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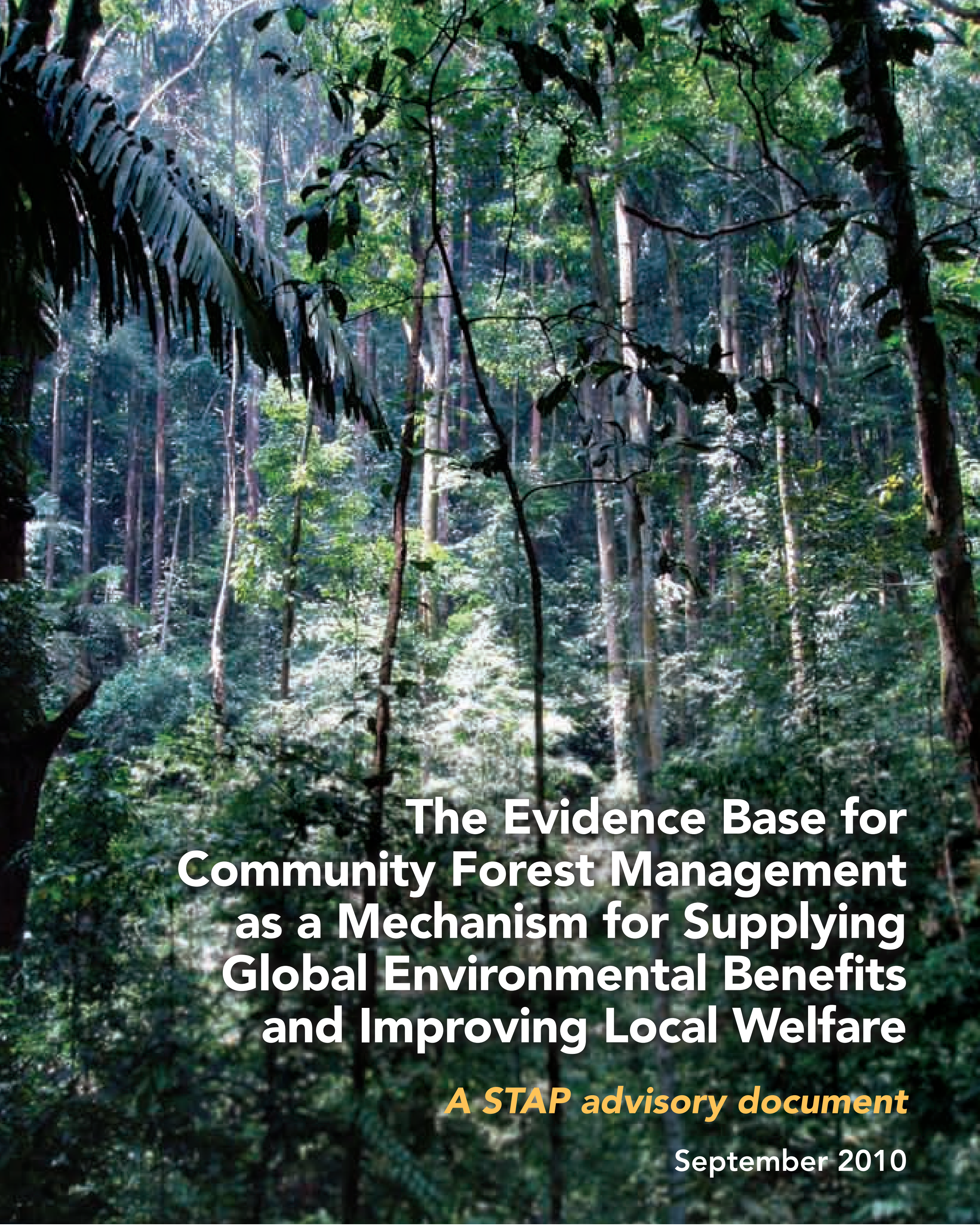
THE EVIDENCE BASE FOR COMMUNITY FOREST MANAGEMENT AS A MECHANISM FOR SUPPLYING GLOBAL ENVIRONMENTAL BENEFITS AND IMPROVING LOCAL WELFARE: A STAP ADVISORY DOCUMENT

(Prepared by STAP)



The Evidence Base for Community Forest Management as a Mechanism for Supplying Global Environmental Benefits and Improving Local Welfare

A STAP advisory document

September 2010

Scientific and Technical Advisory Panel

The Scientific and Technical Advisory Panel, administered by UNEP, advises the Global Environmental Facility

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Prepared on behalf of the Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF) by

Diana Bowler, Lisette Buyung-Ali, John R. Healey, Julia P.G. Jones, Teri Knight and Andrew S. Pullin; a.s.pullin@bangor.ac.uk

Centre for Evidence-Based Conservation, SENRGY, Bangor University, Bangor, Gwynedd LL57 2UW, UK

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About STAP
The Scientific and Technical Advisory Panel comprises six expert advisers supported by a Secretariat, which are together responsible for connecting the Global Environment Facility to the most up to date, authoritative, and globally representative science.

http://www.unep.org/stap

Foreword

Community forest management (CFM) initiatives comprise a range of efforts to involve people who live in and around forests in forest management decisions. CFM initiatives often vest in communities some degree of decision-making power over forest management and rights to the benefits from such management. These initiatives are expected to result in more effective forest management, which is expected to help conserve biodiversity and ecosystem services and contribute to poverty reduction and economic development. CFM initiatives are common components in GEF-funded projects aimed at sustainable forest management and the protection of biodiversity and ecosystem services outside of government-managed protected areas.

This advisory document summarizes the evidence base for the effectiveness of CFM initiatives in generating global, national, regional and local environmental benefits. It also summarizes evidence related to the socioeconomic impacts on participants. It was reviewed by two external reviewers, STAP panel members and STAP Secretariat staff.

The key messages and their implications for the GEF include:

1. There are five main threats to CFM effectiveness in generating global environmental benefits: (i) limited devolution of authority and rights across and within communities, which fails to give community members incentives to manage forests sustainably; (ii) limited technical and institutional capacity of communities, which prevents communities from responding to incentives (institutional capacity includes ability to allocate and enforce rights); (iii) conflict between the production of private and public goods in which communities are most interested and public goods in which national and global stakeholders are most interested; (iv) displacement of forest exploitation from CFM forests to other forests (leakage); and (v) adverse self-selection, whereby communities already engaged in, or intending to engage in, environmentally-friendly forest management practices disproportionately participate in CFM programs. The first two threats are generally recognized in GEF project designs. The third and fourth threats are rarely recognized, although the evidence about whether they are important in practice is unclear. The fifth threat has been shown to limit impacts in a wide range of voluntary programs and there is some evidence that it is a problem in CFM. **We recommend that GEF CFM components should describe design choices to minimize these five threats and specify indicators that will permit one to monitor the importance of these threats.**

2. Despite the abundance of CFM programs operating worldwide, only forty-two studies have attempted to measure these programs' environmental or socioeconomic impacts. A majority were from India or Nepal. Although no consistent impacts were detected on species richness and diversity or local products and livelihoods, CFM forests tended to have higher forest cover, tree basal area and tree stem density compared to non-CFM forests. Unfortunately, of the forty-two studies, only ten attempt to identify the causal impact of CFM by eliminating rival explanations of the observed outcomes that have nothing to do with CFM. Thus even when differences in CFM forests over time or in comparison to non-CFM forests were observed, few studies could make a strong case that CFM was the cause rather than, for example, pre-existing differences in forest condition. Moreover, the connections between global environmental benefits and the indicators typically measured in CFM projects are unclear. In sum, the evidence base provides weak and inconsistent evidence for the hypothesis that CFM has had positive socioeconomic or environmental impacts. **GEF agencies proposing a new or expanded CFM initiative should acknowledge that they are proposing a widely known, but still inadequately understood mechanism for achieving environmental and social gains. We recommend that proposals and reports describe in detail the pathways through which CFM is believed to result in additional environmental, and perhaps socioeconomic, outcomes (i.e., a detailed "theory of change" to use the language of the GEF EO's review of outcomes to impacts practitioners handbook, June 2009).**

3. Financing of CFM initiatives is consistent with the GEF's mandate to increase the supply of global environmental benefits. The limited evidence base does not imply that the GEF should avoid investing in CFM programs, nor does it imply that past investments in CFM have necessarily failed to yield returns. However, it does imply that GEF CFM components must be designed in a way that encourages more credible evaluations of the environmental (and socioeconomic) impacts of CFM programs. Projects must include more than monitoring of status and trends of environmental indicators in CFM forests. **A relatively simple project design improvement would be to select non-CFM community forests that have similar baseline (pre-CFM project) trends and characteristics to CFM community forests and to monitor a few outcome indicators at both CFM and non-CFM sites over the project period (ideally some indicators would be common across GEF CFM projects).** Such a design would make it reasonable to infer that any differences between CFM and non-CFM forests can be attributed to CFM rather than to other factors (or to infer that any lack of differences implies CFM had no impact). More complicated project designs are possible, but this suggested change to monitoring CFM components of GEF projects is feasible and would lead to a much more solid evidence base for CFM. A more solid evidence base makes it more likely that the GEF and its partners will reap a higher return on investments in forest conservation.

Thomas Lovejoy
Chair, Scientific and Technical Advisory Panel

Paul Ferraro
Panel Member for Biodiversity (2007-2009)

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Executive Summary

Background

Sustainable forest management (SFM) aims to *"maintain and enhance the economic, social and environmental values of forests for the benefit of present and future generations"*. In pursuit of SFM, many developing nations have devolved full or partial forest management authority to local communities. This devolution is expected to result in more effective forest management, which is expected to help conserve biodiversity and ecosystem services and contribute to poverty reduction and economic development. Approaches to community forest management (CFM) have in common the involvement of people who live in and around the forest in the management decisions that affect forest use and conservation. In the context of this review, we define CFM as *'de-jure'* government-approved forms of forest management by local communities, with the following characteristics: (1) a core objective of providing local communities with social and economic benefits while promoting the sustainable management of community- or state-owned forests and/or (2) some degree of control and decision-making power vested in the community by the government (or other designated authority). This review focuses on studies that measure impacts from efforts to decentralize and devolve management authority to communities, rather than describe the status quo in communities that have long managed their own forests.

Despite CFM's increasing popularity, theory does not guarantee environmental and socioeconomic benefits from CFM. Behavioural theories from economics and political science make ambiguous predictions about whether

decentralization leads to better local welfare. CFM effects are a function of myriad factors such as the nature of local rights with and without CFM, the benefits and costs of enforcing these rights, the quantity and quality of information, and the economic potential of the forest. In the context of the provision of environmental public goods enjoyed by citizens beyond the communities that manage the forest, theory predicts underprovision of the goods, but the level is ambiguous: it is determined by the degree of joint production of global public goods with private and local public goods. Even if CFM projects could generate positive environmental and socioeconomic gains, on average, they are often not implemented in the average community. Communities who already manage their forests better than the average community are more likely to be selected for devolution of management authority. Because of such selection effects, CFM projects can generate much smaller environmental and social gains than expected.

Although there are many studies that examine CFM, relatively few specifically aim to evaluate empirically the impacts of CFM. Among those that do, many rely on crude empirical designs that do not correct for selection effects and other sources of bias. This review characterizes the empirical evidence that CFM can generate global, as well as local, regional and national, environmental benefits.

Objective

The primary review question is 'Does Community Forest Management supply global environmental and local welfare benefits in less developed countries?'

Methods

Multiple electronic databases, internet engines, and the websites of specialist organisations were searched to identify published and unpublished literature relevant to the review question. A range of keywords in English, Spanish and French were used. Bibliography checks were performed to complement the main search (which ended in June 2009). Predefined inclusion criteria were applied to each article in order to identify the subset to be included in the review:

Relevant subject(s): Any forest ecosystem or human population associated with a CFM programme in less developed countries.

Types of intervention: CFM programmes in less developed countries.

Types of outcome: a. changes to: biodiversity (surrogate measures of), forest cover or forest condition, fuel wood availability, carbon sequestration (any measure), land degradation or conversion, forest loss, desertification, forest productivity (wood and non-wood), water supply; b. changes in the following local welfare indicators: income, employment, food security, social equity, income equality, health.

Types of study: Studies providing empirical data, qualitative or quantitative. Only those studies making explicit comparisons between CFM and 'no CFM' were included in the analysis ('no CFM' includes government, private and open access management regimes).

Relevant articles were grouped by outcome into three pools: those examining the impact of community forest management on forest cover and condition; resource extraction (fuelwood collection and number of cut stems); and livelihoods. Due to the diversity of studies, meta-analysis was not appropriate for the majority of outcome types. Such analysis was conducted on a subset of studies when possible, and a qualitative synthesis conducted for those remaining (see main text for more details).

Overview of the evidence base

In total, 42 articles were included in the review, of which 34 reported data on forest condition or cover, 8 on resource extraction and 12 on livelihoods. Only ten attempt to identify the causal impact of CFM by eliminating rival non-CFM explanations for the observed outcomes. Eleven of the 42 articles compare conditions after CFM to conditions before CFM without considering cotemporaneous changes. The remaining 21 studies compared CFM sites to non-CFM sites without considering baseline differences in the sites. Approximately 60% of the studies were from just two countries (Nepal, India).

Impacts

Summary. With the exception of indicators for tree stem density and basal area, impacts estimates showed no clear pattern. Moreover, few studies had data to address the possibility that any observed post-CFM differences were present before CFM was initiated. Finally, in cases in which a result implied CFM had an impact on environmental indicators, the relationship between changes in these indicators and global environmental benefits was not clear.

