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INTRODUCTION

The cultivation of crops that can be flexibly used for multiple purposes has been a growing trend in recent decades. This change is accelerating as new uses are found, developed and established for crops that are conventionally used for other purposes (Borras et al. 2012). For instance, a growing proportion of palm oil is now used for biodiesel and other energy purposes, rather than simply in the food industry (Overbeek et al. 2012), and sugarcane is increasingly used to provide ethanol alcohol fuel for cars. Although these crops have long been used to provide both food and energy, their non-food usage began to increase significantly in certain regions of the world in response to the crisis faced by petro-chemical agriculture. Brazil, for example, started a national ethanol policy in the 1970s in response to the global oil crises. Later, in the 2000s, in response to changes in global energy markets and a growing demand for non-fossil fuels in the so-called green economy, multinationals producing palm-oil biodiesel began to emerge. The sugarcane, maize, soybean and palm-oil sectors have been extensively analysed, and some studies have examined the political and economic changes brought about by these flex-crop commodity markets (e.g. Borras et al. 2012; Overbeek et al. 2012). One central transformation, emphasised by agrarian political economists studying land-use changes, has been a massive worldwide expansion in plantations for agrofuel or food, a phenomenon linked to land grabbing. For example, Borras et al. (2012) found that in Latin America and the Caribbean, the (re-) concentration of land and capital occurred in two broad sectors: flex-crops (producing crops that could be used for food as well as other purposes, such as energy), and the non-food sector. In this primer, I illustrate the central political economy issues related to the emergence of a third, far less studied, and in some ways more novel phenomenon: the rise of flexible and multiple-use tree and forest commodities.

History has demonstrated that crisis creates and boosts flexing and, over time, trees have been used for many purposes that typically increase in times of crisis when alternatives are needed to food staples. Wood commodities have even been used as food – in Finland, pine sap was used as a substitute for wheat flour during the Second World War, for instance. Flexibility affords a return to former uses, while new choices represent a type of windfall or extra potential. Such historical examples tell us that while such flexing often does not last, some modes of increasing the flexibility and multiplicity of commodity uses do survive. This makes it important to distinguish between lasting and temporary solutions. But this is hard to do in the context of crisis, since it cannot be known in advance how long it will last, whether it is the start of a new more permanent era (with new realities), or whether innovations are merely stop gaps – as with the example of pine sap substituting for wheat flour. Certainly, we are currently facing multiple global crises, which seem both lasting (Gills 2010) and to defy easy solutions; indeed, both the intensity of flexing, and the unpredictability of its consequences, have increased. Crisis also leads to a growth in speculation, and the risk of price bubbles and outright scams based on exaggerated technological promises. It is essential to try to sift out the real changes from opportunistic propaganda, advertising and greenwash.

Current flexing in the forestry industry is taking place on two fronts: new uses are being found for traditional wood materials, and new tree species are being created which are themselves more flexible, the latter taking place, for example, via the genetic manipulation of trees to better serve both pulp and energy-making purposes. New uses are also being found for the by-products of core processes. For instance, pulping by-products can be converted to second-generation (i.e. non-food-based) biodiesel to be sold for transport uses rather than being discarded or burned off to provide energy for pulp mills. The “secondary” or residual uses can eventually become the main product and the previous main product a residual, as flexing and multiple-use capabilities are extended along with the necessary infrastructure and technology. Markets, price, subsidies, policy, supply and environmental changes all provide incentives for this.

FROM THE PETROCHEMICAL ERA BACK TO A GREEN ECONOMY?

Trees were the first and primary fuel for humankind, and roughly half of the entire world's timber continues to be used for energy (Dauvergne and Lister 2011), mainly for household firewood (52% of global wood consumption). This figure dropped dramatically with the advance of early industrialisation, which introduced the use of coal, and the second industrial revolution, which created the petrochemical era (Moore 2000). Oil and gas largely replaced wood for energy needs and the resulting oil industry became the planet's most powerful political and economic industrial sector (Mitchell 2009). Other modern technologies such as nuclear energy have also lessened the need for timber fuel. Meanwhile, paper consumption was increasing alongside modernisation and development, and a global paper industry was created.

Now, at the start of the third millennium, when it has become clear that non-renewable resources including oil and uranium are being depleted, two mega-trends dictate land-use politics. First, there is a race for the remaining non-renewables, dominated by multinationals, oligarchs and powerful governments (Klare 2012). Second, there is a simultaneous turn towards a so-called green or bio economy, where renewable resources, increasingly cultivated on mono-plantations, are seen as the solution to the depletion of resources and global climate disruption. The dramatic global expansion of tree plantations is linked closely to the latter phenomenon (Kröger 2014). Those who get to the land markets first, securing massive areas for present or future cultivation of (flex) crops or trees, will be the future winners because, when non-renewables have been exhausted, those who rule the soil will become kings. Currently we are in the early phase of this major historical shift in the processes and politics of natural resource extraction.

The focus here will be on the industrial forestry sector. I will illustrate the key new uses of timber that the industry is proposing and developing in order to outline how political and economic dynamics are being changed by tree flexing. Forestry may offer the possibility to shift world development back towards the time when forests were the primary source of energy. What this new green economy will look like will be strongly shaped by the ways in which trees become flex and multiple-use commodities.

WHAT ARE FLEX AND MULTIPLE-USE TREES?

Flex trees are the commodity consequence of merging inter-industry interests in the emerging green economy. Biomass in the same plantations can be used for pulp or energy, with pulp prices largely determining the use of biomass until the end of 1990s (Fearnside 1998). Energy and other timber uses have since become more prominent, although pulp continues to be important. Pulp prices have soared in the past 15 years, and consequently there is a boom in mill construction. For example, in Brazil one 1.5 mega-ton pulp mill is projected to open each year until 2020. Companies and governments are now setting up very fast-growth (two-year rotation) plantations in the global South to export pellets to the expanding wood-energy markets and plants in the North; new pulp mills are becoming increasingly salient electricity producers at the local level (*Valor Econômico* 2012); and wood-based, second-generation biodiesel plants are also being set up, reflecting high hopes in the industry that wood-based fuel could become the next oil. The first wood bio-refineries in Finland will start production in 2014; carbon-sequestering plantations may serve in the REDD+ schemes; and polluting industries and consumers such as air travellers are seeking to buy carbon credits or offset impacts by crediting tree plantation. A myriad GM and nanotechnology applications are being developed based on the capitalisation of specially engineered trees. New industrial uses based on new technologies are being developed for wood, particularly in the construction and durable material sectors, where the wood-based revolution is ongoing and expected to continue. Examples of this latter trend include extremely durable wood-based construction materials used in the 3-D printing of wooden houses, and for extra-hygienic wooden surfaces (Linturi et al. 2013). A group of Finnish universities and companies, including UPM (a Finnish timber, paper, pulp and energy corporation created by the merging of Kymmene, Repola and United Paper Mills in 1996), has also produced the world's first high-safety, mass-produced car, made entirely from wood, and weighing 15% less than its conventional counterparts. Furthermore, the vehicle is compatible with UPM's biodiesel fuel, meaning that it could represent a fully forest-sourced product (Nikula 2014). Technology development, particularly in relation to machinery, 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" such as those in Brazil are gaining a strong foothold. Tree plantations are becoming flex-tree plantations (FTPs), a "renewable" capitalist response to the depletion of non-renewable resources.

