Sustainable Palm Oil?

Insights from Material Flow and Land Use Analysis in Brazil's Production Hotspot

Near-ubiquitous in global consumption, palm oil is increasingly connoted with the detrimental environmental and social impacts of its production. Focusing on the production hotspot Pará, Brazil, our study questions the success of the Brazilian national program for sustainable palm oil production.

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Abstract

Negative impacts of plantation agriculture were widely recognized when the expansion of palm oil production began in Brazil. In 2010, president Lula da Silva initiated a program to foster socially and environmentally sustainable palm oil production. Our research in Brazil's palm oil production hotspot Tomé-Açu, Pará, leads us to question the success of this program. Based on data-driven analysis of material and land use and qualitative field research, we reveal unsustainable biophysical patterns and drivers of plantation expansion. In particular, we identify functional links between deforestation, pursuant use of land for cattle ranching, and (perceived) availability of plantation land. By considering the direct and indirect material and land use effects of palm oil production, we find that deforestation sustainability programs seek to avoid remains a prerequisite to plantation expansion. Material and land use patterns shape not only the biophysical but also the economic basis of rural livelihoods with implications for the environmental and the social sustainability of any further expansion of palm oil production.

Keywords

Brazil, cassava, land use change, palm oil, regional material flow analysis, rural communities, sustainability

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Expansion of Oil Palm Plantation

Mention of palm oil triggers images of deforestation, land expulsions, and large-scale plantation monocultures. While demand rises and production rapidly expands – particularly in Southeast Asia, Latin America, and Sub-Saharan Africa – the negative socioecological impacts of this oil crop are becoming more widely known. Political decision-makers cannot afford to ignore palm oil's negative sustainability image: from the international *Roundtable on Sustainable Palm Oil (RSPO)* to various national and local programs, attempts are made to signal to consumers that they need not be concerned. Brazil, for example, implements a highly ambitious national program for sustainable palm oil production, the *Programa de Produção Sustentável de Palma de Óleo (PPSPO)*.

We investigated the socioecological prerequisites to, and impacts of, oil palm plantation expansion in the Brazilian state of Pará, a hotspot where 85 percent of the country's palm oil was produced in 2014. Our main research interest was the sustainability – or lack thereof – of the plantation expansion in the late 20th and early 21st century. In an interdisciplinary approach, we combined the data-driven, quantitative analysis of palm oil production (regional material flow and land use analysis) with insights from stakeholder and expert interviews. We found local knowledge and narratives to be instrumental in truly making sense of the quantitative data. Our results allow us to discuss whether the unsustainable aspects of oil palm plantation expansion in Brazil can be corrected through the political instrument of the *PPSPO*.[1] By focusing on biophysical evidence for prerequisites and impacts, we identified key aspects of the expansion in material and land use patterns. Even without conducting a full-fledged analysis of the *PPSPO*, this allowed us to determine which scope such a program would need to address underlying causes of unsustainability. >

1 For a discussion of other political programs Brazil initiated to foster sustainable land use and development see Schönenberg et al. (2015).

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GAIA MASTERS STUDENT PAPER AWARD

Charlotte Kottusch is the winner of the *GAIA Masters Student Paper Award (GMSPA)*[a]. Her paper *The Socio-Ecological Impacts of Palm Oil Production in Rural Communities. A Study of Material Flows in the Micro-Region Tomé-Açu in Pará, Brazil* was selected by an international jury and is now published in *GAIA* after successful peer review.

The *GMSPA* addresses Masters students. They are encouraged to submit their results from research-based courses or Masters theses in the field of transdisciplinary environmental and sustainability science. The winner will be granted a prize of 1,500 euros as well as a free one-year subscription to *GAIA*. The award 2017 was endowed by Selbach Environmental Foundation.

a For more details see *www.oekom.de/zeitschriften/gaia/student-paper-award.html*.

Palm Oil as Global Fuel

36 percent of global vegetable oil production, more than of any other individual oil, is palm oil[2]. Processed palm oil is used for direct human consumption as well as for industrial purposes including processed foods, cosmetics, lubricants, and biofuel. It is estimated that more than 50 percent of processed products commonly available in supermarkets contain palm oil (Borras et al. 2016). The diversity of uses arises from inherent features of the oil palm fruit as well as from the socioeconomic conditions of its production and consumption as a *flex crop* (Alonso-Fradejas et al. 2016). As Borras et al. (2012, p. 851) put it: "When actual market for biodiesel is not there yet, sell palm oil for cooking oil, while waiting (or speculating) for a more lucrative biodiesel market to emerge."

