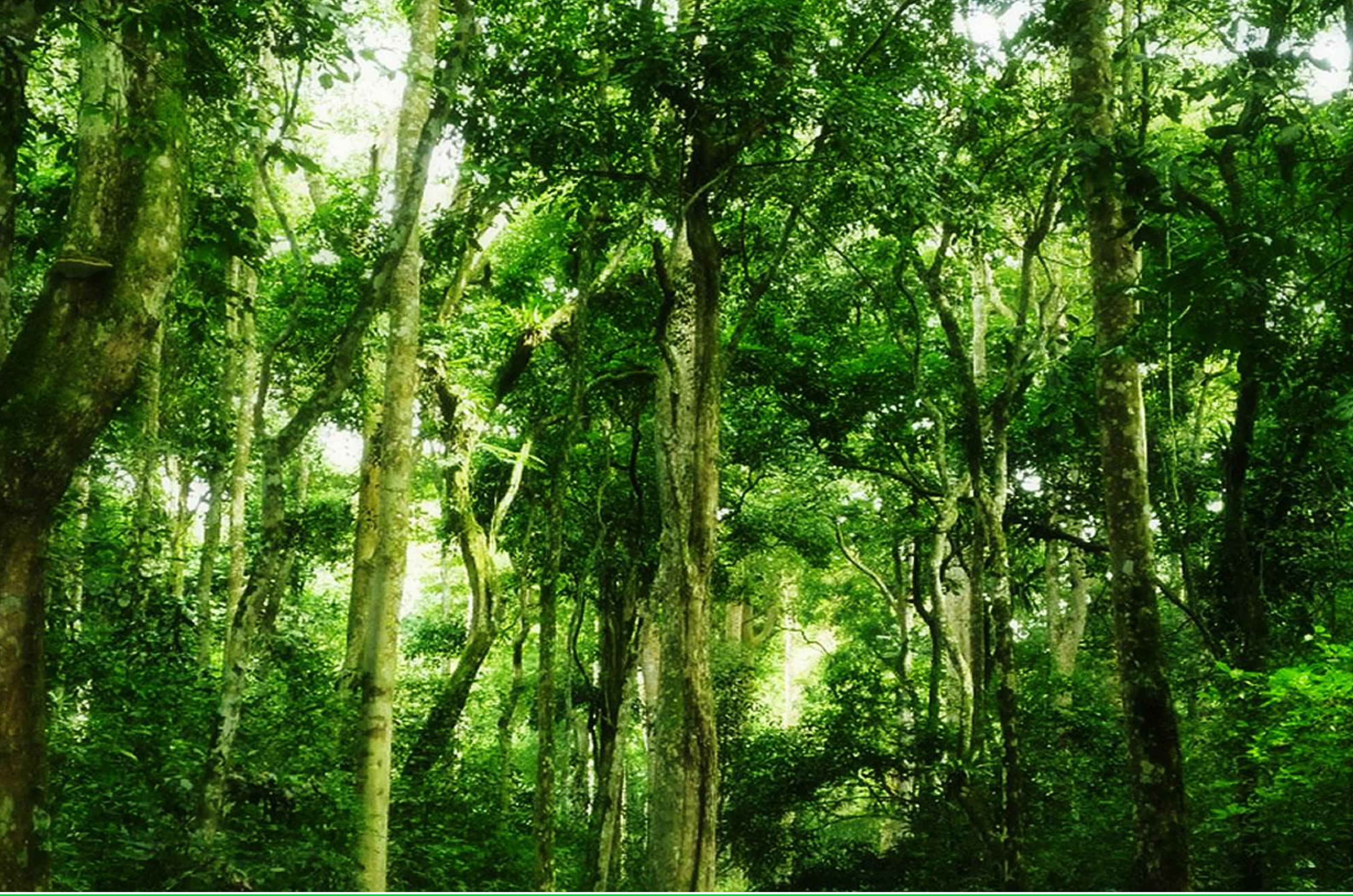

Environmental Impacts of Sustainable Forest Management

Two Systematic Literature Reviews of Scientific Research on the Environmental Impacts of Forest Certifications and Community Forest Management at Global Scale

Master Thesis - FNP80436

Forest and Nature Conservation Policy Group

Wageningen University & Research

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ABSTRACT

Forest Certifications and Community Forest Management are two major forest governance interventions whose aim is to reverse forest degradation and deforestation, while providing socio-economic benefits to the people involved. Despite being applied for more than a quarter of a century, there is a dearth of scientific evidence on the environmental impacts, in the long- and short-term, that these governance interventions have on the ground. Evidence is also needed to elucidate on the governance mechanisms and contextual factors that facilitate the achievements of positive impacts, and to do so by using a theory of change with assumptions specified. To fill this knowledge gap, I conducted two systematic literature reviews comprising sixty five publications in total, which collectively cover a total forest area of around 19 million ha. Out of the publications included only thirteen methodologically rigorous publications could be identified. The evidence of the reported environmental impacts of both Forest Certifications and Community Forest Management shows clear trends towards (strong) positive impacts on the ground, with only six studies reporting no impact, and only two studies, concerning Forest Certifications, reporting negative impacts. However, given the small sample of the publications, I cannot make strong generalizing statements about the impacts that these interventions actually have on the ground. Moreover, both systematic literature reviews highlighted serious evidence gaps concerning the impacts that both forest governance interventions have on Fauna, and Ecosystem Services.

By applying the theoretical framework of "institutions","incentives," and "information" of forest governance interventions of Agrawal and colleagues, I was able to identify the main governance mechanisms that are most associated with (strong) positive impacts. From the systematic literature review on Forest Certifications, "institutions" stood out as being critical for the effectiveness of this intervention, while for Community Forest Management the combination of the three mechanisms is indeed necessary to have positive impacts on the ground. As far as contextual factors are concerned, the political context where forest certifications are being implemented emerged as one important enabling factor for achieving positive impacts, together with the biophysical characteristics of the forests. For community forest management a combination of contextual factors, already identified by the work of IFRI (2015), enables positive impacts in CFM, namely biophysical factors of the forests, user group characteristics, demographic conditions, and history. This thesis is only the second systematic literature review that compares Forest Certifications with Community Forest Management, and it is the only scientific work that uses a theory of change with assumptions specified, to map with what mechanisms and under what contextual factors they achieve (strong) positive impacts on the ground. Because of this, this thesis not only adds to the growing body of impact evaluations in the forest conservation field, but also answers to the multiple calls for rigorous impact evaluations, that use an explicit causal model to be tested.

Keywords: Systematic Literature Review; Forest Certifications; Community Forest Management; Forest Governance Mechanisms; Theory-based Impact Evaluations

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Abbreviations

SLR	Systematic Literature Review
FCs	Forest Certifications
CFM	Community Forest Management
FSC	Forest Stewardship Council
PEFC	Programme for the Endorsement of Forest Certifications

Introduction

Introduction

1.1 Background Information

According to the Food and Agriculture Organization, the annual rate of global net forest loss decreased from 7.3 million hectares in 1990 to 3.3 million hectares in 2015 (FAO, SOFO 2016). Despite the positive results, deforestation as well as forest degradation[1] are still massive problems that need to be solved (IUCN, 2018). The failure to do so will increase the vulnerability of around 1.6 billion of people who depend on forests to varying degrees (Chao, 2012), including 90% of people living in extreme poverty (OECD, 2009). Forests are also major carbon sinks storing approximately 2.4 billion tonnes of CO2 annually, 77% of which is stored in the vegetation, and 39% in the soils (CIFOR, 2012). Their role in mitigating climate change would save around 3.7 trillion dollars, globally, between 2010 and 2200 (FAO, 2011). Besides storing carbon, forests are critically important for the provision of other ecosystem services, such as the regulation of watershed services, the conservation of soils, the prevention of land degradation and desertification, and disaster risk reduction (Jenkins and Schaap, 2018). Deforestation and forest degradation also pose serious threats to the conservation of biodiversity. Hosting 80% of terrestrial biodiversity, the protection of forests is paramount in preventing dramatic consequences for the economies, livelihoods, and food security of people around the globe (IPBES, 2018).

Over the years, there have been numerous international policy reactions to address forest loss and its detrimental consequences. Examples of these include the three Rio conventions from the Earth Summit in 1992 (Convention on Biological Diversity, United Nations Convention to Combat Desertification, and the United Nations Framework Convention on Climate Change); The Non Legally Binding Instrument on All Types of Forests comprising the four Global Objectives on Forests, agreed by the UN Forum on Forests in 2007; The International Tropical Timber Agreement; The European Union initiative on Forest Law Enforcement, Governance, and Trade (FLEGT); and the United Nations programme for Reducing Emissions from Deforestation and forest Degradation, plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks (REDD+). These types of policy reactions, defined as forest and environmental governance (Lemos and Agrawal 2006; Arts et al., 2013), involve not only national governments and their jurisdiction, but also non-state actors, international organizations, and voluntary instruments (Arts et al., 2013). On a transnational level, three types of forest governance interventions are particularly prominent: The role of logging companies that adopt selective logging in forest concessions in the tropics, community forest management, especially in developing countries, and market-based certifications, mostly in developed countries (Agrawal et al., 2013). This thesis will focus only on community forest management, and forest certifications.

This choice is based on two main arguments: First, community forest management and forest certifications are two different types of forest governance interventions, that work with different mechanisms, and with different actors, but share the same goals of improving forest conditions, preserving biodiversity and ecosystem services, and enhancing the socio-economic position of the people involved. Such is different for logging concessions where the attention is more on profits for logging companies and centralized

[1] Forest degradation is defined here according to the IUFRO (2000) definition: "Forest degradation is damage to the chemical, biological and/or physical structure of a soil (soil degradation) and to the forest itself (forest degradation), as a result of incorrect use or management, and which, if not ameliorated, will reduce or destroy the production potential of a forest ecosystem (in perpetuity)" (FAO, 2011).

governments, and less on the protection of biodiversity, ecosystem services, and the human rights of workers and local communities, especially in the Tropics (Hensbergen, 2018).
Second, although I recognize that logging concessions would be a relevant forest governance intervention to explore, this thesis is part of a broader project on the Impact of International Cooperative Initiatives on Biodiversity (ICIBs) carried out by the Forest and Nature Conservation Policy group (FNP) of my University, and the Netherlands Environmental Assessment Agency (PBL). While community forest management and voluntary sustainability standards (VSSs) are the subjects of this broader project, logging concessions are not, hence they are excluded from my thesis.

Forest certifications are a form of non-state market-driven governance developed at the beginning of the 90's. They were developed as a response to the failure of the Earth Summit in Rio in 1992 to agree upon a global forest convention, and as a reaction to the inefficiency of the International Tropical Timber Organization (ITTO) to encourage a sound approach for sustainable forest management (Cashore and van der Ven, 2018; Kraxner et al., 2017). Since then, forest certification schemes have been supported by environmental non-governmental organizations (ENGO's), varying timber producers, and environmentalists, as a way to halt deforestation, forest degradation, and preserve biodiversity (Rametsteiner and Simula, 2003; Kraxner et al., 2017; Cashore and van de Ven, 2018). The two main certifications schemes are the Forest Stewardship Council (FSC) established in 1993, and the Programme for the Endorsement of Forest Certification (PEFC) created in 1999. Both certifications aim at providing environmental, social and economic benefits for forest owners and timber companies that choose to be certified. Both schemes aim at implementing sustainable forest management and measuring its performance, based on a given set of criteria and indicators, principally developed at the national level (Rametsteiner and Simula, 2003). Currently, 432.5 million hectares are certified by either FSC or PEFC, accounting for 11% of the global forest area (UNECE/FAO, 2016), and 71.1 million hectares, globally, are double certified (FSC and PEFC, 2017). Around 90% of the global certified area is located in the boreal and temperate biome, and only 10% is in the tropical one (Kraxner et al., 2017). Forest certifications contribute to the achievement of three Sustainable Development Goals, namely Goal 8 Decent Work and Economic Growth; Goal 12 Responsible Consumption and Production; and Goal 15 Life on Land (FAO, SFM ToolBox).

Community forest management is a form of decentralized governance that can be defined as "the use, the management and conservation of forests by communities" (Arts and de Koning, 2017, p.315). The definition of community forest management comprises mainly five different spectrum of regimes, depending on the tenure rights of the stakeholders (FAO, 2016). When communities passively participate in government programmes, this type of management is defined as participatory conservation, whereas when communities have the complete control over their natural resources, it is defined as private ownership, or smallholder forestry. In between, the spectrum includes joint forest management, and community forestry, whether it is limited devolution of tenure rights, or full devolution (Ibidem). Community forest management developed during the 1970's and 1980's as a reaction to the inability of governments to halt forest degradation and deforestation, and to their inability to improve the livelihoods of the communities living in and around forests (FAO,2016). Local communities, including indigenous people, demanded a more central role in the use of natural resources, as a response to coercive conservation and colonial state forestry (Saunders, 2014). Their importance in the sustainable management of natural resources has been increasingly recognized by decision-makers and academics (e.g., Agrawal and Ostrom, 2001). So much so that in 2007, their fundamental rights to exert control over their lands was enshrined in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) (FAO,2016). Nowadays, community forest management is a prominent approach in forest management, particularly in the Tropics (Arts et al., 2017). On a global level, around 732 million hectares are currently being managed under this regime (FAO, 2016), which is approximately 22.7% of the global forest area More specifically, the goals of community forest management are threefold: First, to decrease the poverty level of the communities involved; Second, to empower them; Third, to enhance and preserve forests (Maryudi et al., 2012). In doing so, community forest management supports the achievement of the Sustainable Development Goals, in particular Goal 15 Life on Land, as well as Goal 1 No Poverty, Goal 5 Gender Equality, Goal 10 Reduced Inequalities, Goal 16 Peace, Justice, and Strong Institutions, and Goal 12 Responsible Consumption and Production (FAO, SFM Toolbox).

1.2 Problem statement and objective

Despite the fact that both forest certifications and community forest management have been applied for more than a quarter of a century, there is a dearth of scientific evidence on the environmental impacts, in the long- and short-term, that these governance interventions have on the ground (Burivalova et al., 2017; Romero et al., 2013; Kraxner et al., 2017; Bowler et al., 2012; Lund et al., 2014; Cashore and van de Ven, 2018; Baylis et al., 2016).

Both scientific literatures lack rigorous studies that allow for establishing whether the observed changes can be ascribed to the governance intervention, or if they are simply correlated to it. The existing evidence is derived mainly from case studies that describe the changes that occurred once the intervention has been implemented; very few studies use a control group, or take confounding factors into account; and even fewer studies measure the outcomes over the long term (Burivalova et al., 2017; Lund et al., 2014; Bowler et al., 2012). The main difficulties of doing an impact evaluation are due to a lack of trustworthy and standardized data, moreover, comparisons on a global level are hindered by the lack of standardized indicators and different units of measurements (Cashore and van de Ven, 2018). Indeed, forest certifications standards change over time, as well as community forest management research approaches, making the long-term impact evaluations a daunting task (Ibidem). Last but not least, these types of evaluations are expensive and time-consuming, and there are few scientists who are trained in both conservation science and environmental impact evaluations (Romero et al., 2013).

It is critically important to provide donor agencies, governments, international organizations, and academics, transparent, rigorous, and reliable evidence (Ferraro and Pattanayak, 2006) on the impacts of both forest certifications, and community forest management. These types of empirical evidence can help to halt deforestation and forest degradation, as well as promote the conservation of biodiversity, by steering funding, influencing policy decision-making, and supporting a more effective and efficient governance intervention. Therefore, it is crucial to investigate what are the environmental impacts that these interventions have on the ground; and to what degree these environmental impacts are positive, negative, or neutral (i.e., no impacts) (Puri et al., 2016). Moreover, it is important to investigate what the mechanisms, and contextual factors are that contribute to the impacts of both forest certifications, and community forest management, and to do so by using a theory of change with assumptions specified (Miteva et al., 2012; Romero and Putz, 2018). Finally, insights are also needed to investigate how the environmental impacts of forest certifications compare with the environmental impacts of community forest management, and vice versa (Romero et al., 2013; Baylis et al., 2016).

This thesis aims to fill this knowledge gap by providing a detailed synthesis of the existing empirical evidence on the environmental impacts of forest certifications, and community forest management on a global scale. Namely, the research questions are:

1) What are the environmental impacts of Forest Certifications and Community Forest Management at global scale, as reported in the academic literature?

2) What are the governance mechanisms and contextual factors identified in the academic literature that facilitate the achievement of positive impacts?

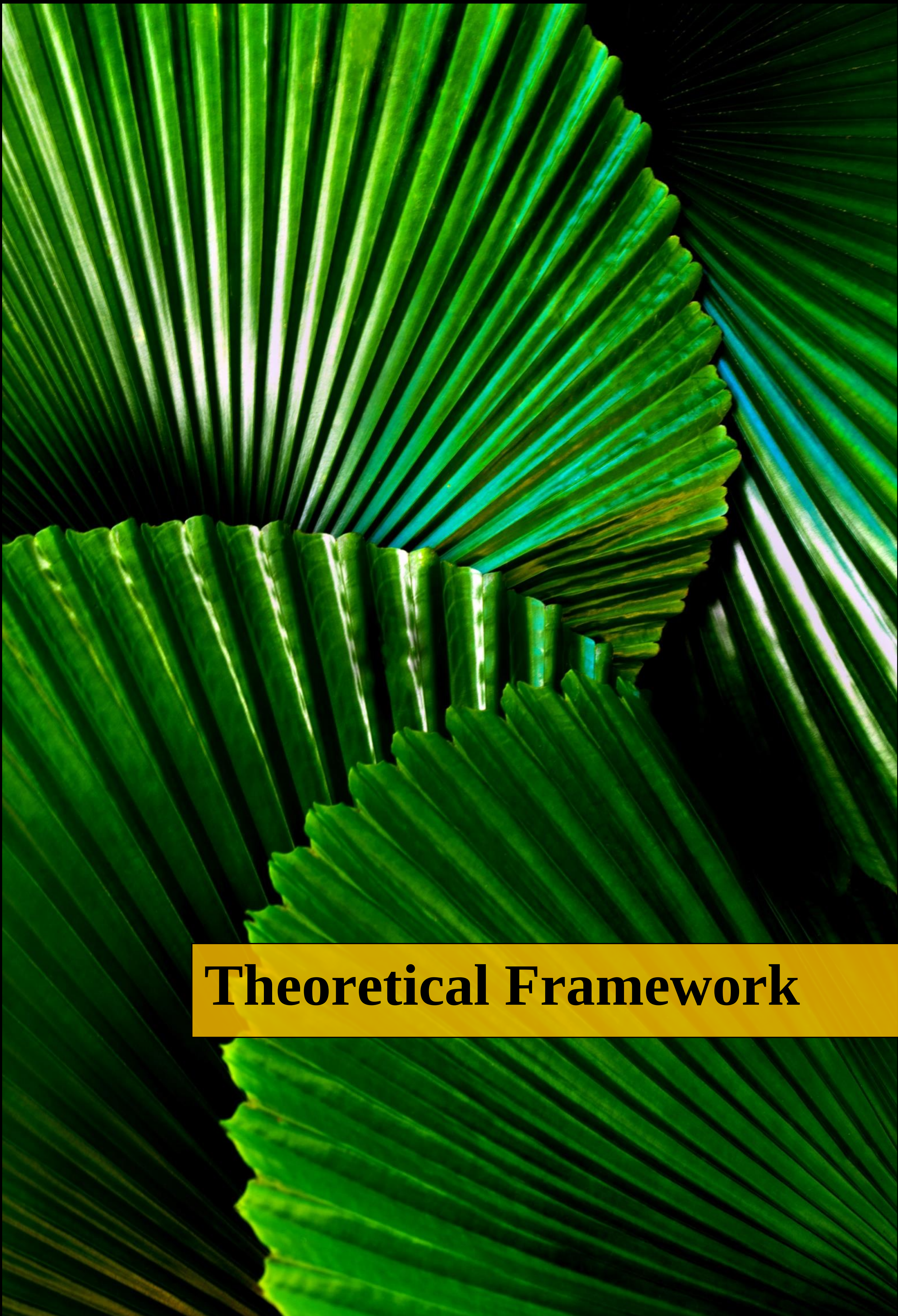
3) How do these environmental impacts compare between the two forest governance interventions analyzed?

To answer to these research questions, I systematically reviewed sixty five publications in total, which investigated the environmental impacts of forest certifications and community forest management around the globe. Collectively, these publications analyzed a total forest area of 19,051,717.74 ha. The scientific and social relevance of the results that I am going to present is threefold:

First, this thesis will provide policy-makers, international donors, and academics, with evidence-based evaluations on the environmental impacts that both interventions have on the ground. This type of information can improve forest governance by drawing lessons from failure and success cases, and it can help to increase sustainable forest management across the globe.

Second, by examining what the governance mechanisms and contextual factors are that promote the achievements of positive impacts, and doing so by using theories of change with assumptions specified, this thesis will answer to urgent calls for impact evaluations in the forest conservation field (Ferraro and Pattanayak, 2006; Miteva et al., 2012; Pullin et al., 2004; Pullin et al., 2003; Sutherland et al., 2004) where is critical to understand how, why, and under what circumstances conservation policies work or do not work. This type of information will in turn make sure that "scarce funds go as far as possible in achieving conservation outcomes" (Ferraro & Pattanayak, 2006, p. 0482), and promote social learning and adaptive management (Belcher et al., 2017; Romero et al:, 2017).

Third, the comparison between the environmental impacts of forest certifications and community forest management is critical to highlight potential synergies among these two interventions (Romero et al., 2017; Romero et al., 2013; Baylis et al., 2016), which share the same goals of halting forest degradation and deforestation, and promote the conservation of biodiversity and ecosystem services.



Theoretical Framework

Theoretical Framework

This thesis focuses on two transnational forest governance interventions: Forest Certifications and Community Forest Management. One useful theoretical framework to analyze how these two forest governance interventions achieve their expected positive impacts, it is the conceptual scheme of Agrawal et al. (2018) that identifies three main mechanisms pertaining to a forest governance intervention, which influence forest-livelihood processes and socio-ecological outcomes. These three mechanisms are "incentives", "information", and "institutions". While these are all important elements in a forest governance intervention, they are not the only ones that influence the final impacts, in fact, contextual factors have a role as well. In order to analyze the complete causal pathway towards the impacts of forest certifications and community forest management, I will use the theory of change framework with assumptions specified.

This chapter is organized as follows: First, I introduce the framework of global governance to provide the theoretical context of global forest governance, and to explain its main features. Second, I present the conceptual scheme that Agrawal et al.(2018) used to identify what the key mechanisms of a forest governance intervention are, and I explain how these mechanisms work in forest certifications and community forest management. Third, to map the causal pathways of Forest Certifications and Community Forest Management towards their intended environmental impacts, I propose two theories of change (one for each intervention), that will be eventually tested against the final results.

2.1 Global Governance

Governance and Government are two different concepts. Etymologically, the word Governance derives from the ancient Greek verb *kybernein* (infinitive) or *kybernao* (first person), which means to steer or to guide (Campbell and Carayannis, 2012). Used for the first time by Plato to describe the process of governing men (Ibidem), nowadays this concept embraces a more extensive and general meaning. Governance comprises not just the actions of the State, but also those of non-state actors (NSAs) such as: Non-governmental organizations (NGOs), Intergovernmental Organizations (IGOs), transnational corporations, community-based organizations, and epistemic communities (a transnational network of knowledge-based experts) (Lemos and Agrawal, 2006). These actors operate with different mechanisms usually associated with the command-and-control, top-down approaches typical of nation-states. Such mechanisms include, but are not limited to, business self-regulation, public-private partnerships, and social partnerships. From the perspective of international relations theory, governance is conceived as global governance. Rosenau refers to it as "Systems of rule at all levels of human activity - from the family to the international organization- in which the pursuit of goals through the exercise of control has transnational repercussions" (Rosenau, 1995 in Dingwerth and Pattberg 2006, p. 189).

In particular, this concept diverges from the international relations scholarship in four ways (Dingwerth and Pattberg 2006): First, global governance acknowledges non-state actors being as equally important in the international arena as the nation states, depicting in this way a multi-actor perspective on the global polity. Second, global governance investigates international processes with a multi-level viewpoint, where the global, regional, national, and local levels of political dynamics are deeply connected, and they influence each other. In other words, this perspective, generally defined as "multilevel governance", analyses how ideas and practices in international forums shape and are shaped by ideas and practices in regional, national, and local contexts. Third, global governance recognizes that there are multiple mechanisms that influence other actors' actions, other than power, central authority, laws and sanctions, and it is almost impossible to identify a hierarchy among them. Such mechanisms are instruments of soft law, namely international agreements, recommendations, criteria and indicators, programs of actions, declarations, resolutions of international organizations, and codes of conduct, just to name a few (Arts et al., 2016; Shelton 2008). Fourth, as Dingwerth and Pattberg wrote "The core of the global governance argument concerns the acquisition of authoritative decision-making capacity by non-state and supra-state actors" (Dingwerth and Pattberg 2006, p. 193). This means that, for instance, NGOs can actively contribute to debates and programmes in the field of local development, environmental protection, and education; private audit companies can verify the compliance with international standards, and so on.

In its broad conceptualization, global governance thus refers to the act of governing by, with, or without the state (Arts, 2014). However, whether the state is indeed excluded from some type of governing practices is a point of debate. According to some scholars, the authority and the power of the nation-state is just shifted to a higher level towards intergovernmental organisations; to a lower level towards subnational authorities, including local communities; and towards other forms of authority such as private markets, and semi-public bodies (Arts et al., 2014).

2.2 Global Forest Governance

Historically, forests have been managed by the state with a central, top-down regulatory approach. However, in many cases, this approach largely failed to conserve and manage forest resources sustainably. The state itself largely depleted forest resources, it favored illegal activities by neglecting to enforce monitoring mechanisms and, in other circumstances, it was largely absent in forest areas, especially the most remote ones, allowing any type of use of forest resources (Arts et al., 2016). This situation lead to deforestation, forest degradation, and impressive loss of biodiversity, which in turn sparked protests and movements of NGOs, local communities and indigenous people, epistemic networks, and international donors all around the globe. What resulted from these global protests was the creation of a "multi-level, multi-actor, non-hierarchical, and information-rich forest governance" (Lemos and Agrawal, 2006, p. 301). This type of governance fostered, on the one hand, the decentralization of forest management, especially through community forest management and, on the other hand, the development of private, or non-state, market-driven mechanisms, in particular forest certifications (Ibidem), both the subject of this thesis.

Decentralization implies the transfer of administration tasks and/or political authority from the state to subnational institutions (Arts et al., 2014). In community forest management, the central state can be still in charge (e.g., participatory forest management, joint forest management, and community forestry with only partial devolution of tenure rights), or it can be absent (e.g., private ownership or smallholder forestry). Generally, the goal of decentralized forest governance is threefold: First, increase the efficiency of forest policies; second, increase accountability and community participation in decision-making processes; and third, take decisions that are more suitable for local natural resources (Lemos and Agrawal, 2006).

In non-state market driven governance, the decision making authority is shared among the business sector, environmental NGOs, corporations, and other transnational groups (Auld et al., 2014). Specifically in forest certifications, the development of rules and the verification of their compliance are done by formal institutions. Formal institutions in charge of creating and revising the certification standards are "the International Organization for Standardization (ISO), the ISEAL Alliance, and other meta-governance organizations" (van der Ven and Cashore, 2018, p. 105). Formal institutions in charge of verifying the compliance with the certifications standards are third party auditors that can assign Corrective Action

Requests (CARs) or even withdraw the certified status, when companies completely fail to respect the certifications requirements. However, Forest Certifications also comprise informal institutions. According to van der Ven and Cashore (2018), these are social values and norms that push business companies to be certified. When these norms and values are violated, companies may be "sanctioned" with boycotting campaigns created by the civil society and environmental NGOs (Ibidem). This type of non-state market driven governance is open, inclusive, transparent and dynamic compared to other forms of governance (Cashore et al., 2007). Although the state authority is absent, it can still play a role in defining national rules and norms that may influence market-driven dynamics, and it can foresee subsidies and tax exemptions for certified forest owners (Auld et al., 2009, Cashore, 2002; Arts et al., 2014).

Despite being two very different types of forest governance interventions, both forest certifications and community forest management comprise three specific mechanisms whose aim is to change business-as-usual outcomes, improve forest condition, protect biodiversity and ecosystem services, and provide socio-economic benefits. Such mechanisms are "information", "incentives", and "institutions" (Agrawal et al., 2018) (Figure 1).

Generally, every forest governance intervention is designed by policy-makers with a combination of these three mechanisms, depending on what is the precise goals that the intervention has to achieve. For instance:

"Information" is essential in all those governance interventions where raising awareness is necessary to reverse unsustainable practices. Examples of these interventions are campaigns in support of indigenous and community land rights, campaigns on sustainably sourced timber, and zero-deforestation initiatives for forest products value chains. Such interventions sensitize citizens, encourage consumers to buy responsibly produced commodities, and incite producers to adopt sustainability standards.

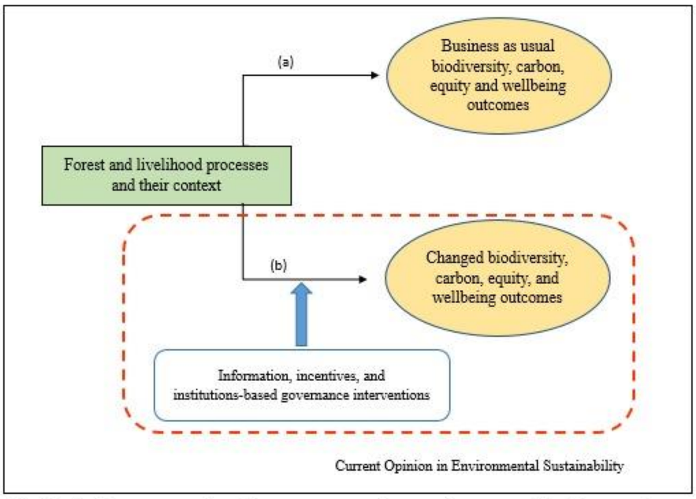


Fig. 1 Basic representation of how governance interventions may affect forest and livelihood processes and socio-ecological outcomes. ***Source***: Agrawal et al., 2018, p. A3

"Incentives" are essential when producers and consumers are in favour of sustainable practices but these practices are too expensive, and therefore governments and private organizations provide incentives to support the transition towards more environmentally friendly goods and services. Examples of these interventions are payments for ecosystem services, price premiums and improved market access by investing in forest certifications, and the acquisition of lands for conservation purposes.

"Institutions" and their power to control and sanction are obviously a critical means to achieve positive results. "Institutions" here are not just governments, but also non-state actors (e.g., NGOs, third-party auditors, and meta-governance institutions), norms and social sanctions. Governments can incarcerate citizens who use forest resources illegally, as well as third-party auditors can assign Corrective Actions Requests (CARs) or even withdraw the certification status to forest companies that are not compliant with the standards; and NGOs can push business companies with naming-and-shaming campaigns to adopt more eco-friendly practices.

The majority of forest governance interventions are indeed a hybrid result of these three mechanisms. Forest certifications and community forest management use the same mechanisms to foster the effectiveness of their intervention, albeit to different extents (Figure 2).

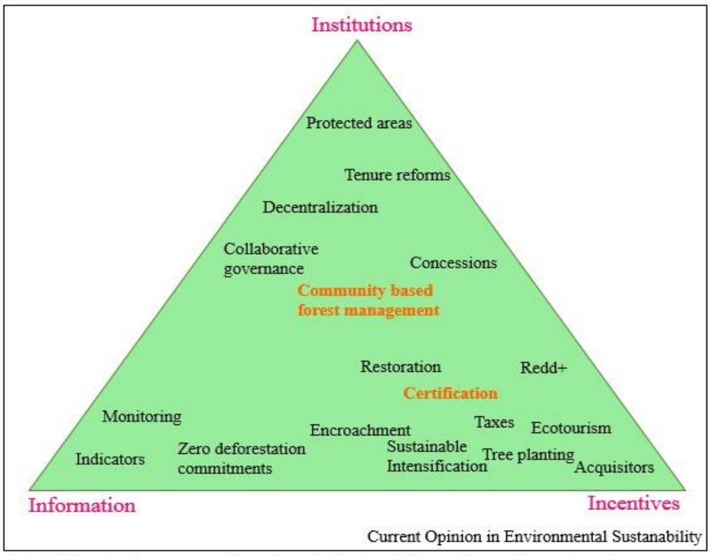


Fig. 2 Triangle of governance dimensions: Institutions, Information, and Incentives. ***Source:*** Agrawal et al., 2018, p. A5

In forest certifications, “institutions” comprise actors that create and revise certification standards, as well as actors that monitor the compliance of forest companies to those standards. “Incentives” are mainly conceived as market incentives, such as price premium, increased market access, exposure to new clients, and improved reputation. “Information” is used in the form of marketing and advocacy campaigns to sensitize citizens on the importance of buying products that are responsibly made, and it is used in the form of standards and guidance documents, in order to improve the forest management practices of logging companies and forest owners.

In community forest management, “institutions” are responsible for the total or partial devolution of tenure rights, for the development of rules that are easy to understand and enforce, and for the inclusion of the local community in the rule-making process. “Incentives” are used both for the central state, and for the local communities. While for the central state, community forest management can be a means to decrease the financial burden of managing forest resources, for the local communities it is a way to be included in the rule-making process, it is a way to use their knowledge to manage forest resources, and it is a way to improve their livelihoods. “Information” is principally conceived as knowledge: the knowledge that the community have about their forest, and the knowledge that they obtain and exchange with capacity building activities organized by NGOs.

Despite being applied for more than two decades, it is still uncertain as to whether forest certifications and community forest management are actually effective in achieving positive impacts on the ground. Because of that, over the years there have been numerous calls for impact evaluations that would, first, establish if the interventions work and, second, that would use causal frameworks (i.e. theories of change) in order to elucidate what are the causal pathways of these interventions, and with what governance mechanisms and under what contextual factors they are more likely to be successful (Miteva et al., 2012; Collaboration for Environmental Evidence, 2013; Romero and Putz, 2018). This thesis aims, among other things, to be an answer to those calls and this is why in the next section I developed two theories of change (one for each intervention analyzed) that were eventually tested in the section dedicated to the results (Chapters 4 and 5).

.

2.3 Theory of Change

Developed in the 1960's (Vogel, 2012), the theory of change is currently a well-renowned approach to understand why a particular intervention worked or did not work, at what costs, with what mechanisms, under what contextual factors, and what were (if any) the synergies and trade-offs between those mechanisms and the contextual factors (Romero and Putz, 2018; Miteva et al., 2012; White, 2009). The theory of change enables the analysis, of "the assumptions underlying the causal chain from inputs, to outcomes, and impacts[2]" (White, 2009, p.3). The assumptions in a theory of change are needed to elucidate the necessary mechanisms in place for the intervention to work, to identify who are the stakeholders involved, and to define what the contextual factors are that might hamper or facilitate the achievements of positive impacts (UNEP, 2019). For this reason, the use of the theory of change is particularly suitable for impact evaluations (Romero and Putz, 2018; Vogel, 2012; Crosse et al., 2012). However, the theory of change can "reduce, but does not eliminate, problems associated with causal attribution of impact" (Crosse et al., 2012, p. 172). Indeed, establishing causality is a difficult task, especially when dealing with complex socio-ecological systems, where multiple factors can contribute to specific impacts. Still, the theory of change is essential for evaluating and improving the effectiveness of a governance intervention (Miteva et al., 2012), because it can increase the understanding of how, why, and under what contextual factors, the intervention works or not (Ibidem).

Based on the previous discussion, and in order to answer to the second research question "What are the governance mechanisms and contextual factors identified the academic literature that facilitate the achievement of positive impacts?", I am now going to present two theories of change - one for Forest Certifications and the other for Community Forest Management - to explore with what governance mechanisms and under what contextual factors, these two interventions are supposed to achieve their environmental and socio-economic impacts. For my thesis, however, I only focused on the environmental impacts (i.e., impacts on deforestation and forest degradation, and impacts on biodiversity and ecosystem services). The "institutions", "incentives", and "information" mechanisms of Forest Certifications and Community Forest Management are reported in the assumption sections of both theories of change, while contextual factors that may influence the intervention outcomes are gathered in a separate section.

Theories of change can differ from one another, depending on the level of the analysis, how detailed they are, and why they are being used (Vogels, 2012). The theories of change that I have developed should be considered as "high-level" theories of change (see Volgels, 2012), where changes from one stage to another (e.g., from output to outcome) are presented as macro-level changes, and the contextual factors presented are not linked to a specific country, region, or continent, but at global scale level. These theories were eventually tested and discussed against the final results obtained through the systematic literature reviews that I carried out to gather the evidence on the impacts of Forest Certifications and Community Forest Management.

[2] Inputs are the starting points (ideas, financial resources); outputs are the interventions that are created; outcomes are the environmental, social, and economic changes that occur as a consequence of the interventions; and impacts are the achievements of the interventions' goals (Arts et al., 2017; Crabb&Leroy, 2012).

a) Theory of change for Forest Certifications:

I developed the theory of change for forest certifications based on the description of the Forest Stewardship Council (FSC) and the Programme for Endorsement of Forest Certification schemes (PEFC) on their respective websites, and mostly based on the scientific research on non-state market-driven governance of Cashore (2002; Cashore et al., 2007; van der Ven and Cashore, 2018). The global theory of change of FSC also provided some useful direction (FSC, Theory of Change, 2018) (Figure3) .

According to van der Ven and Cashore (2018), “institutions”, “incentives”, and “information” have an essential role in the overall causal chain from inputs to impacts. First of all, non-state actors (in this case considered as formal institutions) are those responsible for the creation of the certification schemes. FSC was founded in 1993 in Toronto by 150 organizations operating in the environmental, human rights, and business sector (Arts, 2004), while PEFC was created in 1999 by the European landowner associations, as an alternative of FSC certification, especially for small and family forest owners (PEFC, 2018). In both forest certification schemes, principles, criteria, and indicators are developed by all the stakeholder members, in a process that is defined as “democratic, open, transparent, and participatory” (Cashore et al., 2007; FSC Theory of Change). These standards are periodically revised based on best practices indicated by meta-governance organizations. The legitimacy of both FSC and PEFC is ensured by accredited third-party auditors responsible for verifying the compliance with the standards on the ground (Cashore, 2002). “Incentives”, conceived mainly as market incentives, are an important factor for the uptake of forest certifications. However, without citizens being informed about the importance of buying goods that are sustainably produced, market incentives are not a sufficient factor for the success of forest certification schemes. Therefore, the “incentive” mechanism is heavily dependant on the “information” mechanism of forest certifications.

As contextual factors, the political context is relevant in countries with high corruption and weak governance, where the strict adherence to the rules demanded by forest certifications can generate conflicts between the local communities and the certified logging company, undermining any potential positive impacts of forest certifications (Cerutti et al., 2017). In countries where the national law already prescribes sustainable practices for forest management, forest certifications may be easily adopted because forest companies do not have to undergo costly changes to be certified. However, in these cases, positive impacts of forest certifications may be more moderate (‘low-hanging fruit’). Finally, the biophysical factors of the certified forests are an essential aspect to consider since depending on the plant and the animal species that the forests comprise, and depending on the type of logging management, forests respond differently, and thus determine different impacts (van Kuijk et al., 2009).

