Does community forest management provide global environmental benefits and improve local welfare?

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Global financial donors have invested billions of dollars in "Sustainable Forest Management" to conserve forests and the ecosystem services they provide. A major contributing mechanism, community forest management (CFM), aims to provide global environmental benefits (reduce deforestation, maintain biodiversity), while also improving local human welfare (alleviate poverty). We have systematically reviewed available evidence of CFM effectiveness and consider the implications of our findings for future investment in CFM programs. There is evidence of CFM being associated with greater tree density and basal area but not with other indicators of global environmental benefits. We found no data on local human welfare amenable to meta-analysis. Poor study design, variable reporting of study methodology or context, and lack of common indicators make evidence synthesis difficult. Given the policy interest in and the planned donor expenditure on CFM, evaluation must be improved so that informed decisions can be made about appropriate investment in this approach.

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Much of the world's biodiversity and terrestrial carbon is found in forests in low-income countries, some of which are subject to high rates of habitat degradation, including deforestation (Malhi *et al.* 1999; Luyssaert *et al.* 2007; Hansen *et al.* 2010). This deforestation contributes substantially to global greenhouse-gas emissions and consequently to climate change (IPCC 2007). Many of the world's poorest people are also dependent on forests for resources, and their livelihoods are threatened by non-sustainable forest use (Campbell and Sayer 2003; Sunderlin *et al.* 2005). International funding organizations are therefore seeking "win–win" outcomes: conserving forest resources while improving the welfare of local human populations (Adams *et al.* 2004; Persha *et al.* 2011). Since 1991, the Global Environment Facility (GEF) and co-financers have spent US$6 billion on such "Sustainable Forest Management" (UNFF 2007) and plan to increase funding in this area during 2010–2014 (Contreras-Hermosilla and Simula 2007; GEF 2010). Sustainable Forest Management is also the focus of increasing international policy attention, driven by the objective of Reducing Emissions from Deforestation and Forest Degradation (REDD+) projects (Skutsch and Ba 2010). Many less-developed (low-income and lower-middle-income) nations, with the assistance of international donors, have engaged in community forest management (CFM) programs as a means of delivering Sustainable Forest Management (Figure 1; Bhattacharya *et al.* 2010).

In a nutshell:

- Currently, there is intense political interest in identifying effective mechanisms for conserving the world's forests and the ecosystem services they provide
- Community forest management (CFM) is an approach, funded by global donors, aiming to achieve environmental benefits and improve human welfare
- Using a systematic review methodology, we found that the evidence base for CFM is very weak because of a lack of rigorously designed studies
- Here, we suggest how evaluation of CFM effectiveness could be improved

CFM refers to forest management approaches where governance is devolved to local community groups or institutions, to varying degrees (Klooster and Masera 2000; Padgee *et al.* 2006; Bhattacharya *et al.* 2010). In the literature, several terms are used (including joint forest management, community-based forest management, and collaborative forest management) that cover a diversity of interventions, the details of which vary from place to place. In this review, we define CFM as any government-approved form of forest management in which local communities participate, with an objective of providing communities with social and economic benefits while promoting the sustainable management of forest resources. Through its dependence on the knowledge and institutions of local users for decision making, monitoring, and rule enforcement, CFM may be more successful than management being carried out only by the state (Behera 2009). Officially sanctioned CFM can be traced back several decades (Condori 1985;

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Figure 1. *(a) Slash and burn agriculture is a major cause of tropical deforestation and degradation. Community forest management (CFM) can create incentives for local communities to manage their forests and limit conversion. (b) A CFM committee in Madagascar elects a new president.*

Bhattacharya *et al.* 2010), and in some cases builds on much longer traditions of resource management by communities (Berkes 1999).

Theory on the involvement of users in the management of common-pool resources supports CFM's potential for obtaining social equity, ecological sustainability, and economic efficiency (Ostrom 1990; Agrawal *et al.* 2008). However, the general effectiveness of CFM projects that have already been implemented has been questioned (World Bank 2006; Behera 2009; Bhattacharya *et al.* 2010; Brown and Lassoie 2010). In addition, in many cases, the success of projects has often been measured with respect to uptake of CFM rather than the resulting outcomes (World Bank 2006). Recent reviews of studies on local participation in forest management have analyzed factors affecting the success of projects (Pagdee *et al.* 2006) and the methodology used in studies (Lund *et al.* 2009). In contrast, we have carried out a formal systematic review of the available evidence to evaluate the impact of CFM projects on the environment and on local welfare in less-developed countries (Bowler *et al.* 2010). We assess both the methodology and outcomes of studies, including meta-analysis where possible, to investigate any general emerging patterns. Systematic review methodology is widely used in the health sector to identify effective interventions and is increasingly being used by environmental managers to provide objective, transparent, and critical synthesis of available evidence (Pullin and Knight 2009). This is the first synthesis of evidence, through the use of formal systematic review methodology (CEE 2010), to examine the effectiveness of a major international environmental policy intervention. We use our findings to highlight the challenges of rigorous evidence assessment when applied to such interventions and suggest ways in which future projects could be conducted, in order to develop a much-needed, improved evidence base to underpin decisions on the form of future programs.

