

Multi-level actor-network: Case of Peatland programs in a Riau Village, Indonesia (1974–2020)

Yuti A. Fatimah^{a,b,*}, Zaenuddin Hudi Prasajo^c, Stuart W. Smith^{a,d}, N. Estya B. Rahman^a, David A. Wardle^g, Kwek Yan Chong^e, Asmadi Saad^f, Janice S.H. Lee^a

^a Asian School of Environment, Nanyang Technological University, Singapore

^b Department of Sociology, University of Cambridge, UK

^c Department of Religious Studies, Pontianak State Institute of Islamic Studies, Indonesia

^d Department of Ecological Sciences, the James Hutton Institute, UK

^e Department of Biological Sciences, National University of Singapore, Singapore

^f Department of Soil Science, Universitas Jambi, Jambi, Indonesia

^g Department of Ecology and Environmental Science, Umeå University, Sweden

ARTICLE INFO

Keywords:

Actor-network theory
Non-human
Survivability
Transition

ABSTRACT

This paper studies the survivability of peatland-related programs in Indonesia. Despite an increase in the global and national programs for peatland restoration, many of these programs fail to survive in the long-term. To understand this low survivability, this paper examines how peatland-related programs re-arrange the relationship between the local community and peatland across time and how the new actor-network contributes to the survivability of peatland programs. We develop a multi-level actor-network framework that combines the multi-level perspective from transition studies to capture the stability of actors' relationships and power from actor-network theory to investigate how activities mobilise human and non-human actors to comply with a specific program. Our research shows that non-human actors such as peat, paddy, Acacia, and fire shape peatland-related programs by resisting non-suitable crops, by re-shaping the program, by mobilizing human actors, and by creating pressure to the existing regime. We highlight that the survivability of peatland restoration programs is strongly influenced by how they are adjusted to the materiality of these non-human actors. Given the importance of peatland restoration programs, our study provides an approach in which human and non-human come together to generate plural voices to ensure the survival of peatland restoration programs.

1. Introduction

In Indonesia, over 2.6 million hectares of land were damaged by fire between July and November 2015, emitting an estimated 1157 tonnes of carbon dioxide into the atmosphere (Heymann et al., 2017). During this fire period, there were many days when the Indonesian daily emissions exceeded the US daily fossil fuel emissions (Van Der Werf, 2015). These significant carbon emissions were caused by the burning of 876 thousand hectares of carbon-rich tropical peatlands (Foead, 2016); (Marlier et al., 2015; Turetsky et al., 2015). In pristine conditions, tropical peatlands are not highly susceptible to burning because they are waterlogged. However, when drained, cleared, and converted to plantations and other human activities, peatlands are increasingly at risk of fires (Tacconi, 2016; Turetsky et al., 2015; Miittinen et al., 2017). Peat

fires contribute to smoke-haze pollution in Indonesia and neighbouring countries, resulting in negative impacts on people's health, such as premature mortalities and respiratory ailments (especially across Indonesia, Singapore and Malaysia; (Astuti, 2021; Koplitz et al., 2016)), disruption to the transportation and financial sectors, and environmental damage such as biodiversity loss. In addition, the fires cost the Indonesian economy an estimated 16.1 billion USD (Glauber et al., 2016; Uda et al., 2019; Wooster et al., 2018).

In 2015, in response to the substantial negative impact of peat fires and the resultant haze pollution, the Indonesian government through the Peatland Restoration Agency ('Badan Restorasi Gambut' or BRG) developed a plan to restore 2.4 million hectares of peatland over five years (Safitri, 2016). The targeted restoration areas consisted of non-concession areas, of which 684,637 ha are protected areas (national

* Corresponding author.

E-mail address: yaf21@cam.ac.uk (Y.A. Fatimah).

<https://doi.org/10.1016/j.geoforum.2023.103829>

Received 27 October 2021; Received in revised form 27 April 2023; Accepted 21 July 2023

Available online 28 July 2023

0016-7185/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

parks and wildlife reserves) and 396,943 ha are non-licensed production areas (production forests and forest for other land uses). The area covered by state land leased to companies (concession areas) is 1.4 million hectares and this is managed by oil palm, pulp and, rubber companies under concession rights, through which these companies have to restore the land under the supervision of the Ministry of Environment and Forestry (MOEF) (Budiman and Hapsari, 2021; Dohong, 2017). The Indonesian government allocated 60 million USD from its national budget and received 184.6 million USD from Norway, the US, the UK, Japan, Germany, and the Netherlands to fund the restoration activities (Sari et al., 2021). This funding was used for peatland restoration, which the BRG conceptualized as the 3-Rs, namely *Rewetting* to restore hydrological function through canal blocking to retain water and increase groundwater levels, *Revegetation* to restore plant canopy cover, and *Revitalization* to improve economic outputs from the land (Safitri, 2016).

The 3-R activities were implemented at the village level through a program approach where the local actors were given tasks following specific procedures within a limited time and budget to achieve definitive goals (MOEF Regulation No. 61/2017). The specific procedures included forming a community group (*kelompok masyarakat*) to conduct the 3-R activities (Pandora, 2020), conducting a feasibility study by a university or research organization in proposed villages, and submitting a monitoring and evaluation report that covered the financial and physical progress of the program (MOEF 2017). While these specific procedures were designed to promote local inclusion, studies in Central Kalimantan, Riau and South Sumatra found that many of the revitalization projects only benefited the village government officers and their affiliated groups rather than the broader local communities (Budiman et al., 2020). Additionally, a study in Sumatra showed that most smallholders were not included in the process of building canal blocks on their farms (Ward et al., 2021), and there was a lack of ground-truthed data in the planning process resulting in the selection of villages without peatlands as restoration villages (Budiman and Hapsari, 2021). Revitalisation projects also often did not incorporate local peatland plant species in the restoration designs and instead selected exotic, i.e., non-native, plant species (Budiman et al., 2020). Lack of ground-truthed data also led to some villages only receiving revitalization programs that did not involve rewetting or revegetating of peatlands, despite biophysical restoration being needed to deter wildfire spread (Budiman and Hapsari, 2021; Harrison et al., 2019).

Transforming peatland issues into specific procedures and measured results follows what Li (2007a,b; 2016) described as 'rendering technical'. This allowed the government to justify their success based on technical procedure while excluding other elements. This reduction allowed dominant actors to use the program as a means to advance their own agendas that had no direct relation to the environment (Miller et al., 2021). In the long run, failure to deliver expected outcomes threatens a program's survivability and creates more profound distrust between the actors involved (Reed et al., 2018). To understand how the non-local programs reassemble the relationship between the local community and peatland across time and how the new assemblage contribute to the survivability of these programs, this paper develops a multi-level actor-network framework by combining multi-level perspective (MLP) from transition studies (Fuenfschilling and Truffer, 2014; Geels, 2011, 2002) and power from actor-network theory (Callon and Law, 1997; Latour, 2005, 1987). Our analytical framework places a program as a distortion to the existing human and non-human network and elaborates how the distortion leads to a shift from an existing network to a new network.

To illustrate our framework, we analysed peatland agricultural and restoration activities in a village in Riau province, Indonesia from 1974 to 2020. The village was selected because it has hosted multiple national programs with multi-level interactions. The village also experienced multiple pressures in the form of a land policy change and forest and peat fires. These pressures opened a window of opportunity for changes

at the village level. The dynamics of the village make this an apt case for examining the multiplicity of top-down interventions in the village in terms of including specific members of the community while excluding others and how these interventions were embedded in the institutional settings. The paper is divided into five sections: (1) the conceptual framework elaborating the concept of multi-level perspective and actor-network theory; (2) the methodology detailing our data collection and data analysis; (3) the analysis detailing the life and death of peatland-related programs using the multi-level actor-network framework; (4) discussion focusing the role of non-human actors with regards to power and agency, and (5) concluding remarks highlighting our contribution to the existing conservation on human and non-human actor-networks.

2. Conceptual Framework

We combine the multi-level perspective from transition studies that puts actors' relationship in three groups based on their degree of stability and power from actor-network theory that sees actors' ability to mobilize others as relationally constructed. The multi-level perspective allows us to understand stability of a network. In contrast, the actor-network theory allows us to highlight continuous tensions between one network and the others. By combining these two opposing approaches, we can follow the grouping and re-grouping process of an actor-network. This combination is built on a relational approach where stability and power are not the actors' inherent properties but rather the results of their relationships (Barad, 2007).

2.1. The Multi-level Perspective

The multi-level perspective (MLP) emerged among scholars from the history of technology to explain a technological transition process (Geels, 2002; Rip and Kemp, 1998). This multi-level perspective has been expanded to include general historic transition cases (Jørgensen, 2012). The term 'transition' in MLP refers to shifting from one socio-technical regime to another, such as from a diesel regime to a biogas regime (Fallde and Eklund, 2015). MLP is developed by adopting the idea of the selection process from evolutionary economics and the history of science, specifically on how technical devices, engineering practices, and scientific knowledge are selected against other possible options in a context of a broader institutional system, including market, policy, and norms (Markard et al., 2012; Geels, 2011); .

MLP incorporates three levels, namely: niche, regime, and landscape. The niche refers to experiments, innovation and new activities done by a limited number of actors in a limited network (Geels and Raven, 2006; Raven et al., 2011). Niches may occur in the laboratory or the market, where an invention (or a new product) operates on selection criteria that differ from existing products in the socio-technical regime (Geels and Raven, 2006). The niche grows when the new invention follows the processes of articulating expectations and visions, social networking to build support for the invention, and learning, e.g., how the invention can survive in terms of technical aspects, markets, values, infrastructure, regulation and socio-environmental effects (Schot and Geels, 2008).