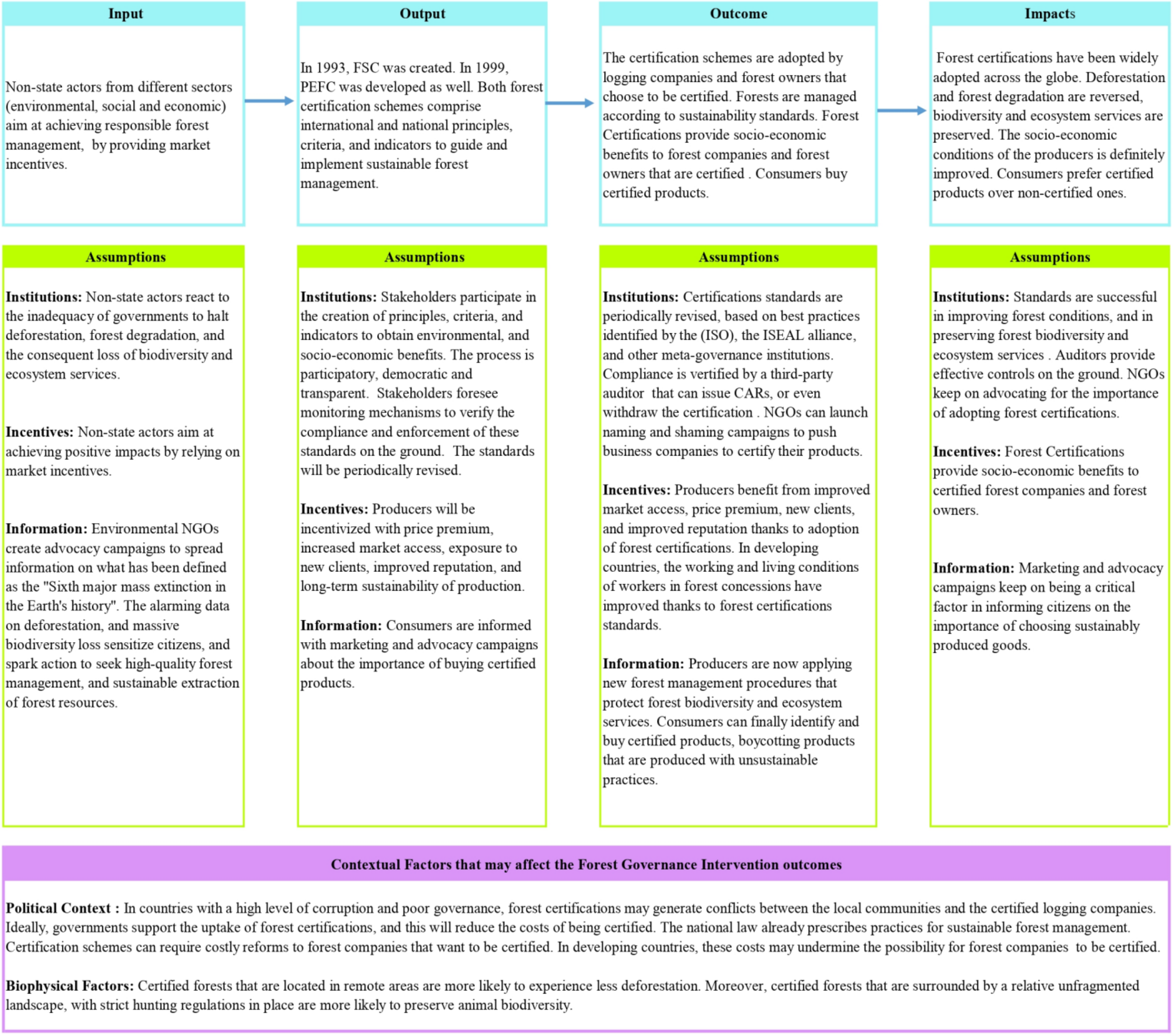


Figure 3. Theory of Change of Forest Certifications **Source**: Inspired by Sami and King (2010), and elaborated by the author

b) Theory of change for Community Forest Management.

I developed the theory of change for community forest management based on five groups of factors that, according to the scientific literature on this forest governance intervention, contribute to positive environmental and socio-economic impacts. These five groups are: 1) forest resource system and biophysical factors; 2) social groups that rely on forests; 3) institutional arrangements; 4) market, demographic, cultural, and historical characteristics of the context; and 5) external support (FAO, 2016; IFRI,2015; Arts and De Koning, 2017). For my theory of change, I have extracted the factors included in these five groups, and I have reclassified them under the three mechanisms of governance interventions (Figure 4).

As with forest certifications, “institutions”, “incentives”, and “information” are equally key mechanisms in this type of forest governance intervention. “Institutions” are particularly relevant to create enabling conditions for the communities to manage forest resources successfully. These conditions comprise, among others displayed in the ToC, the formal recognition of communities tenure rights, the development of rules that are easy to understand, the creation of conflict-resolution mechanisms, and the implementation of efficient benefit-sharing mechanisms (IFRI, 2015). The enforcement of rules and effective sanctioning mechanisms are also identified as being critically important to preserve forest resources (Gibson et al., 2005; Chhatre and Agrawal, 2008; Agrawal, 2001). As “incentives”, the possibility for local communities to develop the most appropriate institutions and be included in the rule-making process is considered paramount to improve forest condition, and to perceive institutions as being legitimate (Chhatre and Agrawal, 2008; Poteete and Ostrom, 2004; Agrawal and Gibson, 1999). The possibility for the local community to increase, improve, and exchange knowledge with capacity development activities implemented by external actors (Arts and de Koning, 2017), is another important mechanism to engage local communities in the intervention, and foster the achievements of positive results. As “information” mechanism, the possibility for the local communities to use their knowledge to efficiently manage forest resources, and to develop the most appropriate institutional arrangements for the local context emerge from the literature as being an important element in CFM (Agrawal and Gibson, 1999; Agrawal, 2007). The role of knowledge, thus, serves both as an “incentive” and both as the “information” mechanism of the intervention.

As contextual factors, user group characteristics have a significant role in influencing the outcomes. Medium sized communities, relatively wealthy, are more likely to successfully monitor and enforce rules (Poteete and Ostrom, 2004; IFRI, 2015). Demographic and market pressures are other essential elements that may influence the outcomes of community forest management (IFRI, 2015). The stability of demographic conditions is particularly important with respect to the homogeneity of the usergroup. Indeed, the homogeneity of the group is important as it fosters the predictability of the interactions and it increases trust, which in turn promotes collective actions (Poteete and Ostrom, 2004). Moreover, as the rate of migration, mobility and market integration increases, the lower is the possibility of cooperation (Behera, 2009). Finally, market and new technologies influence what is going to be harvested, with which technology, and at which rate (Agrawal, 2001).

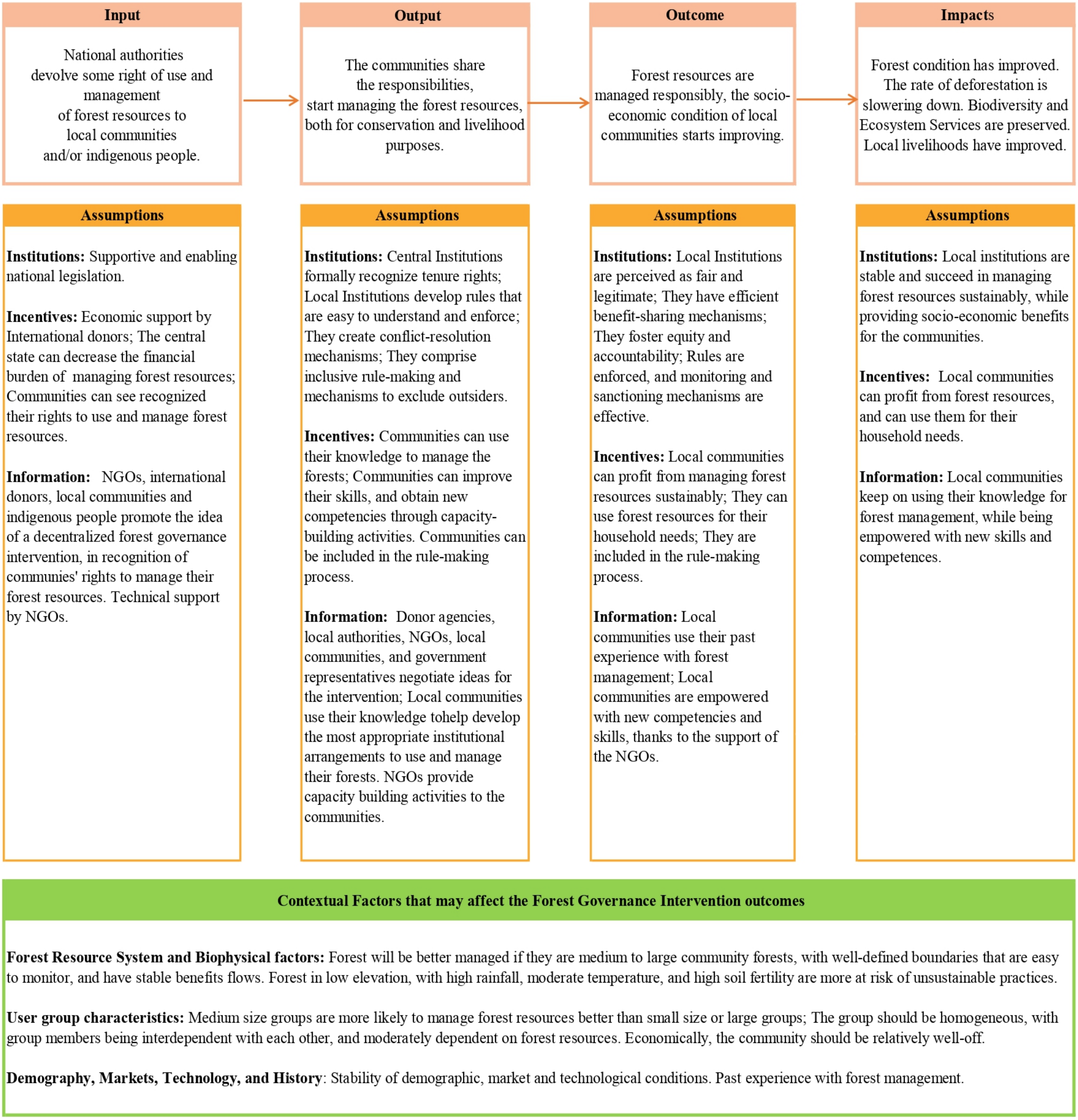


Figure 4. Theory of Change of Community Forest Management **Source**: Inspired by Samii and King (2010), and elaborated by the author

Methodology

Methodology

For this thesis I have applied the guidelines for systematic reviews recommended by the Collaboration for Environmental Evidence (CEE), and the International Initiative for Impact Evaluation (3ie). Systematic reviews use a transparent and reproducible protocol to extract data and critically appraise the quality of the publications, in order to gather high-quality evidence concerning an intervention's impacts. Systematic reviews can also use an explicit theory of change, with assumption specified, to analyze the impacts in the light of underlying governance mechanisms and contextual factors; and they can also include a meta-analysis that allows for a statistical pooling of quantitative data, in order to calculate the general effect size and the variance (Waddington et al., 2012). In this thesis, important differences among the included publications hindered the possibility to quantitatively analyze the findings. Such differences are: different methodologies and indicators used to measure the environmental impacts of the interventions; different study designs; different comparators; different sample sizes; different time scale of the analysis; different forest species involved in the analysis; and different socio-economic contexts. The evidence was thus reported solely in a qualitative way.

This chapter is organized as follows: First, I introduce the search protocol applied for both systematic reviews; Second, I describe the data extraction forms used to select data from each publications; Third, I report on the quality assessment data extraction form, and the creation of the rigour assessment data extraction form; Fourth and finally, I explain how I synthesized the evidence.

3.1 Search protocol

For both systematic reviews included in this thesis, the search protocol was characterized by two different temporal phases. The first phase should be considered as an exploratory stage of this systematic literature review, whose aim was to start collecting preliminary publications, identify key publications in this field to snowball their list of references, and to look for grey literature as to avoid publication bias. The second phase is when the actual research in online databases was carried out.

The inclusion criteria for both systematic reviews were quite general and common for both SLRs. Considering that the focus of this research is to evaluate the environmental impacts of FCs and CFM around the globe, the four main - and common to both parts - inclusion criteria were:

1) Geography of the studies: Global Scale;
2) Environmental Impacts: It needs to include at least one indicator that relates to the categories of Flora, Fauna, and Ecosystem Services of Forests.
3) Type of Impact: Environmental impacts, whether positive, negative, or no impact;
4) Outcome: Change or not change in biodiversity (Flora and/or Fauna); change or not change in forest cover; change or not change in forest condition; change or not change in ecosystem services provision.

Common exclusion criteria were:

1) The paper does not measure the environmental impacts of the intervention;
2) The paper does not provide details on the methodology used;

3) The paper is a meta-analysis that includes studies already in the list.

For both SLRs, only scientific literature written in English was considered for data extraction and synthesis.

3.1.2. Search protocol for SLR on the impacts of Forest Certifications

The systemic literature review on the environmental impacts of forest certifications started with twelve records provided by FNP during the month of March 2018. After reading the full text, out of this sample, nine publications were excluded for two main reasons: Not measuring the environmental impacts of the intervention (n= 6), and for not providing details on the methodology used (n=3). Therefore, only three publications were included in the list (Simonsson et al., 2016; Elbakidze et al., 2011; De Iongh et al., 2014).

Before collecting papers from online databases, I started to develop my list of publications by snowballing the list of references of the main reports and papers on the environmental impacts of forest certifications (e.g., Van Kuijk et al., 2009; Karmann et al., 2009; and Romero et al., 2017). In particular, from Romero et al., (2017), I identified four potentially relevant papers; however, after reading the full text, only two were chosen for this SLR (Panlasisgui et al., 2015; Miteva et al., 2015). The remaning two publications were excluded for not measuring the environmental impacts of the intervention.

Informal meetings with experts on forest certifications informed me about the relatively new forest certification for ecosystem services created by FSC, ForCES. ForCES is a project implemented by FSC in collaboration with several international partners, and financially supported by the Global Environmental Facility (GEF). The main goal of this new scheme is to certify the provision of essential Ecosystem Services (e.g., biodiversity conservation, watershed protection, carbon sequestration) by already FSC certified forests, after verifying the actual impacts on the ground with a third-party auditor (Forces.fsc.org). After testing this new scheme in several pilot projects, nine Ecosystem Services Certification Documents (ESCDs) were published on the official website ForCES.FSC.org, and I decided to include these documents as part of grey literature. I did that for three main reasons: First of all, the novelty of this initiative. Considering that it is a new project, it could actually provide some interesting data on the impacts of FSC on ecosystem services; Second, these documents contain technical information and a clear description of the methodology used to measure the effects on the ground; Third, each ESCDs is assessed by a third-party auditor that decides against a given set of indicators whether to approve the claim or not. This is particularly important, since the impartiality of the auditor is a guarantee that there is no bias in favour or against the claim reported in the ESCD. I contacted via email the policy managers of ForCES to know whether all the documents were approved. Out of nine, only five passed the examination. However, I had to exclude two documents written in Spanish for linguistic limitations. In the end, I included three ESCDs.

The literature search in online databases was carried out in April 2018 mainly in Scopus and Wageningen University and Research online library. The search terms and Boolean search terms were FSC biodiversity impacts OR PEFC biodiversity impacts OR forest certifications impacts on biodiversity OR "forest certifications" OR FSC and PEFC OR forest certification environmental impacts. The research returned 883 papers. I screened the title and the abstract of each one of these papers, and the selection was made based upon three criteria: First of all, the paper had to investigate the environmental "impacts" or "effects" or "performance" or "effectiveness" or "outcomes"[3] of the intervention. This means that, for instance, all the papers that analyzed only the social or economic impacts of FSC and/or PEFC were excluded from my list,

[3] The conceptualization of what actually is an "Impact" can vary from publication to publication. By fully acknowledging this, I have included in the preliminary sample of my body of evidence all papers whose abstract had one of those words.

as well as all opinion and theoretical papers. Second, the publication had to measure the direct environmental impacts of the intervention. This means that all the scientific articles that evaluated the impacts indirectly, based on management practices often associated with forest certifications (e.g., Reduced Impact Logging, retention trees, the creation of riparian buffer zones) were excluded from the research. Third, the paper had to analyze the impacts mainly of FSC and/or PEFC, which are the forests certifications of my interest.

After this step, thirty-seven papers were considered for the full text screening. Out of these, eleven papers were excluded for not actually measuring the environmental impacts of the intervention; two papers did not examined the environmental outcomes of my interest; two papers based their own analysis solely on Corrective Action Requests (CARs), without assessing whether these impacts were produced on the ground; and finally one paper was excluded for not providing details on the methodology used. I eventually collected twenty-one papers from the research performed on online databases. The complete list of the excluded and included papers can be found in Appendix B.

Including the publications gathered during the first three stages of my research, twenty-nine publications in total were used for data extraction and synthesis. Out of these, fifteen publications measured the outcomes only on Flora; six evaluated the impacts on Fauna; four examined the impacts on Ecosystem Services; and four investigated the impacts on Flora and Ecosystem Services. (Figure 5, next page).

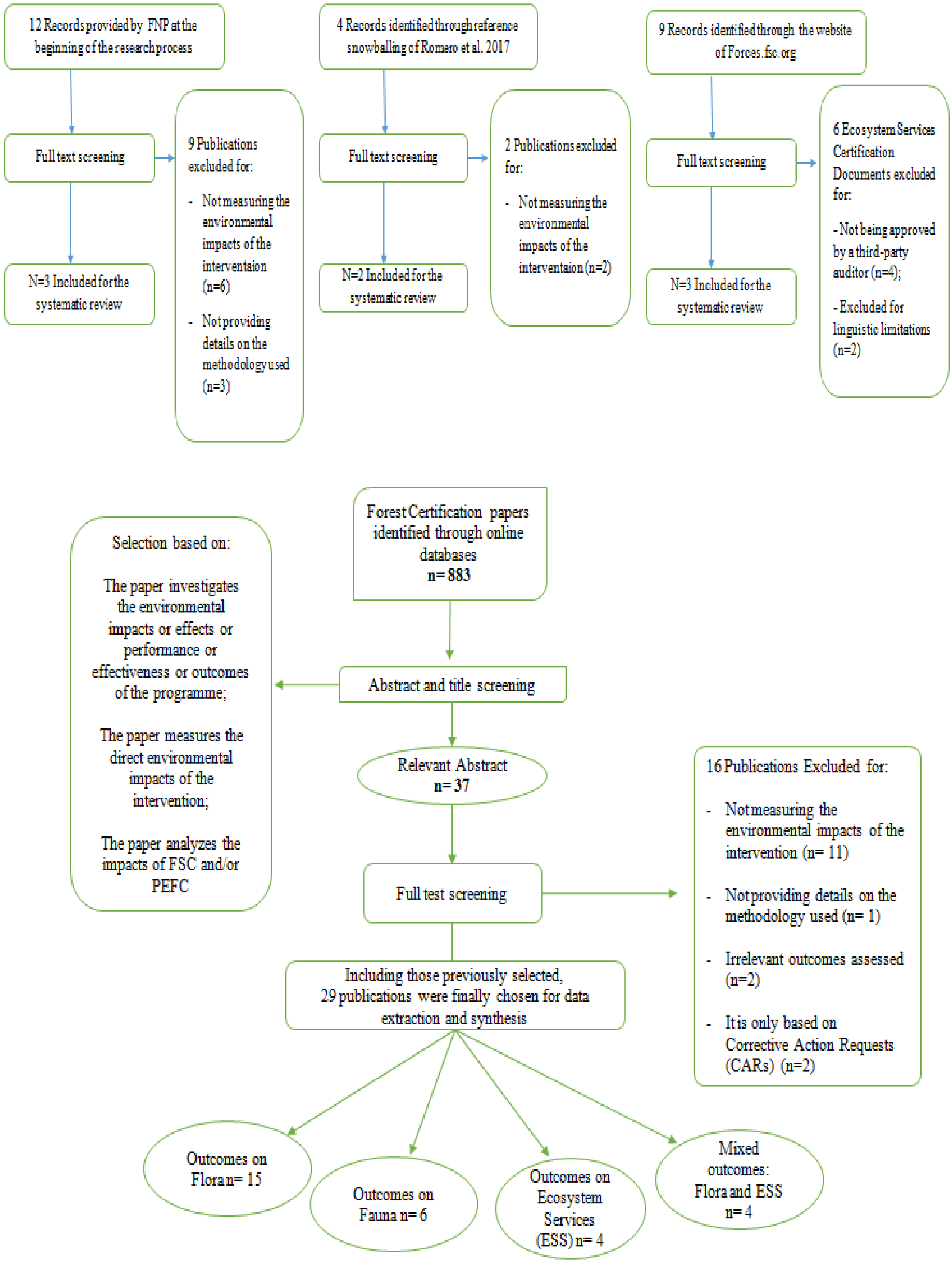


Figure 5. Prisma study flow diagram. Adapted from Pelletier et al., (2016) and Bowler et al., (2012)

3.1.3. Search protocol for SLR on the impacts of Community Forest Management

The literature search started with thirteen records provided by FNP in July 2018. Eleven publications had to be excluded for three main criteria: Not measuring the environmental impacts of the intervention (n=4); Not providing any details of the methodology used (n=5), and for being focused only on community-conservation (n=2). Therefore only two papers were included for the systematic review.

As recommended by the systematic review tool kit of Waddington et al. (2012), before starting the research in online databases, I began building up my body of evidence by snowballing the list of reference of relevant publications in this field. Through the website of Mongabay and the International Initiative for Impact Evaluation website (3ie), I selected two publications that examined the impacts of forest conservation interventions. The first one is the systematic review of Burivalova et al., (2017), and the second one is the impact evaluation of Puri et al. (2016).
In the first case, from the systematic review, I extracted thirteen papers. After screening the full text, eight papers had to be excluded for five criteria: Focusing only on Institutions (n=2); Focusing only on community-conservation (n= 3); Not providing any details of the methodology used (n=1); Not measuring the environmental impacts of the intervention (n=1); and for doing the analysis based only on future scenarios (criterion “other”) (n=1). Hence only five papers were included for the systematic review.
In the second case, from the impact evaluation, I selected three papers. After reading the full text, one paper was removed for focusing only on institutions, and the remaining two papers were included for the review.

The literature search in online database was carried out in November 2018 in Scopus and Wageningen University and Research online library. The search terms and Boolean search term were: “community forest management” OR “community forestry” OR “community-based conservation” OR “participatory forest management” OR “impacts of community forest management” OR “decentralized forest management” OR “environmental impacts of community-based forest management”. Only papers written in English were considered for the selection, and this might have excluded relevant publications written in other languages.
The research yielded a total of 2,082 results, including possible duplicates**.** Abstracts and titles were screened, and the selection of papers was based on three criteria: The paper investigates the “impacts” or “effects” or “performance” or “effectiveness” or “outcomes”[4] of the programme; The abstract includes outcomes specifically on deforestation, forest degradation, biodiversity, and ecosystem services; The abstract specifies the type of tenure rights regime. After this step, forty-six papers were considered for the full-text screening. Out of these, nineteen were excluded for four main criteria: Not measuring the environmental impacts of the intervention (n=6); Not providing any details on the methodology used (n= 4); Focusing only on community-conservation (n=8); and for being a meta-analysis that included studies already in the list (n=1). Despite being an inclusion criterion at first, papers on community-based conservation were excluded on a later stage, as they did not involve any type of management of natural resources by the local communities. The complete list of the excluded and included papers can be found in Appendix C.

Including those selected in the first phase of the research, thirty-six publications were selected for the data extraction and synthesis, twenty-four measured the outcomes on Flora; two measured the impacts on Flora, Fauna, and Ecosystem Services; seven measured the impacts on both Flora and Ecosystem Services; and only three measured the outcomes only on Ecosystem Services. A full graphic description of the selection process can be found in Figure 6 below.

[4] As previously explained, the conceptualization of what actually is an “Impact” can vary from publication to publication. By fully acknowledging this, I have included in the preliminary sample of my body of evidence all papers whose abstract had one of those words

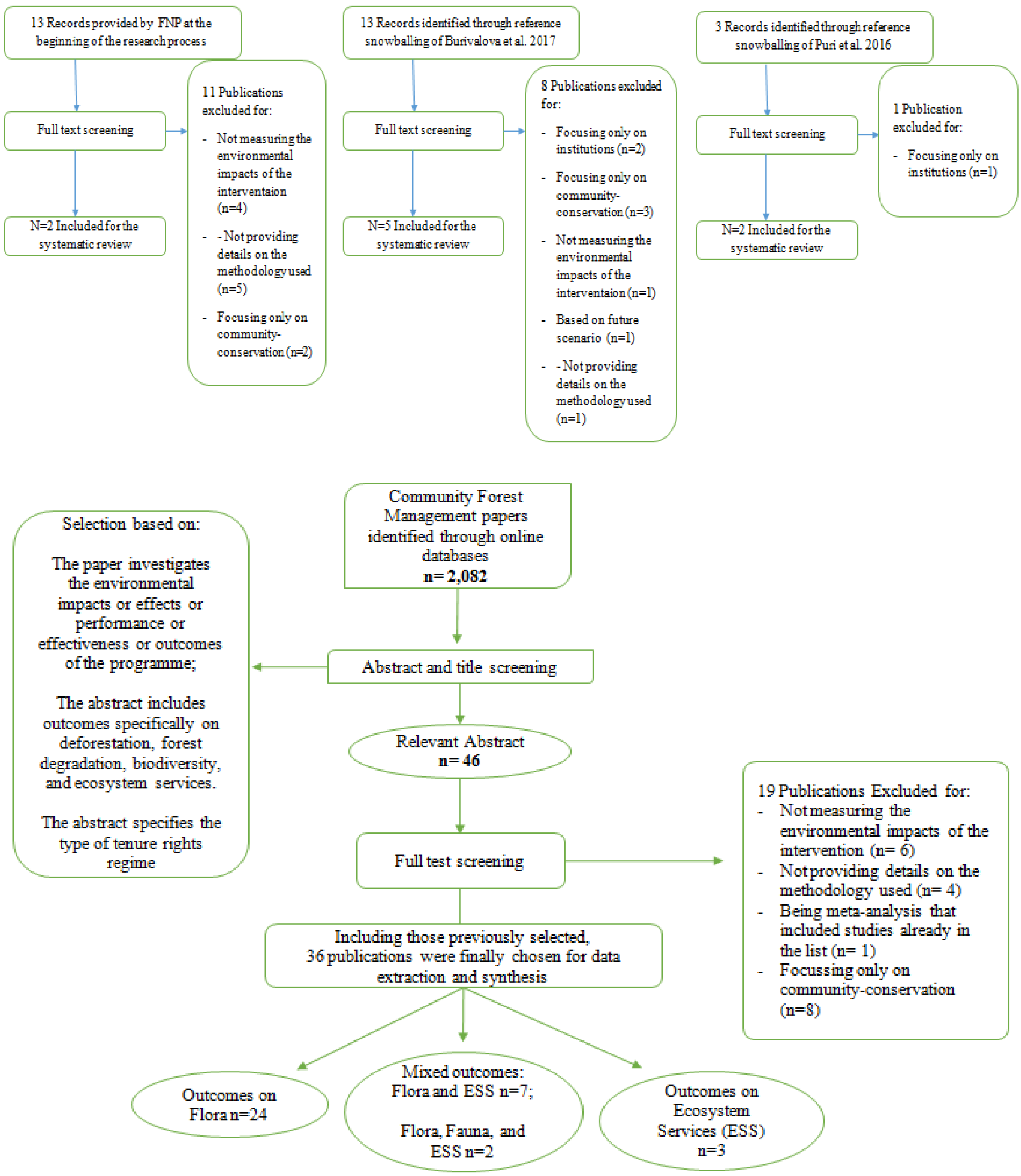


Figure 6. Prisma study flow diagram. Adapted from Pelletier et al., (2016) and Bowler et al., (2012)

3.2 Data extraction

After the completion of the search protocol, and before synthesizing the evidence, I had to extract data from each paper. To do so, I created two different data extraction forms (DEFs), one for each SLR, that comprised seven different parts:

- Part 1: General Study Details (e.g., Research questions/ Study aim; Unit of intervention; Level of analysis);
- Part 2: Study Methodology (e.g., Time scale of the analysis; Study design; Data collection method; Baseline/ Reference point; Comparison group; Sample size; Indication of Bias);
- Part 3: Data Source (e.g., Environmental category examined; Indicator(s); Type of forest certification; Type of Community);
- Part 4: Study Context (e.g., Country; Biome; Area size; Type of forest);
- Part 5: Governance Mechanisms (i.e., Institutions; Information; Incentives)
- Part 6 : Contextual Factors (e.g., Biophysical Factors)
- Part 7: Impacts (Positive, Negative, No impact).

Part 5 and 6 were specifically developed to test my theories of change, and therefore these two parts differ from each other between the two DEF models. In fact, as discussed in the previous chapter, to design the theory of change of forest certifications, I mostly relied on the scientific research on non-state market-driven governance of Cashore (2002; 2007; 2018), the global theory of change of FSC, and the information provided on the website of both PEFC and FSC. However, to define the single queries presented within the sections of part 5 and 6, I needed more specific information. Therefore, I expanded my research looking for scientific papers that investigated not only the environmental impacts, but also the socio-economic impacts of forest certifications. To define the twenty-six queries under Governance Mechanisms, namely Institutions, Incentives, and Information, I took inspiration from Cerutti et al., (2017); Elbakidze et al.,(2011); Ebeling and Yasué, (2009); Kalonga et al., (2015, 2016) and Carlson and Palmer (2016). To establish the eighteen queries under Contextual Factors, specifically, Political Factors; Economic Context; Sustainability Practices; and Biophysical Factors, I took inspiration from Arts et al.,(2017); van Kuijk et al., (2009); Sollman et al., (2017); Polisar et al.,(2017); Tobler et al.,(2018), and Elbakidze et al., (2016). To shape part 5 and 6 for the DEFs concerning CFM, I simply used the elements that I inserted in the assumption sections of my theory of change, which are based on Arts et al.,(2017); IFRI, (2015); and FAO, (2016).

From each publication, I extracted information only for the areas under the interventions. Moreover, I reported only what was explicitly written in a given publication, and this means that the type of impact, whether positive, negative, or no impact, is not the product of my own interpretation.
To establish whether a certain impact was strong, average, or weak, I relied on words used by the authors. For instance, whenever a publication reported “significantly positive”, “significantly higher species richness”, or “significant positive impact” in a given area under the intervention, I classified that as a strong positive impact. Whenever a publication reported positive impacts, but these impacts were, for instance, “slightly higher” or “Slightly different” from the comparison group, I classified these impacts as weak positive impacts. Everything in between these two extremes was classified simply as positive impact. The same reasoning applies to negative impacts. Finally, whenever a publication did not report any type of impact, I categorized that as no impact.

The data extraction forms used for SLR on FCs and CFM can be found in Appendix A.

3.3 Quality assessment

The quality of the reporting of each paper was evaluated based on the quality assessment form inspired by Nyambe et al., (2016), (Table 1 below). This form comprises seven quality indicators: "Clarity of Research Questions/ hypothesis/ study aim"; "Clarity of data collection method"; "Clarity of sampling plan"; "Clarity of sampling size"; "Clarity of analysis method"; "Clarity of Conclusions"; and "Clarity of limitations". All these indicators allow for a score ranging from zero to two, with the exception of "Clarity of Conclusions" that only allows for a range from zero to one. If a publication would score high on each quality indicator, it would get a maximum of thirteen points. All scores from zero to seven were considered as low, all scores from eight to ten were considered as medium, and all scores from eleven to thirteen were considered as high.

Table 1. Data extraction form for quality assessment

Indicator	Categorization	Criteria
1. Clarity of research questions/ Hypothesis/ Study aim	0. Missing	At best, only sub-questions specified
	1. Unclear	CRQs supplied inappropriately (e.g., only in abstract) or incomprehensively (e.g., as identification of a research gap)
	2. Clear	
2. Clarity of data collection methods	0. Missing	None specified
	1. Unclear	Incompletely specified (e.g., type of interview/observation; application)
	2. Clear	
3. Clarity of sampling plan	0. Missing	None specified
	1. Unclear	Missing for at least one reported data collection method
	2. Clear	
4. Clarity of sampling size	0. Missing	None specified
	1. Unclear	Imprecise (e.g., 'more than'), or missing for at least one reported data collection method
	2. Clear	
5. Clarity of analysis method	0. Missing	None specified
	1. Unclear	At least some description of data handling after collection (e.g., mention of transcription, CAQDA, grounded theory, content analysis, regression analysis, etc
	2. Clear	
6. Clarity of conclusions	0. Missing	None specified, or none with a relationship to research questions
	1. Present	At least one conclusion has a (however weak) link with one of the research questions
7. Clarity of limitations	0. Missing	None specified
	1. Unclear	Possible instrument effects and/or fallacies are mentioned but without further discussion
	2. Clear	Research limitations are appropriately identified

3.4 Rigour Assessment

While the quality assessment will tell us how clearly the authors structured and reported their research, it is not sufficient to appraise the methodological rigour of the included studies. Indeed, to be able to make any causality inference and to provide reliable evidence, researchers need to adhere to strict standards when designing an impact evaluation study. For this reason, I created another data extraction form, mostly inspired by the "Guidelines for 'gold standard' CFM assessment" of Bowler et al., (2012). While these guidelines were created specifically to evaluate CFM projects, the principles are general enough to actually be suitable also for the evaluation of the impacts of Forest Certifications. From these principles, I developed nine rigour indicators that can be found in the Table 2, on the next page. Each rigour indicator allows for a score ranging from zero to five, depending on the indicator. If a paper would score consistently high on every rigour indicator, it would get a maximum score of twenty-three points. All scores from zero to ten were considered as low, all scores from eleven to twelve were considered as medium (the average of twenty-three), and all scores from thirteen to twenty-three were considered as high. Besides the explanation provided by Bowler et al.,(2012), the criteria for each score was justified with extracts from the scientific literature and grey literature that concerns impact evaluations (i.e., Burivalova, (2017); Waddington et al., (2012); WorldBank.org; ISAEL, (2017); and UNICEF-irc.org). The original guidelines for the "Gold standard" CFM assessment by Bowler et al., (2012), can be found in Appendix A.

Table 2. Data extraction form for rigour assessment

Indicator of rigour	Score	Criteria/ Explanation for the score
1) Study Design	**0**. Case Study or Multiple Case Studies; **1.** Comparative Case Studies; Pre-experimental (Pre-Test Post-Test; Longitudinal study); **2**. Quasi-experimental	a) Case studies are useful to get in-depth information; however, they are unable to establish whether the changes are caused by the intervention or not (Burivalova, 2017); b) Comparative case studies might be useful to analyze differences and similarities across multiple case studies, and understand how and why a program might succeed or fail, and how contextual factors play a role in the outcomes (UNICEF-irc.org). The pre-experimental design is valuable for an impact evaluation, but is considered weaker than quasi-experimental design (Waddington et al., 2012). A "before and after" or "pre-test - post - test" design can be a valuable approach to investigate the changes in the intervention group; however, it is "simplistic in its ability to attribute impact" (ISAEL, 2017, p. 24) c) Quasi-experimental design can actually test causal hypotheses, but unlike experimental design, it lacks a random assignment (UNICEF-irc.org; Waddington et al., 2012)
2) Comparator / Reference Group	**0.** Missing; **1**. Before/After Intervention Comparison; Comparison with another type of intervention or same intervention. **2.** Multiple combinations of comparisons (e.g., Before/After intervention in comparison with another type of intervention and/ or in comparison with areas without the intervention; **3.** Comparison with areas without the intervention; **4.** Comparison with areas without the intervention with description of management practices.	Areas without the intervention are the most suitable comparators in impact evaluations, as they facilitate the attribution of the impacts (Bowler et al., 2012; World Bank, 2006). Impact evaluations essentially establish what happens under a certain intervention, and what would have happened without it (ISAEL, 2017). Ideally, the management practices of the comparator group should be reported (Bowler et al., 2012).
3) Baseline/ Reference point data collection	**0**. Missing; **1**. At least one reference point; **2.** Baseline/Reference point of multiple indicators (e.g. Forest conditions; Forest growth); **3.** Baseline before/after at least for certified areas; **4.** Baseline before/after for certified sites and comparator/Reference groups. **5.**Baseline before/after for certified sites and comparator/Reference groups, with management practices specified.	Studies doing an impact evaluation should report baseline data (before the start of the intervention) of both the treatment and the control group, to establish if they are comparable. Information on the type of management implemented in both areas should be provided as well (Bowler et al., 2012).
4) Replication	**0**. Missing; **1**. Monitoring of multiple certified and non-certified sites;	Multiple intervention and control areas, with different types of management practices should be included in the analysis and monitored (Bowler et al., 2012).

5) Site Selection	**0.** Missing or unclear (it doesn't specify if it is random or not); **1.** Non-random selection of intervention and comparator sites; **2.** Random selection of intervention and comparator sites.	Sites should be selected at random, and the selection criteria should be comprehensively documented (Bowler et al., 2012).
6) Sampling Procedure	**0.** Missing or unclear (it doesn't specify if it is random or not, or it's incomplete); **1.** Non-random selection of data collection units within the area under the intervention and areas without the intervention; **2.** Random selection of data collection units within areas under the intervention, but not reported for areas without the intervention; **3.** Random selection of data collection units within every areas under the intervention, and areas without the intervention.	Data collection units (e.g., Forest plots, households) should be selected at random, with appropriate sampling techniques, and the same reporting effort across areas (Bowler et al., 2012).
7) Use of statistical techniques to establish the causal impact of the intervention (e.g. Instrumental variables (IV); Difference-in-difference (DIDs); Propensity score matching (PSM); matched difference-in-difference (MDIDs)).	**0.** Missing; **1.** Applied	Impact evaluations should apply statistical methods to help identify the causal impact of the intervention (Waddington et al., 2012; WorldBank.org; ISAEL, 2017).
8) Appropriate time scale	**0.** Not reported -Missing; **1.** Short-term time scale (0-5 years); **2.** Medium-term time scale (5-10 years); **3.** Long-term time scale (10-20 years and onwards)	Outcomes of the intervention might be measurable only after a certain amount of time. This amount of time (time scale) should be taken into consideration when doing an impact assessment. (Bowler et al., 2012)
9) Measurements of confounding variables, including contextual factors and governance mechanisms.	**0**. Not reported- Missing; **1.** Some confounding variables are analyzed including some contextual factors and/or some governance mechanisms; **2**. All possible confounding variables are included in the analysis	Confounding variables should be included in the evaluation in order to avoid biased results (Bowler et al., 2012).