■ Capturing and synthesizing the evidence

We used systematic review methodology following guidelines provided by the Collaboration for Environmental Evidence (CEE 2010). Full methods are detailed in Bowler *et al.* (2010). We developed our precise question – "Does community forest management supply global environmental and local welfare benefits in less-developed countries?" – in collaboration with the Scientific and Technical Advisory Panel of the GEF and broke it down into four basic elements: (1) subject population (any ecosystem and/or human population associated with a CFM project in less-developed countries); (2) types of intervention (CFM projects in less-developed countries); (3) types of comparator (studies making explicit comparisons between CFM and "no CFM", including "before versus after" implementation of CFM at a site and/or the comparison of sites under CFM with sites not under CFM); and (4) types of outcome (any measure of forest cover and condition, including biodiversity [direct and surrogate measures], carbon sequestration, forest stand condition, and forest productivity [wood and non-wood]), as well as any indicators of resource extraction and of local welfare (fuelwood availability, water supply, income, employment, food security, social equity, income equality, or health).

We systematically searched 12 electronic databases and 28 organization websites and made requests to GEF agencies to ensure that we covered as much of the available literature, including peer-reviewed journal articles, theses, and "gray" reports, as possible. We carefully selected our search terms to ensure that we also captured relevant studies where names other than CFM were used to describe the intervention. We identified 3384 articles of potential relevance to the ques-

