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A conceptual framework and its application for addressing leakage: the case of avoided deforestation

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Abstract

One of the most challenging technical issues associated with project-based mechanisms is that of leakage. A conceptual framework is proposed for the identification and analysis of leakage potentially generated by a project. The categorization of leakage based on the actors responsible for their manifestation is proposed, which divides sources of leakage into primary and secondary types. It is the actors or agents responsible for the baseline activities that cause primary leakage. Secondary leakage occurs when the project's outputs create incentives for third parties to increase emissions elsewhere. This distinction, based on the source of leakage, provides a basis for the analysis outlined in the paper. The extent and type of leakage will vary depending on the project typology and design. Using a decision tree approach, the process of identifying potential sources of leakage is demonstrated for the case study of avoided deforestation projects. If the main elements determining a baseline are properly identified and understood, in particular the 'baseline agents', a combination of the decision tree approach and apportioning responsibility, can assist in the quantification and monitoring of primary leakage. An analysis at the project design stage can also assist in minimizing the risk of future leakage. Econometric methods may prove more useful in analyzing secondary leakage.

Keywords: Carbon offsets; Leakage; Baselines; Greenhouse gas mitigation; Avoided deforestation; Sinks; Forest conservation

1. Introduction

The inclusion of project-based mechanisms in climate change policy has generated a number of key technical questions on the validity of such activities. This is particularly evident within the land use, land-use change and forestry sector, where criticism relating to the environmental integrity of carbon dioxide sequestration or avoided greenhouse gas (GHG) emissions through averted deforestation activities are widespread. This has led to the exclusion of avoided deforestation activities from the Clean Development Mechanism (CDM) of the Kyoto Protocol, at least for the first commitment period.

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Among the technical issues in question, the most challenging are the methodologies for baseline establishment and identification and monitoring of leakage. The mere presence of the potential for leakage does not necessarily make a project unattractive, instead strategies need to be developed to either mitigate it and/or account for it. The goal of this paper is to present a conceptual framework on the issue of leakage for land use and forestry projects, and indicate how this could be used to identify and monitor sources of leakage. The methodology could be applied to all project types in the land-use sector, but is applied here to the case of avoided deforestation.

A number of conservation pilot projects have been established around the world to prevent the release of greenhouse gases that would otherwise occur as a result of deforestation (Brown et al., 2000b). Most of these pilot projects have only been implemented for less than five years and have, most likely, not run long enough to detect much leakage. After they have been implemented for a long enough period, these may well provide enough experience and data to draw some conclusions about the occurrence of leakage. To date, however, the treatment of leakage still has to resort to conceptual analysis.

2. Definitions of leakage

The term ‘leakage’ is used to refer to an unanticipated loss of net carbon benefits as a consequence of the implementation of project activities (Brown et al., 1997). For this reason, leakage is also referred to as a greenhouse gas externality (Moura Costa et al., 2000). Because leakage usually occurs outside of the project’s immediate boundaries, it is also referred to as an ‘off-site effect’.

While leakage often refers to the negative externalities of a project, i.e. those that result in additional greenhouse gas emissions, it can also be manifested as a positive GHG externality. This has been referred to as ‘positive leakage’ or ‘spillover’. Due to its negative impact on the environment, the former requires a great deal more attention than the latter, and is therefore the focus of this paper.

Existing literature refers to a number of other terms related to sub-categories of leakage, such as slippage, activity shifting, outsourcing, market effects, life-cycle emission reductions, etc. (Watson et al., 2000; Moura Costa et al., 1997, 2000; Schlamadinger and Marland, 2000; Sedjo and Sohngen, 1999; SGS, 1998; Brown et al., 1997; Carter, 1997; Trines, 1998; USIJI, 1994). This variety of terms have led to additional confusion with regards to leakage analysis.

To analyze leakage, it is necessary to understand its different causes and sources and to adopt a standard terminology to refer to it. This paper proposes a way to categorize leakage based on the actors responsible for its manifestation, to which we refer to as the ‘baseline agents’ (Section 3). Following this logic, we divided leakage into primary and secondary categories. The terms ‘primary’ and ‘secondary’ leakage indicate the order in which they should be assessed, rather than as a reflection of magnitude or importance.