3.5 Evidence Synthesis

For both systematic literature reviews, the presentation of the evidence synthesis consisted in three different steps.
First, I presented the reported environmental impacts – whether positive, negative, no impacts, or a combination of these- over the total area examined. For instance, over the 13,241,894.90 ha examined by the publications included in the SLR on forest certifications, I reported for how many hectares, and in how many publications strong positive impacts were demonstrated; for how many hectares, and in how many publications positive impacts were found; and for how many hectares, and in how many publications mixed impacts were reported.
Second, I specified the overall reported impacts for each environmental category examined (i.e., Flora, Fauna, and Ecosystem Services).
Third, within each environmental category, I further narrowed down the presentation of the reported impacts, based on the indicators used to measure the impacts of the intervention. For the category of Flora, I structured the results according to whether the indicators concerned forest degradation, deforestation, or floral biodiversity. Now considering that the publications on forest certifications used around twenty-nine different indicators to measure the environmental impacts of the intervention, and the publications on CFM used around thirty-nine different indicators; I decided to focus on the most used indicators, and among the studies that employed that indicator, I reported only the results of the studies that scored high on both rigour and quality assessment. For instance: In the SLR concerning forest certifications, under the environmental category of Flora, the most used indicators were "Areas set-aside"(n= 4) and "Deforestation" (n=4). For the first indicator, no publications scored high on both rigour and quality, and therefore I just briefly mentioned the results, without providing any details. For the second indicator, three studies out of four had a high score for quality and rigour, and therefore, I focused on the results of those three studies, by providing details on the study design, the time scale of the analysis, the type of data used, the size of the area investigated (if available), and the type of reported impact.
Whenever I encountered a publication that had the highest rigour and quality, but used a "hardly used" indicator (i.e., an indicator that was not generally employed), I still reported the results of that publication.

I decided to focus specifically on the publications that scored high on both rigour and quality because, as explained in section 3.3 and 3.4, each publication included in these SLRs was appraised against transparent and stringent indicators in order to establish their quality and methodological rigorousness. These steps were taken in order to provide the most objective and high-quality evidence to inform policy-makers, academics, and international donors, which is exactly the goal of every systematic literature reviews (Waddington et al.,2012; Collaboration for Environmental Evidence.org; 2019).

Results

Results

This chapter is organized as follows: First, I report the results of the systematic review on the environmental impacts of Forest Certifications; Second, I report the results of the systematic review on the environmental impacts of Community Forest Management; Third, I compare the impacts of the two interventions analyzed.

4.1. SLR on Forest Certifications

4.1.1 Methodological design of the publications included

Out of the twenty-nine publications included, only three were grey literature, while the remaining twenty-six papers were published in peer-reviewed journals. The most recurring scientific journals were Forest Ecology and Management (n=5), and equally frequent were Biodiversity Conservation (n=2), Biological Conservation (n=2), and Forests (n=2). The complete list is provided in Appendix B. Twenty four studies were published after 2013, and no publications were found for the year 2012 (Figure 7). Only four papers were found for the year of 2018, however considering that this research was carried out during the month of April, it is acknowledged that other potentially relevant papers published over the course of 2018 were excluded from this SLR.

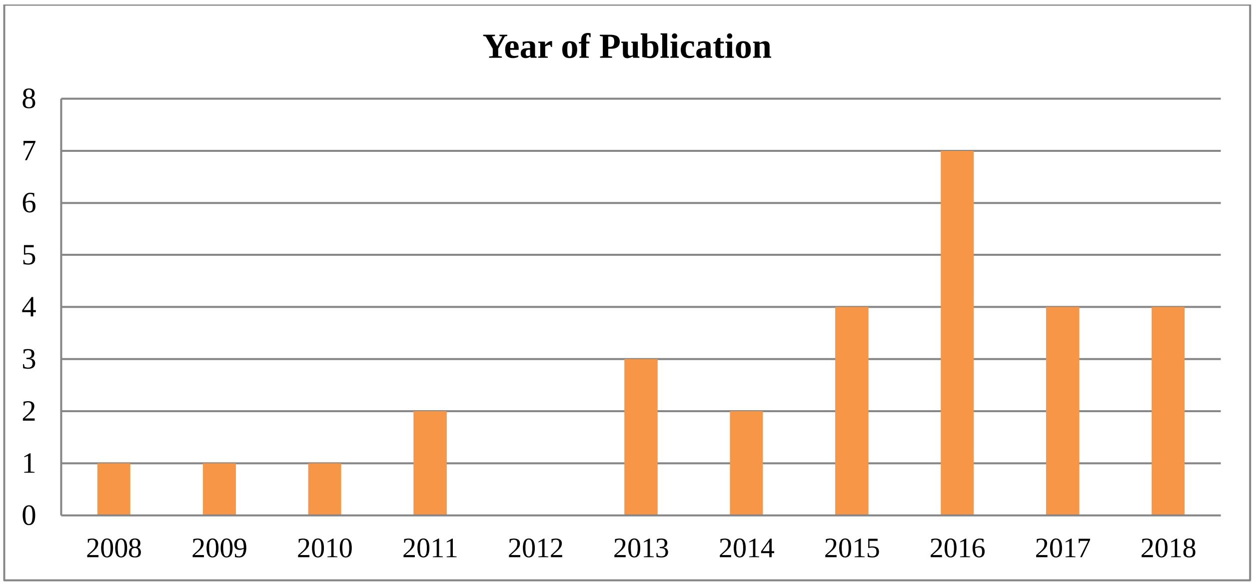


Figure 7. Year of publication of the articles included in the systematic review (n= 29). Figure adapted from Bowler et al., (2012)

The design of the included papers ranges from single case study (n=1), pre-experimental design (n=3), comparative case study (n=8), and to quasi-experimental design (n=17). The main method of data collection is mainly quantitative (n=22), and mixed (n=7), with no publications being purely qualitative. Quantitative methods of data collection generally comprised on the ground measurements, geospatial analysis, and statistical analysis; while mixed methods also involved interviews and focus groups in addition to the purely quantitative methods (Figure 8).

Nineteen publications evaluated the environmental impacts of forest certifications against a baseline. Among these, six used baseline data before the implementation of the certification (ESCD, 2017; ESCD, 2017; Elbakidze et al., 2011; Miteva et al., 2015; Rana et al., 2018; Trisch et al., 2016); eleven papers used a reference point after the certification was granted (De Iongh et al., 2014; Elbakidze et al., 2016; Foster et al., 2008; Grimscom et al., 2014; Johansson et al., 2011; Medjbe et al., 2013; Nordén et al., 2018; Panlasigui et al., 2015; Rivett et al., 2016; Simonsson et al., 2016; Tobler et al., 2018); two publications used both baseline data before the certification, and a reference point after being certified (Blackman et al., 2018; ESCD, 2016), and the remaining ten publication did not have any baseline data nor reference point (Dias et al., 2013; Dias et al., 2015; Dias et al., 2016; Kalonga et al., 2015; Kalonga et al., 2016; Kukkonen et al., 2009; Lõhmus et al., 2010; Mohamed et al., 2013; Polisar et al., 2017; Sollman et al.,2017).

Twenty-two studies did not report any type of bias. However, one study reported potential spillover bias (Dias et al., 2016); two studies indicated confounding bias (Kalonga et al., 2015; Kukkonen et al., 2009); two studies notified selection bias (Foster et al., 2008; Nordén et al., 2018); and two studies presented measurements bias (Griscom et al., 2014; Elbakidze et al., 2011).

Twenty publications reported information on governance mechanisms and contextual factors that may influence the environmental impacts of the intervention; however only ten included these factors in their analysis, including one paper that analyzed possible spillovers effects in neighboring forests (Blackman et al., 2018). The remaining nine publications did not report any type of data on governance mechanisms and contextual factors (De Iongh et al., 2014; ESCD, 2016; Foster et al., 2008; Griscom et al., 2014; Kukkonen et al., 2009; Lõhmus et al., 2010; Medjibe et al., 2013; Rivett et al., 2016; Trish et al., 2016).

With the exception of four publications (the three Ecosystem Services Certification Documents (ESCDs), and Dias et al., 2016), all the papers compared the certified areas with a reference group. The most reoccurring comparison was with non-certified areas (n= 8); followed by comparison between two areas FSC certified (n=3); comparisons between FSC certified areas, and areas certified with another certification (Malaysian Timber Certification Scheme) (n=2); comparison between FSC and PEFC certified areas (n=2); and comparison between open access forests and state forest reserves (n=2). The complete list of reference group can be found in Appendix B.

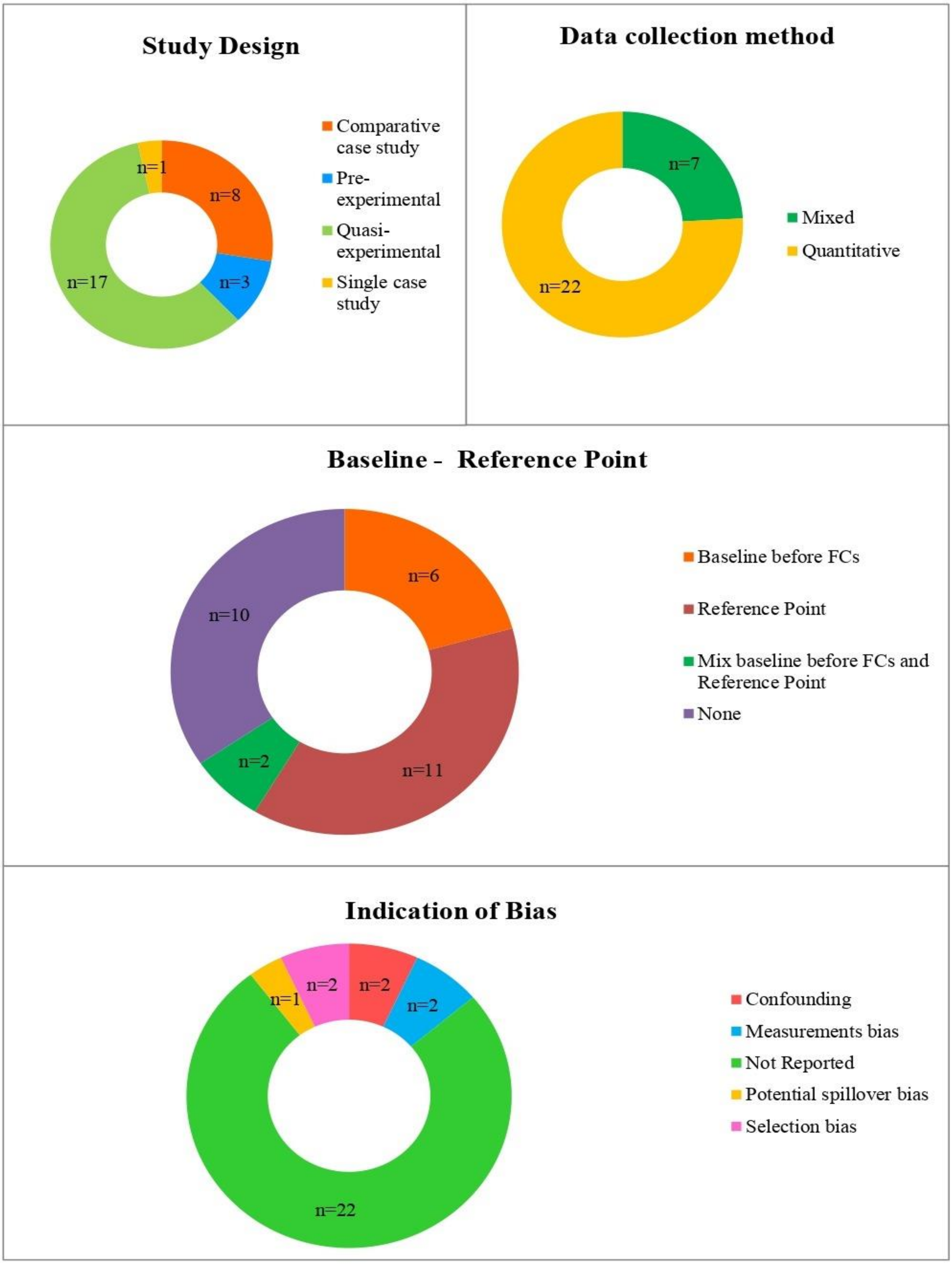


Figure 8. Methodological design of publications included in the SLR on FCs

4.1.2. Quality Assessment

As shown in Figure 9 below, the majority of the papers (n=20) scored high, from eleven to thirteen, on every quality indicators, and only six papers scored medium, from nine to ten (Johansson et al., 2011; Nordén et al., 2011; Polisar et al., 2017; Rivett et al., 2016; Simonsson et al., 2016; Tritsch et al., 2016). No publication scored low, from six to seven. For the three Ecosystem Services Certification Documents (ESCDs) it was not possible to apply the quality assessment form, as they are technical documents and not scientific publications.

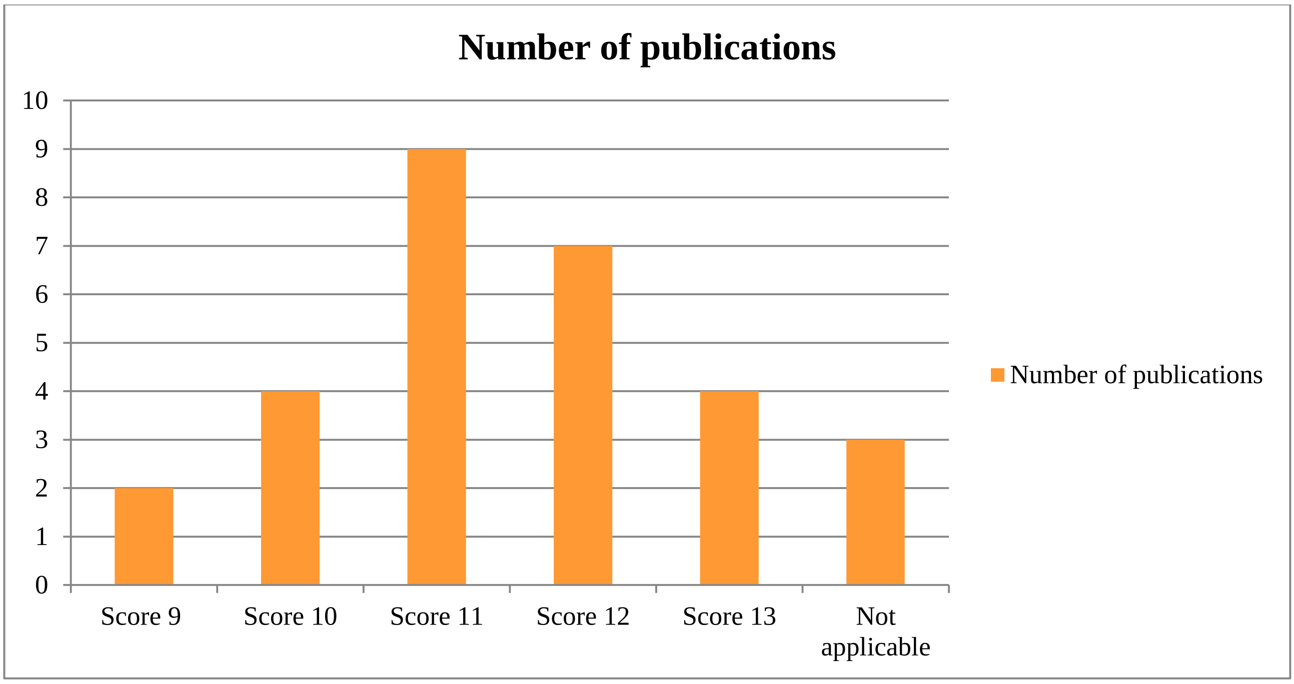


Figure 9. Ranges of scores for the quality assessment of the publications included in the systematic review

In general, the main indicator in which the majority of the papers scored consistently low was for "Clarity of the limitations". Twelve papers scored zero, since they did not mention at all the limitations of their research; ten publications scored one for briefly focusing on their limitations, but without elaborating in details; and only four papers scored two for appropriately addressing their limitations (Blackman et al., 2018; Elbakidze et al., 2011; Foster et al., 2008; Griscom et al., 2014). A complete overview of the quality assessment of each paper can be found in Appendix B.

4.1.3. Methodological rigour assessment

Seventeen papers scored fairly low on the rigour assessment, from five to ten; Five publications scored medium, from eleven to twelve; and the remaining seven papers scored high from thirteen to eighteen. The only publication scoring eighteen is Blackman et al., (2018), which is the only paper that respected most of the "gold standard" for impact evaluation. However, no publication got the maximum score of twenty-three (Figure 10).

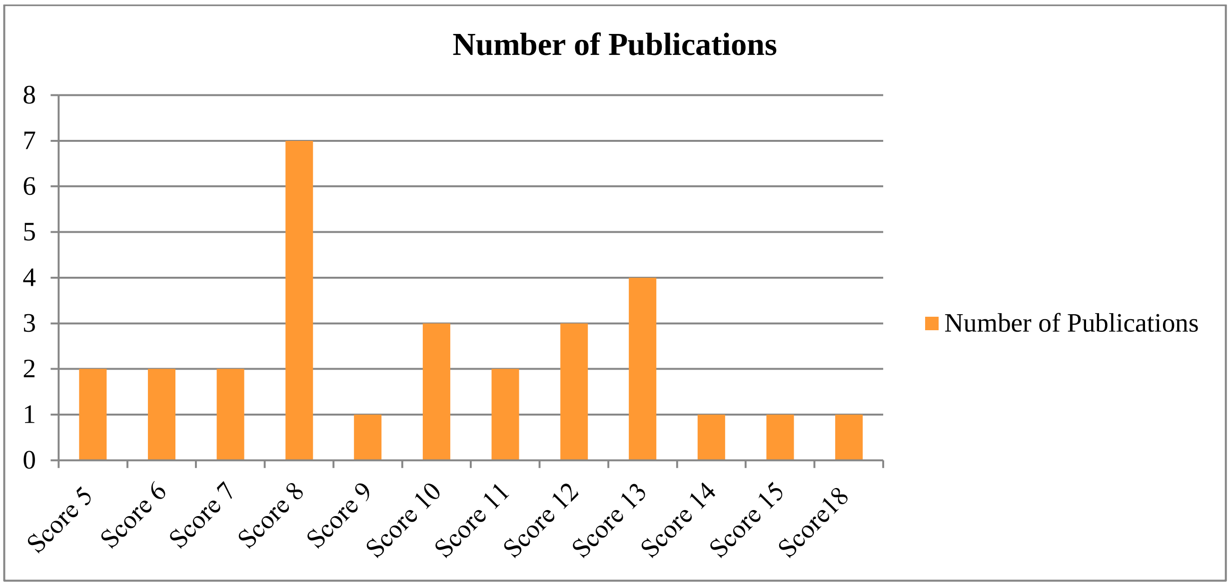


Figure 10 Ranges of scores for the rigour assessment of the publications included in the systematic review

The rigour indicators in which the majority of the publications scored consistently low are "Appropriate time scale", and "Use of statistical techniques". For the first indicator, fourteen papers did not report at all the time scale of the analysis, and seven publications did the analysis within the first five years from the adoption of the certification. For the second indicator, fifteen publications did not apply any statistical techniques to help establishing the causal impact of the intervention.

On the other hand, twenty-five papers used a comparator or reference group to investigate the impacts of the intervention in certified areas; nineteen publications used baseline data or a reference point to help determining the changes, if any, in certified areas; and nineteen papers analyzed multiple certified and non-certified areas (indicator "Replication"). A complete overview of the rigour assessment of each publication included in this SLR is provided in Appendix B.

4.1.4. Description of the publications

The geographic distribution of the included publications covers mainly the tropical biome (n=19), followed by the boreal biome (n=6), and the temperate one (n=4) (Figure 11).

The most frequent forest type and species investigated in the tropical biome are *Dipterocarpaceae* especially in Indonesia; miombo tree species in Tanzania, such as *Acacia polyacantha Willd*, *Lonchocarpus capassa Rolfe*, *Piliostigma thonningii Schum*, and *Xeroderris stuhlmannii (Taub.)*; semi-green broad-leaved forests and pine savanna, in French Guiana, Bolivia, Guatemala and Nicaragua. In the boreal biome, the forest species analyzed are *Pinus sylvestris*, *Picea abies*, coniferous species, and deciduous tree species, especially in Russia and Sweden. Finally, in temperate biome the most reoccurring forest species investigated in the analysis are *Quercus Suber*; *Q.rotundifolia*, *Pinus pinaster*, and *Eucalyptus globules*, particularly in Portugal; and *Betula alleghaniensis*, *Fagus grandifolia*, *Fraxinus americana*, *Juniperus virginiana*, *Tsuga canadensis*, and *Tilia Americana*, in North America. The complete list of forest species is provided Appendix B.

Despite four publications not reporting on the size of the area investigated, the overall area examined in the tropical biome is 5,780,871.84 ha, in the boreal biome 7,300,881 ha and in the temperate biome 160,139.06 ha, for a total of 13,241,894.90 ha which is approximately 3.06% of the total area certified in the world.

Figure 11. Geographic distribution of the included studies

Six papers evaluated the impacts of the intervention after ten years since the adoption of the certification; two publications carried out the research after 5 years since the certification has been granted; seven publications examined the impacts within the first five years since the implementation of the certification standards; and for fourteen papers it was not possible to determine the time scale of the analysis.

The most frequent forest management type implemented in the certified areas is Reduced Impact Logging (RIL) (n=12). Other reported management practices are selective logging (n=1), Small and low intensity managed forest (SLIMF) (n=1), and a generic sustainable forest management (n=2) in the tropics; clear cutting and retention cutting in boreal forests (n=1); and partial harvest treatment in temperate forests (n=1). Eleven publication did not report on the management practices applied within the studied areas.

The reported ownership type of the certified forests ranged from community forest management (n=5), industrial private ownership (n=5), non-industrial private ownership (n=3), state property (n=6), and a mix of all these ownership types (n=6). In four cases, the ownership of the certified forests was not specified.

Finally, all the twenty nine publications evaluated the impacts of FSC, and only three publications also included the impacts of PEFC in their analysis.

4. 2 Reported environmental impacts

Over the total area examined, strong positive impacts have been found in approximately 2,894,215.06 ha (n=11); positive impacts have been found in 3,445,412.84 ha (n=7); no impacts have been found in 2,825,006 ha (n=7), and mixed impacts (i.e., positive, negative, and no impacts) have been found in 4,077,261.00ha (n=4).

The main environmental category examined is Flora (n=19), followed by Ecosystem Services (n=8), and Fauna (n=6).

4.2.1 Reported impacts on Flora

Out of twenty-nine publications included in this systematic literature review, fifteen investigated the impacts of Forest Certifications on Flora. Additional data could be extracted from four publications that analyzed the impacts of FCs on Flora and Ecosystem Services. Hence, in total, nineteen studies provided information on the impacts of forest certifications on Flora. Out of these, seven studies reported evidence of strong positive impacts (De Iongh et al., 2014; Dias et al., 2016; Kalonga et al., 2015; Kalonga et al., 2016; Lõhmus et al., 2010; Simonsson et al., 2016; Tritsch et al., 2016); Two studies demonstrated positive impacts (Rana et al., 2018; Kukkonen et al., 2009); and seven studies found no impact at all (Blackman et al., 2018; Elbakidze et al., 2011; Foster et al., 2008; Medjibe et al., 2013; Nordén et al., 2018; Panlasigui et al., 2015; Rivett et al., 2016); All of these studies concern the FSC certification.

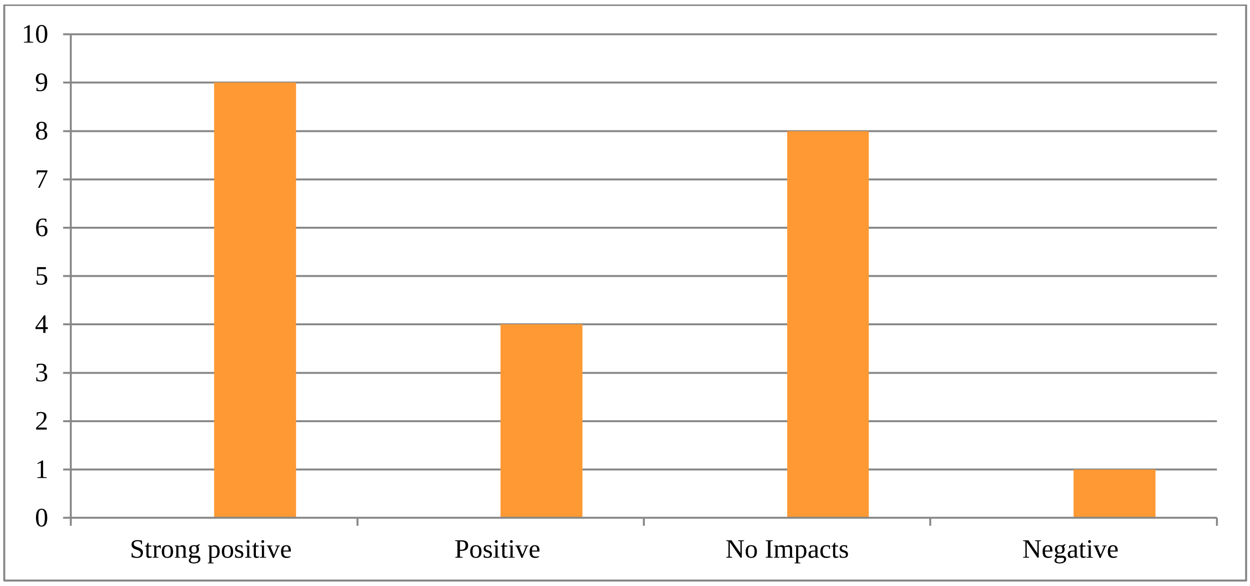


Figure 12. Type of impacts, and their degree, reported in each study, for the category of Flora

Mixed impacts are shown in three studies: First, Elbakidze et al. (2011) presented positive impacts on areas set-aside, potential functional habitat connectivity, and structural habitat connectivity by FSC in Sweden, and strong positive impacts on the same indicators by FSC in Russia. Second, Johansson et al., (2011) compared the impacts of FSC and PEFC in Sweden on broadleaved trees and old forests. The study found positive impacts by PEFC on broadleaved trees and old forests, while for FSC the study could not find any statistically significant impacts on both indicators. Third, Miteva et al., (2015) showed mixed results in Indonesia by FSC, reporting strong positive evidence for the indicator deforestation, and evidence of negative impacts for the indicator of forest disturbance (Figure 12).

As already explained in chapter 3.5, I am now going to present results based on specific indicators, classified according to whether these were used to assess the level of forest degradation, deforestation, or floral biodiversity. Among the papers that employed the most used indicators, I focused specifically on the evidence reported in the publications that scored high on both rigour and quality assessment. If I had publications that scored high on both rigour and quality, but employed a "hardly used" indicator, I still provided the results of those papers.
The most employed indicators under the category of Flora are "Areas set-aside" (n=4), and "Deforestation"(n=4).
"Live tree characteristics" (n=1), and "Tree species richness, diversity, and density" (n=1) are two indicators used only by two publications, respectively. Since these publications scored high on both rigour and quality, I reported their evidence in the following sections.

A) Forest Degradation

Indicator: Live tree characteristics

The indicator of "live tree characteristics" has been used only by one publication of Foster et al., (2008), which scored high on both rigour and quality. This paper analyzed three FSC certified sugar maple stands in comparison with three non-certified stands both with partial harvest treatment, and six unharvested reference stands, in Central Vermont, USA. With a quasi-experimental design, this study found that FSC did not have any impacts on live tree characteristics. In fact, certified stands were identical to the non-certified ones, in terms of tree diameter and relative density of sugar maple.

B) Deforestation

Indicator: Deforestation

Out of four studies investigating the impacts of FSC on deforestation, two studies could not find any impacts (Blackman et al., 2018; Panlasigui et al., 2015); one study reported positive impacts (Rana et al., 2018), and one study reported mixed evidence, both positive and negative (Miteva et al., 2015).
If we consider the reported impacts of the studies that scored high both on rigour and quality (i.e., Blackman et al., 2018; Miteva et al., 2015; Rana et al., 2018); the results are still inconclusive.

With a quasi-experimental design, Blackman et al., (2018) analyzed eight hundred and fifty-nine forest management units in Mexico certified and non-certified, for a total area of 167,327.222 ha, over eleven-year period, from 2001 to 2012. By using data on forest loss from Landsat images to control for unobserved confounding factors, combined with matched difference-in-differences models, the study could not find any statistically significant impact of FSC on deforestation.
Miteva et al.,(2015) evaluated the performance of FSC certified logging concessions in Indonesia, compared to non-certified one, over eight year-period, from 2000 to 2008. With a quasi-experimental design, the study used secondary data such as MODIS Vegetation Continuous Fields datasets and NASA FIRMS datasets, combined with triple difference matching estimators to establish the causal impact of the intervention. The

study found that FSC reduced deforestation by 5% over the examined period, however it also increased perforated areas by 4 km^2 on average.

Rana et al., (2018) analyzed the tree cover change in FSC certified forest management units compared to non-certified ones, over twelve year-period, from 2000 to 2012, in Brazil (545,335 ha), Gabon (688,262 ha), and Indonesia (171,240 ha). This study had a quasi-experimental design, and it used secondary data, such as Hansen data on tree cover change, along with the application of the synthetic control method to control for confounding factors. The study found that FSC had different effects in the examined countries, ranging from no impacts in Gabon, to small positive impacts in Indonesia, and to larger positive impacts in Brazil, although these positive impacts were fluctuating over time.

C) Floral Biodiversity

Indicator: Tree species richness, diversity, and density

The indicator of "Tree species richness, diversity, and density" has been used only by one publication of Kalonga et al., (2016) which scored high on both rigour and quality. This paper compared two FSC certified community forests, Kikole (454 ha) and Kisangi (1966 ha) with open access forests and state forest reserves, in Tanzania. This study had a quasi-experimental design, and used mixed methods of data collection, along with statistical analysis to control for confounding factors. The results showed that adult tree species richness, diversity and density were significantly higher in certified forests, compared to open access and state forest reserves, suggesting that FSC certification may be a valid option to effectively conserve floral biodiversity.

Indicator: Areas set-aside

Out of nineteen studies, four studies investigated the effectiveness of certified driven areas set-aside. Out of these, one reported evidence of strong positive impacts for FSC in Sweden (Simonsson et al., 2016); and one study demonstrated positive impacts for FSC in Sweden, and strong positive impacts in Russia (Elbakidze et al., 2011). The remaining two studies found no impact at all (Elbakidze et al., 2016; Nordén et al., 2018). None of these studies scored high on both rigour and quality assessment.

4.2.2 Reported impacts on Faunal Biodiversity

Indicator: Mammal Richness

Out of twenty-nine publications included in this SLR, six assessed the impacts of FSC and PEFC on Fauna. Out of these publications, four reported evidence of strong positive impacts (Dias et al., 2016; ESCD, 2017; Sollman et al., 2017; Tobler et al., 2018); and the remaining two papers showed positive impacts (Mohamed et al., 2013; Polisar et al., 2013) (Figure 13).

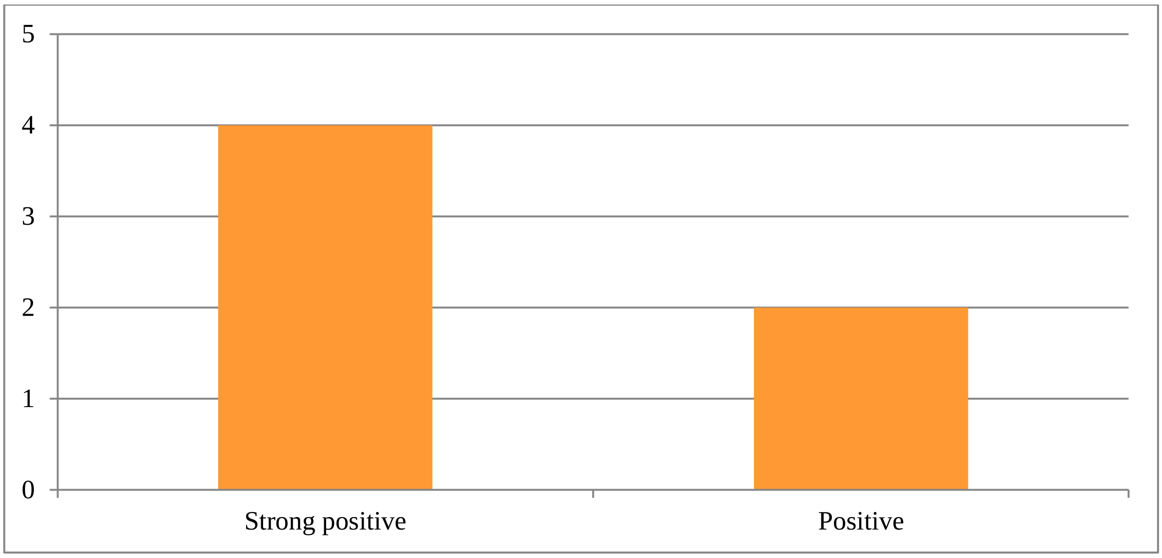


Figure 13. Type of impacts, and their degree, reported in each study, for the category of Fauna

The indicators used to measure the impacts on Fauna were “Bird species” (n=1), “Mammal richness” (n= 4), and “Species richness” (n=1). None of these studies scored high on both rigour and quality assessment. However, two interesting points emerged from these publications: First of all, reduced impact logging (RIL) succeeds in preserving wildlife, including endangered and vulnerable species listed in the red list of IUCN (ESCD, 2017; Tober et al., 2018); Second, strict hunting regulations inside the certified logging concessions, and a relatively unfragmented landscape surrounding the certified areas are essential elements for FSC and PEFC goals to successfully preserve faunal biodiversity.

4.2.3 Reported impacts on Ecosystem Services

Out of twenty nine publications, four measured the impacts of FSC only on Ecosystem Services, and four publications included studies on both Flora and Ecosystem Services. Therefore, data on the impacts that FCs have on Ecosystem Services, could be extracted from eight studies in total. One study reported evidence of strong positive impacts (Kalonga et al., 2015); four studies demonstrated positive impacts (Dias et al., 2015; ESCD, 2016; ESCD, 2017; Johansson et al., 2011); and one study could not find any impacts (Griscom et al., 2014). The remaining two studies reported mixed evidence: Foster et al.,(2008) reported both positive and negative impacts; while Miteva et al., (2015) reported both strong positive impacts, and no impacts at all (Figure 14).

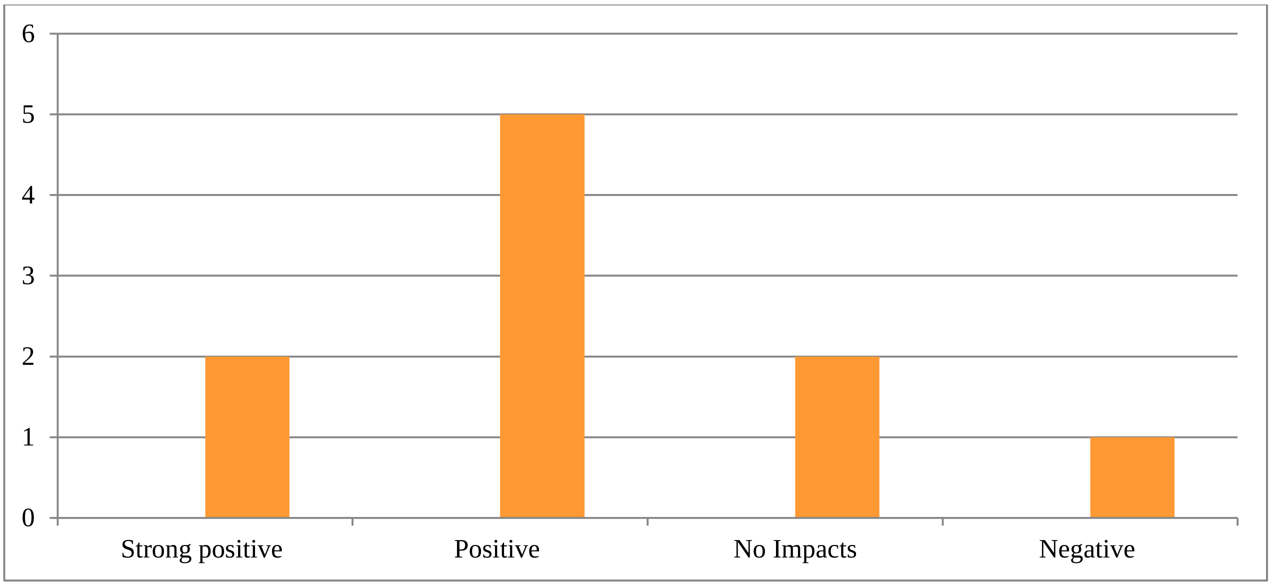


Figure 14. Type of impacts, and their degree, reported in each study, for the category of Ecosystem Services

The most used indicator to measure the impacts on Ecosystem Services was "Fire Incidence" (n=2). "Air pollution", "Coarse woody debris", and "Biomass" are indicators employed by publications that scored high on both rigour and quality, and therefore their results are reported below.

Indicator: Fire Incidents and Air Pollution

Two studies investigated the impacts of FSC on fire incidents: Kalonga et al., (2015) reported evidence of strong positive impacts in two FSC certified community forests in Tanzania; and Miteva et al.,(2015), could not find any statistically significant impacts. Out these two, only Miteva et al.(2015) scored high on both rigour and quality assessment.

As previously reported in the section dedicated to Flora, this study evaluated the performance of FSC certified logging concessions in Indonesia, compared to non-certified ones, over an eight year-period, from 2000 to 2008. With a quasi-experimental design, the study used secondary data such as MODIS Vegetation Continuous Fields datasets and NASA FIRMS datasets, combined with triple difference matching estimators to establish the causal impact of the intervention. The study showed that FSC had no effect on fire events; however, FSC certified logging concessions had 31% less air pollution compared to the non-certified ones.

Indicators: Coarse woody debris volumes, and Biomass

The indicators of "Coarse woody debris volumes", and "Biomass" have been used only by one publication of Foster et al., (2008), which scored high on both rigour and quality. In the three FSC certified sugar maple stands analyzed in comparison with three non-certified stands both with partial harvest treatment, and six unharvested reference stands; the study found that certified stands had significantly higher volumes of coarse woody debris, compared to the non-certified stands, although these volumes were smaller than those in natural mature forests. Moreover, both certified and uncertified reference stands, decreased biomass by one-third compared to the six unharvested reference stands, lowering the potential economic value of carbon storage by 25-30%.

4.3. Summary of the reported impacts

Table 3 on the next page, provides an overview of how many studies reported positive, negative, and no impact, and for which indicator. Each study is differentiated in the table according to its rigour and quality assessment. Moreover, the table provides an indication of the degree of impacts (i.e., strong, average, weak), based on what was reported by the authors in each paper.