It is likely that these strands will be woven together even more tightly in a global flex-forestry cluster, which will in turn lead to its further expansion. The battle to become the most efficient bioenergy source will be tough, however, and wood is not the preferred candidate to win this contest. Nonetheless, subsidies and the politics of securing national and local energy sovereignty, together with self-interest-based pressure on the part of forest and associated machinery industries, ensure that wood will be a major commodity in future energy and other markets. Yet the degree of renewability will still depend on soil quality, water availability and other environmental impacts of FTPs.

POLITICAL LIMITS TO FLEXING: NEW CONFLICT POTENTIAL

A central reason behind the rise of FTPs is the endless pursuit of accumulation that is inherent in capitalism. Through flex trees and crops, global industries will simultaneously reap the benefits of both capitalisation and material-expansion accumulation (Kröger 2013a). When "wild" natural spaces start to become exhausted, as has happened, flex crops and species arise, forming "new natures" (for the conceptualisation of wild, new and other natures, see Hecht 2011); nature is moulded by science to ensure it does not limit growth. Limits to flex accumulation are still set by both politics and nature, however, although several government policies and inter-capitalist changes have boosted the new era of flexing. The 2008 EU Renewable Energy Directive, with its binding targets and subsidies for use of non-fossil liquid fuels by member states, has contributed to a boom in industrial-scale bioenergy, putting pressure on land and leading to dramatic conflicts and problems in the least regulated production areas of the global South. Most of the negative consequences of wood-based bioenergy are still to come, but soils are already being depleted more rapidly where stumps and other forest residuals such as limbs and branches – forest biomass – are being harvested in order to generate heating and electricity in dramatically expanding wood-chip power plants.

The bioenergy boom has enticed powerful new players, such as oil and other energy companies, into the forestry and tree plantation business. Industrial tree plantation (ITP) firms are also playing the carbon markets through ITP "carbon sinks". In addition, they are increasingly involved in the growing trend of financial speculation in natural resources, in which flex trees offer progressively complex tools for creating new "products" for both the financial and material markets. The question that arises is how to calculate the value of a derivative financial product whose future yields may be much higher and risks more widely spread than existing paper, pulp, timber and energy price-based calculations assume.

Flexing is not necessarily limited to increasing the number of outlets to which wood can be sold; rather, it goes deep into the heart of what trees are, drastically changing nature. Genetic manipulation is one contested aspect, promoted by both Northern and Southern companies attempting to increase their control over populations and territories by patenting trees. Markets will be shaped by the public response to it, while environmentalists will be divided between technical solutions emphasising climate-change mitigation via carbon storage (where social justice and soil and water contamination and depletion are secondary priorities), and an emphasis on socio-environmental justice and agro-ecological development (where climate mitigation is a secondary priority). One example of this cleavage between climate and agrarian environmentalists is swidden (slash and burn) agriculture: the former reject this form of farming because of its emissions, while the latter emphasise its importance for indigenous and traditional populations in maintaining their agro-ecological livelihoods. This divide is already being illustrated in development aid and other policy debates concerning the allocation of finance.

FLEX-TREE PLANTATIONS

Timber products are still mostly extracted from natural or modified natural forests, but the share of plantations is increasing fast. In 2001 plantations provided some 35% of globally harvested wood (UNEP 2012).[1] In both natural forest and plantations, we are witnessing the emergence of new flex trees providing the raw materials not only for paper pulp but also for global energy, biomass and carbon-credit markets. Most flex commodities are cultivated in agribusiness plantations, and the same is true for flex-tree plantations (FTPs), which are mostly grown in large-scale monoculture estates controlled by corporations or, in some settings, by smallholders of smaller tree plantations, but not in primary forests. Flex trees are primarily a capitalist development, serving the need to reduce the risk of falling profits by opening up a multitude of different purposes and markets for timber products. If pulp prices drop, the holder of a timber stand can still sell the wood to an energy pellet factory – perhaps its own factory in the case of a multinational paper company such as Suzano in Brazil. Or it can opt to fell no trees for a fixed period of time, selling the accumulating carbon-sequestration potential in carbon markets to steel mills on the other side of the world, for example, that calculate that it makes more business sense to buy pollution rights rather than to reduce emissions. The FTP holder may in fact be the steel company itself, such companies being increasingly forced to "mitigate" a part of their emissions by planting millions of trees, as was the case in the political upheaval following the recent establishment of a contentious steel mill in Rio de Janeiro by Thyssenkrupp and Vale, aimed at producing 5 million tons per year (*O Globo* 2009).

Specialising in order to produce specifically engineered tree species for particular pulp quality demands, using methods such as changing the lignin structure, is becoming a thing of the past. The industry is now seeking to develop species that are adaptable to flexible usage. In fact, tree plantations with a rotation of two to ten years, constantly reducing, may be swiftly and easily logged and replaced by a species more suitable for the new market setting. Thus a stand of trees can be trucked for pulping, generating chemical by-products that offer energy from new mills producing one to two megatons of pulp per year, basically transforming them into pulp and energy plants (they were already producing their own energy in the pulping process by 2005). The area liberated is then planted with another set of trees, specially designed to meet a particular purpose, such as pellets. In addition to this rapid rotation, new FTPs are also starting to cultivate multiple-use species. What does this mean?

Figure 1 Overview of tree-flexing and multiple-use pathways, actors and dynamics

Main pathways of flexing and multiple-use increase	Wood-based Energy		"Carbon sinks"	Flexing tree species (GM trees etc.)	Paper, cardboard and other timber products replacing fossil fuels
Sub-pathways of flexing and multiple use-increase	Biofuels	Electricity and heating			
Key products	Second-generation wood-based biodiesel, ethanol and gas	Wood-chips and pellets	Carbon credits (e.g. REDD, CDM schemes); carbon storage	More adaptable, productive or flexible-use tree species	New construction materials (e.g. wood-plastic composites); indus-trial materials (e.g. cross-laminated timber); bio-plastics; pulp-based textiles replacing polyester; biochemicals in medicines, paints, foods.
Examples of some key forestry companies	UPM and Fibria (wood-fuels), Metsä-Fibre (wood-gas)	Suzano (pellets)	Plantar (CDM)	Suzano (GM and hybrid trees)	UPM, Stora Enso
Inter-industry merging with (and examples of companies linking up), and new players	Chevron, Shell, Fortum (energy), Metso (machinery), Envergent Technol-ogies (oil technology), UOP Honeywell (detergent technol-ogy), Ensyn (energy and chemicals), BillerudKorsnäs (packaging)	Coal and other power plants	Steel industry (TP emission-compensation schemes, charcoal production)	Glyphosate and fertiliser-producers, GM companies	Construction industry, automobile industry, textile producers
Risks, possible problems and conflicts	Too large amount of wood ends up used as transport diesel, ethanol or gas, rather than more value-adding uses (e.g. bio-plastics, paint production)	Stumps and other harvest residuals stripped from forests; intensifying wood collection leads to loss of biodiversity and carbon sinks	Fires, wood carbon ending in non-durable products, soil and water balance damaged, land taken from food production and other uses, biodiversity losses, increased harvesting, calculation errors	Ends up supporting monoculture tree plan-tation or problematic GM-tree expansion; flex tree may be engineered to use more water and nutrients, grow faster, and expand to areas where they displace food production or native biomes	Conflict with non-renewable industries (cement, chemical, oil, plastic and metal producers); conflict with those wanting to use trees for energy, carbon storage and conventional paper products.
Possibilities	Better energy self-sufficiency in some regions; replacement of carbon fuels and first-generation biofuels		Forests store carbon emissions while providing food and serving other purposes	Hybrids yielding higher productivity, better quality, being more adaptable	Replacing polluting or more harmful products (e.g. met-als, cement, plastic, food additives)

On the political front, FTPs are potentially facing more opinion-changing resistance than the already conflict-ridden "traditional" TPs, affecting new and different stakeholders, operating in different industrial systems and supply chains, and raising different grievances. It is worth exploring these new potential risks, as such discussions illustrate that flexibility does not necessarily ensure only greater security of return flows for companies, nor development in its broad sense, but also entails greater risks to the industry.

