe project quantification as an eight step process (see Figure 1). The first four steps are preliminary description and scoping tasks which define the activities targeted by the project, identify their primary and secondary effects and initially assess whether the project is likely to lead to real and substantial GHG reduction benefits. These steps are summarized below in the Mississippi case study description and introduction. Once these initial steps are conducted, Step 5 establishes the project baseline. Here the decision between the project-specific and performance-standard baseline-setting approaches must be made. Most of the remainder of the paper is focused on distinguishing and testing the two approaches for a sequestration case study.

After the baseline has been established in Step 5, the remaining project quantification steps use the baseline projection to estimate the extent to which the projects GHG mitigation effects are additional to what would occur in the baseline. This involves quantification of the direct effects of the GHG project in Step 6. This is followed in Step 7, the estimation of project secondary effects such as leakage, lifecycle, and cross-gas effects. Finally, Step 8 calculates the net project GHG effects, which takes the gross GHG effects from Step 6 and backs out baseline effects from Step 5 and secondary effects from Step 7. The net effects from the Step 8 process quantify the project contributions to GHG mitigation and could form the basis for credit quantities in an offset system.

Figure 1. WRI/WBCSD Project Quantification Process



3.2 Baseline-setting alternatives: Performance-standard vs. project specific approach

The WRI/WBCSD protocol actually considers three alternative approaches for baseline-setting: (1) Performance-standard, (2) Project specific, and (3) Retrofit standard. The retrofit option is not relevant for AgLUCF sequestration options and will not be discussed further in this paper.

The performance-standard baseline is a top-down approach that draws on the behavior and outcomes (observed or modeled) for the relevant sectoral or regional cohort group for the project at hand. In the case of AgLUCF sequestration projects, the outcomes of interest are associated with land use and management practices of landowners engaged in similar
activities in the region. As such, this type of baseline is often referred to as a regional

baseline for AgLUCF purposes. For now, the term "region" is used loosely, as it can refer to large geographic areas or very small ones, depending on the heterogeneity of the landscape and the ability to discern differences in land use patterns across the landscape. The underlying notion of the top-down approach is that these land use/management actions represent what can be expected to occur absent the project, based on the outcomes of similar parties. The baseline estimate may initially be expressed as the rate of land use change or management practice adoption, but ultimately will need to be expressed in units of GHG per unit of area or unit of output. This top-down performance-standard can then be applied to similar projects for baseline-setting in the same geographic region.

The project-specific (bottom-up) approach essentially develops a detailed case study of the proposed project's attractiveness relative to other viable alternatives. The project activity and its alternative candidates are subjected to several tests aimed at identifying the most likely land use or management activities absent the project. Unlike the top-down approach, this baseline is applicable only for the specific project in question. At the end of the process, one determines which of the discrete alternatives is most likely to arise and refer to this as the baseline activity. If the activity proposed for the project is chosen as the baseline activity, the project is deemed to be non-additional. However, if one of the non-project alternatives is selected as the baseline, the project is deemed additional and GHG reductions (sequestration) beyond the GHG effects of the baseline activity could be eligible for crediting under programs with an additionality requirement.

4. Case Study Application of Baseline Methods: Bottomland hardwood restoration the lower Mississippi Valley

The paper now continues with an application of the two baseline-setting approaches to a hypothetical case study of afforestation in the South-central U.S. The purpose of the case study is to determine the relative feasibility and value of each approach for afforestation projects in the lower Mississippi Valley, USA. Afforestation -- the establishment of trees on agricultural lands -- was chosen because it has been among the most commonly proposed biological sequestration activities on the landscape. Afforestation activities in the lower Mississippi Valley have garnered much attention recently because of their high potential for sequestering carbon and generating positive environmental co-benefits such as improvements in wildlife habitat and water quality (USDA 2003, Groninger et al. 2000).[2]

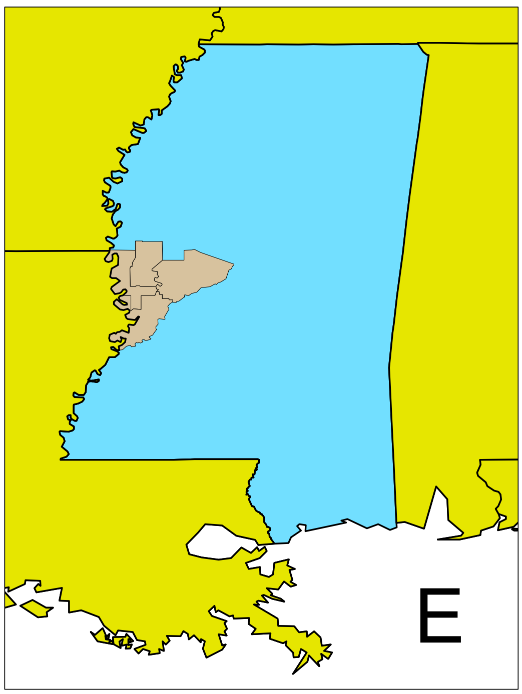
4.1 Project Description

This case study area is located in the Lower Yazoo River Basin (LYRB), within the greater Mississippi River Delta region near Jackson, MS USA. Figure 2 shows a map of the LYRB (shaded in brown) and its surrounding area. Our analysis examines candidate projects that would convert frequently flooded marginal croplands back to the native bottomland hardwood forests that once occupied most of the landscape. The targeted tree species is Nutall Oak.

[2]We use the term "afforestation" to describe these activities because they involve establishing trees on lands that are not currently forested. Because these lands were forested in their native state, before being converted to agriculture in the 20th century, some would refer to this activity as "reforestation."