Without considering rigour and quality scores, across the three environmental categories, overall, eleven publications demonstrated strong positive impacts, seven papers reported evidence of positive impacts, seven publications could not find any impacts, and four papers showed mixed impacts (Elbakidze et al., 2011; Foster et al., 2008; Johansson et al., 2011; Miteva et al., 2015).

The main category for which studies consistently reported (strong) positive impacts is Fauna. As explained in section 4.2.2, these positive impacts can be achieved if strict hunting regulations are in place inside the certified logging concessions, and if a relative unfragmented landscape surrounds the certified concessions. For the category of Flora the reported impacts are highly diversified, ranging from strong positive impacts, to average positive impacts, to no impact, and to negative impacts. The most employed indicators were "Deforestation" principally used by studies investigating the impacts of forest certifications in tropical forests; and "Areas set-asides", mainly used by studies analyzing the impacts in boreal forests.

For the category of Ecosystem Services, the majority of the studies provided evidence of average positive impacts; however, there is also evidence of strong positive impacts for the indicators of "Air pollution", and "Coarse woody debris volumes". Negative impacts were reported for the indicator of "Biomass", no impacts were found for "Carbon emissions", and mixed results were obtained for the indicator of "Fire incidents".

As far as rigour and quality scores are concerned, out of the twenty-nine publications included, only five scored high on both rigour and quality (Blackman et al., 2018; Foster et al., 2008; Kalonga et al., 2016; Miteva et al., 2015; Rana et al., 2018). One publication, Simonsson et al.,(2016), had a medium score for both quality and rigour; and no publication had a low score in both assessments. Other combinations highlighted in the table are: High quality- Low rigour (n=11); Medium quality- Low rigour (n=3); Medium quality- High rigour (n=2); High quality –Medium rigour (n=4); and not applicable for quality assessment-low rigour (n=3). This last combination refers to the three Ecosystem Services Certification Documents (ESCDs), for which it was not possible to apply the quality assessment. These three documents are shown in the table as white circles, with a red outline (i.e., low rigour) (Table 3).

If we consider the reported impacts of the studies that scored high on both rigour and quality, the evidence for the category of Flora is largely inconclusive. Impacts on Deforestation range from strong positive impacts (Miteva et al., 2015), to average positive impacts (Rana et al., 2018), to no impact at all (Blackman et al., 2018). Just one study investigated the impacts on Forest Degradation, Foster et al., (2008); that, however, could not find any statistically significant impacts of FSC on “live tree characteristics”. As far as Floral Biodiversity is concerned, the only study that scored high on both rigour and quality is Kalonga et al., (2016), who reported strong positive impacts of FSC on “Tree species richness, diversity, and density” in two certified community forests in Tanzania, in comparison with open access forests, and state forest reserves.

The reported evidence for the environmental category of Ecosystem Services shows mixed impacts as well. Each one of the studies that scored high on both rigour and quality, used different indicators for this category, and therefore it is not possible to provide a clear answer. Strong positive impacts were found for the indicators of “Air pollution” and “Coarse woody debris volumes”; no impacts were reported for “Fire Incidents”, and negative impacts were demonstrated for the indicator “Biomass”.

As far as the environmental category of Fauna is concerned, no study scoring high on both rigour and quality could be found. (Table 3).

Table 3. Overview table on the reported impacts of FC. Studies are classified according to their rigour and quality assessment scores

CATEGORIES	INDICATORS	NEGATIVE: Strong Negative	NEGATIVE: Average Negative	NEGATIVE: Weak Negative	NO IMPACT	POSITIVE: Weak positive	POSITIVE: Average Positive	POSITIVE: Strong positive
FLORA	Areas set-aside				21, 10		9	26, 9
	Broad-leaved trees				13			13
	Cover, richness and diversity of Mediterranean shrublands							5
	Deforestation				1, 22		24	19
	Environmentally important areas				21			
	Floristic composition						16	
	Forest disturbance		19					29
	Forest structure				18			14
	Live tree characteristics				11			
	Mature stands							17
	Old growth forests				13			13
	Potential functional habitat connectivity				10		9	9
	Seedling recruitment				25			
	Structural habitat connectivity				10		9	9
	Structure, composition and diversity of plant communities							2
	Tree species richness, diversity and density							15
	Trees and high stumps left in the plots				21			
FAUNA	Bird species							7
	Mammal richness						23, 20	7, 28, 27
	Species richness							3
ECOSYSTEM SERVICES	Air pollution							19
	Biomass		11					
	Carbon emissions				12			
	Carbon storage						8	
	Coarse Woody Debris Volumes							11
	Dead wood						13	
	Ecological condition of Mediterranean streams						4	
	Fire incidence				19			14
	Watershed services						6	

Type of Impact and Degree of Impact

Rigour Assessment Score
- Low (0 – 10)
- Medium (11-12)
- High (13- 23)

Quality Assessment Score
- Low (0 – 7)
- Medium (8-10)
- High (11-13)

1. Blackman et al., 2015
2. De Iongh et al., 2014
3. Dias et al., 2013
4. Dias et al., 2015
5. Dias et al., 2016
6. ESCD, Indonesia, 2016
7. ESCD, Indonesia, 2017
8. ESCD, Indonesia, 2017
9. Elbakidze et al., 2011
10. Elbakidze et al., 2016
11. Foster at al., 2008
12. Griscom et al., 2014
13. Johansson et al., 2011
14. Kalonga et al., 2015
15. Kalonga et al., 2016
16. Kukkonen et al., 2009
17. Lõhmus et al., 2010
18. Medjibe et al., 2013
19. Miteva et al., 2015
20. Mohamed et al., 2013
21. Nordén et al., 2016
22. Panlasigui et al., 2015
23. Polisar et al., 2017
24. Rana et al., 2018
25. Rivett et al., 2016
26. Simonsson et al., 2016
27. Sollmann et al., 2017
28. Tobler et al., 2018
29. Tritsch et al., 2016

4.4. Governance mechanisms and contextual factors

Out of twenty-nine publications included in this SLR, nine did not report any information on governance mechanisms and contextual factors. The remaining twenty papers did actually provide some data, however it was still not possible to answer to all the queries in the data extraction form. Out of these twenty papers, sixteen reported on governance mechanisms and contextual factors, and four focused only on contextual factors. Here I reported the governance mechanisms and contextual factors presented on each paper, despite its rigour and quality assessment, that are associated with (strong) positive impacts.

Within the governance mechanisms, in the category “institutions”, the most reoccurring mechanisms are “The certified FMUs are effectively monitored” (n=6); “There are strict hunting regulations in place within the certified forests” (n=4); “Enforcement is verified by a third-party auditor” (n= 3); and “The national standard content comprises indicators for different spatial scale of biodiversity conservation” (n= 2).
In the category of “information”, the main reported mechanisms are “Forest managers are educated about biodiversity issues” (n=2); and “Forest managers changed their management practices after being certified” (n=2). In the category of “incentives”, the principal mechanisms that emerged from the publications are “Forest managers experienced price premium”(n=4), and “Forest managers wanted to be certified for economic reasons” (n=2).

Within the contextual factors, in the category “Political Factors” the main reported queries are “National legislation already prescribed sustainable management practices” (n=9); “The government enforces forestry laws”(n=8); “The national legislation supports the uptake of forest certifications” (n=6); “NGOs support and assist forest companies and forest owners in becoming certified” (n=6); “The national forestry law is compatible with forest certification standards” (n= 4). In the category of “ Biophysical Factors”, the most cited elements are “The certified forest is a hotspot for biodiversity (n=9); “The area set aside for conservation purpose is of high conservation value” (n=3); and “The certified forest is surrounded by a relative unfragmented landscape” (n=3).

Figure 15 on the next page displays the theory of change presented at the second chapter of this thesis, updated with the elements that emerged from the included publications. The assumptions under the section “Input” were left unchanged because these are general factors that actually lead to the creation of Forest Certifications at the beginning of the 1990s. The assumptions under “Output” also remained unaltered, because I did not have any data to inform that section of the theory of change. However, the sections of “Outcome” and “Input” were updated, and this is why these are highlighted. Within both sections, no publication provided some data on the perspective of consumers, as well as on marketing and advocacy campaigns, and thus these assumptions were eliminated from the final theory of change.

Finally, the section concerning “Contextual Factors” is also highlighted, since it was possible to update the categories of “Political Factors”, and “Biophysical Factors”.

Theory Input

Non-state actors from different sectors (environmental, social and economic) aim at achieving responsible forest management, by providing market incentives.

Theory Output

In 1993, FSC was created. In 1999, PEFC was developed as well. Both forest certification schemes comprise international and national principles, criteria, and indicators to guide and implement sustainable forest management.

Tested Outcome

The certification schemes are adopted by logging companies and forest owners that choose to be certified. Forest are managed according to sustainability standards.

Tested Impacts

The certification schemes are adopted by logging companies and forest owners, particularly in the boreal and temperate biome. Forest certifications have beneficial effects for the three environmental categories examined, Flora, Fauna, and Ecosystem Services.

Theory Assumptions

Institutions: Non-state actors react to the inadequacy of governments to halt deforestation, forest degradation, and the consequent loss of biodiversity and ecosystem services.

Incentives: Non-state actors aim at achieving positive impacts by relying on market incentives.

Information: Environmental NGOs create advocacy campaigns to spread information on what has been defined as the "Sixth major mass extinction in the Earth's history". The alarming data on deforestation, and massive biodiversity loss sensitize citizens, and spark action to seek high-quality forest management, and sustainable extraction of forest resources.

Theory Assumptions

Institutions: Stakeholders participate in the creation of principles, criteria, and indicators to obtain environmental, and socio-economic benefits. The process is participatory, democratic and transparent. Stakeholders foresee monitoring mechanisms to verify the compliance and enforcement of these standards on the ground. The standards will be periodically revised.

Incentives: Producers will be incentivized with price premium, increased market access, exposure to new clients, improved reputation, and long-term sustainability of production.

Information: Consumers are informed with marketing and advocacy campaigns about the importance of buying certified products.

Tested Assumptions

Institutions: The national standard content comprises indicators for different spatial scale of biodiversity conservation; There are strict hunting regulations in place within the certified forests; The certified FMUs are effectively monitored; Enforcement is verified by a third-party auditor.

Incentives: Forest managers want to be certified for economic reasons.

Information: Forest managers are educated about biodiversity issues.

Tested Assumptions

Institutions: The national standard content comprises indicators for different spatial scale of biodiversity conservation; There are strict hunting regulations in place within the certified forests; The certified FMUs are effectively monitored; Enforcement is verified by a third-party auditor.

Incentives: Forest managers actually experience price premium.

Information: Forest managers changed their management practices after being certified.

Updated Contextual Factors that may affect the Forest Governance Intervention outcomes

Political Context: National legislation already prescribed sustainable management practices; The government enforces forestry laws; The national legislation supports the uptake of forest certifications; The national forestry law is compatible with forest certification standards; NGOs support and assist forest companies and forest owners in becoming certified.

Biophysical Factors: The area set aside for conservation purpose is of high conservation value; The certified forest is a hotspot for biodiversity; and the certified forest is surrounded by a relative unfragmented landscape.

Figure 15. Theory of Forest Certifications. **Source**: Inspired by Samii and King (2010), and elaborated by the author.

Table 4 below indicates specifically which of the governance mechanisms is most associated with (strong) positive impacts[5]. In ten out of thirteen studies, "institutions" stand out as being particularly important. "Incentives" is the second most reported mechanism, followed by "information". If we consider the data reported in the publications that scored high on both rigour and quality[6] (i.e., the studies highlighted in the table), "institutions", still emerge as the most important mechanism (Kalonga et al., 2015; Miteva et al., 2015), followed by "incentives" (Rana et al., 2018).

Table 4. Governance mechanisms associated with (strong) positive impacts. The **x** indicate the presence of the governance mechanism. Publications that scored high on rigour and quality are highlighted in green.

Author(s)	Institutions	Information	Incentives	Degree of Impacts
ESCD, Indonesia, 2017	x			Strong positive
Kalonga et al., 2015			x	Strong positive
Kalonga et al., 2016	x			Strong positive
Simonsson et al., 2016	x			Strong positive
Sollman et al., 2017	x			Strong positive
Tobler et al., 2018	x			Strong positive
ESCD, Indonesia, 2017	x			Positive
Mohamed et al., 2013	x			Positive
Polisar et al., 2017	x			Positive
Rana et al., 2018			x	Positive
Elbakidze et al., 2011	x	x		Mixed: Strong Positive and Positive
Johansson et al., 2011		x	x	Mixed: Strong Positive, Positive, and no Impact
Miteva et al., 2015	x			Mixed: Strong positive, negative, and no Impact

[5] Johansson et al., (2011) and Miteva et al.,(2015) were included in the list because they mostly reported (strong) positive impacts, besides no impact and negative impact.
[6] This table only shows three out of the five publications that scored high on rigour and quality. Concerning the other two: One publication did not find any statistically significant impacts (Blackman et al., 2018), and the second one, Foster et al., (2008), despite demonstrating (among others) positive impacts, could not be included because it did not report any data on governance mechanisms.

To sum up, the evidence that emerged from this SLR overall points out that Forest Certifications have (strong) positive impacts on the ground, although these findings cannot be generalized (see "Discussion"). The "institutions" pertaining to both Forest Certifications appear to have a central role in increasing the effectiveness of the intervention, so much so it is the main mechanism associated with (strong) positive impacts. Specifically, three aspects of "institutions" come up from this SLR, the standard content of the certification, effective monitoring mechanisms, and the verification of compliance by third-party auditors. As far as "incentives" are concerned, the expectation of having price premium appear to be the main reason for the uptake of forest certifications and, from the evidence reported, forest certifications do actually provide price premium. Finally, "information" is the least reported mechanism although, due to the small sample of publications providing data on governance mechanisms, one must be cautious in claiming that this mechanism has no role at all in increasing the effectiveness of forest certifications.

As explained in chapter 2.3 of this thesis, while "institutions", "incentives", and "information" are important mechanisms to foster the effectiveness of a forest governance intervention, contextual factors have a critical role as well. Indeed, contextual factors can create enabling or disabling conditions for an intervention to work, or not work. From this SLR, it emerged that contextual factors that enable forest certifications to have positive outcomes on the grounds are mainly the political context, and biophysical factors. Not only should governments enforce forestry laws, but it is also important that these laws prescribe sustainable management practices, and that these practices are compatible with forest certifications standards. The role of NGOs also appeared to be important, particularly in supporting forest owners to be certified. As far as biophysical factors are concerned, a relatively unfragmented landscape surrounding the certified forests is a critical enabling factor of successful outcomes, as well as the fact that the certified forest should be a hotspot for biodiversity, and the areas set aside should be of high conservation value.

5. SLR on Community Forest Management

5.1. Methodological design of the publications included

Out of thirty-six publications included, thirty-five were published in peer-reviewed journals, and only one was grey literature. The most recurring scientific journals were World Development (n=3), International Journal of Environment and Sustainable Development (n=3), and Environmental Conservation (n=3). The complete list is provided in Appendix C. Nineteen papers were published after 2013, and no publications were found for the years 2004 and 2007 (Figure 16). Considering that this research was carried out during November 2018, it is acknowledged that potentially relevant articles published over December 2018 were left out from this systematic review.

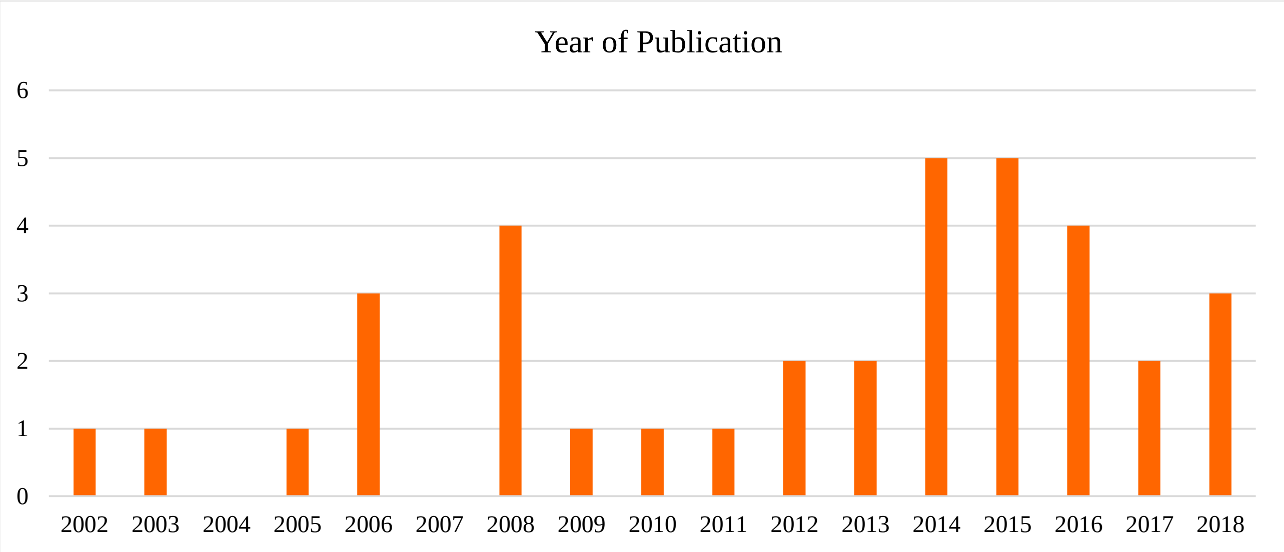


Figure 16 Year of publication of the articles included in the systematic review (n=36). Figure adapted from Bowler et al. (2012)

The design of the included papers ranges from pre-experimental (n=4), quasi-experimental (n=20), comparative case study (n=8), single case study (n=3), and to multiple case studies (n=1). The method of data collection was mainly mixed (n= 18) and quantitative (n= 15), with only three publications being purely qualitative. Mixed method of data collection generally involved the use of interviews, surveys, on the ground measurements, the use of secondary data, and statistical analysis. Quantitative methods comprised on the ground measurements and statistical analysis, whereas qualitative methods relied on direct field observations, participatory mapping, interviews, and photographs (Figure 17).

Thirty publications assessed the environmental impacts of the intervention against a baseline or a reference point. Among these, five papers used baseline data before the intervention was implemented, with a specified year (Ameha et al., 2016; Bluffstone et al., 2018; Gbedomon et al., 2016; Lupala et al., 2015; Takahashi&Todo 2012), six papers had a baseline before the programme started, but without specifying the year (Mohammed et al., 2016; Pandit & Bevilacqua 2011; Patel et al., 2006; Persha and Blomely 2009; Santika et al., 2017; Sudha et al., 2006); five papers used both baseline data before the intervention with a specified year, and a reference year after the programme started (Kedir et al., 2018; Lund et al., 2014; Mbwambo et al., 2012; Nagendra et al., 2008; Niraula et al., 2013); and, finally, fourteen publications used a reference year after the implementation of CFM. Only six papers did not report any baseline or reference point (Aggarwal et al.,2006; Arts and De Koning, 2017; Baland et al., 2010; Blomley et al., 2008; Paudel and Sah, 2015; Tadesse et al., 2016).

Twenty-seven publications did not address any type of bias. However, two publications reported confounding bias (i.e., failure to include potential confounding factors in the analysis) (Mbwambo et al., 2012; Acharya, 2003), one paper indicated selection bias (i.e., non-random selection) (Ameha et al., 2016), and three papers reported different type of bias, ranging from estimation bias (i.e., when a measurement technique or instrument can overestimate or underestimate the true value of the measurement) (Lund et al., 2014), to endogeneity bias (i.e., failure to include relevant characteristics of forests and forest communities in its analysis) (Baland et al., 2010), and to cognitive bias (i.e., type of bias that might occur when results are based on memory and perceptions) (Gbedomon et al., 2016). In three cases, authors checked for a possible bias in their analysis, but no additional details were provided in the results and discussion section (Rasolofoson et al., 2015; Santika et al., 2017; Takahashi&Todo, 2012) (Figure 17).

All thirty-six publications in this review provided some information concerning governance mechanisms and contextual factors that might influence the environmental outcomes of the programme. However, only twelve papers included these factors in their analysis, while the remaining twenty-four publications did not. Finally, just one paper investigated possible spillover effects in the adjacent forests (Baland et al., 2010).

Except for three cases (Thapa et al.,2018; Paudyal et al., 2015; Mazunda & Shively, 2015), all the papers evaluated the environmental impacts of community forest management in comparison with a reference group. The most frequent comparison was with a forest area without the intervention (n=7) and "Before and after the programme" (n= 5). Equally frequent were papers without a reference group (n=3), and publications that compared two types of CFM (n=3). Seven papers compared the environmental outcomes of the programme against those of forests managed by the State, and only two papers compared the performance of CFM with protected areas. The complete list of the reference group can be found in Appendix C.

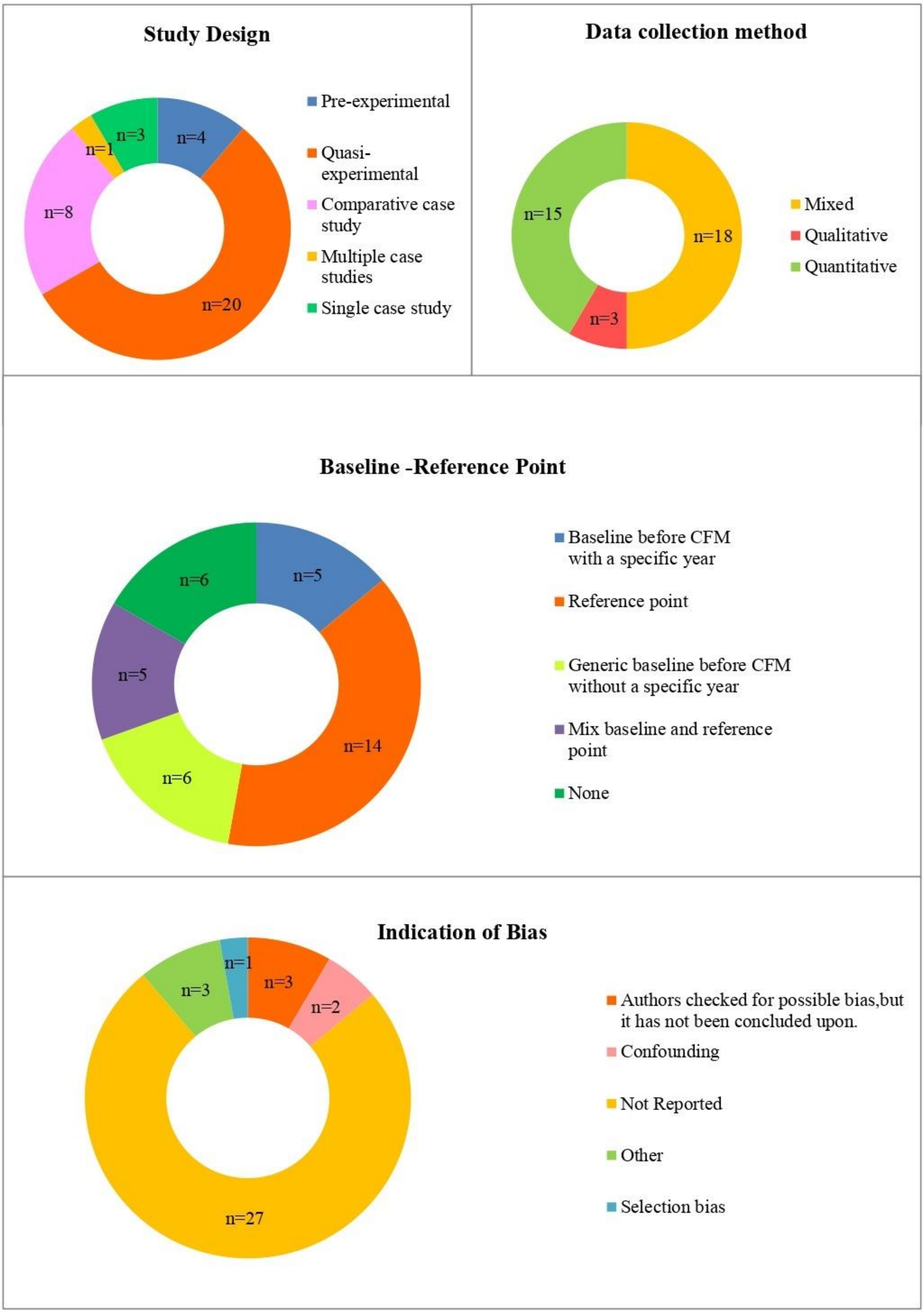


Figure 17. Methodological design of publications included in the SLR on CFM

5.1.2. Quality Assessment

As shown in Figure 18 below, eighteen papers scored fairly high, from eleven to thirteen; thirteen papers had a medium score, from eight and ten; and only five publications had a low score, from six to seven (Acharya, 2003; Aggarwal et al., 2006; Mohammed et al., 2016; Nagendra et al., 2002; Patel et al., 2006) .

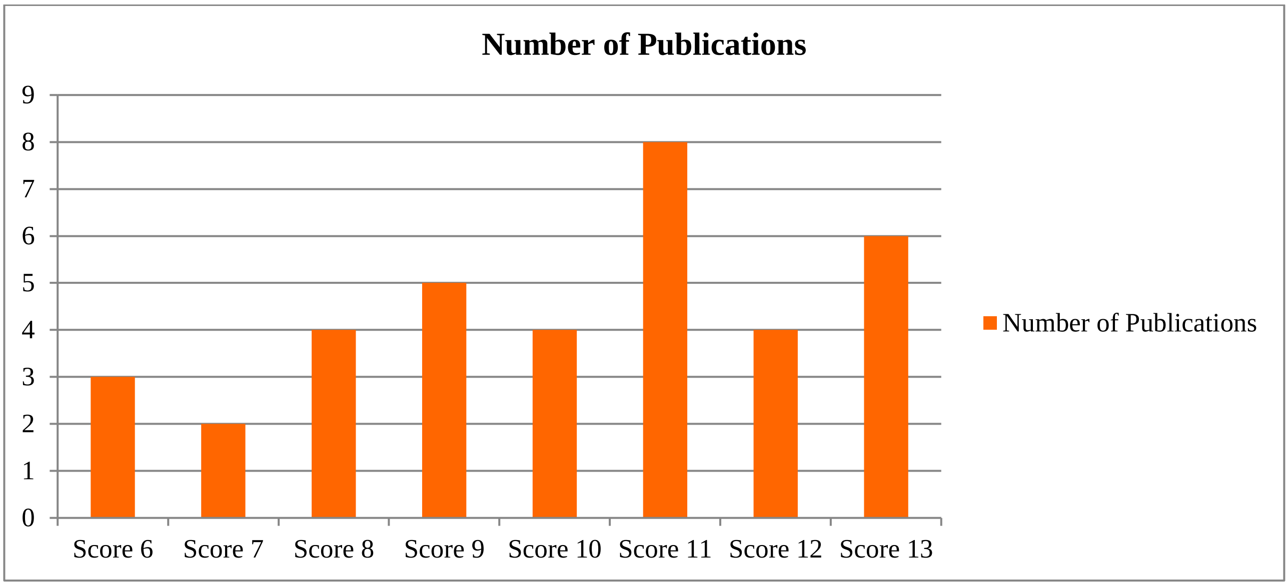


Figure 18. Ranges of scores for the quality assessment of the publications included in the systematic review

These five publications scored low (values of zero and one) for three quality indicators, such as "Clarity of sampling plan"; "Clarity of sampling size"; and "Clarity of analysis method".

In general, the main indicator in which the majority of the papers scored consistently low was "Clarity of the limitations". Twenty-two papers did not specify the limitations of their research, five publications briefly mentioned some limitations but without elaborating in details, and nine papers addressed their limitations appropriately. On the other hand, thirty-four publications clearly specified their research aim, and just two papers mentioned their research aim unclearly (Patel et al., 2006; Sudha et al., 2006). A complete overview of the quality assessment of each paper is provided in Appendix C.

5.1.3 Methodological rigour assessment

As reported in Figure 19 below, out of thirty-six publications, fourteen scored fairly low on the rigour assessment, from eight to ten, with the majority of the publications scoring eight (n=7). Eleven papers had a medium score, from eleven to twelve; and eleven papers scored fairly high, from thirteen to twenty. The only publication scoring twenty (Bluffstone et al., 2018) was the only one which respected the “gold standard” principles for most of the rigour indicators. None of the publications reached the maximum points of twenty-three.

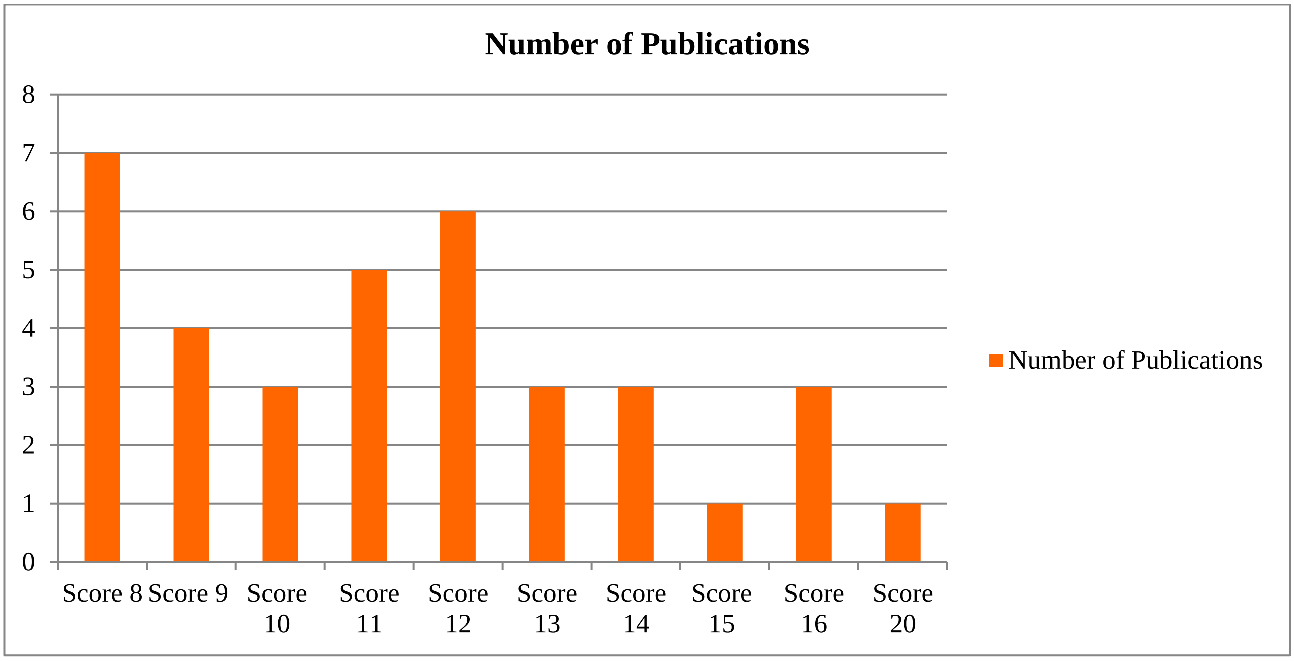


Figure 19. Ranges of scores for the rigour assessment of the publications included in the systematic review

In general, the rigor indicator in which the majority of the publications scored zero was for “Use of statistical techniques to establish the causal impact of the programme” (n= 23). On the other hand, thirty-three publications used a reference group; sixteen papers had a baseline before the beginning of the programme, including two papers which also provided the baseline conditions of the comparator sites (Bluffstone et al., 2012; Mbwambo et al., 2012); eighteen publications evaluated the impacts of the intervention in the long run, ranging from a minimum of ten years until twenty-five years; and all thirty-six papers provided information on contextual factors and governance mechanisms that might have influenced the results of the programme. A complete overview of the rigour assessment of each study is provided in Appendix C.

5.1.4 Description of the publications

The geographic location of the community forests analyzed in the publications covers mainly the tropical biome (n=30), and the temperate one (n=6). No papers analyzing the environmental impacts of CFM in the boreal biome have been identified.

The most frequent forest species and type investigated are *Shorea Robusta*, particularly in Nepal; Dry miombo woodlands and dry Afromontane forest in Tanzania, Malawi, and Ethiopia; Plantations in India, Bangladesh and Philippines; and intact natural forests in Indonesia, Nepal and India (Appendix C).

The majority of the publications (n= 12) analyzed the impacts of CFM in Nepal (60,130.17 ha); Tanzania (n= 6) (3,780,087.60 ha, approximately); Ethiopia (n=4) (132,009.61 ha); and India (n=5) (187,745.00 ha) (Figure 19). Despite eight publications not reporting the area size, overall, the reported area investigated is 5,809,822.84 ha, which is 0,79% of the total area managed under CFM in the world (around 732 million hectares according to FAO, 2016).

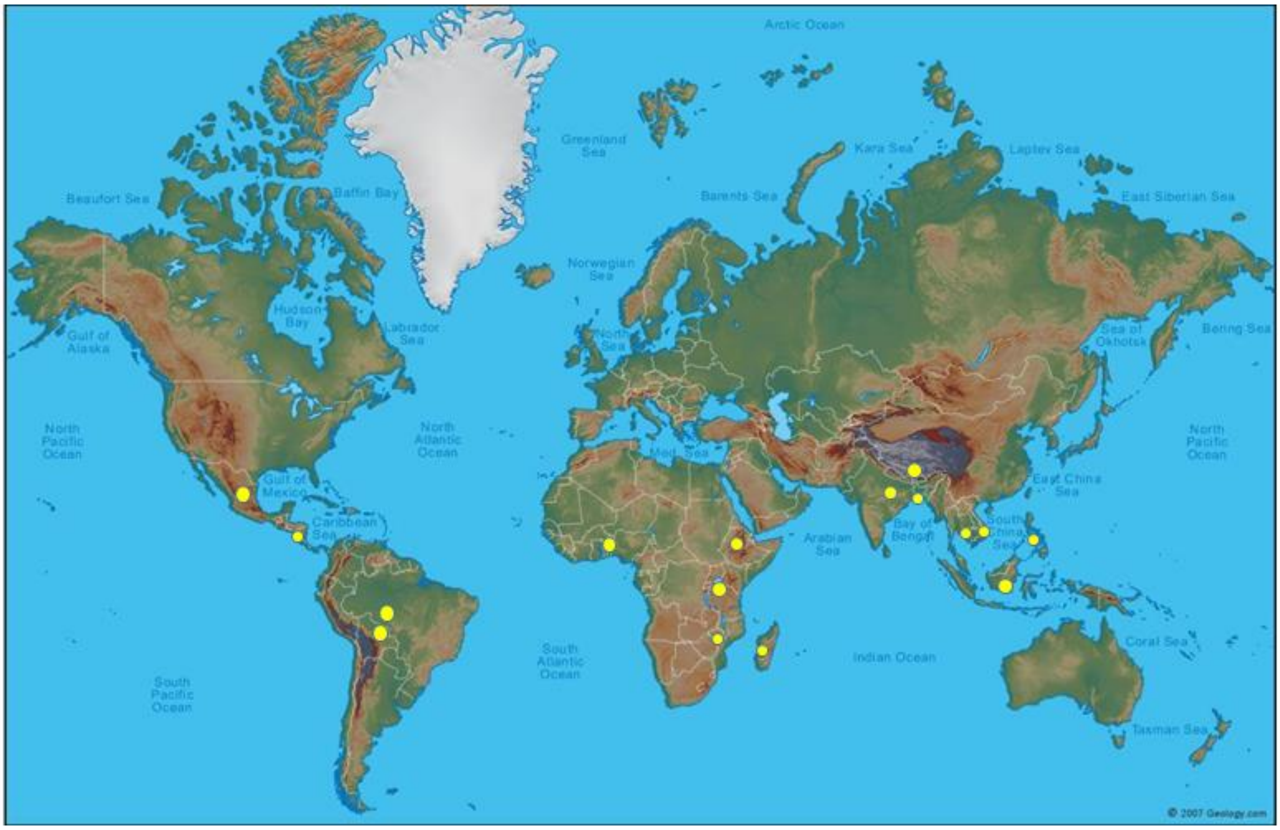


Figure 20. Geographic area of the included studies

The majority of the publications (n=23) measured the impacts of CFM from a minimum of five years to a maximum of twenty-five years, since the beginning of the programme. Five papers were short-term studies (less than five years), including one paper that investigated the condition of community forests within the same year of the beginning of the programme (Nagendra, 2002); and for eight papers it was not possible to determine the time scale of the analysis.

5.2 Reported environmental impacts

Over the total area studied, strong positive impacts have been demonstrated in 452,077.61 ha (n=10); positive impacts have been found in 4,643,089.38 ha (n=16); no impacts have been reported in 709,193.15 ha (n=6); negative impacts have been identified in 140.60 ha (n=1); and mixed impacts (i.e., positive, negative, and no impacts) have been identified in 5,322.1 ha (n=3).

The main environmental category examined is Flora (n= 33) followed by Ecosystem Services (n=12) and Fauna (n= 2).

5.2.1. Reported impacts on Flora

Out of the thirty six publications included in this systematic literature review, twenty-four papers investigated the impacts of community forest management only on Flora. Additional data could be extracted from seven publications that evaluated the impacts of CFM on mixed environmental categories, such as Flora and Ecosystem Services, and from two papers that investigated the impacts on Flora, Fauna and Ecosystem Services. Therefore, in total, thirty-three studies provided information on the impacts of CFM on Flora. Out of these, eleven studies reported evidence of strong positive impacts, sixteen found positive impacts on the ground, five studies showed evidence of no impacts, three studies presented mixed outcomes, both positive and without any impact (Arts and De Koning, 2017; Persha and Blomley, 2009; Nagendra et al., 2005). Only one publication demonstrated negative impacts (Acharya K.P., 2003) (Figure 21).

