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Abstract

This article reviews the recent global expansion of different types of tree plantations. The review collates accounts from recent academic publications and by international, regional and local NGOs, and is accompanied by field research and interview observations about the causal processes, central features and likely futures of contemporary tree plantation expansion. This article offers the largest and most up-to-date review of tree plantations and tree plantation studies in the world and the very latest research and data is surveyed. Class, North-South, socio-ecological and agrarian political economic dynamics in expansion are discussed. Results indicate there are differences – depending on whether smallholder or industrial tree plantations are expanded – but also common problems. The literature on environmental and developmental impacts of expansion is also surveyed.

Keywords: *industrial tree plantations, plantation forestry, fast-growth trees, land-use change, large-scale land deals, exotic tree species, green economy.*

Introduction

This article is the first attempt to comprehensively review the current academic and other knowledge on the expansion of tree plantations (TPs) across the globe. The reviewed material includes FAO data on TPs, existing academic literature, the extensive writings by the World Rainforest Movement on the topic, many other international, regional and local NGOs' publications, movement material, official documents, interviews and discussions with specialists, foresters, company directors, officials and activists aware of the recent changes, field research observations from plantation areas, and quite extensive Google searches to locate articles from local and global newspapers, research institutions, and other bodies on the politics and economy of TP expansion. Hundreds of reports written in the past decade were covered: a comprehensive bibliography of key texts is presented. The aim is to illustrate where we stand now in terms of knowledge, introduce the key explanations on causes and impacts, summarize findings and outline areas needing further inquiry.

The review sheds light on contemporary rural changes globally. Most of the research on current key rural transformations, such as large-scale land deals, has focused on food production. However, a large parcel of land-use, access and control takes place in non-edible industries, such as forestry. The share of new non-food land access, for mining, forestry, energy and conservation purposes, among others, has been significant. For example, in Latin America, the two most important non-food sectors in terms of land use are fast-growing forestry plantations (such as eucalyptus) and conservation (Borras *et al.* 2012). The literature on large-scale land deals has started to deal with these. Fairhead, Leach and Scoones (2012) review a collection of essays on 'green grabs', mostly dealing with conservation schemes.

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Tree plantations have received less attention in this literature, despite being an essential part of the new emerging ‘bio’- or ‘green’-economy. This gap in knowledge needs to be bridged by reviewing the expansion of TPs.

The review of expanding non-food resource exploitation carries potentially significant importance in the academic and political debate on rapid agrarian change of the past years caused particularly by large-scale land deals. As non-edible crops have been left out of analysis of ‘land grabbing’, narratives might be misrepresenting what is actually happening and why. For example, Borras *et al.* (2012) found that in Latin America and the Caribbean land and capital (re)concentration occurred in two broad mega-sectors: the flex crop (crops usable for food as well as other purposes, such as energy) complex/food sectors, and the broad non-food sector. According to the authors, this contradicts the dominant narrative that new land deals have occurred because of the food crisis of 2007–2008 and that such land grabs would be orientated towards food export to food insecure countries. The isolated study of food is thus problematic. It misses more general phenomena explaining large-scale land deals such as the newly emerged flex crop complex, the continuing importance of livestock, the sharp increase in demands for natural resources by newly emerged centers of capital, and responses to policies linked to climate change mitigation strategies (Borras *et al.* 2012).

To understand the quality and extent of ‘land grabbing’ in its totality and sub-parts, sector-specific politics should be analyzed. A discussion of significant changes in the forest industry, focusing on tree plantation expansion – the strongest of the drivers of change and accumulation in globalization – will begin this process. A detailed focus on the forest industry allows comparison with other industries and enables an understanding of how and if industry accumulation and expansion logics derive from industry-specific rules or from global capitalism, as a sub-system of global capitalism.

The focus in this review on the forest industry does not include oil palm and rubber. Oil palms are linked to the food complex and the energy industry. In order to delimit the unit of analysis to only the forest industry, rubber plantations are not included. Rubber plantations are linked more with the chemical and metal industries, as well as to a lesser extent the energy industry, as some old rubber trees have been recently chipped to fuel wood-energy plants.

The main species focus is on eucalyptus and pine; the two fast-growth main commercial plantation species used in pulp-making.¹ Some other similar trees are also surveyed, such as acacia, and all forestry plantations are included in the statistical section illustrating where and what is planted across the globe.

The main emphasis is placed upon the most visible part of the forest industry cluster: the corporate-controlled industrial tree plantation (ITP) holding companies. The most important actors to study in order to understand the expansion and political economy of global forestry are an increasingly merged group of Northern paper companies (such as International Paper from the US and Stora Enso from Finland-Sweden), alongside some rising Southern pulp companies (such as Fibria from Brazil and APP from Singapore). More analysis is required on the forestry empires of leading companies, given the dearth of research on the political economy of globalizing Northern multinational timber firms (Dauvergne and Lister 2011),

¹ There are over 600 known eucalyptus species, of which about 20 are currently widely used commercially. Hybrids such as *globulus* and *urograndis* are common, the first providing the best quality fiber for pulp and papermaking and used for example in Portugal, and the latter being the fastest-growing, used particularly in Brazil. Breeders constantly develop new clones of eucalyptus and pine species. I will refer to all the pine and eucalyptus species here as simply pine and eucalyptus.

although they have been alleged to cause many problems around the globe (Carrere and Lohmann 1996, Lang 2007, Gerber 2010).

Timber products are still mostly extracted from natural or modified natural forests, but the share of plantations is increasing. According to a 2001 publication by Sohngen *et al.*, cited by UNEP (2012), plantations provided in 2001 some 35 percent of the globally harvested wood. Since then the plantation share has increased as plantations have grown while the total forestry area has not (*ibid*). Considering this global importance, discussion on plantations has been remarkably absent, although there is a growing literature.

This review studies the political economic expansion of non-edible tree species cultivated in either 1) industrial large-scale forestry plantations of tens of thousands of hectares contractually controlled or owned by corporations (ITPs), or 2) small plots of a few hectares maximum size by rural households (smallholder-based forestry plantations, STPs). The conceptual division into corporate- and smallholder-based forestry is necessary to explain why there are divergences in expansion dynamics.

The conceptual separation between ITPs and STPs flows from the available data and the existing literature on TPs and agrarian political economy. For example, Bernstein (2010) suggests four questions to disaggregate the process and impact of development in agrarian political economies. These are: who owns what? Who does what? Who gets what? What do they do with the created surplus wealth? Such analysis helps in understanding why, where and how plantations expand, as the politics and types of plantations are tied into relational dynamics between different social groups, including classes of labor. To assess differences in STPs and ITPs, Barney (2004) urges the study of the history of legal and informal resource tenure, within an analysis of rural political-economic restructuring accompanying TP expansion. Such analysis illustrates how expansion differs dramatically, for example in the contexts of Vietnam (Sikor 2012) and Brazil (Kröger 2011, 2012a).