The area considered for project evaluation covers 13,784 acres in total.[3] Of these acres 2,000 meet our criteria of being considered marginal croplands, which are lands that are flooded on average once every two years.[4] The remaining acres in the candidate project area are either currently in forest or do not meet the selection criteria. In cases where these additional lands are currently on non-marginal agricultural lands, forest could be established on the lands, however here we only include the marginal croplands as part of the project. The project is designed to establish a hardwood plantation and, under one option, harvests all timber for commercial sale at the end of 60 years. Given the regional characteristics and species type, this rotation length is expected to achieve maximum timber yield. The primary goal of the afforestation project is to increase carbon storage onsite for the purpose of generating carbon credits.

Figure 2. Mississippi and the Lower Yazoo River Basin, USA



By some estimates, roughly 80 percent of the forests that existed in this region at the time of European settlement have been cleared (The Nature Conservancy 1992), primarily for agriculture. To help protect the populated places and agricultural acreage from the heavy flooding of the Mississippi River, flood control devices have been installed along the river in and around the LYRB. Although intended for flood control, the installment of these structures has resulted in increased flooding in the low-lying areas of the LYRB in exceptionally wet years. The flood control devices are highly effective in regards to their intended function, holding the floodwaters of the MS River at bay. However, they also act as a large catchment device for surface runoff from the upland

[3] Please note that while this specific region is being evaluated for its afforestation project potential, we are not attempting to link this to current or proposed specific project opportunities. The "projects" in this analysis are hypothetical.

[4] Marginal lands were identified as those that are in the two-year flood plain. These lands were identified in a GIS using digital elevation models and the elevation criteria established by USGS delineating the two-year flood plain.

acres protected by the features. The farmers in the area are often faced with severe crop loss due to the flooding. Afforestation of these frequently flooded lands may provide an alternative land use to the landowners, reducing losses and potentially providing economic gain through carbon payments and timber harvest revenues.

From a GHG mitigation perspective, forests are typically a more carbon-intensive land use than agriculture. Through natural processes, forests can remove large amounts of CO_2 from the atmosphere and store it in above- and below-ground biomass and residually in soils. In addition to carbon storage, forests can produce a vast array of other market and non-market outputs and services that society values. From an economic standpoint we must account for the fact that afforestation of such croplands also involves the opportunity cost of foregone agricultural returns. Therefore a well-targeted afforestation project will be one in which the mitigation strategy selected yields positive GHG yields and economic returns.

4.2 Application of the Performance-standard Baseline Approach

As described in the Introduction, the performance-standard approach uses information on the actions and performance of a similar (industry/region/activity) cohort group to determine what is likely to occur at the project site if the project were not to be implemented.

The performance-standard, as applied to AgLUCF sequestration projects, involves three main steps

1. Identify baseline candidates
2. Estimate baseline rates of land use change
3. Quantify and compare baseline and project-generated carbon profile over time

Each step is described in detail below.

4.2.1 Identify the baseline candidates

Baseline candidates for this case study include any potential use of the marginal cropland targeted by the project. Potential land uses under BAU include (1) remaining in crop production, (2) conversion to forest (as targeted by the project), and (3) conversion to other land uses. Each baseline land use option has different consequences for the amount of carbon that would be sequestered onsite in the absence of the project. Preliminary assessment of recent land use data for the region of interest indicates that virtually all of the marginal cropland considered for the project either remains in cropland over time or has been recently converted to forestland. Therefore baseline options (1) cropland and (2) forest remain the focus of this analysis. In other words, we assume that the only possible land uses for the projects of interest are to continue in agriculture or switch to forestry. If subsequent analysis deems that project lands would switch to forestry under BAU conditions, then an afforestation project might be seen as simply replicating a baseline trend rather than producing additional GHG benefits.

Since a performance-standard is based on the behavior and performance of a cohort reference group, we must define the geographic and temporal range of those observations. The *geographic range* selected for performance is the four county region containing the Lower Yazoo River Basin (LYRB). Alternatively, we could have considered performance outside of the LYRB as a basis for comparison as well, but opted not to. For instance, we could base performance on national rates of afforestation, but this level of aggregation was too large due to the great heterogeneity in ecological factors across such a wide landscape. Likewise, we could evaluate land use behavior across the entire South, but chose instead to focus on the LYRB in Mississippi due to its highly unique ecological characteristics. For instance, the flood control structures referred to in the description of the project area make the characteristics of this river basin unlike any other in the US or beyond. The appropriate regional extent to consider for a mitigation project is something that you can test for, which we do below. Thus only land use changes in this sub-region are considered.

The *temporal range* of the reference group behavior is especially important for land use change projects, as these activities often take place over fairly long periods of time. As such, we ideally want to observe land use change over extended time periods, rather than base comparisons on annual fluctuations in land use. The length of time we can observe, however, is largely dictated by the availability of consistent land use data. The data we use for performance-standards development is the National Resources Inventory (NRI, see below), which is available on 5-year time steps since 1982. The last year in which detailed data were available at the time of this analysis was 1997. Therefore, the temporal range of land use comparisons is 15 years (1982-1997).

4.2.2 Calculate the baseline rate of land use change

The next step in this process is estimating the rate of land use change. The WRI/WBCSD protocol document outlines two approaches to this problem; 1) extrapolate past land-use or management trends and 2) project past land use patterns into the future using estimated relationships between land use change and its determining factors (drivers). In this analysis, we employ the latter approach by conducting a multivariate regression analysis to estimate land use change, identifying and parameterizing the drivers of the change. Such an analysis requires the collection or attainment of existing datasets that include information on specific site characteristics and land use over time.

To determine the drivers of land use change for the candidate project area we must identify the characteristics of the project site and surrounding region. We employ several datasets to conduct this spatial analysis including the USDA Natural Resource Conservation Service (NRCS) National Resources Inventory (NRI). This database provides nationwide coverage and collects data on, among other things, land use for 800,000 sample points nationwide every 5 years in the U.S., and can be employed to estimate the rate of land use change from one to 21 different land use types. Using a combination of remotely sensed and field sample data, the NRI characterizes land use/land cover, soil characteristics, crop history, conservation practices, habitat and other natural resource characteristics. The NRI has been collected every five years since 1982. The NRI data for all 800,000 + sample points is available on CD-ROM. We confined our analysis to the 4,299 sample points in Mississippi.

