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Examining the evidence base for forest conservation interventions

December 2016

Evidence Gap Map Report 4

Environment

International Initiative for Impact Evaluation

About 3ie

The International Initiative for Impact Evaluation (3ie) is an international grant-making NGO promoting evidence-informed development policies and programmes. We are the global leader in funding, producing and synthesising high-quality evidence of what works, for whom, why and at what cost. We believe that high-quality and policy-relevant evidence will make help make development more effective and improve people's lives.

3ie evidence gap maps

Evidence gap maps (EGMs) aim to inform funding and research decision-making by compiling existing research accessibily in one place in a way that also shows limitations and gaps. These maps are based on systematic methods to identify and describe the existing evidence base. EGMs are structured around a framework of interventions and outcomes and include a graphic map that highlights areas with extensive, limited or non-existent evidence. EGMs provide an overview of evidence on the effects of policies and programmes in a particular sector or thematic area. They consolidate evidence from impact evaluations and systematic reviews to identify research gaps and provide easy access to existing research. EGMs are available through an online interactive platform on the 3ie website that allows users to explore the full studies and reviews that are included.

About this evidence gap map report

This report summarises the methods and findings of an EGM on the high-quality evidence available on forest conservation across low- and middle income countries. The online map can be found here.

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Summary

The World Bank estimates[1] that 1.3 billion people depend directly on forests for food or fuel, and another 800 million people live in or near forests and savannas, relying on forest resources for their livelihood. In a rapidly urbanising and resource-hungry environment, successfully managing forests and forest resources, while at the same time sustaining forest-dependent livelihoods, is critical to maintaining ecosystem services and functions (Millennium Ecosystem Assessment 2005; Balmford and Bond 2005). In this study, we take stock of evidence that can potentially inform decisions regarding the role of forest conservation interventions in sustaining ecosystems and human well-being.

An important way to identify and measure change brought about by a programme or policy is through theory-based impact evaluations that use mixed methods. Theory-based impact evaluations use experimental and quasi-experimental designs to identify and measure the causal effects of an intervention or policy, and can provide useful evidence for the design and implementation of forest conservation policy and programming. These evaluations can thus guide stakeholders leading, engaging or benefiting from conservation initiatives. They can also help inform funding initiatives that support the twin goals of achieving ecological and social outcomes (McKinnon *et al.* 2015a). Unfortunately, however, very little rigorous evidence exists that evaluates the effectiveness of programmes and initiatives in the forest conservation sector (Ferraro and Pattanayak, 2006; McKinnon *et al.* 2015a). The evidence base is also fragmented across the literature (McKinnon *et al.* 2015b), thus limiting the ability of decision-makers to distil what is important for a particular decision.

In this study, we examine the evidence base for forest conservation interventions (including protected areas, decentralised forest governance, payments for ecosystem services and international policy instruments) in low- and middle-income countries. We generate a visual evidence gap map that documents the availability of robust evidence to inform decision-making.

Evidence gap maps are designed to provide a visual and interactive representation of robust evidence available for a given set of interventions and outcomes. They are a critical first step towards synthesising the evidence base in a sector, highlighting thematic areas with substantial evidence where a more rigorous systematic review (i.e. a quality assessment and a detailed examination of magnitude and direction of impacts for a given intervention type) may be useful. They also highlight areas where there is limited evidence on the effectiveness of an intervention-outcome linkage.

In this study, we classify forest conservation into 15 intervention categories, and take stock of impact evaluations and systematic reviews that examine knowledge and behaviour change, transparency and accountability outcomes, and environmental, social and cost-effectiveness impacts. We use a systematic search protocol to

[1] http://www.worldbank.org/en/news/feature/2016/03/18/why-forests-are-key-to-climate-water-health-and-livelihoods

identify publications on the impacts of forest conservation between 1990 and 2015. Our search yielded 110 impact evaluations, 8 systematic reviews and 4 protocols for systematic reviews that focus on forest conservation interventions in low- and middle-income countries.

Our key findings are:

There are critical gaps in evidence for policy areas. There is little or no high-quality evidence in areas that are otherwise significant for policy. These include evidence on the effect of forest-related climate change policies, trade laws and management, or education and awareness campaigns on environmental and social outcomes in forests. Similarly, there is a paucity of high-quality evidence on the impacts of forest conservation interventions on transparency and accountability, biodiversity, knowledge and behaviour change, supporting services and cultural services.

Some forest conservation interventions are relatively well studied, but important biases remain. Most impact evaluation and systematic review evidence is directed at understanding the effects of protected areas, decentralised forest management and payment of ecosystem services. However, the evidence base for these interventions is geographically skewed, and focuses on a small number of outcome types.

The eight systematic reviews mainly focus on decentralised forest management, protected areas and payment of ecosystem services. Only after 2010 were systematic reviews performed to measure evidence in this sector. Three out of eight systematic reviews estimate only environmental outcomes, with the remainder estimating the trade-offs between social and environmental outcomes. Only one systematic review measures decision-making of the forest communities.

The outcomes that are most frequently measured are forest cover, forest degradation, and income and poverty reduction, which are likely to be driven by the availability of large-scale secondary datasets for these outcomes. Outcomes requiring primary data collection (e.g. biodiversity, knowledge and behaviour change) are rarely examined.

Despite the considerable focus on synergies and trade-offs between environmental and social outcomes in conservation, few studies robustly examine these relationships. We identify a small number of studies that examine trade-offs (n = 27), with all of these published since 2007. Similarly, few studies evaluate the cost-effectiveness of forest conservation interventions: only two studies focus on the cost-effectiveness of protected areas in Indonesia and decentralised forest management in India, respectively.

Quasi-experimental methods can and should be considered for impact evaluations. There are few impact evaluations and systematic reviews that use randomised assignment to understand and measure the effect of forest conservation measures, likely due to the limited capacity of conservation evaluators to randomise

large-scale interventions. Most impact evaluations use quasi-experimental techniques (e.g. propensity score matching) to create real-world experiments to identify and measure the causal impacts of forest conservation.

Implications for science and practice

The current evidence map for forest conservation interventions has implications for conservation science and practice. As the evidence base for conservation expands, there is a need to invest in targeted evidence synthesis efforts to distil information in a format that can directly inform decision-making. This is particularly true because there are now a large number of international agencies that are focusing on climate-related programming (e.g. Global Environment Facility, Green Climate Fund, International Union for Conservation of Nature, World Wildlife Fund). There is also considerable investment in this field. And, last but not least, it is also a low-hanging fruit: monitoring, reporting and verification systems in many programmes already collect large amounts of data. Extending these to make them relevant and useful for impact evaluations should be relatively cheap (as compared to other sectors).

We also note that there is a significant opportunity for communities to leapfrog and learn from other sectors, many of which have had to go through a long trajectory of setting up systems to finally produce high-quality evidence. Additionally, forest conservation has a rich discipline of measurement and data collection. Extending these to include strategic investments in developing robust and scalable data and methods for understanding and measuring causal changes in environmental and social outcomes is therefore likely to be much easier for the forestry sector. However, it is also true that individual and institutional capacities need to be strengthened in this area, and efforts are required to develop and customise impact evaluation science and methods. We believe that this will also be far easier in the climate and forestry sector. Agencies involved in the sector will need to invest in this area, to enable conservation scientists to expand the geographic and thematic coverage of the current evidence base. Similar investments are required to examine highly strategic, but unevaluated conservation interventions such as reducing emissions from deforestation and forest degradation (REDD) and REDD+; forest certification schemes; trade agreements; and national forest policies.

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Abbreviations and acronyms

BACI	before-after, control impact
CFM	community forest management
CMF	community-managed forests
DFM	decentralised forest management
DID	difference-in-difference
EGM	evidence gap map
FAO	Food Agriculture Organisation
FSC	Forest Stewardship Council
ICDP	integrated conservation and development project
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IV	instrumental variables
MTCS	Malaysian Timber Certification Scheme
OLS	ordinary least squares
PA	protected area
PEFC	programme for endorsement of forest certification
PES	payment for ecosystem services
PICOS	population, interventions, comparison type, outcomes and study design inclusion and exclusion criteria
PRISMA	preferred reporting items for systematic reviews and meta-analyses
PSM	propensity score matching
RCT	randomised controlled trials
RDD	regression discontinuity design
REDD	reducing emissions from deforestation and forest degradation
REDD+	REDD+ includes (a) reducing emissions from deforestation; (b) reducing emissions from forest degradation; (c) conservation of forest carbon stocks; (d) sustainable management of forests; (e) enhancement of forest carbon stocks.
SDGs	Sustainable Development Goals
WWF	World Wildlife Fund

1. Introduction

1.1 Background

Approximately, 4 billion hectares or 31% of the world's land area is covered with forests (FAO, 2015). Forests are home to more than 80% of terrestrial species, sequester between 45% and 60% of living terrestrial carbon, produce oxygen and play a vital role in the global freshwater cycle (IPCC, 2014). At the same time, rising global population numbers combined with increased per capita consumption rates are resulting in forest land being converted to other uses to meet food, energy and fibre-related needs (WWF, 2011; Boucher, 2011; FAO, 2014).

The Sustainable Development Goals adopted by 193 countries of the United Nations General Assembly on 25 September 2015 highlighted the importance of integrated approaches for enhancing the multiple contributions of forests to sustainability outcomes. The Sustainable Development Goals articulate forest-specific targets under Goals 13 and 15, underscoring the role of forests in combating climate change; protecting, restoring and promoting sustainable use of terrestrial ecosystems; combating desertification; and halting and reversing land degradation and biodiversity loss.

1.1.1 Evidence on the effectiveness of forest conservation interventions

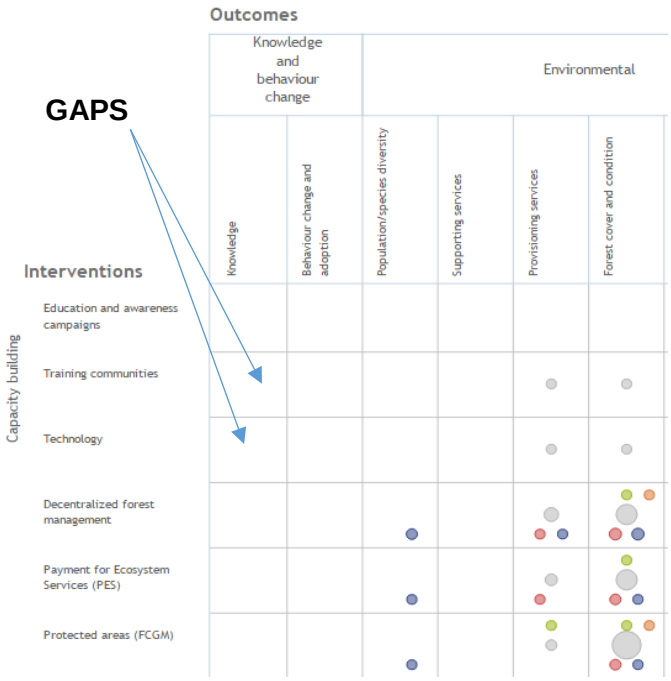
While the importance of sustainably managing forest resources is widely recognised, robust evidence on the impacts of specific forest conservation interventions, e.g. protected areas and payment for ecosystem services (PES), remains limited, forcing policymakers to effectively shoot in the dark when designing or implementing interventions (Agrawal & Redford 2006). Examining trade-offs is important since the direction of impact varies: in some cases, forest conservation interventions may help to achieve human development goals. For example, Andam *et al.* (2010) conclude that the establishment of protected areas contributes to poverty alleviation in Costa Rica and Thailand. In other areas, conservation interventions may be incompatible with other land uses, generating trade-offs between forest conservation and human well-being (Chomitz 1996; Angelsen & Kaimowitz 1999; Pfaff 1999). Conservation interventions can also act to repel or attract other development processes (Sunderlin 1996; Cropper, Puri & Griffiths 2001; Pfaff *et al*. 2007), creating complex arrays of synergies and trade-offs that may vary over space, time and among social groups. Understanding the likely magnitude and direction of ecological and social impacts from a conservation intervention, as well as documenting the likely synergies and magnitude of trade-offs between those impacts, represents a critical challenge for the conservation sector (Cropper, Puri & Griffiths 2001; Puri 2006; Ferraro and Pattanayak, 2006; Persha & Meshack 2015). Evidence on the causal effects of interventions is urgently needed to inform the design and implementation of conservation interventions that minimise trade-offs, and to maximise the synergies between conservation and development (Sims 2010).

1.1.2 Evidence gap maps and their role in decision-making

Over the past decade, the first generation[2] of conservation impact evaluations have begun to shed light on the magnitude and direction of conservation's ecological and social impacts (e.g. Joppa & Pfaff 2010; Ferraro, Hanauer & Sims 2011). Indeed, as more evidence is generated on specific interventions, the need to adopt synthesis tools that allow us to examine and explain the variation in the outcomes and impacts becomes greater. Evidence gap maps (or EGMs; see Box 1) and systematic reviews represent important tools for synthesising the evidence base into credible and salient insights for decision-makers.

Box 1: What are evidence gap maps?

EGMs are thematic collections of studies that measure the effects of international and national development policies and programmes in a specific field or sector to synthesise and review counterfactual analysis (Snilstveit *et al.* 2013). EGMs are a graphical display of existing impact evaluations and systematic reviews organised by type of programme intervention and their corresponding outcomes within the sector. Online EGMs include hyperlinks to summaries of included studies. The framework of an EGM is based on a review of the policy literature and is developed in consultation with relevant stakeholders.