WOOD-BASED ENERGY

Bio-refineries

Oil and paper companies are working together to develop second-generation (non-food-based) fuels derived from wood. While the initial combination of wood and processing will be undertaken by the paper and pulp industry, oil companies will control further processing and distribution of the fuels and other intermediate products. The first pilot plants will be ready in

2014-15, and be concentrated in Finland (Uronen 2010): these include the UPM (old paper company) plant in Lappeenranta, the Fortum (old energy company) plant in Joensuu and the Green Fuel Nordic (a new wood bio-oil company) plant in Iisalmi. These companies, along with three others –Metso, the world's leading producer of pulping machinery; Envergent Technologies, a joint venture of UOP Honeywell and Ensyn[2]; and BillerudKorsnäs, the world's leading manufacturer of fibre-based packaging material – call themselves a "fast pyrolysis bio-oil consortium" and jointly applied for the costly EU REACH registration, which was awarded for their pyrolysis bio-oils in December 2013 (http://www.greenfuelnordic.fi/en/page/23?newsitem=31). Four of these companies are Finnish, one American and one Swedish; four are primarily forestry-based while two are oil-based companies.

This collaboration is one example of a shift in research and development (R&D) in the paper industry towards more value-added products: biomass-based fuels, together with various nanotechnology applications, are considered to add more value to raw wood than pulp or even paper. Pioneering technology is being developed, for example, in Finland, where UPM, the world's third-largest paper producer, is building a wood biodiesel refinery in Lappeenranta near the Russian border. The refinery works in roughly the same way as a traditional oil refinery, but uses wood-based tall oil, a side-product of pulp manufacturing, as its crude. The company director has argued in media interviews that the company has used no public money or subsidies on the project, and anticipates high profitability and the expansion of wood biodiesel to a 6€ billion business. The wood for the mill complex comes mostly from Finland and Russia; if successful, there will certainly be a rise in the use of timber. In fact, the new technology has already started to spread: the European Commission has awarded UPM a grant of 170€ million to build a solid wood-based bio-refinery in France, to be based in Strasbourg. While the pilot project was based on finding multiple uses for a residual that already had a commercial use (the tall oil is sold for the chemical industry paint makers as harts – the companies relying on this supply are unhappy about having to compete for an essential material for which they have no alternative source), the subsequent investments can tap directly into even more clearly non-residual materials, such as bark and wood chips made from stumps (useful also when left after harvesting in order to improve soil fertility and store carbon in the soil).

Each new biodiesel plant now under construction will provide about 100,000–200,000 tons, requiring 0.8-2 million m^3 of wood, peat or other biomass for the process (Jokinen et al. 2011). Jokinen et al. (2011) foresee the construction of many more biodiesel plants as they become less dependent on EU subsidies (once markets have been created), noting that this will of course also depend on the availability of wood. The latter is the biggest issue as there is not enough woody biomass to substantially replace current energy requirements with fuel derived from trees. Kuusi (2010) argues, therefore, that forests are not of global importance for the production of biofuels.

Furthermore, other products such as algae and sugarcane are much better fuel sources and are more competitive than wood-based fuels. But at the local level, in Finland for example, wood-based fuels will play a role, particularly when the fuel is produced not by flexing but as a multipurpose means to exploit pulping residual. Some other studies (e.g. Zhang et al. 2014) have also argued that the demand for woody cellulosic ethanol will increase substantially in the coming 30 years, stimulated largely by the rising cost of gasoline.

It is hard to make any global prognosis, as the markets for car fuel are likely to be confusing for some years to come, with many alternatives (ethanol, methanol, biodiesel, biogas, electricity, hybrid etc.) competing – only time will tell which of these will dominate (Jokinen et al. 2011). At present it seems that biodiesel is more competitive than ethanol in some important markets, as it can be blended in any ratio in normal diesel-distribution systems, without the need for flex-motors or new pumps, in contrast to ethanol, gas, or electricity. This may give a competitive edge to the forest industry as a provider for fuel-selling companies compared to non-tree-based producers. However, woody cellulosic ethanol is also expected to become a major source of a replacement to gasoline as the price of gasoline rises, for example in the USA (Zhang et al. 2014): forests may well prove to become a tough competitor to other flex biofuel crops.

Electricity and heating

Wood is also expected to become an increasingly important source of energy and heating. Over half of woody biomass worldwide is currently used for energy. In Finland, for example, wood accounted for about 24% of all energy consumption in 2012 (oil was responsible also for 24%, followed by nuclear energy in third place with an 18% share): most of the wood consumption was for industrial use (e.g. for heating pulp plants) (Metsäteollisuus 2013). Massive infrastructure construction is currently underway for the burning of biomass in Europe, the USA and other countries (Lander 2012). Since 2000, global wood-pellet consumption has increased dramatically, following the aim to replace oil heating. Europe dominates the sector: in 2010, 85% of global consumption was in the EU, following its biofuel policy incentives (Goh et al. 2013). The expansion of the market for wood pellets is, however, limited as boilers are expensive and it is often easier to burn bark or other wood products (e.g. in Finland). The pellet- and wood chip-energy markets are now differentiating: the UK, Denmark and the Netherlands are examples of countries where the use of wood pellets has increased, while Finland and Sweden are examples of the increased use of wood chips. Pellets can be more easily exported, while chips should be gathered within 150–200 km of power plants, making them feasible only in forested areas. The high hopes of increasing pellet exports have not fully materialised, and many of the firms that entered this business, e.g. in Finland, have had to abandon exporting as markets have not opened up as fast as expected. The stricter EU policies on wood procurement is one explanation for the slowdown in some countries' exporting operations. But there are also many other reasons, including, according to my interviews with industry representatives, that the Finnish exporters could not compete on the international market. Thus, many investments in pellet-production have been cancelled and funds channelled to other flex-wood operations, e.g. bio-refineries or pulping.

The expansion in wood-based heating continues its rapid expansion, following fluctuations in oil price and availability, with expansion focused on EU countries and to lesser extent East Asia. For example, biomass (mostly woodchip) electricity and other projects in the UK will increase the consumption of dry biomass to 50–60 million tons a year, while the UK produces only 8–9 million tons. According to the FAO, by 2020 Europe will suffer a dramatic shortage of wood, which will further increase dependency on imported natural resources. Biomass often comes, and will continue to come, from conflict-affected or problematic sites. For example, MagForest, a Canadian company operating in the Republic of Congo, will soon be shipping 500,000 tons of wood chips annually to Europe. Some NGOs have criticised these developments. For example, according to Guadalupe Rodríguez (2011) from the NGO Rettet den Regenwald, and other NGOs working in collaboration with the World Rainforest Movement (WRM), the use of biomass is moving far away from truly sustainable solutions, such as energy efficiency. She demands outright resistance to the new bio-economy in all its forms, and NGOs are forming new networks to take on the task, with the WRM playing a key role, as the greatest danger comes from a push towards the expansion of tree plantations via an increase in the use of wood-based energy.