Primary leakage occurs when the GHG benefits of a project are entirely or partially negated by increased GHG emissions from similar processes in another area. Primary leakage essentially results in the displacement of the negative activity tackled by the project (the ‘baseline driver’), rather than its avoidance. It is, therefore, directly related to the activities that are modeled in the baseline and the actors responsible for causing them (‘baseline agents’). Primary leakage can be divided into the following sub-types:

- *Activity shifting*—the activities that cause emissions are not permanently avoided, but simply displaced to another area. For example, one discrete area is demarcated for preservation causing cattle farmers who were converting the area into pasture to simply move into another area outside of the immediate project boundaries to convert forests there.

- *Outsourcing*—the purchase or contracting out of the services or commodities that were previously produced on-site. For example, a logging company that was previously extracting timber from the project area, purchases timber from other operators to maintain an ongoing supply, e.g. for a sawmill, in the presence of the project. This differs from market effects (see below), since the outsourcing is undertaken by the baseline agent as opposed to third parties.

Secondary leakage occurs when a project's outputs create incentives to increase GHG emissions elsewhere. Unlike primary leakage, secondary leakage activities are not directly linked to, nor carried out by, the original 'baseline agents'. Secondary leakage can be subdivided into the following sub-types:

- *Market effects*—when emissions reductions are countered by emissions created by shifts in supply and demand of the products and services affected by the project. For example, an avoided deforestation or logging project may result in a decrease in the supply of timber, thereby causing a rise in timber prices and an increase in logging activities by third parties. This type of leakage is likely to be associated with projects that affect market-based activities, such as commercial agriculture, timber harvesting, and reforestation and afforestation. It is less likely to occur in projects whose baselines are driven primarily by subsistence activities (for example projects based on the avoidance of land conversion conducted by subsistence farmers) since these activities do not affect markets for the products involved.
- *'Super-acceptance' of alternative livelihood options*—this is a particular type of leakage that may result from the alternative activities provided by a project. For example, as part of a conservation project, alternative livelihood options may be promoted to reduce the need for conversion of the forest to agricultural land. As a result, there may be an influx of people attracted into the area from regions outside of the original 'project boundaries' or target group, who may adopt the activities promoted by the project. This may result in either positive or negative leakage:
    - *Positive*—people move in from other areas where they were previously undertaking high carbon emissions activities, e.g. forest clearing. By joining in or adopting the project livelihood options there may be an overall reduction in GHG emissions (i.e. positive leakage).
    - *Negative*—an influx of people with lower GHG emitting lifestyles, e.g. coming from farming. The move to the project area may result in an increase in their GHG emissions (e.g. by gaining access to new forest land), thus resulting in negative leakage.

Another source of unexpected carbon emissions occurs in the event of incomplete or inaccurate project or baseline determinations (e.g. emissions from fertilizer production, or transport of wood products). This should be seen more as a fault of the project-baseline calculations rather than an issue of leakage.

3. Leakage, baselines and causes of deforestation

Leakage is a source of emission not anticipated in the baseline and, consequently, leakage analysis is intrinsically linked with an understanding of the project baseline. If the main elements determining a baseline are properly identified and understood at the onset of a project, a large extent of the potential primary leakage may be prevented if addressed at the project design phase.

The main elements determining a baseline can be categorized according to the following criteria: 'baseline drivers', 'baseline agents', 'causes and motivations', and 'indicators' (Table 1). 'Baseline drivers'

Table 1
Main baseline drivers, agents, causes and indicators for different types of projects

Project type	Baseline drivers	Baseline agents	Causes or motivation	Main indicator
Conservation	Deforestation (loss of carbon)	Subsistence farmers, commercial farmers, cattle ranchers, urban developers, mining companies	Opportunity cost of land, (securing land tenure, food supply, financial returns), land use policy, fiscal policy	Forest cover
	Logging (loss of carbon)	Logging companies, small scale extraction by individuals	Financial returns, need for forest products, land use policy	Area logged
Large scale plantation forestry	No economic activity, fallow, agriculture, ranching (low carbon land uses)	Small or large scale farmers, cattle ranchers, absent land owners	Financial returns, policy	Current use of land, area under plantations versus other land uses in a larger landscape, rate of planting at landscape level
Small scale plantings or agroforestry	No economic activity, fallow, agriculture, ranching (low carbon land uses)	Small or large scale farmers, cattle ranchers, absent land owners	Financial returns, supply of agricultural products, policy	Current use of land, area under plantations versus other land uses in a larger landscape, rate of planting at landscape level
Reduced impact logging (alternative technologies)	Conventional logging (loss of carbon)	Logging companies	Financial returns, lack of technology and knowledge	Damage levels and area logged
	Deforestation (commercial) (loss of carbon)	Logging companies, cattle ranchers, commercial and subsistence farmers	Opportunity cost of land, need for land	Forest cover