The scope of uses, paired with the plantations' high productivity (eleven times higher than for soybean monocultures) (Kuss et al. 2015) have allowed for highly competitive pricing of palm oil leading to rising demand, especially in Europe, India and China, and increased production in Southeast Asia, Sub-Saharan Africa, and Latin America (Pirker et al. 2016). On a global scale around 74 percent are used in the food industry and about 24 percent are used for other industrial purposes.[3] Except for the region of Southeast Asia, only a small amount of palm oil is used for biodiesel production so far (Brad et al. 2015).

Negative Social and Environmental Impacts

Its negative social and environmental impacts lead to concern about the expansion of palm oil production. The acquisition of plantation land has been associated with the expulsion of smallholder or indigenous peoples from the land on which they depend for subsistence, the extensive use of pesticides in plantation agriculture is harmful to local populations and the environment (Colchester 2011), and deforestation leads to loss of habitat and is associated with greenhouse gas emissions (Pye and Bhattacharya 2013). For Brazil in particular, competition between the production of palm oil and of staple food crops has been observed (Geraldes et al. 2014), the integration of small-scale farmers[4] into plantation agriculture comes at high social costs, arising with new dependencies from the contracting companies, the prices they pay for the yield and the number of people they employ on the plantations (Nahum and Santos 2015), and the environmental consequences for Amazonian ecosystems and biodiversity are deemed especially grave (Butler and Laurence 2009).

The Promise of Sustainability

Under the pressure of palm oil's increasingly negative connotation (Englund et al. 2015), Brazil has introduced political programs for socially and environmentally less harmful production of palm oil and other oil crops and diversification of the Brazilian biodiesel basis to further energy independence (FAO 2009). It is important to note that such sustainability initiatives accompany (or are integrated into) political mechanisms designed to increase palm oil production (alongside other oil crops). The 2004 national biodiesel program *(Programa Nacional de Produção e Uso de Biodiesel)* introduced a *Social Fuel* seal with tax benefits for companies buying oil palm fruit from small-scale farmers. In 2010, the *PPSPO* was launched to enhance energy security by diversifying biodiesel feedstock and to increase domestic raw material supply for the food and cosmetics industry (Backhouse 2013). To "improve life in the countryside" (MDA 2010, p. 5, translation CK), the *PPSPO* promotes the inclusion of small-scale family farmers via contract farming. In order to avoid further deforestation, plantations are restricted to areas deforested before 2008 and a zoning instrument *(Zoneamento Agroecológico, ZAE)* was implemented to map areas suitable for plantations as well as indigenous or reservation land.

A Multi-scalar Perspective on Palm Oil Production in Tomé-Açu

Compared to Malaysia and Indonesia, responsible for about 80 percent of worldwide palm oil production,[5] Brazil plays a minor role, producing 0.5 percent of global palm oil (Bentes and Homma 2016). Within Brazil, however, the northern state of Pará has, since the early 2000s, produced around 80 percent of all palm oil. In Pará, we focus on the micro-region of Tomé-Açu, the five provinces (Acará, Concórdia do Pará, Moju, Tailândia, Tomé-Açu) of which are responsible for more than 70 percent of the palm oil produced in Pará (IBGE 2015, own calculation). Especially in the early 1990s, oil palm is not a dominating agricultural sector in the

2 *www.oecd-ilibrary.org/agriculture-and-food/oecd-fao-agricultural-outlook-2016-2025/oilseeds-and-oilseed-products_agr_outlook-2016-8-en*

3 *https://na.unep.net/geas/getUNEPPageWithArticleIDScript.php?article_id=73*

4 Small-scale farmers or family farmers (agricultores familiars) are defined by Brazilian law (N° 11.326 de 2006) by their primary use of family workforce, management of the farm by the family, and agriculture as the main source of family income. Family farm size may not exceed four 25 hectare plots (Secretaria da Agricultura Familiar 2012).