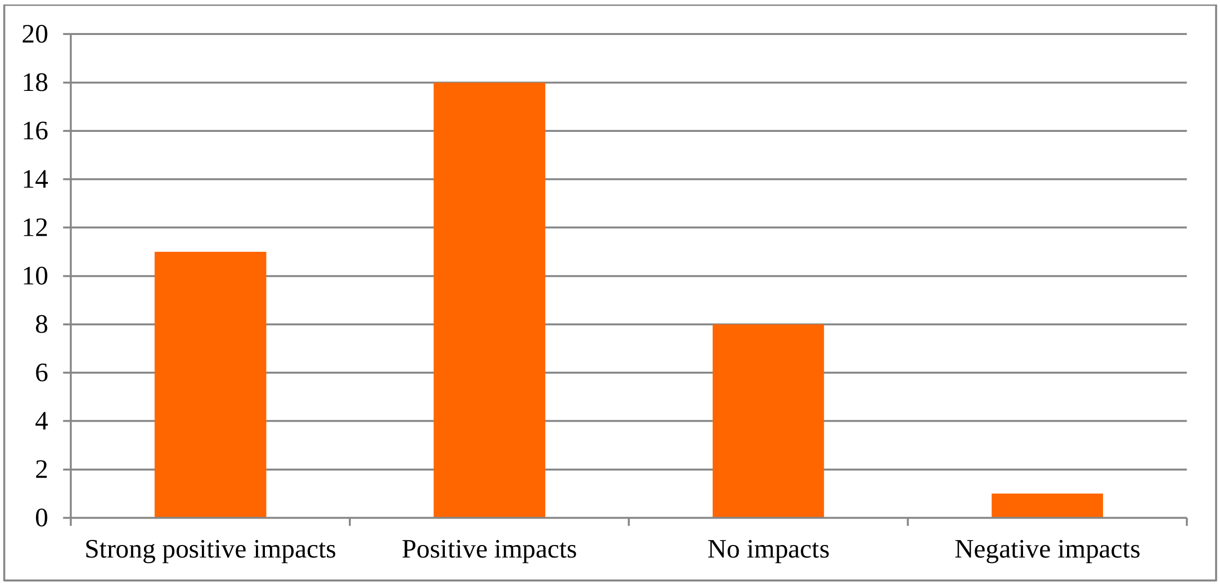


Figure 21. Type of impacts, and their degree, reported in each study, for the category of Flora

As already explained in chapter 3.5 and chapter 4.2.1, I am now going to present results based on specific indicators, classified according to whether these were used to assess the level of forest degradation, deforestation, or floral biodiversity. Among the papers that employed the most used indicators, I focused specifically on the evidence reported in the publications that scored high on both rigour and quality assessment. If I had publications that scored high on both rigour and quality, but employed a "hardly used" indicator, I still provided the results of those papers. For the category of Flora, the main indicators used to examine the impacts of the intervention are "Forest Condition" (n=9), "Deforestation" (n=8), "Basal Area" (n=5), "Tree Density" (n=4), "Forest Cover" (n=3), and "Forest Biodiversity" (n=3).

"Canopy cover" (n=1) has been used just by one publication. Since this publication scored high on both rigour and quality, I reported its evidence in the following sections.

A) Forest Degradation

Indicator: Forest Condition

Out of nine papers examining the impacts of community forest management on forest condition, two papers indicated strong positive impacts (Måren et al., 2013; Tadesse et al., 2016), four papers showed evidence of positive results (Blomley et al.,2008; Lambrick et al.,2014; Lund et al.,2014; Treue et al.,2014); two papers reported mixed outcomes, both positive and no impacts, (Arts and De Koning, 2017; Persha and Blomley, 2009), and one paper did not find any type of impacts (Nagendra, 2002).

Among these publications, only two scored high for both quality and rigour assessment, these are Treue et al., (2014) and Lund et al., (2014). In the first case, with a quasi-experimental design, this study aimed at evaluating whether participatory forest management in Tanzania succeeds in managing forest resources sustainably. After seventeen years since the implementation of community-based forest management and joint forest management, the paper reports that forests were managed sustainably enough to support forest regeneration. Still, these positive results are achieved at the expense of neighbouring forests (non-PFM), where villagers extract the woody products that they need. Despite the fact that these activities are somehow sustainable, the paper concludes that in order to be sustainable in the long run and to meet the needs of the villagers, PFM forests should be larger and include fast-growing species (Treue et al., 2014). In the second case, Lund et al., (2014) evaluated the impacts of community forest management on forest condition, forest disturbance, and forest growth, in two neighbouring villages in Tanzania, Kiwele and Mfyome. By using both primary and secondary data, the study found that the two forests were in decent conditions compared to before the implementation of the programme; however, the level of forest disturbance was higher in Kiwele, and lower in Mfyome. This difference was probably due to different priorities in conservation policies and forest extraction practices inside the two villages. In both cases, the programme fostered higher controls inside the forests, and higher taxation on forest resources extraction.

Indicator: Basal Area

Out of five papers examining the impacts of CFM on basal area, three papers indicated strong positive impacts (Aggrwal et al., 2006; Patel et al.,2006; Sudha et al.,2006), and two papers reported positive impacts (Lupala et al., 2015; Mbwambo et al., 2012).

Considering the reported impacts of Lupala et al., (2015) and Mbwambo et al., (2012) – the two papers scoring high on both quality and rigour assessment- the results are positive (average degree).

Lupala et al.,(2015) analyzed the potential of climate change mitigation of community-based forest management in miombo woodlands in Tanzania, compared to open access forests. By using on the ground measurements combined with satellite images, the paper found that after thirteen years since the implementation of the programme, CFM forests have higher stem density, increased basal area, biomass and carbon stock, compared to non-CFM sites, and before the beginning of the intervention. Finally, the programme has fostered the sustainable management of natural resources and the enforcement of local bylaws, even in non-CFM areas.

Mbwambo et al., (2012) analyzed the impact on forest resources of Joint Forest Management and Community-based Forest Management, in comparison with State forest management. In over fourteen years since the implementation of the two programmes, the paper reports that the basal area, the number of stems, the biomass and carbon stock of forests resources are somewhat similar across the two interventions (JFM and CBFM), and these are slightly better than state forests. However, the paper warns to not generalize the results as, because of several confounding factors, it is not possible to fully attribute the positive results to both types of interventions.

Indicator: Tree density

Out of four papers investigating the impacts of CFM on tree density, three studies reported evidence of strong positive results (Aggarwal et al., 2006; Patel et al., 2006; Sudha et al., 2006) and one paper did not report any type of impacts (Paudel&Sah, 2015). However, none of these publications scored high on both rigour and quality assessment.

B) Deforestation

Indicator: Deforestation

Out of eight papers investigating the impacts of CFM on deforestation, two papers reported strong positive impacts (Ellis&Porter-Bolland, 2008; Kedir et al.,2018); three indicated positive impacts (Mazunda& Shively, 2015; Santika et al.,2017; Takahashi and Todo, 2012); one paper reported mixed outcomes, ranging from strong positive impacts to no impacts (Nagendra et al., 2005); and two studies did not find any type of impact (Bray et al.,2008; Rasolofoson et al., 2015).

If we consider only the evidence of the papers that scored high on both quality and rigour assessments, Rasolofoson et al., (2015) and Santika et al., (2017), the results are definitely mixed. Both cases are quasi-experimental studies that used Landsat Imagery and statistical techniques such as matching, to analyze the effectiveness of CFM at decreasing deforestation.

Rasolofoson et al.,(2015) examined all community forest management areas established in Madagascar between 2000 and 2005, compared to non-CFM sites. Within the CFM areas, the researchers differentiated between CFM sites that allow commercial use of forest resources with CFM sites that do not allow it. Overall, the study does not find any statistically significant impacts between CFM areas and non-CFM sites. However, results show that CFM with commercial use had 1.83% more deforestation between 2000 and 2010, compared to non-CFM forests. On the other hand, non-commercial CFM decreased deforestation by 2.01% compared to non CFM areas, and compared to commercial CFM, there was a deforestation reduction of 5.59%.

Santika et al., (2017) examined the performance of community forestry in Sumatra and Kalimantan in avoiding deforestation in undisturbed natural forests, between 2012 and 2016. The study found a positive but moderate impact in avoiding deforestation across time and space. Whenever a *Hutan Desa* (village forest) had a poor performance, it was due to climatic factors (i.e., El Niño), and anthropogenic factors (i.e., agricultural pressure, and palm oil plantations).

Indicators: Canopy Cover and Forest Cover

If we consider canopy cover and forest cover as additional indicators of deforestation, there are other five papers to take into account. Of these five papers, two studies evaluated the impacts of CFM on canopy cover (Baland et al., 2010; Thapa et al., 2018), and three studies investigated the impacts on forest cover (Mohammed et al., 2016; Nagendra et al., 2008; Niraula et al., 2013).

For canopy cover, studies showed mixed results, ranging from strong positive impacts (Thapa et al., 2018), to no impact (Baland et al., 2010). For forest cover, results are all positive, ranging from strong positive impacts (Niraula et al., 2013) to average positive impacts (Mohammed et al., 2016; Nagendra et al., 2008).

Out of these studies, only one study scored high on both rigour and quality assessment, Baland et al., (2010). This study used a quasi-experimental design to evaluate the status of forest managed by *Van Panchayats* (local forest councils), compared to open access and protected forests, in the Indian state of Uttaranchal. The study examined three hundred and ninety-nine forest areas representing the whole mid-Himalayan region, and controlled for possible spillover effects in adjacent forests. Forests under *Van Panchayats* were 22% less looped compared to other forests without the programme, but in terms of canopy cover, biomass and regeneration, no statistically significant differences have been found between forest areas under the programme and non-CFM forests. Moreover, the study did not find any negative spillovers in adjacent forests without the programme. However, the study warns that as a failure to include relevant characteristics of forests and forest communities in its analysis, these results might be affected by endogeneity bias, which could severely underestimate the possible benefits of CFM on forest quality.

c) Floral Biodiversity

Indicators: Forest biodiversity, Shrubs and Tree Species

Three papers included in this systematic review measured the impacts of CFM on biodiversity (Gbedomon et al., 2016; Acharya K.P., 2003; Paudyal et al., 2015). Results are definitely contrasting, as they range from strong positive impacts (Paudyal et al., 2015), to positive impacts (Gbedomon et al., 2016), and to negative impacts (Acharya K.P., 2003). This latter reported evidence of negative impacts for shrubs and tree species in the two community forests user groups included in the analysis. In over 20 years, the biodiversity of shrubs and trees drastically declined, as the user groups selected only species that have either economic, medicinal or spiritual values. Despite having in place measures to protect biodiversity, the study reported that 100% of the shrub species, and 61% of the tree species were not favoured by the community, slowing turning the mixed Sal forest into a monoculture. However, by assuming that only forest management regimes affect the outcome of the programme, the results of this study might be biased by confounding factors.
In general, none of these publications reached a high score for both rigour and quality assessment.

5.2.2 Reported impacts on Faunal Biodiversity

Indicator: Wildlife Abundance

Out of thirty six publications, only two studies evaluated the impacts of community forest management on Fauna. The main indicators used were “Wildlife Abundance” (n=2), and “Wildlife Species” (n=1). Of these two studies, one reported evidence of strong positive impacts (Thapa et al., 2018), and the second demonstrated positive impacts (Pandit&Bevilacqua, 2011) (Figure 22).

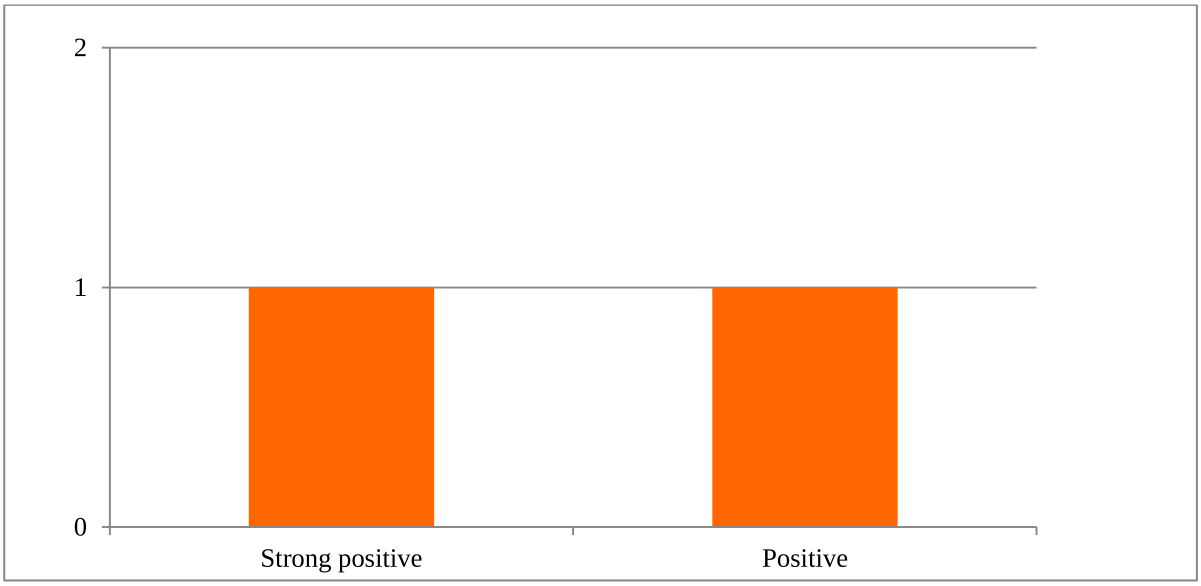


Figure 22 Type of impacts, and their degree, reported in each study, for the category of Fauna

Both studies were carried out in Nepal, and both studies evaluated the impacts after more than thirteen years since the programme has been implemented. However, neither of these studies scored high in both rigour and quality assessment.

5.2.3 Reported impacts on Ecosystem Services

Out of thirty six publications included in this systematic review, only three analyzed the impacts of community forest management purely on ecosystem services. Seven publications investigated the impacts on mixed environmental categories, such as Flora and Ecosystem Services, and two publications evaluated the impacts on Flora, Fauna, and Ecosystem Services. Hence, in total, twelve studies provided information on the impacts of CFM on Ecosystem services.

Out of these twelve studies, five reported evidence of strong positive impacts (Aggarwal et al., 2006; Patel et al.,2006; Paudyal et al., 2015; Sudha et al.,2006; Thapa et al., 2018); five found evidence of positive impacts (Birch et al., 2014; Lupala et al., 2015; Mbwambo et al.,2012; Menezes Vianna &Fearnside 2014; Panidit&Bevilacqua 2011); and two studies could not detect any type of impacts (Baland et al., 2010; Bluffstone et al., 2018) (Figure 23).

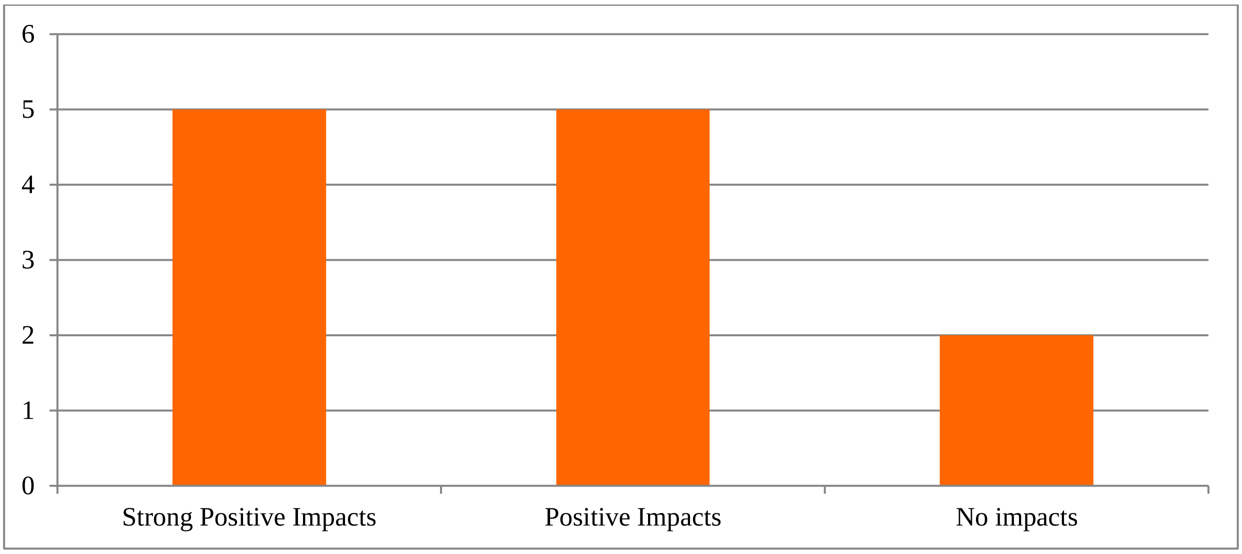


Figure 23. Type of impacts, and their degree, reported in each study, for the category of Ecosystem Services

The main indicators used for this environmental category are "Biomass" (n= 7), and "Carbon Stock" (n=4). "Carbon Sequestration"(n=1) was used just by one study. However, considering that this paper scored high on both rigour and quality, I reported its evidence in the following section.

Studies that scored high on both rigour and quality that used the indicators of "Biomass" and "Carbon Stock" are Baland et al., (2010), Lupala et al., (2015), and Mbwambo et al., (2012), whose evidence has already been reported in the previous sections. I will therefore focus on the indicator "Carbon Sequestration" used by Bluffstone et al., (2018).

Indicator: Carbon Sequestration

Bluffstone et al. (2018) analyzed the effect of community forest management on carbon sequestration after twenty years since the implementation of the programme. The study used a quasi-experimental design and investigated six hundred and twenty plots (three hundred and twenty-five randomly selected plots in CMF areas, and two hundred and ninety-five in non-CFM areas) in one hundred and thirty natural forests across the middle hill and Terai areas of Nepal. The study could not find any statistically significant impact on carbon sequestration in community forests areas compared to non-CFM forests. However, the study reports that communities in non-CFM sites that have well-defined groups and that identify their group formation year store approximately seventy-three tons of carbon per hectare, compared to non-CFM sites with unclear user groups. These findings suggest that is not the programme *per se* that fosters carbon sequestration, but it is the group behaviour (i.e., collective actions) that produces positive effects on the ground.

5.3 Summary of the reported impacts

Table 5 below provides an overview of how many studies reported positive, negative, and no impacts, and for which indicator. Each study is differentiated in the table according to its quality assessment and its rigour assessment. Moreover, the table presents an indication of the degree of impact (i.e., strong, average, weak).

Without considering rigour and quality scores, across the three environmental categories examined, overall, ten publications demonstrated strong positive impacts, sixteen publications reported positive impacts, six papers could not find any impacts, one publication reported negative impacts, and three papers provided evidence of mixed impacts (Arts and De Koning, 2017; Nagendra et al., 2005; Persha and Blomley, 2009).
The main category for which studies reported only (strong) positive impacts is Fauna, whilst for Flora and Ecosystem Services impacts are highly diversified. In the category of Flora, impacts range from strong positive impacts to negative impacts, although the majority of the studies actually reported average positive impacts. The main indicators used to examine the impacts of the intervention were “Forest Condition” (n=9), “Deforestation” (n=8), “Basal Area” (n=5), “Tree Density” (n=4), “Forest Cover” (n=3), and “Forest Biodiversity” (n=3). For the category of Ecosystem Services, the majority of the studies reported average positive impacts, although there are also five studies that demonstrated strong positive impacts. Only two studies could not find any impact, specifically for the indicators of “Biomass”, and “Carbon sequestration”.

As far as rigour and quality scores are concerned, out of the thirty six publications included, only eight papers scored high in both rigour and quality assessment (Baland et al., 2010; Bluffstone et al., 2018; Lund et al., 2014; Lupala et al., 2015; Mbwambo et al., 2012; Rasolofoson et al., 2015; Santika et al., 2017; Treue et al., 2014); Five publications had a medium score in both rigour and quality assessment (Bray et al., 2008; Nagendra et al., 2008; Niraula et al., 2013; Pandit&Bevilacqua, 2011; Persha and Blomley, 2009); and four publications had a low score in both rigour and quality evaluation (Acharya K.P, 2003; Aggarwal et al., 2006; Mohammed et al., 2016; Nagendra et al., 2002). The remaining nineteen publications got mixed results. The different combinations are: high score for the quality assessment, but a low score for the methodological rigour assessment (n=5);Medium score for the quality assessment, but a low score for the rigour assessment (n=5); Low score for the quality assessment, but a medium score for the rigour evaluation (n=1); Medium score for the quality assessment, but high score for the methodological rigour (n=3); High score for the quality assessment, but a medium score for the rigour one (n=5).

If we consider the reported impacts of the publications that scored high on both rigour and quality, the evidence for the category of Flora generally indicates positive impacts on the ground. As far as Forest Degradation is concerned, all the studies point out positive impacts, in particular for the indicators of “Basal area”, “Forest Condition”, “Forest Disturbance”, and “Forest Growth”; while impacts on Deforestation are inconclusive since the evidence indicates both positive impacts (Santika et al., 2017), and no impacts at all (Rasolofoson et al., 2015; Baland et al., 2010). No rigorous studies on the impacts of CFM on Floral Biodiversity could be found.

The reported evidence for the environmental category of Ecosystem Services shows positive impacts for the indicator of “Carbon Stock”, and mixed impacts for the indicator of “Biomass”, with two studies reporting positive impacts (Lupala et al., 2015; and Mbwambo et al., 2012), and one study pointing out no impacts at all (Baland et al., 2010). Just one study measured the impacts of CFM on “Carbon Sequestration”, and it could not find any statistically significant impacts (Bluffstone et al., 2018).

As far as the environmental category of Fauna is concerned, no study scoring high on both rigour and quality could be found (Table 5).

Table 5. Overview table on the reported impacts of CFM. Studies are classified according to their rigour and quality assessment scores

		Type of Impact and Degree of Impact						
		NEGATIVE			NO IMPACT	POSITIVE		
CATEGORIES	INDICATORS	Strong Negative	Average Negative	Weak Negative		Weak positive	Average Positive	Strong positive
FLORA	Basal Area					18	15	32, 26, 2
	Canopy Cover				5			35
	Deforestation				21b, 9, 30		17, 34, 31	10, 21a, 12
	Forest Biodiversity		1				11	28
	Forest Condition				22, 4a, 29a		4b, 7, 14, 13, 29b, 36	16, 33
	Forest Cover						20, 23	24
	Forest Degradation						23	
	Forest Disturbance				29a		29b, 14	
	Forest Greenery						25	
	Forest Growth						14, 11	
	Forest Regeneration				5		25	
	Forest Structure						3	
	Lopping							5
	Shrub Species		1					
	Species Composition				27			
	Species Density						3	
	Species Diversity							32
	Species Richness				27			26, 32
	Stem Density						15	
	Tree Density				27			26, 2, 32
	Tree Species		1					
	Tree Species Diversity							2
	Woody Species Richness							16
	Woody Species Composition							16
FAUNA	Wildlife Species						25	
	Wildlife abundance						25	35
ECOSYSTEM SERVICES	Biomass				5	18	15, 19	2, 32, 26
	Carbon Stock					18	19, 15, 6	
	Carbon Sequestration				8			28
	Firewood							26, 28
	Fuel wood Availability						25	2
	Greenhouse Gas Sequestration						6	
	Landslides						25	
	Soil Conservation							28
	Soil Erosion						25	
	Water Availability						25	35
	Water Provision						6	
	Water Quality						6	
	Water Volumes						25	

Rigour Assessment Score
- Low (0 – 10)
- Medium (11-12)
- High (13- 23)

Quality Assessment Score
- Low (0 – 7)
- Medium (8-10)
- High (11-13)

1) Acharya, 2003
2) Aggarwal et al., 2006
3) Ameha et al., 2016
4) Arts et al.,2017
5) Baland et al., 2010
6) Birch et al., 2014
7) Blomley et al., 2008
8) Bluffstone et al., 2018
9) Bray et al., 2008
10) Ellis et al., 2008
11) Gbedomon et al., 2016
12) Kedir et al., 2018
13) Lambrick et al., 2014
14) Lund et al., 2014
15) Lupala et al., 2015
16) Maren et al., 2013
17) Mazunda et al., 2015
18) Mbwambo et al., 2012
19) Menezes Vianna et al., 2014
20) Mohammed et al., 2016
21) Nagendra et al., 2005
22) Nagendra, 2002
23) Nagendra et al., 2008
24) Niarula et al., 2013
25) Pandit et al., 2011
26) Patel et al., 2006
27) Paudel et al, 2015
28) Paudyal et al., 2015
29) Persha et al., 2009
30) Rasolofoson et al., 2015
31) Santika et al., 2017
32) Sudha et al., 2006
33) Tadesse et al., 2016
34) Takahashi et al., 2012
35) Thapa et al., 2018
36) Treue et al., 2014

5.4 Governance mechanisms and contextual factors

All thirty-six articles included in this systematic literature review presented some information concerning governance mechanisms and contextual factors, however, not all the queries in the data extraction forms could be answered. As I did in the previous section on Forest Certifications, also here I report on the governance mechanisms and contextual factors presented in each paper, despite its rigour and quality assessment, that are associated with (strong) positive impacts.

Within the governance mechanisms, in the category "institutions" the most reoccurring mechanisms are "Institutions include local communities in the rule-making process" (n=20); "Central institutions formally recognize tenure rights" (n=15); "Central institutions do not formally recognize tenure rights" (n=11) "Rules allow to exclude others" (n=10); "Monitoring mechanisms are effective" (n=9); "Enforcement of rule is effective" (n=6) and "Rules are locally devised" (n=2).
In the category of "information", the most reoccurring factors are "The knowledge of the community is used to manage forest resources" (n=11); "The knowledge of the community is used to develop the most appropriate institutions" (n=7); "The knowledge of the community has increased with capacity development activities implemented by NGOs" (n=2).
In the category of "incentives", studies provided information on "External donors provide financial support to implement the intervention (n=21); "The community is included in the rule-making process" (n=20); "The community can use forest products for its household needs" (n= 19); "The community can profit from managing forest resources sustainably" (n=14); "The community is allowed to use its knowledge manage forest resources (n=9); and "The community is empowered by technical assistance and capacity development activities implemented by NGOs" (n=7).

Within the contextual factors, for the category of "Forest Resource System" the main queries are: "Forest size is medium (n=14); "Forest size is small" (n=11); and "Physical boundaries are clear" (n=9).
For the category of "User Group Characteristics" the main reported queries are "Additional source of income are provided (n= 12); "The user group is small" (n=10); "The user group is medium" (n=7); "The community is moderately dependent on forest resources" (n=7); "The community is heavily dependent on forest resources" (n=5). For the category of "Demography" the main reported factor is "The community is subjected to immigration flux" (n=9). For the category of "History" the main answered query is "The community has previous experience in forest management"(n= 5). Finally, for the category of "Biophysical Factors", the main elements are "Forest is in low elevation" (n=8); "Forest is in medium elevation" (n=6); "Forest is in high elevation" (n=5); and "Rainfall per year is medium" (n= 6).

Figure 24 on the next page, displays the theory of change presented at the second chapter of this thesis updated with the elements that that emerged from this SLR. The assumptions under the sections "Input" were left unchanged, since these are general factors that actually lead to the implementation of Community Forest Management during the 1970s and 1980s (see Introduction). Under the sections "Output" and "Outcome", no publication provided information on these governance queries: "Institutions create conflict –resolutions mechanisms"; "Institutions have efficient benefit-sharing mechanisms"; "Institutions are perceived as fair and legitimate"; "Institutions foster equity and accountability", and thus they were eliminated from the final theory of change. Finally, under the section of "Contextual Factors", no information on the role of markets and technology could be found, and hence these were eliminated from the final ToC.
Each updated section of this theory of change is highlighted.

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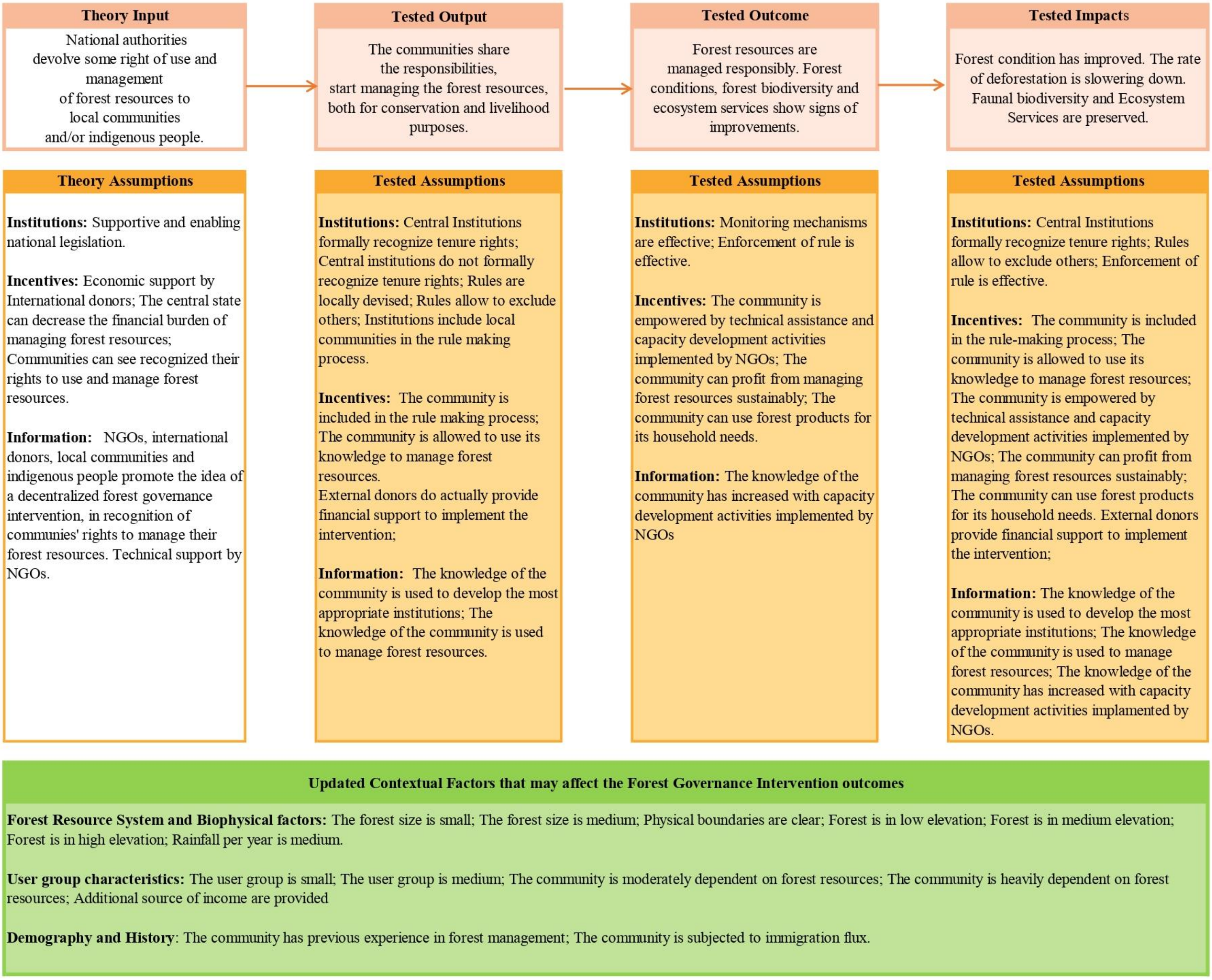


Figure 24. Theory of change of Community Forest Management. **Source**: Inspired by Samii and King (2010), and elaborated by the author.

Table 6 on the next page, indicates which are the governance mechanisms most associated with (strong) positive impacts[7]. The totality of the publications reveal that "incentives" is the main governance mechanism that fosters the effectiveness of the intervention (n=22), followed by "institutions" (n=19) and "information" (n=12). If we consider the data reported in the publications that scored high on both rigour and quality (i.e., the studies highlighted in the table), it appears that all three mechanisms are indeed necessary for the intervention to have positive impacts on the ground. In fact, with the exception of Mbwambo et al., (2012), the remaining three studies indicated "institutions", "incentives", and "information" as being associated with positive impacts (Lund et al., 2014; Lupala et al., 2015; Treue et al., 2014)[8].

To sum up, the evidence that emerged from this SLR overall points out that Community Forest Management has (strong) positive impacts on the ground, although these findings cannot be generalized (see"Discussion"). Governance mechanisms most associated with these (strong) positive impacts are mainly "incentives" and "institutions", although if we focus specifically on the publications scoring high on rigour and quality, the "information"mechanism also appears to foster the effectiveness of CFM.
With respect to the "information" mechanism of CFM, specific elements that emerged from the studies that scored high on rigour and quality, are the importance of using the knowledge of the community to develop local institutions, and the importance of using the knowledge of the community to manage forest resources. Considering that the majority of the "incentives" mechanisms that emerged from this SLR are related to the use of knowledge of the local community, the exchange of knowledge with external actors, and the creation of knowledge by external actors; it is legitimate to affirm that knowledge both as "incentives" and as "information" is definitely key for the success of CFM.

As explained in chapter 2.3 of this thesis, while "institutions", "incentives", and "information" are important mechanisms to foster the effectiveness of a forest governance intervention, contextual factors have an essential role as well, since they can create enabling conditions for the intervention to have positive impacts. From this SLR, it emerged that for CFM to work, the physical boundaries of the forests should be clear, and the size of the forest itself should range from small to medium. Moreover, the forest should be at low or medium elevation, with a medium rainfall level per year. As far as the community characteristics are concerned, the size of the user group should range from small to medium, and the community should be either moderately or heavily dependent on forest resources. Furthermore, the community should already have previous experience in forest management ,and have additional source of income. Interestingly, the fact that the community is subject to migration flux, does not seem to hamper the achievement of positive impacts (see "Discussion").

[7] Nagendra et al., (2005); Arts and De Koning, (2017); and Persha and Blomley, (2009); were included in the list because they mostly reported (strong) positive impacts, besides no impact and negative impact.
[8] This table only shows four out of eight studies that scored high on both rigour and quality. Concerning the other four: three did not find any statistically significant impacts (Baland et al., 2010; Rasolofoson et al., 2015; Bluffstone et al., 2018); and the remaining one that showed positive impacts (Santika et al., 2017) reported data only on contextual factors, and not on governance mechanisms.

Table 6. Governance mechanisms associated with (strong) positive impacts. The **x** indicate the presence of the governance mechanism. Publications that scored high on rigour and quality are highlighted in green

Author(s)	Institutions	Information	Incentives	Degree of Impact
Ellis,& Porter-Bolland, 2008	x	x	x	Strong positive
Kedir et al., 2018	x	x	x	Strong positive
Paudyal et al., 2015			x	Strong positive
Sudha et al., 2006			x	Strong positive
Tadesse et al., 2016	x		x	Strong positive
Thapa et al., 2018	x	x	x	Strong positive
Ameha et al., 2016	x		x	Positive
Birch et al., 2014	x		x	Positive
Blomley et al., 2008	x		x	Positive
Gbedomon et al., 2016	x	x	x	Positive
Lambrick et al., 2014	x		x	Positive
Lund et al., 2014	x	x	x	Positive
Lupala et al., 2015	x	x	x	Positive
Mbwambo et al., 2012	x		x	Positive
Mohammed et al., 2016		x	x	Positive
Nagendra et al., 2008	x	x	x	Positive
Pandit R., &Bevilacqua, E., 2011	x		x	Positive
Takahashi & Todo, 2012	x		x	Positive
Treue et al., 2014	x	x	x	Positive
Harini Nagendra et al., 2005	x	x	x	Mixed: Strong positive and No impact
Arts and De Koning, 2017	x	x	x	Mixed: Positive and no Impact
Persha and Blomley, 2009	x	x	x	Mixed: Positive and no Impact

6. Forest certifications impacts VS Community Forest Management impacts

One of the main goals of this thesis was to investigate how the environmental impacts compare between the two forest governance interventions analyzed. Before answering this question, I will highlight the methodological design of the publications included in the two SLRs; then I will present and compare the results of the studies that scored high on rigour and quality assessment in each systematic review; and finally I will compare the governance mechanism and contextual factors that are most associated with positive impacts in both interventions.

6.1. Comparison of methodological design

The systematic review on forest certifications comprised twenty-nine publications, which the three main biomes (i.e., boreal, temperate, and boreal), for a total area of 13,241,894.90 ha. The systematic review on community forest management, on the other hand, included thirty-six publications which, however, covered principally the tropical biome, and the temperate one, for a total area investigated of 5,809,822.84 ha.

In terms of study design, the publications included in both systematic literature reviews had in the majority of the cases a quasi-experimental design, followed by a comparative case study, pre-experimental design, and single case studies. While the main method of data collection used in the publications included in the SLR of forest certification was quantitative, for the community forest management it was mostly mixed.

Both SLRs mostly lacked publications that used baseline data before the implementation of the intervention, and in fact, in both reviews, the majority of the papers relied on a reference point after the adoption of FCs, or after the beginning of CFM. The majority of the publications, in both reviews, did not provide any indication of bias, although when it was reported, papers mostly indicated the same types of bias: confounding bias (i.e., failure to include potential confounding factors in the analysis), selection bias (i.e. non-random selection), and measurement bias (i.e., when a measurement technique or instrument can overestimate or underestimate the true value of the measurement. See Lund et al., 2014; Elbakidze et al., 2011).

For half of the publications on Forest Certifications, it was not possible to determine the time scale of the analysis, whereas half of the publications on CFM consisted of studies that evaluated the impacts of the intervention in the long run. Moreover, not all the publications on FCs reported data on governance mechanisms and contextual factors that may influence the final impacts, while all CFM publications included in the SLR actually did.

Both SLRs comprise publications that scored high on the quality assessment. The SLR on Forest Certifications included publications of somewhat better quality compared to the publications included in the SLR on CFM. In fact, none of these publications had a low score. For both parts, the main quality indicator for which most of the papers scored low is “Clarity of the limitations”. Only four papers out of twenty-nine properly addressed their limitations in the part of FCs, and only nine papers out of thirty-six did the same in the part of CFM.

Seventeen publications out of the twenty-nine included in the SLR on FCs, scored low on the rigour assessment. The main rigour indicators where these publications fell short are “Appropriate time scale of the analysis”, and “Use of statistical techniques to establish the causal impact of the intervention”. In the systematic literature review on CFM, just fourteen publications out of thirty-six scored low on the rigour assessment. Also here, the main rigour indicator in which the majority of the publications scored low is “Use of statistical techniques to establish the causal impact of the intervention”. However, generally, in both SLRs, the studies used a reference group to compare the impacts; and they included baseline data and/or a reference point to analyze the changes, if any, in the areas under the intervention. A summary of the methodological design of the publications included in both SLRs is provided in the table below.

Table 7. Summary of the methodological designs

Methodological Design	Forest Certifications	Community Forest Management
Study Design	Quasi-experimental design (n=17) Comparative case study design (n=8) Pre- experimental design (n=3) Single case study (n=1)	Quasi-experimental design (n=20) Comparative case study design (n=8) Pre-experimental design (n=4) Single case study (n=3) Multiple case studies (n=1)
Data Collection Method	Quantitative (n=22) Mixed (n=7)	Mixed (n=18) Quantitative (n=15) Qualitative (n=3)
Baseline	Reference point (n=11) None (n=10) Baseline before FCs (n=6) Mix baseline before FCs and Reference Point (n=2)	Reference Point (n=14) Generic baseline before CFM without a specified year (n=6) None (n=6) Mix baseline before CFM and Reference point (n=5) Baseline data before CFM, with a specified year (n=5)
Indication of Bias	Not reported (n=22) Confounding (n=2) Measurements bias (n=2) Selection bias (n=2) Potential spillover bias (n=1)	Not reported (n=27) Authors checked for possible bias, but it has not been concluded upon (n=3); Other (n=3); Confounding bias (n=2) Selection bias (n=1)
Time scale of the analysis	Not reported (n=14) Short term (n=7) Long term (n=6) Medium term (n=2)	Long term (n=18) Medium term (n=5) Short term (n= 5) Not reported (n= 8)
Governance Mechanisms and Contextual Factors	Information provided (n=20) Not provided (n=9)	Information provided (n=36)
Quality Assessment	High quality (n=20) Medium quality (n=6) Not applicable (n=3)	High quality (n=18) Medium quality (n=13) Low quality (n=5)
Rigour Assessment	Low rigour (n=17) High rigour (n=7) Medium rigour (n=5)	Low rigour (n=14) High rigour (n=11) Medium rigour (n=11)

Overall, the publications included in both SLRs mainly differ in three methodological features: data collection method, the quantity of information provided on governance mechanisms and contextual factors, and the time scale of the analysis. The publications included in the SLR on CFM relied mostly on the use of mixed methods, whereas FCs publications mainly relied on quantitative methods. The fact that CFM publications included the use of qualitative methods allowed for a substantial collection of data concerning governance mechanisms and contextual factors, so much so that as shown in section 5.4 I was able to update the theory of change of CFM almost entirely, from output to impacts. Moreover, the majority of CFM publications consisted of studies carried out after more than ten years since the implementation of the programme. This last point is critically important for an impact evaluation, since ecological processes triggered by the intervention (e.g., reaction of forest species to management practices) may take years to manifest themselves (Franklin J.F.,1989), and therefore studies conducted after just two or three years since the beginning of the programme could fail to discern these changes.