Details. Four studies that compared percentage forest cover before and after CFM, obtained with satellite

data, show a range of effect sizes (including one negative). Three studies that compared percentage cover with a similar area of forest under alternative management suggest only moderate differences in forest cover between the different management systems. More data were available on measures of forest condition (tree stem density, basal area, tree/plant diversity or richness) and these were synthesized in a meta-analysis. Based on data from eight studies, basal area and tree stem density were greater in forests, which in some cases included plantations, with CFM than those under either state management or no management. However, there was no consistent effect of CFM on species richness (seven articles) or diversity (five articles) compared with other types of management. Meta-analysis of data from four studies indicated that incidence of cut stems was lower in forests with CFM but this trend was not consistent across studies. Only three articles presented data on fuelwood collection and two of these suggested greater levels with CFM. There were insufficient data to investigate the relative effects of different types of management.

There is insufficient evidence to form any conclusions about the effect of CFM on local livelihoods, which is in part due to the absence of common indicators of CFM effects on livelihoods. Given the variability in the indicators used, no quantitative synthesis could be done.

The limited evidence suggests that forest condition may be improved under CFM. Improvement in forest condition could potentially result in a global benefit through an increase in carbon sequestration. However, the reliability of the measured variables as robust indicators of broader aspects of forest condition needs to be verified. There is no evidence of benefit to biodiversity conservation based on analysis of data on plant species richness or diversity. However, these findings should be considered in the context of the timescales of measurement; specifically how long the management had been in place before measurements were taken, and the timescales over which these biological variables could be expected to respond. Also, as noted by one study, even if CFM were to be no more effective than other management regimes, it may be cheaper, thus increasing the cost-effectiveness of limited environmental funds.

Of great concern for the studies reviewed is the inability of most studies to credibly eliminate rival explanations of any changes, or absence of changes, in the outcome variables. For example, the estimated impacts on stem density from CFM may result from pre-existing differences in the stem density of sites selected and not selected for CFM. Most studies do not collect the necessary baseline data or other relevant information to investigate this potential bias.

Implications for the GEF

Community forest management is a component in many of the forest-related project proposals in the GEF's Biodiversity focal area and Sustainable Forest Management program. Moreover the implications of this review are relevant for the International Waters and Land Degradation focal areas, which also include community-based management initiatives in the most recent GEF-5 programming document.[1]

Although hundreds of CFM programs are operating worldwide, there are no concrete "lessons learned" for GEF partners seeking to boost impacts of new or expanded CFM efforts. Although quite a bit is known about forestry and the processes through which community members can participate in CFM, far less is known about CFM impacts and how to design programs to maximize them. This knowledge gap implies that GEF project designs cannot be justified simply by precedent. In proposals and final reports, they should describe in detail the pathways through which CFM is believed to result in additional environmental (and perhaps socioeconomic) outcomes.

Financing of CFM is consistent with the GEF's mandate to increase the supply of global environmental benefits. The limited evidence base does **not** imply that the GEF should avoid investing in CFM, nor does it imply that past investments in CFM have necessarily failed to yield returns. However, it does imply that the GEF should only invest in CFM projects that are explicitly designed to evaluate the environmental impacts of the CFM effort. In other words, the purpose of CFM projects in the GEF portfolio should not simply be to attempt to generate environmental benefits at the project site, but also to catalyze effective forest management globally though the generation of credible evidence about what works and under what conditions.

Synthesis and interpretation of the current evidence base is hampered by the poor methodological designs and diverse outcome indicators used to measure the effects of CFM. The GEF can greatly contribute greatly to improving the status quo by insisting on a minimum standard of CFM project design that includes the following elements:

1 See GEF_R5_31 GEF_5 Programming Document, May 03, 2010.

1. Agreement on a small set of outcome measures that are recognised indicators of CFM and will be used across GEF projects. These measures may differ across a small number of classes for CFM type, but they should permit quantitative synthesis of data with which one can make more general inferences of the effects of CFM rather than just accumulating disconnected case studies of specific sites.

2. Provision of good documentation of the CFM context and the institutional and technical attributes of the CFM intervention in the progress and final reports of every project.

3. Three design elements that will increase the ease with which internal and external observers can infer the project's impact:

    a. Select non-CFM sites that have baseline (pre-CFM project) characteristics and outcome indicator trends similar to those of CFM sites. Collect and keep data on baseline trends and characteristics to support the choice of the non-CFM sites.

    b. Monitor a few important outcome indicators at both CFM and non-CFM sites over the project period. Given similar baseline trends and characteristics across sites, one can compare the differences in changes in indicators at CFM and non-CFM sites to infer the impact of CFM. The key assumption for such inferences is that the average trend of the non-CFM sites represents the average trend of the CFM sites in the absence of the CFM activities.

    c. Collect and keep information on a small set of baseline characteristics that are believed to affect the trend in the outcome indicators during the project and may differ between non-CFM and CFM sites despite efforts to find comparable non-CFM sites. This information will help observers assess the likelihood that any observed differences between CFM and non-CFM sites are due to CFM activities rather than pre-existing differences.

These realistic changes in project design can have dramatic effects on the ability of the GEF, and thus the world, to develop an evidence base for CFM. With a more solid evidence base, the return on the GEF's investments can be substantially higher in the future.

1. Background

Rates of deforestation and forest degradation are high in many countries, leading to concern about the loss of ecosystem services such as carbon storage, biodiversity conservation, water and food security (as reflected in the United Nations' conventions on biological diversity and climate change, the Forest Principles of UNCED and Agenda 21). Therefore there is an international effort to move towards a more stable and sustainable state for forest condition and management (e.g. through the work of the UN Forum on Forests). At the same time it has been increasingly recognised that many of the world's poorest people get significant resources from forests (Byron and Arnold 1999; Godoy 2000; Campbell and Sayer 2003) and national forest policies increasingly consider local people's needs. In fact, to meet the Millennium Development Goals, countries have pledged to ensure that policies designed to conserve internationally important ecosystem services in forests fully take account of impacts on local livelihoods.

Sustainable forest management (SFM) aims to *"maintain and enhance the economic, social and environmental values of forests for the benefit of present and future generations"*.[1] Among the objectives of SFM is the conservation of biological diversity; prevention, control and reversal of land degradation; mitigation of desertification; mitigation of, or adaptation to, climate change; and the production of wood and non-wood forest products and services.

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1 As adopted in the "Non-legally binding Instrument on All Types of Forests" (NLBI) at the seventh session of the United Nations Forum on Forests (UNFF), April 2007.

In pursuit of SFM, many developing nations have devolved full or partial forest management authority to local communities (Bray et al 2003; Somanathan et al 2009). This devolution is expected to result in more effective forest management, conserving biodiversity while also contributing to poverty reduction and economic development. Approaches to such community forest management (CFM) go by many names and forms: co-management, joint management, participatory management, community-based forest management, indigenous reserves. Despite the differences in names and emphases, they have in common the involvement of people who live in and around the forest in the management decisions that affect forest use and conservation. In the context of this review, we define community forest management as:

De jure, government-approved forms of forest management by local communities, with the following characteristics:

1. a core objective of providing local communities with social and economic benefits whilst promoting the sustainable management of community- or state-owned forests[2]

   and/or

2. some degree of control and decision-making power vested in the community by the government (or designated authority).

The argument for decentralisation of forest management in developing countries is that shortage of resources and poor infrastructure have often resulted in a lack of effective state control (Curran et al 2004). It is hoped that devolving management rights and responsibilities to local people will avoid a 'tragedy of the commons' and encourage local people to actively manage the forest resulting in both ecological and economic benefits. It has been suggested that these benefits are realized at local, national and global scales.

CFM approaches are growing in popularity at the national level and attracting increasing funding from international organisations. The effectiveness of CFM approaches, however, is not well documented despite this being important for informing the development of evidence-based policy. This review characterizes the empirical evidence that CFM can generate global environmental benefits (i.e., public goods not confined to the nation in which the CFM occurs, e.g. biodiversity conservation, carbon sequestration), as well as local benefits (i.e., benefits to communities entrusted with management authority, e.g. changes in household income, food security) and regional/national environmental benefits (i.e., public goods within the nation with the CFM, e.g. watershed protection). This review collates and appraises studies that compare measurements in a forest/village with CFM with a forest/village without CFM implementation (or alternatively before CFM implementation); this direct comparison provides the opportunity to measure the effect of CFM independent of changes in environments/livelihoods due to other causes.

2 We adopt the FAO's definition of "forest" presented in the 2005 Global Forest Resources Assessment (http://www.fao.org/docrep/007/ae156e/AE156E03.htm#TopOfPage).

2. Objectives

2.1. Primary objective

Does Community Forest Management supply global environmental and local welfare benefits in less developed countries?

Table 1. The elements of the systematic review question defined.

Subject	a. Forest ecosystems b. Human populations
Intervention	Community forest management programmes in Less Developed Countries
Outcome Measure	a. Change in biodiversity, forest cover, forest condition, fuel wood availability, carbon sequestration, measures of land degradation and desertification, forest loss, land conversion, forest productivity (wood and non-wood), b. Measures of local human welfare: income, employment, income equality, social equity, food security, health.
Comparator	Without and/or before/after CFM.

3. Methods

3.1. Question formulation

This review was commissioned by the Scientific and Technical Advisory Panel of the Global Environment Facility (GEF) who are interested in the evidence base for the effectiveness of CFM because the GEF is funding CFM initiatives. Thus the broad question for review was developed by the GEF and its Science Panel. The question components were refined by subject experts within the review team and, following a brief period of scoping, the focus of the review was restricted to community forest management in developing nations reflecting the availability of relevant literature. The question breakdown is shown in Table 1.

3.2. Search strategy

The search aimed to capture an unbiased and comprehensive sample of the literature relevant to the question, whether published or unpublished. Thus, a number of different information sources (general and specific) were searched in order to maximise coverage.

3.2.1. General Search

The first part of the literature search involved the use of a wide range of academic literature databases as well as a number of internet search engines: a full list of the sources used for this review is presented in Appendix B.1. Given the many thousands of results returned by internet search engines, these searches were restricted so that the first 100 hits from each search were checked for relevance and any links to potentially relevant material followed only once from the original hit.

3.2.2. Specific Search

This part of the search took two forms: the first, given the focus of the review on interventions of the type run by the GEF family of organisations, was direct contact with the GEF agencies (see Appendix B.2) to identify any relevant material in their data holdings; and the second, searching of a number of specialist organisation websites (listed in Appendix B.2). In order to improve efficiency, this search was restricted to the publications section of these websites where one was available.

3.2.3. Search terms

Discussion with subject experts and iterative testing of individual terms allowed the identification of an appropriate set of search terms for use in the database and internet search engines. These were combined using Boolean operators where possible and utilised truncation/wild card symbols (denoted by *) to search alternative word endings:

- "community forest*";
- "community-based forest*";
- ("co-management" AND forest*);
- ("joint management" AND forest*); "JFM";
- "participatory forest*";
- "indigenous forest* reserve*";
- "decentrali* forest*";
- "integrated conservation development pro*"; "ICDP*";
- "community-based natural resource*";
- (community AND "natural resource management" AND forest*);
- ("common property AND forest*").

Where database or search engine capability precluded the use of multiple terms or lengthy search strings, a single term "community forest management" was used for efficiency.

Foreign language internet searches (see B.1), in French and Spanish, have been conducted[2] using combinations of the following terms:

- "Manejo Forestal Comunitario"; "Ejido forestall"; "Desarrollo forestal participativo"
- "Gestion communautaires (ou villageois) forêt"; "Gestion autorités communales forêt"; "La foresterie communitaire"; "Foresterie pour le developpement rural"; "Transfert de Gestion".

The reference sections of studies included in the review, as well as review papers and meta-analyses identified by the search, were examined for any further relevant citations not already captured. During the draft review consultation period, subject experts and key authors were contacted for additional references that may have been missed by the original search. Any additional studies were included into the final report version.

3.3. Study inclusion criteria

In order to select those articles that were relevant to the review question from those initially captured by the search, a set of inclusion criteria were developed prior to the start of the review and are as follows:

Relevant subject(s): Any forest ecosystem or human population associated with a CFM programme in less developed countries.

Types of intervention: CFM programmes in less developed countries.

Types of outcome: a. changes to: biodiversity (surrogate measures of), forest cover or forest condition, fuel wood availability, carbon sequestration (any measure), land degradation or conversion, forest loss, desertification, forest productivity (wood and non-wood), water supply; b. changes in the following local welfare indicators: income, employment, food security, social equity, income equality, health. We included studies which report any direct measure of these indicators, prioritising for analysis those which present quantitative measurements and/or use validated scores.

Types of study: Studies providing empirical data, qualitative or quantitative data, were included in the review. We prioritised for analysis those studies making explicit comparisons between CFM and 'no CFM': these within-study comparisons may have been made on the basis of internal or experimental comparators (i.e. before-after; intervention A v intervention B), or through the use of constructed comparators (i.e. studies which use external data sets or models to develop scenarios for comparison). Studies without comparators were classified and recorded.

The relevance assessment process was a three-staged one. In the first instance, the inclusion criteria were applied on the title only to remove spurious citations. The remaining articles were then filtered by examining their abstracts, and finally by viewing the remaining articles at full text. Hits from web searches were filtered initially with the inclusion criteria on the abstract of articles (or introduction section or equivalent if an abstract is not available), and then at full text. In cases of uncertainty, the reviewer tended towards inclusion and sought the opinion of a second reviewer to determine final inclusion.

2 These searches are complete and the articles are currently being examined for relevance. To date, only one additional potentially relevant article has been identified which is being translated.

To check for consistency in the application of the inclusion criteria, two reviewers applied the inclusion criteria to a sample of 200 articles at the abstract filter stage. The kappa statistic was calculated to measure the level of agreement between reviewers. Following discussion to clarify the interpretation of the inclusion criteria, a kappa score of 0.68 was achieved, indicating "good" agreement (Landis & Koch 1977).

