Plantation Technologies: More-Than-Human Histories of Operationalisation in the Palm Oil Production Territories of Johor State, Malaysia

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Abstract

In this article we investigate plantation agriculture as a technology aimed at extracting natural resources, utilising unpaid labour, and installing regulatory authority. Using the oil palm plantation territories of Johor State in Malaysia – a core zone of palm oil production, manufacturing and export – as a case study, we ask how more-than-human assemblages enabled the expansion and refinement of oil palm plantations in Malaysia and contributed to the material transformation of the territory. We also explore how plantations can be mobilised as an analytical device to study the urbanisation of territory through agro-industrial production. To explore those questions, we present three episodes of more-than-human involvement in assembling oil palm plantation territories in Johor. Through the conceptual frame of the operationalisation of territory, we bring into dialogue literature on the Plantationocene with critical urban studies and the history of urbanisation.

Keywords

extended urbanisation, operationalisation, plantation, palm oil, Malaysia

Setting the scene: plantations everywhere

Compared to other vegetable oils and foodstuffs, the global production and omnipresent use of palm oil is a recent phenomenon. In less than a hundred years, a series of technological innovations, (geo)political interventions and vast socio-ecological transformations turned palm oil into the most productive and by far most used vegetable oil on the planet. Today, palm oil production is concentrated along the equatorial belt in Central Africa, South America, and Southeast Asia, with only two countries – Indonesia and Malaysia – accounting for 85 per cent of global production. Oil palm plantations in those countries cover an area of 120 000 km² – three times the size of the Netherlands or roughly the size of the American corn belt.

Southeast Asia's lead in palm oil production has been accompanied by a profound material transformation of the territory, primarily based on the logic of plantation agriculture. The plantation serves as the modus operandi of agro-industrial production, which includes the radical simplification, classification and replication of agrarian practices and social relations, steered towards an export market and governed by economies of scale. As a scalable technology, the plantation enables the expansion of agrarian production and associated forms of governance through uniform blocks – or pixels – without transforming the constituting parameters.[1] Thus, in their 'pure form', plantations work as idealised models, an operative vehicle aiming for the extraction of natural resources under capitalist modes of agrarian production driven by efficiency.[2] [Fig. 1]

In Johor, the use of oil palm as cash-crop was predated by a successive introduction of neotropical crops such as coffee, tobacco and sweet potato, and a sweeping territorial transformation based on rubber cultivation.[3] The introduction and fine-tuning of plantation agriculture, associated infrastructures, trading houses, and bureaucratic institutions based on rubber plantations set the scene for the spread of experimental oil palm plantations and the eventual expansion of the commercial production of palm oil.[4]

Today, more than 7 000 km² of Johor State are covered by oil palm plantations, accounting for three-quarters of the total land under cultivation.[5] Those palm oil territories are subject to transformative processes that drive, and in turn are driven, by rapid demographic change, economic restructuring, and large-scale land-use conversion. On the one hand, agro-industrial conglomerates focus on vertical integration and investments in the industrialisation of palm oil production through, for example, food processing and refining facilities. On the other hand, land available for large-scale oil palm cultivation is scarce, and scholars anticipate that farmers who pursue other forms of agriculture are likely to switch to oil palm cultivation in the future.[6] Simultaneously, rapid urbanisation and the expansion of urban centralities – not least driven by the proximity to Singapore – lead to the conversion of plantations into housing estates, commercial and industrial quarters. These structural changes have resulted in higher income levels and rising standards of living, leading to the disengagement of the local population from agrarian labour and growing (legal and illegal) employment of foreign workers.[7] Johor's latest demographic statistics (from 2020) classified 77 per cent of the population as living in urban areas, while agrarian indicators show that the state was in the lead in terms of agricultural gross domestic product per hectare farmland.[8] Through these statistics, Johor appears as a highly urbanised territory comprising large patches of industrialised agriculture mixed with different urban patterns that amalgamate to form the city of Johor Bahru at the southern tip of the peninsula. [Fig. 2]

In this context, historians have investigated the complex relations between colonial agrarian policies, labour regimes and capitalist modes of production that enable and reproduce plantation systems in Southeast Asia.[9] Ethnographic research has engaged with questions of labour, modes of governance and the political ecology of, and in, palm oil producing territories.[10] Additionally, scholars have challenged notions of the urban-rural divide through accounts of the urban integration of rural communities, and the growth of village populations in oil palm territories as an indirect effect of plantation agriculture.[11] The following article contributes to this body of literature by framing agro-industrial production as a process of urbanisation, highlighting the role of plantations as technological devices to commodify nature, resettle human and other-than-human labour, and install infrastructures to manage the extraction of resources.