6.2. Comparison of the reported environmental impacts

Among the three environmental categories examined, no studies investigating the impacts of FCs or CFM on Fauna scored high in both rigour and quality assessment. Therefore, I can only compare the impacts that these two forest governance interventions have on Flora and Ecosystem Services. Within these environmental categories, the two indicators that were most used by the publications included in both SLRs, are "Deforestation" for the category of Flora, and "Biomass" for the category of Ecosystem Services (Table 8).

Table 8. Comparison between the impacts of FCs and CFM, reported by the studies scoring high on both rigour and quality. **Source**: Inspired by Burivalova et al., (2017), adapted by the author

CATEGORIES	INDICATORS	FCs	CFM
FLORA	Basal area		7, 8
	Canopy cover		1
	Deforestation	2, 9, 10	12, 11
	Forest condition		6, 13
	Forest disturbance	9	6
	Forest growth		6
	Live tree characteristics	4	
	Tree species richness, diversity and density	5	
ECOSYSTEM SERVICES	Air pollution	9	
	Biomass	4	7, 8, 1
	Carbon Stock		7, 8
	Carbon sequestration		3
	Coarse Woody Debris Volumes	4	
	Fire incidence	9	

1. Baland et al., 2010;
2. Blackman et al., 2018;
3. Bluffstone et al., 2018;
4. Foster et al., 2008;
5. Kalonga et al., 2016;
6. Lund et al., 2014;
7. Lupala et al., 2015
8. Mbwambo et al., 2012
9. Miteva et al., 2015
10. Rana et al., 2018
11. Rasolofoson et al., 2015;
12. Santika et al., 2017;
13. Treue et al., 2014

LEGEND

STUDIES

Positive

No Impact

Negative

As far as "Deforestation" is concerned, for both interventions, results are definitely inconclusive.

Studies on Forest Certifications report impacts that range from strong positive in Indonesia (Miteva et al., 2015), to average positive impacts in Brazil, Gabon, and Indonesia (Rana et al., 2018), to no impact in Mexico (Blackman et al., 2018); whereas studies on Community Forest Management report average positive impacts in Sumatra and Kalimantan (Santika et al., 2017), and no impacts in Madagascar (Rasolofoson et al., 2015).

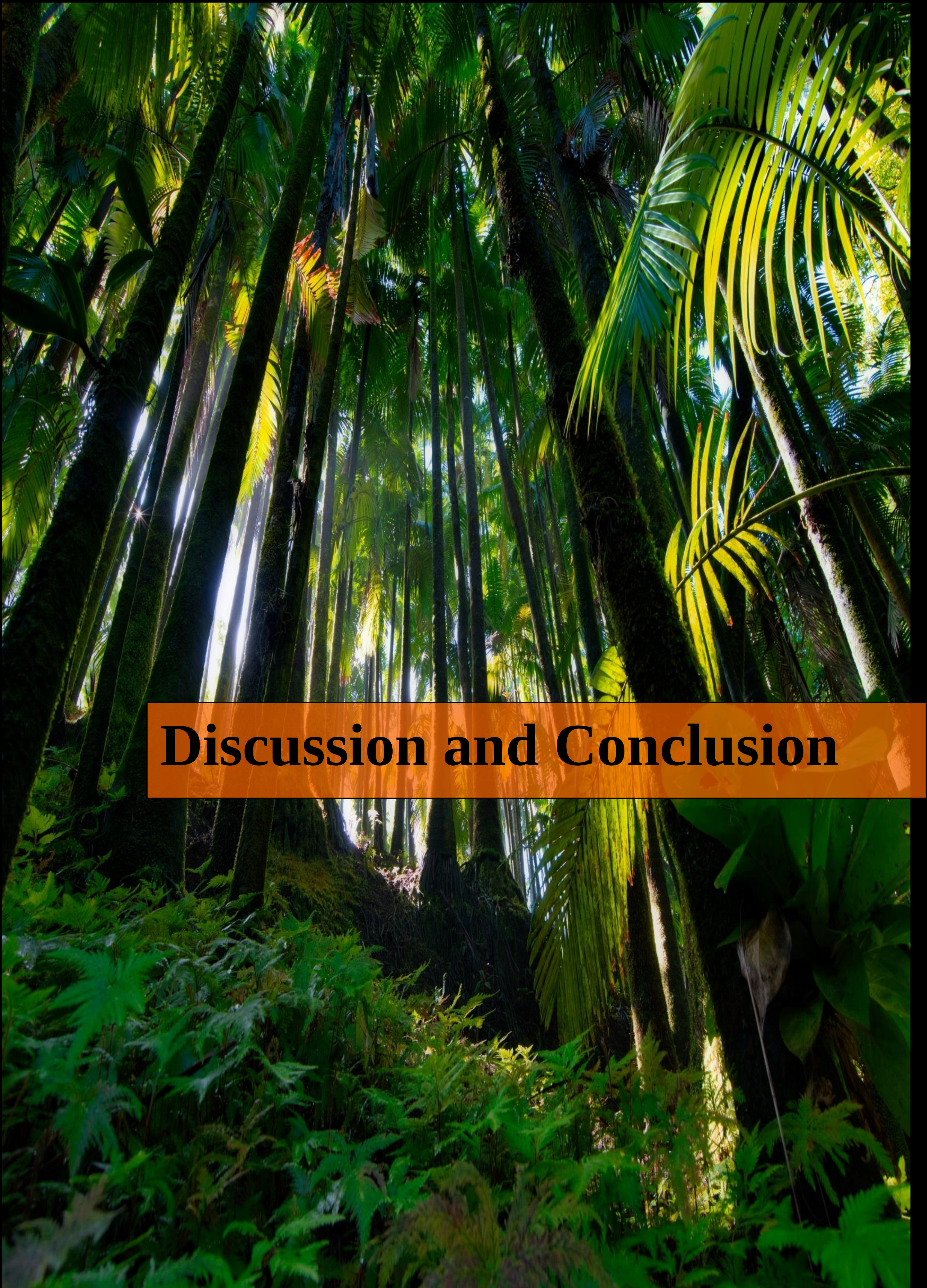
As far as "Biomass" is concerned, Foster et al., (2008) presented negative impacts of FSC on certified sugar maple stands, in Central Vermont. In fact, both certified and uncertified reference stands with partial harvest treatment, reduced biomass by one-third compared to unharvested reference stands, decreasing the potential economic value of carbon storage by 25-30%.
Studies on CFM, on the other hand, presented average positive impacts in Tanzania (Lupala et al., 2015; Mbwambo et al., 2012), and no impacts in India (Baland et al., 2010).
Lupala et al., (2015) and Mbwambo et al., (2012) analyzed the impacts of CFM in comparison with non-CFM forests, after more than ten years since the beginning of the programme. Both studies concluded that there were higher volumes of biomass in forests under CFM, than in their comparison groups.
In India, after analyzing three hundred and ninety-nine forest areas in the mid-Himalayan region, Baland et al., (2010) could not find any statistically significant impacts of CFM on biomass, compared to open access and protected forests.

Overall, Community Forest Management seem to produce more positive impacts compared to Forest Certifications. Indeed, out of eight CFM publications scoring high on rigour and quality, only three publications could not find any impacts; whilst for Forest Certifications the results are definitely mixed. Out of five publications scoring high on rigour and quality, only two reported evidence of positive impacts (Rana et al., 2018; Kalonga et al., 2016) and one could not find any statistically significant impacts (Blackman et al., 2018). The remaining two publications reported evidence of mixed impacts, including negative ones (Miteva et al., 2015; Foster et al., 2008).

6.3 Comparison of Governance Mechanisms and Contextual Factors

From the analysis of the governance mechanisms most associated with (strong) positive impacts, it emerged that "institutions" is the main mechanism that fosters the effectiveness of Forest Certifications, whereas "incentives" is the main mechanism in Community Forest Management. However, if we consider the data reported in the publications that scored high on both rigour and quality, "institutions" still remains the most associated mechanism with (strong) positive impacts in FCs; whilst in CFM, not only "incentives" but also "institutions" and "information" appear related to successful impacts on the ground. From both SLRs, two elements pertaining to the "institutions" of both interventions stand out, namely the importance of effective enforcement of standards in FCs, and norms in CFM; and the importance of effective monitoring mechanisms.

As far as contextual factors are concerned, for both Forest Certifications and Community Forest Management, the characteristics of the forests where the intervention in being implemented, emerged as an important enabling factor for achieving positive impacts on the ground. However, for Forest Certifications, the political context also appears to be an enabling element for having (strong) positive impacts on the ground; while for Community Forest Management, usergroup characteristics (e.g., size of the group, dependency on forest resources; the possibility to have additional source of income), demographicconditions, and the history of the community, are important factors that may trigger (strong) positive impacts.


Discussion and Conclusion

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Forest Certifications and Community Forest Management are two major forest governance interventions whose aim is to reverse forest degradation and deforestation, while providing socio-economic benefits to the people involved. Nowadays, around 732 million hectares and 430 million hectares are being governed under CFM (FAO,2016) and FCs (UNECE/FAO, 2016), respectively. Still, there is a paucity of scientific evidence on their environmental impacts on the ground, and on the governance mechanisms and contextual factors that facilitate the achievement of positive impacts. To fill this knowledge gap, I conducted two systematic literature reviews comprising sixty five publications in total, which collectively cover a total forest area of around 19 million ha. The geographic distribution of the publications gathered for both interventions, covers mainly the tropical biome. Out of sixty five publications in total, only thirteen methodologically rigorous publications could be identified. The evidence of the reported environmental impacts of both FCs and CFM shows clear trends towards (strong) positive impacts on the ground, with only six studies reporting no impact, and only two studies, concerning Forest Certifications, reporting negative impacts. However, given the small sample of the publications, I cannot make strong generalizing statements about the impacts that these interventions actually have on the ground. Moreover, both SLRs highlighted methodological challenges, and these need to be overcome by better research design, and investments in improved counterfactual studies.

Interesting points that emerged from the SLR on FCs is that the main governance mechanism most associated with (strong) positive impacts is “institutions”, while “incentives” and “information” were only reported in a minority of cases. If we consider the data reported in the publications that scored high on both rigour and quality, “institutions” still emerged as the main mechanism that fosters the effectiveness of the intervention. With respect to contextual factors, the political context of the country where certified forests reside, emerged as one important enabling factor for the successful adoption and implementation of this intervention. However, as for the environmental impacts, these results are not exhaustive, and therefore more research is needed to have a precise overview of which governance mechanisms and contextual factors enable positive impacts on the ground.

The SLR on CFM pointed out that “incentives” is the main governance mechanism most associated with (strong) positive impacts, followed by “institutions”. Only a few studies reported on the “information” mechanism. However, if we consider the data reported in the publications that scored high on both rigour and quality, all three governance mechanisms appear to foster successful impacts on the ground. As far as contextual factors are concerned, the reported findings of the studies, generally comport with the scientific work of IFRI (2015) and FAO (2016), with respect to forest resource system and biophysical factors, user group characteristics, demography and history.

This chapter is organized as follows: First, I discuss the reported environmental impacts of FCs and their reported governance mechanisms and contextual factors; Second I discuss the reported environmental impacts of CFM, and its reported governance mechanisms and contextual factors; Third, I discuss how the environmental impacts of FCs and CFM compare with each other; Fourth I reflect on the methodology and theoretical framework; Fifth, I highlight the limitations of this thesis, and Sixth, I draw the conclusions and provide recommendations for future research.

7.1 Reported environmental impacts of Forest Certifications

This systematic literature review confirms the paucity of methodologically rigorous studies on the impacts of forest certifications (Burivalova et al., 2017; Romero et al., 2013; Kraxner et al., 2017; Cashore and van de Ven, 2018). Indeed, out of twenty nine publications included in the SLR on forest certifications, only five scored high on both rigour and quality. The evidence that emerged overall indicates (strong) positive impacts, however, given the small sample of publications and the different countries where these studies were carried out, I cannot provide a generalizable answer on the impacts that forest certifications actually have on the ground.

Besides this SLR, there are only two other SLRs on the impacts of forest certifications, the one of Burivalova et al., (2017) that compared certified, community managed, and conventionally logged forests in terms of environmental, social, and economic impacts; and the ISEAL report on the conservation impacts of voluntary sustainability standards published in 2018 (Komives et al., 2018). Both reviews partially overlap with my SLR, especially the ISEAL report of 2018, which included only studies that passed their quality screen assessment. Still, a comparison is possible since the SLR of Burivalova was broader in scope and inclusion criteria, and therefore has a bigger sample of publications, and the SLR of ISEAL included new papers published over the year of 2018, after I carried out my own systematic research, and therefore can provide new useful insights.

As far as deforestation is concerned, the evidence provided in the review of Burivalova et al. (2017) is consistent with my findings that indicate variable impacts of forest certifications, ranging from no impact to positive impacts. The SLR of ISEAL, on the other hand, reported “effectively zero” (Komives et al., 2018, p. 21) impacts of forest certifications on deforestation, which is a disturbing conclusion given that one of the main goals of this intervention is to halt deforestation, especially in the Tropics. Possible reasons for why we do not have definitive answers yet are multiple, and mainly due to methodological challenges.

First of all, deforestation rates are generally measured with remote sensing data, since they are easy to access and relatively inexpensive, however their use alone is not sufficient to have a reliable answer. Persistent cloud cover and inappropriate resolution can undermine the possibility to exactly identify forest increase or forest clearing within the investigated areas, leading to inaccurate conclusions (Couturier et al., 2012).

Second, studies using remote sensing data combined with quasi-experimental statistical methods, can still provide uncertain results, if they do not use a theory of change (Romero et al., 2017). The theory of change in these cases, can help to inform about the contextual factors where the certified forests are located (e.g., historical, political, and economic situation of the country), and it can help to elucidate the “certification continuum” of certified forests analyzed (e.g., whether the certified area lost its certification status at a certain point, and then re-gained the certified status, or whether it was always certified). These type of data is essential to provide a more reliable and complete interpretation of the detected changes on the ground. So far, just one study (Blackman et al., 2017) which has been included in my SLR, and in both Burivalova et al., (2017) and ISEAL report (Komives et al., 2018), used a theory of change in its analysis. However, the study did not discuss which assumptions in its theory of change were violated or confirmed, as it was out of the scope of its analysis (Blackman et al., 2017).

Third, and finally, the lack of appropriate counterfactuals that are essential to make any causal inference, is and will continue to be in the near future one of the main challenges in impact evaluations, because it is difficult to identify, and it is costly (Romero et al., 2017; Steering Committee, 2012).

A clear gap in the available evidence concerns the impacts that forest certifications have on Fauna. While a multitude of scientific studies do actually exist, and they all report positive impacts (Polisar et al., 2017; Mohamed et al., 2013; Tobler et al., 2018; Dias et al., 2013; Sollmann et al., 2017), rigorous studies to be included in this SLR could not be found. This gap is confirmed in the SLRs of ISEAL (Komives et al., 2018) and Burivalova et al.,(2017). This latter review only reported studies on the impacts that Reduced Impact Logging (RIL) in logging concessions (not certified) has on species richness. Considering that RIL is largely implemented in certified forests, these type of studies can be a valuable source to have an indication of potential impacts of forest certifications on Fauna (see van Kuijk et al., 2009), however, they cannot be used as evidence of the *direct* impacts of the intervention on wildlife. Another evidence gap concerns the impacts that forest certifications have on ecosystem services. My SLR included only two rigorous studies for this environmental category, one of these, Miteva et al., (2015), was also identified and included in Burivalova et al., (2017), and the ISEAL review (2018). The impacts demonstrated are mixed, yet market-based instruments such as forest certifications are identified as one the necessary policy tools to mitigate the alarming "unprecedented" decline of biodiversity and ecosystem services (IPBES, 2019). Hence, there is an urgent need of rigorous scientific evidence on the impacts that forest certifications have on both biodiversity and ecosystem services.

Finally, as far as negative impacts are concerned, I would be cautious in asserting that forest certifications have generally negative impacts on biomass (Foster et al., 2008) and forest disturbance (Miteva et al., 2015). The external validity of both studies is hampered by their small sample size, and by that the fact that neither of them took into account the management history and the "certification continuum" (Romero et al., 2017) of the certified areas analyzed.

7.2 Governance mechanisms and contextual factors

From the analysis of governance mechanisms that can foster the effectiveness of forest certifications, it emerged that "institutions" have an essential role in facilitating positive impacts on the ground, even when considering the data reported in the publications that scored high on both rigour and quality (Kalonga et al., 2016; Miteva et al., 2015). This finding is particularly interesting since forest certifications are believed to work principally with economic incentives and information (Agrawal et al., 2018; Cashore et al.,2002; Cashore et al., 2007).

The "institutions" mechanisms that emerged from this SLR are mainly three, namely effective monitoring mechanisms, compliance verification by third-party auditors, and the importance of standard content of FCs. The publications that scored high on rigour and quality, pointed out that monitoring mechanisms and compliance verification by third-party auditors are critical mechanisms for Forest Certifications to work, and these results comport with the wider scientific literature. Kalonga et al., (2017) reported that monitoring activities taken by guards inside FSC villages in Tanzania together with controlling activities of external auditors, helped to reduce the illegal harvest of forest resources. The verification of compliance by a third-party auditor is indeed one of the main pillars of non-state market driven governance (Cashore, 2002; Cashore et al., 2007), as it provides legitimacy to the intervention, it fosters the recognition of certified products in the market place by consumers, and it supports better market access and price premiums to the producers (Ibidem). However, it is important to stress that the auditing process itself is not free from weaknesses. Bartley (2012) pointed out that companies can still falsify documents, train workers to give the right answers to auditors, and even corrupt auditors to keep the status of being certified. Moreover, Corrective Actions Requests (CARs) issued to companies do not necessarily imply substantial changes on the ground, because CARs concern the management process, rather than the actual impacts (Ibidem). Hence, when studies report efficient compliance controls in certified areas without measuring whether there are environmental changes on the ground, the reader should be cautious in assuming necessarily positive impacts, as the only way to actually establish that an auditing process favoured a change on the ground is with appropriate methodologies for impact assessment. Methods for measuring impacts are many, one is the “gold standard” previously described in section 3.4, other alternatives will be indicated in the Reflection on Methodology, section 7.6.

With respect to the standard content, strict hunting regulations inside the certified area stand out as being particularly important for the protection of Fauna. This result agrees with Rayden and Rawlings (2010), who indicated that FSC certified forest concessions around national parks in Gabon, hosted more gorillas, chimpanzees, and elephants, in comparison to non-certified concessions. A study included in the literature review of Sheil et al., (2010), pointed out that the Deramakot Forest Reserve in Malaysia, FSC certified, retained larger quantity of mammals compared to the neighbouring protected areas. Another study included in Sheil et al., (2010) confirmed that in Congo, FSC certified logging concessions registered a higher presence of forest buffalos and elephants compared to non certified ones. All these studies stressed that positive impacts were due to the rigid hunting regulations in place. However, Cerutti et al., (2017) pointed out that in Congo, the enforcement of these regulations inside FSC certified areas, created some tensions with the local communities in relation to customary rights, especially subsistence hunting. This finding did not come up in my SLR, as the assessment of the social impacts of forest certifications was out of the scope of this thesis; however it would be interesting to investigate how FSC deals with principle 3, namely “Respect of Indigenous people’s rights”, when these rights clash with standards dedicated to biodiversity conservation. Moreover, as Cerutti et al., (2017) suggested, there is a need to explore whether strict hunting regulations inside certified areas push local communities to hunt in the neighbouring non-certified ones.

Furthermore, in this SLR, studies pointed out that the inclusion of all spatial scales of biodiversity protection in the standard content supported positive environmental impacts. While no other studies analyzed the importance of spatial scales of biodiversity conservation; other publications confirmed the effective role of the standard content for the adoption of sustainable practices. Cubbage et al. (2010) pointed out that the Forest Stewardship Council in certified forests in Argentina and Chile, was reason for the adoption of protection measures for threatened species, reforestation and afforestation measures, the development of management plans to protect old growth forests, the promotion of controlling measures for invasive species, and the decrease on the use of chemicals. Kalonga et al.,(2017) indicated that forest certification standards supported biodiversity protection in Tanzania by promoting activities that alleviated the pressure on forest resources, for instance with “conservation agriculture,” a type of intensive agriculture that would deter forest clearing, while increasing agricultural production.

With respect to “information” and “incentives” as governance mechanisms for effective forest certifications, only few data emerged from this SLR. Nevertheless, I would be careful in affirming that both mechanisms have no role in fostering positive impacts on the ground. The education on biodiversity issues provided by forest certifications to logging companies, which in turn fostered a change in the management practices of forest managers, was the main Information mechanism reported in the publications included in this SLR. These findings agree with Hoang et al., (2015), which pointed out that in FSC certified plantations in Vietnam, farmers benefitted from the knowledge that they obtained by being certified. Indeed, farmers started to use fertilizers and pesticides more efficiently, and they decreased the impact of logging. These practices supported a reduction in soil erosion, facilitated the growth of trees, and reduced the incidence of disasters. Tricallotis et al. (2018) reported that logging companies in Chile were more aware of the importance of implementing sustainable management practices after being certified, and because of this new awareness, the companies reduced clear cutting practices, and began restoration activities in their forest areas. As far as Incentives are concerned, the expectation of having price premium appeared as the main mechanism for the adoption of forest certification. This finding is in contrast with other studies that identified increased market access as the main reason for being certified (see Faggi et al., 2014; Galati et al., 2017; Araujo et al., 2009; Carlson et al., 2016) . Considering the small sample of publications reporting on Information and Incentives, more research is needed to have the full picture on how the synergies of the different mechanisms of forest certifications affect the effectiveness of this intervention. Not only this would allow a deeper understanding on how forest certifications actually work, but it would also shed a light on potential "implementation issues" and contribute to the improvement of forest certification schemes (Komives et al., 2018).

The political context emerged as an important enabling contextual factor for the adoption of forest certifications. In agreement with Cashore and Auld, (2012) and Ebeling and Jasué (2009), this SLR highlighted that when the government supports the uptake of forest certifications by providing economic incentives and tax exemptions for logging companies, these latter are more likely to adopt a forest certification scheme. In developing countries, external financial support by NGOs to logging companies, also emerged as being essential. Moreover, if the law already prescribes sustainable management practices that are compatible with forest certifications, there are higher chances that forest companies would opt for a certification, since they do not have to undergo costly changes in order to be certified. These are partially the reasons for why FSC and PEFC are mostly adopted in boreal and temperate countries where, however, the adoption of forest certification is more likely to not make a significant difference in terms of improvements on the ground (see Norden et al., 2018). Tropical countries, on the other hand, are still lagging behind (Arts et al., 2017; Cashore & Auld, 2012). Ebeling & Jasuè (2009) compared enabling and disabling contextual factors for the uptake of forest certifications in Ecuador and Bolivia. The study reported that in Ecuador, a combination of wide spread corruption, weak enforcement of forestry law, lack of external support (i.e., by NGOs), the presence of mainly small size firms, and insecure tenure rights, hampered the wider adoption of FSC certification. However, the size of the companies and the importance of secure tenure rights did not come up from my research. I believe that this is due to the scarcity of qualitative data contained in the ecological publications that were included in this SLR. Nevertheless, I acknowledge that these are indeed factors to consider when evaluating the feasibility of the adoption of forest certifications in developing countries. The bigger the company, the easier is the possibility to develop economies of scale and the vertical integration of the supply chain, which would lower the costs associated with being certified; and the security of tenure rights is important for making long term management plans in a given forest area.

Finally, it is important to be aware that these political factors enable the implementation of forest certifications, however they are not *essential*. The scientific literature presents several cases where forest certifications have been successfully adopted in countries with weak forest governance (see Cerutti et al., 2011; Cerutti et al., 2017), and in some cases forest certifications even helped to improve the forest governance of that country. For instance, Kalonga et al., (2015) and Kalonga et al., (2016), two studies included in this SLR, reported that communities living in FSC-certified forest villages in Tanzania, positively influenced communities living in non-certified villages, so much so that these latter were more open to implement sustainable forest management in their forests. Savilaakso et al., (2017) pointed out that in Indonesia, Cameroon, and Peru, FSC certification influenced national forest governance to increase transparency, legality verification, and trust among different stakeholders in the forestry sector. Therefore, the interplay between forest certifications and different political factors is not straightforward.

7.3 Reported environmental impacts of Community Forest Management

Out of thirty-six publications included in this SLR, only eight scored high on both rigour and quality, confirming the scarcity of methodologically rigorous publications on the environmental impacts of Community Forest Management (Burivalova et al., 2017; Bowler et al., 2012; Lund et al., 2014). The evidence that emerged shows a clear trend towards positive impacts, with only three publications reporting no impacts. However, given the small sample of publications included, the different geographic areas covered, and the different indicators used, I cannot make generalizable statements on the impacts that CFM has on the ground. Beside this SLR there are only three other scientific works that gathered high quality evidence on the impacts that CFM has on the environment, namely the systematic review of Burivalova et al., (2017), already mentioned in section 7.1; the systematic review of Samii et al., (2015), which analyzed the impacts of decentralized forest management on deforestation and poverty, in low and middle income countries; and the systematic review of Venditti et al, (2017) that aimed at exploring which forest policy is more effective in protecting forest cover in Mesoamerica. With the exception of Venditti et al., (2017), the other two SLRs partially overlap with mine; however, a comparison is still possible since the SLR of Burivalova et al., (2017) has a bigger sample of publications due to wider goals and inclusion criteria, and Samii et al.,(2015) despite its small sample, has different papers from this SLR, due to different inclusion criteria.

As far as deforestation and forest degradation are concerned, the evidence provided in Burivalova et al., (2017) and Samii et al., (2015) points out that the impacts of CFM range from positive impacts to no impacts, consistently with my findings. Venditti et al., (2017), on the other hand, highlights negative impacts reported in one study by Bonilla Moheno et al. (2013), which showed patterns of deforestation activities from 2001 to 2010 in all municipalities managed under *ejidos* (local communities) in Mexico, in comparison to *communidades agrarias* (private managed land) which experienced an increase in forest cover. As with forest certifications, there are several reasons for why we still do not have a generalizable answer, and this is partly due to the variability of CFM, and methodological challenges. First and foremost, community forests vary in terms of characteristics of the user groups, different governance mechanisms in place, and different social, economic, and environmental context where they reside. Different combinations of these elements can produce different impacts. This means that a definitive answer will always be difficult to obtain. Second, studies assessing deforestation and forest degradation with the use of remote sensing data without triangulating the results with information on the ground, will be highly susceptible to some kind of bias, and therefore the alleged impacts are not fully reliable. Third, as previously mentioned in section 7.1, the challenge to rigorously select a counterfactual is one of the main obstacles to make any strong causal inference in an impact assessment (Romero et al., 2017; Steering Committee, 2012).

This SLR highlighted a lack of rigorous studies concerning the impacts of CFM on Fauna. While there are many scientific publications on the effectiveness of community conservation that demonstrate (strong) positive impacts (see Shahabuddin & Rao, 2010; Shanee and Shanee 2015; Alcàntara-Salinas et al., 2015; Muench et al., 2016; Corrigan et al., 2018), no rigorous studies on the impacts that CFM has on wildlife could be identified. This gap has been underlined even in Burivalova et al., (2017), which denounced the "striking omission" to investigate the impacts that community forests can have on Fauna. This is particularly important in order to explore the feasibility and compatibility to implement CFM for protecting faunal biodiversity, especially when communities have customary rights related to hunting.

Another evidence gap that emerged from this SLR relates to the impacts that CFM has on Ecosystem Services. Due to the potential synergy that CFM can have with REDD+ (i.e., Reducing Emissions from Deforestation and forest Degradation, plus the sustainable management of forests, and the conservation and enhancement of forest carbon stocks), several rigorous studies measuring the impacts of CFM on Carbon

Stock or Carbon Sequestration actually exist, however little is known about the impacts that CFM can have on other ESS, (e.g., watershed protection, prevention on soil erosion, disaster risk reduction, air purification). Yet community forest management is considered an “effective way to safeguard nature and its contributions to people” (IPBES, 2019), therefore there is an urgent need for increased impact evaluations, to establish the potential conservation impact of faunal biodiversity and ecosystem services of CFM.

7.4 Governance mechanisms and contextual factors

From the analysis of governance mechanisms that are most associated with (strong) positive impacts, “incentives” stand out as being critically important, particularly in the form of knowledge. Knowledge transferred with capacity development activities provided by NGOs; knowledge applied by the local communities in the form of traditional knowledge to manage their forest resources, and knowledge used to create contextually appropriate rules. Other types of “incentives” that emerged from this SLR are the financial support of external donors, and the opportunity to use, and profit from, forest resources. In the second place, this SLR highlights the essential role of “institutions”, consistently with studies of IFRI, (2015), and FAO, (2016). “Information” is the least reported governance mechanism, although if we consider the data reported on the publications that scored high on both rigour and quality, this mechanism of CFM also appears to be associated with successful impacts on the ground. Elements of the “information” mechanism that were highlighted by these publications are the importance of using the knowledge of the community to manage forest resources, and the importance of using the knowledge of the community to develop local institutions. Considering that the role of “institutions” has already been largely debated in the literature (e.g., Agrawal, 2001; Chhatre and Agrawal, 2008; Saunders 2014; Behera, 2009; Gibson et al., 2005; Poteete and Ostrom, 2004), I am going to focus only on the “incentives” and “information” mechanisms, before discussing the contextual factors.

The first knowledge-related incentive concerns the technical assistance and capacity building activities provided by external actors, such as NGOs, to local communities. For instance, Gbedomon et al., (2016) indicated that a small community forest in Benin favourably collaborated with a local NGO, which not only supported the implementation of the programme, but provided for more than thirty years continuous assistance in beekeeping, ecotourism activities, and afforestation practices, that in turn produced environmental and economic benefits. Arts and De Koning (2017) pointed out that the support of external actors (e.g., NGOs, scientists) in raising awareness, exchanging knowledge, and building trust, were critically important for achieving positive impacts on the ground.
These results are consistent with Barnes and Laerhoven (2015) who acknowledge that NGOs in India provided the necessary skills to negotiate with government authorities, to teach official languages, and to educate the communities with respect to policies that might affect the communities themselves. This study also reported that to do so, building mutual trust was a prerequisite. Akamani and Hall (2019) pointed out that two community forests in the Ashanti region of Ghana improved their forest management practices with the transfer of knowledge and technical skills provided by external actors. However, the study warned that this type of assistance can be a risk for the long term survival of traditional knowledge.

The second knowledge-related incentive that is associated with successful impacts, is the possibility for local communities to use their knowledge to manage forest resources. This opportunity is particularly important in CFM, as it not only serves as an “incentive” to engage local communities in the intervention, but it is also a critical “information” mechanism of this intervention, which has been highlighted by the high rigour - high quality studies included in this SLR. For instance, Thapa et al., (2018) analyzed the performance of thirty seven community forests in Nepal, managing their forest resources according to their traditional beliefs “rakauna”, which forbids to overharvest forest resources. After fifteen years since the beginning of the programme, the study found that the forest cover incresead by 20 km^2 compared to the surrounding protected areas. Aggarwal et al., (2006) reported that in India, the implementation of traditional practices of forest management such as *Kesar Chidkaw*, whose aim is to protect both the floral and faunal biodiversity of their forests, determined a substantial increase in tree species richness, diversity, and density, compared to forest areas without the programme. These results are consistent with Kim et al.,(2017) that analyzed the impacts of using traditional ecological knowledge, in particular the Fengshui, in managing forest resources in China, Japan, and South Korea. The Fengshui fostered large afforestation practices in areas surrounding human settlements in all three countries, favouring the provision of important ecosystem services, among which water availability and flood protection. However, the study pointed out that using traditional knowledge to manage forest resources cannot keep up with the current wood demand for industrial purposes, and therefore it can only be a complement to modern ways of forest management, and not a substitution. Other studies reporting on traditional ecological knowledge are Camacho et al.,(2015) that highlighted positive impacts on biodiversity conservation and ecosystem services by using *muyong* practices in the Ifugao province in the Philipphines; and Boafo et al., (2015) that investigated how the traditional ecological knowledge in form of taboos and totems fostered both floral and faunal biodiversity protection in Northen Ghana.

A third knowledge-related incentive that emerged from this SLR is the possibility for the local community to be included in the rule- making process, so as to create local knowledge-informed rules. This third incentive goes hand in hand with the other "information" mechanism that emerged from the high rigour-high quality publications included in this SLR, which pointed out the importance of using the knowledge of the community to develop local institutions. These results comport with Agrawal and Gibson, (1999) that pointed out how such an inclusion would create more contextually appropriate institutions and rules to manage forest resources, mainly because the local communities do possess the local knowledge or "indigenous knowledge", which central government authorities lack. Moreover, such an inclusion would foster the perception that local institutions are "legitimate and fair" (Poteete and Ostrom, 2004).

Other incentives that foster successful impacts are the possibility for the local communities to use the forest resources for their household needs, and the prospect of profiting from managing resources sustainably. These findings are in agreement with Gatiso (2019) that reported strong positive impacts in a participatory forest management programme in Ethiopia, where the dependence on forest resources for both personal needs and income generation, was a critical factor for the success of the intervention. Other studies in line with these results are Pagdee et al., (2006); Heltberg (2001); Kacani & Peri (2018); and Nhem et al., (2018). However, while the possibility to use and profit from forest resources is an important incentive to engage communities in CFM and potentially develop (strong) positive impacts on the ground, other studies underlined that a heavy dependence on forest resources is also associated with higher level of forest degradation (Agrawal and Chhatre, 2008). Hence, it is important that either local communities are moderately wealthy, or that additional sources of income are provided (IFRI, 2015; FAO, 2016).

Finally, the financial support of external agents is an incentive mechanism that enables positive outcomes on the ground. For instance, Nagendra et al., (2008) compared the land cover between a community forest and a buffer zone area with participatory forest management in Nepal. The study reported that forest cover was higher in the buffer zone, due to substantial financial aid by NGOs and International Organization, while Community Forests, which did not enjoy any external financial help, showed significantly higher signs of forest fragmentation. As reported in other studies, external funds are indeed necessary particularly in developing countries, where the costs for the implementation of the programme are around thousands of dollars (Lescuyer et al., 2019).

As far as contextual factors are concerned, findings that emerged from this thesis largely comport with factors related to successful outcomes in CFM indicated by IFRI (2015) (see section 5.4). An interesting point that emerged is that several studies pointed out a certain level of heterogeneity in the communities investigated, due to immigration flows. The role of heterogeneity has long been debated particularly with respect to different ethnicity, religion and culture that could undermine the effective functioning of forest communities (Agrawal and Gibson, 1999). Communities living in the same area, speaking the same language, sharing the same cultural background have potentially higher chances to agree on rules, enforce them, reduce potential conflicts, and ultimately develop trust (Poteete and Ostrom, 2004; Agrawal and Gibson, 1999; Varughese and Ostrom, 2001). Considering that the concept itself of heterogeneity or homogeneity of a community is open to multiple interpretation (e.g, a community can be heterogeneous even without experiencing any immigration flows), I will not dig any further in the debate. The main point worth highlighting is that the few studies reporting on demographic conditions of the communities investigated, did not report any negative impacts on the sustainable management of forest resources, even when immigration flows were experienced after the beginning of the programme (see Paudyal et al., 2015).

7.5 Comparisons of the Interventions

One the of main goals of this SLR was to establish how the environmental impact of forest certifications compared with the ones of community forest management, and vice versa. To my knowledge this is the second SLR that compared these two forest governance interventions, second only to Burivalova et al., (2017), and the only one that use an explicit theory of change with assumption specified, in order to elucidate under what conditions and how, these two interventions achieve their impacts on the ground.

The findings of both SLRs suggest more reported positive impacts in CFM than FCs; however, these results should be treated with caution for three main reasons: First of all, the very small sample of these publications, the different indicators used, the different geographic locations, and biomes investigated, hinder the possibility to provide an exhaustive and generalizable answer. At best, the evidence can only provide an indication of the impacts. Second, the publications included in both SLRs suffer from methodological challenges that hinder the possibility to make any strong causal inference. The majority of the studies failed to control for confounding factors, the comparison group(s) was not always suitable for the analysis (i.e., lack of proper counterfactual), and not all the studies applied statistical techniques to help attributing the impacts to the intervention. Third, considering the amount of (strong) positive impacts reported, it is reasonable to affirm that both SLRs suffer from various forms of biase (see "Limitation of the research").

With respect to governance mechanisms, the publications included in the SLR on Forest Certifications pointed out that "institutions" is the main mechanism that fosters the effectiveness of this intervention, even when considering the data reported on publications scoring high on both rigour and quality. This finding is in contrast with the wider scientific literature, since Forest Certifications are believed to work principally with "incentives" and "information" (Agrawal et al., 2018). Indeed, incentives, such as the prospect of having increased market access and price premium; as well as improved reputation, and exposure to new clients, are considered as critical factors for the uptake of Forest Certifications (Carlson and Palmer, 2016)."Information" is another essential mechanism as well, since consumers need to be informed on the importance of buying certified products, as well as producers need to be informed on the importance of implementing sustainable practices for managing their forests. For this reason, Agrawal and colleagues placed Forest Certifications at the bottom-right of the triangle of governance, presented at chapter two of this thesis (see Figure 2, p.10), near "incentives", and in correspondence to "information". However, according to van der Ven and Cashore (2018), Forest Certifications need also "institutions" in order to be effective, both formal institutions and informal institutions. Formal institutions are those in charge of creating and revising the standards of the certifications, as well as third-party auditors that verify the compliance of logging companies and forest owners with those standards. Informal institutions are social norms and values, generally promoted by NGOs, that support the adoption of forest certifications, and penalize with boycotting campaigns business companies that are deemed as unsustainable. For this reason, van der Ven and Cashore argue that Forest Certifications should be placed closer to center of the triangle of governance by Agrawal et al., (2018), than one would generally imagine. Still, based on the reported data on the publications included in this SLR, Forest Certifications should be placed at the top of the triangle of governance, since "Institutions", specifically the formal ones, emerged as a key mechanism for the effectiveness of this intervention.