After identifying the project activity to track over time, biophysical data such as soil type, elevation and other site characteristics are needed to estimate agricultural productivity, forest productivity, and carbon yields. For soil type data we use STATSGO. *STATSGO* is a publicly available soil characteristics database that provides digital map coverage's for the 48 conterminous states. This database groups the subsets of soil types in a region into larger aggregated soil series. Information such as drainage, porosity, slope, productivity and limitations are provided by this data set. These maps are available in a digital format for use in a geographic information system (GIS).

Our study uses elevation to identify the marginal cropland and candidate acreage for afforestation. We define marginal lands as those that fall below a given elevation, based on elevation thresholds obtained from the Unites States Geological Service (USGS) tied to flood stages of the Mississippi River (Shabman et al 2000). All lands below this established elevation criterion were determined to flood at least once every other year, the main criterion for marginality in this region. *Digital Elevation Models (DEM)* provide a digital representation of traditional topographic maps and were used to determine the elevation of all project lands. The USGS provides national coverage of DEM's to the public at low or no costs. A GIS framework utilizes the digital representation and analysis in a spatially defined framework. Although, the primary drivers of land use change will differ from region to region, drivers such as flooding frequency can be identified through the use of a DEM.

We use the biophysical data just described to perform multivariate regression analysis to estimate the drivers and degree of afforestation in the study region. Using the NRI data that track land use for each plot over time, we use discrete choice (Logit) regressions to estimate the probability of cropland plots being converted to forest as a function of plot characteristics. Table 2 presents the partial results of a Logit regression used to estimate the effects of location in a given county and flooding frequency on afforestation probability. Again, the flooding frequency variable captures the key determinant of "marginal" for the croplands targeted by the project.[5]

The Logit regression results presented in Table 2 reveals several stories about lands in the four county region. As expected, the flooding frequency increases the probability of each counties lands converting to forests and is highly significant.[6] The coefficient translates into an increased afforestation rate of over 3% annually. The Logit regression actually produce a 15 year afforestation rate (the time period covered by the NRI data) that we annualize and presented in Table 3. The county fixed effects in the regression can be used to make county specific adjustments to the afforestation rates. The county in which a plot is located may influence the probability of afforestation, all else equal. The sign of the coefficient for each county variable indicates the probability that lands in that county will afforest relative to the omitted county.[7] Though the county coefficients

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5One note regarding these regressions is related to the lands included in the analysis. There is the potential for marginal croplands to be enrolled in the Conservation Reserve Program (CRP). CRP is a government program aimed at converting marginal agricultural lands to forest or other land uses with high vegetative cover. These lands are identified in the NRI database and are excluded from our regressions, ensuring that we are not capturing any impacts of the CRP program in estimating the baseline afforestation rates. The reason we want to separate CRP lands from other lands is we do not necessarily want to assume that CRP conversions will continue into the future at the rate they have in the past. Therefore, the baseline rate we estimate is for lands outside the program.

6The statistical significance of coefficients in a Logit regression can be difficult to interpret. If a coefficient is found to be statistically different than zero, the Logit transformation of the coefficient results in the probability of the change in the dependent variable being different than 50-50.

[7] The county variables in the model are discrete or "dummy" variables, which means they take on a value of zero or one. In order to avoid statistical estimation problems, one of the counties must

are not statistically significant, when combined with the flooding frequency results, in a statistically significant county specific probability of afforestation is calculated.

Table 2. Partial List of Regression Parameters for the Baseline Rate of Afforestation in the LYRB
Dependent Variable: "Crop-to-forest" = Incidence of NRI plots being converted from cropland to forest over the period 1982-1997

Explanatory Variables	Coef.	Std. Err.	Z	P>|z|	Lower and Upper [95% Conf. Interval]	
Issaquena	0.38	0.95	0.41	0.69	-1.47	2.24
Sharkey	-1.24	1.15	1.08	0.28	-3.50	1.02
Warren	1.13	0.94	1.20	0.23	-0.72	2.98
Yazoo	-0.12	0.94	0.13	0.90	-1.96	1.72
Flooding_freq	0.75	0.25	2.97	0.00	0.26	1.25
Constant	-3.07	0.86	3.56	0.00	-4.76	-1.38

*County coefficients show effects relative to omitted county. 81 of the 82 MS Counties were included in the regressions, however only those in the LYRB used in the analysis are presented here.

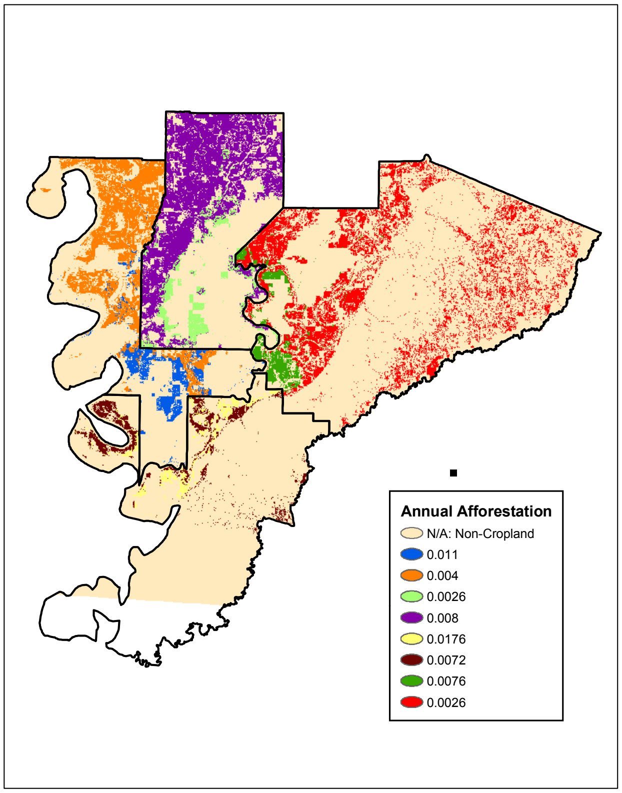
The regression results allow us to calculate distinct baseline afforestation rates for flooded and non-frequently flooded croplands in each of the four counties of the LYRB, resulting in the estimation of 8 distinct baseline afforestation rates for the region (see Figure 3). The agricultural lands in the area are highlighted with a distinct color representing their baseline afforestation rate determined by flooding frequency and county location.