Extended urbanisation in the Plantationocene

Urbanisation and agrarian production are often depicted as separate narratives in studies of the densification and expansion of the urban fabric and the more-or-less market-oriented extraction of resources to produce food and commodities. Different strands of research in geography, history and social science developed bridges between these separated lines of investigation by reading their simultaneity, interaction and mutual dependencies. To unpack the role of plantation agriculture in urbanisation processes, we will introduce the conceptual frameworks of extended urbanisation and the Plantationocene, which both rearticulate the relations of urbanisation and agrarian production. Then we introduce the notion of operational landscapes to frame agro-industrial production as a process of extended urbanisation, and the plantation as one of its manifestations.[12]

Since the early 1990s, a strand of research developed in critical urban studies engaged with territories of extended urbanisation aiming to investigate urbanisation processes beyond the limits of the city. Scholars analysed extended metropolitan regions, but also remote territories including forests and deserts, oceans and alpine landscapes, offering insights and methods for a structural understanding of socio-spatial and multi-scalar dimensions of urbanisation processes.[13] In this context, Brenner and Schmid have developed the conceptual triad of extended, concentrated, and differential urbanisation to define the theoretical framework of planetary urbanisation. Planetary urbanisation, they argue, 'requires new strategies of concrete research and comparative analysis that transcend the assumptions regarding the appropriate object and parameters for "urban" research that have long been entrenched and presupposed within the mainstream social sciences and planning/design disciplines'.[14] Dwelling on Henri Lefebvre's thesis on the 'complete urbanisation of society', they call for a shift in analysis from urban form to urbanisation processes.[15] While concentrated urbanisation is associated with urban agglomerations, extended urbanisation 'involves, first, the operationalisation of places, territories and landscapes, often located far beyond the dense population centres, to support the everyday activities and socioeconomic dynamics of urban life'.[16]

While Neil Brenner and Christian Schmid provide a conceptual framework to understand operationalisation as a process of extended urbanisation, Nikos Katsikis refines the concept in his study *From Hinterland to Hinterglobe*, to develop a territorial analysis of urbanisation processes on a global scale.[17] Applying Kasikis's conceptual apparatus to the case of palm oil territories, operationalisation involves the appropriation of natural resources through the alienation of land and the commodification of nature by various actors, the installation of infrastructures such as palm oil mills, refineries and shipping facilities, direct or indirect population control through resettlement schemes and urban programs, and a wide array of regulatory