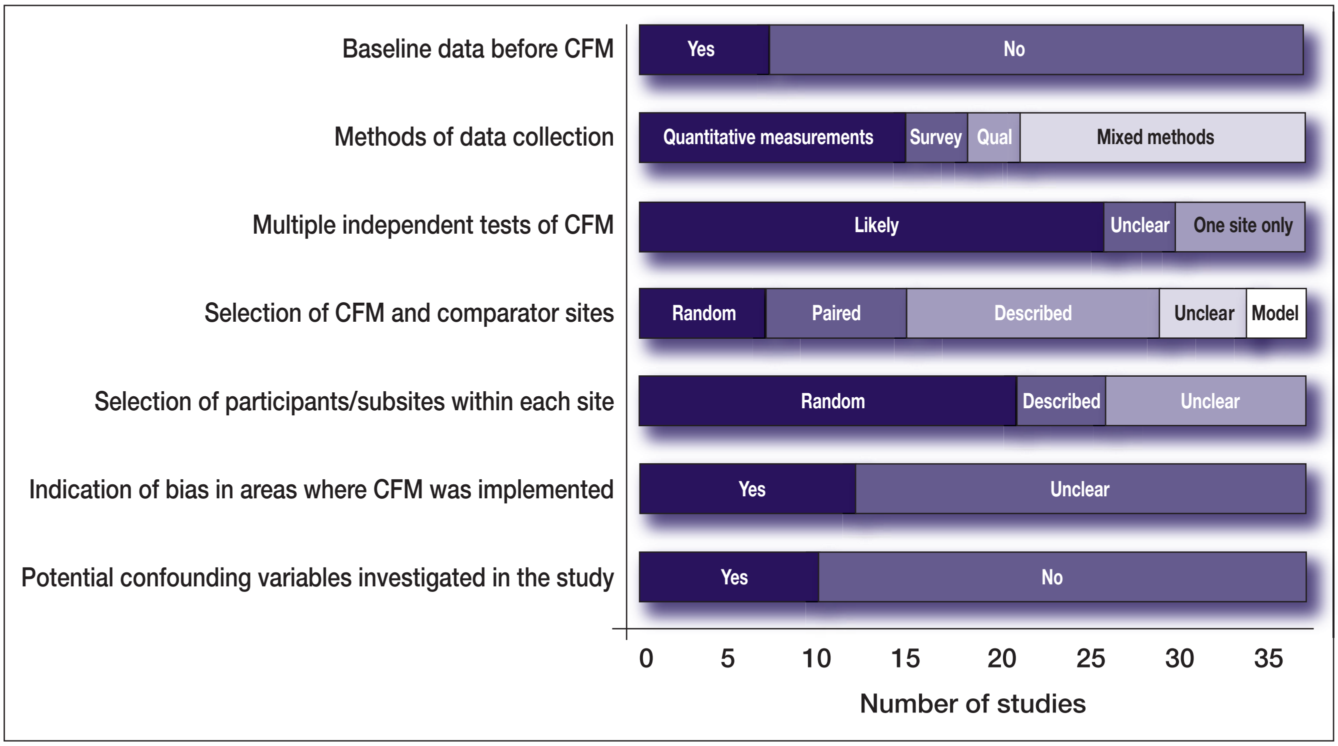

Figure 2. *Number of studies that measured forest condition, resource extraction, and livelihoods, and that used different methodologies. "Qual" is qualitative methods, and "mixed methods" includes quantitative and qualitative methods. For site/subsite selection, "described" refers to studies that stated their method, but this was not random or paired, and "model" refers to studies that used data to predict the effect. Studies only measuring forest-cover outcomes generally shared a similar methodology, involving comparison of satellite images of areas with and without CFM, and were not included in this assessment.*

tion, based on the document title. However, after abstract assessment, only 635 articles matched the inclusion criteria and, after full-text assessments, we found that only 42 of these articles presented studies with appropriate comparators for inclusion in the synthesis (see the WebReferences for the list of included studies).

■ Study characteristics

The geographical focus of the majority of the accepted studies was Asia (70%), particularly India and Nepal, while 16% were in Central America and 14% in Africa. In total, studies were distributed among 13 countries (none in South America or Oceania). These studies varied in design: 77% were comparisons between CFM and alternative management approaches, particularly state management, or were unspecified "non-CFM" management, without any baseline data from before CFM was implemented (Figure 2). The remainder examined outcomes before and after CFM implementation.

Studies investigating forest condition mostly used a quantitative methodology that relied on plots or transects to sample outcomes directly in the forest. Some also qualitatively researched user perceptions of forest condition. Studies investigating livelihood outcomes generally used mixed methods, combining quantitative (eg questionnaires) and qualitative (eg semi-structured interviews) survey approaches (Figure 2). Collectively, the 42 studies reported 51 outcomes, which were classified into three broad types: forest condition and land cover (34 studies), resource extraction (8 studies), and livelihoods (11 studies). Nine studies reported more than one outcome type; therefore data on different outcomes do not represent independent data points. The length of time from project implementation (or at least its formal notification) to data collection varied in the reviewed studies from < 1 year (Nagendra 2002) to > 15 years (Somanathan *et al.* 2009).

Only two studies reported any baseline data from both CFM and comparator sites, and in both cases their collection and presentation were limited (Kumar 2002; Maharjan *et al.* 2009). Ten studies investigated at least one factor that may confound direct comparison of CFM and non-CFM forests, including geophysical or environmental factors like elevation or previous forest conditions/use (eg Nagendra 2007). One of the studies that used satellite imagery to measure canopy cover found differences in variables such as slope aspect between village council forest and state management forest, and used propensity score-matching methods to account for the selection bias (Somanathan *et al.* 2009). Seven studies reported that CFM and comparator sites were selected at random from a wider study area, and eight studies selected sites that could be paired (by either close proximity and/or ecological/sociological variables). Fourteen other studies described different methods of selection (Figure 2), usually suggesting that they deliberately aimed to cover different types of environments. Some stud-