5 Calculation on the basis of download data (Indonesia, Malaysia, and all countries) at *www.fao.org/faostat/en/#data*: crops/production quantity/oil/palm/2014.

region, but it is the crop with the most increasing share of the total biomass extracted, from four percent in 1990 to 20 percent in 2014. Large stretches of land in Tomé-Açu were declared as deforested land suitable for palm plantations under the *ZAE,* providing a decisive prerequisite for plantation expansion. The state of Pará features one of the highest rates of deforestation in the Amazon region (Villela et al. 2014) and it is estimated that 71 percent of the land in Pará has no clear legal title (IMAZON 2015).

While we focus on a spatially well-defined micro-region, we expect the underlying drivers of the development in Tomé-Açu to require a multi-scalar analysis. Demand for palm oil but also for timber from our study region originates from other Brazilian states and other countries. In land use science, such patterns are investigated as telecoupling between production and consumption (Friis et al. 2016) and are considered essential in assessing (potential for) sustainability (Liu et al. 2013). The interlinkages across levels of scale require the consideration of so-called distal drivers (Geist and Lambin 2002), not only in a spatial but also in a temporal and functional sense. The current expansion of palm plantations in Tomé-Açu is also the result of past developments and of decisions that did not directly address this development (Schaffartzik et al. 2016).

Material-flow Analysis and Expert Interviews

Whether or not the development of oil palm plantations in Tomé-Açu is environmentally sustainable clearly depends not on underlying political intentions but on the associated use of resources and the environmental impact associated with changes in pressure on the environment. The expansion of plantations directly requires changes in land cover and use. These changes as well as the eventual harvest of palm fruit additionally become manifest as biomass extraction. In assessing the potential lack of sustainability in plantation expansion, we have relied on these pressure indicators which – in contrast to the impact indicators that are additionally relevant – are directly and indirectly functionally linked to the expansion of the resource frontier investigated here.

Biomass extraction, land cover, and land use in Tomé-Açu were studied through regional material flow analysis (rMFA), an adaption to the regional level of the more commonly used economy-wide (national) MFA (Hammer et al. 2003). The framework and system boundaries for this analysis are derived from the concept socioeconomic metabolism (Fischer-Kowalski and Haberl 1997), allowing for the analysis of the interactions between society and nature. All material flows entering (as domestic extraction by agriculture, forestry, and mining or as imports) or exiting (as waste and emissions or as exports) a given socioeconomic system are accounted for in biophysical terms (most commonly in metric tons).

To reveal changes in the agricultural sector and the relation between different forms of land use, our study focuses on the domestic extraction (DE) of biomass in Tomé-Açu where other materials (metals, non-metallic minerals, fossil fuels) are only marginally extracted. Trade data is typically only available at the national level (Hammer et al. 2003) and Tomé-Açu was no exception. Data on inter- and intranational trade were not available in sufficient coverage to allow us to analytically focus on questions of international telecoupling. We do, however, systematically consider potential drivers across temporal and functional distance.

For the period between 1990 and 2014, official statistical data from the Instituto Brasileiro de Geografia e Estatística (IBGE) (2015) were complemented with data collected during field research. Challenges faced in collecting, verifying, and interpreting official data made it necessary to compare and contrast these data with local knowledge and narratives.

Biomass extraction is dependent on land. Satellite data on land use and cover from the *Programa de Cálculo do Desflorestamento da Amazônia (PRODES)* and *TERRACLASS* projects of the Brazilian National Institute for Spatial Research (INPE)[6] were used to study changes in forest cover, pasture types, secondary vegetation, and the fragmentation of land parcels (i. e., the occurrence of small-scale farming). Data on land use and cover were available for 2008, 2010 and 2012, covering the important period two years before and after the *PPSPO* implementation in 2010.

The field research in the micro-region from October 2015 to January 2016 consisted of semi-structured expert interviews (Gläser and Laudel 2010) and observations made during visits to the palm oil producing provinces. A network of interview partners was established and informed beforehand about the aim of the field research. In a second step, interviewees were selected following the criteria of expertise and relation to the communities. The pool consisted of experts from research, policy, the IBGE and INPE, from involved companies, labor unions, the city councils, agricultural organizations, small-scale farmers, and nongovernmental organizations. In total, 42 interviews were conducted, recorded, and transcribed in Portuguese. All interviews are numbered and labelled with "I" for interviews in Belém and the initial letter of the communities for experts in the respective community.

The mix of quantitative and qualitative methods was developed in acknowledgment of the complexity of the introduction of palm plantations – with simultaneous biophysical and sociocultural implications – into an existing agricultural system.