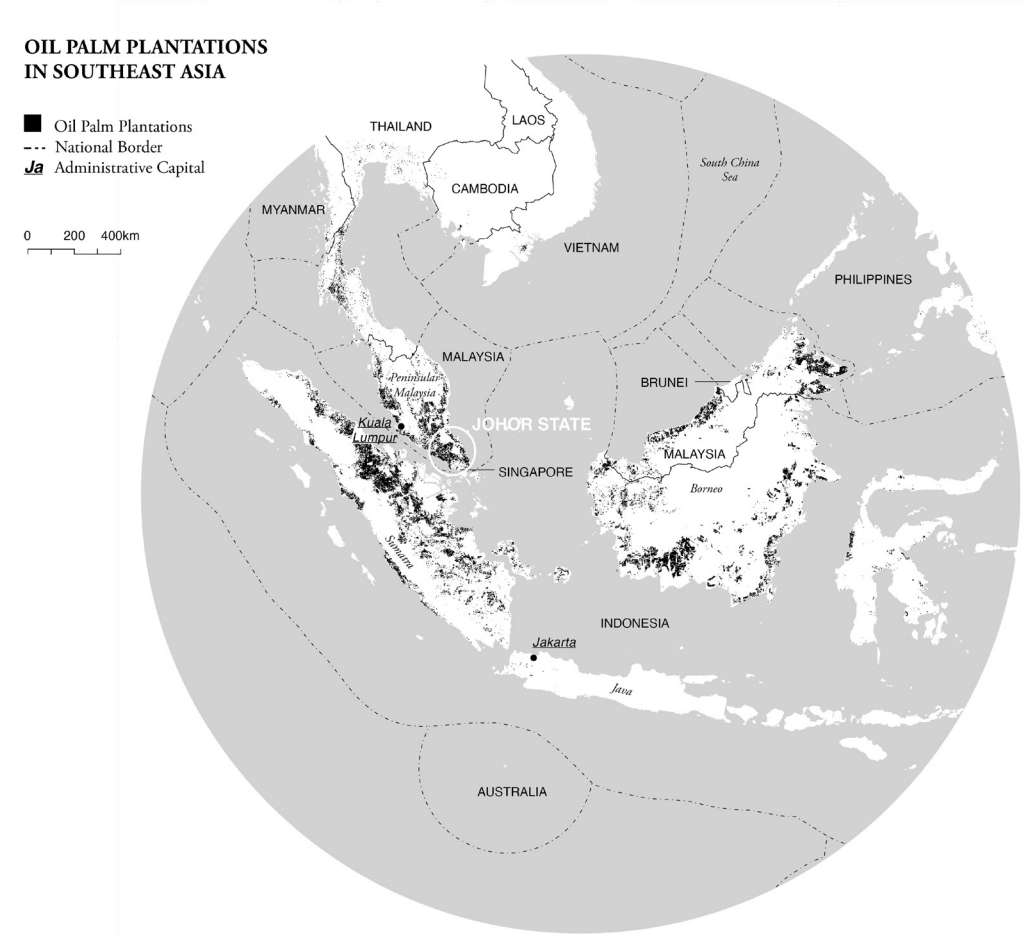

Fig. 1: Global and Southeast Asian palm oil plantations. Source: author. Data: Descals Adrià et al., high resolution global industrial and smallholder oil palm map for 2019 (version 1, 27 January 2021), *Zenodo*, doi:10.5281/zenodo.4473715.

mechanisms from state policies to international development programmes and sustainability standards. These notions of operationalisation engage with what Rania Ghosn calls the 'aesthetics of totalising abstraction' where operations dictate everyday life by sorting spaces of production through the logic of simplification, exploitation, and homogenisation.[18]

To move from the global scale of operational landscapes to the study of specific geographies of production and extraction, Rodrigo Castriota proposes to conceptualise operationalisation as an unfinished process, mediated through everyday struggles and appropriation.[19] This interpretation resonates with accounts of plantation life and everyday resistance described by Tania Li and Pujo Semedi in oil palm plantation territories in Indonesia.[20] Their work highlights that plantations are technologies for the operationalisation of territories, but that they can neither be considered independent entities without relations to the world beyond their boundaries nor are they devoid of internal modes of appropriation, sabotage or capture. Our preliminary research in Johor has revealed similar tendencies. At the first glance, different types of plantations – private estates, government-led smallholders, and individual smallholders – appear as district entities of production with their internal logics, but everyday experiences and appropriations reveal much more fluid spatial constellations. Even if power relations are centred around the milling infrastructure, everyday practices blur the boundaries between production entities and different types of plantation. What emerges are territories of palm oil production characterised by various degrees of operationalisation that are constantly negotiated, adapted, and rearticulated.

Therefore, we understand the conceptual notion of operationalisation not only in its abstract form or 'extreme degree of abstraction', but also as a set of practices deployed by a range of actors at different scales in an attempt to negotiate access to resources and extract agrarian products.[21] Even though territories of palm oil production are vast and appear monotonous, processes of operationalisation cannot be solely associated with the 'colossal' top-down management practices or state interventions.[22] The uneven and combined nature of production arrangements are always negotiated through local material practice, political claims and imaginaries.[23] As generic as operational processes appear in textbooks and managerial guidelines, the specificities of everyday life demand adaptation on the ground, rearranging agrarian routines and practices. Thus, understanding operationalisation as a process of urbanisation involves what Sandro Mezzadra and Brett Neilson describe as operations hitting the ground, unfolding 'moments in which they [operations] enter into complex relations (both generative and destructive) with different forms of life and matter.'[24]

Within the fields of political ecology and anthropology, researchers proposed to frame the current geological epoch as Plantationocene, to describe the socio-ecological consequence of agro-industrial production and account for the global prevalence of plantation monocropping.[25] While plantations have long been a subject of study in the fields of history, social science and economy,[26] a reinterpretation has developed around this conceptual notion, linking social science with ecological research in interdisciplinary discussions around the social, political, and economic workings of plantation systems.[27] The concept highlights the plantation as dominant form of agrarian production based on export crops, a model invented and developed through European colonisation and subsequently translated into various forms of contemporary capitalist agriculture.

Davis highlights the conceptual capacity of the Plantationocene to decentre Eurocentric narratives on the industrial revolution and to strengthen networked relations of social and natural entanglements. Drawing on Black geographic and ecologic literature on plantation histories, he calls for attention to the racial stratification of the plantation landscape.[28] Others have emphasised the need for both theoretical engagement with plantation systems and for grounded ethnographic research to grapple with the plantation as an analytical category and an ontic reality.[29] In addition to the racialising tendencies and ecological simplification of plantation systems, the focus of the Plantationocene discourse on a specific form of agrarian production – the plantations – calls for a spatial interpretation that has only partially entered the debate.[30] In Wendy Wolford's words, plantations 'embody both racial violence and resistance, straddling or bridging the divide between rural and urban, agriculture and industry, town and country, and local and global.'[31] Thus, plantations epitomise the dialectical relations of colony and metropolis summarised as 'synthesis of field and factory' and can be described as an example of how processes of extended urbanisation work and rework material realities on the ground.[32]