The regime refers to a semi-coherent set of rules embedded in a socio-technical configuration of financial rules, technical, norms, cultures, markets, policies, knowledge and infrastructure (Geels, 2002; Markard et al., 2012; Rip and Kemp, 1998). For instance, legal forces that successfully reduce forest loss is a regime in a deforestation socio-technical configuration through its embeddedness in a norm of close monitoring, enforcement policy, and market intervention (Weng et al., 2020). However, this legal regime can be destabilized through competition with a market regime that changes the forest policy to support the reduction of protected areas.

Landscape refers to factors that change very slowly, including physical climate, oil price fluctuations and long-term changes, e.g., demography (Driel and Schot, 2005) as well as physical hazards, such as storm, tornado and drought (Becker and Reusser, 2016; Weng et al.,

2020). In MLP, the landscape is being observed through its action to putting pressure on existing regimes (Markard et al., 2012). For instance, drought created pressure on a market-driven regime and enabled the emergence of a forest monitoring regime (Weng et al., 2020).

MLP has been criticized for underplaying the role of agency and its inconsistency in using the term regime (Coenen et al., 2012; Fuenf-schilling and Truffer, 2014; Geels, 2011; Smith et al., 2005). We contribute to the MLP literature by proposing agency as an emergent effect of human and non-human relations and conceptualizing regime as a form of an actor-network.

2.2. Power in Actor-Network

Using actor-network theory, we conceptualise power as activities to mobilise human and non-human actors to comply with a specific program and remain stable as a whole (Callon, 1984; Latour, 1994, 1990). We place agency and power as mutually constitutive where agency is enabled through and against power (Fatimah, 2016). In accumulating power, dominant actors try to mobilize other actors to follow a specific program through multiple ways. This can take form in a participatory process where certain actors mobilize others through defining how participation should take place and who should be included, and defining this evaluation criteria is a part of power accumulation (Cornwall, 2002). Participation as actions to mobilize support, build trust and maintain the durability of a project (Ostrom, 2014; Reed et al., 2018; UN, 1992; Cornwall, 2002) (and as an empowering process for the local community to gain control of their lives (Chambers, 1994; Williams, 2004) can therefore be seen as a tool to bind others into the structure of power or an act for those with power so that they look good (Kothari, 2001).

To be more inclusive towards community voices, scholars propose the inclusion of local knowledge (Akbulut and Soylu, 2012), the promotion of 'bottom-up' initiatives (Chambers 1994; Lane and Corbett 2005), and the adoption of various participatory tools (e.g., Rapid Rural Appraisal and Participatory Rural Appraisal) as ways to incorporate local opinions and knowledge (Cornwall and Pratt, 2011). However, these ways of inclusion may not guarantee just participation. Lane and Corbett (2005) show that 'bottom-up' approaches can be used to maintain the status quo of local elite domination over the indigenous community. This follows critiques against the romanticizing of communities as capable of doing anything (Cleaver, 2001), ignoring the politics of communities (Agrawal and Gibson, 1999), and oversimplifying the heterogeneity of the 'local community' (Williams, 2004). Furthermore, (Delabre and Okereke, 2020) show how a company used participation in a social impact assessment as a tool to gain legitimacy of their presence from the local community. These examples imply how actions of including marginal actors in a meeting or a collective activity legitimize the existing structure rather than allowing them to create change (Arnstein 1969).

Using actor-network theory, we see participation not from its ideals to promote inclusion and empower people but from its action to mobilize actors. For example, despite the legal possibility of shaping how a project should run, women were being 'silenced' in a meeting by normative expectations or linguistic gaps (Cornwall and Coelho, 2007). This illustration shows how power is being performed through a web of relations in a temporal actor-network where normative expectations work beyond legal norms. This temporal actor-network is made durable by embodying daily gestures such as where women sit at a mixed gathering. This temporal actor-network is continuously contested through a series of mobilizations, such as when wealthy farmers accumulated power by mobilizing production machines and peasants performed their agency through foot-dragging, desertion, and false compliance (Scott, 1985).

We adopt a symmetrical relation between human and non-human actors where human and non-human's 'actions' are articulated

through the changes they can create and not based on their intentions (Latour, 1996; Murdoch, 1997). These relations shows that actors' agencies are distributed, and actions derive from a collective of human and non-human actors (Callon and Law, 1997; Latour, 2014; McGregor et al., 2019). We use this distributed agency to investigate how programs, which often comprise technical design, financial support, infrastructure, and technoscientific experts, can mobilize local actors and hold this new actor-network together as a whole. Non-human actors can re-shape an actor-network by resisting representation and calculation by the human actors (Callon, 1984; Fatimah and Arora, 2016), multiplying itself to smother the feed crops needed by the cows to produce milk (Shepherd and Gibbs, 2006), mediating the local and international community through a flexible bush pump (de Laet and Mol, 2000), and changing the techno-political landscape of Egypt during the early 20th century through the presence of mosquitos and malaria (Mitchell, 2002). These examples imply how non-human actors can re-shape an actor-network at different levels and scales through their relationship with others. By combining actor-network theory and the MLP, we develop a framework that allows us to capture the role of non-human actors in re-shaping actor-networks at three levels of stability.

2.3. Multi-level Actor-Network

There is extensive literature that experiments on the human and non-human relationship through terms like assemblage (Li, 2007b), hybrid collective (Callon and Law, 1997), more-than-human (Whatmore 2006; O'Gorman and Gaynor 2020), and post-human (Margulies and Bersaglio 2018). This research elaborates on the network of humans and non-humans in their relationships to the limit of power since the ability of an actor-network to mobilize actors is an effect of a stable web of relations (Kim, 2019; Law, 2002). In the actor-network theory literature, stability of an network is obtained through adding non-human actors to the network (Latour, 1990), prescription and negotiation (Akrich, 1992; Murdoch, 1998), convergence (Callon, 1990), and translation (Callon, 1984; Strong and Letch, 2013). A stable condition represents a 'cold situation' where agreement regarding ongoing problems is reached (Callon, 1998). However, in practice, a 'hot situation' where everything is controversial becoming more invasive due to the growing complexity of industrialized societies (Callon, 1998).

By adopting multi-level perspective from transition studies, we elaborate the co-existence of hot and cold situations through niche, regime, and landscape. These three levels represent a temporal actor-network with a specific procedure/routine based on their degree of power, with niche as the lowest and landscape as the highest. Using these terms, we can articulate actors' degrees of power in mobilizing other actors to comply with a specific command or procedure. At the lowest degree of power is a niche, a web of relations consisting of limited actors and its location in a specific setting, such as a laboratory or a legal setting. The regime has a more stable power in locking actors to follow specific commands. This power is afforded by the interconnectivity between actors and the presence of actor(s) with high connectivity. By being related to more than one actor, these actors lock others that have also lost their autonomy (Latour 2014). Landscape has the highest degree of power. However, its type of power is the opposite to that of the regime. While regime actors perform power through accumulation and mobilization, landscape actors perform power through destruction and shock. Its connection to regime actors allows landscape actors to mobilize actors to go against a regime.

3. Methodology

This research is part of a project on the role of community participation in Indonesia's peatland restoration project that has been approved by the University Institutional Review Board with reference number IRB-2019-06-067. For the data, we used multiple data sources, including field visits, reports, newspaper articles, discussions with

scholars who have done previous studies in the area (Salim et al., 2018; Thorburn and Kull, 2015), research articles, 17 semi-structured interviews typically of 60–120 min in length, observations of two community events, including a local festival and a fire prevention meeting between November 2019 and October 2020. In selecting the respondents, we adopted a snowballing approach where we selected three respondents from different groups as our starting points and asked them to refer us to other related actors/respondents. The three respondents were selected to reduce the selection bias (Parker et al., 2019). Despite its limitation of selection bias, the approach is considered as a highly effective technique for studying actors who are hidden and difficult to reach (Waters, 2015). The approach is also in line with our interest to understand the actor-network by following the actor (Latour, 1987). The snowballing gave us the following respondents: an expert hired by an international non-governmental organization (NGO), two heads of regional NGOs, a member of a regional NGO, five persons from local community groups, a person who was paid for revegetation activities, four sago entrepreneurs who were also the village elders, and three persons from the village apparatus.

We started analysing the interview data by arranging all the events, covering who was involved, when it happened, where and how the event happened according to our multi-level actor-network framework. This arrangement gave us discrepancies between secondary data and interview data. Instead of trying to find a single truth, we included multiple versions in the analysis to capture informants' realities (Callon, 2007; Mol, 2002). All the villagers and NGO actors' names mentioned in the analysis are pseudonyms, while the national policy makers/government apparatus names are real. We also hide the village name to protect our respondents' identities while keeping the district and province names. The selected village is in the Riau province, a village with the land area divided into sago (*Metroxylon sago*), rubber (*Hevea brasiliensis*) and coconut (*Cocos nucifera*) plantations, forest area, and settlements.

Data on peatland activities were ordered chronologically with events classified into niche, regime, and landscape based on their stability and how these events affect activities at other levels. We analysed the dynamics between these levels by investigating changes in actors' daily activities, how these changes lead to their dis-embeddedness to their land, traditions, economic activity and later on, how the change create new routinized activities that are embedded in a new norm, policy, infrastructure, technology, and others.