The 4 estimated annual afforestation rates for frequently flooded (marginal) cropland are included in Table 3. The WRI/WBCSD protocol counsels a conservative approach to baseline-setting, perhaps using the upper-bound of the 95% confidence interval for the baseline estimate. Given that we used statistical techniques for estimating baseline land use change, we can compute a 95% CI for each afforestation estimate, which can then be used to modify the baseline carbon accounting method. The upper portion of the table presents the mean afforestation rate for marginal cropland in each county, the middle and lower portions report the lower and upper bounds of the 95% confidence intervals respectively.[8]

Figure 3. Baseline Afforestation Rates in the Lower Yazoo River Basin

be dropped from the dummy variable list – though not from the data set or the analysis. This means that "omitted" county becomes the point of comparison for the other three counties. In this model, the omitted dummy variable isAdams County. Therefore, the coefficients for Issaquena, Sharkey, Warren, and Yazoo reflect the extent to which each county is more (positive coefficient) or less (negative coefficient) to be afforested than Adams County, all else equal.

[8] The confidence intervals were calculated using the STATA statistical software package using the standard errors of the predicted probabilities.



Of particular interest is the upper bound of the confidence interval because of general sentiments by some stakeholders that baselines should be conservative. Using the upper bound estimate for BAU afforestation is a conservative estimate, because it says that there is a 95 % chance that afforestation is less than or equal to this rate. In this case, the upper bound is roughly twice as large as the mean.

Table 3. Calculation of the Mean and 95% Confidence Interval Annual Afforestation Rates of Frequently Flooded Croplands, by County in the LYRB Using the Regression Parameters from Table 2

	Issaquena	Sharkey	Warren	Yazoo
Mean	0.80%	0.18%	1.41%	0.52%
Upper Bound of CI	1.58%	0.76%	2.38%	1.43%

In our initial attempt to estimate land use change and the effects of various explanatory variables we restricted the data used in our regression analysis to the four counties within the LYRB. The results from the reduced sample are presented in Table 4. In this regression the omitted county is Sharkey, therefore all signs on the coefficients represent the farmlands, in the given county, likelihood to afforest over the 15-year time period relative to Sharkey County. It can be seen from the results the large ranges associated with the individual coefficients and confidence intervals. Additionally, the standard errors associated with the predicted rates of afforestation (combination of the county and flooding frequency coefficients) were significantly higher than those estimated using the full sample. Drawing on a larger relevant sample size, while controlling for county specific effects, increases the precision of our estimates and the predictions of afforestation in the four counties.

Table 4. 4-County Sample Logit Results

Explanatory Variables	Coef.	Std. Err.	Z	P>|z|	Lower and Upper [95% Conf. Interval]	
Issaquena	1.66	0.94	1.76	0.08	-0.19	3.5
Warren	2.33	0.95	2.46	0.01	0.48	4.18
Yazoo	1.19	0.93	1.27	0.20	-0.64	3.02
Flooding_freq	1.2	0.76	1.59	0.11	-0.28	2.69
Constant	-4.38	0.85	5.18	0.00	-6.04	-2.72

Using the reduced sample regression results, county specific afforestation rates and their upper bound estimates were calculates and are presented in Table Y. The estimates in this table are directly comparable to those calculated for the full sample and presented in Table 3. The variation in the estimates between the two samples is the direct result associated with differences in the standard errors calculated. The smaller sample size (and larger standard errors) results in a large range between the mean afforestation rates and the upper bound estimates.

Table 5. 4-County Sample Baseline Afforestation Rates

	Issaquena	Sharkey	Warren	Yazoo
Mean	1.1%	0.26%	1.76%	0.76%
Upper Bound of CI	4.62%	2.70%	4.68%	4.56%

4.2.3 Quantify and compare baseline and project-generated carbon profile over time

The baseline afforestation rates presented in the previous section are annual rates. We assume that under BAU conditions, baseline afforestation would occur slowly over time – in contrast, say, to an afforestation project, which might lead to wide-scale tree-planting all in the first year. These time dynamics must be accounted for when estimating the baseline carbon consequences. The amount of carbon that accumulates over the baseline projection period can be calculated using a form of cohort accounting. This is illustrated in Table 6.

Table 6. Time Dynamic of Carbon Accumulation on Land that is Projected to Evolve to Forest under BAU Over Time

Year in Which Land	Amount of Land Expected	Amount of Carbon that Will

was Predicted to be Planted Under BAU	to be Planted under BAU[a]	Accumulate by the End of the Baseline Projection Period (T)[b]
1	L_1	C(T-1)
2	L_2	C(T-2)
3	L_3	C(t-3)
T	L_T	0

[a]This is calculated using the baseline afforestation rates from Table 3.

[b]These time-dependent carbon values for the afforestation projectare calculated using the FORCARB model described in the text.

For the portion of the project area projected to convert to forest under BAU in any given year, carbon would begin to accumulate in that year and in all future years throughout the baseline projection. So for land that is predicted to have been planted in Year 1 under the baseline – an amount that can be calculated using the appropriate baseline afforestation rate from Table 3—the total amount of carbon that would have accumulated by the end of the baseline projection period is C(T-1), where C(•) represents the biophysical carbon accumulation function for a forest. This process is carried out for all predicted groupings of land for the baseline projection period. At the end of the baseline projection period, the estimated carbon that would have been expected on the project landscape can be estimated by summing

$$\text{Baseline carbon in Year T} = \sum_{i=1}^{T} L_i * C(T - i) \quad (1)$$

The same process outlined in Table 6 can be used to estimate the total amount of carbon expected to be generated by the project during the baseline projection period. However, rather than a slow evolution of afforestation over time under BAU, we assume that all project afforestation occurs at the beginning of the project (Year 1). Therefore, all project lands can be expected to generate this much carbon by Year T:

$$\text{Project carbon in Year T} = L_P * C(T\text{-}1) \quad (2)$$

where L_P is all of the project land slated for afforestation.