An incorporated comparative analysis (see McMichael 1992) using Bernstein's four questions on class dynamics is used as an underlying frame to organize the accounts of different but globally and temporally connected structural and institutional settings, schemes and actor dynamics where plantations expand. A comparison of studies of different settings suggests STPs have been the main form of industrial forestry expansion in places such as Thailand (Barney 2004), Vietnam (Sikor 2012) and Finland (Forest.fi, Facts, Ownership, accessed 28 June 2012), whereas ITPs have been the mainstay in countries such as Brazil, Uruguay, Chile, Indonesia and Mozambique. Differences in class and power relations are discussed together with other socio-environmental issues commonly given as explanations for the ITP-STP divergence. Both STPs and ITPs are found to share the diminishing biodiversity problem inherent in single-crop plantations. Yet studies also note that plantations exist in radically different agrarian settings and thus have variance between them depending on context, with for example some plantations containing more underbrush vegetation than others.

The review sums up how the literature has answered the questions, why, where and what, and how fast-growth tree plantations have expanded. The main land use changes are outlined and expansion predictions are proposed based on existing data. In the how-section, the most commonly identified methods, consequences and dynamics of TP expansion are reviewed, including analysis of state-industry-civil society interaction, corporate land control, enclosures, class relations and socio-ecological modifications. Studies on STPs are reviewed for their findings on developmental differences and similarities in ITP expansion style. Finally, the environmental impacts are studied. The review is accompanied by sections presenting new and unpublished field research findings by the author, relevant to

understanding the most recent changes or illustrating key issues not considered in the existing literature.

Why?

There are different explanations for the rapid expansion of tree plantations in forest industry. At the visible level, for Dauvergne and Lister (2011), the global discount economy where big box retail companies squeeze producers down the commodity chains to produce timber products for them as much and as cheaply and reliably as possible is the main explanation for problems in the felling areas. The rising power and impact of corporations and their resource exploitation is linked to the globalization of neoliberal capitalism during the past two to three decades. This change is seen most evidently in the past decade, during which new mass-scale Southern producers of pulp have emerged, and traditional Northern firms have downsized at home and invested in the South. The neoliberal international financial and trade infrastructure, demanding strong foreign currency reserves and seeking to squeeze costs, has led Southern governments to boost exports in commodities (such as pulp) and Northern governments to increase exports in machinery for commodity extraction in the South. Fiber costs are the most essential element in paper manufacturing, a main destination of plantation tree. Pulp mills producing 1-1.5 megatons of pulp per year (this figure is set to grow) have resulted in positive trade accounts in the South, while offering cheap fiber to Northern companies and products to (mostly Northern) consumers. Rising consumerism and expanding consumer-base, e-commerce and global trade drive the fast use of the fast-wood timber products. Packaging forest products amongst others in cardboard or paper, typically thrown away as soon as the item is opened or used, further increases consumption (Dauvergne and Lister 2011). Thus, bottom line fixation explains central growth.

Behind the curtains, there are also strong North-South industrial relations, a typical capitalist dynamic explaining expansion. With ITPs, the accompanying pulp mill- and other technology sales, the North has gained a new outlet for expanding their forest industry cluster. This cluster has been developed in the North since the 1920s via capitalization and internal-capitalist innovation, creating capital-intensive forestry technology. As rates of return started to fall drastically below 10 percent at the start of the 1990s, a new fix was needed for the accumulation to continue. Socio-ecological transformations were needed to expand forestry capitalism: ITPs fencing large land areas was the solution. Global forestry capitalism experienced a cyclic change from its capitalization phase into material accumulation and territorial expansion. Arrighi's (1994) theory has illustrated in general how such cyclic change is inherent in global capitalist expansion. For example, smallholder-based agrarian structure led to the development of globally leading capital-intensive farming techniques in the American Midwest by the 1960s: when this emerging agribusiness/food complex globalized, it took the form of the Green Revolution in its land relations, particularly in the Global South (Moore 2011). A similar type of cyclic change from capitalization to territorialization took place as the Northern forest industry cluster started to globalize in the 1970s. New tree plantations are thus linked to this deeper cyclic change in global capitalism. In this view, capitalism is a socio-ecological relation (Moore 2011) with currently globalizing forestry capitalism a plantation-based land use change project.

Over-development of production capacity, in part pushed by machinery producing cores, further explains plantation expansion. The establishment of woodworking industries is the strongest driver of plantation expansion particularly in areas where the processing capacity surpasses timber supply, and natural forest logging is becoming ever harder, such as in Indonesia (Obidzinski and Dermawan 2010).

The interaction of social actors and nature also explains why the current expansion is taking place through land deals where elites and corporations race for the best remaining land and resources (see e.g. Klare 2012). Climate change (e.g. increased droughts, disruptions in climate) will reduce yields, requiring increased plantation area. At a conservative estimate, expansion of 4.5 times the current area will be required by 2050 to meet the increased demand caused by climate change and maintain 1991 plantation fiber production levels in Brazil (Fearnside 1999). In reality this figure will be much higher as global demand has grown, and according to Fearnside this expansion incurs substantial further socio-environmental costs (ibid).

The emergent global ‘bio-economy’ will explain an ever-greater part of future growth. The main reason for the prognosis of robust expansion is that plantations are becoming areas where ‘flectrees’ are planted. Flectrees are the commodity consequence of merging inter-industry interests in the emerging green/bio-economy. Biomass in the same plantations can be used for pulp or energy, pulp prices largely determining the use of biomass until now in the case of Brazil (Fearnside 1998). Energy and other timbers uses become more prominent, while pulp will continue to be important. Pulp prices have soared in the past 15 years, and consequently there’s a mill construction boom. For example, in Brazil one 1.5 megaton pulp mill is projected to open up each year until 2020. Companies and governments are now setting up very fast-growth (2 year-rotation) plantations in the Global South to export pellets for growing wood-energy markets and plants in the North. New pulp mills are becoming also major energy producers (Valor Econômico, 11 September 2012, ‘Produtor de celulose cresce em geração’). Wood-based second generation biodiesel-plants are also being erected, with high hopes in the industry that wood-fuel could become the next oil. Carbon sequestering plantations may serve in the REDD+ schemes. Polluting industries and consumers such as air travelers seek to buy carbon credits or offset impacts by crediting tree plantation. A myriad of GM and nanotechnology paper applications are being developed based on the capitalization of specially engineered trees. The machinery development is still largely controlled by Northern companies, but fast-growth and flex plantation techniques, including GM trees, are an area of innovation where Southern ‘National Champions’ e.g. Brazil are gaining a strong foothold. It is likely these strands will unite even more tightly into a global flex-forestry cluster. This industry consolidation will lead to further expansion. Tree plantations are becoming flex tree plantations, a ‘renewable’ capitalist response to depletion of nonrenewable resources. Yet, the degree of renewability depends on the soil, water and other environmental impacts of TPs, discussed in the end of this review.

The most robust answer to the why question is the endless pursuit of accumulation in capitalism. By flectrees and crops, globalizing industries will reap the benefits of both capitalization and material-expansion type accumulation simultaneously, as noted by Arrighi (1994). When the natural spaces start to become exhausted, as has happened, flex crops and species arise. Nature is molded to ensure it does not limit growth. However, there are limits caused by -, nature- and capitalism in flex-accumulation (whose detailed discussion is beyond the scope of the review).

Where and what?