Effects of Past and Current Land Use

Land Use Cycles

Based on the rMFA, the extraction of 15 types of biomass between 1990 and 2014 was studied in detail. A pattern of biomass extraction over time was identified for Tomé-Açu corresponding to what interview partners described as "typical land use cycles" *(ciclos da ocupação da terra)* of young communities in the Amazon. The extraction data presented in figure 1 (p. 132) illustrate these cycles. The first stage, high timber extraction in the 1990s, is typical for recently (here until the late 1980s) established communities. Trop- >

6 Data provided to the author in personal communication (21.01.2016).

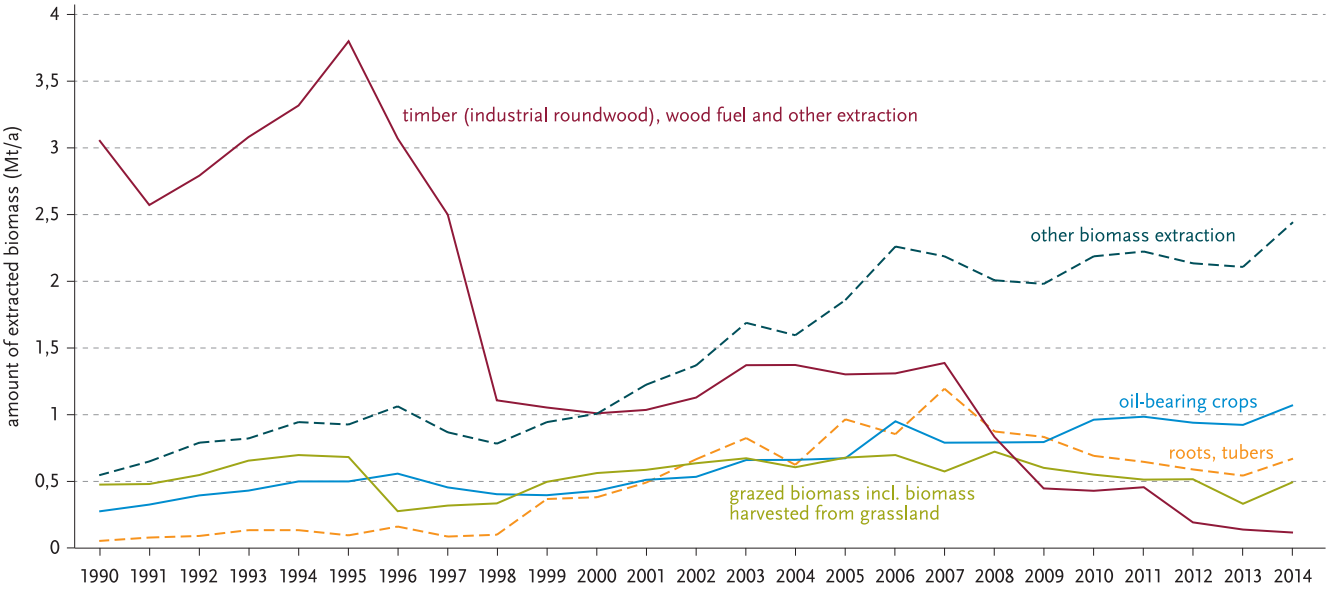


FIGURE 1: Domestic extraction of biomass in the micro-region of Tomé-Açu between 1990 and 2014 in megatons per year (Mt/a).

ical wood is a valuable (and often the only) resource, easy to access and a crucial source of market-based income, increasingly via export, especially to countries experiencing reforestation in their forest transition (Meyfroidt et al. 2010). Harvesting of timber plays an important role in opening up the area for further land uses and often entails new infrastructure like roads or river ports for transportation of wood (IMAZON 2002). Following initial growth in timber extraction, this flow decreased in the late 1990s and again in 2008, possibly a sign for the success of political programs against illegal deforestation (IBAMA 2008).

A typical form of land use subsequent to deforestation is pasture, indicated by increased grazed biomass – due to increasing populations of cattle and buffalo – in Tomé-Açu in the early 2000s. Putting cattle on recently cleared lands is an economically simple form of land use and a common way to declare ownership and use of these areas (Coy and Klingler 2014).