3.4. Study characterisation & quality assessment

General characterisation: In order to provide some characterisation of studies which investigated the effects of CFM but did not present a relevant comparator for inclusion in our synthesis, we recorded from each article: the type of CFM (based on author's terms); the country in which data were collected; and the broad outcome measures of CFM effects.

Detailed characterisation: For those studies with appropriate comparators, we recorded, when available, a range of variables. In addition to recording the general information as per above, we focussed particularly on aspects of the study methodology that have implications for the reliability ('interval validity') and generalisability ('external validity') of study findings. This also allowed us to assess the reporting quality of articles. Recorded characteristics included elements of the following:

- Geographic context of study.
- CFM features/implementation: type, number of sites, age of management and size of forest area; any information on CFM implementation.
- Comparator features: before/after or site comparison (type of site comparison).
- Selection of CFM and comparator sites and the sampling/selection within each.
- Confounders: variables that may confound the effects of CFM (e.g. bias in initial placement of CFM initiatives) and the ability of the authors to account for this (base-line data, collection of variables that may differ between sites; confounders included in analysis; data presented on distance between sites).
- Methodology used to collect data: basic techniques/ instruments used, sampling within each site.
- Outcomes (i.e. variables measured that may indicate the effects of CFM): the types of outcomes collected and presented by a study and the potential of data presented for meta-analysis.
- Reasons for heterogeneity: details of any investigation/ discussion of factors that may explain variation in the effects of CFM as reported by the authors.
- Author's conclusion: a coarse scale on the strength of support the authors conclude on the effectiveness of CFM.

This list is not exhaustive and the full list of items is available in Appendix C.

3.5. Data extraction and synthesis

As part of the initial study characterisation, we recorded the 'potential for meta-analysis', which entailed interrogation of the data presented and consideration of whether a mean and variance of the outcome with and without CFM could be calculated. Thus, where suitable data could be extracted, we pursued calculation of effect size and meta-analysis of the most common outcome measures. In studies measuring forest condition, the most common outcome measures were tree density, forest basal area, plant species richness (trees or trees/shrubs and herbs) and species diversity (trees or trees/shrubs and herbs) and in studies measuring resource extraction, the number or density of cut stems in a forest was the most common. We synthesise data on each of these five outcome measures with meta-analysis.

For each outcome measure, an effect size was calculated using Hedges *g*, which is based on the difference between means in each group divided by the pooled standard deviation (Cooper and Hedges, 1994) to create a unit-less measure of effect. Calculation of standard deviation was based on units of replication at the forest or forest division level, depending on the manner in which data were presented in the article. For most articles, one effect size per outcome per study was calculated however in a few cases the data presented were split by an additional factor and in these cases, effect sizes were based on levels of this factor (e.g. JFM plantations/control and JFM natural forest/control from Aggarwal et al. 2006). Heterogeneity in effect size among different studies was investigated with Cochran's Q statistic. Random effects models were used to estimate the overall average and confidence intervals, which weights individual studies by the inverse of the sum of its effect-size variance and between-study variance. The significance of the overall average effect was assessed by whether its confidence interval overlapped zero.

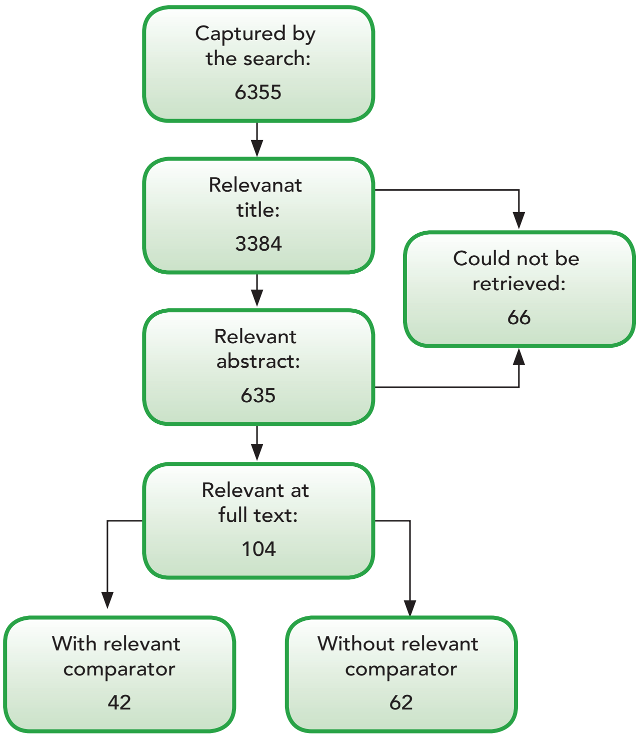
For other outcomes, apart from those five listed above, we did not pursue a meta-analysis because of the low number of studies which could be synthesized. Instead, we tabulated the averages of outcomes with and without CFM, and present effect sizes when possible, to illustrate the trends observed in the data. In these cases, log response ratios, which can be calculated without a measure of variance that is required for meta-analysis, is used to indicate the direction and relative size of effects. Where studies have not presented data in the form required for meta-analysis, authors were requested to provide any unpublished material or missing data that may be relevant to the review.

4. Results

4.1. Review statistics

The literature search returned 6355 articles, after duplicate removal (Figure 1): 3384 remained after checking of titles. Following abstract assessment, 635 (c. 10% of those initially retrieved) were accepted for assessment at full text. Of these articles, 16% were accepted at the full text assessment stage: 42 of these articles were found to present studies with appropriate comparators and thus were included in the synthesis (listed in Appendix D); the remaining 62 articles without comparators are characterised in Appendix E.

Figure 1. Number of articles retrieved in the review search and passing each stage of relevance assessment.



4.2. Description of studies

A list of included articles is provided in Appendix A. The following section provides a characterisation of the studies reported in the 42 articles included in the synthesis (some of these articles presented more than one study). A detailed description of each of these articles is presented in Table D1, Appendix D.

4.2.1. Source

Of those articles included, only 4 (c. 10%) came from non-peer reviewed sources and the remaining 38 (c. 90%) were published in peer reviewed journals. The large majority of studies (88%) were published after 2001. This represents an average of 1 paper per year up to 2001, increasing to 4.8 after 2001. Note that the database search was conducted during 2009 and thus this figure may not be representative of the whole year (Figure 2).

4.2.2. Focus

a) Study location

The geographical focus of the majority of the accepted studies is Asia (70%), dominated largely by India and Nepal, which together accounted for 59%; 16% were in Central America; and 14% in Africa (Figure 3). None of the captured studies examined CFM interventions in South America or Oceania.

b) Study comparator

Only 23% of the included studies examined outcomes before and after the implementation of CFM. The majority (77%) used comparisons with alternative management approaches, particularly comparisons of CFM outcomes with those from areas under state management, protected areas, or under unspecified 'non-CFM' management (Figure 4).

c) Type of CFM

The authors' descriptions of the project intervention are presented in Figure 5. Although some terms were clearly a result of national policy (e.g. 'joint forest management' in India and 'community forestry' in Nepal) and thus we can expect the nature of the intervention to be relatively uniform across projects using the same terminology from the same country, on the whole terminology could not be used to characterise or distinguish different approaches to CFM. The dominance of 'community forestry' and 'joint forest management' as the terms used (Figure 5) reflects the dominance of studies from Nepal and India in the set.

d) Measured outcome

The 42 studies reported 51 outcomes, which were classified into three broad groups in terms of the relevant outcomes that they reported: forest condition and land cover (34 studies); resource extraction (8 studies); and livelihoods (12 studies). Nine studies reported more than one outcome type therefore outcomes are not all independent data points. Figures 6-8 present a breakdown of each of these three broad groups (respectively) into more specific outcomes.

Figure 2. Year of publication of articles included in the synthesis. N=42

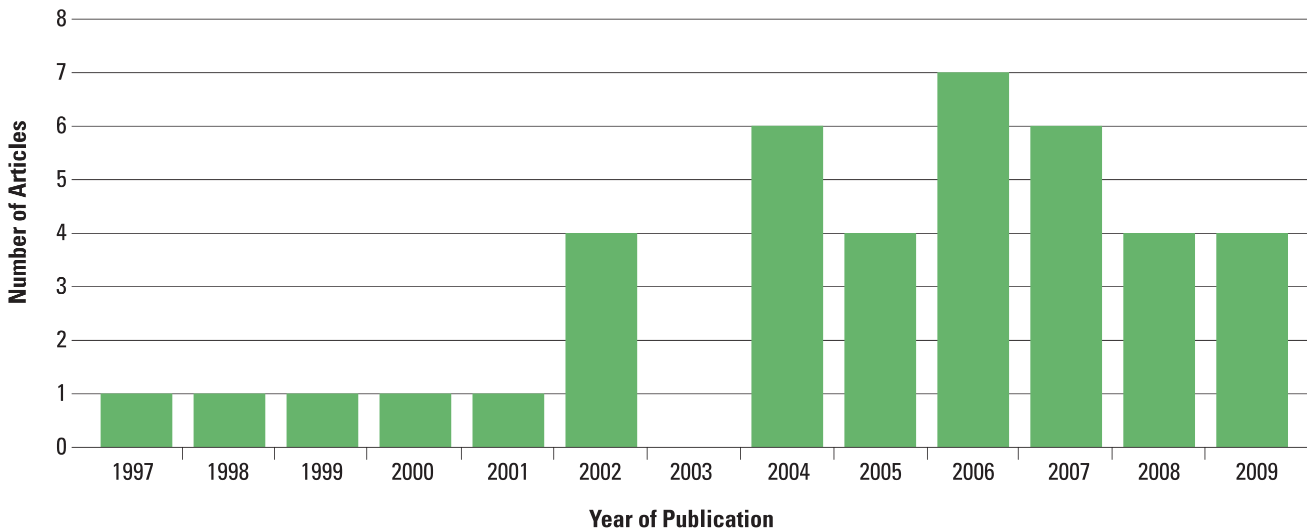


Figure 3. Location of studies included in the synthesis. Note that two articles studied multiple locations, hence n= 44.

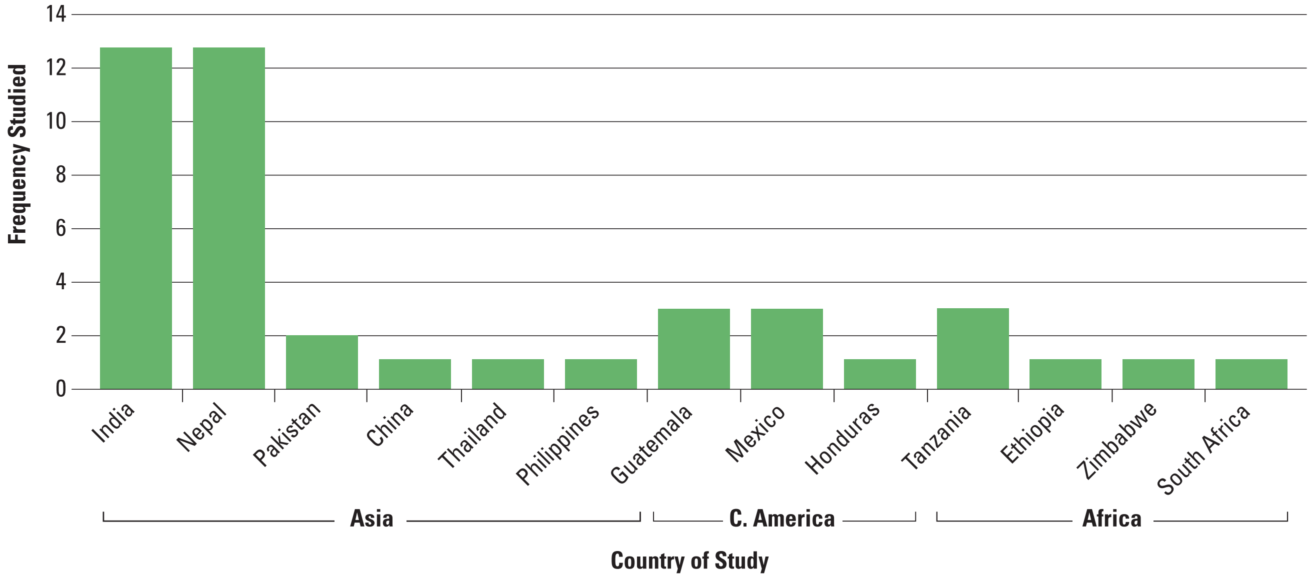


Figure 4. Nature of study comparators presented in included studies. N.B. n=48, accounting for those studies making multiple comparisons.

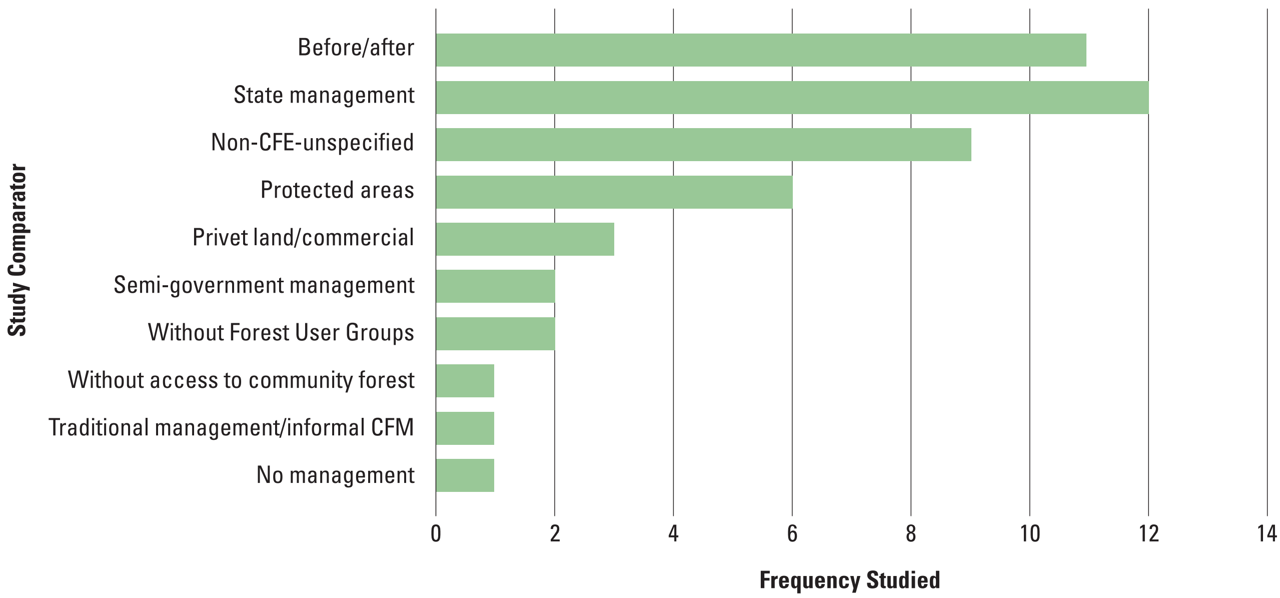


Figure 5. The range and frequency of terminology used to describe the projects' community forest management intervention in the included studies. N=43, reflecting that one article presented two different CFM 'types'.