Clear statistics on plantation coverage are difficult to come by, as different entities use different conceptualizations of forest and plantations, and the field is evolving rapidly and with unsatisfactory monitoring. The United Nations’ Food and Agricultural Organization’s (FAO) Forestry division maintains one of the most extensive databases, which is nevertheless also problematic in some ways. The FAO itself admits that ‘consistent definitions and reliable

data have proven problematic in quantifying plantation forests or planted forest resources in both industrialized and developing countries.² Yet, the FAO data is useful, if used for the purposes for which it is suited.³

Conceptualization differences produce incomparability in databases. FAO, UNEP and other UN-bodies talk about ‘forest plantations’ or ‘planted forests:’ according to FAO (2010, 5) there were 264 million hectares of these in the world in 2010. FAO (2011) states that Europe had 69.3 million hectares of plantations; but a joint publication of Forest Europe, UNECE and FAO (2011) claimed that plantations cover 4 percent of Europe’s 1 billion hectare total forest area, which would mean 40 million hectares. This is a big discrepancy in data, illustrating how even the official multilateral and government organizations are not aware or not in unison over plantation expansion. The FAO gets its data from governments, which use industry associations’ figures (for example in the case of Brazil, data from ABRAF, the Brazilian Association of Planted Forest Producers, is used). This is a problem, as governments, often close to companies, can be keen to hide the extent of tree plantations, and exaggerate the extent of natural forests, or not offer data to the FAO for whatever reason. Some key countries’ data can be missed or misrepresented. NGOs claim that the real extent of plantation expansion is higher than those presented by governments and thus also the FAO. For example in Indonesia, one local NGO says that pulpwood ITPs are estimated to cover about 9 million hectares, with the government planning to expand them to 25 million hectares by 2025.⁴ But the official government/FAO figure for Indonesia in 2010 is 3.55 million hectares (FAO 2010).

Although the following FAO (2011) table on plantations should not be read as the final word considering the methodological-conceptual-political discrepancies, the table clearly indicates that plantations have expanded dramatically between 1990 and 2010.

Table 1: ‘Planted forest’ expansion between 1990 and 2010 by regions, million hectares

	1990	2010	Change %, 1990-2010
Africa	11.663	15.409	32.1
Asia and the Pacific	74.163	119.884	61.6
Russian Federation	12.651	16.991	34.3
Europe	46.395	52.327	12.8
Caribbean	0.391	0.547	39.9
Central America	0.445	0.584	31.2
South America	8.276	13.821	67.0
Near East (excluding N. Africa)	4.677	6.991	49.5
Canada	1.357	8.963	560.5
Mexico	0.35	3.203	815.1
USA	17.938	25.363	41.4
World	178.307	264.084	48.1

Source: Author's elaboration based on FAO (2011) data

² FAO (no date), Definitions Related to Planted Forests, <http://www.fao.org/docrep/007/ae347e/AE347E02.htm>

³ The FAO data gathering focusing on areas with trees destined for forest industry-use (excluding e.g. oil palm) supports the decision of this review to focus on forestry plantations.

⁴ Based on interview with Rivani Noor from CAPP by Nanang Sujana.

The table indicates that global plantations have expanded by 48.1 percent between 1990 and 2010. Mexico has seen a whopping 815 percent increase in tree plantations between 1990 and 2010 and has now 3.2 million hectares (FAO 2011, 25).⁵ Alongside North America, South America (67 percent increase) and Asia and the Pacific (61.6 percent increase) were the two main areas of dramatic, above average plantation expansion increase. In the Near East (in whose figures FAO 2011 calculates also North Africa to belong to, besides counting North Africa also into the Africa category, thus counting it doubly, making the part-sums not match with the whole world sum of the regions; thus I have removed North Africa removed from Near East data in table 1 to avoid double counting) TPs expanded by 49.5 percent. Europe was an exception; plantations were expanded by only 12.8 percent. The rest of the regions in the table experienced plantation expansion of 30-40 percent between 1990 and 2010.

Even considering the faults in this tree plantation data – which is the most reliable data available - the expansion trend is clear and pronounced. The bird's-eye view afforded by table 1 shows that plantation expansion is a major issue and significant trend of the modern world.

The official statistics on global forests illustrate how tree plantations expand while primary forests and other natural forests decrease or retain their size. Plantation forests and primary / semi-natural forests can be separated from the FAO data. According to the FAO (2011), from 1990 to 2010 the total forest area of the world (including plantations) decreased by 3.25 percent to about 4,032 billion hectares. On top of this 3.25 percent decrease loss of primary and other naturally regenerating forest, as a loss of primary and other natural forests also has to be calculated the 85.77 million hectare increase in TPs between 1990-2010. New plantations are counted in by FAO as increase in total forests, although tree plantations are not primary or other naturally regenerating forests. Thus the growth in plantation substitutes (hidden from the data) is a part of the total decrease of primary and other forests. The changes in total forest area and planted forest in Canada is an illustrative data-interpretation issue worth mentioning. According to Canada's forest resource assessment, its forest area did not change at all between 1990 and 2010 (remaining at 310.13 million hectares), but the area covered by planted forests increased by 560.5 percent to about 9 million hectares.

Main land use changes

Very different landscapes have been turned into similar tree plantations (Patterson and Hoalst-Pullen 2011). Plantation forestry is steered more by humans than primary forest growth. The logical result of land cover change induced by humans is even greater landscape control by humans. Ever more adaptable species, rotation cycles and tree uses have increased the scale and scope of human-induced pathways, displacing more clearly non-human-induced forest expansion. The industry focus is on the decreasing cost of extraction and transport instead of increasing yields, and genetic work not focusing on yield increase on best lands but on developing hybrids for marginal lands (Fearnside 1998). This can be explained by the practical limits oil quality places on increasing yields in commercial scale plantations to 30m³ per hectare per year even in the world's best tropical climatic conditions of Brazil (ibid). Nature places limits on expansion.

⁵ However, in FAO (2010) Mexico is presented as having had no tree plantations at all in 1990; in FAO (2011) the figure for 1990 Mexico is 350,000 ha. When asked about the discrepancy, a FAO official responded in email communication that 350,000 ha seems like a mistake, but could not give definite answer on why there is a mistake, or if this is a mistake. If the figure is zero, then the TP growth in Mexico has been even higher than 815 percent.

The best, most fertile lands close to rural cities have been appropriated first in most expansion contexts. A study in New Zealand found that because forestry is a more intensive and higher demand land-use than pasture, tree plantations expand first closer to the city, pushing the second priority pasture and agriculture use to peripheries (Nagashima *et al.* 2002). As the best lands become occupied by TPs, the focus turns increasingly to marginal lands. According to Fearnside (1998), the industry focus on territorializing ever more marginal lands leads to damaging expansion in peripheries, with the search for lower costs cutting the limited local economic benefits in large firm-controlled plantation areas. Such expansion does not take place in ‘vacuums’, but in the contexts of rural cultural and human ecological mosaics with a myriad of different agrarian structures and relations.

With depletion of finite resources, and natural limits on increasing yields on good lands, but the technical capability to make cultivation possible in cheaper marginal lands, expansion takes place in more peripheral, difficult-to-reach areas. The imperative is to get control over as much land as possible in areas where prices are still low (Kröger 2012a).