An EGM is a matrix where the rows list the interventions. Row headings or interventions may include programmes, policies, activities, plans or practices implement ed to meet a desired goal. Column headings cover the most relevant outcomes organised along a causal chain, from intermediate outcomes to final outcomes. The framework is designed to capture the universe of important interventions and outcomes in the sector or subsector covered by the map. Populated cells that lie at the intersection of rows and columns inform the viewer of the evidence available for each intervention and outcome combination. This means that each study is placed in every cell for which the study provides evidence. Therefore, studies may appear in the map multiple times as most studies measure multiple outcomes and evaluate multiple interventions. This provides the user with an easy way to visualise the full evidence base in a sector.

Source: International Initiative for Impact Evaluation (3ie)

[2] Money for Something? Conservation Impact Evaluation 2.0 (https://www.youtube.com/watch?v=SyDcUZWVGpg)

To our knowledge, this is the first EGM of forest conservation interventions that focuses on forest governance, market mechanisms and climate policies and that documents both environmental and social outcomes. An inventory of forest-related evidence is important for two reasons. First, it documents the extent of evidence available on the effectiveness, efficiency, sustainability and cost-effectiveness of forest interventions, enabling evidence synthesis efforts, where appropriate. Second, an EGM can be used to illustrate gaps in evidence, guiding future evidence generation efforts.

1.2 Study objectives

In this report, we present an EGM that seeks to identify and illustrate the existing empirical evidence on environmental and human well-being from forest conservation interventions. The EGM aims to:

- present an overview of what we know and do not know about the interventions implemented;
- enable practitioners and policymakers to explore the findings and quality of existing evidence in the forest conservation sector;
- identify key gaps where little or no evidence from impact evaluations and systematic reviews is available which can assist in informing research in the sector; and
- facilitate evidence-informed decision-making.

This EGM seeks to inform key stakeholders, including funders, evaluators, and organisations across different regions and sectors, of the evidence on the characteristics of successful forest governance and conservation strategies that are effective, efficient and sustainable.

1.3 Report structure

In this report, we document the objectives and methods employed to build the EGM framework (Section 2). We then present a thematic overview of the state of the evidence (Section 3), schematically representing the types of interventions evaluated and outcomes reported in the forest conservation sector, followed by an analysis of the limitations of our methods (Section 4). Finally, we discuss the implications of this EGM for the forest conservation sector and broader efforts to conserve global biodiversity (Section 5).

2. Scope and search strategy

2.1 Scope

This EGM was commissioned by the World Wildlife Fund (WWF) in 2015, to map the current evidence base on the impacts of forest conservation interventions. This effort is intended to inform future investments in evidence synthesis and impact evaluation focused on forest conservation, by identifying well-studied and under-studied causal

links between forest conservation interventions and particular social or ecological attributes. To ensure that the findings of the EGM were salient to conservation decision-makers, the initial framework for the forest conservation EGM was informed by the WWF-US strategic framework, *Forest Theory of Action 2015–2020* (WWF, 2015). WWF-US's main initiatives – governance, capacity building, climate policies and initiatives, and market mechanisms – helped us determine a wider framework for intervention categories. The EGM framework shows this matrix for intervention and outcome categories (see Appendix A).

The scope of the EGM is defined by the intervention and outcome categories included in the framework, as well as the type of studies included. We define inclusion and exclusion criteria for the (a) populations, (b) interventions, (c) comparison type, (d) outcomes and (e) study designs (collectively the PICOS criteria) included in the EGM. We document these criteria in Table 1, and describe them in Sections 2.1.1 to 2.1.5 below.

Table 1: Inclusion exclusion criteria (PICOS)

	Include	**Exclude**
Population	Forest[3] ecosystems (including agroforestry) Humans, government, business Developing countries and WWF priority locations[4] (forest-specific).	Anything other than inclusions Forest ecotones
Intervention	• Capacity building • Governance • Market mechanisms • Climate policies and initiatives.	Studies that: • Geographically map forests • Describe conservation development strategies that only focus on best conservation practices • Describe intervention on non-forest species (e.g. crops, organisms that do not use forest as a habitat) • Contain impact evaluations that only measure land use change and agricultural conversion.

[3] Forest habitat typology: neotropical forests, Indomalayan forests, afrotropical forests, nearctic forests and Australasian forests.

[4] The most intact remaining rainforests: Amazon, Congo Basin, New Guinea; the most species-rich rainforests: western Amazon, north-west South America; the richest places for rare endemic plants and animals: New Caledonia, Fiji, Vanuatu, South Africa, south-west Australia, Madagascar; the most diverse tropical grasslands, savannas and woodlands: central and eastern Africa, central and eastern South America, North America.

	Include	Exclude
Comparisons	Studies that use a comparison group to measure the causal effect of interventions (i.e. experimental and quasi-experimental techniques including before-after control-impact (BACI) design; temporal and spatial comparators).	Studies that do not have implicit or explicit comparisons or control groups.
Outcomes	• Knowledge and behaviour change • Environmental outcomes • Social outcomes (human well-being) • Transparency and accountability outcomes • Cost-effectiveness.	• Outcomes associated with financial outcomes from forestry policies or programmes (such as measuring forest product prices). • Studies focusing on wildlife trade, poaching, non-forest urbanisation.
Study design	• Experimental: randomised assignment • Quasi-experimental: propensity score matching; regression discontinuity design; difference-in-difference with matching; instrumental variables; and others (fixed effects and random effects).	• Case studies • Correlation studies that lack specific intervention • Studies that use before and after data and do not match • Studies that use data that is qualitatively collected • Regression • Cross-sectional without matching • Any other methodology not in the included section.

Source: authors

2.1.1 Population

We included studies conducted in the low- and middle-income countries (as defined by the World Bank[5]). Studies that were included examined terrestrial ecosystems and forest ecosystems (including agroforestry), as defined by the International Union for Conservation of Nature (IUCN) Habitats Classification Scheme (IUCN 2014) and the FAO/IPCC Land Types (IPCC 2000). These include tropical forests, temperate forests and mangroves.

The EGM focuses on the human well-being and economic welfare of human populations living within or near forested or formerly forested lands. We also included

[5] As of 1 July 2013, the World Bank income classifications by gross national income per capita are as follows: low income, US$1,035 or less; lower middle income, US$1,036 to US$4,085.

private sector actors that trade in forest products. The population sample included government agencies (national, state and local) involved in forest management. Studies that were excluded focused on marine, tundra or desert ecosystems, grasslands, forest ecotones (i.e. transitions between two biomes such as forests and grasslands) and urban environments. We also excluded studies that only measured changes in biophysical characteristics of forests (e.g. carbon storage, volume of trees).

2.1.2 Interventions

We included interventions in four major groups: capacity building, governance, market mechanisms and climate change (Table 2). The grouping took into account key focus areas in forest conservation, such as protecting forest areas; decentralising forest governance; agroforestry; reducing emissions from deforestation and forest degradation (REDD) and REDD+[6]; PES; and forest certification.

Papers focused on satellite imagery mapping of forests in the absence of a specific conservation intervention and conservation development strategies and those that only focused on best conservation practices were excluded. Studies that focused on non-forest species (e.g. cultivated species and non-forest species) were also excluded from the search strategy.

Table 2: Intervention categories

Intervention category	**Intervention subcategory and definition**	
Capacity building	Interventions related to means and measures that help to spread knowledge and influence behaviour.	
	Education and awareness campaigns	Conservation-related education and awareness-raising campaigns among communities that aim to increase conservation practices (e.g. campaigns encouraging afforestation or promoting sustainable practices like selective logging).
	Training communities	Grassroots demonstrative training of communities that aims to promote sustainable conservation activities, e.g. sustainable logging practices; training that helps to promote market linkages; training stakeholders on participatory management practices like harvest quota, benefit shares and local governance practices.
	Technology	Resource management technologies that help to curb forest resource extraction either through promoting and using substitutes or leading to the efficient use of resources (e.g. use of improved cooking stoves).

[6] http://theredddesk.org/resources/introduction-redd-1

Intervention category	Intervention subcategory and definition	
Governance	Interventions that examine and promote ways that forests should be managed and governed. Activities that focus on sustainable land management practices, protected areas, community-based management, conservation policies, PES schemes and agroforestry.	
	Decentralised forest management (DFM)[7]	Decentralised forest management involves a variety of stakeholders including the private sector, forest communities and government. It decentralises decision-making, management and governance. Examples of DFM include: joint forest management; participatory management; community-based management; diversifying and clarifying property rights; sustainable land management under different community management strategies.
	Payment for ecosystem services (PES)[8]	Under PES, incentives are offered to individuals or communities in exchange for managing land to provide ecological services that can in turn help to manage forest ecosystems sustainably.
	Protected areas[9]	Protected areas or conservation areas are locations that receive protection because of their recognised natural, ecological and/or cultural values.
	Agroforestry[10]	A land use management system that combines agricultural and forestry technologies to create more diverse, productive, profitable, healthy and sustainable land use systems (e.g. through alley cropping or strip cropping of trees with crops).
	Policy regulating mechanisms	Policies encouraging implementation of forest conservation (e.g. encouraging recycling, policy measures, community self-governance, regulatory enforcement of forest conservation).
	Subsidies and tax concessions	Monetary privileges granted by the state or a public body of the government, local authority, corporation, individual or other legal entity, for natural resource management, to forest-dependent communities or businesses promoting forest preservation (e.g. agricultural subsidies for reduction of forest cover or tax concessions for reduction in greenhouse gas emissions).

[7] Adopted the definition from Enters, Durst and Victor (2000) (Anderson, J., 2000. Four considerations for decentralized forest management: subsidiarity, empowerment, pluralism and social capital. Decentralization and devolution of forest management in Asia and the Pacific, pp.17-27.

[8] Forest Trends; The Katoomba Group; UNEP Payments for ecosystem services: Getting started. A primer. UNEP, Nairobi, Kenya (2008) iii + 64 pp. [ISBN: 978-92-807-2925-2].

[9] As defined by the following institutes: IUCN; Convention on Biological Diversity; WWF.

[10] ICRAF1993.

Intervention category	Intervention subcategory and definition	
	National forest programmes (multi-pronged)	Large-scale programmes (e.g. integrated conservation and development projects, biodiversity and rural development) addressing multiple outcomes, such as deforestation and livelihoods.
Market mechanisms	Interventions that encourage private sector involvement; certifications; voluntary public disclosures or agreements; voluntary partnerships in trading forest products; and trade and legal regulations for forest goods. It also includes community involvement in markets and entrepreneurial activities using forest resources.	
	Forest enterprises	Entrepreneurial use of forest resources, including environmentally and economically sustainable alternatives for the market (e.g. production of artisan wood products, production and sale of natural oils, eco-tourism).
	Forest certification and public disclosure[11]	Public disclosure and certification in order to manage risk and demonstrate responsible sourcing by the private sector towards forest conservation (e.g. for certified and labelled timber, wood, pulp products and non-timber forest products; Forest Stewardship Council (FSC); programme for endorsement of forest certification (PEFC) system; Malaysian Timber Certification Scheme (MTCS)).
	Trade laws and management	Regulation and management of trade associated with forest products through laws or policies (e.g. banning timber trading).
Climate policies and initiatives	This category examines international policies and programmes that focus on climate change mitigation and adaptation.	
	International policies	International legislation, agreements and laws aimed at mitigating and adapting to global warming.
	International programmes and initiatives	International programmes and initiatives (such as REDD and REDD+) that focus on reducing emissions through enhanced forest management.

Source: authors

2.1.3 Comparator

We included studies that use experimental and quasi-experimental techniques to estimate the causal impact of a specific intervention. Experimental designs are those that randomly assign an intervention across a population, in a similar way to a medical drug trial (Rogers 2014). Quasi-experiments aim to create real-world experiments where an intervention is not randomised across a landscape or

[11] From WWF: https://www.wwf.org.uk/what-we-do/projects/forest-certification

population. Quasi-experiments use statistical matching methods to construct a non-intervention comparison group with similar characteristics to the intervention group itself. For example, if a protected area network is established far from markets and on steep slopes unsuitable for agriculture (e.g. Joppa & Pfaff 2011), a quasi-experiment will seek non-intervention comparison groups that are similarly far from markets, and located on land unsuitable for agriculture, and differ only in that they did not receive the intervention. In so doing, quasi-experiments allow us to disentangle the causal impact of an intervention from changes linked to other social, economic or ecological processes occurring in a landscape at any given time (Peersman, 2014). Quasi-experiments may include a variety of specific research designs, such as before-after control-impact (BACI) design; temporal and spatial comparators (i.e. longitudinal studies and space-for-time substitutions). We excluded studies that did not have implicit or explicit comparisons or control groups.

2.1.4 Outcomes

Outcome categories in the EGM framework were informed by extensive literature review and are grouped into four broad types (see Table 3). Other than the environmental impacts of the interventions, we also take into account any effect that the interventions might have had in raising the living standard of people dependent on forest under the social outcomes category. On the supply side, cost-effectiveness and transparency and accountability categories cover studies assessing the sustainability and governance of the interventions. We excluded interventions associated with financial investment in forest policies or programmes. Consequently, we excluded studies focusing on wildlife trade, poaching, non-forest urbanisation and articles that recommend a specific policy without presenting credible evidence.