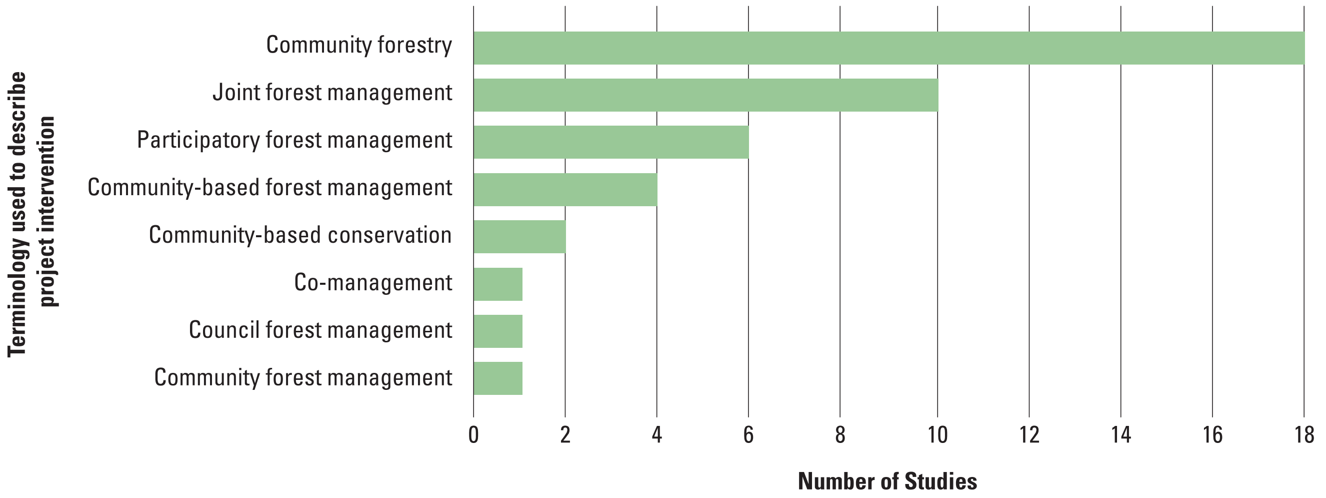


Figure 6. Number of studies giving each specific outcome category in the forest condition and land cover group (number of studies = 34, most studies reported multiple specific outcomes).

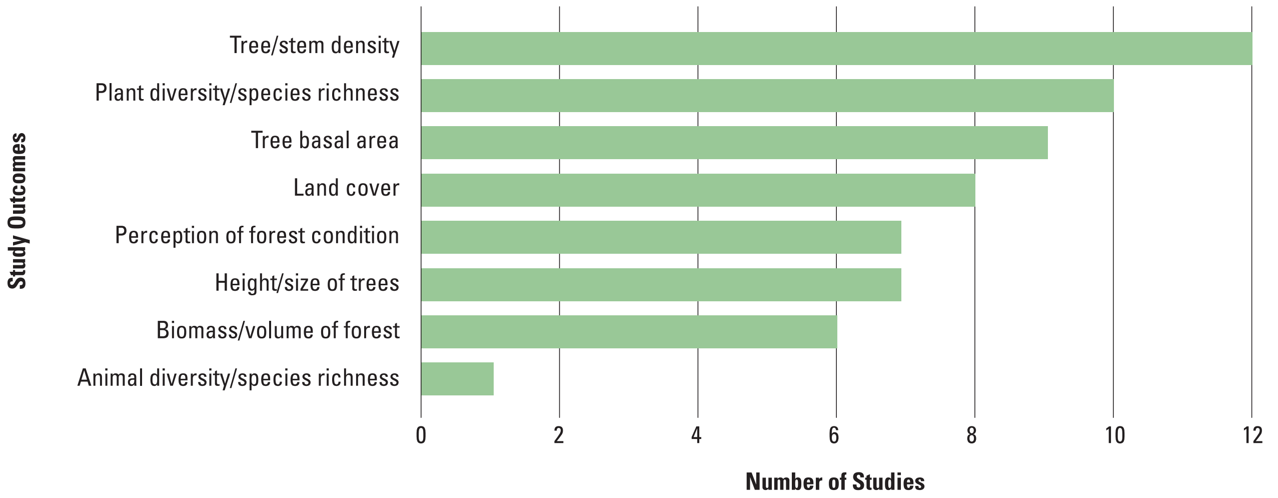


Figure 7. Number of studies giving each specific outcome category in the resource extraction group (n=8, some studies gave multiple specific outcomes). NTFP is non-timber forest products.

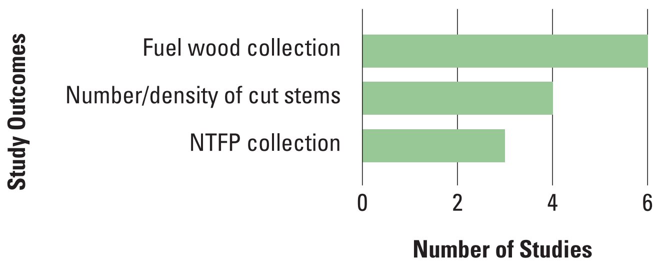
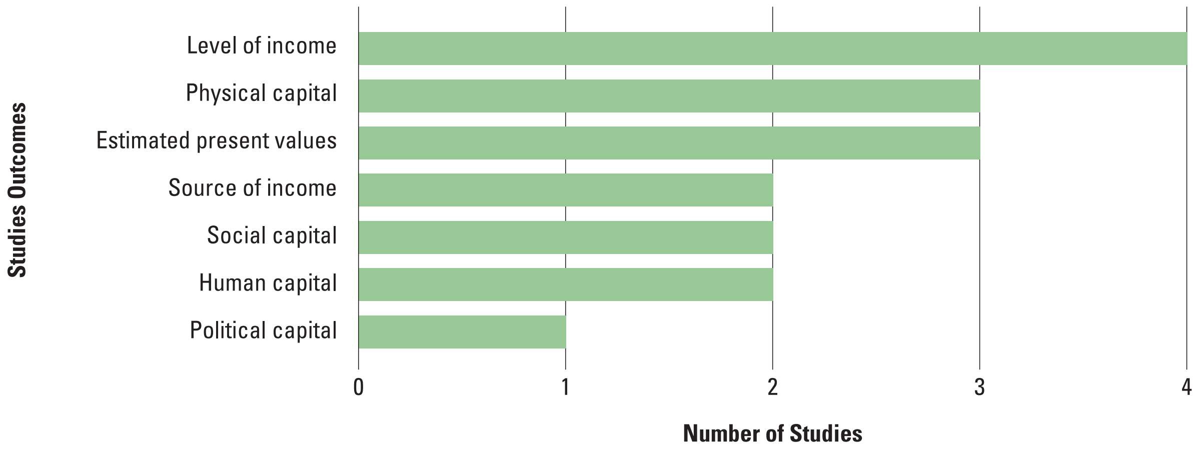


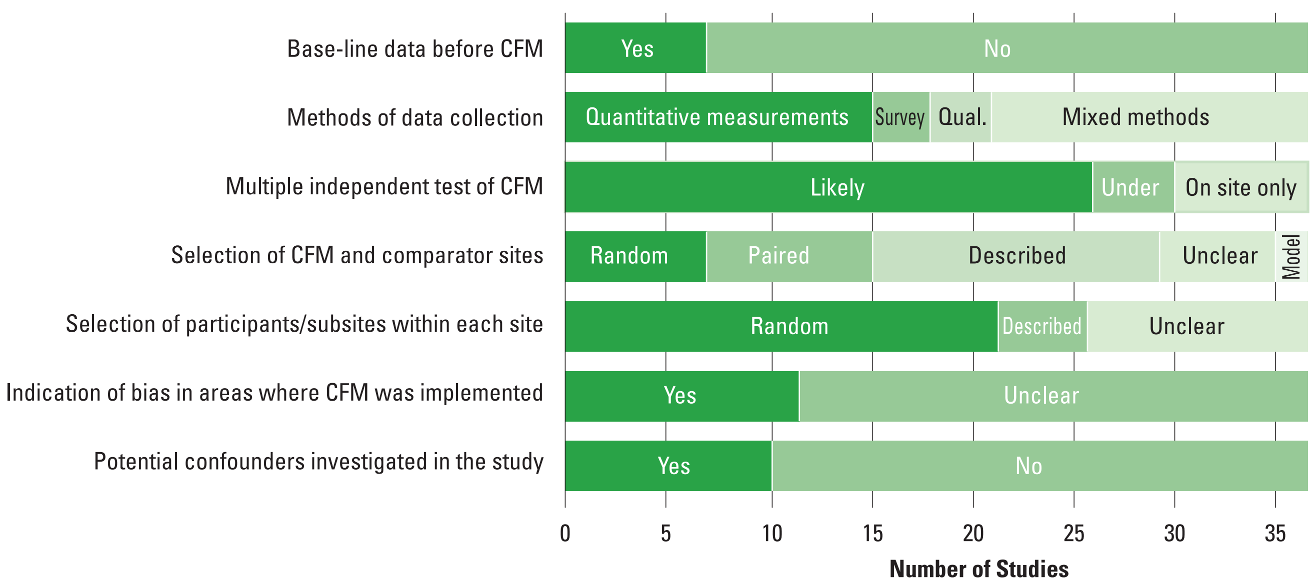
Figure 8. Number of studies giving each specific outcome category in the livelihood group (n=12, some studies gave multiple specific outcomes).



4.2.3. Study designs and methodology

Studies included in this review varied in their study design; basic details of the methodology of the studies are summarised in Figure 9. Most studies were comparisons of sites with and without CFM, without any baseline data collected from before the CFM was imposed; baseline data would allow assessment of the comparability of sites before management. Seven studies reported having some base-line data but only two of these also had control/comparator sites and in both cases the collection and presentation of baseline data were limited in the article (Kumar 2002; Maharjan et al. 2009), which prevented analysis of their findings as a BACI (Before-After-Control-Intervention) design. Studies investigating forest condition mostly employed a quantitative methodology using plots or transects to sample outcomes directly in the forest although some also used qualitative research methods to investigate user perceptions of forest condition. Studies investigating livelihood outcomes generally used mixed methods including a combination of quantitative survey data (e.g. questionnaire) and qualitative research methods such as semi-structured interviews.

Figure 9. Number of studies using different methodological approaches. More information on each component is given in the text below.



Although most studies tended to investigate several different sites with and without CFM, the exact number of sites with independent managements was not always clear. For instance, several studies investigating multiple study sites (e.g. villages, forests or plantations), each within a number of different 'forest divisions' did not make clear whether each forest was subject to independent management, and therefore could provide independent replicate "tests" of the effects of CFM. Seven studies collected data from only one forest/village with CFM and in another four studies it was not clear whether more than one independent site was studied.

There were two scales of site selection within studies: firstly, selection of forests/villages and, secondly, selection of sub-sites/participants within each forest and village. At the first scale, seven studies selected CFM and comparator forests or villages at random from a wider study area and eight studies selected study sites that could be paired (either because they were in close proximity or matched ecological/sociological variables, or a combination of the two). However, in these cases, the exact method of selection or pairing was usually not detailed and therefore the robustness of these approaches is not clear. Studies pairing adjacent sites did not report the distance between sites, nor did any study discuss or investigate the potential for spill-over (or 'leakage') effects between adjacent sites being compared. Fourteen other studies did not select sites at random or based on matched pairs but 'described' another method of selection, which usually suggested that selection purposively aimed to cover different types of environments. Similarly, at the second scale, although 21 studies reported that participants or sub-sites within the area of each forest or village were selected at random, the method of this selection was generally not detailed. Several studies did not clearly explain selection of either the CFM forest/villages (six studies) or the sub-sites/participants within each forest/village (11 studies).