4. The Survivability of Peatland-related Programs

This section groups the chronology of peatland-related activities from 1974 to 2020 into three periods based on their regimes. The first period (1974–2002) focuses on the development of sago from niche and regime and how paddy's agency to grow was disabled by the acidic nature, lack of nutrients and oxygen of peatlands as a non-human actor. The second period (2002–2014) focuses on two opposing actor-networks. The first is sago which, through its relationship with the local human actors, entered the concession area illegally. The second is *Acacia* which, through its relationships with national regulation and financial support, mobilized machines to make canals. This period shows how the *Acacia* network became more stable, represented in its movement from niche to regime actor-network and challenged the power of sago. Finally, the third period (2014–2020) focuses on peatland restoration activities and the re-emergence of the sago regime for restoring peatlands as well as for commercial use.

4.1. 1974–2002: Rise of the Sago Regime

4.1.1. Niche: Community Participation in Sago Experiments

In 1974, the national government mobilized a rice intensification program to the village level by sending a state agriculture extension agent (*penyuluh*) to develop irrigated rice on the peatland. This activity is part of the national movement to shift the village's traditional staple

food from sago to rice. Sago is a palm species native to Southeast Asia that can be cultivated on flooded peatland and harvested as a source of starch, flour and noodles (Hutagaol and Erizal, 2017; Mohamad Naim et al., 2016). At this time, the village was relatively poor financially, with many people leaving the village to find job and education opportunities, to the extent that only around seven families remained. According to Kadir, an elder of the village who was the secretary of the village head for over 30 years, the rice grew well in an area called 'Simpang Kiri' (left crossroad), although with little or no yield from 1975 to 1978. These activities of experimenting new crop, learning from *penyuluh*, and sharing expectation between locals to have irrigated rice are niche activities. However, despite these activities, rice cultivation using the irrigated system ended after three harvest periods with no yield due to peatland's resistance in letting rice to yield. Responding to this resistance, some farmers continued cultivating rice paddies using the rain-fed method in an area located on the right crossroad ('Simpang Kanan') between 1984 and 1986, again with no yield. This peatland's resistance showed that despite human's actions to develop the niche through cultivating paddy on peatland using different methods, the non-human actor of the peatland through its network of acidic soil, water and irrigation (Fawzi and Qurani, 2021), nutrients, and oxygen was able to limit human's agency to create change.

After the local community learned that paddy was not suitable for peatland, they continue their journey to tame the peatland by cultivating sago. This species was selected since the local people found that sago grew well in the wild in peatlands.¹ This process of taming peatlands using sago started in the early 1980 s, when Said, a family member of the Ansori clan, planted sago on peatland in a forested area. The Ansori clan began in 1905 when the seven siblings of Ansori came to the village from Muara Tolam, Pelalawan district to open a new area (Hutagaol and Erizal, 2017). As part of the Ansori clan, Said was considered an important figure in the village, and along with other members of the clan, owned a part of the village land.² Said's success in growing sago on peatland was enabled by a strong relationship between sago and peatland, because sago palm can multiply vegetatively by sending out stolons, which tend to grow better on peatland (Thorburn and Kull, 2015). This success creates a niche that consisted of village elites, ex-rice paddy farmers, rubber tappers, and the state agriculture agent to follow in his step. This network of human and non-human actors enables human actors to move sago from the wild to human care.

4.1.2. Regime: Growing the Sago Network

The niche of sago, peatland, and humans started to become a regime through its relationship with ungoverned land and machines (Fig. 1, 1974–2002). In the 1990 s, after the first sago harvest, some farmers, including those from the Ansori clan, started to build sago mills to process the sago trunk into starch. To strengthen the sago network, the local people extended their sago network to a Chinese buyer (*tauke*) who then brought it to Cirebon in the West Java province to be processed as noodles (Thorburn and Kull 2015). Another version of the sago market from 1990 until 2001 involved people in the village selling their wet sago to a *tauke* in the Alah Air sub-district, which then processed the wet sago into noodles.³ When villagers needed cash in advance for weddings, building houses, health care, payment of school fees or other festive ceremonies, they sold 'futures' of their sago to the buyer.⁴ The system was called *pajak* or mortgage where the buyers determined the sago price based on location, age and size, with price usually much lower than in the regular (non-mortgage) system of selling sago after harvest (Jong, 2001).

In 1995, sago activities became more stable through their

¹ Interview with Kadir, March 5th, 2020.

² Interview with Said, March 4th, 2020.

³ Interview with Karim October 28th, 2020.

⁴ Interview with Kadir, March 5th, 2020.

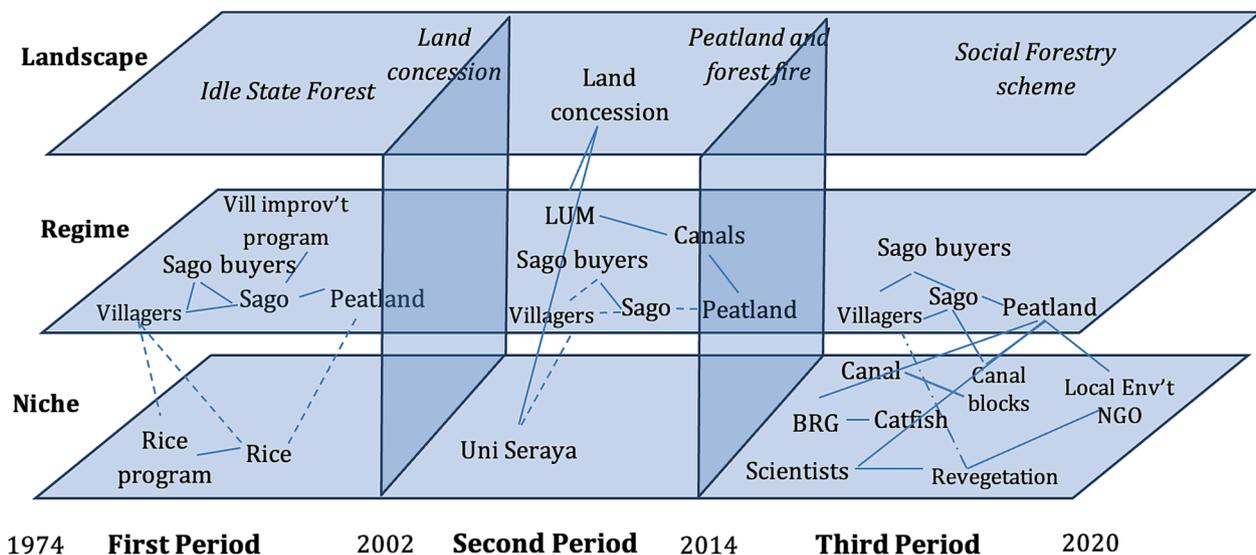


Fig. 1. The transition from one period to another. Solid lines represent strong relationship and dotted lines represent weak relationship. The third period shows actors movement from niche to regime.

relationship with the national government through the Village Improvement Program (or *Inpres Desa Tertinggal*).⁵ This national program was designed to provide grants to support village production initiatives and technical assistance for villages that are identified as underdeveloped by the Statistical Bureau (Akita and Szeto, 2000; The World Bank, 2012). The program included sago seed distribution and a mill designed to process 10 to 20 sago trunks daily, and it involved 10 part-time workers. However, when the mill arrived in the village, the local mechanic had to repair it before it could be used.⁶ The local mechanic's activity to repair the mill implied the development of sago knowledge in the village and despite quality of the mill, coherence between the government's program and the local community's interest. During this time, farmers expanded sago plantations with each villager having on average of 1.5 ha of sago plantation (El Amady, 2017). In 2001, the farmers started to sell their wet sago to the Jaya company through Haocun, a tauke who then processed it into dry sago in a neighbouring town and sold it to Batu Pahat in Malaysia (Pratama et al., 2018)⁷. To maintain the connection to mill owners, Haocun offered mortgages as described above to cover production costs, and through this debt, created dependency and the power to control the sago price.

The sago regime grew and became stable through its relationships with peatland, buyers, sago processing machines, mills, and payment systems. This regime succeeded in creating a coherent set of rules based on the materiality of sago such as can only be harvested after 7 to 10 years and need to be processed in the mills.

4.1.3. Landscape: Change in the Land Policy

The stability of the sago network was disturbed by landscape shock in the form of a land policy change. The government's policy to control land use dates back to the beginning of the New Order era (1965–1998) in 1967 through Law No. 5 of 1967 concerning Basic Forestry Provisions (Prihatin and Wicaksono, 2020). Under the New Order, 143 million ha of land was classified as state forest. This national policy became operational in the Riau province through the Minister of Forestry Decree No.

⁵ Thorburn and Kull (2015) suggest that the national government provided the sago mill to villages in Tebing Tinggi Island where Sungai Tohor is located in the end of the 1980s. However, according to Kadir, Abdullah and Anam, they got the mills in 1995. Their statements were also consistent with the World Bank report on IDT that span from 1994 to 1998.

⁶ Interview with Zulkarnaen March 4th, 2020.

⁷ Interview with Karim, October 28th, 2020.

173/1986 on Forest Management Agreement in 1986. These policies stimulated conflict between the local communities and companies since the local communities had settled, managed, and used the land long before the industrial forest concessions (*Hutan Tanaman Industri* or HTI), which gave company rights to borrow and utilize the state land for a period of time. This Forest Management Agreement decree enabled Uni Seraya II, a timber concessionaire, to obtain HTI and to legally operate in the village in 2000 (Thorburn and Kull 2015).⁸ The presence of this company destabilized the sago network through its actions to damage the villagers' sago plantation, which weakened the relationship between sago, peatland, and the villagers as well as the relationship between the villagers and the sago buyers (Fig. 1).

