



A systematic review of the socio-economic impacts of large-scale tree plantations, worldwide

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ABSTRACT

Since their widespread introduction in the 1980s, large-scale tree plantations have seen contestations over their socio-economic impacts. With the establishment of new plantations on the rise, a review of the literature examining their impacts on local communities is needed to inform policies and practices. In this systematic review, we followed an *a priori* protocol to reduce the selection biases inherent to conventional literature reviews, and considered both grey and peer-reviewed literature. Of the 20,450 studies identified in our literature search, only 92 studies met our predefined inclusion criteria. However, only 22 studies presented a clear comparator and considered confounding factors in their analysis. Of the 251 impacts identified in this sample, most impacts across the nine categories were characterised as predominantly negative impacts attributed to large-scale tree plantations. Impacts on employment (22% of reported impacts/of which 41% predominantly negative), land (21%/81%), livelihoods (12%/48%) and the often intertwined social impacts (20%/69%) were the most commonly considered categories, within which a majority of studies agreed on the impact dynamics when in similar contexts, resembling the dynamics observed in other large-scale land-based investments. Most impacts were reported from Southeast Asia (34% of reported impacts), South America (29%), Africa (23%) and Australasia (12%). We corroborate that costs of large-scale tree plantations for residents tend to be front-loaded, especially when plantations have displaced customary land uses, and possible benefits to accrue over time, moderated by the emergence of local processing and complementary livelihood activities. However, given the methodological inconsistencies in our sample and the under-representation of areas known to have undergone plantation development, strong global evidence on the long-term socio-economic impacts of large-scale tree plantations remains limited.

1. Introduction

Although we can trace the origins of large-scale tree plantations to the colonial era, they have seen increasingly widespread adoption since the 1980s as an alternative source of raw material for tree-based commodities (Bull et al., 2006; Evans, 2009). Tree plantations are often characterised by high density monocultures of non-native species, established to meet increasing commercial demands and reduce the exploitation of natural forests (Chazdon et al., 2016; D'Amato et al., 2017a; Pirard et al., 2016a). Such plantations are also often posited as a

means of mitigating the effects of climate change through carbon sequestration in woody biomass (Ingram et al., 2016; Kröger, 2016). Recent estimates place the global extent of planted forests at 278 million ha in 2015 (Payn et al., 2015), with large-scale plantations of fast-growing tree species occupying 54 million ha in 2012 and predicted to double in extent by 2050 (Indufor, 2012).

The establishment of large-scale tree plantations remains a highly contentious issue among researchers, practitioners and stakeholders (Baral et al., 2016; Gerber, 2011; Kröger, 2011; Schirmer, 2013). Much of the criticism has been directed at their negative environmental

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impacts, commonly caused by the clearing of natural forest prior to plantation establishment (Brockerhoff et al., 2008; Farley et al., 2005; Liao et al., 2012). However, residents exposed to the establishment of large-scale tree plantations also experience a range of impacts, both positive and negative. These impacts are likely to resemble those of other large-scale land-based investments, as they share key features in terms of their physical extent and social disruption in rural areas.

It has been shown that the land acquisition for large-scale agricultural plantations carries a risk of threatening or displacing customary land uses (Cotula et al., 2014; Hall et al., 2015); particularly in Africa and Southeast Asia, where most rural areas remain under land use without formal recognition by the state (Deininger, 2003; Inguanzo, 2014). Investors targeting such areas have tended to align with the interests of influential elites (e.g. politicians, privileged, chiefs, elders) de facto responsible for allocating resources and benefits, and capturing these unless held accountable for their proper distribution among customary land users (Cotula et al., 2014; McIntyre et al., 2015). Significant concentration of land can further threaten access to land by customary land users (Peters, 2009; Toulmin, 2009). Where in place, formal titles are portrayed as being effective safeguards against illegal seizures of land (World Bank, 2010); where not, the gradual processes of land formalisation could threaten communal arrangements and exacerbate inequalities in access to land (Alden Wily, 2011; Dwyer, 2015; Milne, 2013).

In terms of employment and livelihoods, Hunsberger et al. (2017) found that labour intensity in large-scale feedstock plantations is modified by mechanisation and investment phase, with land clearing and crop planting requiring much more labour per unit area than other phases. Labour intensity could also decrease due to efficiency gains achieved through land concentration (Wilkinson and Herrera, 2010). On average, rural residents in lower-income countries derive an estimated 28% of their total income from natural areas (Angelsen et al., 2014); and so the (lost) value of displaced livelihoods could possibly be higher than the (gained) value of labour per unit area (Schoneveld et al., 2011). Impacts are likely to depend on the trade-offs between the new and past employment and livelihoods in terms of labour intensity and value creation (Hunsberger et al., 2017). The type of business model – whether arranged such that the investor controls all means of production, or arranged, for example, so that residents are contracted with direct involvement in production through the large-scale plantation – could affect the trade-offs (Little and Watts, 1994; Vermeulen and Cotula, 2010a). In addition, plantation agriculture and biofuel production have often favoured migrant workers over residents for their greater acceptance of physically demanding labour and precarious contracts often described as exploitative (Deininger et al., 2011b; Lenard and Straehle, 2010). Outsourcing – with a significant role for contractors to undertake most of the tasks on the ground – has been pointed to as worsening working conditions with fewer guarantees for the sub-contracted workforce (ILO, 2016).

Additional impacts could follow the conversion and management of land for tree plantations that could modify the provision of pre-existing ecosystem services with links to human health and well-being (Howe et al., 2014; Scovronick and Wilkinson, 2014). Roads and other infrastructure, of which economies of scale are often beyond the reach of residents and governments in rural areas, in turn, could benefit from land-based investments by external investors (Byerlee et al., 2017). However, disparities in access to resources, utilities or opportunities could shape the perceptions of fairness among residents, between residents and migrants, or between residents and investors, increasing social tensions (Gerber, 2011; Hall et al., 2015; Norton and de Haan, 2012).

Such socio-economic impacts have never been subject to a global review in the context of large-scale tree plantations across different contexts of geographical location, commercial purpose and ownership structure. Our synthesis will also help to identify knowledge gaps and highlight patterns across the literature that promote best practice or changes to existing practices (Haddaway et al., 2016).

Our review thus aims to answer three main research questions: 1) What are the direct and indirect socio-economic impacts of large-scale tree plantations for local communities? 2) How do impacts differ across contexts? 3) What are the patterns, biases and gaps in the available evidence?

2. Methods

Systematic reviews aim to identify the most reliable research on a given question in a manner that minimises selection biases in the literature search and screening process. We used an *a priori* systematic review protocol published as Malkamäki et al. (2017), which was prepared based on the guidance for systematic reviews by the Collaboration for Environmental Evidence (CEE, 2013). This protocol defined the structuring components of the systematic review framework (population, intervention/exposure, comparator, impact and contextual factors) as applied to large-scale tree plantations, and their operationalisation in the literature search and screening process to identify relevant studies from bibliographic databases and organisational sources.

Definitions of these components are provided in detail in Malkamäki et al. (2017), and were developed through a participatory process and a stakeholder workshop in May 2016 involving seven experts from academic, civil society and private sector organisations. The following definitions and scopes were used to guide the identification of relevant studies:

Relevant populations: Local households and communities who reside inside or near to an area where at least one large-scale tree plantation is present. Here, the term *local* is not used to delineate populations within a particular distance from the plantation site as these may vary from area to area. However, non-local processors and consumers of plantation-sourced commodities further down the value chain – who are not impacted by the physical presence of the plantation site – are not considered.

Relevant intervention/exposure: Large-scale tree plantations established and managed for commercial purposes by private or public actors external to the local community. This definition excludes large-scale forest restoration programmes and outgrower partnerships as such. Tree species included are those falling under the FAO (2012) current definition of a *forest*; i.e. those able to reach a minimum height of five meters, hence rubber trees are included. Commercial purposes for which the plantations must be primarily designated are those derivable from the relevant tree species, including pulpwood (e.g. cellulose), sawnwood (e.g. construction), fuelwood (e.g. combustion), latex/rubberwood and carbon credits, or a combination of these.