The rapidity of land use change can also affect the countries of the Global North. In Australia, dramatic tree plantation (mostly eucalyptus) growth between 1997 and 2009 (from 1.2 to 2 million hectares) represents a radical change in rural landscape character and economic activity, with food-producing family farms turning into corporate ITPs (Stewart *et al.* 2011). Farmers have widely opposed this expansion (*ibid.*), but according to the reviewed literature, not by physical protest.

Expansion predictions

TPs are expanding fast, with many consequences. In South America, the expansion pace is at 500,000 ha per year (Jobbágy *et al.* 2012) and this is increasing. In Africa, the rise may be even more dramatic than in South America: for example, Pöyry Forest Consulting – a leading expert on ITP expansion - suggests that within a decade Africa will be the center of TP expansion globally. Africa will see a wide spectrum of tree plantation types and uses, including ecosystem services plantations such as ‘carbon sinks’ operating on the REDD Plus markets and under development cooperation agendas; energy plantations; pulp projects integrated with plantations and mills; and other biomass ventures. Africa is also likely to attract timberland investment by portfolio funds seeking diversification, both from the private and the state sectors; Western pension funds, for example, are looking to land investments for more secure returns than are to be found in the equity markets. Even though land is similarly also a speculative investment, as for example derivatives, land cannot completely lose its value if there is a financial system crash or downturn on financial markets. Land has real use value and not just fictitious value like stocks and derivatives. Land is also a resource whose ever-larger scale control and appropriation by core states and their industries has been and continues to be the essential element in driving capitalist globalization (Bunker and Ciccantell 2005). It is likely that in Africa land tenure will be controlled more tightly by foreign actors, than in the neodevelopmentalist countries of South America (such as Brazil) and Asia (such as China, Indonesia and India) where new laws curb foreign land ownership. China, the EU nations and some others have secured and will continue to attempt to secure 50- to 100-year leases from weaker governments, with ample investment guarantees. China deserves a closer look because of its important role in global TP expansion.

There are severe limits to ITP expansion in China, since

Feeding its enormous population puts so much pressure on land use that China has no real scope for a pulping industry based on plantation forests. Establishing plantations can be a slow and complex business as most of the suitable land is held by households and communities.⁶

Instead, a growing number of timber manufacturing plants, including paper mills, are locating in China, promising for this emerging power a very different position in global forestry capitalism's division of labor and revenues, than for the commodity-producing countries of Brazil or Uruguay, for example. Much of the biomass used in China is imported, mostly from South America, Southeast Asia and Africa. Still, China is a mixed case, as there is considerable TP expansion in China, with violent conflicts involving dramatic suppression of human rights and even deaths (Ping and Nielsen 2010). Stora Enso, a Swedish-Finnish paper company and second largest in the world, was involved at least indirectly in the death and beatings of local resistance activists and lawyers while expanding eucalyptus plantations for its planned 900,000 million ton pulp mill in Guangxi, Southern China, which has already 120,000 hectares of eucalyptus plantations. A report by *Rights and Resources* argued that Stora Enso's 'limits to their legal due diligence... [are] ... raising risks for local people to both their rights to land and livelihoods' (ibid). This fosters conflict.

Some pulp projects in the pipeline will most likely be scrapped because of resistance or more likely the depressed global economic situation, overproduction and low pulp prices. Although in December 2011 long-fiber pulp prices were still above pre-2008 prices, they were coming down rapidly, with a decline of over US\$100 per ton since January 2011: in the US, prices stood at about \$830 dollars per ton in July 2012 (see FOEX Indexes, <http://www.foex.fi/>). Insofar as prices rise, as they have done, those who got in early in land markets will be happy with their established corporate enclaves. With many new large-scale pulp projects in the pipeline, overcapacity, along with slowing growth, is likely to continue to threaten pulp prices. But pulp prices alone do not determine expansion. Pulpwood plantations can be transformed into charcoal or other energy wood projects, as happened with Celmar, a 1990s failed pulp project in Brazil's Maranhão. Therefore, boom-bust market cycles as drastic as in cacao or other edible crops will not likely be seen (although, being a vulnerable monoculture, destruction of plantations might be experienced due to epidemic diseases or uncontrollable fires; these being a growing risk as the size of monocultures and climate disruptions increase). Flex tree plantations are a rising trend offering expansion potential limited only by nature and societal responses.

How?

A corporate or smallholder-driven process?

Whether ITPs or STPs are created depends mostly on whether capital comes in search of land not labor (ITPs created), or both land and labor (STPs created) (see Clapp 1989 for a study of Chile in this respect). The reasons to establish STPs are many, such as the desire by corporations to alleviate risk and conflicts by incorporating smallholders into forestry. One reason may also be to draft socially- and/or environmentally oriented policies, for example in states with deeper democracy, outside of corporate capture, and states seeking to diversify rural incomes and environmental services via STP promotion.

In the world outside East Asia, expansion has been driven as much by smallholders, as by corporations and smallholders. If excluding the East Asian increase from the total global TP expansion (in Del Lungo *et al.* 2006), smallholder plantations rose from 15.18 million ha in

⁶ Pulp Mill Watch, China, <http://www.pulpmillwatch.org/countries/china/>

1990 to 20.99 million ha in 2005, that is, by 5.81 million ha. Meanwhile, corporate plantations expanded by 6.14 million ha. Even in East Asia the expansion may have been in the end driven by ITPs. There are reasons to suspect that empirically grounded conceptual clarification would end up showing that the expansion has been driven more clearly by corporations than by smallholders.

An issue to be considered when comparing ITPs and STPs is that government-reported data on the division of ownership can vary dramatically from the actual control and use of land: contractual terms and *de facto* relations have to be pruned case by case, local context by local context. For example, a clear new sign, is that corporations seek to outgrow or rent land. The rising conflicts around corporate plantations and criticism of them, alongside rising legislation and regulation banning further expansion, has promulgated indirect land control. This trend has already de-corporatized the official land ownership statistics, yet it has deeply entrenched the problem of long-term contractually-binding *de facto* land control skewed in the favor of corporations.

For example, the latest and most large-scale pulp investment in the world, Eldorado's 1.5 megaton pulp mill in Mato Grosso do Sul, Brazil, owns only 20-30 percent of its plantation base; the rest of the eucalyptus cultivation areas are being rented (Siqueira 2012). Eldorado's owner, Brasil Foods, is a latecomer to forestry and its main business is meat production – it is the world's largest meat-producer. It argues that Eldorado has managed to more significantly reduce costs this way (from the already very profitable eucalyptus-based large-scale pulp investment model). Land prices have risen dramatically and the land buying and corporate-enclave creation strategy used still a few years ago is not as cost-efficient or usable any more. This marks a sharp and rapid shift in corporate plantation expansion strategies and speaks about global forthcoming trends shaping agrarian structures. The timber supply chains are ever more tightly corporate-controlled (Dauvergne and Lister 2012).

Yet, Sikor (2012, 1078), citing evidence from the FAO, claims that 'smallholders have driven the dramatic expansion of tree plantations worldwide' between 1990 and 2005, allegedly owning 32 percent of TPs by 2005. The descriptive power of this claim is next assessed. The FAO (2010) and Del Lungo *et al.* (2006) data, on which the smallholder-centrality claim is based in Sikor (2012), are scrutinized closely to see if expansion is driven by corporations or smallholders.