Wood-energy projects are likely to contribute to conflicts. One such example is a scheme by Vattenfall, a Swedish energy company, to buy wood chips from old rubber tree plantations (the world's largest, comprising 260,000 hectares) established by Bridgestone-Firestone in Liberia. Although Liberia itself is in dire need of energy, the chips are being exported to Berlin to feed the growing demand for 'greener' energy (Schenck 2011). Risks abound: "Local NGOs and the UN report on catastrophic labor and social conditions on the plantations, especially on Bridgestone-Firestone: child labour, violence and the general absence of law" (SAMFU 2008).3 There are also other major wood-heating projects underway. The key risk and conflict potential in these is the conversion of woody biomass too intensively into low-value-adding chips and pellets in a way that harms either local social equity (if wood for energy is exported from regions lacking food or energy) or environmental balance (if stumps, branches and all other harvest "residuals" are collected and not left on the ground), or both.

Policies boosting wood-energy expansion

The proportion of wood energy has increased steadily in Finland's energy portfolio in recent years. The price of wood chips in Finland rose from 13€/MWh in 2007 to 19-21€/MWh in 2013. The national aim is to increase production (for electricity and heating) from the 8 million m^3 in 2013 to 13.5 million m^3 by 2020. In 2005, 3.24 million m^3 of forest chips were used (Nieminen 2013), meaning that in past eight years forest chip usage has increased 147%. In 2000 less than 1 million m^3 of forest chips were used.

New climate policies, particularly in the EU, have favoured the increasing use of wood-chips. In Finland, for example the use of wood-chips as a source of energy gain by the new policy the right to not use their emission permits to balance their polluting operations. The state also gives money to chip-users in the form of a bonus Feed-in Tariff (FiT), which is used to guarantee a fixed price for electricity producers for the produced energy. The state pays the difference between the target and spot market price (FiT), thus allowing for the industry to grow fast. The use of these tariffs has been criticised as they mean that the total emissions are not diminished since the tariffs do not decrease the total amount of emission rights but make it cheaper for others to buy them as the demand falls (Aatola and Ollikka 2014). The problem is thus the simultaneous use of overlapping policies: the carbon-trading option should be curbed if FiTs are in place to support the development of otherwise unprofitable new energy forms. The countries using FiTs have a larger use of renewable electricity sources than those that do not: they are the most important component for example in the EU policy package to boost the use of renewable energy. Besides forest chips, the Finnish state's FiT system also supports power plants fuelled by wind, biogas and wood-based fuels (The Act on Production Subsidy for Electricity Produced from Renewable Energy Sources 1396/2010). The cogeneration of power and heat is furthermore supported by paying a standard heat premium (wood-based fuel and biogas plants receive this) or including the heat-producing forest-chip power plants within the FiT system as well for the electricity they produce, the aim of the latter policy being to replace peat with chips (ibid). This has led to a great increase in wood-based electricity production in Finland, and a drop in coal use. The Finnish Forest Industries Federation (interview, Helsinki, March 2014) argues that the most efficient use of wood-chips is in electricity production, and thus this is supported.

Besides FiTs, the increase in the use of forest chips is explained by the fact that the decision to start collecting tree stumps significantly increases the use of mechanical harvesters (rising from 1.5 to two shifts), these capital goods being very expensive and needing to be used to maximum capacity. The production of wood chips is human capital-intensive, while the wood residuals material is cheap (Kärkkäinen 2013). This cost structure implies that in the context of high-wage Finland it is best to collect as much woody biomass as possible by making maximum use of the machinery and staff which in the context of guaranteed price has led to exponential growth in forest use for energy production and investment in production capacity. The same dynamics apply also elsewhere in the global North, while the capacity increase in the North has also attracted increased imports of woody biomass from the South.

"CARBON SINKS"

The consolidation of energy- and wood-based industries allows both to profit directly from the emerging climate markets: forestry can be partly financed by the sale of pollution rights to other industries. Mineral and metal companies are also becoming integrated into forestry as they "offset" their pollution through "carbon sinks" and emissions permits, further adding to incentives for the expansion of plantations rather than using natural forests in sustainable ways. Again, this can have direct effects on rural people who live in these areas.

Carbon Sink-Focus on Tree Plantations

The Indian case illustrates many features shared by government strategies aimed at expanding carbon sinks in the green economy. A new government policy, the Green India Mission, has the goal of radically increasing the country's tree-plantation cover. According to a government document, "The scope of greening is not limited to just trees and plantations… [I]t will not only strive to restore degraded forests, but would also contribute in protection/enhancement of forests with relatively dense forest cover (in line with country strategy on REDD Plus)" (Government of India 2010: 5). In more specific terms: "According to Environment Minister Jairam Ramesh, the overarching objective is to increase forest cover in 5 million hectares and improve the quality of forest cover in an area of corresponding size" (*The Hindu* 2010). Based on similar preceding policies and wording concerning TP expansion in the global South, including India, the government information could be interpreted as meaning that the 5 million hectares' "increase" will use TPs, and a significant part, if not most, of the other 5 million hectares (ha), where the quality of forest cover is to be improved, will involve cutting "secondary" or "degraded" forest areas and planting them with TPs. For forest peoples and activists, such areas are often real forests on which they depend for their livelihoods (Kröger 2013b; 2014). The scope of this policy is unclear as yet. According to Soumitra Ghosh from the National Forum of Forest Peoples and Forest Workers in India, the Minister of Forests has spoken about 30 million ha, and some official documents talk about 20 million ha.[4] Activists have been very worried about the Green India Mission, foreseeing it will generate many TP-connected conflicts and problems.

The government document outlining India's policy has included many of the critical points related to TPs, and if the policy is executed as drafted, the most severe problems could potentially be minimised. However, this is as yet a big "if", as most if not all TP-promoting government policies and corporate projects outline similar safety measures as raised in the Green India Mission, while failing to put them into practice. On page 12, the Green India Mission document refers to the much higher productivity of trees in Brazil and Indonesia compared to India, and suggests that conventional TP techniques will fill the gap and increase India's "potential". The techniques include genetic manipulation and cloning, tree nurseries, and improvement in the "investment climate", implying the likelihood of government subsidies in different forms including "all costs of planting" on government lands and a "supply of seedlings at the site at nominal cost, and training" for private lands. The officially acknowledged coverage area of the new Indian TP programme is 1.5 million ha, a large part of which will be used to gain carbon credits. India is the world's second-largest producer of carbon credits; carbon sinks and other climate-change mitigation projects in the rapidly emerging climate and emission markets are becoming a growth strategy for India and many other Southern countries.

CDM Schemes

This trend is accompanied by a growth in specialised carbon-sink companies. For example, Plantar, a Brazilian ITP company selling wood to steel and pulp industries, derives extra income for its plantations from the climate-change markets. A decade ago, Plantar presented a carbon-sink project to the World Bank's Prototype Carbon Fund, attempting to become a path-breaking example of how to use carbon-storing plantations to compensate for industrial pollution via the Clean Development Mechanism (CDM) of the Kyoto Protocol (WRM 2011). Plantar was granted a Forest Stewardship Council (FSC) certificate on 23,100 ha of charcoal eucalyptus plantations, designed, according to the company, to replace with charcoal the more polluting mineral coal used by the local steel industry. The United Nations (UN) recognised the initiative as a CDM project in September 2010. Dozens of Brazilian movements criticised the decision, arguing that this is a false solution to climate change; rather, the CDM is justifying and increasing pollution. The CDM Executive Board declined to consider the negative impacts of the carbon-sink project, arguing that the Brazilian government had certified it as legitimate "sustainable development", with the FSC certificate adding further credibility to its case.