Applying the cohort accounting method to the baseline and with-project scenarios

To quantify baseline and project carbon effects, we apply the cohort accounting framework just introduced using the baseline afforestation rates calculated in Step 2 with biophysical estimates of timber and forest carbon yields over time (the C(□) function). Each step is now discussed.

The estimated baseline afforestation rates above reveal that under BAU, some marginal lands in each of the four counties will afforest based on specific site characteristics related to location and flooding propensity. Once the baseline afforestation rates are calculated, we can combine them with forest carbon yield functions specific to the project area.

To do this, we employ the USDA Forest Service's Forest Carbon (FORCARB) model (Planting and Birdsey, 1993; Birdsey and Heath 1995). FORCARB is an empirical simulation model used to estimate and predict carbon budgets in U.S. forest ecosystems. The model characterizes the dynamics of carbon within forest systems and analyzes carbon flux on timber production is the U.S. FORCARB tracks the evolution of forest carbon stock in four onsite pools (trees, understory, litter, and soils) and has modular components that include carbon in harvested wood products.

To use FORCARB for the purposes of this analysis, we modify model outputs to account for the specific species and growing conditions of the LYRB. We replace the FORCARB timber growth and yield functions for the region's hardwood forest types with those specific to Nutall Oak (the targeted species) in the LYRB. The first step in estimating site specific carbon is estimating the timber growth rate and resulting biomass yields. We estimate these values using Nutall Oak growth and yield functions obtained from Amacher et al 1997 specific to the LYRB region. Using the results of the GIS analysis and region specific yield functions, we were able to determine the forest productivity for three distinct soil types. Combining the site-specific conditions and the growth and yield functions, we were able to estimate the timber volume onsite at stand ages throughout the timber rotation. We then convert timber volume to tree carbon using FORCARB timber-carbon transformation factors. We then add together the LYRB-specific modified tree carbon estimates with regional values for the other three onsite carbon pools to develop a stand-level forest carbon profile over time that is now customized to Nutall Oak in the LYRB. We use these as the basis for the carbon function described in cohort accounting discussion above.

Table 7 applies this dynamic accounting framework to baseline afforestation rate estimates for the region (Table 6), the growth and yield functions for Nutall Oak on the 3 soil types and the carbon accumulation rates estimated in FORCARB over a 10 year period for the project area in the LYRB. We start with the central mean estimate for the baseline afforestation rate, which will differ by location within the study area due to variation in county and flooding frequency. Then we combine this with forest yield effects that vary across sites due to underlying differences in soil type.

Table 7. Baseline vs. Project Carbon Calculation

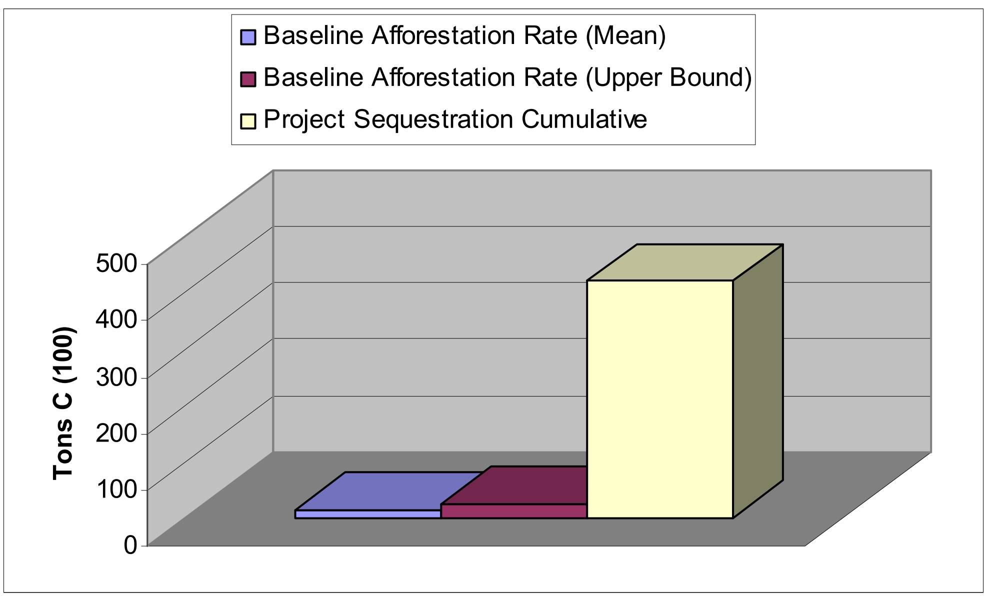
		Evaluated at Mean Afforestation Rates				
			Baseline		**Project**	
Soil Type	**Project Acres**	**Mean Annual C Accumulation Rate (tC/Acre)**	**Afforestation Projection by Year 10 (Acres)**	**C Accumulation Projection by Year 10 (tC)**	**Afforestation Projection (Acres)**	**C Accumulation Projection by Year 10 (tC)**
1	1506	**0.73**	142	1,103	1506	30,554
2	149	**0.78**	14	117	149	3,254
3	345	**0.84**	33	289	345	8,130
Total	2,000		**189**	**1,509**	2,000	**41,938**

First we focus on the carbon stock effects in Year 10 of the project. The methods described above generate a baseline carbon stock estimate of over 1,500 tons of carbon on the roughly 189 acres projected to afforest by Year 10 under BAU. This estimate is most meaningful when we compare it to the Year 10 carbon stock estimate if we assume that all 2,000 acres are immediately planted to trees in Year 1 under a hypothetical project (also shown in Table 7). This "with-project" carbon estimate is almost 42,000 tons for the entire project area in Year 10. Therefore, evaluated at the mean afforestation rate, about 96% of the carbon accumulated on project lands by Year 10 would be considered additional (above baseline).