After the land has been further "cleared" by cattle, annual or perennial crops like coconut, fruit trees or oil palms are planted, with the market price of these crops providing a decisive incentive. In Tomé-Açu, cassava is predominantly planted by small-scale farmers in slash and burn systems on smaller parcels, thus not being part of this land use cycle.

From 1990 to 2014, roots and tubers, oil-bearing crops, timber, and grazed biomass on average account for 70 percent of all biomass extracted in Tomé-Açu. Harvest of oil-bearing crops, of which palm fruits constitute 80 percent in 2000 and 88 percent in 2010, increases from 0.2 megatons per year in 1990 to around one megaton per year in 2014. By 2014, oil-bearing crops are the second-largest form of biomass extraction in the region, surpassed only by what is broadly aggregated here as "other biomass extraction" and consists of cereals, sugar crops, pulses, nuts, vegetables, fruits, fibers, spices, stimulant crops, tobacco, rubber, straw, and other crop residues. Even in this category, the strong increase after the turn of the century is linked to oil palm expansion: crop residues, which dominate this category, are made up mainly of residues of palm oil fruits (about 75 percent) and roots and tubers (which consists entirely of cassava). The growth in this category is therefore functionally linked to the development of the oil-bearing crops.

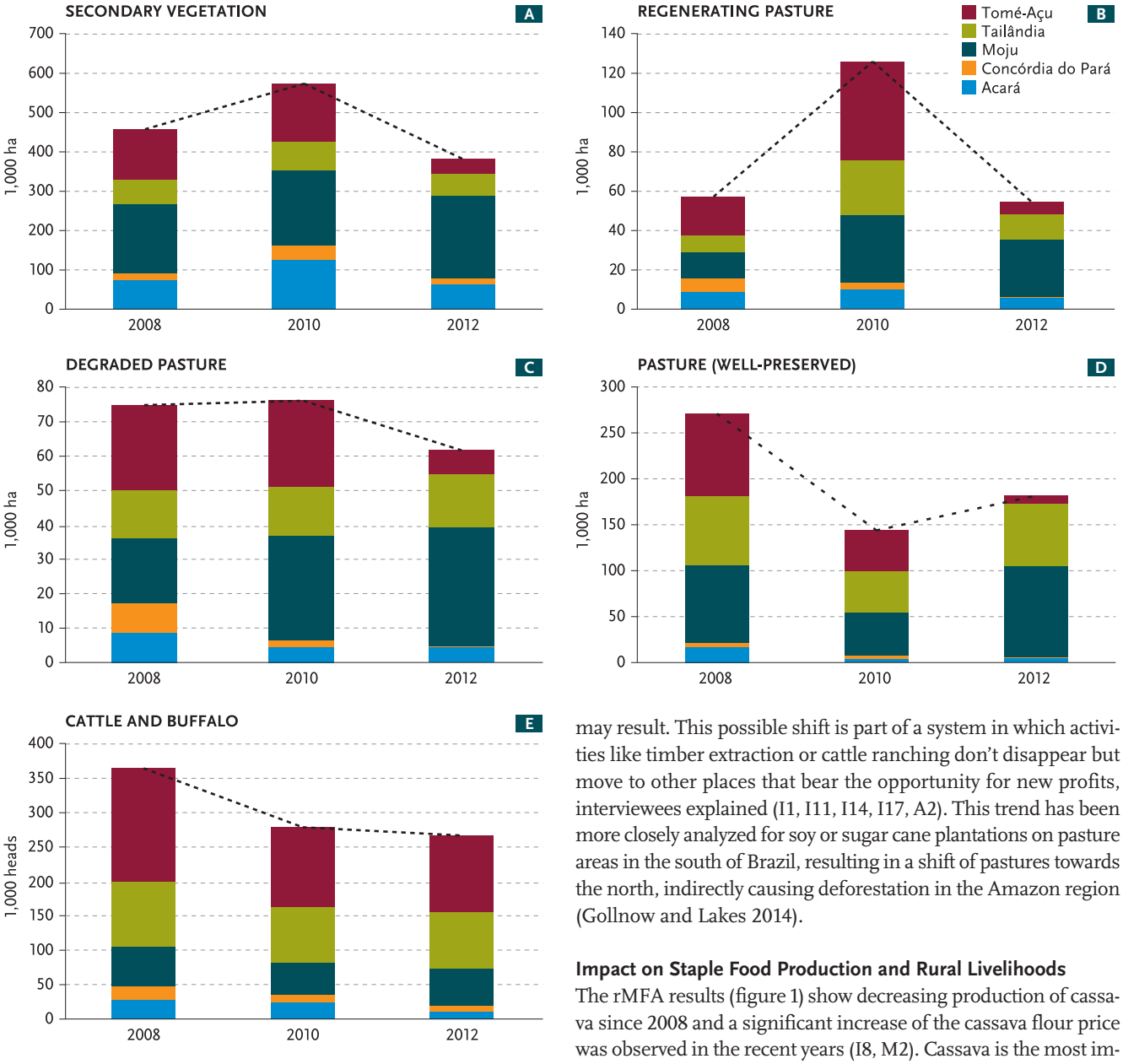
This succession of land use stages reveals a close relation between deforestation, cattle ranching, and oil palm plantations and points to the high relevance of temporally distal drivers in understanding the current development.