Only ten studies investigated factors that may confound direct comparison of CFM forests with forests under an alternative management (either as part of an explicit statistical investigation or implicitly based on the data that were presented in the article). This was assessed on the basis of whether the article presented data on between-site differences (such as in geophysical environmental factors like elevation or in previous forest conditions/past use) apart from the outcomes of interest. Such differences could reflect intrinsic differences in the placement of CFM sites and/or in post-placement activities, or they could simply be due to the method of selecting study sites by the researchers. Three of the studies that were investigating fuelwood collection/consumption accounted for household/village characteristics in their data analysis (Edmonds 2002; Bandyopadhyay and Shyamsundar 2004; Kohlin and Amacher 2005). Three other articles presented data to support the assertion of the authors that their study was comparing sites that were similar in some respects (Gautam and Shivakoti, 2005; Persha and Blomley, 2009; Ali et al. 2007). A further three studies that sampled multiple CFM and comparator sites to investigate differences in forest condition presented data on various variables such as elevation, soil type and slope to investigate covariation between these variables and types of management (Tucker et al. 2007; Sakurai et al. 2004; Nagendra 2007). For instance, Nagendra (2007) found that leasehold forests were on steeper slopes than community and national forests; Tucker et al. (2007) found that common property forest occurred at higher elevations than private forests although there was no difference in slope and soil elements, and Sakurai et al. (2004) compared private and community plantations and found that community plantations were larger, had a higher percentage of gravel in the soil and a higher proportion of formerly grazing land. Kumar (2002) presented demographic data of their sample village in their assessment of forest condition and resource extraction. Overall, twelve studies provided information that was deemed to suggest bias in the types of forests where CFM was implemented. However, this was mostly based on discussion of details in the processes leading to the implementation of CFM in the particular site under investigation. For instance, some studies noted that CFM had been implemented in degraded forests. However, in some cases, a bias in placement could be inferred from the data presented (e.g. Edmonds 2002; Nagendra 2002; Tucker et al. 2007; Sakurai et al. 2004; see also Somanathan et al. 2009). In the remaining studies, no clear information was presented to judge whether there was bias in the types of forests where CFM was implemented. Thus, overall, most studies did not fully consider or account for confounding variables in their investigation of the effect of CFM.

4.2.4. Timescale of studies

Of those studies measuring an aspect of forest condition, 13 did not report the age of the forest management at the time of data collection, in other words, the length of time that CFM had been implemented before assessment. Two studies surveyed recently declared CFMs (Nagendra 2002; Eeden et al. 2006) while the median value of the

remaining studies was approximately as eight years (range = 1 – 21; in two of these cases, only ages of the plantations rather than the date of CFM implementation was given) based on the maximum and minimum ages that could be extracted from the article. Because studies investigating forest cover with satellite data incorporated CFM sites over a large area, the ages of CFMs within these studies was variable. The median age of CFM across all these studies was approximately seven years (range = 0 – 25 years) based on the maximum and minimum ages that could be extracted from the article. Similarly, in studies measuring livelihood outcomes, the age of CFM at the time of data collection ranged between 3 and 12 years, or was not clear in two studies.

Only the study of Blomley et al. (2008) analysed data how the effects of CFM management may change over time following implementation. This suggested a decline in the percentage of cut poles and trees over time following implementation although this trend was not statistically significant.

4.3. Quantitative synthesis/ Meta-analysis

In this section, the findings of studies included in the review are synthesized to investigate the overall results emerging on the effect of CFM. However, the reliability of these findings is affected by the methodological quality of the studies, which must be considered in their interpretation. Most studies suffer from problems associated with selection bias and other potential confounders (see section 4.2.3)

4.3.1. Forest cover and condition

Forest Cover

For the four studies that investigated change in forest cover before and after the implementation of a CFM programme (Table 2), the trend is mixed: three showed an increase in forest cover over the period assessed (Sreedharan & Dhanapal, 2005; Gautam et al., 2004; Gautam & Webb, 2002), and the last, a slight decrease (Dalle et al., 2006).

Table 2. Percentage forest cover before and after the implementation of community forest management in the four studies that present suitable data (number of studies = 4).

Author	Type of CFM	Percentage forest cover[1]		Period of assessment[2]	Geometric rate of change[3]
		Before CFM	After CFM implementation		
Dalle et al. 2006	Community forestry	80	76	21 years	-0.24
Gautam, et al. (2004)	Community forestry	34.8	40	24 years	0.58
Gautam & Webb (2002)	Community forestry	48.3	87.2	14 years	4.32
Sreedharan & Dhanapal (2005)	Joint forest management	47.3	81.4	4 years	6.01

1 For the Gautam & Webb (2002) study, this is the percentage of 'high forest' in the forested area; where forest 'type' is classified on the basis of crown cover as either degraded land with a crown cover of <10% (called 'scrub') or land with a crown cover of >10% (called 'high forest').

2 This period of assessment is based on the time period between satellite images and does not necessarily reflect the length of time of CFM implementation.

3 Following Cote et al. (2005): geometric rate of change, C_{Rg} , = 100 × [1- $(PC_A/PC_B)^{1/d}$], where PC_A and PC_B are the percentage cover after and before CFM implementation respectively; and d is the period between assessments in years. Note: to aid interpretation, the signs have been reversed so that a positive number indicates an increase in forest cover and a negative one a decrease.

Table 3. Comparison of forest cover and annual deforestation rate between areas under community forest management and alternative management interventions based on the six included studies presenting suitable data (number of studies = 4).

Author	Type of CFM	Comparator	Outcome	Mean Non-CFM	Mean CFM	Log response ratio[1]
Gautam & Webb (2002)	Community forestry	Areas without formal CF	Percentage forest cover[2]	79.9	87.2	0.09
Ellis & Porter-Bolland (2008)	Community-based forest management	Protected area	Percentage forest cover	88.5	90.1	0.02
Somanathan et al. (2009)	Local council forest management	State management	Percentage forest cover	97.2 (n=508)	93.2 (n=240)	-0.04
Nagendra et al. (2008)	Community forestry	Mosaic of land uses ("surrounding land")	Percentage deforestation (1989-2000)	8	5	-0.47
			Percentage afforestation (1989-2000)	22	9	0.89
Bray et al. (2008)	Community forestry	Protected area	Annual deforestation rate (%)	-0.327 (n=11)	-0.163 (n=19)	
Duran-Medina et al. (2005)	Community forestry	Protected area	Annual rate of change in 'natural cover' (%)	-0.18 (n=67)	0.14 (n=22)	

[1] Calculated as the log of the ratio between means before and after CFM to compare the direction and relative size of effect among studies. Thus, a value of 0 indicates no difference in forest cover; a positive value, increased cover in the CFM sites; and a negative value, lower cover in CFM sites.
n = number of forests, which is provided when stated in the article.
[2] For this study, this is the percentage of 'high forest' in the forested area; where forest 'type' is classified on the basis of crown cover as either degraded land with a crown cover of <10% (called 'scrub') or land with a crown cover of >10% (called 'high forest').

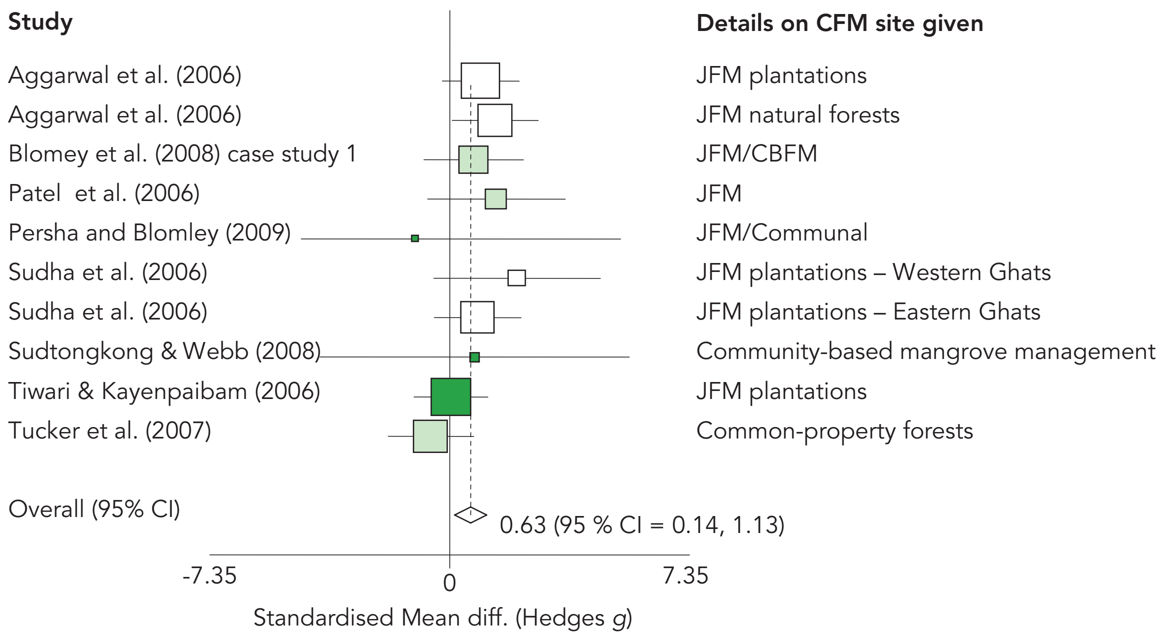
Forest Condition

Meta-analysis was used to calculate weighted averages of the effect sizes from different studies for different forest condition outcomes. In eight out of the ten effect sizes, the basal area of trees was greater in forests under CFM than in their comparators (Figure 10 a; Hedges g = 0.633, 95 % CI = 0.140, 1.126). Heterogeneity (variation in effect size among different studies) was not significant ($Q = 8.046$, $df = 9$, $p = 0.53$). However, there was variation in management of the comparator. We attempted to explore this but noted that detailed information on the management activities in the comparator site was usually not given.

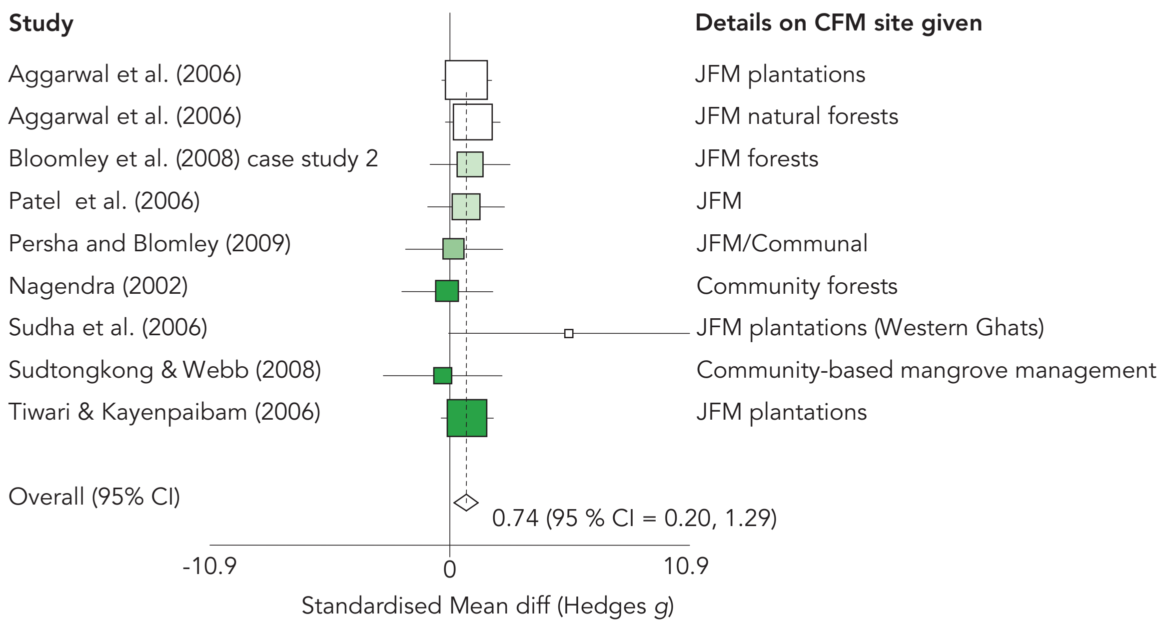
Studies comparing a form of CFM with sites with no silvicultural management tended to find larger than average effect sizes (Hedges g = 1.13, 95 % CI = 0.423, 1.830; four effect sizes from two articles). The remaining studies compared CFM with either state management, some other management, or the comparator was not clear or was a mixture; based on these data there was less evidence of a difference (Hedges g = 0.156, 95% CI = -0.536, 0.848). Too few studies were available to tease apart the effects of different comparator managements.

Figure 10. Effect of community forest management on a) basal area and b) density of tree stems. Data represent the effect size (Hedges g) and its 95% confidence interval. The weighted average is indicated as the 'overall' effect. Information is given on the type of CFM and forest where possible. Shading refers to the type of site that the CFM is compared with: black = state or other management; white = no silvicultural management; grey = mixed comparator or no clear characterisation of comparator.

a) Basal area



b) Tree density



In a second analysis, tree density was greater in seven out of nine cases under CFM (Figure 10 b; Hedges g = 0.745, 95 % CI = 0.197, 1.292) and there was little heterogeneity among studies (Q = 4.606, df = 8, p = 0.799). Studies comparing CFM with no management tended to find a larger effect than the remaining studies, which had various comparators (studies comparing CFM with no silvicultural management: Hedges g = 1.07, 95 % CI = 0.007, 2.125; other studies: Hedges g = 0.549, 95 % CI = -0.177, 1.276) but too few studies were available of different comparator types for rigorous assessment.

We also investigated effects on species richness and diversity. There was no consistent evidence that CFM affects plant species richness (Figure 11 a; Hedges *g* = 0.535, 95 % CI = -0.239, 1.308). While there was some variation in effect among studies the amount of heterogeneity did not reach significance (Q = 10.63, df = 7, p = 0.2). Three effect sizes (from two articles) were derived from comparisons with no management (either "preservation plots" or no silvicultural management declared; Hedges *g* = 1.02, 95 % CI = 0.12, 1.92), which supported a positive effect on richness. The remaining studies were more equivocal (Hedges g = -0.06, 95 % CI = -1.06, 0.945). However, as in previous analysis, the low number of studies limits exploration of the effect of different comparator managements.