Replacing the mean afforestation estimate with the upper bound changes the story. At the 95% CI upper bound, the estimated baseline level of carbon accumulation would be about 2,600 tons of carbon by Year 10, or roughly 6% of the projected carbon for the project (i.e., project carbon would be about 94% additional). The Year 10 project and baseline (mean and upper bound) carbon totals are illustrated in Figure 4.

Once the baseline and project related carbon is determined it is possible to calculate the additional carbon. Using the numbers in year 10, the additional carbon using the mean estimates is 40,429 t/C. When conducting a project quantification or project crediting review, the same process would be conducted at the end the project.

Figure 4. Baseline and Project Carbon Accumulation: Year 10



4.3 Application of the project-specific approach

To enable comparisons with the performance-standard approach, we now employ the WRI/WBCSD project specific approach to baseline establishment. The WRI/WBCSD protocol presents the project specific approach through four sub-steps. The steps are listed here and described in detail below.

1) Identify Baseline Candidates
2) Perform Barriers Test
3) Perform the Investment Ranking Test (If necessary)

4) Estimate Baseline and Project Sequestration

4.3.1 Identify Baseline Candidates

As with the performance-standard baseline, the first sub-step in the project-specific approach is to identify all potential baseline candidates. This step involves the same processes and criterion discussed in detail above. Depending on the type of project being evaluated the amount of potential candidates may be large or small. Using the geographic and temporal ranges determined earlier we identify two potential baselines, continued agriculture (status quo) and forestry or the afforestation project. The candidates are evaluated here using the project specific approach.

After completing step one the GHG protocol outlines two tests, the barriers and investment ranking tests, which are applied to the baseline candidates. The primary goal of these tests is to eliminate candidates arriving at a singe baseline. The barriers test is conducted first eliminating a sub-set of the candidates upon which the investment-ranking test is then applied.

4.3.2 Barriers Test

In accordance with the protocol we first conduct the barriers test. Table 8 lists the 5 barrier categories identified by the GHG protocol; Legal, Financial/Budgetary, Technology, Market Structure, Institutional/Social, Resource Availability. This table and step within the barriers test serves as a scoping device intended to identify all potential barriers to the baseline candidates. If any of the identified barriers affect a baseline candidate, that candidate will be excluded from further consideration. This sub-step of the barriers test also requires the potential effect of the barrier to be summarized in the table.

One note regarding the legal barrier presented in the table, for the purposes of this analysis, we assume that the marginal croplands could be eligible for a GHG mitigation project and generation of GHG credits for exchange in a GHG offset market. Because of the largely voluntary nature of GHG reduction efforts in the U.S., the rules for project eligibility are not well-established. For instance, marginal croplands in this region are also being targeted for conservation programs such as the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP) and other governmental and non-governmental programs. Whether this targeting precludes these projects from being deemed legally additional to the status quo will have to be addressed by policymakers. The results from the scoping section of the barriers test reveals that there are no barriers restricting the implementation of either baseline candidate. Because we did not identify any barriers in the initial scoping, more than one baseline candidate exists after completing the barriers test. In such a case the investment-ranking test is required to eliminating remaining candidates in order to arrive at a single baseline. The proceeding section discusses this application and its results.

Table 8. Identified Barriers and Relevance to Baseline Candidate

Barriers	Change made in project to overcome barrier	Status Quo (Continued Cultivation)	Modified Status Quo (Project/Forestry)
Legal: No legal barriers exist	No barriers Identified.	No legal barriers exist	No legal barriers exist
Financial/Budgetary: Does landowner have access to capital or outside funding.	No barriers Identified.	No financial or budgetary barriers exist under the status quo.	No financial or budgetary barriers exist
Technology, operation and maintenance	No barriers Identified.	No technology, operation or maintenance barriers exist	No technology, operation or maintenance barriers exist
Market structure: Commodity demand	No barriers Identified.	No market barriers exist under the status quo. The agricultural market is well established.	No market barriers exist. The forestry market is well established.
Institutional/social:	No barriers Identified.	No institutional/social barriers exist	No institutional/social barriers exist
Resource Availability:	No barriers Identified.	No resource availability barriers exist.	No resource availability barriers exist.

4.3.3 Investment Ranking Test

Once the barriers test has yielded the remaining baseline candidates, the investment-ranking test is employed to arrive at a single baseline. This is achieved by estimating the financial returns from each of the baseline candidate activities. Based on our candidates we examine the returns from agriculture and commercial forestry. In the forestry case we include returns from timber harvest only. We do not add any value of carbon payments.

To calculate expected agricultural returns we first identified the current cropping practices, and the number of acres in each crop type, for theproject area using US Department of Agriculture National Agriculture Statistics Service (NASS) historic cropping data. This data is collected through satellite imagery which can then be employed in a GIS. After the acreage and crop mix was identified, data on average crop yields and prices for the specific geographic region obtained from Shabman *et al* 2000 were used to calculate the expected returns for agriculture. The predicted returns from agriculture over the 60 year time period are then annualized and reported on a per acre basis (Table 9). In order to determine the returns that could be expected from forestry a similar process was completed for timber production. Timber growth rates and yields, specific to local soil types in the geographic area, were used to calculate the harvest potential from the project acreage. The volume of harvest was combined with local timber prices estimating the potential returns (Shabman *et al* 2000).

Under current market conditions, the outcome of the investment test reveals that converting the marginal lands in the project area to commercial forestry would result in net loss to the landowner.[9] [10] Based on the results of the investment-ranking test we can state with some confidence that agriculture is the baseline land use using the project-specific approach. If the returns to forestry would exceed those of agriculture the land owner would likely engage in forestry, absent any carbon policy, thereby making forest the more likely baseline land use for the area proposed for the project, and undercutting claims for project additionality.