To account for a nuanced and localised reading of the Plantationocene, the role of more-than-human involvement in the histories of making and unmaking plantations has been the topic of several academic contributions.[33] Scholars draw on the work by Anna Tsing, Donna Haraway, Tim Ingold and María Puig de la Bellacasa to capture varieties of life forms associated with plantations.[34] These insights emphasise alternative cosmologies negotiated within plantations and engage with ecologies of reproduction and labour beyond the human body. The focus on seemingly marginal subjects of plantation territories questions the totalising singularity of monocropping and opens

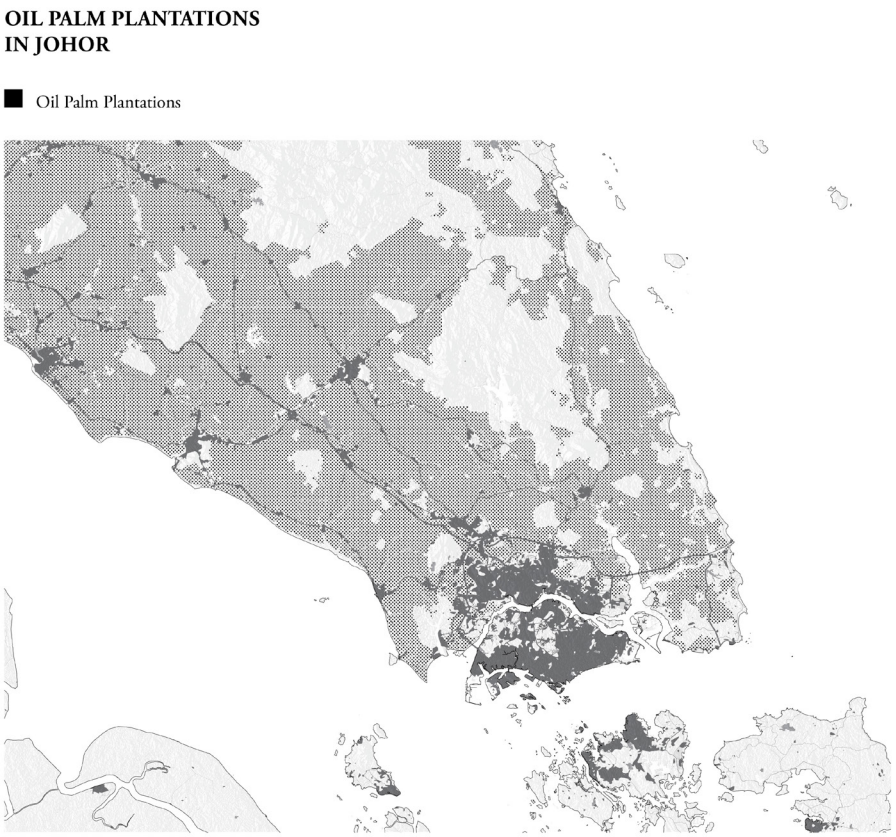

Fig. 2: Johor State palm oil plantations. Source: author. Data: Descals Adrià et al., high resolution global industrial and smallholder oil palm map for 2019 (version 1, 27 January 27 2021), ***Zenodo,*** doi:10.5281/zenodo.4473715.

a field of research engaging with specific modalities of operationalisation.[35]

Drawing on these theoretical frameworks, I refer to Jill Casid's 'Necrolandscaping, where she asks: 'If forests are flush with the chatter of humans and other species, can the plantation speak?' While Casid's reference to questions of agency and representation is evident, the aim of this article is not to shift away from anthropo-centrism by focusing on non-human lifeworlds per se, but rather to explore human and non-human relationships that led to the operationalisation of territory.[36] I follow AbdouMaliq Simone's novel approach to 'explore … what it means to inhabit the processes rather than places of urbanisation' by highlight how palms, weevils, and owls enable and contribute to the operationalisation of territories through oil palm plantations.[37]

In the following section, I investigate the spatio-temporal formation of Johor's and Southeast Asia's highly urbanised agrarian territory, and present three episodes crucial to the proliferation and solidification of oil palm plantations. The first episode on oil palms, highlights the role of botanical imperialism and the industrialisation of palm oil production, the second investigates non-human labour in enhancing the productivity of oil palm plantations through weevil pollination, and the third focuses on barn owls to highlight relations between methods of sustainable production and animal management.