Table 3: Outcome categories

Outcome category	Outcome subcategory and definition	
Knowledge and behaviour change	Outcomes related to awareness, knowledge, behaviour change and adoption for all stakeholders (local communities, government bodies and agencies)	
	Knowledge	Changes in conservation-related facts or information acquired as a result of education or experience (e.g. learning sustainable practices, feedback on effective management)
	Behaviour change and adoption	Transfer or modification of behaviour in implementing conservation practices for sustainable forest management.
Environmental	Outcomes focusing on change in forest cover, forest condition, biodiversity changes, ecosystem services (regulating, supporting, provisioning or cultural).	
	Population or species diversity[12]	Any measure of the variety of organisms present in different ecosystems. This can refer to genetic, ecosystem or species variation (number of species) within an area, biome or planet.
	Supporting services[11]	These capture benefits from services necessary for the production of all other ecosystem services and include nutrient recycling, primary production and soil formation. They make it possible for ecosystems to provide services such as food, flood regulation and water purification.
	Provisioning services[13]	These target products obtained from the ecosystems that can be used directly by consumers.
	Forest cover and condition	These target and measure changes in forest quality and quantity, such as deforestation, forest cover, forest loss, forest degradation, afforestation, reforestation or restoration, and forest fires.
	Regulating services[11]	These target benefits obtained from regulating ecosystem processes including carbon sequestration, climate regulation, waste decomposition, purification of air and water, pest and disease control.
	Cultural services[11]	These capture non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, aesthetic experiences and research and development (e.g. travel cost is used to measure the recreational value of a protected area).

[12] Noss *et al.* (1990); Millennium Ecosystem Assessment 2005.
[13] Millennium Ecosystem Assessment 2005; de Groot *et al.* (2002).

Outcome category	Outcome subcategory and definition	
Social and economic outcomes[14]	Outcomes on communities affected by forests. Includes income, employment opportunities, human well-being, health, food security and so on.	
	Livelihoods, employment	Employment opportunities for forest-dependent communities and negative or positive effects on livelihoods.
	Income and poverty reduction	Changes in assets and incomes derived from various types of forest-related livelihood activities (wage work, business, forest utilisation, cash transfers) measured as is or through poverty indices (index of unsatisfied basic needs, multi-dimensional poverty index, and so on.)
	Decision-making	Increase in the decision-making authority (investment decisions, rule-making) and public participation in democratic decision-making of local users.
	Food security	Physical, social and economic access to basic food and its effects on nutritional intake.
	Health	Health condition improvements due to improved forest conditions (changes in air and water quality, carbon absorption) and better socioeconomic conditions due to forests.
	Education	Individual and collective literacy, skills and access to school or training opportunities. Includes informal training and formal education.
Transparency and accountability	Transparency and accountability in forest or natural resource governance (including ways to allay corruption and improve governance).	
Cost-effectiveness	Studies that have undertaken an economic or a cost analysis of forestry-related policies or programmes. These include, but are not restricted to, cost-benefit, cost-effectiveness and cost-utility analysis.	

2.1.5 Study types

This EGM focuses on robust evidence derived from experimental or quasi-experimental impact evaluations. Theory-based impact evaluations are programme evaluations or field experiments that use experimental or quasi-experimental techniques to measure the causal change effected by a programme. In most cases, this requires a counterfactual, which allows understanding and measuring what would have happened in the absence of the programme (Gertler, 2011). We included impact evaluations meeting the study design and analysis criteria outlined below:

- Studies that use randomised assignment, also called randomised controlled trials (RCT). For example, Vianna & Fearnside (2014) use an RCT in Brazil to evaluate the effect of decentralised forest management on carbon stocks.

[14] Glew, Mascia & Pakiding (2012); Authors.

- Studies that use quasi-experimental designs such as regression discontinuity design (RDD); and studies that match beneficiaries with non-beneficiaries to control for selection bias and confounding, using techniques such as propensity score matching (PSM). We also included studies that use difference-in-difference (DID) methods with matching, studies that explain selection using instrumental variables (IV), fixed- or random-effects models with an interaction term between time and intervention for baseline and follow-up observations, and studies that use natural experiments. Table 4 defines experimental and quasi-experimental designs.

Table 4: Study design

Study design	Description
Difference-in-difference (DID)	Difference-in-difference (DID), also known as the double difference method, compares the changes in outcome over time between treatment and comparison groups to estimate impact. Applying the DID method removes the difference in the outcome between treatment and comparison groups at the baseline. Nonetheless, this method is best used in conjunction with other matching methods such as PSM or RDD.
Instrumental variables (IV)	A statistical technique for estimating causal relationships when an RCT is not feasible or when an intervention does not reach every participant or unit in an RCT.
Matching	Matching methods rely on observed characteristics to construct a comparison group using statistical techniques. Different types of matching techniques exist, including judgmental matching, matched comparisons and sequential allocation. Perfect matching would require each individual in the treatment group to be matched with an individual in the comparison group who is identical on all relevant observable characteristics such as age, education, religion, occupation, wealth, attitude to risk and so on.
Propensity score matching (PSM)	In PSM, an individual is not matched on every single observable characteristic, but on their propensity score, i.e. the likelihood that the individual will participate in the intervention (predicted likelihood of participation) given their observable characteristics. PSM thus matches treatment individuals or households with similar comparison individuals or households, and subsequently calculates the average difference in the indicators of interest. In other words, PSM ensures that the average characteristics of the treatment and comparison groups are similar, and this is deemed sufficient to obtain an unbiased impact estimate.
Ordinary least squares (OLS)	A generalised linear modelling technique that may be used to model a single response variable that has been recorded on at least an interval scale. The technique may be applied to single or multiple explanatory variables and also categorical explanatory variables that have been appropriately coded (Hutcheson's definition, 2011).
Randomised controlled trials (RCTs)	A research or evaluation design with two or more randomly selected groups (an experimental group and control group) in which the researcher controls or introduces an intervention (such as a new programme or policy) and measures its impact on the dependent variable at least two times (pre- and post-test measurements).
Regression discontinuity design (RDD)	This approach can be used when there is some kind of criterion that must be met before people can participate in the intervention being evaluated. This is known as a threshold. A threshold rule determines eligibility for participation in the programme or policy and is usually based on a continuous variable assessed for all potentially eligible individuals.
Note: adapted from White & Sabarwal (2014)	

We excluded studies that use observational data with no control; correlation studies; before and after studies without matching; theoretical or modelling studies; editorials and commentaries; literature reviews; and synthesis and systematic reviews of efficacy trials (e.g. trials undertaken in laboratory settings).

2.2 Search strategy

Discussions with sector experts and a literature review contributed to developing the PICOS strategy (Table 1) and informed the initial EGM framework. In order to ensure that relevant categories of interventions (Table 2) and outcomes (Table 3) were not omitted, the draft framework was reviewed by external researchers and policy makers.[15] This helped to ensure that each term used to describe the categories was explicitly defined and aligned within the strategies.

The study team then worked intensively with an information and search specialist to put together a comprehensive search strategy with relevant keywords (see Appendix B) and systematically searched seven online publication databases (listed in Appendix B). However, we know that finding evidence cannot be left solely to protocol driven search strategies such as these, and we accessed additional libraries and resources to make the search more comprehensive. While less efficient, these additional avenues yielded important sources that would otherwise have been missed (Greenhalgh & Peacock 2005). This search was complemented with studies found through hand searches and snowballing techniques.

- Hand searching consisted of manually examining publications on prominent databases such as the World Bank Open Knowledge Repository, 3ie Impact Evaluation Repository, and Google Scholar for additional papers that were not captured through the initial search strategy. This included going through grey literature, working papers, and so on.
- Snowballing or reference tracking involved scanning reference lists of relevant full text papers and systematic reviews to find other papers that could be evaluated for inclusion.
- Personal knowledge and academic networks were also explored.

The search was conducted in June 2015 and the results were methodically screened using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement[16] and our explicit inclusion and exclusion criteria. We searched for documents published between 1990 and 2015. The initial protocol driven search resulted in 33,658 hits; these were distilled down to 122 eligible studies that were all systematically coded by the study team. EPPI-Reviewer 4 ® and Endnote ® software were used to manage the references obtained through the search strategy. Study

[15] Dr Louise Glew, Martha Stevenson, Margaret Arbuthnot (WWF-US), Dr Madeleine McKinnon (Conservation International) and Dr Birte Snilstveit (3ie, London).
[16] To see the checklist please see: http://www.prisma-statement.org/documents/PRISMA%202009%20checklist.pdf
To understand the process please see: http://prisma-statement.org/documents/PRISMA%202009%20flow%20diagram.pdf

titles and accompanying abstracts were screened for relevance, and full text papers (n = 1,358) were then screened by two reviewers for inclusion. We also included systematic reviews, quality assessed to reflect 3ie standards and limited to those using experimental and quasi-experimental designs. Information on study design, location, intervention and outcomes were coded using an internally designed template (Appendix C) in Microsoft Excel ®.

Figure 1: Overview of the search results

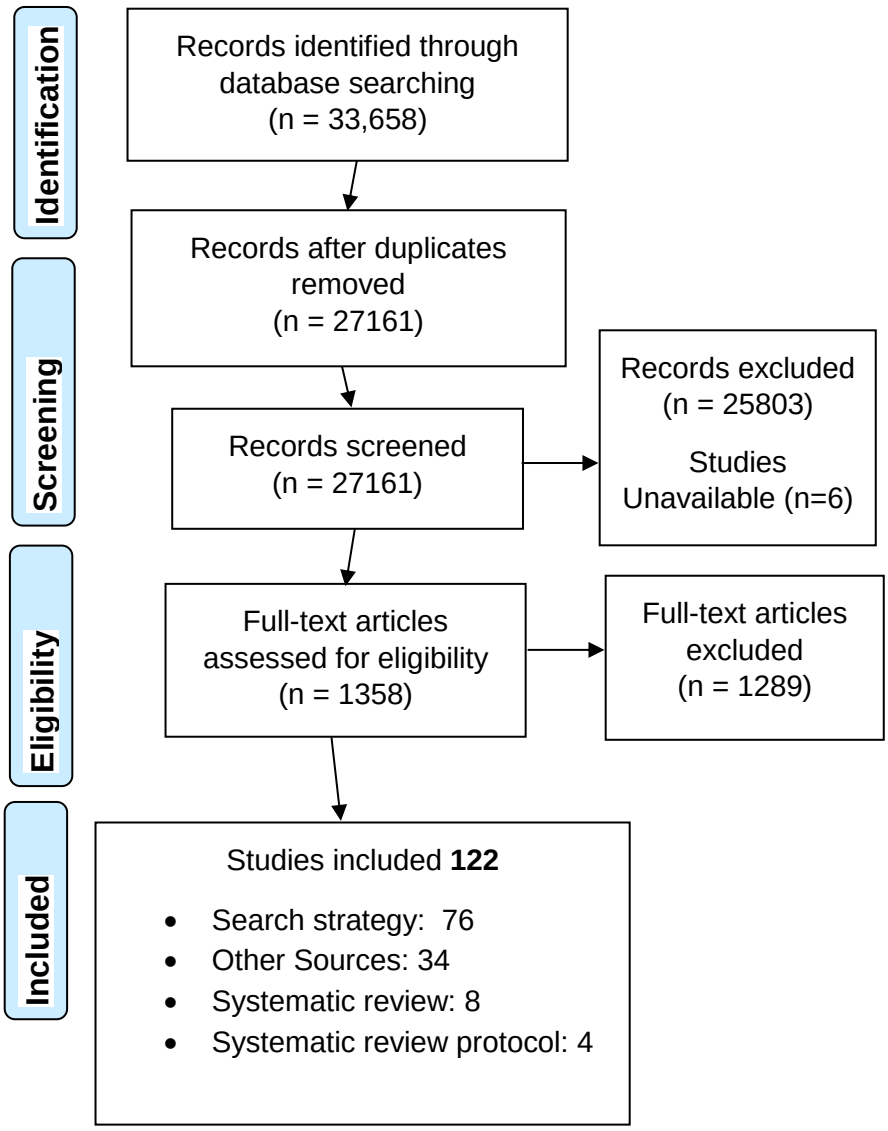


Figure 1 shows that 110 impact evaluations, 8 systematic reviews and 4 protocols for systematic reviews resulted from this search strategy.

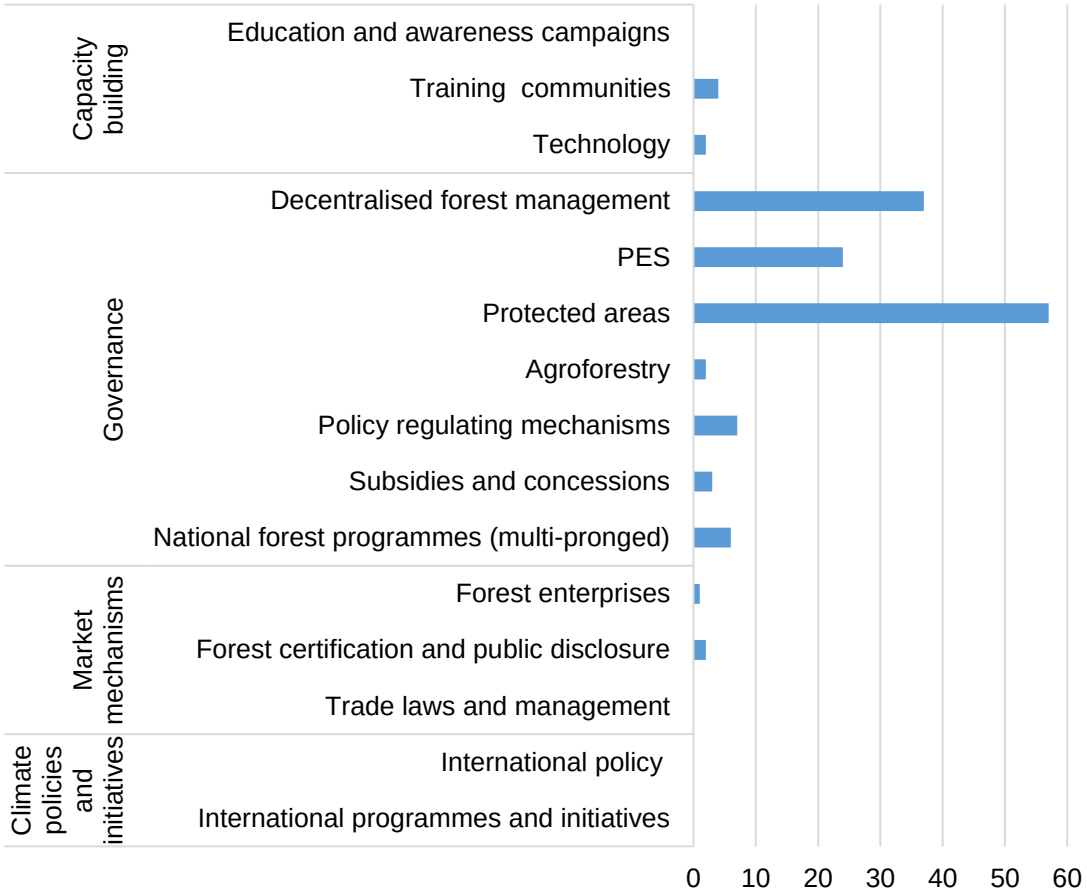
3. Findings

In this section, we discuss our findings based on 122 studies (110 impact evaluations, 8 systematic reviews and 4 protocols for systematic reviews that are quality assured by 3ie) identified through our systematic search for this EGM.