Relevant impacts: Intentional and unintended changes to human well-being that are felt directly or indirectly due to the establishment or management of a large-scale tree plantation. These should fall under one of the nine impact categories: land, employment, livelihoods, cash income, infrastructure, health, regulating ecosystem services, cultural ecosystem services or social impacts (Table 1).

Apart from the initial list of potential impacts proposed in the stakeholder workshop, the design of impact categories drew from the literature on impacts of other land-based investments and links between ecosystem service provision and human well-being (Chapter 1; Fisher et al., 2014; Howe et al., 2014). To adapt these concepts into the context of tree plantations, we drew from the impact logic by Ingram et al. (2016).

The very final working definitions for the nine categories could only be assigned after we understood the range and types of all reported impacts. Taking into consideration the multi-dimensionality of some concepts also meant dealing with higher levels of complexity. For example, food security “exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 2003, p. 29). Of the four dimensions of food security (Gross

Table 1
Working definitions of impact categories.

Category	Working definition
Land	Impacts caused by the process of land acquisition and its direct consequences, including changes in formal or customary access to land with or without compensation, concentration of land ownership, and changes to availability of and access to local food or fuel.
Employment	Impacts related to wage employment, including labour intensity, working conditions and the roles of outsourcing and migrant workers. Local processing and nurseries, which depend on the physical presence of the plantation, are included.
Livelihoods	Impacts on conditions for engaging in previous or other livelihood activities; not including cash income and wage employment.
Cash income	Impacts on monetary earnings at individual, household and community levels, and changes to income-based poverty levels.
Infrastructure	The delivery - or lack thereof - of roads, schools, clinics, electricity and water-related infrastructure.
Health	Impacts on health due to injury, pesticide usage, disease vector or change to nutritional status.
Cultural ecosystem services	Impacts on human well-being related to changes to ecosystem function that support recreation, traditions, aesthetics, identity and sense of place.
Regulating ecosystem services	Impacts on human well-being related to changes to ecosystem function in regulating water quantity and quality, soil fertility, shade, erosion and micro-climate.
Social	Impacts on social fabric (migration, demographics, trust, equity, conflict, legality, morality) and social ties among residents, between residents and migrants, or between residents and investors.

et al., 2000), physical food availability as well as physical and economic access to food are reflected in the “land” category, while food utilisation falls under the “health” category. Stability of the other three dimensions is considered across categories. Hence, it is important to note the possible interactions and overlaps between the nine categories. Although changes to inequality (whether between classes, ethnicities, genders or generations) is considered under the broad category of “social” impacts, considerations of who can and wants to access benefits are important across all categories (Fisher et al., 2014; Hall et al., 2015).

Literature searches were conducted in July 2016 and updated in April 2017 using English language searches in Web of Science (5856 hits), Scopus (9373), CAB Abstracts (9939) and Google Scholar (1990) (for complete search strings, see Malkamäki et al., 2017). In Google Scholar, only the first 200 hits as sorted by relevance were exported for screening. All search results were then merged into a single database before removing duplicate studies. To complement these database searches, we searched for relevant literature from 48 organisational sources, which include research institutes (e.g. French Agricultural Research Centre for International Development), civil society organisations (e.g. World Rainforest Movement) and intergovernmental bodies (e.g. International Tropical Timber Organization); the list can be accessed through Malkamäki et al. (2017). Although searches were conducted in English, also French, Portuguese and Spanish studies identified in these searches were included in screening. Fig. 1 summarises the key stages in the review process.

Of the 20,450 individual search results, only 111 studies met our inclusion criteria of relevant populations, intervention/exposure, and impacts. We were unable to acquire the full texts of 72 additional studies for screening, and excluded previous versions of studies using the same data (e.g. working papers that preceded journal articles). These 111 studies underwent data extraction using a standardised data extraction sheet (Appendix 1), the design of which relied on principles common to qualitative meta-synthesis, including systematic coding of variables (CEE, 2013). When studies presented multiple case studies from distinct geographical or institutional contexts, we coded such cases separately. Thus, we have more “case studies” than the total number of included “studies,” and will retain this terminology to refer to them separately.

We soon realised that characterising the impacts either as positive, negative or mixed was challenging. Some studies did not provide a clear indication or statement of the nature of impacts, which meant that case-specific, deliberative interpretations by the authors of this paper had to be made in order to assign a characterisation, while also ensuring inter-reviewer consistency in interpretation. After assigning characterisations for the reported impacts within each case study, we also tracked possible associations between impact categories, noting whether they were of a mutually reinforcing (negative impacts leading to negative impacts or positive impacts leading to positive impacts) or negating (positive impacts leading to negative impacts or vice versa) nature.

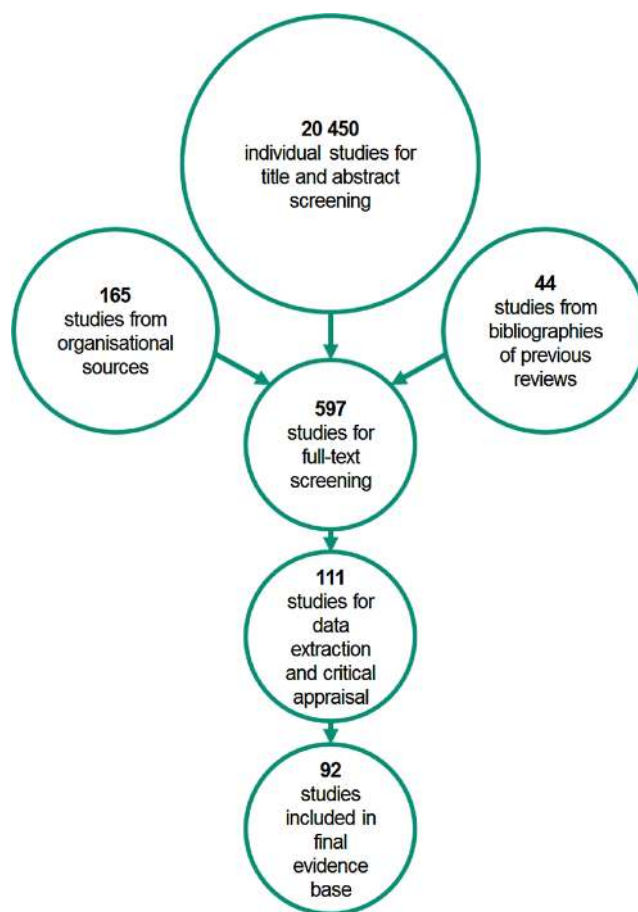


Fig. 1. Literature searches and screening results.

The data extraction sheet also included a quality appraisal of included studies, which included nine criteria (Table 2). The baseline criterion for study inclusion was that key results and conclusions had to be logically derived and supported by the data and methods presented. Of the 111 studies, only 92 studies met this criterion, of which six were published in Portuguese, nine in Spanish and 77 in English; no French studies met the criteria for inclusion in this final set. We further divided these studies into two groups based on additional quality criteria that were considered critical. Group A studies had to consider confounding factors that could have influenced the validity of their data and methods, and they had to use an appropriate comparator in their research design (with/without; before/after). Only 22 studies (25 case studies) met these two criteria. The remaining 70 studies (80 cases) are categorised as Group B, even though there was considerable variation

Table 2
Applied quality criteria.

Baseline criterion
Key results and conclusions are logically derived and supported by the data and methods
Critical additional criteria
Confounding factors that could have influenced the validity of data and methods are considered
A clear and appropriate comparator is present
General additional criteria
Key terms and concepts are clear, replicable and reliable
Data collection methods are clear, replicable and reliable
Sampling selection is explained
Sampling selection is justified
Data analysis methods are clear, replicable and reliable
Key conclusions and recommendations are logically derived and supported by the results

among studies with respect to their quality, with eight of them considering confounding factors and 14 using a comparator in their study design. Variation in Group B is even more pronounced in terms of general additional criteria, although it should be noted that a few studies in Group A did not meet all general additional criteria either. Selected details of all included studies are provided (Appendix 2). The raw data and a record of studies excluded at different stages of the review have been made (data set) accessible.