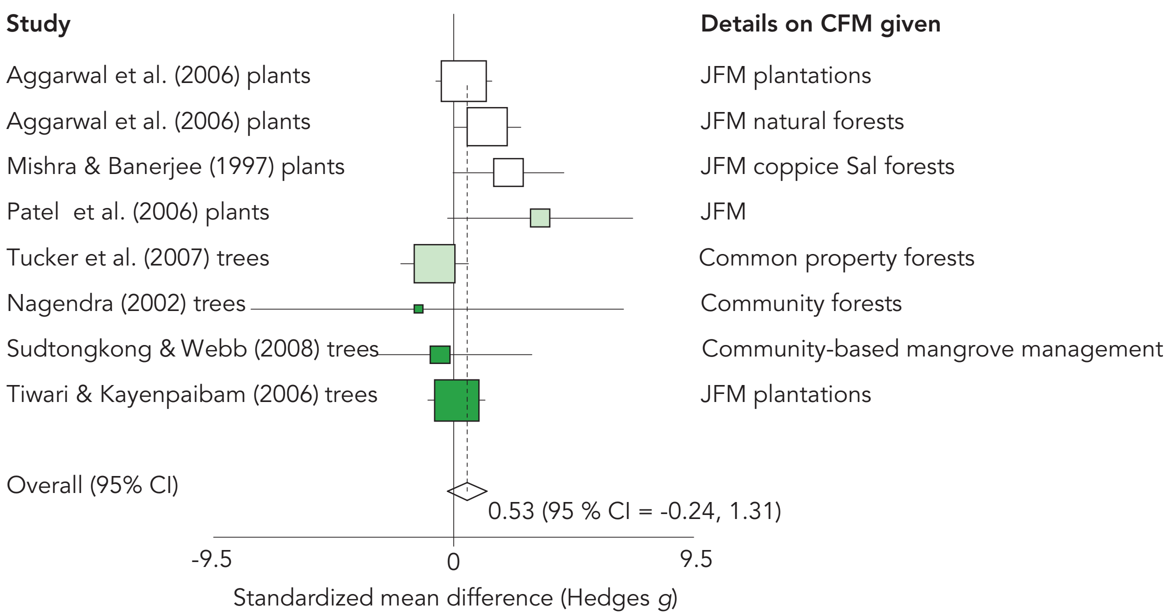
Similarly, there was very little evidence of any consistent effect on plant species diversity (Figure 11 b; Hedges g = -0.046, 95 % CI = -0.819, 0.727) and insignificant heterogeneity among studies (Q = 3.73, df = 4, p = 0.4). Three of the five effect sizes compared CFM management with another form of management (state, national forest or plantation; Hedges g = -0.56, 95 % CI = -1.52, 0.40) and no difference was evident based on this subset.

Across all outcomes, there was no evidence of publication bias as assessed with a funnel plot and Egger's test but the ability to detect bias is limited given the small number of separate studies within each meta-analysis.

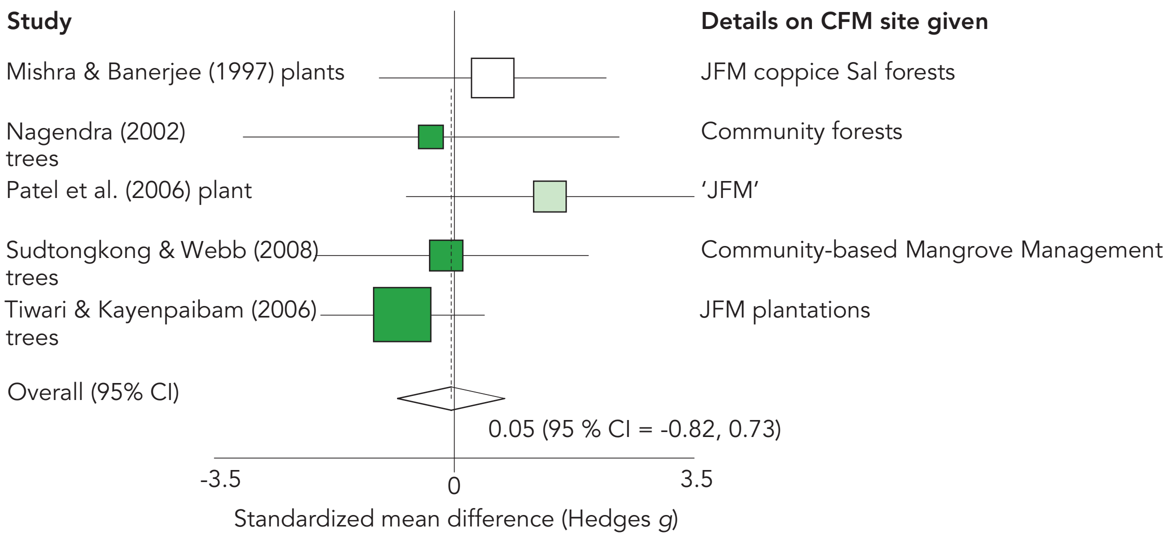
Some studies also presented data on the user perceptions of forest condition but because there are 12 studies that directly measured forest condition we chose not to review these reports of less-quantitative indirect information.

Figure 11. Effect of community forest management on a) number of species (trees or all plants as stated by the authors) and b) species diversity (Shannon-Weaver index; trees or all plants as stated by the authors). Data represents the effect size (Hedges g) and its 95% confidence interval. The weighted average is indicated as the 'overall' effect. Information is given on the type of CFM and forest where possible. Shading refers to the type of site that CFM is compared with: black = state or other management; white = no silvicultural management; grey = mixed comparator or no clear characterisation of comparator.

a) Species richness



b) Species diversity



4.3.2. Resource extraction

Two resource-extraction outcomes were analysed: stem cutting and fuelwood collection. The six studies reporting data on stem cutting found that this tended to be lower in forests under CFM but the confidence intervals of the overall effect slightly overlapped zero (Hedges g = -1.06, 95% CI = -2.195, 0.075; Fig 12). However, there was some indication of variation in effect size among studies, which suggests that other factors affected this outcome ($Q = 12.964$, $df = 5$, $p = 0.02$). There was no evidence of publication bias as assessed with a funnel plot and Egger's test but the ability to detect bias is limited given the small number of separate studies within each meta-analysis. The four studies reporting on fuelwood extraction are summarised in Table 4.

Figure 12. Effect of community forest management on the number, density or percentage of cut stems. Information is given on the type of CFM and forest where possible. Shading refers to the type of site CFM is compared with: white = no silvicultural management; grey = mixed comparator or no clear characterisation of comparator.

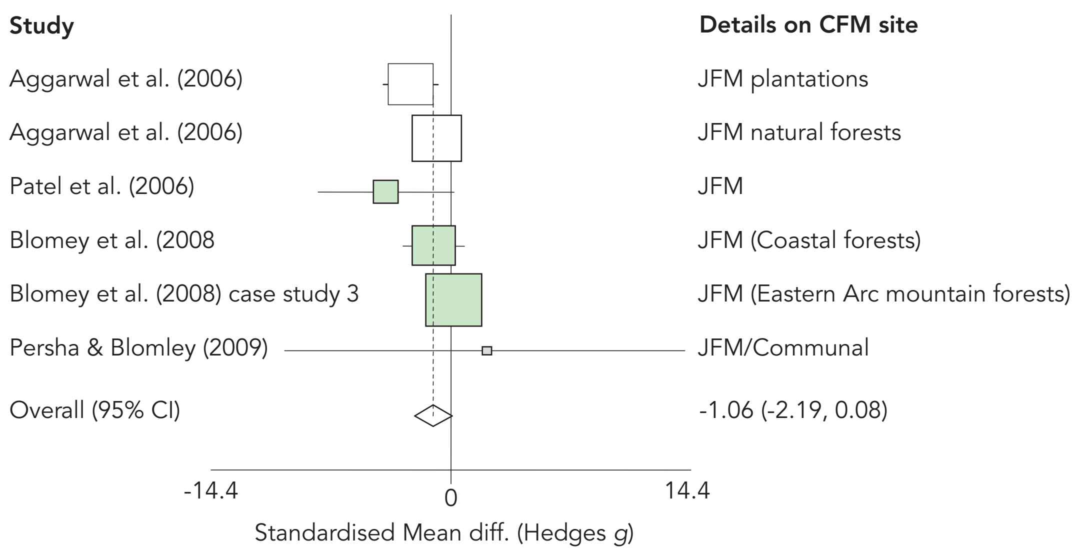


Table 4. Comparison of fuelwood extraction in forests with and without community forest management in the studies presenting suitable data (number of studies = 4).

Author	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 & Priya (2004)	Community forestry	Villages without community forestry	Average annual fuelwood collection (kg 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

n = number of forests/villages depending on author presentation.
[1] Log Response Ratio

4.3.3. Livelihoods

Few studies gave quantitative information on livelihood outcomes. Those that did usually presented very different types of data which were not directly comparable between studies. We were not able, therefore, to undertake meta-analysis of livelihood outcomes data and were confined to providing a narrative synthesis. This means that the synthesis on livelihoods is less concise than in previous sections.

Tables 5–11 contain a summary of livelihood outcomes from included studies, presented within DFID's 'capital assets' framework (DFID 2000). In Table 5, Ali et al (2007a), present data from Pakistan showing no difference in the number of income sources available to participatory forest management (PFM) and non-PFM households and only small differences in primary source of income (with slightly more income from forest sources and small business activities, but less income from agriculture in PFM sites). For both PFM and comparator sites, the single largest sources of income were from "labour", and qualitative findings suggest that this is mostly from sources outside the village locality. This study lacks baseline information and does not provide convincing evidence of any meaningful impact of PFM on income over the five years studied. In contrast Gupta et al. (2004) recorded that PFM projects in two case-study villages in India led to forest-based occupations becoming a new (but relatively small) source of income (Table 5). There was also an increase in the percentage of income from "labour" in one village, after the introduction of PFM. This study also suggests (Table 6) that levels of household income increased after the introduction of PFM although the extent to which this is due to new forest-based sources is not clear. The length of time studied is also unclear, projects having been running for "at least three years" in each site.

Niesenbaum et al (2005) present data suggestive of an increase in forest-related income levels over a five-year period since project initiation in Guatemala. However, this study uses baseline data collected by participant recall as the comparator and therefore lacks reliability. Kassa et al. (2009), in a modelling study using empirical data from an Ethiopian project, build PFM and non-PFM scenarios and predict trends in annual household income over a 30-year period. The model predicts income to increase more in non-PFM compared with PFM households in the medium (up to 7.5 years) term but this predicted trend then reverses over a longer period (7.5-30 years). However, since this is a model, these findings cannot reliably be used as primary evidence. Collectively, and taking the methodological robustness of studies into consideration, these studies do not provide convincing evidence that PFM has any significant impact on income levels over the medium time periods they cover. There were no data available from a longer time period to substantiate the predictions by Kassa el al. (2009).

Table 5. Impact of community forest management on livelihood outcomes: financial capital—income sources (number of studies = 2).

Author	Type of PFM	Comparator	Outcome		Mean non-CFM	Mean CFM
Ali et al. (2007a)[1]	Participatory forest management	Traditional management	Two or more household cash income sources		52.5% (n=4)	54.5% (n=4)
Ali et al. (2007a)[1]	Participatory forest management	Traditional management	Frequency of different primary household income sources	*Agriculture*	17%	9.5%
				Labour /salary	40%	41%
				Livestock	2%	2.5%
				Small business	7.5%	16.5%
				Forest	0.5%	3.5%
				Other	32.5% (n=4)	27.5% (n=4)
Gupta et al. (2004)	Participatory forest management	Before/after comparison	Frequency of different household income sources	*Agriculture*	25[2] 26	20 27
				Labour	5 5	7 17
				Service	16 14	15 15
				Animal husbandry	10 27	10 27
				Forest	0	9 18
				Other	0.1 (n=2)	3 (n=2)

n = number of forests/villages as reported by the author.
[1] Additional data available in article: how money was stored, sources of loans.
[2] In studies presenting only two data points, we present each value rather than calculating an average.

Table 6. Impact of community forest management on livelihood outcomes: financial capital–levels of income (number of studies = 5).

Author	Type of CFM	Comparator	Outcome	Mean Non-CFM		Mean CFM
Maharjan et al. (2009)	Community forestry	No community forestry or development project	Net annual per capita income (NRupees)	*Well-being category*		
				Rich	44017 23801	21944
				Middle	22409 39409	16117
				Poor	12135 18091	11941
				Ultra-poor	13047 12195	10499
					(n=2)	(n=8 except ultra-poor=4)
Maharjan et al. (2009)	Community forestry	No community forestry or development project Data in italics in 3rd data column are for 'before' implementation of CFM in CFM sites	Proportion (%) of net annual income from forest related activities			Before After
				Rich	5 36[1]	21.1 5.9
				Middle	7 35	26.9 15.0
				Poor	13 46	32.5 15.9
				Ultra-poor	7 44	28.8 25.5
					(n=2)	(n=8 except ultra-poor=4)
Niesenbaum et al. (2005)[2]	Community forestry	Before and after (5 years)	Average income per person from participation in forestry-related activities (Guatemalan Queztales)	*Income-generating activity*	*Before*	*After*
				CFM	400	800
				NTFP	150	1420
				Furniture making	200	1650
				Ecotourism	0	125
					(n=?)	(n=?)
Gupta et al., (2004)	Participatory forest management	Before and after (3 years)	Change in family income (Rupees) – number of families at each income change level	*Annual income*	*Before*	After
				<12000	1 7	0 1
				12-24000	6 9	0 12
				24-36000	2 8	6 4
				36000+	15 3 (n=2)	18 10 (n=2)

Author	Type of CFM	Comparator	Outcome	Mean Non-CFM		Mean CFM
Vyamana (2009)	Joint forest management	Before and after (5-10 yrs)	Average annual household income from PFM forest(Tanzanian Shillings)	*Wellbeing category*	*Before*	*After*
				Very rich	0	0
				Rich	9200 48000	0 57900
				Poor	15310 27484	2653 65066
				Very poor	0 38541	0 59571
					(n=1 or 2)	(n=1 or 2)
Vyamana (2009)	Community-based forest management	Before and after (5-10 yrs)	Average annual household income from PFM forest (Tanzanian Shillings)	*Wellbeing category*	*Before*	*After*
				Very rich	68300 50049	61313 56561
				Rich	1607495 28000	3235386 32200
				Poor	50310 33174	62013 50530
				Very poor	46205 16800	70235 27200
					(n=2)	(n=2)
Kassa et al. (2009)	Participatory forest management	No PFM	Predicted annual household income over 30 years[3]	In first 7.5 years: no PFM > PFM 7.5 years to 30 years PFM >no PFM		

n = number of forests/villages as reported by the author.
[1] In studies presenting only two data points, we present each value rather than calculating an average.
[2] Additional data available in article: % participation in the forestry-related income generating activities.
[3] This model was based on empirically collected data.