3.1 Characteristics and trends of interventions

We find considerable variation in the relative size of the evidence base to support specific causal links (Figure 2). Forest governance interventions are the most commonly evaluated intervention type, representing 93% of the total evidence base. Capacity building interventions, market mechanisms, and climate policies and initiatives are seldom evaluated, collectively representing 7% of the studies identified.

Figure 2: Frequency of impact evaluations by intervention category and nested subcategories



Last updated on 31 July 2015; Source: authors

Fifty-seven impact evaluations estimate the effectiveness of protected areas in the low- and middle-income countries, which comprise 47% of the current evidence base. In addition, decentralised forest management and direct payments associated

with PES programmes were two of the more frequently evaluated interventions, comprising 30% (n = 37) and 20% (n = 24) of the total respectively. There were no impact evaluations that investigated the role of forests in helping to mitigate or adapt to climate change or increasing the resilience of forests to climate change (the climate policies and initiatives intervention category).

Interestingly, while investments in initiatives such as REDD and REDD+ exceed US$6 billion (UN-REDD Programme, 2014)[17], no impact evaluations have investigated the environmental or social outcomes of these interventions as a whole. While there is no impact evaluation evidence of REDD impacts available to date, studies were found during our screening process that measured a country or region's readiness for REDD, potentially laying the foundations for future evaluations. Given the likely investment of an additional US$30 billion by 2020 to support REDD and REDD+ interventions (UN-REDD Programme, 2014), the robust evaluation of these initiatives represents a critical priority for future evidence generation efforts.

While there is limited evidence of the efficacy of the full suite of REDD and REDD+ interventions, there are many studies that do examine the effectiveness of PES schemes. Additionally, agroforestry[18] (which is sometimes also a component of REDD and REDD+ programmes) is included as a separate intervention category highlighting best practices of forest conservation along with agriculture. We find that agroforestry is relatively under-studied, with only two studies (that meet our criteria) included in the EGM (Hegde & Bull 2011; Faße & Grote 2013).

Few impact evaluations focus on community training and market linkages (3.2%, n = 4), or interventions encouraging the use of improved cooking stoves (1.6%, n = 2). Similarly, only one study (Weber *et al.* 2011) documents the impacts of microenterprises in forest systems. Weber *et al.* (2011) conclude that participation in microenterprise increased cash and total income as well as asset accumulation significantly, suggesting that the microenterprises contributed to the development goals of the broader integrated conservation and development project (ICDP) of which they were a part.

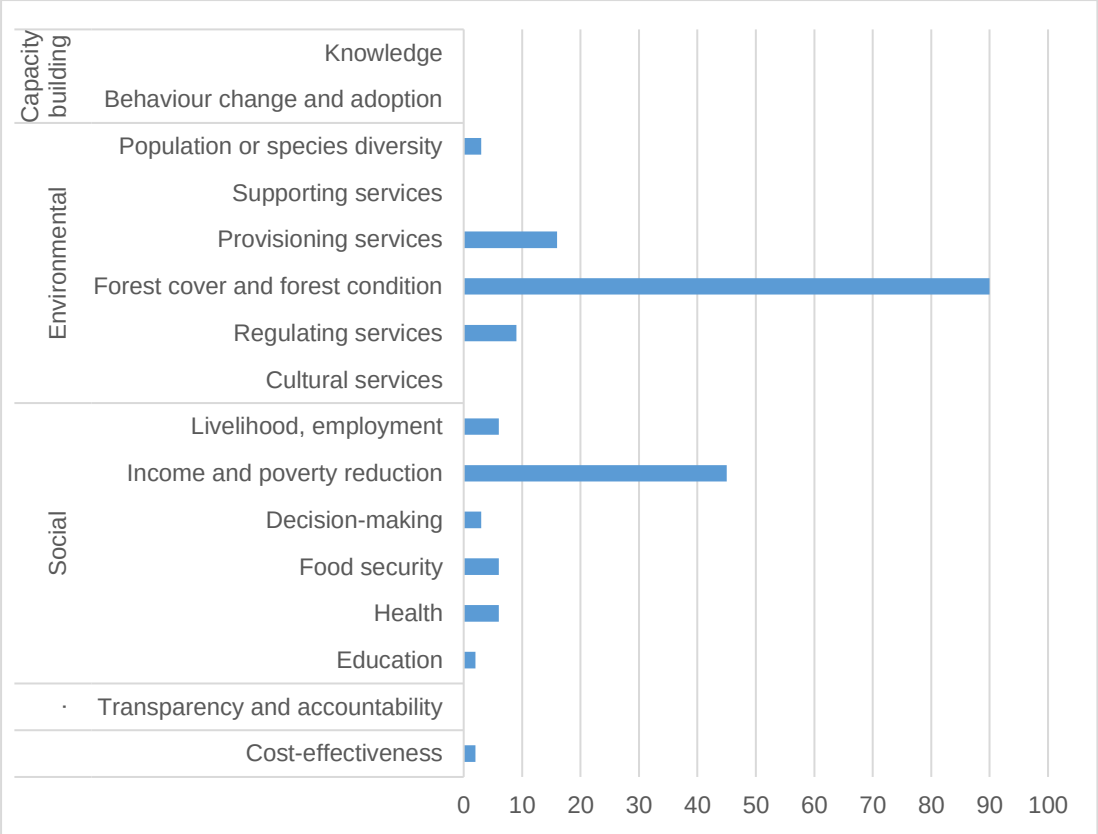
3.2 Outcome characteristics and trends

The evidence base varies considerably between outcomes (Figure 3). Forest cover and condition is the most studied environmental outcome, accounting for 74% of studies, potentially due to the availability of remotely sensed datasets that enable researchers to monitor changes in forest cover and condition (e.g. Joppa & Pfaff 2011). Similarly, the evidence base on human well-being associated with forest conservation is largely focused on income and poverty reduction (37% of studies). Many linkages remain under-explored, including the effects of forest conservation on species population and diversity, although it is worth noting that some specific

[17] http://www.un-redd.org/
[18] Agroforestry encourages forest conservation along with sustainable farming practices by multi-cropping and managing trees with crops.

intervention-impact linkages have not been studied because they are unlikely or implausible (McKinnon *et al.* 2015a). In general, the environmental impacts of forest conservation have been explored in more impact evaluations than social and economic impacts. The impacts of forest conservation on accountability, knowledge and behaviour change remain almost entirely undocumented.

Figure 3: Frequency table showing impact evaluations that evaluate environmental and social outcomes

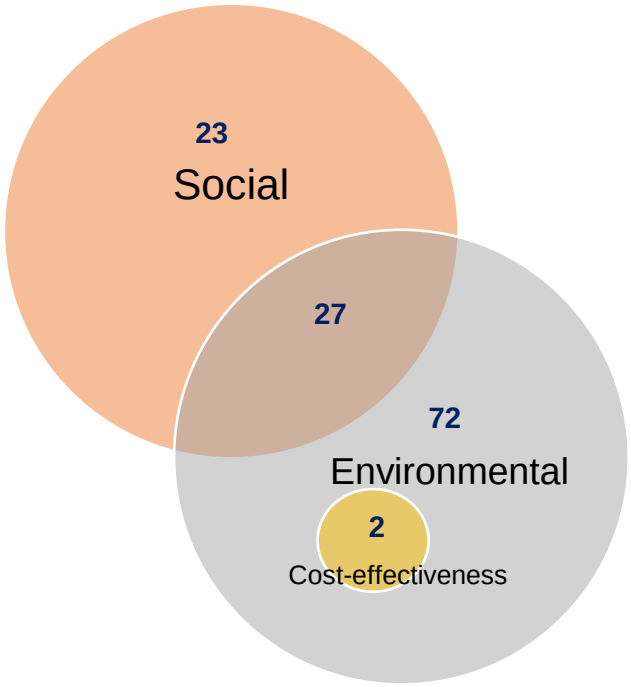


Last updated on 31 July 2015; Source: authors

Few studies look at ecosystem service impacts, with 13% of studies examining provisioning services and 7% examining regulating services.

A minority (22%) of the impact evaluations and systematic reviews in the EGM document both environmental and social outcomes, potentially allowing for an examination of the synergies and trade-offs between these domains (Figure 4). However, the majority of the studies focus on a single outcome or domain, with 18% looking at social and economic outcomes only and 59% at environmental outcomes only, largely precluding the analysis of synergies and trade-offs for many intervention types.

Figure 4: Distribution of impact evaluations and systematic reviews measuring environmental and social outcomes individually and collectively



Last updated on 31 July 2015; Source: authors

Similarly, only two impact evaluations (1.6% of all impact evaluations and systematic reviews) measured the cost-effectiveness of forest conservation interventions. These included a cost-effectiveness assessment of protected areas in Indonesia (Schwarze & Jurhbandt 2010) and decentralised forest management in India (Somanathan, Prabhakar & Mehta 2009). Both studies used propensity score matching to estimate the impacts of the intervention.

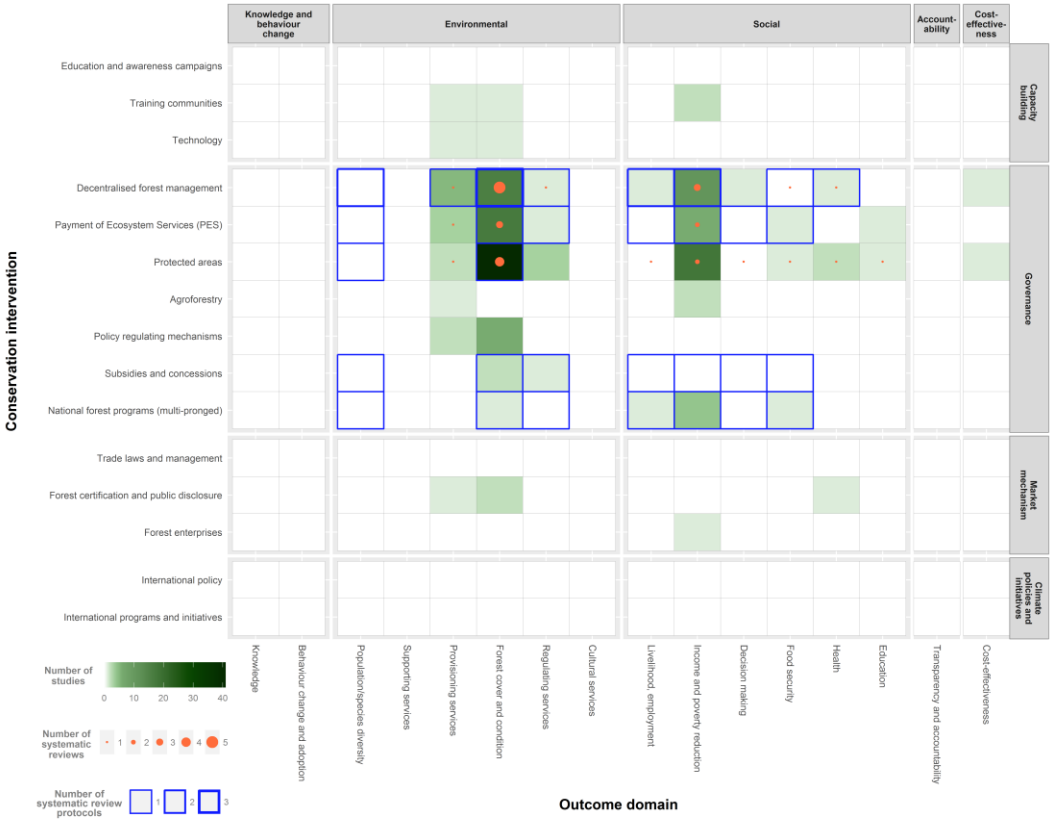
No impact evaluations study knowledge and behaviour change, supporting services, cultural services, biodiversity, or transparency and accountability. We suspect that this is because these outcomes are both hard to measure and have long ecological or social lag times between the establishment of the intervention and the ability to detect an impact. Very few studies (11.4%) measured non-economic attributes of human well-being, such as health, education and food security. Recent studies, authored by a small group of researchers, have pushed the boundary of conservation impact evaluation, adopting rigorous quasi-experimental designs (e.g. propensity score matching) to examine the health impacts of protected areas and decentralised forest management (Bauch, Sills & Pattanayak 2014 in Brazil; Riehl, Zerriffi & Naidoo 2015 in Namibia).