Because of the insufficient number of cases using common statistical methods, we were unable to perform any quantitative meta-analyses of the data. Although descriptive statistics were used to provide an overview of the evidence base, studies were synthesised qualitatively based on their reporting of impacts in each of the nine impact categories.

3. Results

3.1. Overview of the evidence base

3.1.1. Temporal and geographical distribution

The publication years of all 91 studies are shown in Fig. 2, indicating increasing research interest in the subject area in the past ten years (although there is another small peak in published literature between 2005 and 2008). Based on an analysis of incentives provided for plantation establishment and the timing of data collection, research tends to be conducted soon after plantations are introduced for the first time or changes in government policy encourage their further development. For example, South American tax incentive programmes attracted new investments into pulp mills and plantations at the turn of the last century (Almeida et al., 2008; Carámbula and Piñeiro, 2006). In Australia, investments into plantations in the early 2000s also followed the introduction of favourable tax regulations for projects under the Managed Investment Scheme (O'Toole and Keneley, 2010). Investments into plantations and the corresponding rise in associated studies in Eastern Africa and the Indochinese Peninsula, especially into rubber in Cambodia and Laos¹, are generally more recent, reflecting investor interest in acquiring and selling carbon credits and government policies granting land concessions to investors (Gironde and Peeters, 2015; Lyons and Westoby, 2014). Of the 71 cases specifying the incentives underlying plantation establishment, 76% report that government support played a key role in promoting investments in capital-intensive plantations.

Of the 82 case studies reporting the timing of plantation establishment, most examine the impacts between five to 15 years after establishment (Fig. 3). More than half of these (52%) also deal with impacts within 15 years after plantation establishment, which may lead to an overemphasis on front-loaded impacts.

¹ It is worth noting that Vietnam and Thailand have been characterised by the expansion of smallholder tree plantations since the 1990s, rather than expansion in large-scale plantations by external actors (Hall, 2011; Sikor, 2012).

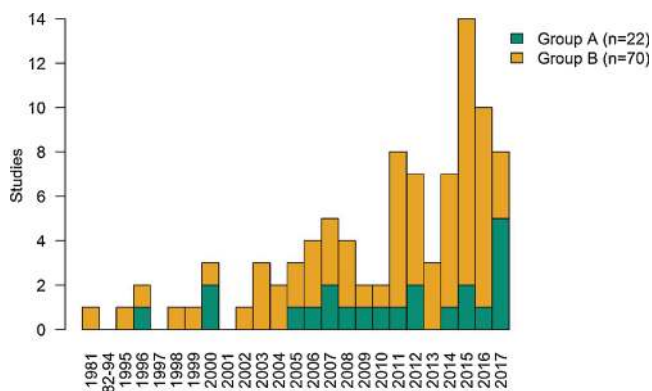


Fig. 2. Studies by publication years.

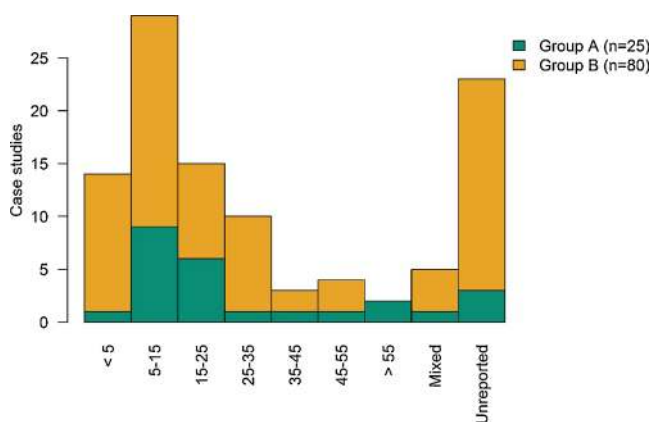


Fig. 3. Case studies by time between plantation establishment and data collection.

The geographical locations of the 105 cases by plantation type (primary tree species and designated commercial purpose) are mapped in Fig. 4. Even though we did not restrict our search to a specific geographical area, recorded cases are concentrated in Australasia, South America, Southern Africa, and Southeast Asia. However, some areas known to have significant coverage of large-scale tree plantations were not represented in our evidence base. These include the northern countries of South America, the Iberian Peninsula, and the southern United States (which was represented by only one case). Our evidence base thus shows a geographical bias towards certain regions or even certain countries, such as Cambodia and Chile.

3.1.2. Methods used in the studies

Most studies were qualitative in nature and based their reporting of impacts on local perceptions (Table 3). Studies using quantitative indicators are more commonly paired with quasi-experimental research designs in our sample. In both groups, socio-economic impacts have been studied using a range of methods, with key informant interviews being most commonly reported. We also recorded potential conflicts of interest in 18 out of 92 studies (20%).

3.1.3. Aggregate summary of the impacts

Altogether, the 105 cases reported 251 impacts that were grouped under nine categories (Fig. 5). The most frequently reported impacts are those related to “employment” (22%), “land” (21%), “social” impacts (20%) and “livelihoods” (12%). Most impacts are reported from Southeast Asia (34%), South America (29%), Africa (23%) and Australasia (12%). While most categories provide a rather balanced representation across continents, it appears that impacts related to “land” are more common to Africa and Southeast Asia in relation to other continents.

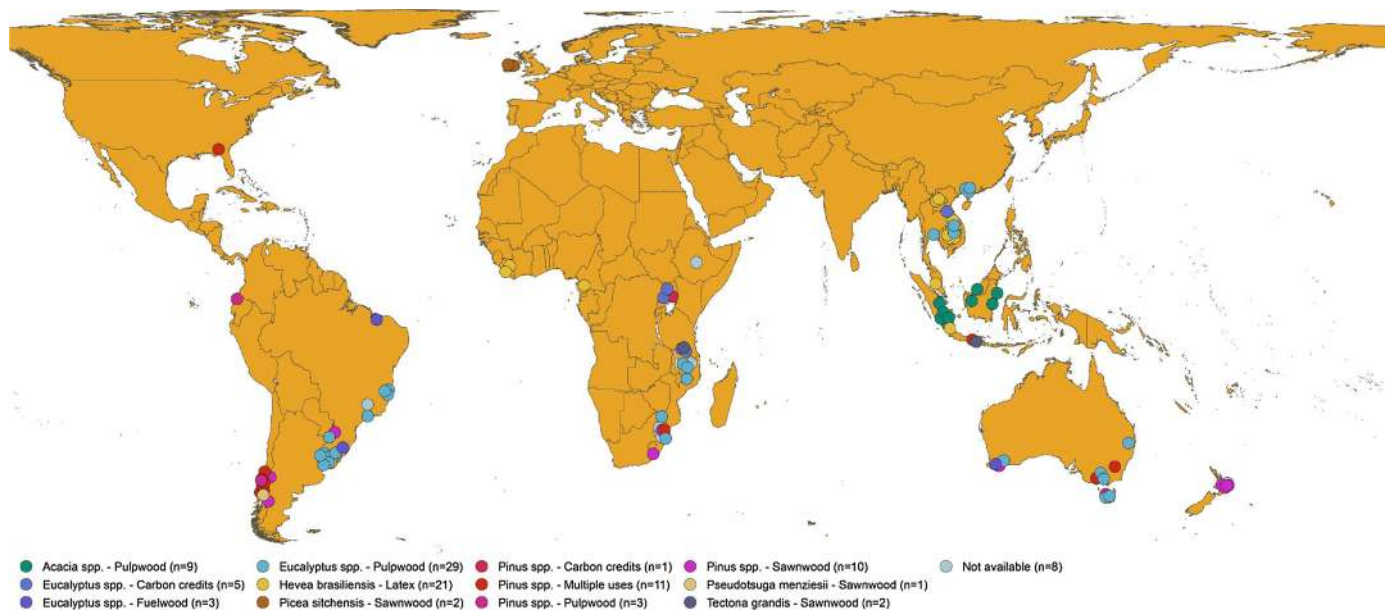


Fig. 4. Geographical distribution of case studies by plantation type.

Table 3
Overview of the methods used.