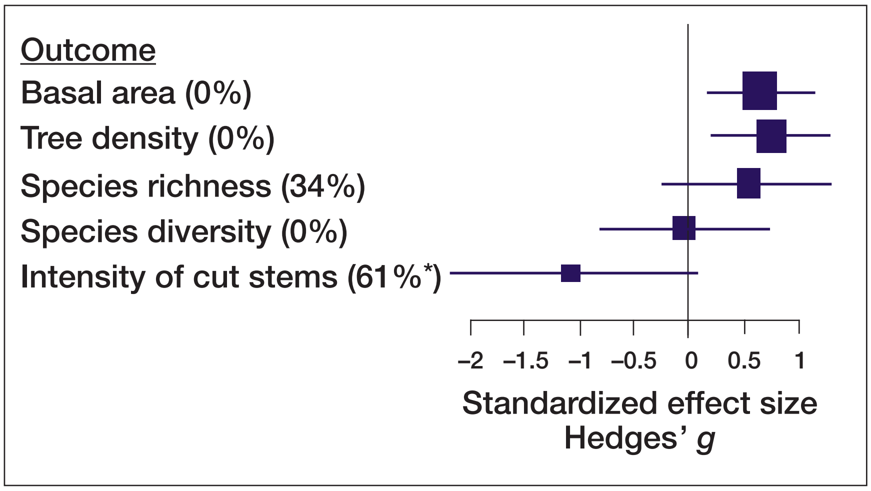

Figure 3. *The weighted average effect size (Hedges' g) and 95% confidence interval for the five outcomes meta-analyzed: basal area (10 effect sizes from 8 articles); tree density (9 effect sizes from 8); plant species richness (8 effect sizes from 7); plant species diversity (5 effect sizes from 5); and intensity (number, density, or percentage) of cut stems (6 effect sizes from 4). In parentheses after each outcome type is the* I^2*% index, which reflects the percentage of total variability due to between-study variability (heterogeneity) rather than sampling error (an asterisk indicates when the amount of heterogeneity was significant at 5%, based on Cochran's Q test).*

ies mentioned or provided evidence that CFM was implemented in an area because the forest either was degraded or was less productive than lands under different management schemes. Maharjan (1998) described how local people, having recognized the degradation of their community forest and its implications for their subsistence, approached the District Forest Office to establish a Forest User Group.

Global environmental impacts of CFM

Although many relevant outcome measures were reported in the included studies, comparatively few were reported frequently enough (data from at least four separate articles) to enable a quantitative synthesis. We calculated the standardized mean difference (using a statistic known as Hedges' *g*) of these outcomes with and without CFM (when sufficient data were available within an article, effect sizes were calculated separately for different managements or geographic areas due to potential heterogeneity) and used meta-analysis to calculate weighted (by inverse variance) averages of the effect sizes of each.

Total tree basal area and tree density were greater in forests under CFM than in comparator sites (Figure 3). In both cases, there was no support for heterogeneity (variation in effect size among different studies); however, studies did vary in the type of community management (eg community-based or joint). There was only weak (non-significant) evidence that plant species richness was increased by CFM, and no evidence for an effect on plant species diversity (Figure 3). Data on forest cover or deforestation rate assessed by satellite images could not be synthesized because of the limited number of studies and inconsistency in specific outcome measures.

We found marginal (non-significant) evidence that CFM decreased the intensity of stem cutting (Figure 3); however, there was an indication of variation in effect size, which suggests that other factors modified this outcome. There was variation in forest management type of the comparator site(s) and study location, but the studies were insufficient to enable robust analysis of how these variables may have modified the impact of CFM. Four studies reported on fuelwood extraction but some did not present the data necessary to calculate effect sizes for quantitative synthesis (Table 1).

Differences between CFM and non-CFM cases could be caused by differences in previous forest condition, environmental variables, or socioeconomic variables (where this cannot be eliminated by baseline data); direct effects of changes in management activities due to the initiation of CFM (eg initiation of tree planting or reduction in livestock grazing); and/or the indirect effects of management changes on the potential to detect certain impacts (eg cut stems).

Local human welfare benefits from CFM

Of the included studies, only seven provided quantitative information on welfare outcomes and each presented very different types of data, which were not directly comparable (Table 2; see Bowler *et al.* [2010] for data extracted on financial capital). We were therefore unable to undertake a quantitative synthesis but summarized the reported data within the Department for International Development's "capital assets" framework (DFID 2000). Collectively, and taking the complexity of interpretation of different measures (such as number of income sources) into consideration, the available studies did not provide convincing evidence that CFM has any substantial impact on "financial capital" over the 0- to 12-year time period that they covered. As compared with data on financial capital, there were even fewer quantitative data on social, human, or physical capital outcomes. In this review, we included only studies that presented quantitative information on relevant outcomes and collected data in CFM and non-CFM sites. We acknowledge that important insights into aspects of the processes behind impacts might be gained from a formal synthesis of studies using qualitative research methods, but this was not within the scope of this review.