3.3 Concentration and gaps in evidence

The gap map highlights that the most frequently evaluated interventions are protected areas, decentralised forest management and PES (Figure 5). The relatively high frequency of evidence for these interventions may be due to their clearly defined

boundaries (relative to more diffuse policy or supply chain interventions) and the availability of secondary data (e.g. remotely sensed forest cover, household income from national census datasets) at a temporal and spatial resolution appropriate for the evaluation of these interventions. Scarce evidence is found on the impacts of training and education campaigns as well as subsidies and concessions, agroforestry, national forestry programmes and policy regulating mechanisms. No impact evaluations or systematic reviews document the impacts of climate change policies and initiatives towards forest conservation. Similarly, none measures biodiversity, supporting services, cultural services, knowledge and behaviour change, or transparency and accountability as outcomes. For some less-studied interventions, the limitations of impact evaluation (e.g. the need for clearly defined treatment and control groups) may pose a barrier to generating robust evidence. In others, the need for primary data collection (e.g. on behavioural or attitudinal outcomes) may be the limiting factor.

Figure 5: Forest conservation heat map of impact evaluations and systematic reviews

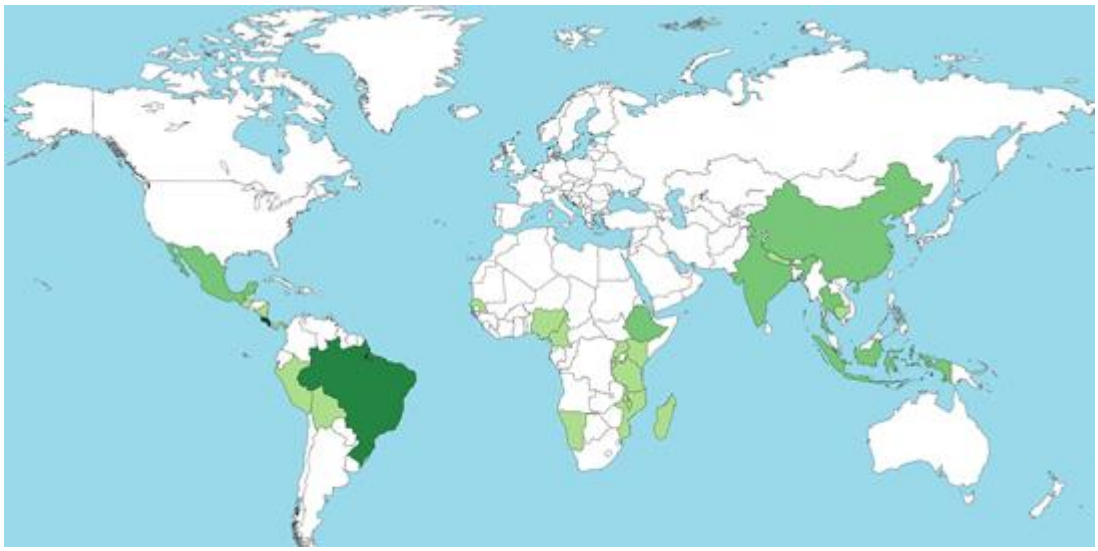


Last updated on 31 July 2015; Source: authors

3.4 Trends in geographic focus of impact evaluations

This EGM considers impact evaluations and systematic reviews that evaluated interventions in low- and middle-income countries (Figure 6).

Figure 6: Frequency of forest conservation impact evaluations by country



Last updated on 31 July 2015; source: authors

Results indicated that forest conservation-related impact evaluations were most frequently conducted in Costa Rica (19.5%; n = 24), which is likely due to the availability of appropriate secondary datasets and the application of different econometric techniques to assess the same interventions over different periods of time. For example, the impacts of the Costa Rican protected area network have been documented in 14 studies (equivalent to 24% of the overall evidence base on protected areas; see Figure 7), while PES schemes in the country have been studied 11 times (representing 45% of the overall evidence base on PES; Figure 7). The Costa Rican experience highlights the potential to generate a substantial evidence base where secondary or baseline datasets are available together with a supportive governance system (Abdallah *et al.* 2012). Together, Latin America and the Caribbean represent the most evidence-rich region, contributing 49% of the overall evidence base on the impacts of forest conservation. The Middle East and North Africa had no impact evaluations, although this is likely to be due to the relative paucity of high conservation value forests in this region. Other regions with substantial numbers of forest conservation impact evaluations include the Sub-Saharan Africa (with a 26% share) and East Asia and the Pacific (with a 23% share).

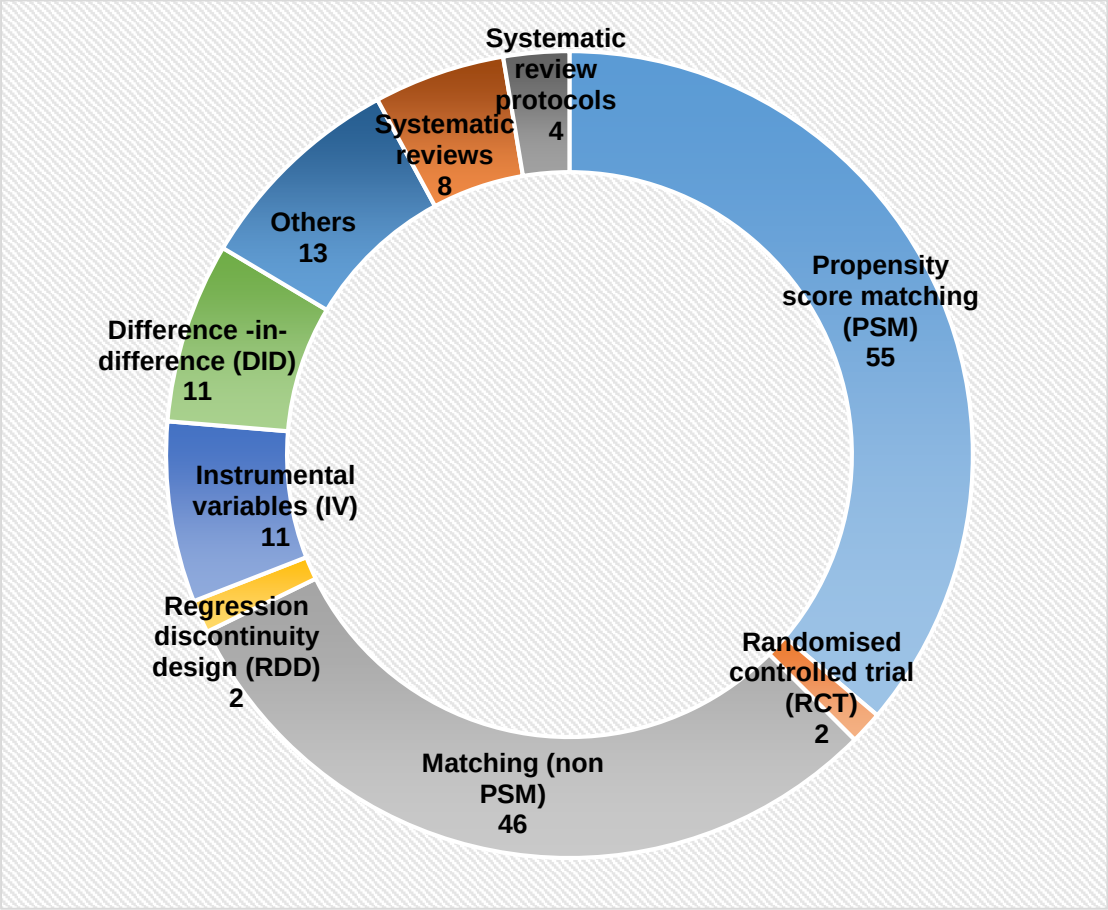
Figure 7: Distribution of forest conservation interventions across countries

Regions/ Interventions		Technology	Training	Decentralised	PES	Protected areas	Agroforestry	Policy regulating mechanism	Subsidies and concession	National forest programmes	Forest enterprise	Forest certification and public disclosure
East Asia and Pacific	**China**				2	2		3	1	4		
	Indonesia			1		**6**		1	1	1		1
	Thailand					**6**						
	Combodia			1	1	2						
South Asia	**India**			**6**		1						
	Nepal			4								
Latin America and the Caribbean	**Bolivia**			2		2						
	Brazil			3		**10**		1			1	
	Costa Rica				**11**	**14**						
	Mexico			1	**7**	3						
	Guatemala					1						
	Nicaragua			1								
	Panama					2						
	Peru	1	1			2		1				
Sub-Saharan Africa	**Cameroon**			2				1				
	Ethiopia		2	**5**		1						1
	Kenya			4		1						
	Madagascar			1								
	Malawi			3					1			
	Mozambique				3		1					
	Namibia			2		2						
	Nigeria									1		
	Rwanda				1							
	Senegal	1	1									
	Uganda			2		1						
	Tanzania			2			1					
All				7	2	8						

Last updated on 31 July 2015; Source: authors

3.5 Distribution of impact evaluations by study design

Figure 8: Occurrence of number of study designs used to evaluate forest conservation



Last updated on 31 July 2015; Source: authors

Propensity score matching is the most common impact evaluation design employed to document the impacts of forest conservation.[19] Overall, studies that employ matching techniques (including PSM; see Figure 8) account for 80% of forest conservation impact evaluations. Several studies have used DID (9% share) and IV (9% share). Both Vianna & Fearnside (2014 and Martin *et al.* (2014) used RCTs to assess decentralised forest management, and PES and policy-regulating mechanisms, respectively. In some cases, scholars estimate the impacts of a specific intervention in the same region, employing different evaluation designs. For instance, Alix-Garcia uses RDD (2011), PSM (2014) and other matching (2010 and 2012) to estimate the effectiveness of PES in Mexico and to measure forest cover and household income levels.

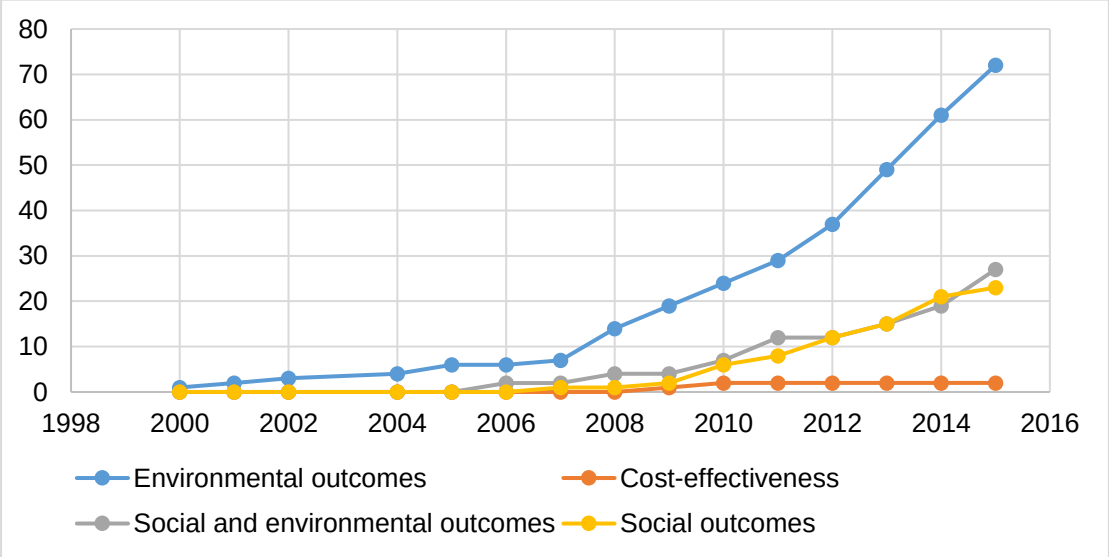
[19] This finding is also seen in Puri and Dhody 2015.

3.6 Trends in outcomes in impact evaluations over time

The use of impact evaluation in the forest conservation sector has increased rapidly over the past 15 years (Figure 9). Until 2008, the first generation of impact evaluations in the forest conservation sector focused on evaluating protected areas and decentralised forest governance schemes. From 2008, we witnessed a rapid increase in impact evaluations of forest conservation interventions, including PES, national forestry interventions and policy regulating mechanisms. After 2010, an increasing number of studies began to examine the effectiveness of market mechanisms and capacity building initiatives. We also find that studies have increasingly used non-randomisation techniques to examine and measure these changes (e.g. Busch *et al.* 2015 and Chibwana, Jumbe & Shively 2013 evaluate subsidies and concessions in Indonesia and Malawi using fixed effects and IV respectively).

The breadth of forest conservation outcomes documented by impact evaluations have also increased over time. Between 2000 and 2005, impact evaluations focused exclusively on environmental outcomes. Since 2006, the range of outcomes has expanded, first with the inclusion of human well-being, and later (from 2009 onwards) with the inclusion of cost-effectiveness assessments. Typically, cost-effectiveness assessments have focused on decentralised forest management interventions, documenting the health and education of forest-dependent communities, as well as the regulation of ecosystem services.