The conflict between villagers and the company became heated when the villagers burned the village head's house because the village head had issued a letter allowing the company to hoard timber logs in the village.⁹ This action shows the villagers' attempt to perform their agency through their relationship with fire. This action was countered by the local official who sentenced the villagers to prison for their violent action. While the presence of the timber concession reduced the power of the existing sago regime, it stimulated the emergence of niche activities of many villagers working at the timber company.

4.2. 2002–2016: Land Contestation between the Local Community and the Company

4.2.1. Multiple Niches: Local Community versus LUM

The issuance of the industrial forest concessions enabled the emergence of corporate niche activities in the village, while it destabilized the sago regime, turning it into niche. After Uni Seraya II left the village, Lestari Unggul Makmur (LUM) PT, a pulpwood plantation company associated with Asian Pacific Resources International Holding Limited (APRIL) obtained the concession right. Based on the Ministry of Forestry Decree number 217/Menhut-II/2007, LUM was granted access to 10,390 ha in Tebing Tinggi Island, including the village area. The concession was located mainly in a peatland area with a peat depth

⁸ While both Eyes of the Forest and Thorburn & Kull articles mentioned Uni Seraya II, Abdullah and Karim referred the company before LUM as Perkasa Baru. According to Kaspi, who worked in Perkasa Baru, the company started to operate in the village in 2000.

⁹ Interview with Basuki March 4th, 2020.

between 2 and 4 m (Eyes on the Forest 2010). The local people contested this new development, where the Head Village Association Forum for Tebing Tinggi sub-district sent a letter to the Ministry of Forestry to state their objection to the operation of LUM in the area in February 2008.

Despite protests from the local community, in 2008, LUM mobilized its resources by digging canals over 10 km long, 12 m wide and 5 m deep in the peatland area. The canals were constructed to transport seeds and other materials needed for plantations from the settlement area into the concession area and to bring in machinery for land clearing as well as for draining the area for plantations (Eyes on the Forest, 2010; Salim et al., 2018). These mobilizations of human workers and non-human canals changed the peatland's materiality from wet to dry, thus lowering the productivity of the sago that thrives on wet peatland.

As a protest against LUM activities, in April 2008, the Independent Environmental Activist and Riau Care Community Forum sent a letter to the regent of Bengkalis District requesting the government to cancel the permit for the company because of its role in ecological destruction, the decline of the community's plantation productivity through a reduction in freshwater resources, and water competition between the company's *Acacia* pulpwood plantations and the village's sago plantations (Salim et al., 2018). A month later, the Head Village Association sent a letter to the head of Bengkalis district stating their protest of the pulpwood plantation in Tebing Tinggi.

In this segment, the pulpwood company performed power by mobilizing machines to dig canals on the peatland. This activity made local actors comply with the company's program to grow *Acacia* on a drained peatland. The local human actors countered this action by seeking legal support from the district government. At this point, both groups were unstable. The company managed to get the land right and peatland support while still lacking community support. In contrast, the sago network was supported by the local community and NGO, while its relationship with peatland was weakened due to the legal right and drainage.

4.2.2. Unstable Regime: Frictions between Legal and Idle

LUM and sago groups try to accumulate power and stabilize their niches by becoming a regime through expanding their relationships with legal and political actors. In August 2009, the Village Consultative Body (*Badan Permusyawaratan Desa*) of the village, headed by villager Abdullah, a member of the Ansori clan, gathered a petition to reject the presence of LUM, and sent it to the Regent of Meranti Island district. Meanwhile, the company continued growing their strength by approaching the government, resulting in the issuance of Decree of Forest Plantation Management Director number 13/BPHT-3/2009 for a permit to clear 2,832 ha of natural forest and to obtain 262,837 cubic meters of natural forest logs. Despite getting legal support, this decree could not be executed because they still needed an operating license.

Apart from political diplomacy through petitions and letters to the head of Bengkalis district, the villagers also resisted the presence of LUM through physical activities by planting sago and rubber in the concession area with support from the village apparatus and the head of the East Tebing Tinggi sub-district. They requested that the government acknowledge their activities and exclude this area from the concession. In response to these continued protests, the acting regent (or *pelaksana tugas*) of Bengkalis district postponed the LUM operation in Tebing Tinggi in 2009, which led to restrictions on bringing the logs out of the forest and an end to canal construction and land clearing (Salim et al., 2018). The district government continued to support the local community and other East Tebing Tinggi villages by arranging ceremonies and events centred around local sago products.

In 2013, the district government sent a petition to the Ministry of Forestry, asking them to revoke LUM's concession in the area due to 4 years of them being inactive (Thorburn and Kull 2015). The local people also collaborated with an NGO in the Riau district focusing on environmental advocacy. One of their strategies was to host peatland-themed concerts in the Indonesian capital city, Jakarta, and the

village. During the village performance, a musician from a well-known Indonesian band highlighted that peatlands should be seen for their financial benefit and ecological value.

This segment shows how both groups expanded their regimes to legal and political actors. However, the sago regime became more powerful in the village due to its affiliation with sago and rubber plantation in the concession area. Mobilization by the two groups shows that the company's activities became more political and less material, whereas the sago group's activities became political and material. The sago regime through its illegal sago and rubber plantation strengthens their position in the village while weakening the company's power there.

4.2.3. Landscape: Peat Fire and Pressure to Change the Land Policy

In March 2014, both sago and company regimes experienced a landscape shock in the form of a large fire. This non-human actor through its relationship with peat that has a high carbon content and is naturally porous cause smouldering wildfires and release substantial amount of carbon (Davies et al., 2013). By affiliating with the negative impact of peat fire, the sago regime created pressure on the company regime. A Riau NGO together with the local people of East Tebing Tinggi sub-district used the peat fire to pressure the new president, who was about to be inaugurated on October 20th, 2014, to support their fight against LUM that had drained peatlands and contributed to the peat fire. Abdullah, who in 2009 mobilized local people through his position as the head of the Village Consultative Body, submitted a petition on 'change.org' that asked the new elected President, Joko Widodo, to 'blusukan asap' (make an impromptu visit) to the haze-affected area in the village. The term 'blusukan' (impromptu visit) was strategically adopted to match the term used by Widodo in his political campaign to emphasize equality between political leaders and commoners (Gama et al., 2019). The petition received more than 28,000 signatures in less than a month. To strengthen the virtual petition, Abdullah, and Andi, an academic from Riau University, went to Jakarta in October 2014 to hold a press conference about repeated fires in the village due to HTI concessions in the area (Nugraha, 2015). The press conference was facilitated by Riau NGO, Greenpeace and Yayasan Perspektif Baru, an organization formed by Wimar Witoelar, an Indonesian journalist who was also a supporter of Joko Widodo (Nugraha and Satri, 2014).

On November 27th, 2014, Widodo and the Minister of Environment and Forestry (MoEF) responded to the petition by visiting the village. During his visit, Widodo promised that companies who converted peatlands into monocultures should be evaluated since, as the locals told him, this land-use change increased pest populations (Setneg, 2014). Despite the President's promise to evaluate the company operating in the area, LUM still had its permit intact for more than half a year later. In June 2015, Riau NGO together with people from the village and neighbouring villages held a festival, demanding the President to fulfil his promise to evaluate the permit of LUM. In late 2015, the Ministry of Environment and Forestry (MoEF) evaluated the permit of LUM in Tebing Tinggi, and in June 2016, officially revoked the permit (Leandha, 2017). Following this, the MoEF issued seven decrees about handing over the initial LUM concession area to the village and six other villages on Tebing Tinggi Island. Based on the MoEF decree number 6722/MENLHK-PSKL/PSL.0/12/2016, the village has the right to manage 2,940 ha under the social forestry scheme. The scheme was reinvented during the presidency of Joko Widodo, by shifting its focus from supporting the interest of the state and the corporations towards improving local livelihood and protecting a socio-cultural balance (Wong et al., 2020).

The peat fire as a non-human actor and land policy change created a shock to the regime actors. This shock enables sago actors to recover their relationship with sago and disconnect LUM's relationship with the village. It also enabled the emergence of niche activities that support peatland restoration.

4.3. 2016–2020: The Sago Regime and Emergence of Multiple Niches

4.3.1. Multiple Niches: Peatland restoration and Revitalization Activities

A shift in the land tenure from concession to social forestry allowed the local community to return to the land. Together with the Indonesian President visit in 2014, the village attracted the Peatland Restoration Agency, NGOs, and universities both national and international to conduct restoration and research activities. What followed were niche activities of rewetting, revegetation, and revitalization that emerged in the village.

The first niche refers to canal block constructions as part of the rewetting program (Fig. 1). After LUM built drainage canals in the village, the dried peatland became more vulnerable to fire. By blocking the canals using materials such as timber, sand, stone rock or concrete, the water flow slows down, rewetting the peat and slowing its decomposition and degradation. During the Presidential visit, Joko Widodo gave the local community 300 million IDR (~20.5 thousand USD) to build canal blocks for hydrological restoration. BRG added to this by allocating resources for 20 canal blocks for the village. These blocks were built in the canals by three Community Groups (POKMAS). Each community group consisted of 15 village members and was responsible for constructing 6–7 canal blocks.¹⁰ These groups were dominated by the local elite, e.g., one POKMAS was led by the head of the forest management committee who was also one of the mill owners, and another POKMAS placed the village head's relatives as the secretary and treasurer. The survivability of these canal blocks was strongly influenced by their relationships to sago. Two of these blocks, which were located on *Simpang Kanan* have been reconstructed by the community because the design did not allow sago trunks to pass. According to the village head, who was also a member of the Ansori clan, the local communities were not allowed to modify the design of the canal blocks before construction and could only modify it once the project had been handed over.¹¹ This suggests that sago through its relationship with the local community was able to re-shape the canal block construction.