As far as Community Forest Management is concerned, the data reported in the publications included in this SLR, highlighted how the "incentives" mechanisms, particularly in form of knowledge, and "institutions", are key for achieving positive impacts on the ground. However, publications that scored high on both rigour and quality, pointed out that the "information" mechanism is also associated with (strong) positive impacts on the ground. Because of this, these findings are consistent with Agrawal et al., (2018), who defined CFM as a "hybrid born of an important institutional component, an incentive, and information" (Agrawal et al., 2018, p.3) placing this intervention at the very center of the triangle of governance (see Figure 2, at page 10).

7.6 Methodological Reflection

The strong point of systematic literature reviews is that they use a transparent, replicable, and rigorous protocol to gather high quality evidence, whether qualitative and/ or quantitative, in order to answer specific research questions (Waddington et al., 2012; Mallet et al., 2012). As part of the protocol, every systematic literature review entails a critical appraisal to establish the internal validity, and external validity of each study included in the review. For my thesis, I conducted two types of appraisals, one related to the quality of the reporting of each research, and the second related to the methodological rigour of each study included. The advantage of doing so was twofold: First of all, it allowed me to identify the studies that were most transparent in the way they collected, analyzed, and presented their findings; Second, it allowed me to select the studies that respected the "gold standard" of impact assessment as much as possible. The respect of the "gold standard" was particularly important in my thesis for two main reasons: First of all, the existing scientific literature largely denounced inappropriate ways to measure the impacts of an intervention, blaming inappropriate time scales, inappropriate comparison group(s), inappropriate sampling procedures, lack of baseline data, and lack of control for confounding factors, as the main reasons for the inability to make any causal inference (Burivalova et al., 2017; Lund et al., 2014; Bowler et al., 2012, Romero et al., 2017; Miteva et al., 2012). Therefore, by applying the nine rigour indicators listed in Table 4, I was able to present the best available evidence among the sample of publications included in my SLRs. Second, impact evaluations have a "Pyramid of Evidence" (Ho et al., 2008) or "Evidence Hierarchy" (Head, 2010) that considers Randomized Controlled Trials (RCTs) as the most rigorous evidence, followed by quasi-experimental designs, pre-experimental and comparative case study designs, and single case studies at the very bottom (Waddington et al., 2012; ISAEL, 2017; Burivalova, 2017). In ecology, quasi-experimental design is considered the most reliable and suitable method to make any causal inference in non-randomized settings (Van Butsic et al., 2016), and that is why I paid special attention to studies having this design. However, when dealing with socio-ecological systems such as forests, the question arises as to whether only quantitative type of evidence is actually the most suitable to investigate complex interventions, such as FCs and CFM.

I acknowledge that in privileging the "gold standard" for rigour assessment, I might have excluded other potentially relevant sources of evidence deriving from purely qualitative studies. There is an ongoing debate within the world of evidence-based conservation with respect to what type of knowledge should be used to inform policy-makers (see Sutherland et al., 2004; Head, 2010; Haddaway and Pullin 2013; Adams and

Sandbrook, 2013). Ecologists, on one side, consider quantitative data and analysis as being the "more rigorous, testable and hence reliable" evidence (Adams and Sandbrook, 2013, p. 330); social scientists, on the other side, stress the importance of including qualitative data, in particular traditional and indigenous knowledge, in full recognition that biodiversity per se is a social construct, and therefore it is necessary to acknowledge the different worldviews attached to it (see Escobar, 1998). Moreover, proponents of the inclusion of local and indigenous knowledge in impact evaluation, argue that there are at least two main benefits of doing so. First, it increases the democracy of the knowledge creation process, by considering the voices of individuals that are affected by the intervention, and know their reality better than central government authorities (Adams and Sandbrook, 2013; Corburn, 2003; Hulme, 2000); Second, it is a cheaper way to increase the efficiency of impact evaluation, compared to relying solely on scientific methods (Corbun, 2003). The use of mix methods approach can, in theory, reconcile this dichotomy by involving among the stakeholders, local and indigenous people, to inform theory-based impact evaluations, where an in-depth understanding of the social, cultural, historical, political, and economic context, is key for a proper impact assessment (White, 2009). Moreover, the use of mix methods allows the triangulation of data gathered with qualitative and quantitative methods, as well as the triangulation of these two methods themselves (Thurmond, 2001; Bamberger, 2012). Triangulation in impact evaluation is key, as it can "increase the confidence in research data, create innovative ways of understanding a phenomenon, reveale unique findings, challenge or integrate theories, and provide a clearer understanding of the problem" (Thurmond, 2001, p. 254).

In this thesis, publications including data on local and indigenous knowledge were particularly useful to inform the governance mechanisms that enable the effectiveness of community forest management (see section 7.4), while no data on local and indigenous knowledge could be found for forest certifications. In any case, being this thesis an investigation of the environmental impacts of FCs and CFM on a global scale, it was out of the scope of this research to use local and indigenous knowledge to have an understanding of a specific context. With the help of both "high-level" theories of change, I was able to structure and identify the main governance mechanisms from output to impact, that enable successful results on a general scale, and highlight under what contextual factors, (strong) positive impacts are more likely to occur. While it lacks the precision needed to inform policy-makers, it is still a valuable example that theories of change are key to understand in what ways an intervention works in practice, and potentially improve its design and implementation.

7.7 Reflection on the Theoretical Framework

In a special 2018 issue on Forest Governance, Agrawal and colleagues, outlined a conceptual framework to understand how forest governance interventions change socio-ecological outcomes, and improve forest-livelihoods processes. They argue that every intervention is designed with three mechanisms, namely "institutions", "incentives", and "information", and depending on the goals that the intervention has to achieve, the emphasis is on one or more of these mechanisms. These three "Is" are not new in the scientific literature, in fact, already in 1998 Vedung argued that regulations or *Sticks*, economic means or *Carrots*, and Information or *Sermons*, are the "fundamental three instruments" with which government authorities exert their power in supporting or preventing social change (Vedung et al., 1998). Over the years, this framework has been widely applied, whether to investigate how monetary stability can be achieved (see Persson and Tabellini 1999); or to explain why foreign aid has widely failed in achieving its goals (see Williamson, C. R. 2010); or to investigate how "institutions", "incentives", and "information" affect food quality, safety, and technological innovation in the agri-food sector (see Hobbs, 2003). In forest governance analysis, this framework has been applied, for instance, to analyze and compare the role of forest management plans in Sweden and Lithuania (see Brukas & Sallnäs, 2012), to explore how "institutions", "incentives", and “information” affect private forest management practices (see Serbruyns, I., & Luyssaert, S., 2006); or to compare the impacts that different supply chain interventions have on tropical forest landscapes (see Newton et al., 2013). In this last case, Newton and colleagues, highlight how this framework facilitated the comparison of different interventions, and such was also the case for this thesis.

Considering that Forest Certifications and Community Forest Management are two very different types of forest governance interventions, the three “Is” of Agrawal and colleagues, allowed me to have a common theoretical ground to analyze how both interventions achieve (strong) positive impacts on the ground, and which are, specifically, the mechanisms that most contribute to the effectiveness of these interventions. The results of my thesis have been quite surprising, particularly for FCs. Indeed, from the SLR on forest certifications it emerged that “institutions”, mainly in form of standards and third-party accreditation bodies, is the main reported mechanism that fosters the effectiveness of forest certifications; contrary to claims that FCs works mainly with “information” and “incentives” (Agrawal et al., 2018), or a pure combination of the three mechanisms (van der Ven and Cashore, 2018). For CFM, according to the data reported in the publications that scored high on both rigour and quality, Community Forest Management appear to be effective with a balanced combination of the three mechanisms (i.e., “institutions”, “incentives”, and “information”), in agreement with Agrawal et al., (2018). Moreover, knowledge, especially in form of “incentives” and “information”, stood out as being one critical reported mechanism correlated with (strong) positive impacts, in line with theories that consider CFM as a “knowledge partnership” between local communities and external actors, where knowledge production, and mutual learning are considered as key factors for successful impacts on the ground (Minang et al., 2019).

To my knowledge, this thesis is actually the first one that worked with the three “Is” to analyze Forest Certifications and Community Forest Management, both singularly and in comparison. This means that I had no blueprint for applying this framework to analyze both interventions. However, that was not a problem, since the mechanisms of “institutions”, “incentives”, and “information” are wide enough to easily incorporate multiple factors that I wanted to test. For instance, the work of IFRI (2015) identified five groups of factors that contribute to successful impacts in CFM, namely forest resource system and biophysical factors; user group characteristics; institutional arrangements; and contextual factors (i.e., demography, history, market dynamics). I have extracted the factors included in these groups, and I have easily reclassified them under the three “Is”. For Forest Certifications, I did not have any pre-identified list of factors correlated with positive impacts, and therefore I developed a list of factors based on the scientific literature on non-state market-driven governance (Cashore 2002; Cashore et al., 2007; van der Ven and Cashore, 2018), and the theory of change of FSC. Even for this part, the allocation of different factors under the three “Is” was simple. However, future researchers that will apply this framework to analyse the mechanisms internal of a specific intervention, should be aware that in some cases the boundaries between “institutions”, “incentives”, and “information” may be blurry at times. For instance, in Community Forest Management, the fact that the local community can use its knowledge to manage forest resources, can be considered both as “incentive” as well as an “information” mechanism. It basically depends on how such data it is framed in a given paper, and it depends on the interpretation of the researcher. It generally also depends on the intervention itself, as for Forest Certifications, distinctions between “institutions”, “incentives”, and “information” were definitely more straightforward.

With respect to contextual factors, as shown it Tables 3 and 4 in chapter 2 of this thesis, these were analyzed separately from the three mechanisms. Considering that the effectiveness of an intervention largely depends also on the context where it is being implemented, one might think that this framework is not enough to analyze the effectiveness of FCs and CFM. I believe that this is only partially true. Contextual factors related to the political and economic context can be still analyzed under this framework and, in this way, one might even explore more systematically how “institutions”, “incentives” and “information” mechanisms of the central government interplay with the three "Is" internal of a given intervention. However, to carry on such comparison would require a substantial amount of data, and that is why I did not do it for this impact assessment. Generally, for other contextual factors, for instance, biophysical characteristics of the forests, I agree that this type of framework is not enough, and other theories would be needed to explain the interaction between forest species and a given intervention.

Overall, this framework was suitable to explore the mechanisms upon which Forest Certifications and Community Forest Management depend to achieve positive impacts, and it allowed a comparison between these two interventions. Ideally, for someone doing a systematic review in order to gather the most rigorous, and high quality publications to assess the impacts that these two interventions have in a specific country, the use of this theoretical framework has at least three advantages. First, it allows to explore what the internal governance mechanisms of a specific intervention are that foster positive impacts on the ground; Second, it provides a common theoretical ground to compare two or more interventions that are inherently different; Third, it can enable the researcher to analyse possible synergies and trade-offs between the internal mechanisms of a given intervention, and between the external governance mechanisms in place in the country where they are being implemented.

7.8 Limitation of the research

Considering my academic background in social sciences, this thesis reported the environmental impacts of forest certifications and community forest management on a global scale as reported in the academic literature, without exploring technical ecological aspects. This point had two implications.
First, it means that I could not discuss to what extent the reported impacts (i.e., positive, negative, and no impact) were also depended on the type of forest investigated (e.g., plantations, mature forests, old growth forests), the species that the forest contained, and the general characteristics of the forest. For instance, I was not able to establish to what extent positive impacts on tree stem density of *Shorea-Shima* were also dependent on the tree size and age (see Bowler et al., 2012). Second, I was unable to elaborate on the consequences that certain management practices could have on the forest species examined in the publications included in both SLRs, and why.

Systematic literature reviews are a "complex and time-consuming task" (Sturm et al., 2019, p.91; Mallet et al., 2012), that, ideally, are carried out by a team of people with different expertise (e.g., content expert, statistician, methodologist, experienced searcher) (library.cumc.columbia.edu), and at least one of the members should have in depth knowledge of systematic review protocols (Ibidem). For my thesis, I did two systematic literature reviews without a second reviewer, and without any prior experience in this task. This means that this thesis is not immune to flaws in its execution, and a possible, unconscious, bias in the selection of the articles, in the data extraction process, and in its conclusions, could not be avoided.

Given the clear indication of (strong) positive impacts reported in both SLRs, it is plausible to affirm that this thesis might suffer from several other biases.
First of all, publication bias. Scientific journals are more prone to accept and publish scientific researches that report positive results, rather than null or negative ones. This is particularly detrimental, because negative results are actually essential to know where, how, and why a certain intervention needs to be improved (Simundic, 2013).
Second, confirmation bias. This type of bias takes place when researchers tend to collect, analyse, and report data that only confirm their hypothesis, or their beliefs. This can have several consequences: It can lead to report data that do not exist, or eliminate data that do not support their hypothesis or beliefs, or use inappropriate statistical tests to validate their findings (Ibidem).

Third, methodological bias. The majority of the publications included in both SLRs had methodological flaws that might have affected the reliability of their findings. Besides some form of bias already reported by some publications (e.g., cognitive bias, selection bias), most of the papers did not control for confounding factors, and this might have affected the validity of their reported impacts.
Fourth, language bias. Both systematic literature reviews comprise only scientific literature written in English, and it is acknowledged that other potentially relevant researches written in other languages were excluded from this thesis.

7.9 Conclusion and recommendations for future research

The two systematic literature reviews that I carried out as part of my Master's thesis, add to the growing body of impact evaluations in the forest conservation field. By applying the theoretical framework of Agrawal and colleagues, concerning "institutions", "incentives", and "information", I was able to shed light on the mechanisms pertaining to both interventions that most facilitate the achievement of positive impacts on the ground, and it provided me with a common theoretical ground to compare such different forest governance interventions. Moreover, this thesis is only the second systematic literature review that compares Forest Certifications with Community Forest Management, and it is the only scientific work that uses a theory of change with assumptions specified, to understand with what mechanisms and under what contextual factors they achieve (strong) positive impacts on the ground. Because of this, this thesis should be considered as an attempt to answer the multiple calls for rigorous impact evaluations in the forest conservation field, with the help of explicit causal models to be tested (Ferraro and Pattanayak, 2006; Miteva et al., 2012; Pullin et al., 2004; Pullin et al., 2003; Sutherland et al., 2004; Agrawal, 2001).

The results of both systematic literature reviews confirm the paucity of methodologically rigorous studies, and confirm the difficulty of providing a generalizable answer to the question "What are the environmental impacts that Forest Certifications and Community Forest Management have at global scale, as reported in the academic literature?". The evidence reported in both SLRs generally indicates positive impacts on the ground; however, if we examine the impacts on Flora, the reported evidence is largely inconclusive, with studies reporting either positive impacts or no impacts at all. I found a significant knowledge gap on the impacts that FCs and CFM have on Fauna, and evidence is largely lacking concerning the impacts that both interventions have on Ecosystem Services too.

To better inform this impact assessment, I investigated what the governance mechanisms that facilitate the achievement of positive impacts in FCs and CFM are, and what the contextual factors that enable successful impacts are. By applying the theoretical framework of the three "Is" of forest governance interventions of Agrawal and colleagues, I was able to identify the main governance mechanisms that are most associated with (strong) positive impacts. From the SLR on Forest Certifications, "institutions" stood out as being critical for the effectiveness of this intervention, while for CFM, studies that scored high on both rigour and quality revealed that the combination of the three mechanisms is necessary to have positive impacts on the ground. Interestingly, the role of knowledge as "incentives" and "information" mechanism stood out as being one important factor for the success of this intervention. Ideally, contextual factors related to the political and economic factors could have been analyzed with this theoretical framework as well, but due to lack of data, it was not possible. The political context where forest certifications are being implemented is one important enabling factor, together with the biophysical characteristics of the forests. For community forest management a combination of contextual factors, already identified by the work of IFRI (2015), enables positive impacts in CFM, namely biophysical factors of the forests, user group characteristics, demographic conditions, and history. However, due to the small sample of publications included in both SLRs, and the even smaller sample of publications scoring high on both rigour and quality, more research is needed to investigate the interplay between governance mechanisms of FCs and CFM, and contextual factors. This would allow to identify potential “implementation issues”(Komives et al., 2018), so that both intervention can be improved (if needed), and better investments can be made.

The aim of comparing Forest Certifications and Community Forest Management was to highlight potential synergies between the environmental goals of these interventions, however a meaningful comparison was hindered by the very small sample of methodologically rigorous studies, and a lack of common indicators and common geographic areas covered. Still such a comparison is needed, to explore the synergies, but also trade-offs, between the impacts that these interventions have on the ground. That understanding would allow policy-makers to improve the implementation of FCs and CFM, and be aware of how, if, and where, these two interventions can be combined to foster a “transformative change”, which is essential to slow down the “alarming” loss of biodiversity and ecosystem services (IPBES, 2019).

Overall, based on the findings of my thesis, here are my recommendations for future research:

1. Research is needed to fill the evidence gap on the impacts that Forest Certifications and Community Forest Management have on Fauna and Ecosystem Services. To facilitate future comparisons, ideally, such investigations would use standardized indicators, standardized methodologies for impact evaluations, a common theoretical framework such as the one that I have applied, and would use a theory of change, to elucidate in which ways, under what conditions, and at what costs (strong) positive impacts can be achieved.

2. Forest certifications and Community Forest Management aim not only at improving forest conditions, but they also aim at providing socio-economic benefits for the people involved. This thesis only sheds light on one of the impacts that these interventions can have, and future researches would greatly benefit from the analysis of socio-economic impacts, besides the environmental ones. This is because the impacts of an intervention can have synergies and trade-offs between each other, and to explore just one type of impact inevitably provides just one tiny part of a bigger picture. Even better would be a research that compares the environmental and socio-economic impacts that Forest Certifications and Community Forest Management have in specific contexts, to explore the potential synergies and trade-offs that these two interventions can have, if combined. As previously recommended, such investigation should be done by using standardized indicators, standardized methodologies for impact evaluations, a common theoretical framework, and the use of theories of change with assumptions specified.

3. Methodologies for impact evaluations need to be improved, and more investments are needed to identify the proper counterfactual. However, when dealing with complex socio-ecological systems such as forests, to use only quantitative methods is restrictive. To have a holistic understanding on the impacts that a certain intervention has in a given context, the involvement of all stakeholders, including local and indigenous communities is essential. This will increase the understanding of who really benefits from the intervention and at what costs, and it will foster collaboration, equity, and respect to the people that are most affected by the intervention itself.

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APPENDIX A – Methodology Material

A) Data Extraction Form for Forest Certifications

DATA EXTRACTION FORM

- What are the environmental impacts of Forest Certifications at global scale, as reported in the academic literature?
- What are the governance mechanisms and contextual factors identified in the academic literature that facilitate the achievement of positive impacts?

The data extracted from each is paper is based on the authors' findings

GENERAL INFORMATION

ID#		Date Form Completed:		Excluded ☐ Included ☐
Title:				
Author(s):				
Publication Type:	Peer Reviewed Article ☐		Grey Literature ☐	Other ☐
Year:	Volume:	Issue:	Page(s):	Country:

Journal Title:	
Boolean Search Terms:	
Number of search results displayed:	Database:

INCLUSION CRITERIA

Geography: Global scale	**Time:** Studies from 2008 onwards
Type of Impact: Environmental impacts, whether they are Positive, Negative, or Neutral (no impact at all).	
Forest Certifications: The two main forest certification schemes are Forest Stewardship Council (FSC) founded in 1993, and the Pan-European Forest Certification (PEFC) established in 1999, and later renamed the Programme for the Endorsement of Forest Certification (Berry et al., 2012). Both FSC and PEFC aim at providing social, economic, and environmental benefits for forest owners and timber companies that choose to be certified.	
Environmental Impacts: It needs to include at least one indicator that relates to the categories of Flora, Fauna, and Ecosystem Services of Forests.	

Comparison: With and without Forest Certification, Before the Certification; Primary Forest; Areas formally set-aside; Unharvested Reference Stands; Open Access Forest; State Forest Reserves; Protected Areas; Conventionally Managed Forests; Old –Growth Forests; Forest Certified with another Certification; Production Forests; Areas with unknown management Practices; Unlogged forest.
Baseline Measurement: Before the adoption of the Certification; Reference Point.
Outcome: Change or not change in biodiversity (Fauna and/or Flora), change or not change in Forest Cover, change or not change in Forest Condition, and change or not change in Ecosystem Services provision.
Types of study: Studies providing empirical data, qualitative and/or quantitative. Studies must have at least one of the following three characteristics: (i) focus on the environmental impacts of Forest Certifications, either FSC or PEFC or both; (ii) include a control group and/ or take confounding factors into account; (iii) highlight contextual factors and governance mechanisms. Case studies, literature reviews and systematic reviews –including meta-analyses- will be included if they comprise one or more of these characteristics.
Language: English

STUDY ELIGIBILITY

The study measures the environmental impacts of the Intervention.	YES ☐ NO ☐ Unclear ☐
The study includes outcomes on Deforestation, Forest Degradation, Biodiversity, and Ecosystem Services.	YES ☐ NO ☐ Unclear ☐
Which type of forest certification does the study analyse?	FSC ☐ PEFC ☐ Both ☐ Other ☐ Unclear ☐ Not Reported ☐
FINAL DECISION	INCLUDE ☐ EXCLUDE ☐

REASONS FOR EXCLUSION OF STUDY FROM REVIEW

What are the reasons for the exclusion?	Irrelevant outcomes assessed	☐
	There is no mention of the methodology used	☐
	It does not analyse the impacts of Forest Certification of our interest	☐
	It does not measure the environmental impacts of the intervention	☐
	It only based on Corrective Actions Requests (CARs)	☐
	Other	☐

Do Not Proceed if Study Excluded from Review

PART 1: GENERAL STUDY DETAILS

Topics	Deforestation	☐	Other	☐		
	Forest Degradation	☐				
	Biodiversity	☐				
	Ecosystem Services	☐				
Research Questions – Aim of the study						
Hypothesis						
Unit of Intervention	Forest Area	☐	Mature Stands	☐	Other	☐
	Logging Concession	☐	Forest Plots	☐		
	Areas Set-Aside	☐	Unclear	☐		
Level of Analysis	Local	☐	Global	☐		
	National	☐				
	Regional	☐				

PART 2: STUDY METHODOLOGY

Time Scale	Time forest certification was adopted: Time measurements were taken: Time study was published: Not Reported ☐ Unclear ☐
Study Design	Randomized controlled trial ☐ Nonrandomized intervention ☐ Case-control ☐ Case Study ☐ Single Case Study ☐ Multiple Case Studies ☐ Replications ☐ Comparative ☐ Meta-Analysis ☐ Systematic Review ☐ Literature Review ☐ Cross Sectional ☐ Longitudinal ☐
Data Collection Method	Interviews (structured, semi-structured, unstructured) ☐ Surveys / Questionnaires ☐ On the ground measurements ☐ Secondary Data ☐ Other ☐ Statistical Analysis ☐ Focus groups ☐
Type of Data	Qualitative ☐ Unclear ☐ Quantitative ☐ Mixed ☐
Sampling Strategy	Random ☐ Simple ☐ Systematic ☐ Stratified ☐ Clustered ☐ Non-Random ☐ Convenience ☐ Quota ☐ Snowball ☐ Purposive ☐
Baseline / Reference Point	YES ☐ Unclear ☐ NO ☐
Comparison Group	With Forest Certification ☐ Without Forest Certification ☐ Before the Certification ☐ After the Certification ☐ State Forest Reserves ☐ Protected Areas ☐ Conventionally Managed Forests ☐ Old –Growth Forests ☐

	Primary Forest ☐ Areas formally set-aside ☐ Unharvested Reference Stands ☐ Open Access Forest ☐	Forest Certified with another Certification ☐ Production Forests ☐ Areas with unknown management Practice ☐ Unlogged forest ☐
Number of Replications		
Sample Size	Unclear ☐	Not Reported ☐
Bias	Language Bias ☐ Information Bias ☐ Confounding ☐	Unclear ☐ Not Reported ☐ Other ☐

PART 3: DATA SOURCE

Type of Forest Certification	FSC ☐ PEFC ☐	Both ☐
Type of Forest Management	Reduced Impact Logging (RIL) ☐ Selective Logging ☐ Small and Low Intensity Managed Forest (SLIMF) ☐ Sustainable Forest Management (SFM) ☐ Partial Harvest Treatment ☐	Clear Cutting ☐ Retention Cutting ☐ Unclear ☐ Not Reported ☐
Type of Ownership	Community Forest Management ☐ Industrial Private Ownership ☐ Non-Industrial Private Ownership ☐	State Property ☐ Different Ownership Type ☐ Unclear ☐ Not Reported ☐
Environmental Category Examined	Flora ☐	

	Fauna ☐ Ecosystem Services ☐	Multiple ☐	
Indicator (s)	Air pollution ☐ Areas set-aside ☐ Biomass ☐ Bird species ☐ Broad-leaved trees ☐ Carbon emissions ☐ Carbon storage ☐ Coarse Woody Debris Volumes ☐ Cover, richness and diversity of Mediterranean shrublands ☐	Dead wood ☐ Deforestation ☐ Ecological condition of Mediterranean streams ☐ Environmentally important areas ☐ Fire incidence ☐ Floristic composition ☐ Forest disturbance ☐ Forest structure ☐ Live tree characteristics ☐	Mammal richness ☐ Mature stands ☐ Old growth forests ☐ Potential functional habitat connectivity ☐ Seedling recruitment ☐ Species richness ☐ Structural habitat connectivity ☐ Structure, composition and diversity of plant communities ☐ Tree species richness, diversity and density ☐ Trees and high stumps left in the plots ☐ Watershed services ☐

PART 4: STUDY CONTEXT

Country		
Study Setting	High Income Country ☐ Middle Income Country ☐	Low Income Country ☐
Biome	Tropical ☐ Temperate ☐	Boreal ☐
Area Size (ha)		
Type of Forest		

PART 5: GOVERNANCE MECHANISMS

Institutions	The national standard content comprises indicators for different spatial scale of biodiversity conservation YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Which one ___________ The percentage of the area set-aside (prescribed by the certification) for conservation purposes is effective YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Certified FMUs have better working conditions than non-certified FMUs YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Such as ____________ Certified FMUs have better living conditions for workers and their family than non-certified FMUs YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Such as ____________ Institutions in certified FMUs are more inclusive than the ones in non-certified FMUs YES ☐ NO ☐ Unclear ☐ Not Reported ☐ How? ____________ Benefit sharing mechanisms in certified FMUs are better than the ones in non-certified FMUs

Institutions	YES ☐ NO ☐ Unclear ☐ Not Reported ☐ How? ____________ Conflict resolution mechanisms in certified FMUs are better than the ones in non-certified FMUs YES ☐ NO ☐ Unclear ☐ Not Reported ☐ There are strict hunting regulations in place within the certified forest YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The certified FMUs are effectively monitored YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Enforcement is verified by third party auditor YES ☐ NO ☐ Unclear ☐ Not Reported ☐

Information	Forest Managers are educated about biodiversity issues YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest Managers can identify pristine forest YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest Managers can identify HCVFs YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest Managers changed their management practices after the certification was awarded YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers are more aware of environmental problems after being certified YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers have improved their monitoring mechanisms after being certified YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers improved their data collection methods after being certified YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers were more in favour of sustainable forest management after being certified YES ☐ NO ☐ Unclear ☐ Not Reported ☐

Incentives	Forest managers wanted to be certified for sustainability reasons YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers wanted to be certified for economic reasons YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers experienced price premium YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers experienced improved reputation YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers experienced improved market access YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers were exposed to new clients after being certified YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers experienced tax exemptions after being certified YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest managers experienced preferential treatments after being certified YES ☐ NO ☐ Unclear ☐ Not Reported ☐

Incentives	Which one ____________
Does the study take confounding factors into account?	YES ☐ NO ☐ UNCLEAR ☐ Which one

PART 6: CONTEXTUAL FACTORS

Political Factors	National legislation already prescribed sustainable management practices YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The government enforces forestry laws YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The national legislation supports the uptake of forest certifications YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The national forestry law is compatible with forest certification standards YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Land property and land use right are clear YES ☐ NO ☐ Unclear ☐ Not Reported ☐
	There is low level of corruption YES ☐ NO ☐ Unclear ☐ Not Reported ☐ NGOs support and assist forest companies and forest owners in becoming certified YES ☐ NO ☐ Unclear ☐ Not Reported ☐ In which way ____________ The area of formally protected forests is higher than the area of voluntary set-asides YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Economic Context	The government provide tax benefits to certified forest owners/companies YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Certification costs are relatively low YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Sustainability Practices	Areas near the forest concession have strict hunting regulations YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The forest managers already implemented silviculture treatments required by the forest certification YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Which one ____________
Biophysical Factors	The area set aside for conservation purpose is of high conservation value

	YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Which type of forest are set aside Areas set aside are functionally connected YES ☐ NO ☐ Unclear ☐ Not Reported ☐ To what extent _________ The certified forest is a hotspot for biodiversity YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The certified forest is surrounded by a relative unfragmented landscape YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The certified forest is close to the main road YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The certified forest is close to the main market YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Does the study take confounding factors into account?	YES ☐ NO ☐ UNCLEAR ☐ Which one :

PART 7: IMPACTS

Conceptualization of Impact						
Flora	Areas set-aside	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐
	Broad-leaved trees	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐
	Cover, richness and diversity of Mediterranean shrublands	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐
	Deforestation	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐
	Environmentally Important Areas	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐
	Floristic Composition	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐
	Forest Disturbance	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐
	Forest Structure	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐
	Live Tree Characteristics	Positive ☐	Negative ☐	Neutral ☐	Unclear ☐	Not Reported ☐

	Mature Stands	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Old Growth Forests	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Potential Functional Habitat Connectivity	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Seedling Recruitment	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Structural Habitat Connectivity	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Structure, Composition, and Diversity of Plant Communities	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Tree Species Richness, Diversity, Density	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Trees and high stumps let in the plots	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
Fauna	Bird Species	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Mammal Richness	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Species Richness	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
Ecosystem Services	Air Pollution	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Biomass	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Carbon Emission	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Carbon Storage	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐

	Coarse Woody Debris Volume	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Dead Wood	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Ecological Condition of Mediterranean Streams	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Fire Incidence	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
	Watershed Services	Positive ☐ Negative ☐ Neutral ☐ Unclear ☐ Not Reported ☐
DEGREE OF IMPACT (Extracted from the literature source)		

NOTES:

B) Data Extraction Form for Community Forest Management

DATA EXTRACTION FORM

- What are the environmental impacts of Community Forest Management at global scale, as reported in the academic literature?
- What are the governance mechanisms and contextual factors identified in the academic literature that facilitate the achievement of positive impacts?

The data extracted from each is paper is based on the authors' findings

GENERAL INFORMATION

ID#		Date Form Completed:		Excluded ☐ Included ☐
Title:				
Author(s):				
Publication Type:	Peer Reviewed Article ☐		Grey Literature ☐	Other ☐
Year :	Volume: -	Issue: -	Page(s):	Country:

Journal Title :	
Boolean Search Terms:	
Number of search results displayed:	Database:

INCLUSION CRITERIA

Geography: Global scale	**Time**: Studies from 1980 onwards
Type of Impact: Environmental impacts, whether they are Positive, Negative, or Neutral (no impact at all).	
Community Forest Management: Conceived as "the use, the management and conservation of forests by communities" (Arts and de Koning, 2017, p.315). It includes five different regime of tenure rights: Participatory Conservation; Joint Forest Management, Community Forestry (Limited devolution); Community Forestry (Full devolution); Private ownership (FAO, 2016).	
Environmental Impacts: It needs to include at least one indicator that relates to the categories of Flora, Fauna, and Ecosystem Services of Forests.	

Comparison: Before and After CFM; Buffer Zone Areas; Customary Land; Forest Managed by the State; Historical Sacred Forests; Human-Modified Landscapes; National Park; Open Access Forest; Private Forest; Protected Forest; Reserve Forest; State Production Forest; Wildlife Sanctuary; With and without CFM; With and Without Joint Forest Management; With and Without Participatory Conservation; With and Without Private Ownership;
Baseline Measurement: Before implementing CFM; Reference Point.
Outcome: Change or not change in biodiversity (Fauna and/or Flora), change or not change in Forest Cover, change or not change in Forest Condition, and change or not change in Ecosystem Services provision.
Types of study: Studies providing empirical data, qualitative and/or quantitative. Studies must have at least one of the following three characteristics: (i) focus on the environmental impacts of Community Forest Management; (ii) include a control group and/or take confounding factors into account; (iii) highlight contextual factors and governance mechanisms; Case studies, literature reviews and systematic reviews –including meta-analyses- will be included if they comprise one or more of these characteristics.
Language: English

STUDY ELIGIBILITY

The study measures the environmental impacts of the Intervention.	YES ☐ NO ☐ Unclear ☐
The study includes outcomes on Deforestation, Forest Degradation, Biodiversity, and Ecosystem Services.	YES ☐ NO ☐ Unclear ☐
FINAL DECISION	INCLUDE ☐ EXCLUDE ☐

REASONS FOR EXCLUSION OF STUDY FROM REVIEW

What are the reasons for the exclusion?	Irrelevant outcomes assessed	☐
	There is no mention of the methodology used	☐
	It focuses only on Institutions	☐
	It does not measure the environmental impacts of the intervention	☐
	It focuses only on Community Conservation	☐
	Other	☐

Do Not Proceed if Study Excluded from Review

PART 1: GENERAL STUDY DETAILS

Topics	Deforestation	☐	Other	☐
	Forest Degradation	☐		
	Biodiversity	☐		
	Ecosystem Services	☐		
Research Questions / Aim of the study				
Hypothesis				
Unit of Intervention	Individual	☐	Forest Plots	☐
	Household	☐	Unclear	☐
	Community	☐	Other	☐
Level of Analysis	Community	☐	Regional	☐
	National	☐	Global	☐

PART 2: STUDY METHODOLOGY

Time Scale	Time CFM started: Time measurements were taken: Time study was published: Unclear ☐ Not Reported ☐
Study Design	Randomized controlled trial ☐ Nonrandomized intervention ☐ Case-control ☐ Case Study ☐ Single Case Study ☐ Multiple Case Studies ☐ Replications ☐ Comparative ☐ Meta-Analysis ☐ Systematic Review ☐ Literature Review ☐ Cross Sectional ☐ Longitudinal ☐

Data Collection Method	Interviews (structured, semi-structured, unstructured) ☐ Surveys / Questionnaires ☐ On the ground measurements ☐ Secondary Data ☐ Other ☐ Statistical Analysis ☐ Focus groups ☐	
Type of Data	Qualitative ☐ Unclear ☐ Quantitative ☐ Mixed ☐	
Sampling Strategy	Random ☐ Simple ☐ Systematic ☐ Stratified ☐ Clustered ☐	Non-Random ☐ Convenience ☐ Quota ☐ Snowball ☐ Purposive ☐
Baseline / Reference Point	YES ☐ Unclear ☐ NO ☐	

Comparison Group	Before CFM ☐ After CFM ☐ Buffer Zone Areas ☐ Customary Land ☐ Private Forest ☐ Forest Managed by the State ☐ Historical Sacred Forests ☐ Human-Modified Landscapes ☐	National Park ☐ Open Access Forest ☐ Protected Forest ☐ Reserve Forest ☐ State Production Forest ☐ Wildlife Sanctuary ☐ With CFM ☐ Without CFM ☐	With Joint Forest Management ☐ Without Joint Forest Management ☐ With Participatory Conservation ☐ Without Participatory Conservation ☐ With Private Ownership ☐ Without Private Ownership ☐
Number of Replications			
Sample Size		Unclear ☐	Not Reported ☐
Bias	Language Bias ☐ Information Bias ☐ Confounding ☐	Unclear ☐ Not Reported ☐ Other ☐	

PART 3: DATA SOURCE

Type of Community	Indigenous Community ☐ Local Community ☐	Both ☐	
Location of Community	Inside the forest ☐ Outside the forest ☐ Unclear ☐	Both ☐ Not Reported ☐	
Environmental Category Examined	Flora ☐ Fauna ☐ Ecosystem Services ☐	Multiple ☐	
Indicator (s)	Above ground Biomass ☐ Avian Biodiversity ☐ Basal Area ☐ Biomass ☐ Biomass Production ☐ Canopy Cover ☐ Carbon Management ☐	Forest Regeneration ☐ Forest Restoration ☐ Forest Structure ☐ Fuel wood Availability ☐ Greenhouse Gas Sequestration ☐ Herbaceous Species ☐ Landscape Beauty ☐	Species Diversity ☐ Species Dominance (Fauna) ☐ Species Richness (Fauna) ☐ Species Richness ☐ Stand Density ☐ Stem Density ☐

	Carbon Stock ☐	Land Conversion ☐	Sustainable Use of Natural Resources ☐
	Carbon Sequestration ☐	Land Cover ☐	Taxonomic diversity (Fauna) ☐
	Crown Cover ☐	Land Degradation ☐	Tree Biomass ☐
	Crop Pollination ☐	Landslides ☐	Tree Composition ☐
	Deforestation ☐	Lopping ☐	Tree Density ☐
	Desertification ☐	Sapling Species ☐	Tree Structure ☐
	Firewood ☐	Sapling Density ☐	Tree Species ☐
	Forest Biodiversity ☐	Sapling Diversity ☐	Tree Species Richness ☐
	Forest Condition ☐	Sapling Species Richness ☐	Tree Species Diversity ☐
	Forest Conservation ☐	Seedling Species ☐	Understory Regeneration ☐
	Forest Cover ☐	Shrub Species ☐	Water Availability ☐
	Forest Density ☐	Shrubs Species Diversity ☐	Water Conservation ☐
	Forest Degradation ☐	Soil Organic Carbon ☐	Water Regulation ☐
	Forest Disturbance ☐	Soil Conservation ☐	Water Provision ☐
	Forest Greenery ☐	Soil Erosion ☐	Water Quality ☐
	Forest Growth ☐	Species Composition ☐	Water Volumes ☐
	Forest Loss ☐	Species Composition of Mammals (Fauna) ☐	Wildlife Conservation ☐
	Forest Plant diversity ☐	Species Density ☐	Wildlife Species ☐
	Forest Productivity ☐	Species Distribution (Fauna) ☐	Wildlife Abundance ☐
			Woody Species Richness ☐
			Woody Species Composition ☐

PART 4: STUDY CONTEXT

Country	
Study Setting	High Income Country ☐ Low Income Country ☐ Middle Income Country ☐
Biome	Tropical ☐ Boreal ☐ Temperate ☐
Area Size (ha)	
Type of Forest	
CFM (Including Tenure Rights Regime)	Participatory Conservation ☐ Community Forestry (Full Devolution) ☐ Joint Forest Management ☐ Private Ownership ☐