Maharjan et al. (2009) studying PFM projects in Nepal and Vyamana (2009) in Tanzania, explored impacts on equality of income. Maharjan et al. (2009) estimated net annual income for four "well-being" categories (indicating economic status), comparing community forestry (CF) and non-CF sites. No baseline data were collected, rather participants recalled the situation prior to CF and described the direction of change, which limits the reliability of the estimates. Therefore we only present quantitative data for the study year (2006) with only a qualitative indication of the trend since project initiation some 3-10 years previously. These data (Table 6) suggest that for all well-being categories, the non-CF communities had, on average, higher net annual income per capita than the CF communities. The authors suggest that these arose from increased "remittances" and wage labour rather than increases in income from forest-related sources. This is somewhat supported by data on the proportion of the net per-capita income which comes from forest-related activities (Table 6) which suggest that forest-related cash income may have decreased with CF in all except the ultra-poor households. However reported data for the two non-CF communities vary greatly with, for each well-being category, one average being below the CF average and the other, well above it. There were no baseline data for non-CF controls so there is no way of knowing if they experienced similar decreases over the same period, but in 2006 the average forest related incomes in households in the two non-CF communities were higher than the average in CF households in all except the ultra-poor category. Forest-related incomes were derived both from community forestry and from other, non-CF forests and the proportion of net annual income which derived from community forestry varied across household income categories, with a mean of 4.6% for rich and 6.5% for middle-income households compared with 9.1% for both the poor and ultra-poor. This suggests a greater

dependency on community forestry income amongst the poorest but the percentages are still small, and without information on the variance in the estimates of the means it is not possible to interpret whether any differences presented are significant. This latter limitation is not confined to just this study.

In Tanzania, Vyamana (2009) studied two types of PFM: JFM and community-based forest management (CBFM) In this study, subjects were classified differently to Maharjan et al. (2009), which limits direct comparison between the two studies, but Vyamanas' data show that change in income from PFM forest (after the introduction of PFM) varied within wellbeing categories between the two types of PFM studied (Table 6). For the JFM type there was no clear trend with conflicting findings between the two communities studied within each well-being category, whereaswith the CBFM type, the findings were more consistent in that (with the exception of the very rich group where there was little difference) all well-being groups experienced an increase in forest-related income. These two studies therefore highlight the need to understand how benefits from PFM activity might be distributed within PFM communities. Vyamana (2009) only showed data for four of the eight studied communities which were actively using their PFM forest. This represents a potential bias in the results as data from the other four PFM communities included in the study were not reported because either they were using alternative forest, reportedly to avoid the restrictions placed on use of JFM forests, or (for the CBFM sites) obtained their forest products from nearby plantations and natural forests. This illustrates the point made by several of the studies that restrictions imposed by PFM rules can, in some cases, reduce the opportunities for income generation from forest and this impact is likely to be greatest for those without other income sources, for example those without privately owned forest or who live in areas with no other accessible forest. It also illustrates the high potential for leakage of forest exploitation activities from areas where CFM has been initiated into other local forests.

Table 7. Impact of community forest management on livelihood outcomes: social capital (number of studies = 3).

Author	Type of CFM	Comparator	Outcome	Mean Non-CFM	Mean CFM	
Ali et al. (2007b)	Participatory forest management	Traditional management	Mean score - trust and relationship to state institutions	Relationship: Forest Dept. 1.96 Police 2.13 Courts 2.29 Jirga (Elders) 3.57 Union Council 2.98 Trust: Forest Dept. 1.60 Police 1.96 Courts 2.08 Jirga (Elders) 3.38 Union Council 2.79 (n=4)	 2.72 2.13 2.12 3.58 3.28 2.44 1.95 2.21 3.47 3.11 (n=4)	
Sun (2007)	Community-based natural resource management	Not CBNRM (traditional practices) Before/after	Mean social capital score	Before/After 5.47/6.21 5.09/5.14[1] (n=2)	*Before/After* *5.49/6.23* (n=6)	
Vyamana (2009)	PFM (JFM and CBFM)	No PFM	Composition of village Natural Resource Committees by well-being category (% of general population in this category)	Wellbeing category Very rich 4 (0.6) Rich 17 (5.4) Poor 70 (73.6) Very poor 0 (20.4) (n=2) (n=2)	JFM 4 (2.3) 57 (9.2) 30 (62.4) 0 (26.1) (n=2) (n=2)	CBFM 3 (9.9) 19 (24.2) 61 (36.1) 10 (29.8) (n=3) (n=3)

n = number of forests/villages as reported by the author.
[1] In studies presenting only two data points, we present each value rather than calculating an average.

Compared with financial capital, there were fewer data on social capital outcomes presented in the included studies (Table 7). Sun (2007) asked participants to provide a score (based on recall) from 1 to 10, for various indicators, for a baseline (1995, 1998 or 2001 as appropriate for each study site) and compared these with 2006 after the initiation of the community-based natural resources management (CBNRM), when the survey took place. A composite score of indicators including trust, mutual help, networking and collective activities was then constructed. These suggest a greater increase in score since baseline, in CBNRM communities, compared with one of the two control communities, but the differences are small and, given the nature of their derivation, have limited reliability. Ali et al. (2007b) reported that perception of both 'trust' and 'relationship' (good) were greater in a PFM community than in a traditional management (control) community only for the forest department and union council but not for police, courts and elders (Table 7). However, the lack of baseline makes it difficult to draw firm conclusions from this study. Maharjan et al. (2009) allude to the difficulty of assessing social capital and, although they do present some data on village Forest User Group committee composition, there are no comparator data. Vyamana (2009) investigated composition of village Natural Resource Committees (NRCs) finding that the rich disproportionally dominated the NRCs in JFM communities whereas the poor dominated them in CBFM and control communities. In the control communities, this was reported to be a reflection of the local demography, whereas in the CBFM community NRCs this dominance by the poor was disproportionately high. Only the CBFM community NRCs included the very poor.

Of the included studies, only Sun (2007) provides data relating directly to human capital (Table 8). This is constructed in the same way as for social capital; combining indicators of health, education level, technical skills and labour availability in the family. Again, mean scores show only small differences between baseline and the year of the study (2006) although the difference was slightly higher for the CBNRM communities than the two control communities. Data on fuel wood collection from Kohlin et al. (2005) suggest that individuals in villages without a community forest spend more time collecting fuel from alternative forest sources and that total time spent on collection was lower for those communities able to collect from a community forest.

Table 8. Impact of community forest management on livelihood outcomes: human capital (number of studies = 2).

Author	Type of CFM	Comparator	Outcome	Mean Non-CFM	Mean CFM
Kohlin et al. (2005)	Community forest (but separate 'natural' forest also available)	No community forest (only 'natural' forest available)	Time spent (hours per week) in fuelwood collection	Collection from natural forest 23.6 (sd = 39.7) (n=248)	Collection from natural forest 15.6 (s.d.=2.32) (n=494) Collection from community forest 4.7 (4.6) (n=494)
Sun (2007)	Community-based natural resource management	Not CBNRM (traditional practices) Before/after	Mean human capital score	Before/After 5.33/5.54[1] 5.92/6.33 (n=2)	Before/After 5.77/6.33 (n=6)

n = number of forests/villages as reported by the author.
[1] In studies presenting only two data points, we present each value rather than calculating an average.

Physical capital outcomes were reported in three of the included studies (Table 9). The composite score of Sun (2007) included indicators of road and house construction, work on irrigation and drinking water facilities, production tools, fuel energy, communication and markets. As with the other 'capital assets' reported in this study, there were increases in scores since the baseline in both the CBNRM and control sites but the increases were slightly greater in the CBNRM communities than the two control communities. Gupta et al. (2004) reported that the number of families collecting wood as a source of fuel in one of their two study sites decreased after introduction of PFM whereas use of kerosene increased. Vyamana (2009) presented data on three indicators of community physical capital, demonstrating marginally more instances of improvements in CBFM communities than in JFM communities, with no improvement in the two control communities, suggesting that this was due to differences in income-generating opportunities.

Table 9. Impact of community forest management on livelihood outcomes: physical capital (number of studies = 3).

Author	Type of CFM	Comparator	Outcome	Mean Non-CFM	Mean CFM
Sun (2007)	Community-based natural resource management	Not CBNRM (traditional practices) Before/after	Mean physical capital score	Before/After 3.83/5.11[1] 4.55/5.7 (n=2)	Before/After 4.04/6.38 (n=6)
Gupta et al., (2004)	Participatory forest management	Before and after (3 yrs)	Sources of fuel (number of families using each source)	Wood 20 27	16 27
				Dung 3 1	4 1
				Kerosene 12 16	19 16
				Agri-waste 1	1
				Biogas -	10 4
				LPG 6 1	15 10
				(n=2)	(n=2)
Vyamana (2009)	Participatory forest management (Joint forest management and Community based forest management)	No PFM Data presented for before/ after (5-10 yrs) initiation of PFM	Proportion of communities in which developments had taken place	Road building 0/2	0/4 JFM 0/3 CFM
				School building 0/2	2/4 JFM 2/3 CFM
				Tractor repair 0/2	0/4 JFM 1/3 CFM

n = number of forests/villages as reported by the author.
[1] In studies presenting only two data points, we present each value rather than calculating an average.

The final group of studies which present livelihood related data (Table 10) are those that conducted cost-benefit analyses, presenting net present values (NPV) over various periods and for various discount rates. Calderon et al. (2006) studied CFM in the Philippines and Kumar (2002) studied JFM in India, both collecting data from actual PFM project sites. Grundy et al. (2000), working in Zimbabwe, used data from one non-PFM site and estimated NPV for model-constructed scenarios of co-management with forest dwellers. The former two studies produced lower NPV for PFM than non-PFM whereas the latter study produced very similar NPV for both scenarios. Kumar (2002) also investigated equality of benefit, estimating net benefit across different land-owning classes; these data (not included in Table 10) show the decrease in net benefits over time from JFM forests to be greater for landless and marginal farmers (45–50%) than for those with large farms (6%). As for income, Kumar (2002) suggests that restrictions placed by JFM impact most on the poorest, reducing the benefits they receive from forest resources.

Table 10. Studies presenting cost-benefit analyses of community forest management (number of studies = 3).

Author	Type of CFM	Comparator	Outcome	Mean Non-CFM	Mean CFM
Calderon et al. (2006)	Community-based forest management	Commercial management (IFM)	Estimated net present value (US $ per ha)	368 (n=3)	11 (n=3)
Kumar (2002)	Joint-forest management	Government management	Predicted net benefit of management (Rupees per household) averaged across different landholding classes[1] after 40 years	112440 (n=5)	72367 (n=3)
Grundy et al. (2000)	Co-management with forest dwellers included (model constructed scenario)	"Status quo" state management (model-constructed scenario)	Predicted total net present value of benefits (Zimbabwe$ million) over 60 years using 3 discount rates	Discount rate 1% 955 6% 329 15% 142 (n=1)	1035 349 148 (n=1)

n = number of forests/villages as reported by the author.
[1] Presented in the article separately for different landholding classes; here we present the average across classes.

5. Discussion

5.1. Evidence of effectiveness

Quantitative syntheses of data on forest condition suggest that, in a majority of the studies, areas with CFM have higher forest cover, tree basal area and tree stem density. This may indicate that CFM has had a positive impact on forest condition during the lifetime of current CFM arrangements but the study designs do not eliminate the possibility that these differences were present at baseline (before CFM was implemented), i.e. due to bias in the selection of locations for implementation of CFM. The type of management in the comparator site is variable among studies but the detail of management activities was not usually described. Thus, despite the fact that the effect of CFM would be expected to vary with the comparator management, this could not be rigorously explored. Given that CFM can take a number of different forms, understanding the elements that influence its success is crucial for successful implementation. However, the low number of studies available means that it is not possible to tease apart which attributes of the CFM being implemented were the most important for its impact on forest condition. Additionally, and importantly, the indicators that were measured in the reviewed studies are unlikely to be correlated with all components of forest condition and ecosystem services. Indeed, the benefit of any effects observed on tree stem density alone will also depend on tree size and age. No evidence was found of an impact of CFM on plant species richness or diversity. Regarding resource extraction, the data on number of cut stems suggest a tendency towards fewer cut stems in forests with CFM than without, but this is based on only four studies. This result could be indicative of the effectiveness of implementation

of the management rules formed by the community institutions. Similarly, a small number of studies presented data on fuelwood collection but their findings were not consistent.