The second niche refers to revegetation programs by international and local NGOs (Fig. 1). In May 2017, a group from the Singapore Institute of International Affairs (SIIA), a Singapore NGO, and Singapore national newspaper went to the village to learn about peatland activities and local life. This visit resulted in a documentary on 'haze fighters' by SIIA and a collaboration between the Singapore NGO and a local Riau NGO to build a canal block. In 2019, the Singapore NGO continued their activities in the village by collaborating with DEA, a local youth organization that focuses on community development. Initially, the Singapore NGO wanted the program to focus on revegetation and therefore, hired an expert from North Sumatra to supervise the planting. After discussing with DEA, the Singapore NGO agreed to extend the program to develop a vegetable plot for villagers' daily diet while also developing a nursery plot and initiating revegetation activities. Based on discussions with the village head and DEA members, Abdullah's land was selected as the location for the nursery because of its accessibility to the community and hence ease of maintenance. For the restoration, a Singapore NGO started by identifying tree species in the peat swamp forest and mapping restoration sites. In October 2019, Singapore NGO and DEA started to plant native swamp forest species, including sago, to revegetate retired sago plantations. Villagers involved in these peatland restoration activities were mostly DEA members, although more villagers engaged with the DEA's nursery, where they could buy vegetables. In this niche, the local community was able to reshape the international NGO's program through which they could connect the program to the local's daily activity of buying vegetables.

The third niche refers to a revitalization program that involved

¹⁰ Interview with Hasan and Zulkarnaen, both are head of the community group, March 4th, 2020.

¹¹ Interview with the village head, March 5th, 2020.

projects of constructing 32 ponds for catfish and that gave training to women in processing the catfish into nuggets and chips (Fig. 1; (Safrizal 2018)). The program was funded by the Indonesia Climate Change Trust Fund (ICCTF) and was run by 10 lecturers from the Faculty of Fisheries and Marine Science (FAPERIKA), University of Riau, and 12 alumni from the same institute for 16 months (Lusiana 2018). Based on the Ministry of National Development Planning decision number KEP.59/M.PPN/HK/05/2020, the funding allocated for the catfish projects was 160 million IDR (10.9 thousand USD) for the fish farming community group and 30 million IDR (2 thousand USD) for the fish product community group. The catfish project lasted only two years, ending not long after its first harvest. According to Karim, the village elder, the reason for the failure of the catfish project was due to difficulty in finding suitable catfish feed, the absence of a catfish market, and lack of trust in the project management.¹² This niche shows lack of connection to the local community due to domination of the project management and no connection the local market. The power to mobilize actors to construct catfish ponds was only temporarily afforded by the project management's connection to external funding.

The contrast between these multiple niches showed that the stability of new initiatives is determined by their ability to adjust to the local conditions. This is shown by adjusting canal blocks to support sago's mobility and the revegetation program to support the local's interest in vegetables. In contrast, because of the lack of connection to the local network, the catfish program was not adjusted to support the local network and therefore failed to survive.

4.3.2. Regime: Strengthening the Sago

Parallel to the niche initiatives is the growth of the sago network after the company left the area. In 2016, the local community had 2,650 ha of sago plantation and 12 sago mills with a total production of 400–600 tons per month and worth around 1.29 billion IDR (87 thousand USD) (Hutagaol and Erizal, 2017). Despite an increase in the number of mills to 15 in 2019, the villagers' relationship with sago was highly dependent on a single buyer, Haocun, who has been the single buyer for the village's wet sago since 2001 and had bonded the majority of mills' owners through the mortgage system.¹³

An attempt to increase the value of sago was taken up by the central government by building a sago factory in the village on the land owned by Abdullah's family. According to the head of Industry, Trade, Cooperative and Small Medium Enterprise of Meranti Island Regency, the initial funding for constructing the factory was 18 billion IDR (1.2 million USD) derived from the 2018 Indonesian Government State Budget (APBN) (Riaubook.com 2018). In March 2020, the special staff of the Cooperative and Small Medium Enterprise Ministry handed a decree letter on the Integrated Sago Product Cooperative to Abdullah as the head of the cooperative (Kemendag 2020). By October 2020 the factory was no longer in operation. The head of Industry, Trade, Cooperative and Small Medium Enterprise for Meranti Island Regency said that the sago factory had all the machines needed to process sago into rice, starch, pearl, sugar, and other derivative products, but lacked the capital to operate the factory (Suryadi, 2020). Karim from DEA said that the factory needed at least 1.29 billion IDR to buy sago from the farmers and 1 billion more to pay for factory workers, raw materials, and electricity.¹⁴ Another challenge was the inability of the sago mill owners to detach from Haocun who loaned them money whenever they had personal needs.

The high numbers of sago plantation and production show the centrality of sago in creating a semi-coherent set of rules for the local actors that makes a regime. At the household level, this network consists of sago, peatland, processing activities, and selling the sago, either as a

¹² Interview with Karim, October 28th, 2020.

¹³ Interview with Aji March 6th, 2020.

¹⁴ Interview with Karim October 30th, 2020.

trunk or as a wet sago. At the village level, the sago activities are centred around Houcan as the single buyer. The centrality of sago and Houcan to the local network represent their power in shaping the network. To reduce Houcan's power, the local community through its relationship with the government built a sago factory that is able process sago into various derivative product and thus, increase the value of sago. However, the local community failed to attract further investment needed to operate the factory. High dependency on a single buyer makes the sago network vulnerable as shown during the COVID-19 pandemic in 2020. At that time, Haocun did not buy sago from the village due to disconnection between him and the Malaysian market since the border was closed. This disconnection created disruption to the local economy, which forced one of the mill owners to travel to a nearby town to sell his wet sago around one-fifth of the price typically offered by Haocun (Suryadi, 2020). This COVID-19 disruption suggests that despite being a regime, the sago network was vulnerable to non-local actors.

5. Discussion

The study adopts a multi-level actor-network approach to understand why many peatland-related programs failed to survive. By focusing on how external programs influence the relationship between humans and peatland in a village across time, we shed light on elements that influence the ability of external actors to mobilize local actors and to reshape the local actor-network (Fig. 1).

Our analysis shows how the stability of actors affects the number of resources needed to destabilize these actors. In a network, stability is represented by the number of lines an actor has. The more its connected, the more stable an actor becomes (Fig. 1). For instance, the rice program that mobilized a limited number of actors for the program failed to adjust the peatland's conditions (available nutrients, oxygen, acidity). This suggests the peatland's power to resist minor disturbance. However, when the pulp company mobilized machines and canals to the peatland, it failed to maintain its wet condition. To resist the company's mobilization, the dry peatland partnered with the dry season and human activity to create fire. This new actor-network enabled a landscape type of power, where the fire pressured actors to change their connection with canals and the company. This finding supports the existing literature about the role of non-human actors in reshaping actor-network (Fatimah and Arora, 2016; Mitchell, 2002; Shepherd and Gibbs, 2006), while adding information regarding the level of influence. A non-human actor at the niche level can influence less actors than a non-human actor at the regime and landscape level.

Our study identifies five peatland-related programs, including rice intensification, village improvement, pulp concession, canal blocks and catfish ponds. Contrasts between these five programs show tensions between agencies of the local actors to resist the programs and the power of the programs to mobilize the actors (Table 1). Our study shows that the local actors' agencies to resist the programs are being enabled against the lack of power, represented by the limited number of actors

being mobilized (Fig. 1). Our approach shows that an actor-network, as a vessel for participation, is shaped not only based on actors' ability to control the direction of the program (Arnstein, 1969) or based on opportunities to engage in the design-making process (Reed et al., 2018; White, 1996) but also on how the programs include the materiality of non-human actors. As shown from our study, the non-human actors reshape the programs by resisting non-suitable crops, by re-shaping the program, by mobilizing human actors, and by creating pressure to the existing regime.

Our research shows that land concession policy plays a significant role in creating tensions in the local community. As seen in our case study, the land policy change from illegal planting in state land into concession created instability in the existing sago regime since it allowed the inclusion of the company's activities in the village. The argument for resisting the company's presence followed what Dhiaulhaq and McCarthy (2020) described as the agrarian justice narrative. This narrative was built on the argument that land should be distributed to marginal people who have the right to access productive resources. In building the narrative against the company, our case resonates with Dhiaulhaq and McCarthy (2020) in terms of using a tragedy to get attention from national policymakers and local and international NGOs. However, this tragic narrative can only be effective in changing the land concession policy if it is accompanied by continuous lobbying at the national level. For example, the case in Rangsang island shows how the local community's lobby at the district and province level against a pulp and paper company failed in ending the company's activities on the island (Salim, 2019). By placing land conflict as part of an actor-network at the village level, we can complement existing land conflict studies (Beckert et al., 2014; Dhiaulhaq and McCarthy, 2020; Hein and Faust, 2014) that investigate land conflicts at the institutional level. A village-level focus allows us to articulate how land conflict affected the local's daily activities and how the local's resistance included political and agricultural actions (Fig. 1).

6. Concluding Remarks

Our case study in a village in Riau province, Indonesia, shows that the survivability of the programs is strongly influenced by how the programs are being adjusted to the materiality of non-human actors. This highlights power and agency as mutually constitutive: that the absence of power enables actors to act against a particular program. In turn, this implies that we must pay attention to the voices of non-human actors that speak through its relationship with other actors, including unproductive paddy, fire, and scientists. By pluralizing the voices of non-human actors beyond commercial benefit, we are able to broaden the spokesperson for peatland based on indigeneity of the proposed crops to peatland (Giesen, 2021) or based on the survivability of the proposed plant species in peatland in Indonesia and across Southeast Asia (Smith et al., 2022). This democratic pluralism may be crucial to ensure the survival of peatland restoration programs since these

Table 1
Comparison between the programs based on design, power, agency, and survivability.