There are likely to be many more such UN-recognised CDM ITPs, given the number of entrepreneurs hoping to profit from the climate market. While critical issues including the destruction of soils, depletion of water, and restriction of communal access to land have not been satisfactorily addressed, new forms of carbon finance are being successfully lobbied for by the ITP sector such as REDD+ and ++, under which TPs, considered "reforestation", could result in still more profit for companies promoting them.

The Risks in Carbon Stores

Carbon-storing TPs pose, however, new and growing risks. For Ricardo Carrere (2005), the risk of fire in TP carbon sinks alone disqualified them for carbon storage. Damage to plantations by wildfires in South Africa over the past two decades has increased steadily and, recently, dramatically: around 70,000 ha of tree plantations have been damaged by fire since 2007 (van Wilgen and Richardson 2012). Fires can occur naturally; pine and eucalyptus monocultures, for example, are highly prone. Fires can also be set by local people who have no other means to protest against TP expansion; or by companies who want to frame resisters as vandals and/or get insurance payments and greater (security) support from the government against such activism. Arson is common in Latin America, Africa and Asia, as locals, including company workers, are often mistreated by ITP companies, promises are broken, and community cultural values and dignity are not respected; fires can be set easily and quickly in revenge for felt injustices. Conflicts over carbon sinks can swiftly combust. Such mobilisations and conflicts limit flexibility as a result of increasing political risks.

A recent study in Australia (Paul et al. 2013) found that the current price of carbon is not nearly high enough for tree plantations to make a significant contribution to carbon sequestration while remaining economically viable, thereby limiting their expansion. Nevertheless, "carbon sink"-plantations are expanding, particularly in some African countries, where lower returns suffice due that fact that companies do not fully pay some of the costs (for example, of relocating populations and causing damage to the environment). Furthermore, as in other flexing, the greatest business benefits ensue from increased promise, expectations and potential, which make it possible to raise more speculative finance and political support for the industry.

Carbon-Capture Measurement Problems

Another limitation in flexing trees for carbon-sink usage is that it is very difficult to measure the baseline of forest carbon sinks, either politically or scientifically. First, there is no consensus on the basis of calculation. Most carbon is stored in the ground, not in trees (Palmujoki 2011). This implies that the strong modifications of soils – such as collecting all harvest residuals by using powerful machines, thereby leaving the soil exposed – should be curbed in order to avoid carbon emission. Yet, practices causing damage to soils are nevertheless on the increase as the amount of woody biomass collected during logging has increased. This suggests that the policy is not guided by an overall projection of benefits and costs, but driven by industry-specific and limited calculations. The wood-based energy industry is particularly interested in the "residual" materials that would otherwise be left on the forest floor. Palmujoki (2011) recommends that soil impacting, and thus also carbon-emission impacting, uses for trees should be integrated into climate policy. Furthermore, the amount of conventional energy the forest industry is using to produce its wood-fuels in mills should be tabulated in order to get a clear perspective on the relation between forestry practices and carbon capture.

The EU member states have mandates to increase the carbon sink offered by their forests. So, although there is more interest in making "full use" of the woody biomass seen as a "residual", such as in Finland – this amounts to about 20 million m^3 of "unused forest" per year according to the industry – by law the amount of carbon stored should be increased while taking more wood out to produce energy and for other purposes.

The industry argues that effective forestry practice is the best way to increase the carbon sink, by about half in 50 years, as opposed to letting the forest grow old without harvesting it. Countries in the global North can gain a small remuneration if they reach a higher storage of carbon that what was targeted as a mechanism to boost carbon storing. However, landholders do not gain a credit for increasing the carbon store.

FLEXING THE TREE SPECIES: POLITICAL ISSUES IN GM TREES

Another aspect of flexing is modifying the trees to be used more flexibly. This tendency has particular political dynamics. Companies promote the genetic engineering of tree species as a means to curtail climate disruptions and market changes. The tendency in tree breeding has been to create increasingly adaptable species (Fearnside 1998; 1999). The danger is that this genetic engineering will lead to even deeper enclosure of the commons, through the patenting and licensing of trees by private companies, and expansion into increasingly marginal lands where communities that have already been dispossessed have often migrated in the belief that they face less of a threat of future dispossession. Genetic contamination of native tree species by exotic GM trees is a likely outcome, and a source of new conflicts. These conflicts would not be the same as in the past since it might prove difficult to stop contamination by GM pine, for example, and because such hazards would, and have already, been responded to in different ways by different stakeholders. GM-tree conflicts in the North have inspired more radical acts of resistance than did conflicts about conventional forests. Different types of fears, ideologies and beliefs about the manipulation of nature surface in such disputes, and the proponents or opponents of genetic manipulation do not follow the conventional left–right or environmentalism–industry divisions as closely as the conflicts over corporate land-use concentration. The GM-tree conflicts are about to become a major issue: Brazil, for example, is set to legalise GM eucalyptus, and there are test sites all around the world (Kuusi 2010). If the genetic engineering of trees becomes accepted more widely, conflicts currently typical in GMO-based plantations – such as those cultivating soybean and maize – over royalties, biological contamination, and the "theft of intellectual property rights", will also become more frequent in the forestry industry. GM trees are particularly likely to transform currently peaceful smallholder-TP and non-TP forestry settings into areas of conflict, allowing for greater corporate control and gains over smallholder-owned plantations and semi-natural/semi-planted forests. Patents on GM technology permit the greater control of out-grower farmers (landholders who have made contracts with companies to offer their land for the outsourcing of material based on production on their land, typically with binding terms for whom to sell and with what price, and how and what to produce). This is because it is easy to become dependent on the necessary combination of GM-trees, pesticide, and fertiliser, while the existence of alternatives is naturally, technologically, and non-politically extinguished by the GM expansion.

The drive by agribusiness firms for GM-out-grower schemes has allowed them to gain royalties and use GM technology to distribute risks. This strategy of securing higher returns is likely to be applied if smallholders start to pose a major threat to higher rents secured by monopoly over the land. Furthermore, the risks and interests associated with the use of GM crops are distributed across a wider group than just the large companies if out-grower farmers also start to use GM variants. They, too, quickly become interested in pro-GMO legislation, as they cannot go back: this provides greater legitimacy, and allows the building of a political constituency for even more drastic pro-GMO manoeuvres across the globe. Smallholder support for GM trees should not be difficult to obtain, as the environment has not been a major concern for those peasants planting fast-growth eucalyptus in small plots in the past, for example in Vietnam (Kröger 2014): GMOs are an especially strong political weapon in concentrating control. In the case of conventional TP conflicts, the issue is about the size and political dynamics of plantations; in the GM-TPs, it is about changing (possibly) forever the (natural) rules of the game. Preventive conflicts have followed: on 8 March 2006 (International Women's Day) a group identifying themselves as the women of Via Campesina destroyed an Aracruz tree laboratory in Rio Grande do Sul; the event gained considerable publicity and the women and rural movements involved were framed in the mass media as being "against science, development and progress" (Kröger 2010).