are defined as the activity predominantly taking place in the absence of the project, and that the project will replace. These activities are actually conducted by the ‘baseline agents’. Different baseline agents may be motivated by different factors to engage in the baseline driving activities, such as the (perceived or real) opportunity cost of land or the need to secure land tenure through ‘land use’. These, in turn, could be affected by other conditioning factors enhancing or reducing the intensity of the main motivation.

Estimation of the degree and intensity of baseline drivers can be done through the use of indicators, such as forest cover, or the reduction in forest cover taking place in a region. In many cases, secondary indicators may need to be used to infer what the primary indicator is. For example, because of data availability constraints, it may be easier to analyze the volumes of timber extracted from a region, instead of trying to determine the area actually logged.

4. Leakage in relation to project typology

A combination of the categories of leakage with the elements determining a baseline provides us with a process to determine the types of leakage likely to be associated with different projects (Table 2).

Conservation projects (particularly avoided deforestation) are susceptible to primary leakage of the activity shifting type because the project is based on the discontinuation or avoidance of an activity (agriculture, logging) taking place in a site. If no alternative livelihood option is provided to the agents of deforestation, it may simply lead to a direct displacement of activities to another location. If the baseline driver involves the production of commercial products, such as agricultural products or timber, then the project is also susceptible to secondary leakage.

Reforestation and afforestation projects are based on the development of an economic activity where it was previously not taking place. If the baseline agents get directly involved in the project, they may, consequently, engage in an economic activity provided by the project and not need to move elsewhere. Occurrence of primary leakage, therefore, is confined to situations where the baseline agents are displaced by the project, but this can be considered a project design flaw. Secondary leakage caused by market effects, can occur as a result of ceasing baseline activities, such as commercial agriculture, and as a result of project activities. This can happen if the additional supply of forest products generated by a project drive their prices down. This in turn may lead to an increase in demand or to a feedback effect on supply (i.e. a reduction in planting rates). There are project types whereby the risk of secondary leakage will be minimal, such as the rehabilitation of native forest on abandoned land.

Alternative technology projects (such as the introduction of reduced impact logging practices or intensification of agricultural activities), if properly managed, may be able to avoid both types of leakage. By not discontinuing, but changing land-use practices, there is no displacement of the original baseline agents, and because the project is based on the maintenance of the same economic activity occurring previously, there should be no market effects. This type of activity may lead to leakage if: (a) there is resistance to the adoption of the new technology (difficulty, lack of capacity and/or training, higher costs, etc.), thus creating a source of primary leakage due to activity shifting; or (b) if the new technology results in a reduction of forest products output (for instance, reduction in logging outputs because of operational constraints caused by new logging guidelines), resulting in secondary leakage due to market effects.

Table 2
Types of leakage associated with baseline drivers for different types of projects

Project activity	Baseline driver to be neutralized	Type of leakage	Causes of leakage
Conservation	Deforestation	Primary—activity shifting due to lack or inappropriate alternative livelihood options	Opportunity cost of land (to secure land tenure, food supply, or financial returns)
		Primary—refusal of the alternative livelihood options, leading to activity shifting	
		Secondary—‘super-acceptance’ of alternative livelihood options	
		Secondary—market effects: limited to cases when deforestation is driven by market forces, rather than subsistence	Financial returns caused by market effects
	Logging	Primary—logging shifts or intensifies elsewhere, conducted by same baseline agents	Demand for logs, and no livelihood options provided
		Primary—non-adoption of livelihood options (or partial adoption), leading to activity shifting	Livelihood option provided is inadequate
		Secondary—market effects	Reduced production leads to changes in supply and demand equilibrium
		Secondary—‘super-acceptance’ of the livelihood options	Livelihood option attracts other actors previously not involved with the baseline
Afforestation Reforestation	No land use or agricultural use	Primary—afforestation on agricultural land or land demarcated for development	Competition for land leading to deforestation elsewhere
		Secondary—market effects	Over supply leads to reduction in prices, increased demand or causes a reduction in supply elsewhere
Alternative technologies (e.g. RIL)	Logging	Primary—activity shifting, if new technologies are imposed on baseline agents, and loggers move elsewhere	E.g. intensification of extraction rates elsewhere, by baseline agents, because of failures in the project
		Secondary—market effects, if the technologies lead to changes in the volume of forest outputs	E.g. intensification of extraction rates elsewhere, by other actors, in response to reduction in supply