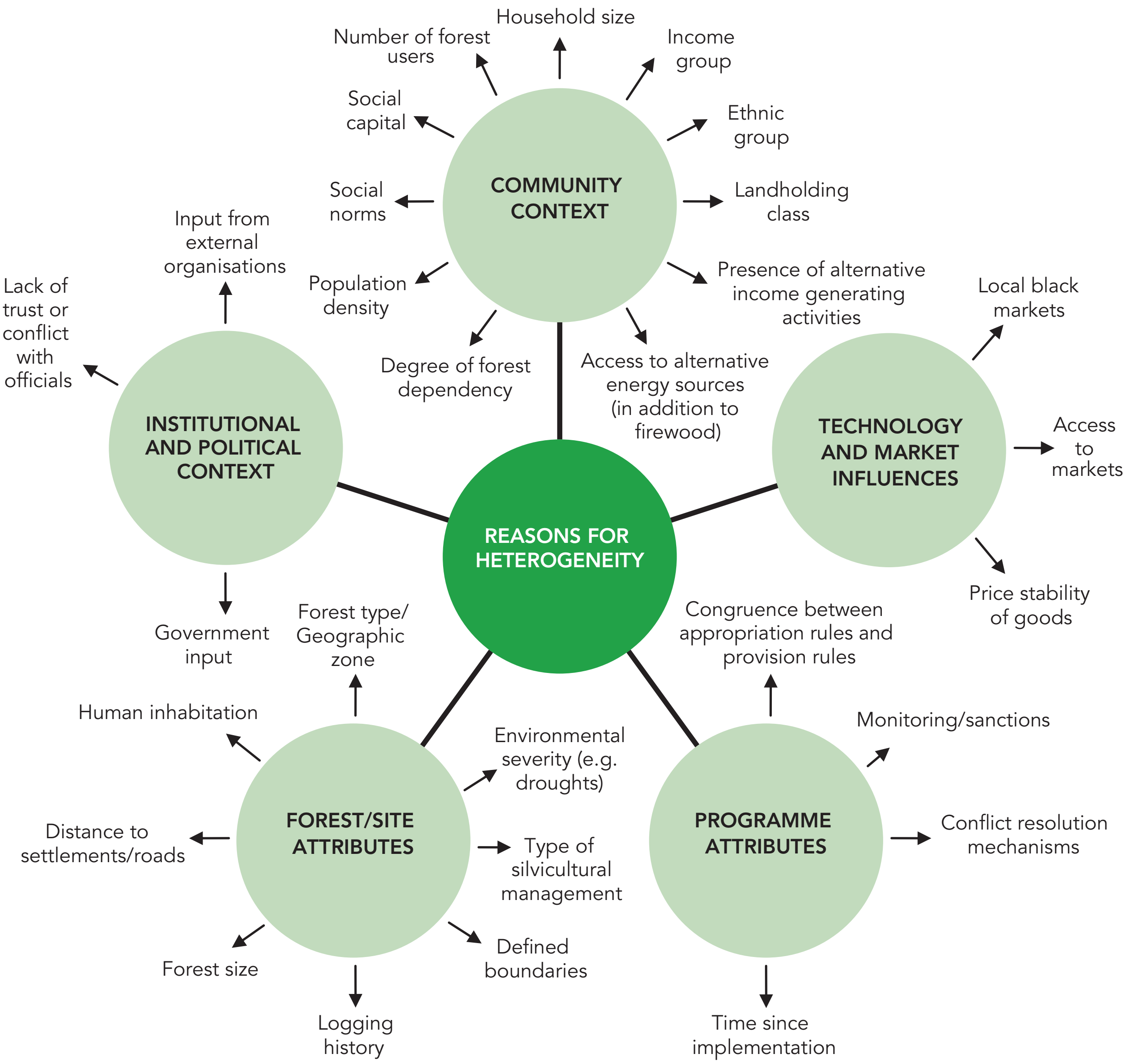
The evidence for the impact of CFM on local livelihoods was even less conclusive. Only 12 studies met the inclusion criteria to be retained in the review and these reported highly variable outcomes. Most data are on financial capital but these show no consistent evidence that PFM results in increased cash income. However, there are important messages regarding the distribution of financial benefits within PFM communities (Table 6).

5.2. Reasons for variation in effectiveness

Many 'reasons for heterogeneity' or 'effect modifiers' were discussed within articles included in the review (Figure 13). Note that in many cases the discussion by authors was not backed-up with data that would allow investigation of the effect.

Consequently, no formal analysis of the significance of these variables was possible.

Figure 13. Potential reasons for variation in community forest management impacts discussed by the included studies.



5.3. Review limitations

5.3.1. Study designs

The review is limited by the quality of the methodological designs used in most studies. Many studies were not included due to the lack of a comparator that would enable any change in outcome to be attributed to the treatment (CFM). All the studies included fall short of a full BACI (before/after and control/intervention site comparison) design and very few had a sufficient sample size of independent CFM and non-CFM forests/communities to reduce error and account for bias to levels reasonable for the accurate interpretation of the differences in outcome between treatment and comparator. This means that even though differences may have been found by individual studies, attributing these differences to a general effect of CFM is problematic. Given that randomisation of allocation of CFM between locations/forests is unlikely to be carried out, it becomes even more important for studies to investigate base-line differences and other potentially confounding variables between CFM and non-CFM sites. Potential confounders should be accounted for in the data analysis (e.g. using propensity-score matching methods) before any causal inference of the effects of CFM can be attempted. The selection of the appropriate covariates requires debate and explicit investigation. However, in the studies included in this review, commonly measured variables were distance of village to nearest forest or nearest road, forest elevation, steepness of slope and soil quality of the forest.

Only a minority of the studies were based on a before-after CFM project intervention comparison, or contained any other useful baseline data on the situation before CFM. Information was not usually provided about the criteria used to decide which forests/communities would receive a project intervention to promote CFM and which not. Bias could be in either direction. A few studies noted and/or provided evidence that CFM was implemented in an area because either the forest was degraded; was suffering from deforestation or was generally less productive than lands with other managements. For instance, Maharjan (1998) describes how local people, having recognised the degradation of their community forest and its implication for their subsistence, approached the District Forest Office in order to establish a Forest User Group. In the case of this direction of selection bias, any positive differences in forest condition that are estimated after implementation between CFM and the comparator site underestimate the total effect of CFM. Whereas in opposite cases CFM may have been preferably implemented in the forests that were in better condition; we found little evidence of this but given that bias was rarely discussed or investigated, this cannot be ruled out for some regions/countries. Positive bias is even more likely for social factors, with a probability that communities with stronger existing institutions (or greater social capital) would be selected for CFM. Therefore, whether or not CFM has been a 'bottom-up' community-led innovation or come about through intervention by government or other agencies, it is unlikely that its distribution between forests/communities is independent of the previous situation there. Bias in post-hoc comparisons between CFM and non-CFM cases is therefore inevitable; however the direction of that bias may vary.

Tropical forest policy, e.g. with respect to project intervention of payment for ecosystem services such as carbon storage, has been increasingly concerned with the potential problem of 'leakage', i.e. that a project intervention to reduce a form of forest exploitation may successfully achieve this in the target area but simply displace this exploitation to an adjacent area with no net benefit. This phenomenon is a particular risk for many of the reviewed studies comparing CFM with non-CFM forests, since so little information is provided about how independent the compared sites are; and even the geographic distance between the different sites being studied. Close proximity of study sites may be beneficial in terms of the matching of environmental variables, but risky in terms of the likelihood that the results have been distorted by 'leakage'.

Various additional factors may vary between the sites with and without CFM that may confound any direct comparison, however only a few studies have attempted to investigate and/or account for this.

5.3.2. Interpretation of outcomes measures

The reviewed studies measured a broad range of different outcome measures which we classified between forest condition and livelihood 'pools'. Our meta-analysis on forest condition focused on tree stem density, basal area, and plant species richness and diversity as these were the most commonly reported outcome measures. However, particularly in the case of tree stem density, interpretation of any changes as an indicator of CFM success (with respect to carbon sequestration) will depend on other variables such as tree size or species (Chave et al. 2005; Newton, 2007; Gibbs et al. 2007). Thus, effects of CFM on tree stem density alone cannot be easily interpreted as being positive or negative

as they are also a reflection of stand development and the frequency of disturbances. In addition, some studies were measuring plantations rather than mature forests.

Inferring effects of changes in tree basal area on (above-ground) carbon sequestration may be possible as basal area indicates wood volume, but other variables such as tree height will also affect this relationship (Philip, 1994). Extrapolation to carbon sequestration will be even more subject to error if below-ground storage is included. None of the studies included in the review attempted to estimate total carbon stocks.

Similarly, extrapolating from the few outcome measures in most of the reviewed studies to the impact of CFM on whole livelihoods must be done with great caution. For instance, it is not clear how a change in the source and number of income sources impact on livelihoods.

Consensus on, and standard measurement of, indicators of the success of CFM would greatly aid synthesis on its effectiveness. This is, at present, lacking from the body of empirical studies included in this review.

5.3.3. Diversity of comparators

There is no consensus on the appropriate comparators for a community-managed forest and the use of a varied set of comparators in the studies included in this review increases the difficulty of interpreting differences in outcome. For instance, differences in the effects of a CFM plantation versus a forest with no silvicultural interventions may be more a reflection of the type of forest than of CFM per se. The direction of the effect on the outcome would be expected to differ between cases where the comparator is a formal protected area, open access exploitation or private management. Too few studies were available to allow any contrast in the effect size between different comparator managements to be investigated.

5.3.4. Study reporting

In some cases the incorporation of study data in a synthesis and interpretation of heterogeneity in outcome is inhibited by lack of reporting of key variables and aspects of methodology. For example, some studies presented simple means (with no measure of variance) for the treatment and comparator and many failed to give sufficient information on the type of intervention and the nature of comparators.

5.3.5. Geographical coverage

It is probable that the socio-economic and cultural contexts of the location in which CFM takes place would have an influence on its effectiveness. It is a limitation for global interpretation, therefore, that most studies included in the review have taken place in just two neighbouring countries (India and Nepal).

5.3.6 Study timescale

The length of time from CFM implementation (or at least its formal notification) to data collection varies between studies from less than one year to more than 15 years. Effects of CFM management are likely to be realised only after a period of time but it is not clear how long this should be (cf. Blomley et al. 2008). Thus, effects sizes in studies measuring sites with more recent intervention may more likely represent selection bias rather than the effect of CFM. Future meta-analysis could aim to examine how the effect size varies with the study timescale. The environmental and socio-economic impacts of changes in natural resource management often have a very long timescale, especially with long-lived organisms such as trees. Whilst sustainability may be a widely held goal, it is very difficult to judge whether it has been achieved for forest resource management until many decades have past. Achievement of such sustainability may also occur at the expense of the short-term rate of resource exploitation, meaning that the effect on livelihoods may change depending on whether short-, medium- of long-term outcomes are considered. Therefore, the short duration of the majority of studies reviewed is a severe limitation in the value of their results for assessing the longer-term effectiveness of CFM.

6. Reviewers' Conclusions and Implications for policy and research

The available evidence suggests that there are some benefits of CFM in terms of forest condition. However, only a limited number of components of forest condition have been measured and their reliability as robust indicators of broader aspects of forest condition and the full range of ecosystem services, and their resistance to manipulation for self interest, need to be tested. The outcome of the review suggests that some evidence exists for global environmental benefit of CFM through increase in carbon sequestration on the assumption that higher levels of tree basal area indicate a higher level of ecosystem above-ground carbon storage. However, there is no evidence of benefit to biodiversity conservation. This finding should be considered in the light of the short timescale of measurement versus the low likelihood of significant changes in species composition over such timescales, especially in countries such as India and Nepal where there is a high level of forest fragmentation. There is insufficient evidence to conclude what effect CFM has on local livelihoods.

There is a strong need for institutions making costly project interventions to critically assess the attribution of any positive outcomes achieved (i.e. whether they are due to the project intervention or would have occurred anyway). For this reason, much better information needs to be recorded in studies of CFM about the selection of communities/forests to receive CFM project intervention. If they have been selected as communities with the most degraded forests that are currently providing low levels of local income, then the occurrence of subsequent forest condition and local incomes that are comparable with non-selected forests may represent a very successful project outcome. However, if a CFM

project is located in a community that already has higher levels of community participation in forest management, an assessment which indicates a moderately higher level of forest condition and local income than a non-CFM community may not indicate any additional project benefit at all.

In addition, while assessment of outcome may be required even in short-duration projects, great care is needed in its interpretation: short-term success may not predict longer-term benefit, whereas even if there is a lack of short-term success the impacts of improved community participation may still lead to important longer-term benefits (e.g. in social capital). It will never be the case, however, that project impacts can be considered 'permanent', even though this has increasingly been used as a criterion for assessment of carbon payment for ecosystem services projects. There is an increased trend towards iterative 'adaptive' approaches in CFM projects, e.g. following the methods of 'integrated natural resource management' (Campbell and Sayer 2003). By potentially creating more temporal variability in project activities, this will create particular challenges in terms of the long-duration required for reliable assessment of project outcomes.

Drawing conclusions from the current evidence base is hampered by the methodological designs and diverse outcomes of the research conducted to date. A minimum quality of study design, which will contribute useful data to a future updated review, whilst also being realistically feasible, should be provided for guidance to inform evaluation of CFM initiatives. Standard outcome measures that are recognised indicators of the success of management should be proposed so that they are common across projects. Higher standards of reporting of study context and baseline data are essential to enable meaningful analysis of reasons for variation in effectiveness of CFM. The use of BACI designs, which allow investigation of the comparability of sites at baseline, along with a full investigation/accounting of further potentially confounding variables affecting the comparability of sites should be possible within the constraints imposed by the socio-economic context of the study. Research should be better integrated into CFM project activities, so that time-course studies can be reported that document changes from the start of a CFM project and during its development (with parallel studies in non-CFM communities). This will provide far stronger evidence about the actual direct effects of the project interventions.

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8. Appendices

10.1 APPENDIX A – Studies included in the synthesis

10.2 APPENDIX B –The Search strategy

10.3 APPENDIX C – Study characterisation

10.4 APPENDIX D – Description of studies included in the review synthesis

10.5 APPENDIX E – Characterisation of studies without appropriate comparators

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