The main focus of GM research so far has been directed at forcing natural genes to be overactive, silencing some, or inserting genes from other species to bring about the desired outcomes of pest resistance and increased tree quality and growth. An especially fast-growing area is the engineering of trees to maximise production of wood-biomass-based ethanol. Glyphosate-resistant trees pose the greatest danger (Kuusi 2010), and their monoculture would effectively prevent any other species from surviving under eucalyptus or pine, creating an even emptier "green desert" than existing monocultures, with far more damaging environmental and health impacts. Eventually, however, resistance to glyphosate develops among pests and other species alike and after the glyphosate-resistant soybean was introduced in South America, the use of Monsanto's Roundup Ready pesticide increased dramatically.[5] In addition, mounting scientific and empirical evidence from Argentina to Canada and elsewhere indicates that significant health damage may be caused by glyphosate.[6]

If allowed, GM-tree expansion is likely to closely accompany the expansion of both carbon-sink and wood-based bioenergy plantations. For example, US producers calculate they could generate about 9.1 billion gallons of fuel with the right GM-tree woody biomass.[7] According to the industry, GM-tree development will have to take into consideration soil conservation, but the main aim is to increase yields, not by direct yield increase in the most productive existing sites, where much of the potential limit has already been reached, but by developing specially engineered trees for particular places where it is hard to grow other crops or where previous varieties been unable to make best use of available nutrients, water and climate conditions for maximum yield. So, according to some experts, the attention in GM-tree production is largely directed at creating more resilient trees (e.g. the Chinese GM-poplar, which is resistant to very damaging insect and plague losses), or trees better equipped to extract the maximum benefit from particular conditions, rather than at creating particular qualities in trees. The latter option would decrease flexing possibilities, while the former increases the usable wood-stock. Moreover, some tree breeders have mentioned to me that they are trying to bring together the prior alternatives of producing either pulp or energy-wood, which limited both, by producing new varieties which, they say, can be obtained through cloning and hybrids without the use of GM.

PAPER AND CARDBOARD PRODUCTS REPLACING FOSSIL FUELS

Tree flexing is also being given a push by the broad change from oil-derived consumer and industrial goods to renewable products. Massive changes in the packaging business from plastic and metal to new paper products of tougher or more sophisticated quality are planned. The technology has developed to the extent that growing numbers of plastic products can be replaced with similar commodities made from paper (bio-refineries can produce bio-plastics instead of biofuels, and the technology allowing for this conversion is rapidly advancing). This is an argument used by paper companies in demanding that governments sell them land. Some Green politicians and NGOs have also embarked on this green dream, which does not allocate primary interest to political economy issues such as the social control of land and the displacement of local communities. For example, the Finnish-Swedish Stora Enso, the world's largest wood processor, has secured a 120,000 ha land-use deal from the Chinese authorities as it has proposed to build a huge pulp mill in Guangxi, producing second-generation paper packaging to replace plastic. Most of the growth in paper and cardboard consumption in recent years has accompanied the rise of China as the worlds' new manufacturing hub because its products are increasingly shipped in wrapped form, including its e-commerce, which is wrapped in paper (Dauvergne and Lister 2012). Stora Enso is currently building a mill in Guangxi to produce beverage cartons mostly for the Chinese market.

POLICY RECOMMENDATIONS: LIMITS TO FLEXING TREES

Flex trees are only as renewable as their soil and water use is sustainable. Natural forests rich in biodiversity, where harvesting is based on sustainable thinning practices, should be prioritised. Tree plantations should be eschewed due to their negative soil, biodiversity and water impacts (Kröger 2014). Rising energy and food prices will increase the tendency to clear forest for plantations. Many agricultural sectors consider that forests provide an alternative, non-food, land use. This perception will also lead to rising wood prices, as a higher valuation of the land as a potential source for food, feed and fuel will lead to the greater monetisation of forest reserves, either as carbon sinks or as timber and producers of other forest products. This suggests that the forest industry will have to focus on more added-value products in order to compete in the growing struggle for land.

The forest industry seeks to use forests primarily as a biomass source for oil-alternative energy and production materials in the new flexing trend, not as carbon sinks. According to the industry, the substitution of polluting production methods by forest products is more important than retaining old forest stands as carbon sinks. These discourses are already out there, and are directed at policy-makers, financiers and customers: a sign of increased inter-industry struggle for (forest) land.

The forest industry, an important sector in deciding what happens to forests, does not necessarily consider them to be sources of non-wood products, particularly forest-based foods such as berries, mushrooms, herbs, medicinal plants, and game; nor does it consider the other benefits of forests, such as supplying water sources such as springs. These products are governed and marketed by other industries that are not linked to the powerful global food system, which is controlled by large multinational trading houses (the four Ds). Considering this power balance, where the forest industry is now merging with the energy (particularly oil) industry to reclaim trees as an oil-substitute, while global agribusiness wants forests to be cleared, poses difficulties for the proponents of an alternative policy on the use of trees. Traditional populations who benefit from the rich biodiversity in forests that offer much more than wood – indeed, often a substantial part of their diets – will face tough pressure on their very subsistence once trees are flexed.

But flexing and new multiple uses of trees also offer possibilities for forest-dwelling peoples such as indigenous and traditional forest extractivists. They should strive to frame policies that value forests based on the number of different products they yield, while retaining large amounts of carbon and offering traditional livelihoods and homes for people, and reject tree and forest valuation based on the commercial value of the woody biomass that the land in question can provide. In such settings, carbon sinks could be a source of extra income for forest populations, but it will still be very problematic to allow some to pollute based on the argument that they can afford to pay for this. In this sense the income source should come from outside the current carbon market-schemes, and be rather a stipend for the ecological stewardship that forest populations offer and that does not offer the possibility of polluting elsewhere.

Nevertheless, there are also pitfalls in adopting pro-forest dweller policies unless these are applied on the basis of an understanding of the global capitalist system that has intersected impacts and markets. The current global governance of carbon sinks is problematic. As CDM projects have largely failed, REDD+ schemes – whereby biodiversity issues are supposed to be considered – have been introduced by the UN and other bodies. The biggest problem with the REDD+ and carbon sinks is that these currently apply only to countries in the global South, the aim being to diminish the forest loss that is a major source of its carbon emissions (Palmujoki 2011). In the rich Northern countries, where forests comprise large carbon sinks (e.g. in Finland), the latter are not included in emissions calculations. This is a major problem for many reasons. First, it drives forest valuation and use in the North – in the context of climate change (business) – as based on maximum usage of tree biomass for energy and other alternative, substitution-based uses. The greater use of trees as a fossil substitute is valued more than the carbon-sink option. This signifies a tendency to move rapidly towards converting forests into tree plantations of very limited biodiversity in all forests in the North that are outside the scope of REDD+, particularly if the country is affected by policy targets aimed at cutting carbon emissions, such as those of the EU. The forest industry can frame itself as contributing to the green economy because the major carbon emissions it causes through the large amounts of energy it uses (to replace fossil-fuel products) are not typically counted as its own emissions, but rather as those of the energy industry (this is the case, for instance, in Finland and the EU) (Palmujoki 2011).

Second – and this tendency is already visible – the decision to leave the Northern forests out of carbon-sink calculations and markets, coupled with state subsidies and incentives for renewable energy, have functioned to produce a strong industrial policy aimed at boosting the creation of new wood-based energy, fuel and tree-yield technologies, rather than directing attention to forests as having other functions besides replacing industrial, metal and oil minerals. The technology developed – particularly the machinery and chemistry of wood-based bio-refineries and pulping methods to produce new wood-based textiles, bio-plastics and so on – is concentrated in Northern countries, although the technology will certainly be sold in every possible way to the South; in turn, the South will establish ITPs in its extensive land areas, thereby making even more profitable use of the new technology than the North. Streamlined green-field investments will also place pressure on the value of natural forests as carbon sinks in the South. Different stakeholders stand to benefit from the two alternative options for Southern governments, for whom the globally negotiated emission-reduction targets are not yet binding. There is less incentive to create carbon sinks under REDD+ (benefiting local populations) when national elites can make profits by yielding land to producing wood-based fuels and products for new green economy markets, more cheaply than the North.