5. Assessing leakage—a conceptual framework

A step-wise approach can be devised to guide the process of identification and analysis of leakage potentially generated by a project. A decision tree approach was adopted to facilitate this process (Fig. 1) and its use will be illustrated through the example of a forest conservation project to avoid deforestation

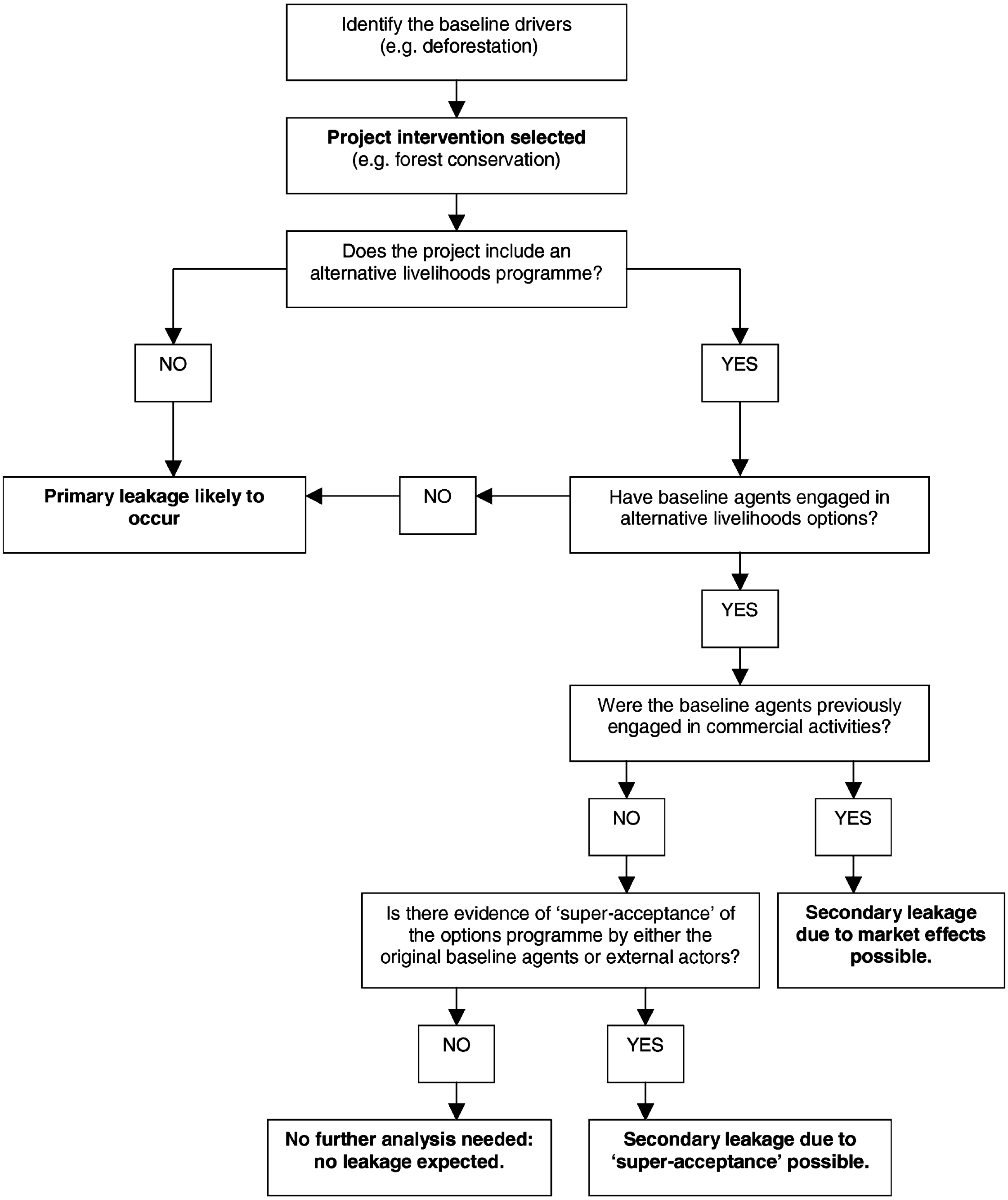

Fig. 1. Decision tree for identification of types of leakage likely to impact land-use projects.

activities caused by subsistence agriculturalists. This approach should be used at the project design phase to identify possible future sources of leakage, assess the relative risks of leakage, and therefore adjust the project design to minimize leakage effects. It can also be used during the implementation phase to attempt to assess and monitor the effectiveness of leakage prevention activities, or to identify possible new sources of leakage.