	Group A 25 case studies		Group B 80 case studies		Total 105 case studies	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Approach						
Qualitative	9	36%	52	65%	61	59%
Of which, perception-based	6	67%	45	87%	51	84%
Quantitative	10	40%	13	16%	23	22%
Of which, perception-based	5	50%	7	54%	12	52%
Mixed	6	24%	15	19%	21	19%
Of which, perception-based	2	33%	8	53%	10	50%
Design						
Quasi-experimental	20	80%	11	14%	31	30%
Non-experimental	5	20%	69	86%	74	70%
Method						
Household-level surveys (e.g. village)	6	24%	20	25%	26	25%
Area-level surveys (e.g. municipality)	4	16%	4	5%	8	8%
Key informant interviews	8	32%	37	46%	45	43%
Focus group interviews	1	4%	4	5%	5	5%
Mixed	6	24%	15	19%	21	20%

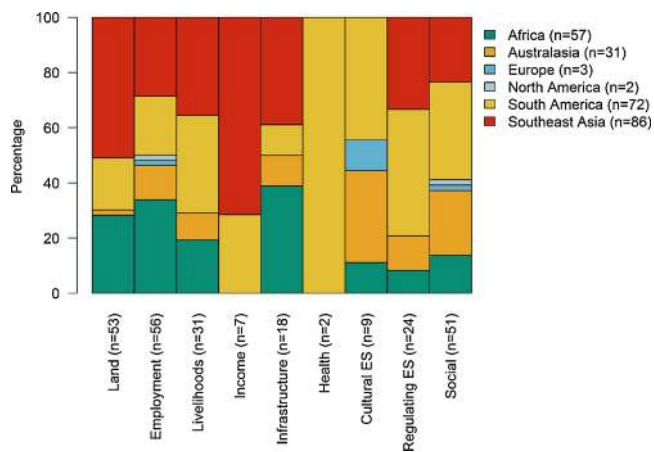


Fig. 5. Geographical distribution of impacts by category.

Although only studies in Group A have a comparator and consider confounding factors, reported impacts across categories and groups A and B lean towards negative assessments (Fig. 6). Of all the 53 impacts in category “land,” of which most are reported from Southeast Asia (51%) and Africa (28%), 81% are characterised as predominantly negative impacts. For “employment,” “social,” “livelihoods,” “regulating ecosystem services” and “infrastructure,” the corresponding figures are 41%, 69%, 48%, 79% and 28%, respectively. Two impacts are characterised as “neutral” (plantations not affecting well-being for better or worse), two as “unmet” (plantations not having contributed to well-being as per objectives) and two as “unreported” (plantations affecting well-being; unreported whether the change is for better or worse). When examining, for example, employment intensity, poverty rate or value accumulation, the baseline status clearly influences whether the impacts are perceived as positive or negative. Impacts are intended as measures of marginal change rather than in absolute terms.

Only 13 cases in our sample consider gendered dimensions of impacts. Ethnic dimensions are considered by 25 cases, all of which concern minority groups within the wider community. Interestingly,

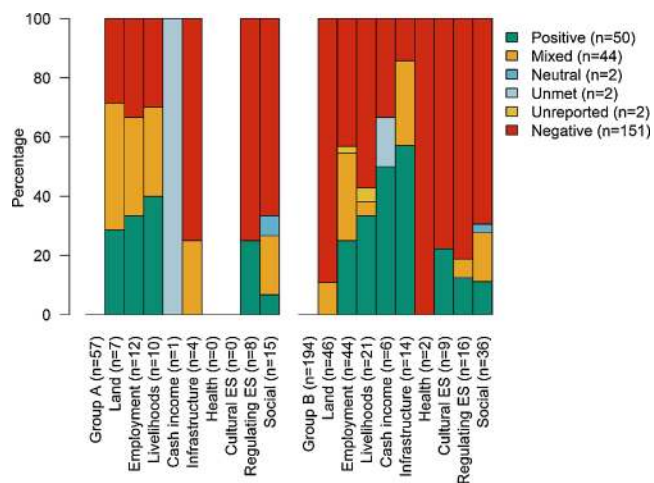


Fig. 6. Share of impacts by group and category.

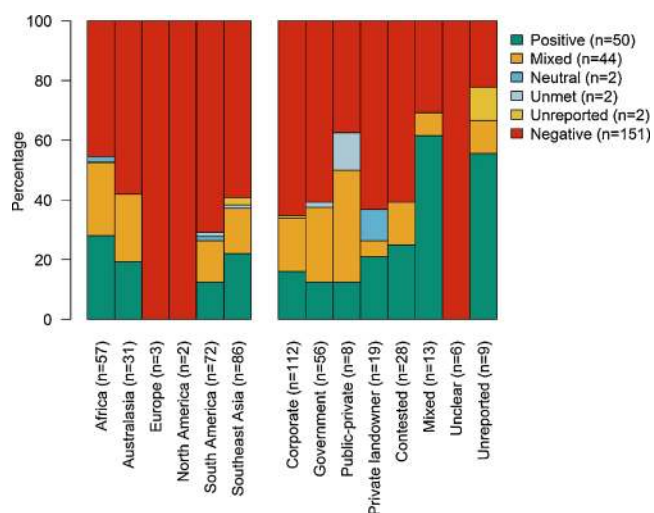


Fig. 7. Share of impacts by geographical location and ownership structure.

the presence or absence of management certifications that can include grievance mechanisms was mentioned in only 27 cases. However, in cases where plantations are not certified, certification is unlikely to be mentioned. Their actual effects on impacts are considered in only five cases. However, ownership structure is usually well-covered in our sample. Land being formally owned by the government is much more common to Africa (42% of cases on continent) and Southeast Asia (26%) than in South America (7%) and Australasia (6%). When assessments of impacts are contrasted with geographical locations and ownership structure at the aggregate level (Fig. 7), neither of them seems to explain variation in impacts. Similar to the other contextual factors (gender, ethnicity, certification), a more nuanced picture can only be drawn by analysing the cases separately.

Impacts were also found to fall into overlapping categories and the categories themselves may share overlapping characteristics (Fig. 8). Hence, community well-being is manifest as a complex spatial-temporal and social-ecological system. A total of 81 associations between categories from 52 case studies are found; 91% of them are of a mutually-reinforcing nature. For impacts on previous livelihood activities, for example, and for which the loss of land tends to be detrimental (Daranth et al., 2015; Myllylä and Takala, 2011), the labour offered by plantations can offer some relief (at least for some) (Bleyer et al., 2016). Associations are most frequently observed between categories “land” and “social” (16%) and “employment” and “social” (15%), within which a clear tendency of negative impacts to accumulate is found.

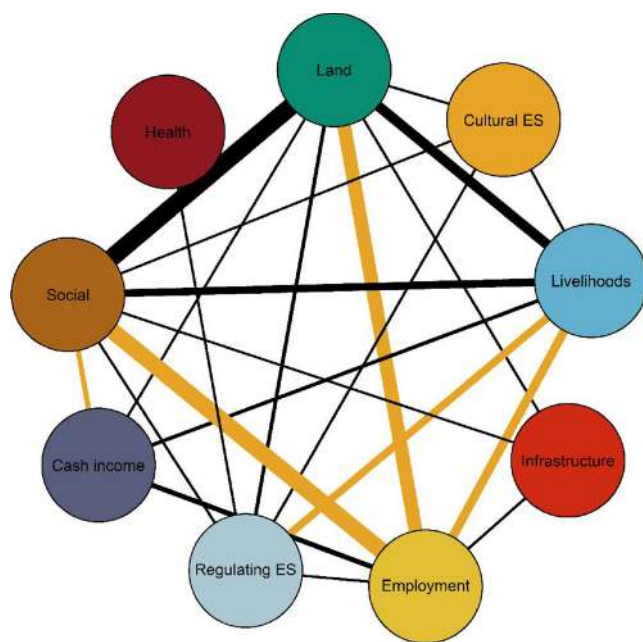


Fig. 8. Associations between categories.