RELATIONSHIPS BETWEEN DIFFERENT FORMS OF TREE FLEXING

The flexibility of carbon-storing trees is determined by the harvesting cycle: since this is around 50 years in the North, not much flexing is expected there. The situation is wholly different in the South, with faster rotations: the flexing to and from forestry carbon sinks is thus focused on TPs in the global South. The increased flexing in the South makes it imperative for Northern forestry practitioners to flex, as the markets are global and flexing offers such market benefits that they must respond by increasing the number of sales outlets for wood also in the North. As the North cannot really compete with the South in flexing the sinks or the forestry practices (the increased collecting of stumps and branches being one of the only feasible responses) when the gap in harvesting times is so large, the North must compete by flexing the wood-processing chains. This means that the same tree in the North is used to make an increasing number of products. The South will reap the benefits of scale via TPs in maximising the production of single products, while the North will respond by multiplying and flexing uses, creating new products with higher added-value, and selling technologies to the South.

Pulp is a key product, which can be turned into multiple products – also the pulping side-products are acquiring more flexible uses. Pulp production has started to recover from a dip in the global North, with new investment, following the flexing boom.

New players are entering the business. Wood could become a major construction material as technology improves. Until now the lobbying power of the cement industry plus the fire risks have, for example, limited somewhat the use of wood in high-rise buildings in Finland. Another dilemma has been the lack of a competent technical chain of know-how that would make it possible to promote wooden housing – something that calls for education of this chain.

THE RELATION OF FLEX-WOOD TO OTHER INDUSTRIES

Flex-Trees vs. Flex-Food Crops

As tree plantations are the strongest trend in sourcing wood-based energy, a growth in wood-energy use implies that less land is available for food production. Tree plantations (TPs) have already had dire negative consequences for local food balances and rural populations across the world (Kröger 2014). The forest industry markets its second-generation (non-food-based) biofuels as a solution to the problem caused by flexing sugarcane, palm oil, soy, maize and other foodstuffs into energy crops, linking their value to that of crude oil, increasing food prices and taking production out of food and feed use. But the fact that monoculture TPs provide no food and even decrease food-production potential in areas affected by the damage they cause to the water balance, takes vital land out of food production and also drives up food prices.

Jokinen et al. (2011: 68-9), looking at forests in the context of agricultural changes, observe that "globally the increasing use of forests as biofuels threatens the reservation of forests and swamps," even though global pressure to mitigate these negative impacts is increasing. They argue that the Finnish wood-biofuel plants are too small to have a global presence. But this view overlooks the fact that we are now at the stage of testing new technology and pilot plants, a forerunner of potentially large sales of this production technology and pattern worldwide. Such global impacts of national industrial development are very seldom considered. In this equation it is possible that soil, water and biodiversity will be traded for climate-change mitigation – and that particular industries stand to profit from this trading, under the guise of being green.

The control of the supply and distribution chains is bound to become more crucial, and may determine which industry or crop-use expands. To give an example, the expansion of second-generation wood-biodiesel will be much easier than the expansion of food-crop-based ethanol. The tall-oil-based wood-biodiesel is accounted twice under the 10%-biodiesel requirement in Finland: first-generation biodiesel and ethanol are calculated only once, requiring double the amount of fuel. The second generation (non-food biofuels) is inherently more flexible, not requiring the installation of new distribution systems as ethanol does, for example.

CONCLUDING REMARKS

The flexible and multiple uses of trees have increased significantly in recent years, and this trend is becoming ever more important to the future of world's forestry, forests and industrial development. There are many reasons for this trend, including the rise of the bio and green economies to replace the fossil-fuel and non-renewables economy; international climate policies; a decline in the consumption of paper (leading to the paper industry's need to find new uses for wood); and the higher expectations of the forest industry over the oil and metals industry in relation to innovation and sustainability.
A key reason is the increased security that flexing offers for those who are able to flex: the forest industry gains greater autonomy and stability in addition to its potential growth.
It has become, for example, increasingly self-sufficient in energy, as sawmills and pulp mills not only produce their own energy, but also export the excess energy produced in wood processing, thus reducing their reliance on energy markets. Considerations about energy cost have been the key issue in recent Northern investment in the forest industry.

The potential expansion in flex trees is limited only by nature and social responses. The rapidly changing global economy and environment require flexibility and rapid adaptability, thus flex and multiple-use trees have inbuilt survival advantages as they increase the range of possible timber uses. Their use will continue to expand, producing entire landscapes of artificial, single-species forests as tree plantations proliferate. Rich, semi-natural forests, on the other hand, can also be expanded when forest-dwellers manage to shape forestry practices rather than allowing the forest industry to dictate them.

There has been a paradigm shift. In the past, many tree species were used for the same purpose. In the future, one tree species, engineered to be as flexible as possible, will be used for interchangeable and multiple purposes. First, capitalism created standardised commodities to ease the globalisation of their markets. Now these globally standardised commodities – with an ever-declining number of species – are maximising their access to markets by flexing them. The question becomes whether green can have shades of moral darkness. To what extent will important stakeholders seeking a reduction in carbon emissions, who stand behind the drive for bio-energy policies, tolerate unethical socio-agrarian relations in a green economy?

In some cases, civil society movements could side with the forest industry against its competitors to improve opportunities to develop products that are better than existing products in terms of climate change. For example, the cement industry opposes the introduction of wooden materials for housing, but using wood in construction would be a wise way to reduce carbon emissions and the consumption of non-renewable materials, and is one of the best uses for wood. To promote the use of wood in the building industry, existing subsidies for cement should be cut and the price paid for sawn timber significantly increased since it is currently priced and valued too cheaply. Such alliances in particular product segments would create benefits both for social movements and the forest industry, and lead to more sustainable solutions, working arenas, and models. In the other areas mentioned above, such as the expansion of tree plantations, a critical voice should be retained to steer production towards natural forests and sustainable thinning practices.

The asymmetry in technology development for flexing tree uses is also a potential source of conflict. Countries in which there is substantial new know-how in key technologies may face resistance from countries defending their own (non-wood) technologies. Wood-plastic composites (WPC) and cross-laminated timber (CLT), which are new and more useful construction and industrial materials, as well as the wood biofuel technology, are heavily concentrated in a few European countries, with some technology development taking place also in Canada and the USA (UNECE/FAO 2013). In this sense, the flexing of trees seems to follow the historical North–South technology development pattern as in other sectors.

The forest industry faces competition from established players such as the oil industry as it enters new markets, such as energy production. In replacing plastics and chemicals with tree products, the chemical and oil industries will also see the forest industry as a competitor. Oil and chemical companies will want to both merge and mix with the forest industry, besides competing directly. But there will be also conflicts and increased inter-industry lobbying for policies that further particular industry interests.

Disputes will continue. Politically, the industry argues that the best way to store carbon is by offering wood-based substitute products for petrochemicals, while biodiversity and conservation-emphasising stakeholders see standing forests as the best way to do so (Palmujoki 2011): both provide calculations to justify the adoption of their views. The industry argues that non-economically-used forests cannot be viewed as a means to store carbon, as they can burn and the carbon can thus be lost. The Finnish forest industry argues that wood harvesting could be increased sustainably from the current 50Mm^3 to 70Mm^3, as the current annual wood-mass growth is 100 Mm^3, this meaning that the carbon sink of forests would still increase. A key debate seems to be forming around the way in which is carbon storing is calculated.