A first step in the identification of leakage is to determine the main drivers of the project baseline. A separate analysis needs to be conducted for each baseline driver identified, following the decision tree in Fig. 1. In the case of this fictitious project, the baseline driver is deforestation, and the establishment of an area of effective forest conservation could prevent deforestation within this area.

After defining what the project activities are, the next step is to consider whether or not alternative livelihood options have been provided by the project for the baseline agents involved. This should be done for each driver that is considered in the establishment of the baseline over the project lifetime and the associated baseline agents. In the case of the subsistence agriculture example, the main type of alternative livelihood option promoted by projects in the past revolve around sustainable agriculture and agroforestry activities in buffer zones surrounding the conservation area (e.g. Noel Kempff Mercado, Brown et al. (2000a); Costa Rican Protected Areas Project, Stuart and Moura Costa (1998); Care-Guatemala, Brown et al. (1997)). If no alternative livelihood options are provided, primary leakage will certainly occur through the shift of the activities currently conducted by baseline agents to another area.

If alternative options have been provided then the analysis needs to determine whether or not the baseline agents are actually engaging in these options, assuming the project is in the implementation stage.[1] Those who do not engage fully in these alternative options may be a source of primary leakage, and the project developers must analyze the reasons for them not engaging. A key to monitoring the likelihood of leakage for the example project is to measure the rate of adoption of the alternative practices, and then to determine what level of adoption will result in little to no leakage. This offers the opportunity for adopting a threshold, below which projects do not need to quantify and account for this type of leakage (Section 6).

If the baseline agents do engage in alternative options, two potential forms of secondary leakage may still occur. Where activities are very successful, they may attract the participation of people previously not involved with the original baseline, leading to the ‘super-acceptance’ of the alternative livelihoods program. Depending on what activities these groups were engaged in previously, this may have a positive or negative effect in terms of GHG emissions. For example, if these were shifting cultivators, their adoption of the alternative activities may lead to an expansion of the project’s benefits beyond the expected area of project influence. If, on the other hand, farmers from other regions are attracted to the area by the prospects of securing land tenure by joining the agricultural activities promoted by the project, this could lead to the deforestation of additional land than was previously anticipated at the onset of the project. Another cause of leakage may be derived from the market effects of additional agricultural production generated by this alternative livelihoods program, but in the case of subsistence agriculturalists, this is likely to be of limited scale.

The leakage analysis needs to take into consideration the whole timeframe of a project because the baseline agents involved may be expected to change over time (Section 6).

[1] Prior to project implementation, project developers can maximize the effectiveness of alternative options and interventions by ensuring the consultation and/or participation of baseline agents in project design.

6. From classification to quantification

The framework described addresses the identification and classification of different types of leakage likely to occur as a consequence of a project. It is necessary to link the analysis to a methodology for the estimation of the extent of potential leakage or leakage that may have already occurred. In some cases, however, it may be deemed unnecessary to continue with further analyses if no leakage is expected to occur (Fig. 1).

The first step is to apportion the primary leakage to the different baseline drivers and agents, as they may change with time. For example, if the baseline driver is deforestation, but there are two key baseline agents, subsistence farmers and commercial cattle ranchers, the extent to which each contributes to potential leakage may differ over the project lifetime (Table 3). The information for this first step should be based on the relative contributions of different agents to the baseline emissions, therefore stressing the importance of the link between baseline and leakage analyses. The complexity of this analysis, number of drivers and agents, and relative timeframes will depend on the project and associated baseline analyses.

This allocation between groups of agents may become important if a socially based monitoring approach is used (see below). A spatial modeling approach may facilitate this analysis, especially if baseline agents of deforestation are composed of, for example, a development front emanating from a large urban center and from subsistence farmers. The front can be modeled, and the time it takes to arrive at the project area of interest and the magnitude of its impact estimated; this can be differentiated from the more local clearing due to subsistence farmers.