How certain categories were framed led inherently to the recording of either positive or negative characterisations. The “land” category, for example, tends to emphasise the often-inevitable land losses caused by plantation establishment. Some categories were also broader than others, such as that of “social” impacts. Hence, we refrain from making statistical comparisons of characterisations between categories that are not directly comparable, focusing rather on building a synthesis of the cases under each category and naming the most interesting and illustrative examples (for a discussion of the significance of such mixing of means and ends for environmental management, i.e. “category mistakes,” see Wallace and Jago, 2017).

3.2. Impacts by category

3.2.1. Land

The immediate impacts after land acquisition are reported by seven Group A cases and 46 Group B cases. Overwhelmingly, these cases are characterised by negative impacts. When in place, formal land titles for local residents seem to provide greater bargaining power over land transactions, enabling, not guaranteeing, a higher acceptance of plantation investments. However, property formalisation as part of plantation projects has also become a means for dispossession, as demonstrated in some Southeast Asian cases.

Within Group A, there are three cases characterised as having mixed impacts, two as positive and two as negative. Pirard et al. (2017) compare perceptions of impacts across plantation types in Indonesia. They find that government-managed pine and teak plantations with longer rotations in Java permitted a greater access to land and resources than acacia plantations that were more recent with shorter rotations for fast-growing species in contested areas on Kalimantan, which were viewed as more intrusive and competitive for land. Manzanal et al. (2011) report on negative impacts following the earmarking of vast areas for commercial forestry by the government in northern Argentina. This reportedly led to a concentration of ownership and higher land prices, pushing the families without formal title or investment capacity to out-migration. In neighbouring Uruguay, those with recognised land titles are reported to have benefitted from the concentration of land into foreign hands and the subsequent rise in land prices, by selling or leasing their lands to corporations in anticipation of, for example, early retirement (Piñeiro, 2012). In this same case,

acquisitions by corporations were seen more positively than acquisitions by foreign pension funds aimed at securing financial assets in plantations with limited management, and hence fewer jobs created. In Cambodia, villagers lost access to natural forests as part of the formalisation of government land as concessions; with only the few having formal land titles reported to have received reasonable compensations for their land (Gironde and Peeters, 2015). Tanzanian villagers entered a leasing arrangement with the government-owned corporation and received regular cash transfers in exchange (not specified how much and for whom), but found themselves prevented from expanding rice production to meet the needs of a growing population (Johansson and Isgren, 2017).

Changes in access to land is also the main impact reported in Group B cases. An overwhelming majority report perceptions of negative impact, with 36 cases mainly from Africa and Southeast Asia finding people losing customary access to land or forest with little or no compensation (see Purnomo et al., 2014 for a prime example from Indonesia). In Mozambique, Bleyer et al. (2016) found that the closer the plantation is, the more difficult accessing vital resources becomes (which is one of the rare cases considering the effect of distance). Eight cases also correlate the land loss with reduced food security. Friis et al. (2016) report on decreased rice production due to land conversion in newly-formalised Laotian concessions, while Ehrnström-Fuentes and Kröger (2017) report that food security reduced due to a combination of decreased local production due to land conversion and a general increase in food prices in Uruguay. Ehrnström-Fuentes and Kröger (2017) also stress that the concentration of land in the hands of foreign corporations has inflated prices and intensified competition over land; consequently, farming activities of the poorest landowners in rural Uruguay are reported to have become unviable. Similar findings from privately-held plantations in southern Brazil and New Zealand indicate that the concentration of land is a more prominent issue in regions with relatively secure land titles (Almeida et al., 2008; Wall and Cocklin, 1996). An interesting mixed impact in Group B is reported from Thailand, where a corporation bought the land titles from previously indebted smallholders; despite the land loss, this one-time compensation enabled some to recover economically and invest elsewhere (Barney, 2004).

Land being seized by coercion is reported in 13 cases. While recent examples come from Cambodia and Laos where the granting of concessions to private investors has displaced local land uses in rural areas that are not officially recognised (Gironde and Peeters, 2015; Kenney-Lazar, 2012; McAllister, 2015), examples dating back several decades come from South Africa and neighbouring Swaziland, from times when plantation development was driven by the government (reported in Chirwa et al., 2015; Menne and Carrere, 2007; Tropp, 2003). The South African “land grabs” have also led to a difficult land reform process (Chirwa et al., 2015).

3.2.2. Employment

There are 12 Group A case studies and 44 Group B case studies reporting employment-related impacts, the majority of which report negative perceptions. The presence of local processing appears to be correlated with more positive impacts on employment; on the other hand, in permissive institutional environments, characterised by weak labour regulation and/or implementation, the presence of sub-contracting was linked to inferior working conditions.

Within Group A cases, there is frequent debate over the job creation per unit area of tree plantations relative to other land uses. One case from Tasmania, Australia, describes eucalypt and pine plantations as generating an average of 0.33 and 1.8 jobs per 100 ha between 2006 to 2008, respectively, while other primary sector land uses created slightly more jobs (Schirmer, 2009). In Indonesia, the rate of residents with employment experience was never lower than a third for any given settlement across teak, pine and acacia plantations – this is considered as an indication of substantial job creation on plantations, with little

variation in perceptions between men and women and migrants and natives (Pirard et al., 2017). With new infrastructure and increased demand for services to support forestry operations, however, secondary (i.e. manufacturing) and tertiary (i.e. service) sectors are reported to have expanded and started hiring people in New South Wales, Australia (Schirmer et al., 2005). Generally, cases point to the need to have local wood processing to improve employment impacts, although this in itself is insufficient. A case from New Zealand shows that only the presence of these additional processing jobs can enable plantations to generate more employment per unit area than agriculture, yet such jobs are commonly created in urban centres and so are often distant from the site of plantation establishment (Fairweather et al., 2000).

Our sample also shows that plantation jobs are often temporary, part-time, or both. For instance, the one case from the southern United States documents the employment of migrants from Central American countries on guest visas, who do not enjoy the security of permanent contracts (Sarathy and Casanova, 2008). Another case from pine plantations in south-central Chile states that less than 5% of contracts are permanent (Unda and Stuardo, 1996). Similarly, the outsourcing of basic plantation jobs to contractors is said to have worsened conditions for sub-contracted workers in Laos (Barney, 2007). Another case from corporate-owned eucalypt plantations in Uruguay shares the main features of other cases and leads to a mixed characterisation (Carámbula and Piñeiro, 2006): these plantations generate precarious employment, one of the reasons lying with the responsibilities of contractors, not having standards for wages and contracts in place; however, with more people coming into the area, the tertiary sector provides more jobs compared to areas that see only grazing or small-scale agricultural activities.

Group B largely backs the findings of Group A. One frequent finding is that plantations do not offer stable employment, but instead bring mostly temporary jobs without benefits associated with permanent contracts, as reported in cases from Brazil, Indonesia and Mozambique (Almeida et al., 2008; German et al., 2016; Tyynelä et al., 2002). Pirard and Mayer (2009), however, note that village-based male workers travelling distances up to 50 km from their homes for particular plantation-related tasks, the total labour needs for these workers by the public-private acacia plantation in South Sumatra is quite evenly spread or staggered through the year, and from year to year through the seven-year rotation. Liberian corporate-owned rubber plantations serve as counterexamples, where significant employment opportunities with substantial benefits are reported to have been created, albeit alongside a lack of transparency in formation and distribution of salaries among workers (Verité, 2012).

A few cases in Group B report on the exclusion of women from plantation-related work for various reasons, such as their traditional family roles (Bleisch et al., 2006; Negede et al., 2015; Ramos and Bonilla, 2008). An older case from Malaysian rubber plantations argues that women's lower cost of labour makes them attractive to employers (Heyzer, 1981), possibly induced by wage discrimination. However, a high rate of women's employment is found in plantation nurseries in Uruguay, with women receiving wages higher than the regional average (Cárcamo, 2007).

3.2.3. Livelihoods

Thirty-one cases fall in this category, 10 in Group A and 21 in Group B. Here, prior land use, the associated trade-offs following conversion to tree crops, and time since plantation establishment play key roles in determining the nature of impacts.