Oil palm, *Elaeis guineensis*: the landscape as factory

The oil palm, *Elaeis guineensis,* can reach a height of thirty metres and an age of up to three hundred years. Fertilised female flowers produce fruits that grow and ripen over about six months. The fruits are sessile drupes borne on a large compact bunch, also called a fresh fruit bunch, with a weight ranging from 5 to 50 kg depending on the age of the palm, the genetic traits, and the environmental conditions.[38] A mature bunch contains a few hundred to a few thousand fruits which hold an average of 5 kg of crude palm oil and 0.6 kg of crude palm kernel oil.[39] [Fig. 3]

In its native environments, along the west and central coast of Africa, the oil palm provides not only edible oil, but is used as a building material, in handicrafts and to produce everyday objects such as carpets, mattresses and baskets.[40] Fresh fruit bunches have been harvested in semi-natural groves for thousands of years, and palm oil trade between Africa and Europe is documented since the sixteenth century. Traded quantities remained small until the early nineteenth century, when the British slave trade was officially abolished and traders foraged for new 'commodities' to keep their trading ships afloat. Discoveries in oil and fat chemistry opened the market for the use of palm oil in the production of soap, candles, and as a lubricant for industrial manufacturing. From the early 1800s onwards, merchants such as William Lever, the subsequent founder of Lever Brothers (which later became UniLever), sought to establish mono-crop plantations in Africa, with limited success. Political instability, internal conflict, and difficulties in obtaining land, providing transport and processing infrastructures are among the impediments cited as hindering the commercial success of large-scale oil palm plantations.[41] At the same time, oil palm seeds began to be distributed around the world by botanists who operated within colonial networks of plant collections and botanical gardens. In Southeast Asia, the botanical gardens of Bogor (on Java, within the Dutch colonial sphere) and Singapore (as a British outpost of the Royal Botanical Gardens in Kew) provided seeds to entrepreneurial planters.[42] As centres of research, propagation and economic experimentation, the botanical gardens became essential infrastructures and laboratories in the commercialisation of crops. The 'mastery of nature' through modern science in botanical gardens fostered the power and knowledge systems to expand the influence of imperial networks.[43] It is thus not surprising that one of the early descriptions of the economic properties of the oil palm circulated in Southeast Asia was published by Henry Ridley, the first director of the Singapore Botanical Gardens in 1907.[44] As part of the European imperialist project, the transplanting of plant specimens proved useful in erasing local cultural practices and cosmologies associated with their use and cultivation.[45] In colonial territories with similar environmental characteristics, plants could be turned into crops without any cultural 'ballast'.[46] This process of transplantation marked the transformation of the semi-wild harvested oil palm into a crop producing a globally traded commodity.

Contrary to most historic accounts of the distribution of oil palms in Malaysia, the first estate experimenting with large-scale cultivation was opened at Kluang, Central Johor in 1910.[47] In the 1920s, it was incorporated into the British/Singaporean Guthrie group, which was floated at the London Stock Exchange in 1924 and merged with two other conglomerates in 2007 to form the largest plantation company in the world in terms of land holdings, Sime Darby.[48] The Kluang estate remains operational today. It has gone through the fourth and fifth cycle of oil palm replanting on most of the plot. In plantation management, the 'critical age' for replanting oil palms is determined at twenty to twenty-five years, because the oil content of fresh fruit bunches begins to drop, and the harvesting of fruits above ten meters hight is not considered economically viable.[49]

Once harvested, the fresh fruit bunches need to be processed within twenty-four hours to prevent the build-up of fatty acids. Therefore, palm oil mills are crucial infrastructures dominating the production process and industrialising agrarian territories. During our fieldwork in Johor State,

Fig. 3: Plantation worker harvesting fresh fruit bunches with a 12-meter-long rod. Johor, Malaysia 2019.
Source: author.

interlocutors invariably called palm oil mills 'the factory', indicating the industrial character of palm oil production, despite the geographic location in the middle of agrarian landscapes. The 440 registered mills located in Malaysia have various production capacities from 20 to 120 metric tons per hour, and produce crude palm oil and palm kernel oil that is transported by trucks to shipping facilities or refineries. Compared to other states in Peninsular Malaysia, Johor is in the lead in terms of milling capacities and number of mills.[50] [Fig. 4]

The mill as industrial technology is a crucial element in agrarian change. Once installed, smallholders can change their cropping system and opt into the logic of plantation agriculture through out-grower schemes or by selling fresh fruit bunches to middlemen who supply the mill.[51] Even on the smallest plot of land, harvesting, maintenance, transport and processing of fruits are governed by the industrial logic of production and the rhythms of the plant's reproductive cycle.

This phenomenon can be observed in Pontian district in Johor, where a large share of individual smallholders planted oil palms during the 1980s.[52] The declining rubber prices, harsh environmental conditions for coconut production, and government subsidies for oil palm planting, together with the establishment of oil palm mills, triggered a substantial land use change.[53] Today, almost 70 per cent of the agrarian land in the district is covered by smallholder oil palm plantations.[54]

Li describes how the plantations' operational logic and infrastructural dominance spreads throughout the territory, creating 'saturated [palm oil] zones'. Plantations, she argues, expand to monopolise livelihood resources and subordinate law and governance to leave no outside for alternative forms of life.[55] Through the properties of the palm and associated milling techniques, the plantation model has been able to proliferate beyond the large scale plantation form, rooted in colonial estates, and expanded on smallholder landholdings.