Forming the evidence base

Clear evidence is now available on the scale of deforestation (Hansen *et al.* 2010) and the value of forest

Table 1. Comparison of fuelwood extraction in forests with and without community forest management (CFM) in the four studies presenting suitable data

Author(s)	*Type of CFM*	*Comparator*	*Outcome*	*Mean non-CFM*	*Mean CFM*	*Ln RR*[1]
Adhikari *et al.* (2007)	Community forestry	Before/after	Total fuelwood collection (kg)	29 429 (n = 8)	31 395 (n = 8)	0.06
Bandyopadhyay and Shyamsundar (2004)	Community forestry	Villages without community forestry	Average annual fuelwood collection (kilogram per household)	753 (n = 482)	955 (n = 42)	0.24
Edmonds (2002)	Community forestry	Villages without community forestry	Average household fuelwood collection (bhari/headloads per year)	114 (n = ?)	98 (n = ?)	–0.15
Gupta *et al.* (2004)	Participatory forest management	Before/after	Average annual quintals of fuelwood collected per family	28 (n = 2)	13 (n = 2)	–0.76

Notes: n = number of forests/villages, depending on author presentation. [1]Ln RR = log response ratio, used to show the relative change in means.

ecosystems (TEEB 2010), leading to broad political consensus about the need for Sustainable Forest Management (Angelsen *et al*. 2009). Unfortunately, the evidence about which approaches are effective in tackling the problem is much weaker (Lund *et al*. 2009). Our extensive search and rigorous assessment of the available evidence – on the effectiveness of CFM projects – highlight the weaknesses and major gaps in the evidence base that underpin this approach. We suggest that funders should require an a priori, peer-reviewed protocol for the design and evaluation of CFM projects, and propose some general standards for monitoring and evaluation (Table 3). Improvement in the quality of individual assessments will enable more powerful meta-analyses and contribute to the development of an informative evidence base.

Study design

In complex environmental and social situations, there are many factors other than the intervention that may cause change, so quantifying the effectiveness of an intervention is impossible without identifying an appropriate comparator or counterfactual (what would have happened in the absence of the intervention; Table 3; Ferraro and Pattanayak 2006; Margoluis *et al*. 2009). Where evaluation of effectiveness is an objective and where local circumstances permit, the implementation of CFM

Table 2. Indicators of different capital assets for which quantitative data were presented

Type of capital asset	*Indicator measured*
Financial	Estimated net present value/net benefit (Grundy *et al.* 2000; Kumar 2002; Calderon and Nawir 2006)
	Income sources expressed as a percentage (Gupta *et al.* 2004; Ali *et al.* 2007a)
	Number of income sources (Ali *et al.* 2007a)
	Levels of income: income for different "well-being" categories (Maharjan *et al.* 2009; Vyamana 2009); income from different forestry-related activities (Niesenbaum *et al.* 2005); number of families at different income levels (Gupta *et al.* 2004); model predicted annual income (Kassa *et al.* 2009)
Social	Mean score derived for "trust" and "relationship" with state and local institutions (Ali *et al.* 2007b)
	Mean "social capital" score derived from multiple indicators (Sun 2007)
Human	Mean "human capital" score derived from multiple indicators (Sun 2007)
	Time spent in fuelwood collection (Kohlin and Amacher 2005)
Political	Composition of village Natural Resource Committees (Vyamana 2009)
Physical	Mean "physical capital" score derived from multiple indicators (Sun 2007)
	Sources of fuel (Gupta *et al.* 2004)
	Proportion of communities in which developments had taken place (Vyamana 2009)

Table 3. Guidelines for "gold standard" CFM assessment

Design principle	*Explanation*
Comparator	Assessment in sites without CFM that can be used as a comparator to determine the effect of CFM. There are various possible non-CFM types; the most appropriate comparator may depend on the objectives of a particular CFM. The management of the non-CFM sites should be clearly described.
Baseline data collection	Measurement of baseline condition (including management) of both comparator and intervention sites before any intervention to determine their comparability and enable assessment of subsequent change.
Replication	Monitoring of multiple CFM and non-CFM (comparator) sites with independent implementation of management.
Site selection	Random selection of intervention and comparator sites from a wider predefined "population" of sites allows inferences at the population level. When only a low level of replication can be achieved, or there is structure within the population (eg forest patches differing in size, administrative unit, or market access), then a paired design may be more efficient. Independence of intervention and comparator sites is important to reduce the risk of leakage effects. Selection criteria must be fully reported.
Defined sampling procedure	Random selection of data collection units (forest plots or households) within each CFM and comparator site through appropriate sampling frames. Equality of recording effort across sites.
Defined timescale	Planning an appropriate timescale of monitoring and evaluation according to the expected timescale of outcomes. This expectation should be based on ecological and social theory of how CFM will affect the outcomes.
Development of success indicators	Identification and measurement of unambiguous indicators of the success of CFM in delivering outcomes.
Measurement of confounding variables and context	Measurement of environmental variables and community characteristics that may cause bias in estimation of the effect size within a study (eg whether they differ between CFM and non-CFM sites) or explain differences between the specific effect size in the study case and those of other cases (eg study-level variables).