In Group A, two impacts are characterised as positive due to the small-scale tree planting opportunities that emerged after the establishment of corporate-managed tree plantations in China and Uganda (Ainembabazi and Angelsen, 2014; D'Amato et al., 2017b). Two other positive characterisations from Indonesia are linked to the perceived benefits of complementary livelihood opportunities such as resin tapping, fuelwood collection and intercropping on the long-standing

government-managed teak and pine plantations (Pirard et al., 2017). In South Africa, a government-managed plantation operator granted access to plantations and thereby supported other livelihoods based on the free collection and sale of timber and fuelwood; however, the range of available non-timber forest products (NTFPs) was found to be greater in other ecosystems, leading to a mixed characterisation (Mensah et al., 2017). In Pelluhue, Chile, a quarter of participants, perceived an increase in opportunities for small-scale enterprises following establishment of corporate-owned pine plantations; however, a quarter of participants also perceived a reduction in the range of possible uses of the plantation compared to the natural forests they replaced (Alfonso et al., 2016).

Negative impacts were mostly related to the loss of, or restrictions to previous livelihood activities. For example, a case concerning Cambodian villagers reports that livestock grazing came to an end once customary access was suppressed, and access to fishing and hunting areas were reduced following the establishment of rubber concessions (Gironde and Peeters, 2015). In Chile, eutrophication of coastal waters was linked to the increased run-off of nutrients from pine and eucalypt plantations on steep slopes, pushing fishermen further out to sea in search of target species and reducing the overall productivity of fisheries (Van Holt et al., 2017).

As in Group A, one of the main negative impacts reported in Group B was the reduced access to and availability of NTFPs after plantation establishment. Where plantations replaced or reduced the extent of natural forests, the resulting reduction in NTFPs had negative impacts on livelihoods across a range of countries, including Cambodia, Chile and South Africa (Daranth et al., 2015; Karumbidza, 2005; Navarro et al., 2005). Negative changes to livelihood activities due to rubber concessions displacing customary shifting cultivation systems were also reported in Cambodia (Prachvuthy, 2011). Instead, in Niassa, Mozambique, the seasonal jobs that emerged were viewed more positively as being complementary to traditional agriculture (Nube et al., 2016). Environmental issues caused by plantations were also reported to indirectly affect other livelihood activities, thus demonstrating a clear interaction between “livelihoods” and “regulating ecosystem services.” In Ecuador, for example, the reduction in fish populations in rivers was perceived to be the result of plantation-induced changes to soil and water (Ramos and Bonilla, 2008).

Positive impacts in Group B were related to changes in livelihood activities made possible by plantation establishment such as partly enhanced conditions for beekeeping in Uruguayan eucalypt plantations (Malkamäki et al., 2016), and improved agricultural production in Laos following the introduction of intercropping between rows of planted trees (Levall and Prejer, 2013). An enabling factor in both cases was the permissive attitude of the corporate owner of the plantation, although the risk of communities losing their self-determination is noted. In Argentina, the free collection and sale of a valued mushroom (*Suillus luteus*) abundant in pine plantations of private landowners provided a complementary source of income for the poorest households and women in particular, although the contribution of this new income to overall livelihood conditions remains unclear (Fernández et al., 2012). Ofoegbu (2014) reports on similar impacts from South African corporate-managed plantations. Acciaresi et al. (2015) found changes in perceptions in a long-term study from central Argentina, where only 18% of informants representing diverse local stakeholder groups saw the introduction of government-owned pine plantations as positive in the 1980s due to its displacement of sheep herding, while 30 years later 89% thought plantations were positive. This change was driven by the perception of sheep herding itself becoming ecologically unsustainable during the period; moreover, residents, including most herders, witnessed a recovery of the soil following plantation establishment. Simultaneously, local eco-tourism was stimulated, offering alternative livelihood opportunities. While most herders had changed from nomadic to localised herding practices, those who did not change their practices remained in opposition.

3.2.4. Cash income

In this category, there is one case in Group A and six in Group B dealing with actual monetary earnings of residents. The only case in Group A finds that income-based poverty has not decreased in areas near Chilean privately-held pine plantations, in contrast to expectations (Unda and Stuardo, 1996). Areas with more than 20% afforestation rate are also reported to have a higher incidence of poverty than areas with less than 5%. The most afforested areas also see the highest proportion of indigenous people relying on subsistence agriculture and the highest incidence of poverty in Chile, although this seems to have been the baseline status preceding the arrival of plantations.

Within the six Group B cases, four cases come from Indonesia and three of them show positive impacts. Although Tyynelä et al. (2002) note an increased average household income at the community level in West Kalimantan, these benefits are not evenly spread among households due to disparities in accessing jobs on acacia plantations, of which ownership has been contested. In a similar context in South Sumatra, residents view the work on plantations as providing minor, but complementary flows of additional cash income during the months when village-based agricultural work is not available (Pirard and Mayer, 2009). Firdaisy (1999) notes that contrary to expectations, the incidence of income-based poverty did not change after the establishment of a rubber plantation in Lampung. However, one case from West Kalimantan reports significant contributions to household income and well-being at both the individual and community levels due to livelihood interventions undertaken by the corporate investor, including intercropping of subsistence crops and engagement of locals in small-scale tree planting (Greenhill et al., 2017). Here, the direct involvement of residents in tree production through the large-scale plantation (combined with intercropping) also helped to meet seasonal income gaps.

The other two cases in Group B report impacts on cash income that did not directly result from employment opportunities. Andersson et al. (2015) found a correlation between an increased area of tree plantations and increased income-based poverty among communities in south-central Chile. However, tree plantations are reported to account for only 2.1% of the total area of the municipalities in the sample, and the influence of the confounding factor related to possible changes in land use in the remaining areas remains unclear. Finally, negative changes to pre-existing income sources were reported in Laos by Baird and Fox (2015), where only a fraction of residents earned income from working on the rubber concessions and their wages were adjusted according to fluctuations in commodity prices.

3.2.5. Infrastructure

There are four cases reporting on infrastructural impacts in Group A and 14 cases in Group B. Within Group A, three negative infrastructural impacts are reported, although both Manzanal et al. (2011) and Peeters (2015) report on perceptions of neglected infrastructural development in Argentinian pine plantations and Cambodian rubber concessions, respectively, rather than the effects of infrastructure creation per se. In Tanzania, a government-managed teak plantation is reported to have cut access to existing roads and paths that villagers were no longer allowed to use (Johansson and Isgren, 2017). In Indonesia, acacia plantations were perceived as opening up inaccessible areas with road infrastructure development, although corporations managing the plantations did not intentionally carry out infrastructural improvements, leading to a mixed characterisation (Pirard et al., 2017).

Of the 14 cases reporting on infrastructural impacts in Group B, most reported impacts are characterised as positive, whereas cases reporting positive and mixed impacts alike found that investments by corporations have improved infrastructure through the construction and provision of roads, housing, electricity, water, and other social services, including schools and medical clinics (e.g. Bleyer et al., 2016; Ofoegbu, 2014; Palma, 2008; Potter and Lee, 1998; Westoby and Lyons, 2016a). Nevertheless, the issue of who really wanted and could access

the benefits remains largely unclear, and where land and livelihoods were reportedly displaced, e.g. in Uganda, infrastructural improvements were seen as secondary priorities (Westoby and Lyons, 2016a). Similar to Group A, cases reporting negative and mixed impacts cite insufficient or absence of infrastructural development, or else unequal access to the infrastructure that was created. For example, Leys and Vanclay (2010) find that the lack of infrastructural investment for wood processing in New South Wales, Australia, hampered local socio-economic development; on the other hand, Bues (2011) finds that a corporate that was granted a concession by the Cambodian government had blocked villager access to existing roads in Ratanakiri.

3.2.6. Health

The evidence base for health impacts is very limited, with only two Group B cases. Both report negative impacts, which are related to the working conditions on Chilean pine plantations and at a Uruguayan eucalypt nursery (Cárcamo, 2007; Navarro et al., 2005). Both cases cite the use of pesticides as causing deterioration in worker health.