The deforestation rates obtained through remote sensing highlight that in the early 2000s, up to 80 percent of the community areas were already deforested. The restriction of the *PPSPO* of palm plantations to areas deforested before 2008 is therefore a rather weak criterion for sustainability and not highly consequential in this region.

Land Use and Cover Change and Indirect Deforestation

The link between pasture and oil palm plantations can be further understood using land use and land cover data. We find that, between 2008 and 2010, fallow land (degraded and regenerating pasture and secondary vegetation) increases markedly (figure 2 a–c). Well-preserved pastures (figure 2 d), on the other hand, decrease in all communities. A parallel development can be observed for livestock population (figure 2 e), in contrast to a strong increase of cattle in the rest of Pará (IBGE 2015, own calculation). The increased production of oil-bearing crops, notably palm fruit, which occurred during this time and had to take place on deforested land, must have mostly taken place on former pasture land; this corresponds to the assessment provided in most of the interviews. Given the significant rise in land prices after 2005 and especially after 2009 (Silva 2015), it appears to have been more profitable to let pastures lie fallow and eventually sell them to palm oil companies than to use them for extensive cattle ranching:

FIGURE 2: Land use and land cover in 1,000 hectares (a–d; note the differences in the scaling of the y-axes) and livestock population (cattle and buffalo) in 1,000 heads (e) between 2008 and 2012 in all five communities of Tomé-Açu.



"Land use decisions are strongly related to changes in the land market. This indicates why these (pasture) areas were sold to the global players of the palm oil sector. Once the famers understood that land prices were up, they saw the advantage of the moment to sell the properties to the companies installing in the region." (I19, translation CK)

As demand for meat remains high in Brazil and internationally, there is a socioecological risk inherently associated with the decrease in cattle ranching on already deforested land: the shift of livestock systems further into resource frontier regions in the inner Amazon where there is less control and new deforestation may result. This possible shift is part of a system in which activities like timber extraction or cattle ranching don't disappear but move to other places that bear the opportunity for new profits, interviewees explained (I1, I11, I14, I17, A2). This trend has been more closely analyzed for soy or sugar cane plantations on pasture areas in the south of Brazil, resulting in a shift of pastures towards the north, indirectly causing deforestation in the Amazon region (Gollnow and Lakes 2014).

Impact on Staple Food Production and Rural Livelihoods

The rMFA results (figure 1) show decreasing production of cassava since 2008 and a significant increase of the cassava flour price was observed in the recent years (I8, M2). Cassava is the most important staple in the region, and 95 percent of it is produced by small-scale farmers (IBGE 2006) for subsistence consumption and local markets (Embrapa 2008). Low-income households spend a high proportion of their budget on cassava flour (IBGE 2010) and are therefore strongly affected by changes in availability and price.

Two explanations for the drop in cassava production were extracted from the interviews: 1. the area available for cassava production decreased, and 2. the number of people producing cassava decreased.

The land use analysis supports the first reason and indicates an important link to the expansion of oil palm plantations. Between 2008 and 2010, "fragmented land parcels" – land used by >

small-scale farmers – fell from almost 200,000 to about 60,000 hectares. In proximity to designated plantations, much of this land was bought by palm oil companies, often through a practice known as *grilagem*[7], for reforestation with native vegetation. Plantation owners thereby meet the requirements for forest reserves that they are legally obligated to maintain alongside agriculturally productive land (A7, MMA 1998).