The issue of time becomes an important one, particularly when a baseline agent only becomes an actor in the medium or long term. Whether or not the project should be responsible for quantifying and accounting for such leakage is a valid question, particularly when the assumed causes and motivations driving the agents may no longer be applicable at that stage.

Different methods have been proposed to quantify leakage in avoided deforestation projects (Brown et al., 2000b). Given the complex nature of the causes of deforestation and the agents involved, it is useful to devise methods that focus on specific types of leakage, i.e. primary and secondary. Methods proposed for quantification of primary leakage in deforestation projects include:

(a) Tracking historical series of deforestation surrounding projects, before and after project inception. This requires extending the area for analysis beyond the project's original boundaries. As a result of leakage occurring, the rates of deforestation taking place after the project may increase. It remains challenging how to determine whether or not such changes can be attributed to the project or to other factors affecting deforestation in a region as a whole.

Table 3
Example of apportioning potential primary leakage to baseline agents

Baseline driver	Baseline agent	Timeframe		
		Short term	Medium term	Long term
Deforestation	Subsistence farmers (%)	25	15	5
	Cattle ranchers (%)	0	35	45
Logging	Logging companies (%)	50	50	50

(b) To address the weakness of the method above, it is suggested that control areas independent from the project area can be used to ascertain the rate of deforestation without influence of a project and compare this rate to the area encompassing the project. Such a comparison could theoretically show whether leakage outside the project area has occurred or whether the change can be attributed to other factors affecting the underlying causes of deforestation (e.g. a change in forest law, enforcement policies, etc.). However, identifying "matching" control areas is likely to be difficult, taking into consideration the need to match both biophysical and socio-economic factors.
(c) Another way to correct for these external factors could be to run correlation analysis with other factors, such as rate of population, agricultural prices, road density, etc., but lack of data availability at the right definition limits the use of this approach.
(d) The use of leakage indicators, such as trends in demand for timber, firewood, and agricultural land throughout the project timeframe, has been proposed as a surrogate for the activities directly impacting the forest (Brown et al., 1997). However, at present such data at appropriate time scales and resolution are not available for many developing countries (Aukland and Brown (2002), ongoing research).
(e) Socio-economic surveys, tracking the agents involved in the baseline throughout the project timeframe and the activities they engage, may be a possible method to determine primary leakage effects.

Most of the methods described previously are 'spatial' approaches to estimating the area of forest loss that can be attributed to leakage (except for methods (d) and (e)). Satellite imagery has been proposed (or used) as a tool to facilitate such analyses (e.g. Hall et al., 1995; Chomitz and Gray, 1996). An issue that is key to this approach relates to the selection of boundaries for analysis, since often the analysis needs to be extended well beyond the project's boundaries. This has led to the idea of using regional baselines to try to detect whether leakage may be occurring outside a project's boundaries (Brown et al., 1997, 2000b). This 'regional baseline' approach has been used by the Scolel Té project in Mexico (Tipper and de Jong, 1998).

Most projects have not run for a long timeframe (Brown et al., 2000b), and it is unlikely that significant changes in previous land-use trends can already be detected through spatial analysis. Lack of data, or data of the right scale of definition, is another hindrance making this type of analysis difficult. This has indeed been the experience of this research project. Given these constraints, socially related analysis may provide a more feasible method to track possible sources of leakage, whereby the combination of the framework analysis and leakage apportioning provides a simple methodology for estimating primary leakage. However, it does assume that the baseline analysis is able to provide assumptions relating to the agents and their relative contributions to predicted baseline emissions. The Noel Kempff Project in Bolivia is used as a case study to demonstrate how this framework can be applied to a real project (Box 1).

Methods for determination of secondary leakage are more concerned with volumes of products produced, their prices and levels of demand elasticity. The theory is to try to detect any effect that a change in the levels of output may have on price and demand for these products (e.g. Sedjo et al., 2000; Sohngen and Mendelsohn, 2001; Sedjo and Sohngen, 1999, 2000). While econometric models exist for this type of analysis, it remains to be seen whether the data sets required for analysis exist, and whether the scale of these projects is large enough to generate detectable results. Testing of these assumptions is underway (Sohngen (2002), personal communication), and it may lead to guidelines and thresholds for dealing with secondary leakage.