3.2.7. Cultural ecosystem services

Within this category, no cases qualified into Group A. Nine cases under Group B are found, of which only one includes a comparator. Seven report negative impacts such as disruption of traditional landscapes and related feelings of belonging and identity in Ireland and Australia (Flécharde et al., 2007; Williams et al., 2003). A case from Chile cites the difficulty of passing on traditional knowledge about natural environments and livelihoods after plantations replaced natural forests and disturbed sites of cultural value (Barreau et al., 2016; Ehrnström-Fuentes and Kröger, 2017). A Brazilian case by Azevedo and Fialho (2015) specifically report on negative impacts on the local *gaúcho* culture, caused by the increasing number of wild boars near plantations after their establishment that damaged livestock central to the culture. Tomlinson et al. (2000) state that government-managed pine plantations reduced opportunities for tourism in New Zealand, although Palma (2008) finds, a few years later, that corporate-managed pine plantations offered a new venue for various recreational activities elsewhere in New Zealand. Acciaresi et al. (2015) also report on the contribution of plantations to local eco-tourism in Argentina after environmental management attitudes and standards were improved in the 1990s.

3.2.8. Regulating ecosystem services

As with cultural ecosystem services, impacts on regulating ecosystem services were often linked to changes in livelihood activities. Eight Group A cases and 16 Group B cases were identified. Six Group A studies dealing with acacia, eucalypt, pine and teak plantations in Australia, Chile, China, Indonesia and Tanzania find negative impacts on water quantity or quality, and associated soil and nutrient cycles that affect agricultural productivity (Alfonso et al., 2016; D'Amato et al., 2017b; Gordon et al., 2012; Johansson and Isgren, 2017; Pirard et al., 2017), although the Indonesian teak and pine plantations with longer rotations are reportedly perceived to have improved water flows and controlled for erosion (Pirard et al., 2017).

Of the 16 Group B cases, 13 cases report negative impacts mainly concerning water quantity or quality, but also address impacts on soil erosion and wild fauna (e.g. Ehrnström-Fuentes and Kröger, 2017; Oliveira, 2011; Olwig et al., 2015). Vihervaara et al. (2012) report diverging opinions on the impact of eucalypt plantations on water availability for other uses in Durazno, Uruguay, with half of respondents being very worried and the other half being slightly or not at all worried. Positive characterisations include enhanced control of fire outbreaks with help from established fire brigades, and increased fertility of soils previously considered unsuitable for agriculture (species is left unreported) (Myllylä and Takala, 2011; Wall and Cocklin, 1996). The linkage to human well-being in this category is primarily drawn from perceptions of impacts rather than measured ecological changes in

the delivery of regulating ecosystem services after plantation establishment. The impacts seem to be similar regardless of the tree species, although eucalypt plantations represent 46% of the cases in this category.

3.2.9. Social

Under social impacts, 15 Group A cases and 36 Group B cases were identified. In Group A, most cases report on negative changes to social fabrics after plantation establishment. Plantations are expectedly reported to have increased tensions between residents and other groups or actors, rooted in conflicts over land acquisition, competition over jobs, and the exclusion of residents from decision-making.

In cases from Ireland and Australia, small-scale afforestation by residents is perceived to be less conflictual than that done by large-scale corporations (Schirmer, 2007). In the southern United States, the arrival and constant relocation of sub-contracted migrant workers has kept them from integrating into communities and also restricted their access to help in the event of injury (Sarathy and Casanova, 2008). A Cambodian case highlights the absence of credible grievance mechanisms, hampering the possibility of re-establishing trust following violations and disputes between residents and investors (Peeters, 2015). In Laos, the officials are reported to have violated the previously recognised right to access land (Barney, 2007), while in Argentina, people were forced to illegally clear new land after losing their customary access to land and consequently had criminal charges pressed against them (Manzanal et al., 2011).

There is some evidence that plantations have also increased intra-community conflicts. An example of residents losing their trust to forestry comes from Australia, wherein plantation development had relied on government subsidies in the early 2000s that crashed after the financial crisis of 2008, leaving behind perceptions of mismanagement among the affected communities. Those working in forestry felt frustration that their work was undermined by past wrongdoings by other residents. Community structure is also reported to have changed in Southeast Asia, as those who lost their customary access to land after plantation establishment in Cambodia left to find low-skilled jobs in Vietnam (Gironde and Peeters, 2015). In Laos, the same phenomenon was attributed to a complex set of linkages between ecological degradation and village socio-economics, while remittances sent back home reportedly helped the families to make new investments in their land (Barney, 2007). Unda and Stuardo (1996) also report on how the displaced livelihoods in Chile led to out-migration following land acquisition and conversion, leaving residents, many of which were indigenous, with fewer children and forcing schools and other services to close. Positive cases in Group A find increases in populations in other areas; for example, declining populations in rural Uruguay increased after timber harvests, rejuvenating the countryside (Carámbula and Piñeiro, 2006).

Cases in Group B reported mostly negative impacts on social ties. Changes in neighbourliness and moral standards are reported across geographical contexts (e.g. González-Hidalgo and Zografos, 2017; Myllylä and Takala, 2011; Tropp, 2003), and three cases report on increased crime, the fear of increased crime following the arrival of outsiders, and dense tree stands providing cover for criminals (Bues, 2011; Heyzer, 1981; Ramos and Bonilla, 2008). Residents themselves have also been charged as criminals for organising resistance to tree plantations (e.g. Baird and Fox, 2015; Navarro et al., 2005), although extensive resistance in Sarawak, Malaysia, is reported to have led to previously non-existent legal protections on land access rights of indigenous groups (Barney, 2004). In Australia, in both Tasmania and the South West, the certification of eucalypt plantations and active stakeholder dialogue is reported to have brought the residents and private investors closer together (Dare et al., 2010). Kenney-Lazar (2012) and Machoco et al. (2016) - in Attapeu, Laos, and Zambezia, Mozambique, respectively - also cite the many broken promises of corporate investors and the government to have cemented distrust between them and the residents.

In Group B, the skewed distribution of benefits from plantation projects is frequently reported to have led to increased inequality among residents (e.g. Ehrnström-Fuentes and Kröger, 2017; Tomlinson et al., 2000; Tynnelä et al., 2002). Corporate responsibility programmes in African countries were also criticised either for favouring elites in charge of distribution or being conditional on the generosity of individual corporations (Bishop, 2006; German et al., 2016; Westoby and Lyons, 2016b).

4. Discussion

The study of the local socio-economic impacts of large-scale tree plantations has focused on impacts related to land acquisition, creation and conditions of wage employment, and changes to conditions of various livelihood activities. Frequently, such impacts are also intertwined with changes in local social relations. Our findings largely corroborate the dynamics observed in other large-scale land-based investments.

We found that residents holding formal titles to land seem to have more positive attitudes towards plantation establishment, although such cases are few and do not exclude the co-existence of negative impacts elsewhere. In our sample, issues with land acquisition are more prominent in regions with weak recognition of access to land at an individual level, predominantly in Cambodia and Laos (Dwyer, 2015; Inguanzo, 2014). Residents with secure land titles, found in Australia and Uruguay with well-functioning land markets, seem to have benefited from increasing value of their land owing to intensified competition. However, prices or compensations throughout our sample have rarely been perceived to be fair. There could be many reasons for this, one of them possibly deriving from the information asymmetries between residents and investors (or elites) (Asiama et al., 2017).

Negative impacts accrued due to land acquisition are accentuated when plantations do not bring sufficient employment opportunities to compensate for livelihoods that were frequently based on customary access to land. Jobs on large-scale tree plantations are often seasonal and precarious, and tend to become available only during land clearing or tree planting (although these tasks could also be phased by compartments on very large plantations). Labour per unit area on tree plantations is unlikely to match that of agriculture or biofuels (Deininger et al., 2011b; Hunsberger et al., 2017; Pirard and Mayer, 2009), although the picture could change if the additional value-adding steps - from seedling production through wood processing - are accounted for (Hassan, 2003). However, such steps may not occur locally, nor treat women and men equally, and have tended to be more prominent in higher-income countries.