Figure 9: Trends in outcomes being measured for forest conservation programmes over time



Last updated on 31 July 2015; source: authors

3.7 Implications for conservation science, policy and practice

The forest conservation EGM highlights the relative distribution of evidence regarding the impacts of specific conservation interventions. This distribution is highly unequal, with some interventions subject to much greater examination (e.g. protected areas, PES, decentralised forest management) than others (e.g. policy level interventions, REDD and REDD+), likely due to the relative ease of conducting these impact evaluations. Similarly, the evidence base is skewed towards specific outcome types, with considerable focus on forest cover and condition, as well as income and poverty reduction. Impact evaluations focused on forest conservation are also concentrated geographically, with eight countries (Brazil, Costa Rica, Ethiopia, India, Indonesia, China, Mexico and Thailand) accounting for 78% of the evidence base. Within these, Brazil and Costa Rica alone account for more than a third of studies (35%) focusing on the impacts of forest conservation. These biases in the evidence base have implications for scholars engaged in efforts to document the ecological and social impacts of forest conservation. Here, we highlight the implications of these findings for conservation science, practice and policy.

3.7.1 Implications for conservation science

- **Targeted investment in evidence synthesis that examines impacts of protected areas.** The EGM highlights the existence of a relatively sizeable literature on the social and ecological impacts of forest protected areas, where targeted investments in systematic reviews are required. Potential systematic reviews should also consider broader examinations of protected area social and ecological impacts (e.g. Pullin *et al.* 2013; Brooks, Waylen & Mulder 2013; Geldmann *et al.* 2013; Porter-Bolland *et al.* 2012; Ojanen *et al.* 2014).
- **Invest in developing robust, scalable and replicable methods for documenting key outcome types.** The majority of the current evidence base on the impacts of forest conservation documents forest cover and condition or income and poverty reduction. While the emerging evidence base documents the impacts of forest conservation on forest extent, and the rate of forest to non-forest transitions, the impacts of forest conservation on biodiversity are unexplored due to challenges in the acquisition of data at the necessary scales. In the absence of these data, we risk drawing biased or inaccurate conclusions about the effectiveness of forest conservation, based on forest extent alone. Similarly, targeted investments in robust and scalable methods for documenting the impacts of forest conservation interventions on livelihoods, health and education are required to articulate the contribution of forest conservation efforts to the SDGs.
- **Examine highly strategic, but under-evaluated conservation interventions such as REDD and REDD+, forest certification schemes, trade agreements and national forest policies.** These interventions pose substantive challenges to would-be evaluators, including access to proprietary secondary datasets or privately held lands for primary data

collection, long ecological lags between intervention and outcome (e.g. in forest management regimes where cutting cycles may operate over decades; Blackman and Rivera 2011) and their spatially diffuse effects. However, great attempts have been made to evaluate forest certifications in Indonesia (Miteva, Loucks & Pattanayak 2015) and Ethiopia (Takahashi and Todo 2013), measuring the forest cover, health and provisioning services. In these cases, we may need to identify intermediate bridging indicators that are detectable earlier or more easily than ultimate outcomes, implement novel evaluative designs, or accept lower standards of evidence (e.g. longitudinal studies rather than quasi-experiments) to make weaker causal inferences.

- **Expand the geographic coverage of impact evaluations** to increase the geographic representation of the evidence base. In particular, there is a need for targeted investments in impact evaluation in dry tropical forests (e.g. the *miombo* of southern Africa), the moist tropical forests of Central and West Africa, and temperate forests.

3.7.2 Implications for conservation practice

- **Decision-making under conditions of uncertainty.** The forest conservation EGM highlights that for much of the global forest conservation portfolio, we have limited robust evidence on the impacts of interventions. Importantly, among the 15 subcategories that we have mapped, impact evaluation evidence was non-existent for 4 intervention types (trade law and management; education and awareness campaigns; international climate policies; international climate programmes and initiatives. Consequently, decisions about adaptive management and conservation policy will need to continue to rely on other sources of evidence, while investing in strategic evidence generation efforts.
- **Develop evaluation-ready baselines and data collection and integrate impact evaluation into broader conservation practice and programming.** The ability to evaluate conservation interventions is frequently limited by the availability of data on key outcomes of interest over the appropriate time period. This is particularly the case for retrospective impact evaluation efforts that rely on secondary data. While impact evaluation is not appropriate for all interventions, targeted investment in baseline data (qualitative and quantitative) on intended outcomes of conservation interventions (ecological, social and economic) may substantially increase the ability to evaluate interventions in geographic areas that lack substantial secondary data archives.

3.7.3 Implications for conservation policy

- **Invest in well-designed impact evaluation.** The forest conservation EGM highlights the relative paucity of robust evidence on the social and ecological impacts of forest conservation interventions. These findings are consistent with the conservation sector as a whole. For example, McKinnon *et al.*

(2015a) developed an EGM examining links between conservation intervention and human well-being, finding that only 9% of the 1,043 studies included in the gap map meet the study design criteria applied in this report. Similarly, Pullin *et al.* (2013) concluded that there is limited quantitative evidence on the social impacts of protected areas, due to widespread adoption of relatively weak research designs when seeking to make causal inferences about the impacts of conservation interventions. To build a robust evidence base for conservation decision-making, there is an urgent need for strategic investment in targeted impact evaluations that maximise the informational return on investment.

- **Commit to open-data practices.** Not surprisingly, and given the big demands of data and information that impact evaluations make, we also find that impact evaluations tend to be concentrated in a few countries, and on a small subset of intervention types. For example, different scholars have evaluated multiple intervention types (e.g. decentralised community management, PES, protected areas), in the same locations on multiple occasions. Early impact evaluations tend to seed impact evaluations later, especially if they are using publicly available data and area sharing or making their own data publicly available. This seeding phenomenon may help to rapidly scale up the quantity of impact evaluations in the conservation sector, particularly if organisations and individuals make baseline data publicly available or discoverable (i.e. sharing metadata, rather than the data itself).

4. Limitations

It is important to recognise the caveats and limitations associated with the EGM we present.

Owing to the broad nature of this topic, the search strategy yielded a large number of results (n = 33,658). We filtered these initial search results by screening each article's title or abstract for information on the research design employed, to narrow our search radius to impact evaluation studies alone. While this process is efficient, it may have omitted those studies that do not make their research design explicit in either title or abstract. Similarly, we conducted double screening, where two individuals code the same studies to ensure consistent coding, for a random subsample (every tenth study) of those references included in our full text review. Double screening allows us to assess whether individual coders were coding consistently. While double screening of a random subsample is a cost-effective option when reviewing a large number of studies, there may be inconsistencies in the broader dataset not subject to double coding. All the included studies were double screened at the stage of coding by the two researchers.

Many studies included in this report employ propensity score matching. It should be made clear that our EGM does not quality assess each individual study. Consequently, some of these studies, while seemingly robust, may provide limited causal evidence, due to weakness of the implementation.

To attribute impacts to conservation interventions, it is important to compare areas that are exposed to the intervention with a counterfactual or a scenario where the area would not have been exposed to the intervention. Estimating the counterfactual outcome is difficult, due to the non-random placement of conservation interventions (Miteva, Pattanayak & Ferraro 2012), particularly where single cases of an intervention (e.g. a single protected area) may be sizeable. Some common conservation interventions are more easily evaluated through randomised experiments, including PES and conservation education efforts (Ferrarro & Pattanayak 2006). The EGM highlights that while impact evaluation designs are capable of attributing causal impact, quasi-experimental designs (in particular IV, matching and DID designs) are the most commonly adopted impact evaluation techniques in the context of forest conservation (Ferraro, 2009; Greenstone & Gayer 2009; Pattanayak 2009; Joppa & Pfaff 2010; Miteva, Pattanayak & Ferraro 2012). It is worth noting, however, that well-designed impact evaluations represent a small fraction of the overall conservation evidence base (McKinnon *et al.* 2016).

5. Conclusions

5.1 Sustainable development in forest ecosystems

The need to understand the impacts of forest conservation is increasingly pressing. As the world becomes more dependent on forests (IPCC 2014), we need to know much more about the effectiveness, efficiency, sustainability and cost-effectiveness of the interventions that we are adopting and implementing to conserve biodiversity, sustain human livelihoods, and mitigate and adapt to climate change.

5.2 Impact evaluation in conservation

Impact evaluation is the systematic process of assessing the causal effects of a project, programme or policy (Gertler *et al.* 2011). By comparing what actually happened *because of* an intervention to what would have happened *without* it (i.e. the counterfactual), impact evaluations measure the intended and unintended consequences attributable to a (conservation) intervention. Specifically, impact evaluations of forest conservation interventions help understand what works, what does not, why, and for whom (Puri and Dhody, 2015; Angelsen 2011; Wunder 2014; UNEP 2011). Impact evaluation and broader evidence synthesis efforts can contribute to understanding the overall effectiveness, efficiency and sustainability of forest conservation interventions that aim to manage, conserve and sustain forests and forest-related services. Impact evaluations also hold enormous innovation potential because they are able to leverage the potential held by big and open data (Puri and Dhody 2015). We discuss this later.

5.3 Evidence for forest conservation interventions

In this report, we have collated and synthesised the considerable, and often disparate, evidence on the social and environmental impacts of forest conservation,

published in a 25-year period to 2015. We find that the evidence available to inform decisions about the design and management of forest conservation is highly variable, with considerable disparities across intervention and outcome types, as well as geographic areas. Some intervention types, such as protected areas, have a relatively long-standing and well-developed evidence base. Others, such as certification schemes, REDD, and environmental education interventions remain little studied.

Surprisingly, the majority of impact evaluations of forest conservation interventions focus on the causal impacts once an intervention has occurred. Very few studies examine the role of creating the enabling conditions necessary for these interventions to occur. Evidence on interventions that help to build and strengthen capacity by educating communities and spreading awareness are sparse, representing only three per cent of the current evidence base. Similarly, studies that examine the effectiveness of trade laws and climate policy are, in general, absent. Where evaluations examine the impacts of specific governance systems modified by conservation interventions (e.g. decentralised management, PES, agroforestry and concessions), few examine the ability of these interventions to alter the enabling environment. These enabling conditions are frequently hypothesised to be critical to the long-term sustainability of conservation efforts in common pool resource systems such as forests (e.g. Ostrom 2007). Consequently, this knowledge gap is critical, and targeted investment in evidence generation to understand these dynamics is required.

Box 2: Conclusions of systematic reviews

Samii, C., Paler, L., Chavis, L., Kulkarni, P. and Lisiecki, M., 2014. Effects of decentralized forest management (DFM) on deforestation and poverty in low and middle income countries: a systematic review. *Campbell Systematic Reviews*, 10(10).

This study reviews the evidence on the effects of DFM on deforestation as well as host community welfare. The authors aimed to assess the evidence on the effects of DFM interventions on deforestation and poverty outcomes in low and middle income countries. In addition, they also aimed to assess whether there was a relationship between effects on poverty and whether or not conservation benefits were realised. The authors included eight impact evaluations of eight different programmes in seven countries (Bolivia, Ethiopia, India, Kenya, Malawi, Nepal and Uganda). No studies assessed the effect of DFM on both forest cover and human welfare outcomes. All of the studies used quasi-experimental methods. Five studies examined the effects of DFM programmes on annual forest cover change rate. Meta-analysis was not feasible due to the differences between the outcome measures used between studies. The observed effects ranged from 0.026% (95% CI: [-0.09, 0.14]) for a study examining DFM and community forest use in India to 0.80% (95% CI: [0.41, 1.19]) for a study examining DFM-based administration of protected forests in Bolivia. Three studies assessed the effects of DFM on welfare or

poverty outcomes. The studies provide different comparisons, but all found that DFM did lead to an improvement in household income on an average. The effects reported range from an estimated 35% increase in per capita consumption expenditure in Ethiopia (95% CI: [16.5, 53.5]) to a 2% gain in Uganda (95% CI: [-2.63, 6.63]). The authors highlight the lack of high-quality studies assessing the effects of DFM on environmental and human welfare outcomes.

Samii, C., Lisiecki, M., Kulkarni, P., Paler, L. and Chavis, L., 2014. Effects of payment for environmental services (PES) on deforestation and poverty in low and middle income countries: a systematic review. *Campbell Systematic Reviews*, 10(11).

The authors included 11 studies evaluating the effects of 6 different PES programmes in 4 different countries: Costa Rica, China, Mexico and Mozambique. The evidence suggests PES has a very small effect on deforestation, reducing the annual deforestation rate by 0.21 percentage points on average (95% CI: [0.03, 0.39]). Only two studies assess effects on household income, and they suggest a modest improvement in income. Nine studies of four PES programmes in Costa Rica and Mexico assessed the effect on forest cover. The effect is slightly larger for forest cover change, which included measures of both forest loss and forest gain. Two studies assessed the effect of PES on human welfare outcomes. The authors found that PES improves participating households' income by 4% in Mozambique (95% CI: [0.96, 7.04]) and 14% in China (95% CI: [7.3, 20.7]). The study in Mozambique finds effects substantially lower for poor households. Qualitative evidence: a study on the Mexican PES programme found that forest conservation effects were worse in poorer areas.

Pullin, A.S., Bangpan, M., Dalrymple, S., Dickson, K., Haddaway, N.R., Healey, J.R., Hauari, H., Hockley, N., Jones, J.P., Knight, T. and Vigurs, C., 2013. Human well-being impacts of terrestrial protected areas. CEE protocol 11-009 [online*] Collaboration for Environmental Evidence*, www.environmentalevidence.org/SR11009.html.