	Community Forestry (Limited Devolution) ☐

PART 5: GOVERNANCE MECHANISMS

	Central institutions formally recognize tenure rights YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Rules are easy to understand YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Rules are easy to enforce YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Rules are locally devised YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Rules allows to exclude outsiders

Institutions	YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Institutions include local communities in the rule-making process YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Institutions create effective conflict-resolution mechanisms YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Institutions are perceived as fair YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Institutions are perceived as legitimate YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Institutions create effective benefit-sharing mechanisms YES ☐ NO ☐ Unclear ☐ Not Reported ☐

Institutions	Institutions foster accountability YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Sanctioning mechanisms are effective YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Monitoring mechanisms are effective YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Enforcement of rules is effective YES ☐ NO ☐ Unclear ☐ Not Reported ☐

Information	The knowledge of the community is used to develop the most appropriate institutions YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The knowledge of the community is used to manage forest resources YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The knowledge of the community has increased with capacity development activities implemented by NGOs YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Incentives	External donors provide financial support to implement the intervention YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The community is allowed to use its knowledge to manage forest resources YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The community is empowered by technical assistance and capacity development activities implemented by NGOs YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The community can profit from managing forest resources sustainably YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The community is included in the rule-making process

	YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The community can use forest products for its household needs YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Does the study take confounding factors into account?	YES ☐ NO ☐ UNCLEAR ☐ Which one ___________________________

PART 6: CONTEXTUAL FACTORS

Forest Resource System	Forest size is small ☐ Forest size is medium ☐ Forest size is large ☐ The size of the forest is unclear ☐ The size of the forest is not reported ☐

	Resources are stationary YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Physical boundaries are clear YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Boundaries are easily monitored YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Benefit flow is predictable YES ☐ NO ☐ Unclear ☐ Not Reported ☐
User group Characteristics	*Size of the user group* The user group is small ☐ The user group is medium ☐ The user group is big ☐ The size of the user group is unclear ☐ The size of the user group is not reported ☐

	Dependency on Forest Resources The community is not dependent on forest resources ☐ The community is moderately dependent on forest resources ☐ The community is heavily dependent on forest resources ☐ The dependency on forest resources is unclear ☐ The dependency on forest resources is not reported ☐ *Sources of income* Additional sources of income are provided YES ☐ NO ☐ Unclear ☐ Not Reported ☐ *Economic status of community* The community is poor ☐ The community is rich ☐ The community is moderately wealthy ☐ The economic status of the community is unclear ☐ The economic status of the community is not reported ☐ *Dependency* Resource users are interdependent YES ☐ NO ☐ Unclear ☐ Not Reported ☐

	Composition of users Resource users are homogeneous YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Demography	Demographic conditions are stable YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The community is subjected to migration flux YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Market	Market conditions are stable YES ☐ NO ☐ Unclear ☐ Not Reported ☐ The community has access to the market YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Technology	Technology influences forest resource management YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Smart phones are used to detect chainsaw noises to prevent illegal logging YES ☐ NO ☐ Unclear ☐ Not Reported ☐

	Smart phones are used to report illegal logging YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Barcode tags are used to help map timber supply chains YES ☐ NO ☐ Unclear ☐ Not Reported ☐ Forest fires are notified via email or SMS alert systems YES ☐ NO ☐ Unclear ☐ Not Reported ☐
History	The community has previous experience in forest management YES ☐ NO ☐ Unclear ☐ Not Reported ☐
Biophysical factors	Forest elevation Low ☐ Medium ☐ High ☐ Unclear ☐ Not Reported ☐ Rainfall Low ☐ Medium ☐ High ☐ Unclear ☐ Not Reported ☐ Fertility of the soil Low ☐ Medium ☐ High ☐ Unclear ☐ Not Reported ☐ Temperature

	C°________________________ Unclear ☐ Not Reported ☐
Does the study take confounding factors into account?	YES ☐ NO ☐ UNCLEAR ☐ Which one ___________________________

PART 7: IMPACTS

Conceptualization of Impact											
	Basal Area	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Canopy Cover	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Crown Cover	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Deforestation	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Desertification	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Biodiversity	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐

Flora	Forest Condition	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Conservation	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Cover	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Density	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Degradation	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Disturbance	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Greenery	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Growth	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Loss	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Plant diversity	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Productivity	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Regeneration	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Restoration	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Forest Structure	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Herbaceous Species	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Land Conversion	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Land Cover	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Land Degradation	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Landslides	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Lopping	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Sapling Species	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐

Flora	Sapling Density	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Sapling Diversity	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Sapling Species Richness	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Seedling Species	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Shrub Species	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Shrubs Species Diversity	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Species Composition	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Species Density	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Species Diversity	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Species Richness	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Stand Density	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Stem Density	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Sustainable Use of Natural Resources	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Tree Composition	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Tree Density	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Tree Structure	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Tree Species	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Tree Species Richness	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Tree Species Diversity	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Understory Regeneration	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Woody Species Richness	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐

	Woody Species Composition	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
Fauna	Avian Biodiversity	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Species Composition of Mammals (Fauna)	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Species Distribution (Fauna)	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Species Dominance (Fauna)	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Species Richness (Fauna)	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Taxonomic diversity (Fauna)	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Wildlife Conservation	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Wildlife Species	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Wildlife Abundance	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Above ground Biomass	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Biomass	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Biomass Production	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Carbon Management	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Carbon Stock	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Carbon Sequestration	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐

Ecosystem Services	Crop Pollination	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Firewood	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Fuel wood Availability	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Greenhouse Gas Sequestration	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Landscape Beauty	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Soil Organic Carbon	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Soil Conservation	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Soil Erosion	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Tree Biomass	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Water Availability	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Water Conservation	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Water Regulation	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Water Provision	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Water Quality	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
	Water Volumes	Positive	☐	Negative	☐	Neutral	☐	Unclear	☐	Not Reported	☐
DEGREE OF IMPACT											

(Extracted from the literature source)	

NOTES:

C) Guidelines for " Gold standards" CFM assessment by : Bowler, D. E., Buyung-Ali, L. M., Healey, J. R., Jones, J. P., Knight, T. M., & Pullin, A. S. (2012). Does community forest management provide global environmental benefits and improve local welfare?. *Frontiers in Ecology and the Environment*, *10*(1), 29-36, Page. 34

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Table 3. Guidelines for "gold standard" CFM assessment

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

Appendix B - Forest Certifications chapter material

A) List of excluded papers

Angelstam, P., Roberge, J. M., Axelsson, R., Elbakidze, M., Bergman, K. O., Dahlberg, A., ... & Johansson, T. (2013). Evidence-based knowledge versus negotiated indicators for assessment of ecological sustainability: The Swedish Forest Stewardship Council standardasacasestudy.Ambio , 42 (2), 229-240.

Blackman, A., Raimondi, A., & Cubbage, F. (2017). Does forest certification in developing countries have environmental benefits? Insights from Mexican corrective action requests. *International Forestry Review*, *19*(3), 247-264.

Burivalova, Z., Hua, F., Koh, L. P., Garcia, C., & Putz, F. (2017). A critical comparison of conventional, certified, and community management of tropical forests for timber in terms of environmental, economic, and social variables. *Conservation Letters*, *10*(1), 4-14.

Carlson, A., & Palmer, C. (2016). A qualitative meta-synthesis of the benefits of eco-labeling in developing countries. *Ecological Economics*, *127*, 129-145.

Cerutti, P. O., Lescuyer, G., Tsanga, R., Kassa, S. N., Mapangou, P. R., Mendoula, E. E., ... & Yembe, R. Y. (2014). *Social impacts of the Forest Stewardship Council certification: An assessment in the Congo basin* (Vol. 103). CIFOR.

Cerutti, P. O., Tacconi, L., Nasi, R., & Lescuyer, G. (2011). Legal vs. certified timber: Preliminary impacts of forest certification in Cameroon. *Forest Policy and Economics*, *13*(3), 184-190.

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Ecosystem Services Certification Document (ESCD) for Gaurishankar Landscape, Nepal

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B) **List of included papers**

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Ecosystem Services Certification Document (ESCD) for Sesaot forest, Lombok island, Indonesia, Watershed services, ForCES, 2016

Ecosystem Services Certification Document (ESCD) for Ratah Timber, Long Hubung sub-district, Ulu Mahakam District, East Kalimantan, Carbon sequestration and storage, ForCES, 2017

Elbakidze, M., Angelstam, P., Andersson, K., Nordberg, M., & Pautov, Y. (2011). How does forest certification contribute to boreal biodiversity conservation? Standards and outcomes in Sweden and NW Russia. Forest Ecology and Management, 262(11), 19831995.

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Medjibe, V. P., Putz, F. E., & Romero, C. (2013). Certified and uncertified logging concessions compared in Gabon: changes in stand structure, tree species, and biomass. Environmental management, 51(3), 524-540

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Tritsch, I., Sist, P., Narvaes, I. D. S., Mazzei, L., Blanc, L., Bourgoin, C., ... & Gond, V. (2016). Multiple patterns of forest disturbance and logging shape forest landscapes in Paragominas, Brazil. Forests, 7(12), 315

C) Complete list of scientific journals where the included papers were published

List of scientific journals	Number of publications
Forest Ecology and Management	5
Biodiversity and Conservation	2
Biological Conservation	2
Forests	2
Ambio	1
Annals of forest science	1
Diversity and Distribution	1
Duke Environmental and Energy Economics Working Paper EE	1
Environmental Management	1
EuropeanJournal of Forest Research	1
Forest Policy and Economics	1
Global Change Biology	1
International Forestry Review	1
Journal of Mammology	1
Journal of Sustainable Forestry	1
Journal of Applied Ecology	1
Journal of Environmental Economics and Management	1
Land Economics	1
Plos One	1

D) Complete list of reference group

Reference Group	Number of Publications
Without forest certification	8
Areas FSC certified	3
Without comparison group	3
Areas FSC certified; Certified with another certification	2
Comparison between areas FSC and PEFC certified	2
Open access forests; State Forest Reserves	2
Areas formally protected	1
Before-After; Areas without forest certification	1
Comparison between areas FSC and PEFC certified, and without forest certification	1
Non-conservation zones within FSC certified woodlands	1
Old-growth forests	1
Primary Forest	1
Protected areas; Conventionally managed forests	1
State Forest Reserve; Production Forests	1
Unlogged forests within FSC certified area	1

E) Quality Assessment Scores of the publications on FCs

Author	Clarity of RQs/ Hypothesis/ Study Aim	Clarity of data collection methods	Clarity of sampling plan	Clarity of sampling size	Clarity of analysis method	Clarity of conclusions	Clarity of limitations	Quality assessment
Blackman et al., 2018	2	2	2	2	2	1	2	13
De Iongh et al., 2014	2	2	2	2	2	1	1	12
Dias et al., 2013	2	2	2	2	2	1	0	11
Dias et al., 2015	2	2	2	2	2	1	0	11
Dias et al., 2016	2	2	2	2	2	1	1	12
ESCD, Indonesia, 2016	-	-	-	-	-	-	-	-
ESCD, Indonesia, 2017	-	-	-	-	-	-	-	-
ESCD, Indonesia, 2017	-	-	-	-	-	-	-	-

Elbakidze et al., 2011	2	2	2	2	2	1	2	13
Elbakidze et al., 2016	2	2	2	2	2	1	0	11
Foster at al., 2008	2	2	2	2	2	1	2	13
Griscom et al. 2014	2	2	2	2	2	1	2	13
Johansson et al., 2011	2	2	2	1	1	1	0	9
Kalonga et al., 2015	2	2	2	2	2	1	1	12
Kalonga et al., 2016	2	2	2	2	2	1	1	12
Kukkonen et al., 2009	2	2	2	2	2	1	1	12
Lõhmus et al., 2010	2	2	2	2	2	1	0	11
Medjibe et al., 2013	2	2	2	2	1	1	1	11

Miteva et al., 2015	2	2	2	1	2	1	1	11
Mohamed et al., 2013	2	2	2	2	2	1	1	12
Nordén et al., 2018	2	2	2	1	2	1	0	10
Panlasigui et al., 2015	2	2	2	2	2	1	0	11
Polisar et al., 2017	2	2	2	2	0	1	0	9
Rana et al., 2018	2	2	2	1	2	1	1	11
Rivett et al., 2016	2	2	2	2	1	1	0	10
Simonsson et al., 2016	2	2	2	2	1	1	0	10
Sollmann et al., 2017	2	2	2	2	2	1	1	12
Tobler et al., 2018	2	2	2	2	2	1	0	11

Tritsch et al., 2016	2	2	2	2	1	1	0	10

F) Rigour Assessment scores of the publications on FCs

Author	Study design	Comparator/ Reference Group	Baseline/ Reference point data collection	Replication	Site Selection	Sampling Procedure	Use of statistical techniques	Appropriate time scale	Confound -ing variables	Rigour Assessment Score
Blackman et al., 2018	2	3	4	1	1	1	1	3	2	18
De Iongh et al., 2014	2	3	1	0	0	3	1	0	0	10
Dias et al., 2013	2	3	0	1	1	3	0	0	1	11
Dias et al., 2015	2	3	0	1	1	0	1	1	1	10
Dias et al., 2016	0	0	0	1	0	2	1	2	1	7
ESCD, Indonesia, 2016	1	0	4	0	0	0	0	0	0	5
ESCD, Indonesia, 2017	1	0	3	0	0	2	0	1	1	8
ESCD, Indonesia, 2017	1	0	3	0	0	2	0	1	1	8
Elbakidze et al., 2011	1	1	3	0	1	1	0	0	1	8

Elbakidze et al., 2016	2	3	1	0	1	1	0	0	1	9
Foster at al., 2008	2	3	1	1	1	3	1	0	1	13
Griscom et al. 2014	2	3	1	1	1	3	1	0	0	12
Johansson et al., 2011	1	1	1	1	1	2	0	0	1	8
Kalonga et al., 2015	2	3	0	1	1	3	0	1	1	12
Kalonga et al., 2016	2	3	0	1	1	3	1	1	1	13
Kukkonen et al., 2009	2	3	0	0	1	0	0	0	0	6
Lõhmus et al., 2010	2	3	0	1	1	0	1	0	0	8
Medjibe et al., 2013	2	3	1	0	0	3	1	1	0	11
Miteva et al., 2015	2	3	3	1	1	0	1	2	1	14
Mohamed et al., 2013	1	1	0	1	1	0	0	3	1	8
Nordén et al., 2018	2	2	2	1	1	3	1	0	1	13
Panlasigui et al., 2015	1	1	1	1	1	0	1	3	1	10
Polisar et al., 2017	1	1	0	1	1	0	0	0	1	5
Rana et al., 2018	2	2	3	1	1	1	1	3	1	15

Rivett et al., 2016	1	1	1	0	0	2	1	1	0	7
Simonsson et al., 2016	2	3	1	1	1	3	0	0	1	12
Sollmann et al., 2017	1	1	0	1	1	0	0	3	1	8
Tobler et al., 2018	1	1	1	1	0	1	0	0	1	6
Tritsch et al., 2016	2	3	3	0	1	1	0	3	0	13

G) Forest species and types

Author(s)	Country	Type of forest
Blackman et al., 2018	Mexico	Relatively undisturbed and old growth
De Iongh et al., 2014	Indonesia	Palms-trees; Dicots-trees; Monocots-other herbs; Dicots-Shrubs; Palms-lianas; Palms-palmlets, Monocots-small lianas; Monocots-other herbs; Monocots-grass-like Dicots-small treelets; Dicots-small lianas; Dicots-small shrubs; Ferns-small lianas; Ferns-herbs
Dias et al., 2013	Portugal	Cork (Quercus Suber); holm oak (Q.rotundifolia) Maritime Pine (Pinus pinaster), blue gum (Eucalyptus globulus) plantations
Dias et al., 2015	Portugal	Riparian vegetation is dominated by a dense shrub layer (3–6 m high) mainly composed of willows such as Salix salviifolia Brot. and Salix atrocinerea Brot., but also of Hawthorn Crataegus monogyna Jacq., tree heath Erica arborea L., alder buckthorn Frangula alnus L. and wild blackberry Rubus ulmifolius Schott. Oleander Nerium oleander L. and African tamarisk Tamarix africana L. also occur but are less frequent. In more disturbed areas, two invasive species may occur, the giant reed Arundo donax L. and the parrot feather Myriophyllum aquaticum Verde.
Dias et al., 2016	Portugal	Cork oakwoodlands are the dominant forest type in this region (42% of the study area) and are characterized by a sparse tree cover of cork oak, mixed with holm oaks Quercus ilex rotundifolia Lam. or pine trees and a diverse understory of shrublands (e.g. rockroses Cistus spp., gorse Ulex spp., basil-leaved rock rose Hallimium ocymoides Willk., topped lavender Lavandula stoechas L. and rosemary Rosmarinus officinalis L.) interspersed with grasslands (e.g. Agrostis spp., Avena spp., Bromus spp.), pastures, fallows and cereal crops.
ESCD, Indonesia, 2016	Indonesia	Not reported
ESCD, Indonesia, 2017	Indonesia	Not reported
ESCD, Indonesia, 2017	Indonesia	Dipteocarpacea; Macaranga; Virgin/primary forests; Previously logged forest type.
Elbakidze et al., 2011	Sweden; Russia	Sweden (Norway spruce and Scots pine. Birches and aspen occupy less then 8% of the total forested land) Russia (Norway spruce and Scots pine. Birch and Aspen occupy almost 40% of the total forested land).
Elbakidze et al., 2016	Lithuania	Scots pine; Norway spruce; coniferous species; Deciduous tree species
Foster at al., 2008	Central Vermont (USA)	Sugar maple Yellow birch (Betula alleghaniensis) American beech (Fagus grandifolia) white ash (Fraxinus americana) eastern red cedar (Juniperus virginiana) eastern hemlock (Tsuga canadensis) American basswood (Tilia americana).
Griscom et al. 2014	Indonesia	Latosols, Forest canopies dominated by Dipterocarpaceae.
Johansson et al., 2011	Sweden	Not reported

Author(s)	Country	Type of forest
Kalonga et al., 2015	Tanzania	The study area falls on the western part of Kilwa which is characterised by miombo woodlands with some patches of coastal forests, and north Zambezian undifferentiated woodlands and wooded grassland. Indicator miombo tree species such as Acacia polyacantha Willd, Lonchocarpus capassa Rolfe, Piliostigma thonningii Schum and Xeroderris stuhlmannii (Taub.) Mendonça & E.P. Sousa were observed during fieldwork.
Kalonga et al., 2016	Tanzania	The sites fall on the western part of Kilwa, and the study system is characterised by miombo woodlands with some patches of coastal forests, north Zambezian undifferentiated woodlands, and wooded grassland (Lillesø et al., 2014). Miombo woodlands are dominated by woody plants, primarily trees (Chidumayo and Gumbo, 2010), with high diversity and degree of endemism (Chidumayo et al., 2011; Chidumayo and Gumbo, 2010). They are dominated by species in the genera Brachystegia, Julbernadia, and Combretum of the Caesalpinoideae subfamily (Chidumayo and Gumbo, 2010; Frost, 1996). They are the most extensive tropical savannah woodland and dry forest formations in Africa (Campbell et al., 2007; Campbell, 1996), covering about 2.7 million km2 of southern Africa including southern Tanzania (Chidumayo and Gumbo, 2010). Indicator miombo tree species, such as Acacia polyacantha Willd, Lonchocarpus capassa Rolfe, Piliostigma thonningii Schum, and Xeroderris stuhlmannii (Taub.) Mendonça & E.P. Sousa were observed in the study forests during fieldwork.
Kukkonen et al., 2009	Honduras	Typical tree species include species include Euterpe precatoria Mart. (Arecaceae), Vochysia spp. Aubl (Vochysiaceae) (Salazar, 2000), Genipa americana L. (Rubiaceae) and Terminalia amazonia (J.F. Gmel.) Exell (Combretaceae) (Ferrando, 1998).
Lõhmus et al., 2010	Estonia	Dry boreal forests; Meso-eutrophic forests; Eutrophic boreo-nemoral forests; Mobile water swamp forests.
Medjibe et al., 2013	Gabon	Mixed lowland tropical forest is characterized by the presence of Aucoumea klaineana (Burseraceae, okoume´), the principal source of commercial timber, along with Julbernardia pellegriniana (Caesalpiniaceae, be´li) and Scyphocephalium mannii (Myristicaceae, sorro)
Miteva et al., 2015	Indonesia	Not reported
Mohamed et al., 2013	Malaysia	Not reported
Nordén et al., 2018	Sweden	Not reported
Panlasigui et al., 2015	Peru Cameroon	Not reported
Polisar et al., 2017	French Guiana; Bolivia; Guatemala; Nicaragua	Moist evergreen upland forest with high tree diversity; Dry forest ecoregion covered with Chiquitano dry forests and Cerrado savannas; Wet and moist evergreen and semi-green broad-leaved forests and pine savanna; Tropical rainforest
Rana et al., 2018	Brazil; Gabon; Indonesia	Not reported
Rivett et al., 2016	Guyana	Dominant forest type include: (i) mixed C. rodiei, Eschweilera spp. and Swartzia leiocalycina forest; (ii) Mora excelsa, Euterpe oleracea, Carapa guianensis and Pentaclethra macroloba forest; and, (iii) mixed C. rodiei, Catostemma fragrans, and Eperua falcata forest
Simonsson et al., 2016	Sweden	Spruce Forests; Pine forests; Coniferous-Broadleaved forests
Sollmann et al., 2017	Malaysia	Tropical evergreen rainforest
Tobler et al., 2018	Peru and Guatemala	Not reported
Tritsch et al., 2016	Brazil	Not reported

Appendix C- CFM chapter material

A) List of excluded papers.

Agarwal, S., Nagendra, H., & Ghate, R. (2016). The influence of forest management regimes on deforestation in a central Indian dry deciduous forest landscape. *Land*, *5*(3), 27

Alcántara-Salinas, G., Hunn, E. S., & Rivera-Hernández, J. E. (2015). Avian Biodiversity in Two Zapotec Communities in Oaxaca: The Role of Community-Based Conservation in San Miguel Tiltepec and San Juan Mixtepec, Mexico. *Human ecology*, *43*(5), 735-748.

Andersson, K. & Gibson, C.C., 2006. Decentralized Governance and Environmental Change: Local Institutional Moderation of Deforestation in Bolivia. Journal of Policy Analysis and Management, 26(1), pp.99–123.

Blackman, A. et al., 2017. Titling indigenous communities protects forests in the Peruvian Amazon. Proceedings of the National Academy of Sciences, 114(16), pp.4123–4128

Bowler, D.E. et al., 2012. Does community forest Management provide global environmental benefits and improve local welfare? Frontiers in Ecology and the Environment, 10(1), pp.29–36

Corrigan, C., Bingham, H., Shi, Y., Lewis, E., Chauvenet, A., & Kingston, N. (2018). Quantifying the contribution to biodiversity conservation of protected areas governed by indigenous peoples and local communities. *Biological Conservation*, *227*, 403-412

Dalle, S.P. et al., 2006. Integrating analyses of local land-use regulations, cultural perceptions and land-use/land cover data for assessing the success of community-based conservation. Forest Ecology and Management, 222, pp.370–383

Gilmour, D. (2016). *Forty years of community-based forestry: A review of its extent and effectiveness*. FAO.

Hayes, T. M. (2006). Parks, people, and forest protection: an institutional assessment of the effectiveness of protected areas. *World Development*, *34*(12), 2064-2075.

Heltberg, R., 2001. Determinants and impact of local institutions for common resource management. Environment and Development Economics, 6, pp.183–208

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C) Complete list of scientific journals where the included papers were published

List of scientific journals	Number of Publications
Biological Conservation	1
Conservation Biology	2
Ecological Economics	1
Ecology and Society	2
Ecosystem Services	2
Environmental Conservation	3
Environmental Management	1
Forest Ecology and Management	1
Forest Policy and Economics	2
Forests, Trees, and Livelihoods	1
Global EnvironmentalChange	1
International Forestry Review	1
International Journal of Biodiversity Science, Ecosystem Service & Management	1
International Journal of Environment and Sustainable Development	3
International Journalof Forestry Research	1
International Journal of the Commons	1
Journal of Sustainable Forestry	2
Journal of Environmental Management	1
Journal of Sustainable Forestry	2
Landscape Ecology	1
Oryx	1
Small-scale Forestry	1
World Development	3

D) Complete list of reference group

Reference Group	Number of Publications
Without CFM	7
Before/After CFM	5
Forest Managed by the State	4
Without reference group	3
With another type of CFM	3
Protected Forest	2
Before/After CFM + With another "type" of CFM	2
Before/After CFM + Open Access Forest	1
Before/After CFM + Without CFM	1
Forest Managed by the State + With another "type" of CFM	1
Forest Managed by the State + Protected Forests	1
Forest Managed by the State + With two types of CFM (JFM, and Communal)	1
Open Access Forest + Forest Managed by the State	1
Open Access Forest + Protected Forest	1
Open Access Forest+ Protected Forest + With another "type"of CFM	1
With another type of CFM + Without CFM	1
Without CFM (Plausible alternative state)	1

E) Quality Assessment Scores of the publications on CFM

Author	Clarity of RQs/ Hypothesis/ Study Aim	Clarity of data collection methods	Clarity of sampling plan	Clarity of sampling size	Clarity of analysis method	Clarity of conclusions	Clarity of limitations	Quality assessment
Acharya, 2003	2	1	1	1	0	1	1	7
Aggarwal et al., 2006	2	1	1	1	0	1	0	6
Ameha et al., 2016	2	2	2	2	2	1	2	13
Arts et al.,2017	2	2	2	2	2	1	2	13
Baland et al., 2010	2	2	2	2	2	1	2	13
Birch et al., 2014	2	2	2	2	1	1	2	12
Blomley et al., 2008	2	1	2	1	0	1	1	8
Bluffstone et al., 2018	2	2	2	2	2	1	2	13
Bray et al., 2008	2	2	2	0	1	1	1	9

Ellis et al., 2008	2	2	2	2	2	1	0	11
Gbedomon et al., 2016	2	2	2	2	1	1	2	12
Kedir et al., 2018	2	2	2	2	1	1	0	10
Lambrick et al., 2014	2	2	2	1	1	1	0	9
Lund et al., 2014	2	2	2	2	2	1	0	11
Lupala et al., 2015	2	2	2	2	2	1	0	11
Maren et al., 2013*	2	2	2	2	1	1	0	10
Mazunda et al,. 2015	2	2	2	2	2	1	2	13
Mbwambo et al., 2012	2	2	2	2	2	1	1	12
Menezes Vianna et al., 2014	2	2	2	2	1	1	0	10

Mohammed et al., 2016	2	1	1	1	0	1	0	6
Nagendra et al., 2005	2	2	2	1	1	1	0	9
Nagendra, 2002	2	2	1	1	0	1	0	7
Nagendra et al., 2008	2	2	1	1	1	1	0	8
Niarula et al., 2013	2	1	1	1	2	1	0	8
Pandit et al., 2011	2	2	2	1	1	1	0	9
Patel et al., 2006	1	1	1	1	1	1	0	6
Paudel et al, 2015	2	2	2	2	2	1	0	11
Paudyal et al., 2015	2	2	2	2	1	1	1	11
Persha et al., 2009	2	2	1	1	1	1	0	8

Rasolofoson et al., 2015	2	2	2	2	1	1	2	12
Santika et al., 2017	2	2	2	2	2	1	0	11
Sudha et al., 2006	1	2	2	2	1	1	0	9
Tadesse et al., 2016	2	2	2	2	2	1	0	11
Takahashi et al., 2012	2	2	2	2	2	1	0	11
Thapa et al., 2018	2	2	2	2	1	1	0	10
Treue et al., 2014	2	2	2	2	2	1	2	13

F) Rigour Assessment Scores of the publications on CFM

Author	Study design	Comparator / Reference Group	Baseline/Reference point data collection	Replication	Site Selection	Sampling Procedure	Use of statistical techniques	Appropriate time scale	Confounding variables contextual factors and Governance mechanisms	**Rigour Assessment**
Acharya, 2003	1	0	1	1	1	0	0	3	1	8
Aggarwal et al., 2006	2	3	0	1	1	1	0	0	1	9
Ameha et al., 2016	2	3	2	1	1	0	1	1	1	12
Arts et al.,2017	1	1	0	1	0	0	1	3	1	8
Baland et al., 2010	2	3	0	1	2	3	1	0	2	14
Birch et al., 2014	2	3	1	0	1	0	0	0	1	8
Blomley et al., 2008	0	3	0	1	0	0	0	3	1	8
Bluffstone et al., 2018	2	3	4	1	2	3	1	3	1	20

Bray et al., 2008	1	3	1	1	1	0	1	3	1	12
Ellis et al., 2008	2	3	1	0	1	0	1	3	1	12
Gbedomon et al., 2016	1	1	3	0	1	2	0	3	1	12
Kedir et al., 2018	1	1	3	1	1	2	0	3	1	13
Lambrick et al., 2014	2	3	1	1	1	3	1	1	1	14
Lund et al., 2014	1	2	3	1	1	2	0	2	1	13
Lupala et al., 2015	2	2	3	1	1	3	0	3	1	16
Maren et al., 2013	2	3	1	1	1	3	1	3	1	16
Mazunda et al,. 2015	0	0	1	0	1	1	1	3	1	8
Mbwambo et al., 2012	1	2	4	1	1	3	0	3	1	16

Menezes Vianna et al., 2014	2	3	1	1	0	0	0	2	1	10
Mohammed et al., 2016	1	2	3	1	0	0	0	0	1	8
Nagendra et al., 2005	1	1	1	1	1	0	0	3	1	9
Nagendra, 2002	2	3	1	0	1	0	0	0	1	8
Nagendra et al., 2008	2	2	3	1	1	0	0	2	1	12
Niarula et al., 2013	1	1	3	1	1	0	0	3	1	11
Pandit et al., 2011	1	1	3	1	1	0	0	3	1	11
Patel et al., 2006	2	3	3	1	1	0	0	0	1	11
Paudel et al, 2015	2	3	0	0	1	3	0	2	1	12
Paudyal et al., 2015	0	0	1	1	1	2	0	3	1	9

Persha et al., 2009	2	2	1	1	1	3	0	0	1	11
Rasolofoson et al., 2015	2	3	1	1	1	3	1	2	1	15
Santika et al., 2017	2	3	3	1	1	0	1	1	1	13
Sudha et al., 2006	2	2	3	1	1	0	0	0	1	10
Tadesse et al., 2016	2	3	0	0	1	3	0	1	1	11
Takahashi et al., 2012	1	1	3	1	0	0	1	1	1	9
Thapa et al., 2018	0	0	2	0	1	2	1	3	1	10
Treue et al., 2014	2	2	1	1	1	3	0	3	1	14

G) Forest species and types

Author(s)	Country	Type of forest
Acharya K.P.	Nepal	*Shorea-Schima* dominated by Sal (*Shorea robusta*)
Aggarwal, A., Sharma, R. S., Suthar, B., & Kunwar, K.	India	Plantations and Natural Forests
Ameha, A., Meilby, H., & Feyisa, G. L	Ethiopia	Juniperus excelsa M. Bieb., Afrocarpus falcatus (Thunb.) C.N. Page, Hagenia abyssinica J.F. Gmel., Ekebergia capensis Sparrm., Schefflera abyssinica (Hochst. ex A. Rich.) Harms, Olea europaea subsp. africana (Mill.) P.S. Green and Maytenus spp. Pittosporum viridiflorum Sims, Hypericum lanceolatum Lam., Rapanea melanophloeos (L.) Mez, Erica arborea L. and a residual group termed 'Others', which included, e.g., Nuxia congesta R. Br. ex Fresen. and Buddleja polystachya Fresen.
Bas Arts and Jessica De Koning	Ecuador; Tanzania; Bolivia; India; Vietnam; Ethiopia; Indonesia	Not Reported
Baland, J. M., Bardhan, P., Das, S., & Mookherjee, D.	India	Not Reported
Birch, J. C., Thapa, I., Balmford, A., Bradbury, R. B., Brown, C., Butchart, S. H., ... & Peh, K. S. H.	Nepal	Schima-Castanopsis forest; Pinus roxburghii forest; Alnus nepalensis forest; and Quercus-dominated forest.
Blomley, T., Pfliegner, K., Isango, J., Zahabu, E., Ahrends, A., & Burgess, N.	Tanzania	Miombo woodlands; Acacia woodlands; coastal forest; mangrove forests, closed canopy forests
Bluffstone, R. A., Somanathan, E., Jha, P., Luintel, H., Bista, R., Toman, M., ... & Adhikari, B..	Nepal	Over 90% of forests are natural forests rather than plantations

Bray, D. B., Duran, E., Ramos, V. H., May, J. F., Velazquez, A., McNab, R. B., ... & Radachowsky, J.	Guatemala and Mexico	Tropical Semideciduous Forest
Ellis, E. A., & Porter-Bolland, L.	Mexico	Dry tropical forest ranging from deciduous, to semi-deciduous or semi-evergreen
Gbedomon, R. C., Floquet, A., Mongbo, R., Salako, V. K., Fandohan, A. B., Assogbadjo, A. E., & Kakaï, R. G.	Benin	Gallery forest; dry dense forest; woodland savannah; tree savannah
Kedir, H., Negash, M., Yimer, F., & Limenih, M	Ethiopia	Dry Afromontane forests
Lambrick, F. H., Brown, N. D., Lawrence, A., & Bebber, D. P	Cambodia	Moist, lowland, evergreen forest, with some areas of deciduous forest and few plots in stands of *Lagerstroemia*.
Lund, J. F., Burgess, N. D., Chamshama, S. A., Dons, K., Isango, J. A., Kajembe, G. C., ... & Njana, M. A.	Tanzania	Dry Miombo woodland
Lupala, Z. J., Lusambo, L. P., Ngaga, Y. M., & Makatta, A. A.	Tanzania	Miombo Woodlands; dominated by genera Brachystegia, Julbernardia, Isoberlinia species
MÅREN, I. E., Bhattarai, K. R., & Chaudhary, R. P.	Nepal	Low to mid-montane hemi-sclerophyllous broadleaf forest with concentrated summer leaf drop.
Mazunda, J., & Shively, G.	Malawi	Miombo woodlands;
Mbwambo, L., Eid, T., Malimbwi, R. E., Zahabu, E., Kajembe, G. C., & Luoga, E.	Tanzania	Montane forest vegetation; Miombo woodland; Lowland forest

André Luiz Menezes Vianna & Philip Martin Fearnside	Brazil	The forest types present are: dense ombrophilous forest con terra firme (unflooded uplands), igapó (blackwater swamp forest), and floodplain; in addition to campinarana and campina (oligotrophic woody vegetation; Amazonas, SDS, 2009; Veloso et al., 1991). The present study was carried out in Dense Ombrophilous Forest on terra firme (unflooded uplands)
Mohammed, A. J., Inoue, M., Peras, R. J., Nath, T. K., Jashimuddin, M., & Pulhin, J. M.	Bangladesh; Philippines	Plantations
Harini Nagendra, Mukunda Karmacharya, and Birendra Karna	Nepal	Semideciduous forests constitute the climax vegetation in this region. In addition, tropical, deciduous, riverine forest patches are found along the banks of rivers and streams, along with patches of grassland, bamboo, and swampy vegetation in these areas.
Harini Nagendra	Nepal	The forests in this region are tropical moist deciduous, and typically dominated by large tree species: especially by Sal (Shorea robusta), the single most valuable and most exploited tree species in the region.
Nagendra, H., Pareeth, S., Sharma, B., Schweik, C. M., & Adhikari, K. R.	Nepal	Dense moist sub-tropical deciduous forests; interspersed with marshy grasslands.
Niraula, R. R., Gilani, H., Pokharel, B. K., & Qamer, F. M.	Nepal	Not Reported
Pandit R., &Bevilacqua, E.	Nepal	Mixed Sal, Katus; Mixed Sal, Chilaune; Mixed Sal, Chilaune, Sallo; Regenerated Sal; Mixed Sal, Saj, Sallo; Katus–Chilaune shrubs; Khasru, Banjh, Gurans, Salla; Khasru, Banjh, Kaphal, Gurans;
Patel, R., Mali, S., Tripathi, J. P., Kaushal, V., & Mudrakartha, S.	India	Teak Forests
Shishir Paudel & Jay P. Sah	Nepal	The overstory forest vegetation of the study area was dominated by the Shorea robusta Geartn.f., a typical hardwood and economically important tree species, which regenerates naturally in the Terai, Nepal.
Kiran Paudyal, Himlal Baral, Benjamin Burkhard, Santosh P.Bhandari, Rodney J.Keenan.	Nepal	Not Reported

Lauren Persha and Tom Blomley	Tanzania	Moist montane forests
Ranaivo A. Rasolofoson, Paul J. Ferraro, Clinton N. Jenkins, Julia P.G. Jones.	Madagascar	Not Reported
Santika, T., Meijaard, E., Budiharta, S., Law, E. A., Kusworo, A., Hutabarat, J. A., ... & Ekaputri, A. D.	Indonesia	Intact natural forest and peat forests (i.e. 80-100% forest cover)
Sudha, P., Ramprasad, V., Bhat, P. R., Murthy, I. K., Rao, R., Hedge, G. T., ... & Shetty, D. M.	India	Plantations of fuel wood species, such as: Casuarina equisetifolia and Acacia auriculiformis, and local timber species. To some extent, local species such as Terminalia crenulata, Lagerstroemia microcarpa, Pterocarpus marsupium and non-timber forest product (NTFP) yielding species such as Mangifera indica and Anacardium occidentale were planted (KFD, 2000). Bamboos and canes were also raised in suitable sites
Solomon Tadesse, Muluneh Woldetsadik & Feyera Senbeta	Ethiopia	Moist evergreen Afromontane forest; and dominated by Albizia gummifera (J.F.Gumel.) C.Asm, Millittia ferruginea (Hochst.) Baker, Pouteria adolfi-friederici (Eng.) Baehni, Schefflera abyssinica (Hochst.ex.A.Rich.) Harms, Sapim ellipticum (Krauss) Pax, Ficus Sur Forssk, and Croton macrostachyus A.Rich.
Ryo Takahashi & Yasuyuki Todo	Ethiopia	Not Reported
Thapa, K., Gnyawali, T. P., Chaudhary, L., Chaudhary, B. D., Chaudhary, M., Thapa, G. J., ... & Bhatta, S. R.	Nepal	Not Reported
T. Treue, Y.M. Ngaga, H. Meilby, J.F. Lund, G. Kajembe, S. Iddi, T. Blomley, I. Theilade, S.A.O. Chamshama, K. Skeie, M.A. Njana, S.E. Ngowi, J.A.K. Isango and N.D. Burgess	Tanzania	The main forest types include deciduous miombo woodlands in the western, central and southern parts of the country, Acacia-Commiphora woodlands in the northern regions, coastal forests or woodland mosaics in the east, mangrove forests along the Indian Ocean coast, and closed canopy forests