Table 9. Investment Ranking Test

Net Annualized Returns to Project Activity (relative to current value)			
	Total NPV	**Total Annualized**	**Annualized Per acre**
Timber Production Revenue	$53,133	$2,348.60	$1.17
Current use (Agriculture)		$35,893.75	$17.95
Net return to timber production		-$33,545.16	-$16.78
* Total project activity acres =		*1999.5*	

4.3.4 Baseline and Project Sequestration

Baseline Sequestration

Once the baseline is selected, the carbon that would be sequestered under these conditions (absent the project) must be determined. The WRI/WBCSD GHG protocol states that this task can either be completed through on the ground measurement or through the use of model predictions. The external program in which the project will be enrolled will presumably dictate the required method of measurement.

We work under the assumption that continued agriculture results would continue to follow conventional cropping practices and would thereby generate a steady state carbon pool (no net sequestration). However, this assumption could be modified to allow for non-constant carbon stocks in the baseline – either positive accumulations (sequestration) or negative accumulation (emissions) and thereby develop a dynamic baseline, just as it was done in the performance-standard approach. But this would require data and underlying assumptions for cropping practices over time and the GHG

[9] Notice in Table Z the total project activity acres are reported. Discussed earlier we are only investigating the afforestation of marginal croplands in the region. The total acreage of the project is 13,784 acres, however only 2,000 meet the criteria establishing them as marginal.

[10] In previous work we develop a model that calculates net returns with and without carbon payments. More information on this work can be obtained from the authors upon request.

consequences thereof (CO_2 and non-CO_2). That was beyond the scope of the current paper.

Project Related Sequestration
Using the same process as described above in the performance-standard approach, the project related carbon is estimated. Because all plantings occur at the same time, carbon accumulation occurs immediately. The biophysical data, timber growth and yield functions, and FORCARB tabular data are used to calculate the carbon that would accumulate on site, starting in year one and continuing for the duration of the project. At the end of the first 10 year period, the project specific carbon accumulation is 41,938 t/C (Table 5). Establishing baselines through the project specific approach and related sub-steps, business as usual was determined to be a steady state carbon system (continued agriculture). As a result 100% of the carbon accumulating under the project conditions is determined to be additional.

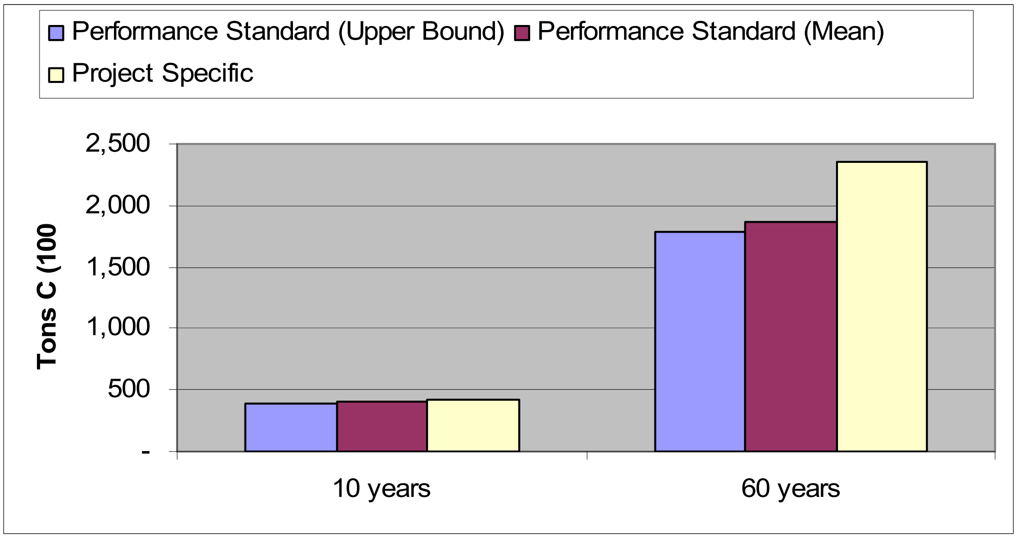
4.4 Comparison of carbon stock estimates between the two approaches

In the previous sections the performance-standard and project specific approaches to baseline setting were applied to the afforestation case study. The additional (net of baseline) carbon sequestered as a result of the afforestation project is presented below in Figure 5. The figure present the results of the mean and upper bound estimate of the performance-standard approach, respectively. Carbon stock results are evaluated at 10 years and at 60 years. Except in the case of the mean estimate applied for 10 years, the project specific approach results in considerably larger estimates for additional carbon attributable to the project. Of course, that is not terribly surprising given that the project-specific method determines that the baseline land use for the project area is all agriculture, whereas the performance-standard projects a mix of agriculture and forests based on analysis of regional land use data. However, the size of the difference reflects the empirical importance of the cohort group afforestation behavior in setting the baseline.

Figure 5 shows that using the more stringent upper bound estimate generated under the performance-standard approach can reduce the amount of project carbon determined to be additional. The project specific carbon accumulation after the first ten years results in roughly 4% more additional carbon than the mean performance-standard estimates. However when the more stringent upper bound estimates are used for calculating the baseline accumulation rate, the project specific approach results in over 6% more carbon after the first decade.

Figure 5. Project Additional (Net of Baseline) Carbon Sequestration Using the Performance-standard and Project Specific Approaches (*Baseline afforestation evaluated at mean and upper bound estimate from logit regressions for performance-standard. Differences*

between approaches are minimal after 10 years, but diverge if baseline is projected out to 60 years.)