First, Del Lungo *et al.* (2006, 24) mention that the largest bulk of the alleged rise in smallholder ownership can be attributed to a dramatic increase in China. Whether this nominal smallholder ownership is really significant enough to define as smallholder-based control is questionable. Between the mid-1980s and mid-2000s expansion in China was driven by publicly owned tree plantations (Rudel *et al.* 2005).⁷ Public TPs were more important than smallholder plantations. Therefore, representing the global rise as driven by smallholders may be stretching the STP concept, and the claim that TP-expansion would be

⁷The government was in equally important role in India, granting control of most small tree plantations to villages, to communal plantations, not to smallholders (Rudel *et al.* 2005). State-created communal TPs differ from STPs. According to Barr and Sayer (2012), the socially-attuned forestry programs have excelled mostly just in theory until now. For example in India, with a markedly more social than corporate forestry model, targets have not been met, and villagers have mostly been passive spectators of the raising of trees on their land (Saxena 1997, Kumar *et al.* 2000). The developmental outcomes of plantations have depended on the existing power relations. Plantation forestry in India developed since late 1970s by government-led village plantations, and India is one of the most marking state/socialist plantation forestry examples. The 1988-created Joint Forest Management program expanded usufruct rights of villagers, but the spilling of economic benefits to the most marginalized community members depended on local power relations (Sekher 2001, Sarin 2003, Kumar *et al.* 2000, cited in Barr and Sayer 2012), such as gender and class cleavages.

driven mostly by smallholders seems incorrect. China had over 77 million hectares of TPs in 2010, according to the FAO. However, the figure is presenting mostly publicly owned and controlled plantations, and has been found in any case an over-estimation of actual plantation cover. Many foresters believe that China systematically overestimates the area it has planted, as tree planting is a high-profile government policy. All kinds of trees are planted - according to some estimates, over 70 billion over the past three decades. Plantings are of many types, but most (for example, 10 meter-wide green zones on roadsides) would be considered neither corporate nor smallholder but public TPs. Local Chinese tend to distinguish very clearly between eucalyptus plantations for pulp, for example, which they do not consider 'tree planting' (which has a positive connotation), and activities of the positively-viewed government treeplanting program.⁸

Second, as mentioned, corporations have started to increasingly rent or make outgrower contracts on public land and land belonging to smallholders and individuals, for expanding plantations. Yet, in many contexts these contracts have been biased towards corporate control, removing smallholder control (Kröger and Nylund 2012). Global smallholder 'ownership' of plantation lands cannot be correlated with 'smallholder-driven expansion', without studying the variance in contracts and de facto tenure. More studies are needed on these.

Third, Del Lungo *et al.* (2006) include both 'plantation forests' and 'planted semi-natural forest' categories in their FAO calculation. Most people do not call the first a 'forest' (but a plantation), and the latter not a 'planted forest' (but a forest). Monoculture eucalyptus plantation in Brazil fit in the first category, but for example a mixed-species semi-natural forest in the Nordic countries fits the second. To include both in the calculation may stretch the concept of 'tree plantation' too far, and in any case it is not precise enough a measurement for making the claim that smallholders have driven the most recent TP expansion.

These three reasons make shaky the claim that smallholders have driven tree plantation expansion. In reality most expansion of TPs has taken place because of corporate expansion. This becomes clear if exotic species are included –whose composition per TPs across countries are given by the FAO (2010) - and even clearer if the 'planted semi-natural forests' are left outside the definition of TP.

State-industry-resistance interaction and investment location

Where TPs expand is explained by a variety of issues, and is understandable only in the global interdependent context where forestry capitalists, states and civil society groups interact. The state role has been discussed thoroughly in the literature. State dynamics help to explain how, where and what plantations are established. The research has emphasized that most governments eased the corporate-driven globalization process from the beginning with subsidies to large-scale plantations (e.g. Silva 2004, Bull *et al.* 2006, Clement *et al.* 2009, Patterson and Hoalst-Pullen 2011, Redo *et al.* 2012, Kröger 2012a, 2012b), weakened environmental regulation and territorial titling (Clapp 1995, du Monceau 2008, Miola 2009, Pakkasvirta 2010, Gautreau and Vélez 2011), liberalized financial markets (Stewart *et al.* 2011) and/or violent methods such as dispossession (Marchak 1995, Carrere and Lohmann 1996, Kay 2002), if governments shared an electoral-institutional-ideological alliance with the industry (Kröger 2010). However, also notable exceptions exist, including for example the ALBA-countries in Latin America (field research, 2004-2011), Thailand (Barney 2004), Vietnam (Sikor 2012) and India (Saxena 1994, Dauvergne and Lister 2011), which have

⁸ Discussion with Mika Koskinen, the director of documentary Red Forest Hotel on Chinese tree planting and Stora Enso pulp project in China, www.redforesthotelthemovie.com

barred an expansion of markedly corporate forestry. Instead, STPs or state-owned ITPs have been created in some of these countries.

According to the literature above, the first wave of expansion in the 1970s-80s was the most violent and socio-environmentally destructive. At this time, the dictatorships, for example in Indonesia, Brazil and Chile, rooted the corporate ITP model to their countries with an iron fist. Some expansion still takes place by violence necessary for enclosing lands and a large number of ITPs expanded via accumulation by dispossession (see Kröger 2012a for an illustration of this in Brazil).

Dispossession by tree plantation expansion began in earnest worldwide between the 1960s and 1970s, at a time when the World Bank was getting into its stride as an agent of Western 'development.' ITPs were framed as a key development policy, promising jobs, modernization and 'progress.' In Thailand, the major eviction threats began in the 1980s (Lohmann 2002). In Indonesia, Suharto's dictatorship started a pulp investment cycle after a bloody civil war against alleged socialists in which more than half a million people were killed (Li 2007). The Suharto regime established a 'tight link between corporations, officials, and the police who protect investor interests in the pulp and paper industry', which remains today, as Human Rights Watch has extensively documented (Li 2007, 265, Human Rights Watch 2003).

Although the main reasons for TP expansion are placed on the pushing side, the resistance has been found to also play a role. In some places resistance has become a major force in impacting where expansion takes place. Early examples are India (Saxena 1994) and Thailand in the 1980s and early 1990s (Hall 2002). In Thailand in 1992, militarized expansion of eucalyptus plantations was discontinued because of resistance. Expansion would have required the displacement of 250,000 families. Instead paper firms from Japan withdraw from Thailand and invested in Australia. Thai firms responded to the toughening political and regulatory context by investing in neighboring countries with lower levels of regulation and resistance (Hall 2002). The 1992 Re-Afforestation Act, an outcome of increasingly strong eucalyptus-activism, led to a complete halt on new corporate plantation (ITP) concessions since 1992 (Barney 2004).

The industry moves are thus based on state support and societal resistance responses. For example, Finnish paper companies started to avoid Indonesia after global criticism by powerful NGOs of environmental destruction in the 1990s. Instead they shifted focus to South America, particularly Uruguay as it provided a less conflictive setting than the more productive, yet more resistance orientated context of many Brazilian states (Kröger 2010).

