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 “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).

Community forest management (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;
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-

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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.

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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-
Inconsistent in specific outcome measures. Because of the limited number of studies and estimation rate assessed by satellite images could not be synthesized because of forest or deforestation species diversity (Figure 3). Data on forest cover or deforestation increased by CFM, and no evidence for an effect on plant species richness was significant (non-significant) evidence that plant species richness was increased by CFM, and no evidence for an effect on plant species diversity (Figure 3). 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 I²% 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).

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 I²% 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).

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
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 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) | 29429 (n = 8) | 31395 (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 (bahi/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.

| 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) |
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

<table>
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<tr>
<th>Table 3. Guidelines for “gold standard” CFM assessment</th>
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<td><strong>Design principle</strong></td>
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<td>Comparator</td>
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<td>Baseline data collection</td>
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<td>Replication</td>
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<td>Site selection</td>
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<td>Defined sampling procedure</td>
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<td>Defined timescale</td>
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<td>Development of success indicators</td>
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<td>Measurement of confounding variables and context</td>
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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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