Palm weevil, *Elaeidobius kamerunicus*: cheap nature

The main protagonist of the second episode is *Elaeidobius kamerunicus,* a brown to black weevil with an adult average length of around 2.5 cm. It is part of the *Curculionidae* weevil family, which is associated with a narrow range of hosts, in many cases only living on a single species.[56] The weevil is an important pollinator of the oil palm, but it is not native to Southeast Asia. Although it is tightly connected to the oil palm's reproduction, the weevil's introduction to Southeast Asia occurred much later, but had a profound impact on the production of palm oil and the plantation management.

In the early twentieth century, when commercial experiments with oil palms in Southeast Asia began to take off, human-induced artificial pollination became crucial.[57] Planters and scientists recommended assisted pollination to control fruit production and stabilise the supply of fresh fruit bunches for the mill.[58] Estate workers collected pollen from male flowers to dust receptive female flowers with it through hand puffers, or lance puffers for taller palms. The routine recommendation was for eight to ten rounds of pollination per month.[59] Assisted pollination increased yield and it was commonly assumed that oil palms were wind pollinated.

In 1976, the entomologist Rahman Syed was commissioned by Unilever to investigate the significance of weevils in pollinating oil palms. Through various experiments in Cameroon, he was able to confirm the role of weevils as important pollinators and the lack of animals in Southeast Asia as the reason for comparable low yields. He identified *Elaeidobius kamerunicus* as the most fitting species for Malaysia because it carries more pollen grains than other weevil, is adapted to wet and dry seasons, and is unable to breed on other host plants, minimising unintended environmental effects. Subsequently, the Malaysian government approved the import of an initial weevil population, which was released at the Unilever Mamor palm oil estate in central Johor on 21 February 1981. The release was celebrated in the media, and a newspaper article in the Singaporean Straits Times portrayed the weevil as potential 'labour-saving and production-improving device'.[60] The weevils personally released by Syed soon replaced assisted pollination previously performed by plantation workers. [Fig. 5]

During the early 1980s, monitoring of output performances confirmed the increasing production of fresh fruit bunches by 20 to 30 per cent.[61] While most subsequent publications focused on the productivity and environmental characteristics of the weevil population, the long-term effects on labour management and the social implications associated with the weevil's introduction were sidelined. Syed and Yusoff Hussein report an annual labour cost saving USD 60 million, since the practice of hand pollination was abandoned, while accounting for the increased yield led to an annual saving of USD 100 million.[62] The reported increase in palm oil production was found to be unevenly distributed throughout palm oil production territories. While Sabah on Borneo reported a 20 per cent increase in oil production per hectare, outputs at estates in Johor did not change due to other pollinating species and the effective human pollination which was already in place.[63] The yield per palm did not rise, because fresh fruit bunches increase in weight while the annual number of bunches decreased.[64]

Fig. 4: Video: Palm Oil Weevil release, Johor 1981. Source: https://www.youtube.com/watch?v=SpgYb44tpUM.

Fig. 5: Barn owl nesting box in an oil palm estate in Johor, Malaysia 2019. Source: author.

The introduction of the weevil had numerous effects on labour management on the plantation. It enabled the fine-tuning of fieldwork tasks that could not be mechanised, but were 'outsourced' to the pollinating insects. The workforce for hand-pollination was replaced by the 'cheap nature' of the weevil.[65] Human-assisted pollination was phased out and the reduced amount of fresh fruit bunches further diminished the labour required for harvesting. The effects of this reduction of labour inputs are not reflected in scholarly work other than the statistical accounting of the reduced labour force. Anecdotal evidence from fieldwork in Johor suggests that it was largely female casual labourers who worked in the plantations as 'pollinators' and lost their jobs. Resulting labour pools have been largely absorbed in downstream industrial facilities developed at the new Johor port. From the 1970s onwards, resource-based industrial complexes and port facilities have been developed in Pasir Gudang close to Johor Bahru.[66] The port and bulking facilities are fed by palm oil refineries, oleo chemical plants and other industrial facilities. Today, Pasir Gudang represents the largest concentration of palm oil refining industries and downstream activities in the world.[67]

The weevil as 'living technology' played a vital role in fine-tuning oil palm plantations as agro-industrial production complexes and solidified the logic of plantation agriculture in Malaysia.[68] While colonial projects of expanding agro-industrial production through plantations relied on enslaved, coerced, indentured, or otherwise exploited cheap labour, the introduction of the oil palm weevil signifies a shift towards efficiency based on the exploitation of natural resources. What was initially celebrated as a potential increase in yield, turned out to substitute labour input by operationalising 'cheap nature'.