When faced with resistance capable of challenging land control, this uncertainty about long-term corporate access to land is one of the most major concerns for ITP-promoters. In interviews for this study, executives gave more importance to the resistance movement than the movement leaders themselves. When resistance is too strong, plantation firms choose instead to expand in political environments with greater land access security and less dense rural populations, such as in Australia and Uruguay. Hall (2002), studying ITPs as pollution havens, notes that the main reason for selecting political systems where private corporate land tenure is protected more strongly is not merely land control per se: More important is that greater security of tenure raises the likelihood of environmental damage, environmental damage being a required outcome for establishing ITPs for Hall (2002). Low population density is understood to diminish the prospects and strength of resistance over water use and pollution issues by impacted populations. Evidence from a comparative study of expansion in Brazil, (Kröger 2012a) however, suggests that ITP expansion even in high rural density

contexts has been rapid and massive, given that large land masses have been appropriated easily and cheaply.

Low land prices, natural conditions, supportive state policies and incentives remain the key reasons for plantation location, particularly in contexts of low-visibility, low-impact, or absence of conflictive resistance.

‘Political forests’: the centrality of land control in ITPs

Forestry plantations started to be developed most extensively after the Second World War. In this period, argue Vandergeest and Peluso (2006), the FAO became a central organization promulgating a type of Forestry Empire, which accompanied the older ideal German forestry model that has replaced natural forests with managed timber stands ever since its nineteenth-century inception. These empires still interact with local ecologies and political economies. The result has been dramatic expansion in tree plantations and restriction of old forestry practices in most areas of the world, particularly if states have promoted industrial forestry as a key developmental policy. For example, forestry played a major role in the post-WWII national political economies and states of Southeast Asia, leading to tree plantation expansion (Fox *et al.* 2009). The expansion happened in an agrarian political economic-setting based on the creation of what Peluso and Vandergeest (2001) call ‘political forests’; a term by which they emphasize how ‘forests’ are politically constructed and might not even have forest in them; with ‘forest’ demarcation serving more the political needs of land control than the ecological concerns of forest preservation or use, with this notion applying globally. In fact, tree monocultures have often replaced high-biodiversity natural forests, although officially expanding on ‘degraded’ lands (Sargent and Bass 1992).

Modification of class- and socio-ecological relations

The Southeast Asian expansion, where most current plantation areas were previously primary forests and spaces under traditional peasant practices such as swidden agriculture, illustrates that the ‘modifying’ of existing socio-ecological and class relations has been necessary for establishing TPs. According to Fox *et al.* (2009), the plantation expansion in Southeast Asia replacing swidden in natural forest had a double impact: plantations lessened the peasants’ ability to produce their own food by swidden cultivation, and created internal class divisions by increasing the power of those able to expand landholding via government-backed tree planting replacing the swidden. The expansion of swifiting cultivation had to be tamed so that plantations could be expanded. In Malaysia’s Sarawak state, swidden expansion was blocked to reserve land for logging and plantations.

The elites have gained most from this consolidation of ‘degraded’ forests under state control, in the form of land concessions, subsidies and rents; argue Barr and Sayer (2012) in a discussion of the Asia-Pacific. Timber provides rents for the elites in a similar way as oil (Ross 2001). The elites have directed the ITP-created timber rents to political and economic activities allowing even greater expansion of the rent-yielding area (thus further expanding ITPs) and power outside the forestry sector. The rent-incentive has led in Indonesia to what Barr and Sayer (2012) call perverse outcomes, wherein naturally or already-commercially valuable forest or timberland is destroyed and replaced with ITPs.

North-South enclosures

It is unlikely that European or Japanese ITP companies would be able to expand in the ITP-way in their home countries in the global North because of a lack of land. As an example, a typical new big pulp mill requires at least 100,000 hectares of land, plus preservation areas required by local laws - preferably not further than 100 km from the mill in order to save money in transport costs. People are usually fenced off from these privatized lands. In the South, companies often use private guard units to keep people out of the ITP enclaves. Such guard units are sometimes considered to be similar to paramilitary units by the local people whom they harass, hurt and occasionally kill. In most cases, most of the pulp produced from such lands is exported.

Companies have expanded their control over some of the best and most fertile, flat land areas, seizing control of land areas at zero or low cost and spurring rural exodus as part of a more general process – analyzed for example by Mike Davis in *Planet of Slums* – through which more than one billion people have migrated to urban areas. The people who remain behind tend to suffer from precarious working conditions and find themselves bereft of their former cultural sites as well as memories. Those most severely impacted by both ITP and STP expansion are poor rural women who are frequently not even smallholders.

Most worryingly, according to researchers, the conversion of land to TPs is irreversible, e.g. in Uruguay (Carámbula *et al.* 2011) and Chile (Nahuelhual *et al.* 2012). In Chile, the conversion to plantation forestry is absolute and irreversible: once established corporate areas are required to permanently remain under plantation forestry by Chile's law DL 701 (Nahuelhual *et al.* 2012). In Uruguay, the government has given very strict investor guarantees to foreign companies such as Stora Enso, assuring that they will receive land for establishing a sufficient number of plantations for the needs of their pulp mill investment (Bacchetta 2012). These North-South enclosures ensure the export of cheap commodities.

On the other hand, governments feel they need to boost export-based commodity production to join the global economy. For example, the government officials of Laos have started to give more large-scale land concessions to companies after the 2000s neoliberal period. In some cases peasant land has been bulldozed at night without warning: most forest and perennial cropland is transformed into plantation land very quickly, even in one night.

In Brazil, people displaced by these activities have formed camps and started to work as wage workers for the plantations; while in Laos, companies have in-built planning for such camps on future plantations, to get access to and control cheap labor close to land. Indigenous people living in forests have had to shift from an economy where they produce 90% of their own food and buy only 10%, to an economy in which they must buy 90% of their own food and can gather only 10%. This has led to a violent process of proletarianization, in which land is turned into capital and people into labor, according to Baird (2011).

The jobs offered by TP expansion depend on the TP investment type. If the trees are destined for large-scale pulp mills, jobs have been more precarious and temporary than in construction-wood destined forestry areas, studies in Brazil (Gonçalves 2001) and Uruguay (Carámbula and Piñeiro, no date) suggest. The literature on relations (including conflict) between TP owners and labor, larger than the scholarship on TP-peasant conflicts (Gerber and Veuthey 2010), would require a review of its own, being away from the focus of this review on expansion dynamics. Such comparative studies are in the pipeline, for example by the research group comparing forestry workers' unions in Uruguay, Chile, Brazil, Finland and Canada, among other countries, led by professors Ron Harpelle, Diego Piñeiro and Thomas Dunk. Such studies are an essential accompaniment to the current expansion's many negative

impacts, such as the cutting of autonomy and power from ITP-critical trade unions, as happened in Brazil when Aracruz and Votorantim were merged to form Fibría (Kröger 2012b).

In some cases, for example in Southeast Asia, plantation companies have not even wanted the peasants they have expelled to become their workers: instead, they have imported laborers they see as more fit for plantation work (Kenney-Lazar 2011). In most cases, possible compensation for land loss has been paid only if dispossessed groups have mobilized, as a retroactive way to smooth the resentment, and not as an a priori strategy to try to peacefully remove people from their lands.