The authors included 79 studies in a review of quantitative evidence, and 34 studies in a synthesis of qualitative evidence. The majority of studies included in the quantitative analysis were assessed as having a high risk of bias. The authors found that terrestrial protected areas (PAs) can have both positive and negative effects on human well-being, but there is insufficient evidence to draw conclusions about how to maximise positive impacts. The evidence base provides a range of possibilities to inform but little evidence to support decision-making on how to maximise positive impacts of PAs on human well-being. The diversity of studies and of outcomes measured, together with the diversity (or lack of clear signal) in the data suggests that impacts of PAs are highly dependent on context. However, the evidence base is insufficient to provide any capacity with which to predict impacts on well-being from a knowledge of context.

Bowler, D., Buyung-Ali, L., Healey, J.R., Jones, J.P., Knight, T. and Pullin, A.S., 2010. The evidence base for community forest management as a mechanism for supplying global environmental benefits and improving local welfare. CEE review, pp. 08–011, Available at: http://www.environmentalevidence.org/wp-content/uploads/2014/07/SR48.pdf

The authors include in the evidence synthesis a total of 42 articles from 10 countries in Sub-Saharan Africa, South Asia, Central and North America, Latin America, and East Asia and the Pacific. Seven of these studies investigate the impact of community forest management (CFM) on resource extraction, 32 studies investigate the link between CFM and forest condition and cover, and 12 assess the impact of CFM on livelihoods. Overall, CFM seems to have a positive impact on forest condition outcomes such as basal area of trees, tree density and forest cover (although the evidence for the latter is mixed). There is no evidence that CFM programmes affect biodiversity conservation outcomes.

The evidence regarding the impact of CFM on livelihood outcomes (e.g. social capital and income) is insufficient, which is partly due to the heterogeneity in the indicators used to measure CFM success. The evidence is also inconclusive for the impact of CFM on resource extraction outcomes such as stem cutting and fuel-wood collection. More evidence addressing confounding factors is needed before drawing conclusions. In short, the existing evidence is inconclusive with regards to the impact of CFM on local livelihoods, but CFM seems to benefit forest conditions and the global environment.

Brooks, J., Waylen, K.A. and Mulder, M.B., 2013. Assessing community-based conservation projects: a systematic review and multilevel analysis of attitudinal, behavioral, ecological, and economic outcomes. *Environmental Evidence*, 2(1)

This study evaluates success in four outcome domains (attitudes, behaviours, ecological, economic) and explores synergies and trade-offs among these outcomes. The paper tests hypotheses about how features of the national context (H-NC), project design (H-PD), and local community characteristics (H-CC) affect these four measures of success. The analyses suggest that project design, particularly capacity building in local communities, is critical in generating success across all outcomes. In addition, some community characteristics, such as tenure regimes and supportive cultural beliefs and institutions, are important for some aspects of project success. Surprisingly, there is less evidence that national context systematically influences project outcomes.

Geldmann, J., Barnes, M., Coad, L., Craigie, I.D., Hockings, M. and Burgess, N.D., 2013. Effectiveness of terrestrial protected areas in reducing habitat loss and population declines. *Biological Conservation*, 161, pp.230–8.

From 2,599 publications, the authors found 76 studies from 51 papers that evaluated impacts on habitat cover, and 42 studies from 35 papers on species populations.

Three conclusions emerged: first, there is good evidence that PAs have conserved forest habitat; second, evidence remains inconclusive that PAs have been effective at maintaining species populations, although more positive than negative results are reported in the literature; third, causal connections between management inputs and conservation outcomes in PAs are rarely evaluated in the literature. Overall, available evidence suggests that PAs deliver positive outcomes, but there remains a limited evidence base, and weak understanding of the conditions under which PAs succeed or fail to deliver conservation outcomes.

Porter-Bolland, L., Ellis, E.A., Guariguata, M.R., Ruiz-Mallén, I., Negrete-Yankelevich, S. and Reyes-García, V., 2012. Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics. *Forest Ecology and Management*, 268, pp.6–17.

The authors conducted a meta-analysis of published empirical case studies that assessed forest cover change in tropical environments, either under PA status (including national parks, biosphere reserves and wildlife reserves) or community managed forests (CMF; including indigenous reserves, extractive reserves, community forest management or areas with communal forest resource use). The mean annual rate of forest cover change in PAs was -1.47%, indicating a net loss of forest cover. There was, however, a wide variation in the data (SD = 3.46) with a maximum annual rate of deforestation of 19.40% and a maximum rate of forest recovery of 0.40%. In contrast, for the CMF case studies, the mean rate of forest cover change was higher than for PAs (0.24%). In other words, CMFs had a lower average rate of deforestation than PAs. There was also less variation between CMF case studies.

Roe, D., Booker, F., Day, M., Zhou, W., Allebone-Webb, S., Hill, N.A., Kumpel, N., Petrokofsky, G., Redford, K., Russell, D. and Shepherd, G., 2015. Are alternative livelihood projects effective at reducing local threats to specified elements of biodiversity and/or improving or maintaining the conservation status of those elements? *Environmental Evidence*, 4(1), p.1.

The collected studies identified a wide range of different types of alternative livelihood interventions being used to address an equally wide range of threats and conservation targets, but we were unable to determine trends in terms of the relative effectiveness of one type of intervention compared to another. Our search of the published and grey literature identified 106 projects reporting alternative livelihood interventions. Conservation effectiveness was measured in only 21 of these, of which only 9 reported that the intervention was effective in either improving local attitudes to conservation, reducing environmentally damaging behaviour, or improving the conservation status of a biodiversity target. It is important to note, however, that for many of the projects it was difficult to be conclusive about effectiveness. Some projects operating in multiple sites were successful in some sites and not in others, and there appears to be no robust way of predicting what might be the key causal factor.

Despite the current emphasis on synergies and trade-offs between conservation and human well-being in biodiversity conservation science, policy and practice (WWF 2015), very few studies (22%) explicitly examine the synergies and trade-offs involved in forest conservation (but see Jumbe & Angelsen 2006; Pender, Suyanto & Kato 2008; Coleman & Fleischman 2012). While the evidence base is limited, these studies suggest substantial variation in synergies and trade-offs, between intervention types, and across geographies. A study evaluating decentralised forest management in Malawi finds the programme reduces revenues in Liwonde, suggesting that participants sacrifice forest revenue to participate in co-management programmes, but raises forest income for participants in Chimaliro. Participants capture more benefits due to discrimination and endowment differences accounting for 100% and 60% of the inter-group income disparity, respectively (Coleman & Fleischman 2012). In contrast, Jumbe & Anglesen (2006) find that decentralised forest management increases forest investment in Uganda, Mexico and Bolivia but leads to drastic falls in Kenya. The study concluded that the different impacts depend on the adaptation of new institutional environments of the local users. There is an increase in investment in Uganda, Mexico and Bolivia as local users were more familiar than the users in Kenya, since Kenya was highly centralised before the reforms.

The implementation of a well-designed impact evaluation requires resources. Our EGM suggests that a considerable amount of time and money has been spent on evaluating the impact of a relatively small number of forest conservation interventions, concentrated in a few geographic areas. Assuming a conservative estimate for the financial cost of a well-designed impact evaluation,[20] we estimate that more than US$16 million has been spent on the 110 impact evaluations included in the EGM presented here. While this investment represents a tiny fraction (less than 1%) of overall global conservation impact investment for this sector (estimated to be US$23.4 billion[21] between 2009 and 2013, the relative paucity of evaluations including cost-effectiveness findings (n = 2; 1.8%) is surprising. As the evidence base matures, continued lack of cost-effectiveness analysis as part of well-designed impact evaluation is unlikely to maximise the value of robust evidence for decision-making.[22] Consequently, we recommend the inclusion of cost-effectiveness analyses wherever possible in future evaluations of forest conservation interventions.

[20] Average support to an impact evaluation provided by 3ie is approximately US$400,000. Even taking the lower end of this, since most studies use quasi-experimental methods and previously collected or secondary data, and with the assumption of an average spend of approximately US$150,000 per impact evaluation, we calculate that more than US$16 million has been spent on impact evaluations collectively. This is not much. However, the fact that only two of these studies do cost-effectiveness calculations is a glaring gap.
[21] Investing in Conservation: A landscape assessment of an emerging market (see http://www.naturevesttnc.org/pdf/InvestingInConservation_Report.pdf).
[22] We use cost-effectiveness to mean interchangeably most measures of cost that are then compared with the benefits of forests. So cost-effectiveness studies also include cost-benefit studies, cost-utility studies and so on.

Critically, the existing evidence base on the impacts of forest conservation interventions in low- and middle-income countries largely omits examinations of the effect of market mechanisms, such as trade in forestry products, with negligible evidence on the impacts of forest enterprises, forestry product certification[23] and public disclosure interventions. Given the potential for these intervention types to expand forest conservation efforts into privately owned lands (Kiker & Putz 1997; Garnett 2007), and current interest in impact evaluation among private sector actors (Auld, Gulbrandsen & McDermott 2008; Lund, Balooni & Casse 2009), we advocate that future research should focus on these areas and build a critical mass of evidence to examine the contribution of forest enterprises, trade[24] and certification[25] to both environmental and social outcomes.

Evidence-based conservation

The forest conservation EGM, together with other efforts to synthesise the current evidence base for conservation (e.g. Pullin *et al.* 2013; McKinnon *et al.* 2016) illustrates both the challenges and opportunities facing evidence-based conservation.

On the one hand, the relative paucity of robust evidence generated via impact evaluation and systematic review shows that much needs to be done to provide salient information to decision-makers. Most conservation interventions are not 'impact evaluation ready', lacking both qualitative and quantitative baseline data as well as data on carefully selected comparison sites. This failure to design interventions with their potential to generate evidence in mind stems from limitations (perceived or real) in the financial resources available, as well as low levels of familiarity with the principles and data needs of impact evaluation.

The ability to plan for and undertake complex and technically demanding rigorous impact evaluations is crucially dependent on creating a cadre of experts in this sector who are able to marry their sector expertise with expertise in impact evaluations. However, most studies included in the EGM were conducted by a small group of scientists and concentrated in a few areas of the world. In effect, the ability of conservation decision-makers to design and implement conservation interventions based on robust evidence is constrained by the small number of experts able to implement appropriate impact evaluations. Impact evaluations of forestry interventions entail some challenges, not shared by interventions in sectors where

[23] http://www.rainforest-alliance.org/business/forestry/certification

[24] Illegal logging generates illicit earnings **of US$10–15 billion annually**, including the huge underpayment of royalties and taxes (Goncalves *et al.* 2012).
The annual turnover of wood products, including pulp and paper, **exceeded US$200 billion in 2007**, with developing countries accounting for over 17 per cent of the trade. **The value of annual tropical timber exports was over US$20 billion (Blaser *et al.* 2011).**

[25] The area of certified forest expanded by 8% **between 2009 and 2010 (UNECE, 2010) and by 12.6% between 2010 and 2011. More than 30%** of the world's industrial roundwood supply is now sourced from certified forests, and the certification of related products, including paper, pulp, panels and plywood, is also increasing.

impact evaluation has traditionally been employed. These challenges include, for example:

- The need to consider the public (and often global) good rendered by forests. In impact evaluation terms, this means that it is important to measure what are traditionally (dis)counted as spillovers or contaminants as critical impacts of forest conservation interventions.
- Most forestry programmes are multi-sectoral, targeting ecology, biology, livelihoods, health, education and infrastructure. This means that there are multiple actors and multiple teams and agencies involved and there is high causal density in these programmes. Forestry programmes are therefore complex and require a vast variety of competencies. The interdisciplinary nature of forest conservation outcomes transcends traditional sector boundaries. Consequently, well designed impact evaluations in conservation require the involvement of interdisciplinary teams, working to integrate diverse datasets on environmental, social and economic outcomes.
- Implementation fidelity is hard to maintain because there are different agencies. In many cases, monitoring data is insufficient to track this, and this makes it difficult to understand why programmes may not be displaying the sorts of effects that are expected.
- The limited ability to implement randomised controlled trials in forest conservation. Frequently, quasi-experimental techniques are required to identify and measure causal change. In a sector that is characterised by relatively low familiarity with impact evaluation techniques, and interdisciplinary interventions and outcomes, this is not always easy even for trained scientists.

But there are reasons to be hopeful. Even though we acknowledge the constraints on mainstreaming impact evaluation in conservation, the sector may also lend itself to innovation and leapfrogging. Forestry-related studies can take much more advantage than studies in other related sectors of exogenous variables, such as slope, elevation and rainfall, to help identify and measure causal change. This is primarily because the environment discipline uses large amounts of spatially disaggregated data. It is routine for environment-related programmes to have or measure biophysical characteristics (e.g. Chomitz, 1996; Cropper, Puri & Griffiths 2001; Puri, 2006). There are several gains to be had from undertaking impact evaluations, both for the scientific community and for the policy community. The constraints mean that there is plenty of room for these communities to think creatively on methods, data and programme design, so that the benefits from measurement far outweigh the costs of performing them.

Appendix A: Evidence gap map

Link to the online EGM: http://gapmaps.3ieimpact.org/evidence-maps/forest-conservation-gap-map

Appendix B: Search Strategy

B.1 Databases and search strategy

Studies are taken from 1990 to 2016. Databases used for the search strategy are listed below:

- CAB abstracts: an applied life sciences bibliographic database emphasising subjects including agriculture, environment, veterinary sciences, applied economics, food science and nutrition
- Econlit: focuses on literature in the field of economics
- Web of Science (SCI, SSCI & AHCI): coverage includes the sciences, social sciences, arts and humanities, and goes across disciplines
- Scopus: includes peer-reviewed journals in the scientific, technical, medical and social sciences (including arts and humanities)
- Greenfile (Ebsco): is a free database designed to help people research the impact humans have on the environment. Key journals include Agriculture, Ecosystems & Environment, Conservation Biology, Forest Ecology & Management, International Journal of Green Energy, and Journal of Wildlife Management
- Academic Search Complete (Ebsco): the focus disciplines are social sciences, arts, sciences and humanities covering full text, academic journal titles, author, publication dates, abstracts, summations, cited references and relevant images
- Proquest: supports research and learning, publishing and dissemination, and the acquisition, management and discovery of library collections. We focused on ASSIA, IBSS, PAIS and WPSA databases
- 3ie Repository: the Impact Evaluation Repository is an index of all published impact evaluations of development interventions (http://www.3ieimpact.org/evidence-hub/impact-evaluation-repository/)

In addition, snowballing and hand searches were used.