Barn owl, *Tyto alba*: sustaining operations

The barn owl, *Tyto alba,* is one of the most widespread bird species in the world, occurring in a large variety of environments. Adult animals are thirty to forty centimetres tall, can live up to twenty years, and feeds on insects, amphibians, and rodents. As the English name suggests, barn owls are widely associated with human settlement and agrarian production. Similarly to the oil palm weevil, the barn owl was intended to work as cheap nature in the palm oil agro-industrial complex, but it gradually became a symbol for sustainable production practices.

In the 1960s, oil palm plantations started to expand significantly in Johor. The ecological simplification through monocropping triggered the spread of species that found shelter and abundant food sources in plantations. Among wild boars, snakes and squirrels, rats became a significant cause of plant and fruit 'damage' in the territories of palm oil production. For rats, oil palms are an ideal environment, as the crown can serve as a nesting site and the fruits growing there are a constant source of food. Consequently, the control of rat populations in plantations became a continual and costly operation.[69] The initial manager's response was chemical warfare: pesticides and baits were used in large quantities on oil palm estates.[70] The introduction of natural predators such as cats and snakes, as well as hunting, were among the experimental practices to keep rat populations at bay.[71]

When plantations and rats started to proliferate, the barn owl increasingly became a key species on Malaysian palm oil estates, solidifying its role as integrated pest control decades before discussions on sustainable production sparked public interest. The bird has been sighted as casual visitor in Malaysia, and the first recorded nesting was at the Fraser Estate in Johor in 1969. When it was estimated that rats make up 98 per cent of barn owls' diet on the plantation, and individual owls consume up to two thousand rats per year, the animal was rapidly incorporated into management programmes.[72] A potential limit to the growth of the population due to a lack of available nest sites triggered experiments with the design and introduction of nesting boxes from 1976 onwards.[73] The original design by Graham Lenton can still be found all over Johor and Malaysia, with slight modifications and materials variations. It consists of a basic box with a waterproof roof, an entrance and a maintenance shaft.[74] The box is mounted on a four- to five-metre-high pole to keep it safe from predators. The recommended density of nesting boxes varies from one per five hectares to one per ten hectares.

Since 1985, the Palm Oil Research Institute of Malaysia promoted barn owls as biological control agents.[75] Through breeding and research programmes the birds spread in tandem with the expansion of oil palm plantations. With a reported 20 per cent of the cost of baiting, the economic calculus enabled the incorporation of the species into the plantation system. However, the relations between rat populations and barn owls are more complicated: a minimum rat population must be maintained to feed the owls; owls' hunting grounds vary greatly, which makes accounting for their efficiency uncertain; and the specific targeting of rats might increase other rodent populations. Thus, Hereward Corley and Bernard Tinker conclude that 'the effectiveness and the economics of biological control of rats by owls remain uncertain'.[76]

A significant shift in the perception of the bird occurred during the early 2000s. The mounting pressure on the palm oil industry's environmental effects lead to the establishment of the Round Table on Sustainable Palm Oil (RSPO) in 2004. The global-scale NGO seeks to regulate the palm oil industry through auditing processes designed to guide

producers in fulfilling the principles set to achieve sustainable production. The principles are linked to specific practices and technical requirements. Criterion 7, titled 'Planet', includes Integrated Pest Management, to 'reduce pollution, minimise resource use, and optimise productivity'.[77] Through this framework of sustainable production, barn owls became part of a counter-narrative against the utilisation of the orangutan as key species of the campaigns against the palm oil industry. As natural predators of rats, owls did not only take up the work of cheap nature, but served as indicator species for integrated pest management at a time when the concept gained popularity in conventional agriculture.

The RSPO introduced a layer of techno-managerial practices to the palm oil industry by introducing global standards for the 'commodification of sustainability'.[78] Peter Vandergeest's work exposes how sustainable standards in the fishing industry assemble 'sustainable territories', deploying standards and governance structures, 'redefin[ing] bounded spaces for the purpose of controlling activities'.[79] Similarly, the RSPO legitimises territories of sustainable production through auditing practices based on plantation agriculture, which includes large estate plantations, managed smallholder schemes, or mills. While independent smallholders have been able to seek approval for their oil palm production since 2018, their participation in the market for sustainable palm oil remains marginal to this day.[80]