should be treated as experimental. Ideally, investigation of impacts of CFM would be planned simultaneously with CFM implementation and would begin with identifying a set of forests/communities, some of which would be selected at random for CFM and some as the comparator. Where this is not possible, for instance because of issues related to social equity amongst communities, an appropriate observational study design should be used, which carefully considers confounding variables that might be creating differences between sites under CFM and sites without CFM. Baseline data are clearly important to determine whether CFM and comparator sites were similar before CFM implementation. "Leakage" (spill-over) of human impacts between intervention and comparator areas can also confound analysis (eg whether CFM affects the management or use of nearby non-CFM sites). Although short distances might maximize matching, they may also increase the risk of leakage effects (Somanathan *et al*. 2009).

Reporting of contextual factors as potential effect modifiers

No two CFM projects will be the same in terms of ecological, social, and economic variables. We would therefore not expect different CFM projects to prove equally effective relative to their respective comparators, even if the studies had equally valid designs (Pagdee *et al*. 2006). For example, studies of CFM have recognized that there are variations in the extent of decentralization, specifically the types of rights and benefits devolved, and their authors have proposed that this may explain why some projects are successful while others fail (Agrawal and Ostrom 2001; Persha *et al*. 2011). Pagdee *et al*. (2006) classified the impact of different CFM projects as a binary "success" or "failure" outcome and described effects of institutional arrangements, including community incentives and property rights. Other variables that may determine the success of a project include physical features (such as project size) and community context (such as resource scarcity and dependency; Agrawal and Chhatre 2006; Behera 2009; Brown and Lassoie 2010; Hayes and Persha 2010). Clearly, it would be extremely useful for funders to be able to predict effectiveness in a particular context. For this to be supported by a meta-analysis, original studies of CFM projects need to accurately report other site variables that may influence CFM effectiveness. Our review includes data from studies conducted in a range of countries, with different forms of CFM (eg joint forest management and community-based forest management, both of which may differ in their definition and implementation) and different comparator types. However, exploration of heterogeneity of the effect size was not possible given that each meta-analysis only included a few independent studies and the features of the CFM were not consistently described by the studies.

Spatial and temporal scale

Many of the desired outcomes are likely to vary with spatial and temporal scale. Short-term success may not predict longer-term benefit; even in the absence of short-term success, however, the impacts of improved community participation may still lead to important longer-term benefits (Brunner *et al.* 2005; Blomley *et al.* 2008). It will never be the case, though, that project impacts can be considered "permanent", even though this is often used as a criterion for assessment of projects involving payments for climate-regulation-related ecosystem services (Angelsen *et al.* 2009). Those undertaking such projects should include some indication of the timescale over which objectives might be met and should plan monitoring and evaluation accordingly.

Globally relevant outcome measures

Funding agencies should agree on indicators of success and failure of CFM projects and on standard methods of their measurement across studies. This is especially important for the reporting of welfare outcomes, which were particularly variable in the included studies, and resource-use variables, which were difficult to interpret in the review. Social and public health scientists should be involved in identifying appropriate indicator sets to ensure better linkage with other socioeconomic monitoring systems.

■ Conclusions

The outcome of our systematic review should be of concern to organizations planning to invest substantial financial resources in CFM. Of course, lack of evidence that CFM is effective should not be taken as evidence that it is ineffective, or to justify lack of action or cessation of support. However, responsible public expenditure requires proper evaluation and, given planned future expenditure on CFM (GEF 2010), the lack of evidence of effectiveness is problematic. The integration of robust evaluation principles into all CFM projects would also allow those involved in implementing the policy to learn from successes and failures, and ensure the potential of this approach to deliver much needed environmental benefits and poverty alleviation is realized. A fundamental improvement in the quality of evidence of the effectiveness of CFM will occur if new CFM projects are set up with rigorous plans for monitoring of outcomes built into their design. There are other major donor-funded programs that aim for environmental sustainability and improved human welfare. By extrapolating from the analysis of this study, the effectiveness of such programs would also benefit from similarly rigorous impact evaluation through systematic review methodology.

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