Market mechanisms of land access and their developmental consequences

Today, with overt violence discouraged in most political systems, companies have had to resort to a variety of market mechanisms and state negotiations to ensure land access: purchases, concessions, leases, outgrower schemes, partnership, or theft. The developmental consequences of leasing land from the government have been problematic: in the Mekong region, for example, ‘concessions have frequently been granted at the cost of the livelihoods of the poor, sometimes leading to greater impoverishment’ (Barney 2007). It might sometimes be possible for current landholders to demand non-exploitative terms, but, this is likely to happen only later.

The institutional arrangements for dealing with the rapid pace of plantation expansion have remained very inadequate even in a country such as Australia (Mercer and Underwood 2002). Given the demand, ITPs have been given concessions so fast that few state institutions can monitor or regulate them. For example, in Laos the ‘exponential growth of the granting of land concessions’ has led to the feeling that the government has ‘lost control of the process’ (Hanssen 2007).

Thus, the conditions under which pulp plantations may complement, rather than threaten livelihoods of local communities are extremely limited, argue Pirard and Mayer (2009) in a study of Indonesia. They claim that at least one fifth of land should be left to intensified local agriculture and agroforestry instead of plantations. Company operations should be carried over with care and constant consultation with impacted populations, not too hastily and uncarefully. Priority should be given to local employment. The minimum conditions should also include careful determination of plantation sites and more transparent government licensing of plantation concessions and pulp mills recognizing local and customary rights (ibid). The abovementioned minimum conditions Pirard and Mayer (2009) find essential for ITPs and large-scale pulpwood TPs to support local livelihoods are very tight, in fact, so tight that it might be impossible to fulfill them by ITPs. Thereafter, some have argued for a need to turn more massively away from corporate monocultures and towards small-scale tree plantations that would ideally be controlled by and based on family forestry.

Smallholder versus industrial tree plantations

This section discusses the smallholder-industrial tree plantation differences in different agrarian dynamics. In some contexts STPs are the main route of TP expansion, in other contexts it is ITPs. In Thailand, strong government policies and a land tenure system that supports smallholders and bans corporate plantations are in existence because of resistance movements in the 1980s. Thus, contract eucalyptus farming on smallholders’ lands has come to be the mainstay of fiber provision for Thailand’s pulp industry (Boulayand Tacconi 2012). Pulp mills are small in Thailand and there is real competition between them to secure fiber.

Barney (2004) notes that about 65% of all eucalyptus in Thailand is cultivated by smallholders (over 30,000 households, with on average 5-8 ha plantations), with some companies such as Phoenix Pulp and Paper buying 100 percent of their fiber from local outgrowers. Establishment of large-scale corporate eucalyptus plantations has been made impossible in Thailand with the resistance against eucalyptus based also on environmental reasoning (Puntasen *et al.* 1992). However, smallholders are currently increasingly interested in planting eucalyptus as a cash crop (Boulay and Tacconi 2012).

Tree planting may therefore also promise benefits to smallholders, besides the elites and corporations, although potentially it would undermine livelihood security (Barr and Sayer 2012) as subsistence food cultivation areas would turn into timber production. The potential is seen in smallholder TPs whose plantations do not present a harmful rent-base for the elites. Leys and Vanclay (2010) see potential in STPs if undertaken by people themselves, for example by forming cooperatives able to influence decision-making, particularly regarding sale prices. The bargaining power of smallholders in Thailand was very good, according to Barney (2004), but this was largely due to the impossibility of expanding corporate plantations and the creation of a competitive cash crop market for eucalyptus. This suggests the promoters of ITPs and STPs are in a zero-sum game over producing smallholder or corporate-benefiting agrarian structures.

Failures of STP schemes are common, illustrated for example by Barney's (2008) discussion of the failed attempt to transform subsistence-oriented peasants into smallholder arboreal entrepreneurs in Laos. Stable institutions, secure tenure and enabling policies are necessary preconditions for STPs to even potentially improve livelihoods, argue Kassa *et al.* (2011), in a detailed study of Ethiopia. Smallholders are typically in an unfavorable bargaining position, not being well enough informed about wood markets or about the growth of their wood stock, even in Vietnam, which is considered a relative STP 'success-story' (Schnell *et al.* 2012). The grand STP program of Indonesia has failed dramatically (Obidzinski and Dermawan 2010). Government policies led to financial unfeasibility of community and smallholder tree plantation activities.

Failures in livelihood provision are linked to environmental degradation, which has taken place also in the 'success' context of Vietnam (McElwee 2009). In most cases the environment suffers because of TPs even though smallholders would gain economically. McElwee (2009) argues that the Vietnamese STP program focused on establishing tree plantations rather than supporting natural regeneration, which explains why important sources of non-timber forest products have been replaced with monocrop exotic TPs. The most vulnerable populations have been negatively impacted, even though some other smallholders would have gained from the conversion of supposedly 'bare' hills composed of shrubs, into tree plantations. McElwee argues that exotic tree plantations targeting individual households in Vietnam have supplied often only low-quality and low-value timber and fuelwood, and suggests that natural regeneration targeting villages would be a better forest policy by supplying a diversity of forest products. STPs targeted at the poor in Vietnam have often disadvantaged the poorest as these developmental schemes have been embedded in unequal local power and economic relations (Sikor and Nguyen 2007), although the situation might have improved in recent years (Sikor 2012).

Even the smallholder tenure TPs that improve smallholders' rights have their problems. In some places with predominant national smallholder-policy 'success', such as Vietnam, the livelihoods of those not earning tenure have actually been damaged by smallholder tenure as they have become even more poor or marginalized (Barr and Sayer 2012). Most problematically, as plantation forestry is dominated by forest industry power, the majority of

smallholder farmers seeking buyers or contracts for selling their plantation wood face a negotiating opponent whose strength and self-interest far outstrips that of families, leaving these typically with highly unfavorable terms, or worse, timber flows accompanied by coercion. In some political economic-settings, it is better for one's livelihood and quality of life to be a subsistence farmer not whose production is not overtly tied to commodity markets.

In any case, in general more safety measures are needed for ITP timber markets to work for development. Cossalter and Barr (2005) argue that the lack of mechanisms ensuring mutual accountability typically leaves smallholders or other outgrowers in a very disadvantaged position. For example, in Brazil, pulp companies have tried, with some success particularly where social movements or progressive state actors do not provide smallholder-support, to infiltrate and persuade agrarian reform settlers to plant eucalyptus in contravention of the law (Kröger 2011). Outgrower schemes have also created a class of wealthy middle-farmers sidelining with companies and criticizing the resistance against ITP expansion (Kröger and Nylund 2012). Such outgrower expansion is currently becoming a main ITP-expansion tactic as conflicts and land prices are booming.

For these reasons - as most political contexts in the global South are dominated by pro-ITP government-industry alliances and protected only in a limited way if at all by progressive state actor-social movement agency - most smallholder and other plantation forestry schemes endowed with developmental expectations will continue to create future resentment. In any case, environmental concerns of TPs are sidelined in these development-debates.