Despite integrated pest management practices, rodenticides continue to be used in palm oil plantations to control large rat populations, leading to the unintentional poisoning of barn owls and other non-targeted species through the consumption of contaminated rats. This was a less pressing issue until the 1980s, when warfarin-resistance was discovered in rats and a new generation of rodenticides, with more toxic ingredients, was introduced. The use of stronger poison reduced the population of barn owls at Fraser estate from forty to four in less than three years.[81] In a more recent case, barn owls were discovered being captured and traded illegally for meat consumption. In 2008, the Department of Wildlife and National Parks of Peninsular Malaysia confiscated over nine hundred frozen owls in Muar, Johor, with evidence suggesting they were collected by covering nesting boxes with nets or hunting along the edges of plantations. Prior to this uncovering of wildlife trade, owls had not been associated with illegal capture and trade.[82] It can be estimated that the seized animals covered 10 per cent of Johor's oil palm plantations, but no changes in population were reported by plantation managers.[83]

The example highlights how overreliance on barn owls as a pest control method can lead to unintended consequences, such as a breakdown of the predator-prey system or overpopulation. Brian Wood and Chung Gait Fee conclude that there is no evidence to demonstrate that the introduction of barn owls for rat control 'has any advantage over simply allowing "natural" predation to restore'.[84] Consequently, the barn owl has become a heraldic animal for integrated pest control, expanding managerial practices of population control to non-human actors rather than engaging with natural fluctuations between pests and their various predators. Questions of how to monitor and respond to fruit damage remain, and the emergence of new management systems, such as biological pest control, as well as new pests, are constantly challenging plantations' fragile ecologies.

Plantation technologies and territories of extended urbanisation

Concluding, we would like to highlight three crucial aspects of more-than-human involvement in shaping oil palm plantation as technologies of extended urbanisation in Johor and Southeast Asia. First, the oil palm's vegetal agency illustrates how temporal rhythms of production are inscribed into the landscape and social structures, leading to the urbanisation of the countryside through industrial temporalities. Contrary to other plantation crops, such as cotton, 'the factory' (mill) never left the fields. Wolford's description of the 'metabolic rift of colonial agriculture', the shift of factories towards the metropolis, did not emerge in the palm oil industry, leading to the effective industrialisation of the countryside.[85] Second, while oil palm plantations have largely resisted efforts to mechanise production until today, animals serve as alternative technologies of cheap nature. The introduction of the oil palm weevil did not increase production but reduced labour inputs, providing profits based on the exploitation of non-human labour. The available human labour was absorbed in downstream manufacturing and industrial agglomerations such as the Johor port, leading to the depopulation of the countryside. Third, the example of the barn owl highlights how market participation is substantiated through transnational governance structures for sustainable production. As an allegory of environmentally friendly management practices, the barn owl was integrated into sustainable production while the efficiency of barn owl-related rat management became side-lined.

The episodes outlined above illustrate the intricate interconnections of agro-industrial production and more-than-human life in plantation territories. The plantation as a managerial and spatial category of analysis enables us to trace the patterns and pathways of extended urbanisation in their specific spatio-temporal trajectories. On the one hand, the material transformation of the countryside through plantation agriculture highlights the interconnectedness of

colony and metropolis, or centre and periphery. It reveals the ongoing extraction and gradual exhaustion of natural resources in a continuous expansion of the frontier of commodification – from land and human labour to chemical inputs and cheap nature – and exposes the potential emergence of 'plagues of planetary urbanization', which are nourished through the simplification of agrarian territories.[86] In the case of Johor, the dialectics of extended and concentrated urbanisation manifest in the industrialisation of the countryside, the agglomeration of manufacturing and processing facilities, and associated urban development.

On the other hand, through the notion of operationalisation, it becomes apparent how the plantation as a managerial system transforms the territory beyond the estate boundaries, incorporating villages, smallholders and middleman into the logics of agro-industrial production. The more-than-human perspective allows for an understanding of operationalisation as an urbanisation process that can be established, deepened, and reoriented. Thinking with operationalisation thus involves constantly asking who operationalises what for whom and why. In this context, operationalisation does not appear as a linear process of industrialisation or mechanisation, but includes a host of actors aiming for different goals in a complex socio-ecological territory. Beyond the colossal techno-infrastructures of production and circulation, the inquiry into more-than-human entanglement enables an engagement with the background – or the 'ordinary' forms – of extended urbanisation through the specificities of palm oil production. Although scholars have long challenged the statistical representations of urbanisation in Southeast Asia, arguing that rural dwellers are by and large well-integrated into urban or 'more-than-rural' modes of living and inhabitation, Johor's agro-industrial territories of palm oil production are still described as rural, peripheral landscapes.[87] In this article, we emphasise that the operationalisation of territory through palm oil production has significantly transformed the social and environmental conditions of Peninsular Malaysia by rendering palms into factories, weevils into labour and owls into regulatory guardians of sustainable production, shaping the plantation as a technology of extended urbanisation.

Notes

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Biography

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