Program	Design	Power	Agency	Survivability
Rice intensification	Non-inclusive design; the program did not consider the local diet and condition of the peatland	The central government mobilized paddy supervisor to plant paddy rice.	The human actors tried a different rice cultivation method but failed; they went to another island to cultivate rice	Discontinued; ended at niche level
Village Improvement	Inclusive design; the program was designed to support local livelihood	In line with the local livelihood and support sago that grew in peatland	The local community modified the mill that broke down and used it to support their sago business	Continued and became part of the sago regime
Pulp concession	Non-inclusive design	The company mobilized machines to build drainage canals and legal support	The drainage canal dried the peatland, which damaged sago; the villagers planted sago in the concession area	Discontinued; ended at regime level
Canal blocks	Non-inclusive design but can be modified	The central government mobilized resources to build canal blocks	The local community had reshaped the canal blocks to allow peat trunk transportation	Continued and became part of the sago regime
Catfish ponds	Non-inclusive design	The central government mobilized resources to build catfish ponds	The lack of catfish feed and market were not followed by activities to address the problem	Discontinued; ended at niche level

programs are shaped not only by humans' interests but also by non-human actors' materiality. In terms of developmental praxis, our multi-level actor-network framework suggests the program's survivability through two strategies: the first one is by having a small-scale initiative at the niche level that support the existing regime, such as canal blocks or vegetable garden, and the second one is by mobilizing a large number of actors to create a new regime that is compatible with the existing human and non-human actor-network.

CRediT authorship contribution statement

Yuti A. Fatimah: Conceptualization, Methodology, Investigation, Writing – original draft, Visualization. **Zaenuddin Hudi Prasajo:** Writing – review & editing. **Stuart W. Smith:** Writing – review & editing. **N. Estya B. Rahman:** Resources, Project administration. **David A. Wardle:** Writing – review & editing, Funding acquisition. **Kwek Yan Chong:** Writing – review & editing, Funding acquisition. **Asmadi Saad:** Writing – review & editing. **Janice S.H. Lee:** Writing – review & editing, Funding acquisition, Supervision, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

Acknowledgement

This research was supported by the Singaporean Ministry of Education Academic Research Fund MOE2018-T2-2-156 on 'The Role of Community Participation in Indonesia's Peatland Restoration Project' and has been approved by the Nanyang Technological University Institutional Review Board IRB 2019-06-067. Y F is supported by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (grant agreement no. 866006). The authors thank all the respondents who could be named to protect the anonymity of the informants for their time in sharing their stories and their invaluable insights on peatland-human relationship in the village. We would like to thank the reviewers for their valuable comments.

References

- Agrawal, A., Gibson, C.C., 1999. Enchantment and Disenchantment: The Role of Community in Natural Resource Conservation. *World Dev.* 27, 629–649. [https://doi.org/10.1016/S0305-750X\(98\)00161-2](https://doi.org/10.1016/S0305-750X(98)00161-2).
- Akbulut, B., Soylu, C., 2012. An inquiry into power and participatory natural resource management. *Camb. J. Econ.* 36, 1143–1162. <https://doi.org/10.1093/cje/bes034>.
- Akita, T., Szeto, J.J.K., 2000. Inpres Desa Tertinggal (IDT) Program and Indonesian Regional Inequality. *Asian Econ. J.* 14, 167–186. <https://doi.org/10.1111/1467-8381.00107>.
- Akrich, M., 1992. The De-scription of Technical Objects, in: *Shaping Technology/Building Society*. The MIT Press, Cambridge, Massachusetts.
- Arnstein, S.R., 1969. A Ladder Of Citizen Participation. *J. Am. Plann. Assoc.* 35, 216–224. <https://doi.org/10.1080/0194436908977225>.
- Astuti, R., 2021. Governing the ungovernable: The politics of disciplining pulpwood and palm oil plantations in Indonesia's tropical peatland. *Geoforum* 124, 381–391. <https://doi.org/10.1016/j.geoforum.2021.03.004>.
- Barad, K., 2007. Meeting the universe halfway. In: *Meeting the Universe Halfway*.
- Becker, S.L., Reusser, D.E., 2016. Disasters as opportunities for social change: Using the multi-level perspective to consider the barriers to disaster-related transitions. *Int. J. Disaster Risk Reduct.* 18, 75–88. <https://doi.org/10.1016/j.ijdrr.2016.05.005>.
- Beckert, B., Dittich, C., Adiwibowo, S., 2014. *Contested Land : An Analysis of Multi-Layered Conflicts in Jambi. Asean*.
- Budiman, I., Hapsari, D., Wijaya, C.I., Sari, E.N.N., 2021. The governance of risk management on Peatland: A case study of restoration in South Sumatra, Indonesia. *WRI Indones. Work. Pap.* 10.46830/wriwp.20.00008.
- Budiman, I., Januar, R., Daeli, W., Hapsari, R.D., Sari, E.N., 2020. Designing the special pilot economic zone on peatlands. *J. Geogr. Lingkung. Trop.* 4, 1–23. <https://doi.org/10.7454/jglitrop.v4i1.73>.
- Callon, M., Law, J., 1997. Agency and the Hybrid Collectif, in: *Agency and the Hybrid Collectif*. Duke University Press, pp. 95–117. 10.1515/9780822382720-006.
- Callon, M., 1984. Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. *Sociol. Rev.* 32, 196–233. <https://doi.org/10.1111/j.1467-954X.1984.tb00113.x>.
- Callon, M., 1990. Techno-economic Networks and Irreversibility. *Sociol. Rev.* 38, 132–161. <https://doi.org/10.1111/j.1467-954X.1990.tb03351.x>.
- Callon, M., 1998. An Essay on Framing and Overflowing: Economic Externalities Revisited by Sociology. *Sociol. Rev.* 46, 244–269. <https://doi.org/10.1111/j.1467-954X.1998.tb03477.x>.
- Callon, M., 2007. What does it mean to say that economics is performative? *Econ. Make Mark. Performativity Econ.* 311–357.
- Chambers, R., 1994. Paradigm shifts and the practice of participatory research and development.
- Cleaver, F., 2001. Institutions, agency and the limitations of participatory approaches to development. *Particip. New Tyranny* 36–55.
- Coenen, L., Benneworth, P., Truffer, B., 2012. Toward a spatial perspective on sustainability transitions. *Res. Policy* 41, 968–979. <https://doi.org/10.1016/j.respol.2012.02.014>.
- Cornwall, A., Coelho, V.S.P., 2007. Spaces for change?: the politics of citizen participation in new democratic arenas. *Spaces Change Polit. Citiz. Particip. New Democr. Arenas* 1–29.
- Cornwall, A., Pratt, G., 2011. The use and abuse of participatory rural appraisal: Reflections from practice. *Agric. Hum. Values* 28, 263–272. <https://doi.org/10.1007/s10460-010-9262-1>.
- Cornwall, A., 2002. Making spaces, changing places: situating participation in development.
- Davies, G.M., Gray, A., Rein, G., Legg, C.J., 2013. Peat consumption and carbon loss due to smouldering wildfire in a temperate peatland. *For. Ecol. Manag.* 308, 169–177. <https://doi.org/10.1016/j.foreco.2013.07.051>.
- de Laet, M., Mol, A., 2000. *The Zimbabwe Bush Pump: Mechanics of a Fluid Technology*. *Soc. Stud. Sci.* 30, 225–263.
- Delabre, I., Okereke, C., 2020. Palm oil, power, and participation: The political ecology of social impact assessment. *Environ. Plan. E Nat. Space* 3, 642–662. <https://doi.org/10.1177/2514848619882013>.
- Dhiaulhaq, A., McCarthy, J.F., 2020. Indigenous Rights and Agrarian Justice Framings in Forest Land Conflicts in Indonesia. *Asia Pac. J. Anthropol.* 21, 34–54. <https://doi.org/10.1080/14442213.2019.1670243>.
- Dohong, A., 2017. Bolstering Peatlands Restoration in Indonesia through 3Rs Approach. *Dev. Int. Collab. Address Fire Conserv. Issues Cent. Kalimantan Indones.*
- Driel, H.V.A.N., Schot, J., 2005. Radical Innovation as a Multilevel Process : Introducing Floating Grain Elevators in the Port of Rotterdam Author (s): Hugo Van Driel and Johan Schot Source : *Technology and Culture* , Vol. 46 , No. 1 (Jan ., 2005), pp. 51–76 Published by : The John 46, 51–76.
- El Amady, M.R., 2017. Jaminan Konsumsi Rumah Tangga Petani Sagu di Desa Sungai Tohor Kabupaten Meranti, Riau. *Umbara Indones. J. Anthropol.* 2. <https://doi.org/10.24198/umbara.v2i2.20448>.
- Eyes on the Forest, 2010. *Laporan Investigatif Eyes on the Forest Investigasi September – Oktober 2009 (Investigation)*. *Eyes on the Forest*.
- Falalde, M., Eklund, M., 2015. Towards a sustainable socio-technical system of biogas for transport: the case of the city of Linköping in Sweden. *J. Clean. Prod., Special Volume: Support your future today! Turn environmental challenges into opportunities*. 98, 17–28. 10.1016/j.jclepro.2014.05.089.
- Fatimah, Y.A., Arora, S., 2016. Nonhumans in the practice of development: Material agency and friction in a small-scale energy program in Indonesia. *Geoforum* 70, 25–34. <https://doi.org/10.1016/j.geoforum.2016.01.009>.
- Fatimah, Y.A., 2016. Transition in action : non-linearity, multiplicity, materiality in Indonesian biofuel villages. *Technische Universiteit Eindhoven*.
- Fawzi, N.I., Qurani, I.Z., 2021. Lesson learned from the development of sustainable rice farming in peatland. *IOP Conf. Ser. Earth Environ. Sci.* 752, 012037 <https://doi.org/10.1088/1755-1315/752/1/012037>.
- Foead, N., 2016. Recovery and Restoration of Indonesian Peatland [WWW Document]. *PeatL. Restor. Agency Repub. Indones.* URL <https://drive.google.com/file/d/0B0bphNpFTYgRTxdtlcyU1pFWEU/view> (accessed 6.8.21).
- Fuenfschilling, L., Truffer, B., 2014. The structuration of socio-technical regimes- Conceptual foundations from institutional theory. *Res. Policy* 43, 772–791. <https://doi.org/10.1016/j.respol.2013.10.010>.
- Gama, B., Sudardi, B., Abdullah, W., Wijaya, M., 2019. Blusukan Cultural as a Political Power in The Regional Head Election of Surakarta. Presented at the 2nd Workshop on Language, Literature and Society for Education, Wol2SED 2018, December 21-22 2018, Solo, Indonesia.
- Geels, F., Raven, R., 2006. Non-linearity and expectations in niche-development trajectories: Ups and downs in Dutch biogas development (1973–2003). *Technol. Anal. Strateg. Manag.* 18, 375–392. <https://doi.org/10.1080/09537320600777143>.
- Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Res. Policy* 31, 1257–1274. 10.1016/S0048-7333(02)00062-8.
- Geels, F.W., 2011. The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environ. Innov. Soc. Transit.* 10.1016/j.eist.2011.02.002.
- Giesen, W., 2021. Tropical Peatland Restoration in Indonesia by Replanting with Useful Indigenous Peat Swamp Species: Paludiculture, in: Osaki, M., Tsuji, N., Foead, N., Rieley, J. (Eds.), *Tropical Peatland Eco-Management*. Springer, Singapore, pp. 411–441. 10.1007/978-981-33-4654-3_14.