Box 1. The Noel Kempff Mercado Climate Action Project, Bolivia.
The Noel Kempff Mercado Climate Action Project was initiated in 1997 and involved the expansion of the original national park. The baseline drivers for this project are the conversion of forest (deforestation) and conventional logging. The agents that are driving the deforestation baseline are likely to be:

1. local communities surrounding the park;
2. possible isolated colonization's from people moving into the area (already occurring);
3. the imminent arrival of the 'agricultural frontier'.

The project has been implementing community development projects in the region surrounding the park, to prevent leakage from the averted deforestation activities. These activities focus on the agents likely to cause leakage in the short term but do not address the implications of the longer-term threats to the area. However, given the timescale of the project and the difficulty in predicting longer-term land-use patterns (and therefore in estimating the potential impact of other agents) it would seem appropriate to focus on the immediate threat, as is being done in the Noel Kempff.
Table 4 illustrates how a project can think about the issues of time and magnitude of threat for the different baseline agents, and therefore apportion responsibilities for potential leakage. The values are estimates, to illustrate the method, and not the result of an actual analysis.
This methodology can be applied at the project design stage to identify which type of project activities and leakage prevention measures should be priority. It can also be used during the implementation phase in combination with the decision tree for identifying the types of leakage likely to impact the project (Fig. 1). The results of this analysis for the avoided deforestation part of the Noel Kempff Project are shown below (Fig. 2).

Leakage from super-acceptance of alternative livelihood programs would most likely be easier to quantify through socio-economic surveys, as described previously.

Irrespective of which method is used, leakage needs to be incorporated into the carbon accounting of the project. Leakage can simply be deducted from the project's claims (Brown et al., 2000b), or 'leakage coefficients', based on the perceived risk of leakage, can be used to reduce the project's claims accordingly (Trexler and Kosloff, 1998). The scheme proposed in this paper could assist with both these approaches, since it involves the apportioning of potential leakage according to different baseline drivers and agents, and can use the framework (Fig. 1) to assess the extent of leakage for each driver. It could therefore assist in estimating the amount of leakage to be deducted from the project's claims, or help prevent certain types of leakage from occurring.

Table 4
Apportioning potential leakage to baseline agents—a hypothetical example for the Noel Kempff Project

	Short term (0–10 years)	Medium term (10–20 years)	Long term (20–30 years)
Local communities (%)	2	3	5
Migration 'sporadic colonization' (%)	0	25	0
Agricultural frontier (%)	0	5	60