There is a need for a sound global policy should to be applied uniformly. This would also mean either scrapping REDD+ schemes or calculating forests in the North as well as in the South as carbon sinks. In both cases the monetisation of forests and the creation of markets for polluters should be avoided because of the many problems these tendencies have caused (see the extensive and insightful work by Larry Lohmann, e.g. at: http://www.thecornerhouse.org.uk/resources/results/taxonomy:48).

The best use of trees would be to let them grow in natural forests rich in biodiversity and free from the use of fertilisers and pesticides, serving to increase water- and soil-rich ecosystems that provide important climate benefits as well as products that also include food. As the forest industry develops new wood-based products in the rising green economy, pressure should be placed upon them, through both subsidies and policies, to focus less on wood-based fuels and more on more value-added products, such as bio-plastics and wood for construction purposes, as substitutes for polluting (petrochemical and mined) materials. Only the wood material that is not usable for physical production should be used to produce energy, and this should not include the "residual" biomasses left after harvesting which are important for soil carbon storage and forest regeneration. In all cases tree plantations should be avoided. The tendency of large farmers and even some smallholders to consider forests as an obstacle to agriculture and cattle-herding should be countered by establishing forests as sources of potentially much healthier foods than agro-industrial produce. Uniting truly sustainable forest use with conservation should be the goal, to include well-managed forest control, tenure, and revenue distribution to rural inhabitants. Forests should be understood not only as sources of wood, but also as increasingly important sources of food and other products, in addition to their essential non-commercial values as places of relaxation, sports, and spiritual rejuvenation and well-being.

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Endnotes

1 It should be noted that there are conceptual differences between plantations: The Food and Agriculture Organization (FAO), the United Nations Environment Programme (UNEP) and other UN bodies talk about "forest plantations" or "planted forests". The planted forest concept was introduced in early 2000s. It is much broader than the older forest plantation, roughly doubling the size of plantations in FAO statistics (Kanninen 2010). The FAO (2004) conceptualises forest plantations as having "few species, even spacing and/or even-aged stands". In contrast, planted forests may have many species of different age stands and uneven spacing, and are defined as "predominantly composed of trees established through planting and/or after deliberate seeding of native or introduced species" (Carle and Holmberg 2008). The latter category of planted forests therefore includes natural, forest-like tree stands, semi-natural forests that non-foresters typically do not consider "plantations." In studying TPs as such, "forest plantation" data would be more precise. However, the FAO data no longer offer information on forest plantations. By tree plantations, I refer to the above-mentioned forest plantations, but want to avoid using the term 'forest' here as it may confuse those who require a clearer difference between forests and plantations for analytical purposes.

2 UOP Honeywell describes itself as the world's leading provider of gasoline and biodegradable detergent technology, among other things. Ensyn describes itself as using biomass to produce not only fuels and electricity but also food-industry chemicals from food flavourings to adhesive resins. Its most important owners include Chevron, investment banks, Felda Palm Industries (one of the world's largest palm-oil producers) and Fibria (Brazil's largest pulp producer). Fibria and Ensyn have established a joint venture to produce wood-fuels in Brazilian pulp mills, and the first investment in Aracruz, based on

eucalyptus-plantation wood, is underway. Ensyn is also heavily involved in new oil booms in the oil sands of Canada, for example. Its ties with Brazil and Southeast Asia will make it an important provider in both wood and palm-oil fuels from the global South's problematic monocrop plantations.

3 See also: UN Mission in Liberia. 2006. *Human Rights in Liberia's Rubber Plantations: Tapping into the Future*. At: http://unmil.org/documents/human_rights_liberiarubber.pdf

4 Email communication, 27 February 2012.

5 For example, "According to IBAMA, between 2000 and 2004, the use of glyphosate, an agrotoxin used widely for transgenic soy, increased by 95 percent in Brazil, as the area of soy grown jumped by over 71 percent. In the state of Rio Grande do Sul, home to the country's largest area of transgenic soy, glyphosate use increased 162 percent and the area grown by 38 percent" (Martins 2008).

6 See for example: "Scientist warns of dire consequences with widespread use of glyphosate": The Organic & Non-GMO Report, 2010, at: http://www.non-gmoreport.com/articles/may10/consequenceso_widespread_glyphosate_use.php

7 U.S. Government, House Hearing, 111 Congress. Hearing to review the future of next generation biofuels, October 29, 2009. Serial No. 111-35, at: http://www.gpo.gov/fdsys/pkg/CHRG-111hhrg53867/html/CHRG-111hhrg53867.htm

AGRARIAN JUSTICE PROGRAMME

In recent years, various actors, from big foreign and domestic corporate business and finance to governments, have initiated a large-scale worldwide enclosure of agricultural lands, mostly in the Global South but also elsewhere. This is done for large-scale industrial and industrial agriculture ventures and often packaged as large-scale investment for rural development. But rather than being investment that is going to benefit the majority of rural people, especially the poorest and most vulnerable, this process constitutes a new wave of land and water 'grabbing'. It is a global phenomenon whereby the access, use and right to land and other closely associated natural resources is being taken over - on a large-scale and/or by large-scale capital – resulting in a cascade of negative impacts on rural livelihoods and ecologies, human rights, and local food security.

In this context TNI aims to contribute to strengthening the campaigns by agrarian social movements in order to make them more effective in resisting land and water grabbing; and in developing and advancing alternatives such as land/food/water sovereignty and agro-ecological farming systems.

Agroecology by the Filipino painter ***Boy Dominguez****, 2013*

TNI Think Piece Series on Flex Crops & Commodities

The convergence of multiple crises (food, energy and fuel, climate and financial) in the midst of the rise of newer hubs of global capital (BRICS countries and some middle income countries) – and the various responses to these by states and corporations – have paved the way for the emergence of 'flex crops and commodities'. Flex crops and commodities are those that have multiple and/or flexible uses: food, animal feed, fuel, and other commercial-industrial uses. In fact the contemporary global land rush is intertwined with the rise of flex crops and commodities: sites of large-scale land deals tend to be sites of expansion of production of these crops and commodities, e.g. soya, sugarcane, palm oil, corn, cassava, industrial trees. What are the implications of this phenomenon for how scholars, civil society and grassroots social movements undertake 'engaged research', public actions and policy advocacy around agrarian justice issues? The issues are compelling and urgent, yet still largely under-researched. TNI is launching the TNI Think Piece Series on Flex Crops & Commodities to jump-start collaborative action and a critical dialogue between engaged academics, civil society and grassroots movement activists on this issue.

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With the rise of green and bio economies and the decrease in non-biomass-based resources, forests and trees are now seen as major sources to replace fossil fuels. What political dimensions are involved in this transformation, which is simultaneously ongoing, anticipated and imagined? How will the transition affect rural realities and well-being? What issues should be considered in thinking about the possible directions that the more flexible use of trees might take? What are the potentials and pitfalls? What are the main drivers of change in developing new, flexible and multiple uses of trees and forests? This paper explores the unknowns in the form of posing questions to which it seeks answers. The flexible and multiple uses of trees seem to offer timely opportunities for socio-environmentally sustainable solutions, but also present dangers, particularly if such changes accelerate the concentration of land and plantation-based development, whereby forests compete with and may replace food production.

Keywords: flex crops | flex trees | flex-tree plantations (FTPs) | forestry | capitalism | green economy | risks | political dynamics | conflicts | forest futures