- Glauber, A.J., Moyer, S., Adriani, M., Gunawan, I., 2016. The Cost of Fire : An Economic Analysis of Indonesia's 2015 Fire Crisis, Indonesia Sustainable Landscapes Knowledge Note No. 1.
- Harrison, M.E., Ottay, J.B., D'Arcy, L., Cheyne, S.M., Anggodo, Belcher, C., Cole, L., Dohong, A., Ermias, Y., Feldpausch, T., Gellego-Sala, A., Gunawan, A., Hoing, A., Husson, S.J., Kulu, I.P., Soebagio, S.M., Mang, S., Mercado, L., Morrogh-Bernard, H. C., Page, S.E., Priyanto, R., Capilla, B.R., Rowland, L., Santos, E.M., Schreer, V., Sudyana, I.N., Taman, S.B.B., Thornton, S.A., Upton, C., Wich, S.A., van Veen, F.J.F., 2019. Tropical forest and peatland conservation in Indonesia : Challenges and directions. *People Nat.* 1–25. [10.1002/pan3.10060](https://doi.org/10.1002/pan3.10060).
- Hein, J., Faust, H., 2014. Conservation, REDD+ and the struggle for land in Jambi. *Indonesia. Pac. Geogr.* 41, 20–25.
- Heymann, J., Reuter, M., Buchwitz, M., Schneising, O., Bovensmann, H., Burrows, J.P., Massart, S., Kaiser, J.W., Crisp, D., 2017. CO₂ emission of Indonesian fires in 2015 estimated from satellite-derived atmospheric CO₂ concentrations. *Geophys. Res. Lett.* 44, 1537–1544. <https://doi.org/10.1002/2016GL072042>.
- Hutagaol, J., Erizal, Kamari, A., 2017. Desa Peduli Gambut Provinsi Riau Desa Sungai Tohor, Badan Restorasi Gambut.
- Jong, F.S., 2001. Sago production in Tebing Tinggi Sub-district, Riau, Indonesia. *Sago Palm* 9, 9–15.
- Jørgensen, U., 2012. Mapping and navigating transitions — The multi-level perspective compared with arenas of development. *Res. Policy* 41, 996–1010. <https://doi.org/10.1016/j.respol.2012.03.001>.
- Kim, J., 2019. Designing multiple urban space: an actor-network theory analysis on multiplicity and stability of public space. *J. Urban Des.* 24, 249–268. <https://doi.org/10.1080/13574809.2018.1468214>.
- Kopitz, S.N., Mickle, L.J., Marlier, M.E., Buonocore, J.J., Kim, P.S., Liu, T., Sulprizio, M. P., DeFries, R.S., Jacob, D.J., Schwartz, J., Pongsiri, M., Myers, S.S., 2016. Public health impacts of the severe haze in Equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure. *Environ. Res. Lett.* 11, 094023. <https://doi.org/10.1088/1748-9326/11/9/094023>.
- Kothari, U., 2001. Power, knowledge and social control in participatory development. *Particip. New Tyranny* 139–152.
- Lane, M.B., Corbett, T., 2005. The tyranny of localism: Indigenous participation in community-based environmental management. *J. Environ. Policy Plan.* 7, 141–159. <https://doi.org/10.1080/15239080500338671>.
- Latour, B., 1987. *Science in Action: How to Follow Scientists and Engineers Through Society*. Harvard University Press.
- Latour, B., 1990. Technology is Society Made Durable. *Sociol. Rev.* 38, 103–131. <https://doi.org/10.1111/j.1467-954X.1990.tb03350.x>.
- Latour, B., 1994. Pragmatologies: A Mythical Account of How Humans and Nonhumans Swap Properties. *Am. Behav. Sci.* 37, 791–808. <https://doi.org/10.1177/0002764294037006006>.
- Latour, B., 1996. On actor-network theory: A few clarifications. *Soz. Welt* 47, 369–381.
- Latour, B., 2005. *Reassembling the Social: An Introduction to the Actor-Network Theory*. Oxford, England and New York, NY, USA: Oxford University Press.
- Latour, B., 2014. Agency at the Time of the Anthropocene. *New Lit. Hist.* 45, 1–18. <https://doi.org/10.1353/nlh.2014.0003>.
- Law, J., 2002. Objects and Spaces. *Theory Cult. Soc.* 19, 91–105. <https://doi.org/10.1177/026327602761899165>.
- Leandha, M., 2017. Jalan Panjang Menuju Kembalinya Hutan Kita... Halaman all [WWW Document]. KOMPAS.com. URL <https://regional.kompas.com/read/xml/2017/03/23/17452991/jalan.panjang.menuju.kembalinya.hutan.kita>. (accessed 7.24.23).
- Li, T.M., 2007a. The will to improve: Governmentality, development, and the practice of politics. *duke university Press*.
- Li, T.M., 2007b. Practices of assemblage and community forest management. *Econ. Soc.* 36, 263–293. <https://doi.org/10.1080/03085140701254308>.
- Li, T.M., 2016. Governing rural Indonesia: convergence on the project system. *Crit. Policy Stud.* 10, 79–94. <https://doi.org/10.1080/19460171.2015.1098553>.
- Margulies, J.D., Bersaglio, B., 2018. Furthering post-human political ecologies. *Geoforum* 94, 103–106. <https://doi.org/10.1016/j.geoforum.2018.03.017>.
- Markard, J., Raven, R., Truffer, B., 2012. Sustainability transitions: An emerging field of research and its prospects. *Res. Policy* 41, 955–967. <https://doi.org/10.1016/j.respol.2012.02.013>.
- Marlier, M.E., DeFries, R.S., Kim, P.S., Kopitz, S.N., Jacob, D.J., Mickle, L.J., Myers, S. S., 2015. Fire emissions and regional air quality impacts from fires in oil palm, timber, and logging concessions in Indonesia. *Environ. Res. Lett.* 10, 085005. <https://doi.org/10.1088/1748-9326/10/8/085005>.
- McGregor, A., Challies, E., Thomas, A., Astuti, R., Howson, P., Affif, S., Kindon, S., Bond, S., 2019. Sociocarbon cycles: Assembling and governing forest carbon in Indonesia. *Geoforum* 99, 32–41. <https://doi.org/10.1016/j.geoforum.2018.12.003>.
- Miettinen, J., Hooijer, A., Vernimmen, R., Liew, S.C., Page, S.E., 2017. From carbon sink to carbon source: extensive peat oxidation in insular Southeast Asia since 1990. *Environ. Res. Lett.* 12, 024014. <https://doi.org/10.1088/1748-9326/aa5b6f>.
- Miller, M.A., Tonoto, P., Taylor, D., 2021. Sustainable development of carbon sinks? Lessons from three types of peatland partnerships in Indonesia. *Sustain. Dev.* <https://doi.org/10.1002/sd.2241>.
- Mitchell, T., 2002. *Rule of Experts: Egypt, Techno-Politics, University of California Press, Modernity*.
- Mohamad Naim, H., Yaakub, A.N., Awang Hamdan, D.A., 2016. Commercialization of Sago through Estate Plantation Scheme in Sarawak: The Way Forward. *Int. J. Agron.* 2016, 1–6. <https://doi.org/10.1155/2016/8319542>.
- Mol, A., 2002. *The body multiple: Ontology in medical practice*. Duke University Press.
- Murdoch, J., 1997. Inhuman/nonhuman/human: Actor-network theory and the prospects for a nondualistic and symmetrical perspective on nature and society. *Environ. Plan. Soc. Space* 15, 731–756. <https://doi.org/10.1068/d150731>.
- Murdoch, J., 1998. The spaces of actor-network theory. *Geoforum* 29, 357–374. [https://doi.org/10.1016/S0016-7185\(98\)00011-6](https://doi.org/10.1016/S0016-7185(98)00011-6).
- Nugraha, I., Satri, S., 2014. Jokowi Diajak Blusukan ke Lokasi Kebakaran Hutan dan Gambut [WWW Document]. Mongabay.co.id. URL <https://www.mongabay.co.id/2014/10/28/jokowi-diajak-blusukan-ke-lokasi-kebakaran-hutan-dan-gambut/> (accessed 7.24.23).
- Nugraha, S., 2015. Tiga Bulan Pasca Blusukan Jokowi ke Tohor, Bagaimana Hasilnya? [WWW Document]. Mongabay.co.id. URL <https://www.mongabay.co.id/2015/02/26/tiga-bulan-pasca-blusukan-jokowi-ke-tohor-bagaimana-hasilnya/> (accessed 7.24.23).
- Ostrom, E., 2014. Do institutions for collective action evolve? *J. Bioeconomics* 16, 3–30. <https://doi.org/10.1007/s10818-013-9154-8>.
- O'Gorman, E., Gaynor, A., 2020. More-Than-Human Histories. *Environ. Hist.* 25, 711–735. <https://doi.org/10.1093/envhis/ema027>.
- Pandora, A., 2020. Pelibatan Masyarakat Menjadi Hal Penting dalam Restorasi Gambut di Sumsel — BRG Indonesia [WWW Document]. BRG. URL <https://brg.go.id/pelibatan-masyarakat-menjadi-hal-penting-dalam-restorasi-gambut-di-sumsel/> (accessed 2.25.21).
- Parker, C., Scott, S., Geddes, A., 2019. Snowball Sampling. *SAGE Res. Methods Found.*
- Pratama, G.R., Hardjomidjojo, H., Iskandar, A., Muhandri, T., 2018. ANALISIS RANTAI NILAI AGROINDUSTRI SAGU DI KABUPATEN KEPULAUAN MERANTI. *J. Teknol. Ind. Pertan.* 28.
- Prihatin, P.S., Wicaksono, A., 2020. The Conflict in Indonesia's Forestry Sector: A Case Study of a Community Conflict with Company Industrial Plantation Forest (HTI) in Pelalawan Riau Province.
- Raven, R.P.J.M., Verbong, G.P.J., Schilpzand, W.F., Witkamp, M.J., 2011. Translation mechanisms in socio-technical niches: A case study of Dutch river management. *Technol. Anal. Strateg. Manag.* 23, 1063–1078. <https://doi.org/10.1080/09537325.2011.621305>.
- Reed, M.S., Vella, S., Challies, E., de Vente, J., Frewer, L., Hohenwallner-Ries, D., Huber, T., Neumann, R.K., Oughton, E.A., Sidoli del Ceno, J., van Delden, H., 2018. A theory of participation: what makes stakeholder and public engagement in environmental management work? *Restor. Ecol.* 26, S7–S17. <https://doi.org/10.1111/rec.12541>.
- Rip, A., Kemp, R., 1998. Chapter 6 Technological change. *Hum. Choice Clim. Change.* 10.1007/BF02887432.
- Safitri, M.A., 2016. PEATLAND RESTORATION in Indonesia Indonesian Tropical Peatland matters 1–16.
- Salim, M.N., Piniuji, S., Utami, W., 2018. Reforma Agraria Di Kawasan Hutan Sungaitohor, Riau: Pengelolaan Perhutanan Sosial Di Wilayah Perbatasan. *BHUMI J. Agrar. Dan Pertanah.* VO - 4, 164. [10.31292/jb.v4i2.277](https://doi.org/10.31292/jb.v4i2.277).
- Salim, M.N., 2019. WITHSTAND IN THE BORDER AREA : Abstrak. *Semin. Ser. Humanit. Soc. Sci.*
- Sari, A.P., Dohong, A., Wardhana, B., 2021. Innovative Financing for Peatland Restoration in Indonesia, in: *Climate Change Research, Policy and Actions in Indonesia*. pp. 247–264. [10.1007/978-3-030-55536-8_12](https://doi.org/10.1007/978-3-030-55536-8_12).
- Schot, J., Geels, F.W., 2008. Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. *Technol. Anal. Strateg. Manag.* 20, 537–554. <https://doi.org/10.1080/09537320802292651>.
- Scott, J.C., 1985. *Weapons of the weak: Everyday forms of peasant resistance*. yale university Press.
- Setneg, 2014. Presiden Jokowi Blusukan Kabut Asap di Provinsi Riau | Sekretariat Negara [WWW Document]. URL <https://www.setneg.go.id/baca/index/presiden-jokowi-blusukan-kabut-asap-di-provinsi-riau> (accessed 7.24.23).
- Shepherd, C.J., Gibbs, M.R., 2006. "Stretching the Friendship": On the Politics of Replicating a Dairy in East Timor. *Soc. Technol. Hum. Values* 31, 668–701. <https://doi.org/10.1177/0162243906291866>.
- Smith, A., Stirling, A., Berkhout, F., 2005. The governance of sustainable socio-technical transitions. *Res. Policy* 34, 1491–1510. <https://doi.org/10.1016/j.respol.2005.07.005>.
- Smith, S.W., Rahman, N.E.B., Harrison, M.E., Shiodera, S., Giesen, W., Lampela, M., Wardle, D.A., Chong, K.Y., Agusti, R., Wijedasa, L.S., Teo, P.Y., Fatimah, Y.A., Teng, N.T., Yeo, J.K.Q., Alam, M.J., Bruges Sintes, P., Darusman, T., Graham, L.L. B., Katoppo, D.R., Kojima, K., Kusin, K., Lestari, D.P., Metali, F., Morrogh-Bernard, H.C., Nahor, M.B., Napitupulu, R.R.P., Nasir, D., Nath, T.K., Nilus, R., Norisada, M., Rachmanadi, D., Rachmat, H.H., Ripoll Capilla, B., Salahuddin Santosa, P.B., Sukri, R.S., Tay, B., Tuah, W., Wedeux, B.M.M., Yamanoshita, T., Yokoyama, E.Y., Yuwati, T.W., Lee, J.S.H., 2022. Tree species that 'live slow, die older' enhance tropical peat swamp restoration: evidence from a systematic review. *J. Appl. Ecol.* <https://doi.org/10.1111/1365-2664.14232>.
- Strong, M., Letch, N., 2013. Investigating cultural heritage data integration with an ANT perspective. *VINE* 43, 322–340. <https://doi.org/10.1108/VINE-05-2013-0030>.
- Suryadi, 2020. Tak Terserap Pasar, Produksi Sagu Sungai Tohor Lesu di Masa Pandemi [WWW Document]. Mongabay.co.id. URL <https://www.mongabay.co.id/2020/05/22/tak-terserap-pasar-produksi-sagu-sungai-tohor-lesu-di-masa-pandemi/> (accessed 7.24.23).
- Tacconi, L., 2016. Preventing fires and haze in Southeast Asia. *Nat. Clim. Change* 6, 640–643. <https://doi.org/10.1038/nclimate3008>.
- The World Bank, 2012. *History and Evolution of Social Assistance in Indonesia (No. 647479)*. The World Bank.
- Thorburn, C.C., Kull, C.A., 2015. Peatlands and plantations in Sumatra, Indonesia: Complex realities for resource governance, rural development and climate change mitigation. *Asia Pac. Viewp.* 56, 153–168. <https://doi.org/10.1111/apv.12045>.