Environmental impacts

The environmental impacts of TP expansion have been studied extensively in peer-review journal articles. Tree plantations typically cause severe damage to the soil, water flows and ecosystems (Jackson *et al.* 2005). TPs have a higher water use compared to pastures and agricultural crops, which is a main reason for local grievances by farmers (Stewart *et al.* 2011). Water usage by eucalyptus is dramatic and environmentally dangerous particularly in plantations set in prior pasture or agriculture areas and managed under large-scale cutting practices (Jackson *et al.* 2005, Stape *et al.* 2008, Jobbágy *et al.* 2012). Pine plantations increase evapotranspiration and decrease streamflow; pines are also invasive, impacting negatively on surface water runoff, grazing resources and biodiversity, and exacerbating the problem of wildfires (van Wilgen and Richardson 2012). The greatest possibility of negative trade-off between tree plantations and reduced water yields is in regions where water resources are threatened by climate change (Calder *et al.* 2007). Water use and pollution are the key concern of impacted populations both in the South and the Global North, such as in Tasmania (Flaten 2011). Tree plantations reduce average streamflow and groundwater recharge, but may also have some minor environmental planning benefits in some environments (van Dijk and Keenan 2007). Yet, commonly; no corporation or state research institution systematically monitors the impact of tree plantation expansion.

Forest destruction and loss of unique biodiversity (including also natural grasslands) has accompanied expansion (Nosetto *et al.* 2008, 1, Little *et al.* 2009, 162). According to Nahuelhual *et al.* (2012), TP expansion, for example in Chile, has been a direct cause of deforestation and biodiversity loss. The biodiversity loss experienced by the conversion of shrubs to TPs applies across the globe, also in Global North contexts like New Zealand (Nagashima *et al.* 2002).

Government forest policies linked directly with land tenure security have had tremendous impact on changes in forestland cover. In Brazil, primary forest clearance was a sign of

productive use of land, which gave stronger tenure rights and led to massive deforestation by both large and small-scale actors (Puppim de Oliveira 2008). ITPs were established on these prior primary forestlands, as they were a sign of productive land use for the National Institute of Colonization and Agrarian Reform. The new Forest Code approved in 2012 allows for the consideration of the conversion of ‘degraded forest’ (which might be primary forest) or recently logged primary or secondary forest into a tree plantation such as pulpwood eucalyptus as reforestation. This change in the legislative setting will drive further TP expansion in Brazil, as plantations are associated not only with stronger land control and ownership rights, but also with ‘green development’ –according to the official view - within the new ‘bio-economy’. On the other hand, in China, under the Sloping Land Conversion Program, farmers were offered long-term property rights on areas in which they planted trees (Barr and Sayer 2012), to give environmental benefits such as flood control. Both in China (Grossjean and Kontoleon 2009) and in Brazil (Puppim de Oliveira 2008) increased tenure and land use control rights were the most important factor leading to conversion, planting or maintenance of land cover.

Some tree plantations might also give some benefits. Land tenure of plantations is seen in the literature as making a difference. Smallholder and communal forestry are seen as better solutions than state or corporate forestry. However, according to Palo and Lehto (2012), both of the ‘social’, public forms of forest land tenure (communal and state control) are more problematic than private smallholder ownership (particularly semi-natural) forests, because in state-owned forests (and TPs) administrative orders typically force stumpage prices under the respective market prices, leading to deforestation or overuse. Higher stumpage prices would naturally benefit smallholders, but not necessarily the environment if TPs were to replace high-biodiversity areas or cause soil and stream flow damages.

The genetic variety in trees as well as other species is vanishing rapidly with the drive to establish TP monocultures. Exotic tree species, particularly numerous pine species, are often invasive aliens from plantations into nearby nature: the sustained functioning and the provision of important ecosystem services of conservation or water production areas have been mostly negatively impacted (Richardson 2008). Most impacts are detrimental to the invaded systems and threaten sustained functioning and the provision of important ecosystem services. The invasive spread of alien trees from plantations into adjoining areas of natural vegetation has meant that the negative effects are being felt in areas set aside for conservation or water production (ibid).

Corporations prefer exotic species monocultures, introduced species being thus related to agrarian structures. Public and smallholder plantation ownership correlates with a lower percentage of exotic species-TPs. For example, India with 70 percent public ownership had only 13 percent of exotic plantations (FAO 2010), but in Chile with 70 percent corporate ownership (Del Lungo *et al.* 2006), 100 percent of plantations were exotic (FAO 2010). These points suggest that agrarian political economy explains also a large part of the environmental impacts of TPs.

Concluding remarks

This article has reviewed the existing academic literature, NGO reports and other research material and information available on tree plantation expansion around the world. There’s a much larger academic literature on tree plantations in Southeast Asia than in South America or other regions such as Africa currently experiencing even more ITP expansion than Asia. In

all regions, TP expansion, environmental impacts and developmental consequences have been studied much more than TP conflict dynamics.

The TP expansion has been mostly a corporate-driven process. State-industry-civil society interaction has determined investment locations. Corporate land control is central for expanding ITPs. To ensure this, class- and socio-ecological relations have had to be modified. North-South enclosures of land have accompanied most expansion, securing cheap timber commodity flow to the North. Developmental and environmental consequences of these expansion mechanisms have been dire. STPs and ITPs are in a zero-sum game over molding agrarian political economic structures such as land tenure systems and local timber markets.

Agrarian structures and state-industry-resistance relations are key to explaining whether and what type (smallholder or industrial) of TPs are established. Fast-growth trees expand by smallholder tree plantations where significant agrarian reform has taken place and scattered family-based ownership is maintained (such as Finland), or where reform is taking place, for example by a combination of direct action land reform and supportive state policies blocking the intrusion of powerful corporations (such as in Thailand and Vietnam). Industrial tree plantations boom in places where corporate land access is eased by the retained rural existence of colonial plantation economies and/or land-holding elites, such as Brazil. ITPs have also boomed in settings with state interference/paramilitary violence supporting key forestry capitalists, such as in Indonesia and Chile.

The tendency in all TPs is to use ever more fast-growing trees in shorter cycles. Many existing pine plantations, for example, which have a relatively slow rotation, are being converted to faster hybrid, cloned or genetically modified eucalyptus variants, better adapted to cold. This development and global warming open up previously unsuitable lands for ITP expansion – and potentially resistance following them. The same TPs can be used in ever more numerous ways, including as pulpwood, energywood, or as ‘carbon sinks’, and the processing plants of plantationwood such as modern pulp mills can become important energy producers. The rapidly changing global economy and nature require flexibility and rapid adaptability: thus flex tree plantations have inbuilt survival skills as they increase the range of possible timber uses. They will continue to expand, forming entire landscapes of phony forests of single species.

As non-food land use changes, TP establishment should be integrated more fully into the debate on land grabbing. TPs should be studied by both agrarian political economy and by forest sciences, including forest policy and conflict studies, as well as by any other industry-specific literature to understand the supply chains in which TP-timber is used. Such cross reading of literature is greatly helpful for social scientific environmental research as it allows more comprehensive explanation. The review suggests that even though there is a need for many more studies to accompany the ever more rapid expansion, we already have a growing, and empirically and theoretically rigorous literature on which future studies on tree plantations can be built.

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