B.2 Search words

1 (forest* or deforest* or afforest* or reforest* or agroforest*).ti,ab. (291165)
2 exp forests/ or community forestry/ or agroforestry/ or agroforestry systems/ or farm forestry/ or deforestation/ or forest fragmentation/ or protected areas/ or conservation areas/ (188965)
3 1 or 2 (317962)
4 (conserv* or preserv* or protect* or restor* or reserv* or welfare or fragment* or slippage or degrad* or REDD* or income* or poverty).ti,ab. (861371)
5 conservation/ or protection of forests/ or environmental protection/ or ecosystem services/ or environmental degradation/ or nature conservation/ or welfare economics/ or income/ or farmers' income/ or household income/ or income

distribution/ or income transfers/ or poverty/ (117058)
6 4 or 5 (879371)
7 ("quasi experiment*" or quasi-experiment* or "random* control* trial*" or "random* trial*" or RCT or "propensity score matching" or PSM or "regression discontinuity design" or "discontinuous design" or RDD or "difference in difference*" or difference-in-difference* or "diff in diff" or DID or "case control" or matching or "interrupted time series" or "random* allocation*" or "research synthesis" or "scoping review" or "rapid evidence assessment" or "systematic literature review" or "Systematic review*" or "Meta-analy*" or Metaanaly* or "meta analy*" or "Control* evaluation" or "Control treatment" or (random* adj3 allocat*) or "instrumental variable*" or IV or evaluation or assessment or ((quantitative or "comparison group*" or experiment*) adj3 (design or study or analysis)) or counterfactual or "counter factual" or counter-factual or QED).ti,ab,sh. (986289)
9 ((developing or less* developed or under developed or underdeveloped or middle income or low* income or underserved or under served or deprived or poor*) adj (countr* or nation? or population? or world)).ti,ab. (43189)
10 ((developing or less* developed or under developed or underdeveloped or middle income or low* income) adj (economy or economies)).ti,ab. (695)
11 (low* adj (gdp or gnp or gross domestic or gross national)).ti,ab. (41)
12 (low adj3 middle adj3 countr*).ti,ab. (1693)
13 (lmic or lmics or third world or lami countr*).ti,ab. (2224)
14 transitional countr*.ti,ab. (77)
15 exp developing countries/ (1312725)
16 ("north* great plain*" and (usa or united states)).ti,ab,sh. (351)
17 or/8-16 (2014924)
18 participation/ or public participation/ or participative management/ or stakeholders/ or community programmes/ (20812)
19 decentralization/ (2127)
20 forest management/ or forest administration/ or forest ownership/ or forest policy/ (43526)
21 "land use"/ or "land use planning"/ (51133)
22 (decentrali* or ((village* or communit* or stakeholder*) adj3 (participat* or manag* or engag* or empower* or policy or policies)) or "land use*" or (sustain* adj2 land adj2 (manag* or cultivat* or farm* or plan* or policy or policies))).ti,ab. (71955)
23 18 or 19 or 20 or 21 or 22 (139356)
24 3 and 6 and 7 and 23 (4925)
25 limit 24 to yr="1990 - Current" (4882)
26 25 and 17 (2483)
27 emissions/ (7842)
28 carbon/ or carbon sequestration/ or net ecosystem carbon balance/ (61505)
29 climate change/ or global warming/ or greenhouse effect/ (33283)
30 (emission* or climate change* or (greenhouse adj1 (effect* or gas*)) or global warming or carbon sequest*).ti,ab. (116942)
31 27 or 28 or 29 or 30 (169679)
32 3 and 6 and 7 and 31 (1613)

33 limit 32 to yr="1990 -Current" (1610)
34 33 and 17 (771)
35 3 and 6 and 7 (15865)
36 limit 35 to yr="1990 -Current" (15650)
37 3 and 6 and 7 and 17 (7977)
38 limit 37 to yr="1990 -Current" (7873)
Filters for low and-middle income countries (LMIC) and study designs were set across all the seven databases.

B.3 Reference management

The online literature review and reference management software, Endnote and EPPI-Reviewer 4, were used to upload relevant titles and abstracts for candidate studies identified through the search strategy. A project workspace was established to assist the research team in organising and managing the sources of evidence (i.e. where possible studies were located) and the screening process.

B.4 Data extraction

We used a standardised data extract form to extract descriptive data from all studies meeting our inclusion criteria. Data extracted from each study include bibliographic details, intervention type, outcome type and definition, study design, geographical location and scale.

Appendix C: Coding questionnaire

	No	ID	Question	Description
1. Publication details	1.1	Id	Unique study identifier	Surname of first author followed by year identifier, e.g. xyz *et al.* 2006
	1.2	Authors	Full list of author surnames	E.g. Chahar, Lala, Waddington
	1.3	Date	Publication date	Year (NS= Not specified)
	1.4	Title	Full title	E.g. "Impact of community health workers on immunisation".
2. Intervention details	2.1	Location	Name of the country	Note the countries in which evidence is collected.
3. Study design	3.1	Counterfactual _evaluation	Categorise the type of counterfactual evidence collected (if relevant).	1.1= Experimental impact evaluation using randomised assignment to allocate groups or individuals to a treatment and a control (randomised controlled trial, RCT)
				1.2= Impact evaluation using quasi-experimental methods to compare a treatment and control group (e.g. difference-in-difference with matching, propensity score matching, instrumental variables)
				1.3= Other (Other forms of Matching)
				NA= Not applicable
4. Interventions	4.1	Interventions	Categorise the intervention being observed or specify and put into other section if it does not	Education and awareness campaigns Training communities

	fall into the existing categories	Technology Decentralised forest management PES Protected areas Agroforestry Policy regulating mechanisms Subsidies and concessions National forest programmes (multi-pronged) Forest enterprises Forest certification and public disclosure Trade laws and management International policy adoption REDD and REDD+ Climate change-specific conservation programmes

5. Final outcomes	5.1	Outcomes	Categorise the outcome being measured or specify and put into other section if it does not fall into the existing categories	Knowledge Behaviour change and adoption Population/species diversity Supporting services (nutrient cycling, primary production, soil formation) Provisioning services (raw materials) Regulating services (carbon sequestration, Greenhouse gas emission, water and air purification, disease control) Forest cover and condition Ecological foot-printing Cultural services (tourism, recreation, spiritual, historical, research and development. aesthetic value) Livelihoods, employment Income, poverty Decision-making Health Education Food security Transparency and accountability Cost-effectiveness

Appendix D: Bibliography of impact evaluations and systematic reviews included in the evidence gap map

Admasu, B., Jema, H., Chisholm, N. and Enright, P., 2013. Impact of protected forests on rural households' fuel tree planting in Chiro district, eastern Ethiopia. *International Forestry Review*, 15(1), pp.18–32.

Adrianzén, M.A., 2013. Improved cooking stoves and firewood consumption: Quasi-experimental evidence from the Northern Peruvian Andes. *Ecological Economics*, 89, pp.135–143.

Alix-Garcia, J., Aronson, G., Radeloff, V., Ramirez-Reyes, C., Shapiro, E., Sims, K. and Yañez-Pagans, P., 2014. Environmental and socioeconomic impacts of Mexico's payments for ecosystem services program. Available at http://finesse.nara.com.mx/sites/default/files/11.%20Environmental%20and%20Socioeconomic%20Impacts.pdf

Alix-Garcia, J., McIntosh, C., Sims, K.R. and Welch, J.R., 2013. The ecological footprint of poverty alleviation: evidence from Mexico's Oportunidades program. *Review of Economics and Statistics*, 95(2), pp.417–35.

Alix-Garcia, J.M., Shapiro, E.N. and Sims, K.R., 2010. The environmental effectiveness of payments for ecosystem services in Mexico: Preliminary lessons for REDD. Unpublished Manuscript. Draft available at URL: http://www.aae.wisc.edu/events/papers/devecon/2010/alix-garcia.05.06.pdf

Alix-Garcia, J.M., Shapiro, E.N. and Sims, K.R., 2012. Forest conservation and slippage: Evidence from Mexico's national payments for ecosystem services program. *Land Economics*, 88(4), pp.613–38.Ameha, A., Nielsen, O.J. and Larsen, H.O., 2014. Impacts of access and benefit sharing on livelihoods and forest: Case of participatory forest management in Ethiopia. *Ecological Economics*, 97, pp.162–71.

Andam, K.S., Ferraro, P.J. and Hanauer, M.M., 2013. The effects of protected area systems on ecosystem restoration: a quasi-experimental design to estimate the impact of Costa Rica's protected area system on forest regrowth. *Conservation Letters*, 6(5), pp.317–23.

Andam, K.S., Ferraro, P.J., Pfaff, A.S. and Sánchez-Azofeifa, G.A., 2007. *Protected areas and avoided deforestation: a statistical evaluation*. Final report. Global Environment Facility Evaluation Office, Washington, DC.

Andam, K.S., Ferraro, P.J., Pfaff, A., Sánchez-Azofeifa, G.A. and Robalino, J.A., 2008. Measuring the effectiveness of protected area networks in reducing deforestation. *Proceedings of the National Academy of Sciences*, 105(42), pp.16,089–94.

Andam, K.S., Ferraro, P.J., Sims, K.R., Healy, A. and Holland, M.B., 2010. Protected areas reduced poverty in Costa Rica and Thailand. *Proceedings of the National Academy of Sciences*, 107(22), pp.9,996–10,001.

Arriagada, R.A., 2008. Private provision of public goods: applying matching methods to evaluate payments for ecosystem services in Costa Rica. [online]. Available at: http://search.proquest.com/docview/304534567?accountid=10598

Arriagada, P., Ferraro, J., Erin, S., Pattanayak, S.K. and Cordero, S., Forthcoming. Do payments for environmental services reduce deforestation? A farm-level evaluation from Costa Rica. *Land Economics*, *88*.

Arriagada, R.A., Sills, E.O., Pattanayak, S.K. and Ferraro, P.J., 2009. Combining qualitative and quantitative methods to evaluate participation in Costa Rica's program of payments for environmental services. *Journal of Sustainable Forestry*, 28(3–5), pp.343–67.

Baland, J.M., Bardhan, P., Das, S. and Mookherjee, D., 2010. Forests to the people: Decentralization and forest degradation in the Indian Himalayas. *World Development*, 38(11), pp.1,642–56.

Bandyopadhyay, S., Humavindu, M., Shyamsundar, P. and Wang, L., 2009. Benefits to local communities from community conservancies in Namibia: an assessment. *Development Southern Africa*, 26(5), pp.733–54.

Bandyopadhyay, S. and Shyamsundar, P., 2004. Fuelwood consumption and participation in community forestry in India. Policy Research Working Paper 3331. Washington DC: World Bank

Bauch, S.C., Birkenbach, A.M., Pattanayak, S.K. and Sills, E.O., 2015. Public health impacts of ecosystem change in the Brazilian Amazon. *Proceedings of the National Academy of Sciences*, 112(24), pp.7,414–9.

Bauch, S.C., Sills, E.O. and Pattanayak, S.K., 2014. Have we managed to integrate conservation and development? ICDP impacts in the Brazilian Amazon. *World Development*, 64, pp.S135–S148.

Beresford, A.E., Eshiamwata, G.W., Donald, P.F., Balmford, A., Bertzky, B., Brink, A.B., Fishpool, L.D., Mayaux, P., Phalan, B., Simonetti, D. and Buchanan, G.M., 2013. Protection reduces loss of natural land-cover at sites of conservation importance across Africa. *PLoS One*, 8(5), e65370.

Blackman, A., 2015. Strict versus mixed-use protected areas: Guatemala's Maya Biosphere Reserve. *Ecological Economics*, 112, pp.14–24.

Blackman, A., Pfaff, A. and Robalino, J., 2015. Paper park performance: Mexico's natural protected areas in the 1990s. *Global Environmental Change*, 31, pp.50–61.

Blomley, T., Pfliegner, K., Isango, J., Zahabu, E., Ahrends, A. and Burgess, N., 2008. Seeing the wood for the trees: an assessment of the impact of participatory forest management on forest condition in Tanzania. *Oryx*, 42(03), pp.380–91.

Börner, J., Kis-Katos, K., Hargrave, J. and König, K., 2015. Post-crackdown effectiveness of field-based forest law enforcement in the Brazilian Amazon. *PloS One*, 10(4), e0121544.

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This evidence gap map presents available high-quality evidence in the area of forest conservation. The mapping team used a systematic search strategy across multiple databases to find the existing stock of rigorous forest conservation sector evidence in low- and middle-income countries. The evidence gap map shows that there is little or no high-quality evidence in areas significant for policy, such as the effect of forest-related climate change policies, trade laws and management, or education and awareness campaigns on environmental and social outcomes in forests. There is a paucity of high-quality evidence on the impacts of forest conservation interventions on transparency and accountability, biodiversity, knowledge and behaviour change, supporting services and cultural services.

Evidence Gap Map Report Series

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