The results in Figure 5 also show the importance of the length of time that an estimated baseline is relevant or applicable. Forest carbon sequestration projects are likely to be long-lived, given the amount of time it takes for trees to mature. Land use change and biophysical responses are extremely complex, dynamic and difficult to model accurately far into the future. As market conditions change over time, the direction and rate of land use change may also change. If the baseline conditions established at the beginning of a mitigation project are assumed to be unchanged over the project lifetime, there is the potential for over or underestimating the actual baseline carbon consequences. Figure 5 reveal the potential differences in carbon estimates at the end of a 60-year period. Sixty years is chosen here for illustration as it is a reasonable project length for hardwood forest rotations – and therefore a reasonable length of time to view a forest carbon project of this type. The difference between the mean estimate and the upper bound estimate at the end of sixty years is more dramatic. Therefore,locking into an initial baseline for the entire 60 year-period could be problematic. If the project standard/mean estimate is selected for baseline estimation at project initiation, but over the course of the project the baseline conditions begin to shift toward the upper bound estimates, the amount of carbon determined additional may be overestimated. Alternatively, if the upper-bound estimate is selected at project initiation, there may be a pretty good chance of under-estimating the carbon that is additional to the baseline in the out years. Taken together, this suggests that baseline updating may be warranted for forest carbon projects. For instance, if after every 10 years the baseline afforestation rate is revised, and changes in direction or magnitude of the baseline conditions will be identified and the baselines could be adjusted accordingly.

5. Conclusions and Discussion of Next Steps

One of the must crucial steps in the quantification of GHG effects resulting from mitigation project development is determining the baseline against which project activities must be evaluated. The steps outlined by the WRI/WBCSD and applied here to hypothetical afforestation projects in the lower Mississippi Valley highlight some of the data and model requirements involved, the complexity of the overall task, and the potential differences in outcomes between the two approaches. An evaluation of the two approaches and their results can be viewed from two distinct perspectives. The first is the through the eyes of potential project developers, while the other is through the eyes of the governing authority or some other public policy perspective.

A GHG mitigation project developer's primary goal is to establish projects that are recognized - financially or otherwise - for generating GHG emission reductions or sequestration. Therefore, a project developer's interests are aligned somewhat with demonstrating that project credits are highly additional. This is a difficult position from which to select a baseline method, if some methods are systematically more likely to suggest additionality than other methods. In the case study we evaluated, the systematic likelihood of additionality was found to pertain to the project-specific approach. However, that need not always be the case. Here, the project-specific approach indicated that all project carbon was additional, while the performance-standard approach indicated that only part of it is additional. However, the project-specific approach could have also found that afforestation was more profitable than agriculture under BAU at the project site, in which case, no project carbon would have been deemed additional.

The "all-or-nothing" nature of the project-specific method is problematic and may reinforce incentives to game the system to get an "all" rather than a "nothing" (or a part). Yet, aside from the incentive issues, the project-specific approach has a number of advantages in that it generally provides a more in-depth assessment of the circumstances applicable to the situation at hand. But the extra depth may come at a cost. Data collection, project quantification and evaluation costs are often high, time consuming and involve a great deal of technical expertise. If every project were to use the project-specific approach, these costs would be replicated time and again. The performance-standard approach, though, offers some opportunities for economizing on these transaction costs. If pre-existing performance-standards exist for a candidate project's activity and region, an individual project developer may find it in his or her best interests to use the performance-standard rather than expend the resources to develop a baseline from scratch. In this case, unless the expected revenues from the additional credits that may accrue using the project specific approach more than offset the additional costs, the performance-standard approach would be preferred.

Froma public policy perspective, many aspects of the performance-standard seem favorable. As indicated above, there is the opportunity to conserve costs. To the extent that transaction costs of entering into projects can be lowered, this raises the probability that good projects can be implemented. Of course, it also raises the possibility that bad projects – those with little additional benefit – will also be implemented, which is where the issue of policy integrity comes into play. Establishing performance-standards for project related activities in regions across the nation can help ensure the integrity of the policy. Mentioned in the introduction, the underlying principle of any offset policy is to ensure that credits only be granted for a net reduction in GHG. The performance-standard can be set at various levels of stringency, leading a higher level of certainty in the additionality of the project reductions. Performance-standards are based on historical activities in the geographic region representing "on average" what is actually occurring. Although some developers may be negatively affected in terms of credits granted, it may reduce some of the incentives for gaming the system and credits resulting from false additionality.

The cost of establishing performances standards however is a major obstacle for policy or crediting programs. If pre-existing standards for various activities over multiple regions are required by the program, the responsibility of developing them will likely lie in the hands of the governing authority for the program. Collecting the data, developing the models and estimating the variation resulting from geographic and biophysical heterogeneity can be very expensive, time consuming and challenging. But this is not unlike many other calls for industry standards (e.g., standards of identify for foods, internet protocol standards,…) wherein a centrally organized effort to develop standards pays off by reducing transactions cost and ensuring integrity for the entire industry and society at large.

However, there are situations and projects for which a performance-standard approach may be very difficult to apply, for instance, when there is no data or methods for interpreting cohort group behavior. The case study we examined here dealt with an easily observable action (planting trees on cropland) for which there is much verified secondary data, However, suppose the project involved changes in the way an existing forest is managed. Cohort group data on forest management practices is much less available than tree-planting data. Therefore, it will be more difficult to say whether some management action taken at a specific year in a forest's lifecycle is BAU or additional based on the observed phenomena on other forests of similar conditions. Some sort of modeling or subjective (i.e., project-specific) investment analyses may be needed.

The results form the afforestation example and the points raised above highlight the need for a formalized process and protocol for selecting the approach to establishing baselines, and the steps involved in each approach to ensure that the integrity of the policy is not compromised. The joint effort of the WRI/WBCSD has been a productive step in this direction through the development of their GHG Protocol. As specific program, information can be gleaned from the WRI/WBCSD experiences. Applications of the preliminary protocols such as the case study presented here will help tease out problems in the approaches. Also case study applications to test the approaches could offset the programs cost by utilizing the results to develop performance-standards. Policy incentives such as cost offsets may lead to project developers engaging in the early stages of program development and design.

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