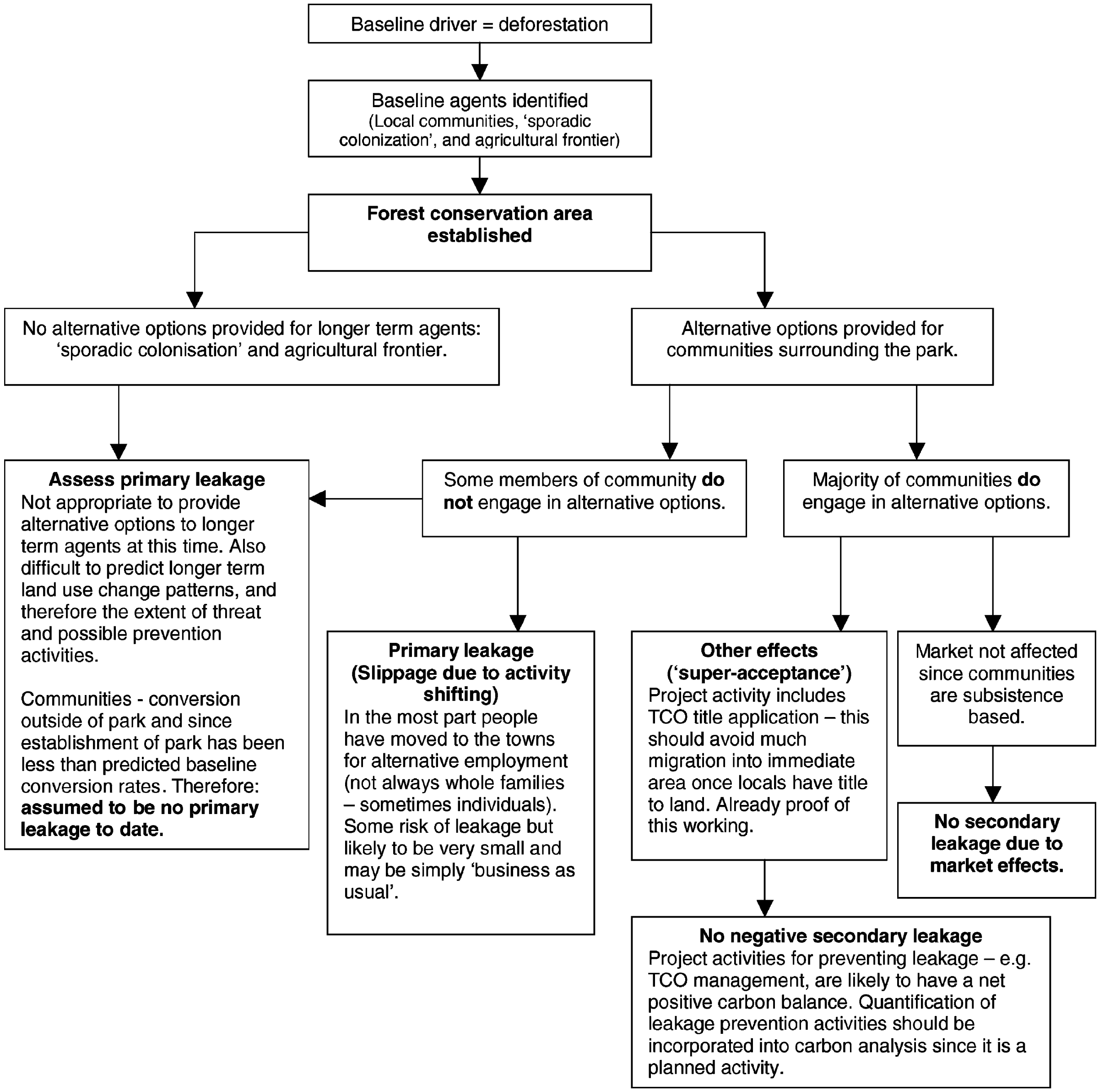

Fig. 2. Decision tree applied to the Noel Kempff Project. (Tierras Comunitarias de Origen' (TCO)—grants land management rights to indigenous groups. A detailed natural resource management plan is required.)

7. Conclusions

Identification and quantification of leakage remains one of the most challenging technical issues related to the development of GHG mitigation projects. This has been the subject of many studies, and it appears to be equally problematic for both land use and energy projects (Chomitz, 2000; Schlamadinger and Marland, 2000).

Experience to date has been limited to a few projects, and hindered by the lack of data, and short timeframes since project inception. Quantitative methods may need to be further developed, together with efforts to generate more accurate data at the right level of definition.

In the meantime, the approach described may enable project developers to identify possible sources of leakage that could occur as a consequence of the project. If used in the project scoping or design phase, modifications can be made to try and avoid the occurrence of leakage. Particularly effective is the case of primary leakage, where well-structured alternative livelihood programs may be the most appropriate way to prevent leakage from occurring, and avoid the need for more complex quantification analyses. Combined with the use of socio-economic surveys and monitoring linked to specific ‘baseline agents’, this may prove an effective strategy.

With relation to secondary leakage and market effects, econometric methods may prove useful, but their application may remain limited due to the lack of data and the complexity of the analyses required. A more pragmatic approach may be to determine threshold values below which market effects can be considered negligible.

This paper presents a framework and concepts on how to address the issue of leakage for land-use projects, from which some key points can be made to international climate change policy. Contrary to common belief, certain avoided deforestation projects appear to have a low risk of primary leakage as long as alternative livelihood options are implemented and adopted—a key goal of the CDM to address sustainable development. From a practical perspective, an important question is what level of adoption is necessary to assume little to no leakage—100% or something less? Further research is needed to determine a practical rate of adoption whereby primary leakage can be considered minimal. It is also possible to imagine a system whereby projects undertake an initial assessment of leakage risks, using the framework presented here, and thereafter choose from either a series of default values to account for leakage as indicated by the framework, or the option to undertake a project specific leakage study with independent review.

A more philosophical question relates to whether this should be the subject of concern or not. The objective of carbon finance is to provide financial incentives to promote a new paradigm, in this case related to a better utilization of forests by valuing them as carbon stocks and carbon sinks. In an initial phase, while availability of carbon finance remains limited to a few, isolated projects, their impact could be questioned because of the possibilities of leakage. As carbon funding becomes available to a wider population, this opportunity cost will become integrated in the decision-making process of the agents of deforestation, altering their behavior. Perhaps this phase of uncertainty is a necessary step towards this desirable output.

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