Sub-contracting in forestry is a common practice (Garforth et al., 2005); based on our sample, this tends to be as commonly associated with inferior working conditions as in most other sectors (ILO, 2016). One explanation could be that tree plantations rarely occupy the most fertile soils suitable for agriculture and instead tend to expand in remote areas, wherein labour regulations are difficult to enforce (Deininger et al., 2011a). The use of migrant labourers is also common in forestry, arguably due to their greater acceptance of physically demanding forestry work and temporary contracts (Lenard and Straehle,

2010). Possibly this could be also due to their possession of more relevant skills, which could become necessary for the few permanent jobs available. Increased competition over jobs and land, and new or reinforced ethnic divisions, were also seen as a source of social tensions locally (Norton and de Haan, 2012), although such cases in our sample took place mainly in the populous nations of Southeast Asia. Impacts are likely to have gendered dimensions as well (White and White, 2012), although very few cases in our sample considered these.

Whether overall impacts are positive or negative depend on what the prior land uses were (and therefore what was lost and whether the opportunity cost is adequately compensated for), how long plantations have been part of the landscape, and who wanted and could access the compensatory opportunities. With more recently established plantations, perceptions focus on what has been lost; longer-established plantations see residents enjoying more of the opportunities arising from plantations. This indicates that costs tend to be front-loaded and the benefits accruing over time, although such benefits may not be comparable to those that existed from previous or alternative land uses. For younger generations there may also be few alternative options in remote areas in the first place (Chinsinga and Chasukwa, 2012; Mwaura, 2017).

It appears that forestry has favoured a highly centralised business model, although complementary livelihoods on plantations (e.g. intercropping, beekeeping) seem to have become more common recently. Combined wage employment and on-plantation intercropping could enhance the complementarity function of plantations in helping residents to overcome seasonal income gaps. The benefits provided by more inclusive models and corporate responsibility programmes may also be precarious in nature. For example, access to plantation sites has tended to be contractual to control risks associated with open access (e.g. fire) and the benefit-sharing arrangements have tended to favour local elites due to inadequate accountability mechanisms (cf. Cotula et al., 2014). Finally, the often limited (economic and political) agency of those affected by plantation establishment over decisions and processes that can profoundly change their lives is an important concern regardless of the impacts being positive or negative (Vermeulen and Cotula, 2010b). We corroborate the need to consider distributional issues upfront and reinforce mechanisms for governing risks and accountability also in the context of large-scale tree plantations (Goetz et al., 2017; Moog et al., 2015; USAID, 2018).

The studies reviewed here show that the socio-economic impacts of large-scale tree plantations have been mostly negative for those residing inside or near to them. The degree of agreement between studies, within the same geographical and institutional contexts as well as between groups A and B, is high for most categories (Table 4). With only 22 studies using a comparator and considering confounding factors, geographical gaps, topical and temporal research emphases, and methodological inconsistencies identified, strong global evidence on the longer-term socio-economic impacts remains limited. For categories with a high degree of agreement, confidence in results can still be considered relatively high despite limitations in evidence (IPCC, 2010).

The majority of the 251 impacts are situated under categories with high degree of agreement between groups A and B, suggesting that findings in Group B, in those categories, are generally valid despite

Table 4
Qualitative indication of uncertainties in the evidence base.

	Land	Employment	Livelihoods	Cash income	Infrastructures	Health	Cultural ES	Regulating ES	Social
Cases ^a	7/46	12/44	10/21	1/6	4/14	0/2	0/9	8/16	15/36
Agreement ^b	High	Medium	High	Medium	High	–	Medium	Medium	High
Evidence ^c	Medium	Medium	Medium	Limited	Limited	Limited	Limited	Limited	Medium

^a Group A/Group B.

^b Within similar context, between groups A and B.

^c Type, amount, quality, consistency.

limitations in scientific rigor. The measures of scientific validity that were chosen to appraise the quality of the studies can also favour quasi-experimental designs over more critical, ethnographic designs. The different designs and ontologies can also sometimes be disconnected or even irreconcilable (Klenk and Meehan, 2015; Miller et al., 2017). The discourse of evidence-based policy as a global response to global sustainability challenges has also tended to overlook issues of power and politics (e.g. who controls resources, whose voice is being heard, what knowledge is relevant to policy), calling for self-reflexive and deliberative governance to complement evidence-based policy in sustainability-related decision-making (Elgert, 2010; Emmenegger et al., 2017). Hence, validity can be determined from multiple sources, not merely from systematisation with confounders and counterfactuals that can even be difficult to establish in some situations.

The evidence base is largely characterised by local perceptions of impacts, which are powerful in shaping current and future behaviour (Sultana, 2011). Perceptions must also be understood in relation to local expectations, preferences and aspirations, which can be complex, multivalent and historically determined (Emirbayer and Goodwin, 1994). For the purposes of this review, however, it should be recognised that studies may only represent a snapshot in time in an ever-changing context. People that can hold rather divergent perceptions on tree plantations in the first place may feel differently, for example, once the initial benefits available during the labour-intensive planting phase cease, and women may perceive impacts differently from men due to their varying roles and tasks in the community (Anderson et al., 2013; Ingram et al., 2014; Pirard et al., 2016b).

Dealing with studies drawn from different disciplines and methods, as well as with a wide range of often intertwined socio-economic impacts, proved to be challenging. As most studies on the topic rely on non-experimental designs, it is challenging to interpret these as either positive or negative characterisations, or to estimate the respective magnitudes of impacts, especially with changes over time. The lack of clear and common indicators and coherent terminology across studies further complicate interpretation and comparisons. Systematic reviews also tend to fall short in capturing the explanatory nuances of qualitative studies (Bondas and Hall, 2007).

Studying the impacts of large-scale tree plantations using different methods (possibly through interdisciplinary approaches) continues to be necessary to better understand the extent, patterns and dynamics of specific impacts, preferably paying attention on impacts with longer incubation periods (of which there was a relative lack of) and using clear indicators (Adams et al., 2016; Miller et al., 2017). For example, using a quasi-experimental before-after-control-intervention (BACI) design could help to establish causal linkages between impact categories that were not well-represented in the sample, including cash income, health and ecosystem services (Sills et al., 2017). The influence of contextual factors related to plantation management and governance (e.g. certification) need to be also studied more carefully.

5. Conclusions

With our review identifying only 92 relevant studies out of an initial total of 20,450 search results, of which only 22 presented a comparator and accounted for confounding factors, strong evidence on the socio-economic impacts of large-scale tree plantations remains limited. Most studies on the topic have also emphasised the impacts occurring soon after plantation establishment: changes in access to land and livelihoods (negative), wage employment (mixed) and the often intertwined social impacts (negative).

Most impacts across the nine categories can be characterised as negative, especially when considering changes in customary access to land and livelihoods. We also found an uneven distribution of research among regions; it is thus probable that reports on respectively negative and positive impacts are to a great extent determined by geographical (and potentially topical) distribution in the sample. Positive impacts,

which are relatively few and do not necessarily come without problems, coincide with secure individual land titles and the ability to negotiate land transfers, complementary roles between plantations and other land uses, and the generation of stable employment, in particular through wood processing. Benefits also tend to accrue over time, although they may not be fully comparable to those that existed from previous land uses. Keeping in mind that trade-offs are certainly ubiquitous and take various forms across regions, the argument that large-scale tree plantations are more beneficial than costly to local communities is poorly supported by our systematic review on an aggregate basis.

Evidently, there is a need for more research that uses a clear comparator in the study design and accounts for confounding factors. Further research is needed in certain regions where there is a lack of research, for instance the Iberian Peninsula and the southern United States. The use of other potentially relevant languages, including Chinese, Indian and Indonesian, which were not considered here, would certainly extend the evidence base by providing access to a larger sample. More research is also needed on impact categories that were under-represented in our sample, such as changes in cash income, health, and ecosystem services. Besides, having longitudinal data that monitors changes in perceptions and impacts over time would be extremely useful. Studies should also go beyond impact assessments and take a closer look at the drivers of plantation-related policies that are likely to affect human well-being.

Conflicts of interest

None

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi: <https://doi.org/10.1016/j.gloenvcha.2018.09.001>.

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