In order to include small-scale farmers in the expansion of palm plantations, the *PPSPO* offered a credit scheme for initial production costs, which, according to the Associação Brasileira de Produtores de Óleo de Palma, 1,124 smallholders in Pará had joined by 2014, with over 30,000 hectares of land (Mota et al. 2015). Nahum and Santos (2015) even account for 1,171 contracts signed by smallholders in Tomé-Açu alone, suggesting that approximately ten percent of the small-scale farmers in the micro-region had joined the credit scheme. For oil palms, the credit granted is significantly higher than for other crops. Producers of oil palm fruit are guaranteed purchase of the harvested fruits at fixed prices by the companies. In contrast, price-volatile cassava became less attractive. Included small-scale farmers typically used half of their land (on average ten hectares) for oil palm; the remaining resources (land, time and/or labor power) often do not suffice to simultaneously maintain food or subsistence agriculture (I8, I9, I19, A3, Mota et al. 2015, Silva 2015). Still, "for somebody in this situation (of a small-scale farmer), having no loophole, palm oil production should not be totally demonized. We know that better alternatives exist but it is the palm oil production that is supported by public policies" (I13, translation CK). Research on the oil palm expansion in Indonesia has identified the integration of small-scale farmers into large-scale corporate plantations as affording the "double advantage" of maintaining control over population (especially in remote areas) and of attracting foreign investment (Brad et al. 2015). A similar argument could be made to Amazon region as well. The measures to include people in palm oil production also resulted in a decreasing number of farmers producing cassava (explanation 2). In addition, new employment opportunities arose, not only on the palm plantations but also in associated services.

Contract farming and new employment opportunities were associated with a regular income, a perceived advantage compared to the uncertainties of fluctuating cassava production, and hope for improved livelihood and economic security is attached to the palm oil sector. With the expansion of plantations, health and education services also improved, due to the local governments' persistent negotiations with the palm oil companies, an interviewee in the community Acará explained (I21). The working conditions on the plantations, however, are precarious (I19). In the community of Moju, a plantation already appeared on the "dirty list"[8] of slave work. Income from contract farming and plantation labor proved to be less secure than anticipated. Prices for palm oil and production costs are volatile, and, during the field research period in the micro-region, several hundred plantation employees were laid off in three communities due to the economic recession (C2, A3, TA1).

The concurrence of the plantation expansion in Tomé-Açu with alternative production and income opportunities allowed it to become decisive in also indirectly (across a functional distance) shaping land use decisions and changing the basis of rural livelihoods.

A System-wide Perspective Is Needed

We find that the expanding oil palm plantations in Tomé-Açu are deeply integrated with social dimensions and historically grown patterns of land use. Even before the *PPSPO* credit scheme emerged, the prospect of financial support and income dictated planting decisions of small-scale farmers. The biophysical dimensions of land use changes well underway prior to plantation expansion also constitute an important explanatory variable for land use decisions: deforestation in the young Amazonian communities created a legacy for further deforestation. By not sufficiently considering the indirect effects of past and current land use decisions, sustainability initiatives such as the *PPSPO* may result in a spatial shift of deforestation rather than avoiding it. Any political program that does not take a system-wide perspective is unlikely to be ultimately successful in contributing to sustainability. As one interviewee said, the problem is not the palm oil per se, the problem is systemic in nature (I4).

For a rural community, the emergence of a new, intensely promoted crop can result in more than just changes in the agricultural production. It can lead to social changes that are strongly intertwined with fundamental changes in the "value" – in a social, cultural, economic sense and also in terms of sustaining human and other life – of land.

Charlotte Kottusch would like to thank all interview partners and other local contacts, supporting her during the field research, for their time and valuable information. Most direct quotes were in Portuguese and are translated to English, using as little alterations as needed in the translation process. The original quotes are available from the authors.

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7 *Grilagem* means "grabbing", a term used in Brazil to describe sale of government or private land by falsifying property documents. The *grileiro* appropriates land cheaply and sells it at a much higher price.

8 The "dirty list" *(lista suja)* is a cadaster of companies or persons who exploit and make use of slave work. The list is continuously updated on behalf of the Brazilian Labor Ministry (MTE) and the secretary of human rights (SHD) and presented by the NGO Repórter Brasil: *http://reporterbrasil.org.br/listasuja*.

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