- Turetsky, M.R., Benscoter, B., Page, S., Rein, G., van der Werf, G.R., Watts, A., 2015. Global vulnerability of peatlands to fire and carbon loss. *Nat. Geosci.* 8, 11–14. <https://doi.org/10.1038/ngeo2325>.
- Uda, S.K., Hein, L., Atmoko, D., 2019. Assessing the health impacts of peatland fires: a case study for Central Kalimantan, Indonesia. *Environ. Sci. Pollut. Res.* 26, 31315–31327. <https://doi.org/10.1007/s11356-019-06264-x>.
- UN, 1992. *The United Nations Conference on Environment and Development*. United Nations.
- Van Der Werf, G., 2015. Global Fire Emissions Database [WWW Document]. URL http://www.globalfiredata.org/updates.html#2015_indonesia (accessed 7.27.21).
- Ward, C., Stringer, L.C., Warren-Thomas, E., Agus, F., Crowson, M., Hamer, K., Hariyadi, B., Kartika, W.D., Lucey, J., McClean, C., Nurida, N.L., Petorelli, N., Pratiwi, E., Saad, A., Andriyani, R., Ariani, T., Sriwahyuni, H., Hill, J.K., 2021. Smallholder perceptions of land restoration activities: rewetting tropical peatland oil palm areas in Sumatra, Indonesia. *Reg. Environ. Change* 21. <https://doi.org/10.1007/s10113-020-01737-z>.
- Waters, J., 2015. Snowball sampling: a cautionary tale involving a study of older drug users. *Int. J. Soc. Res. Methodol.* 18, 367–380. <https://doi.org/10.1080/13645579.2014.953316>.
- Weng, W., Becker, S.L., Lüdeke, M.K.B., Lakes, T., 2020. Landscape matters: Insights from the impact of mega-droughts on Colombia's energy transition. *Environ. Innov. Soc. Transit.* 36, 1–16. <https://doi.org/10.1016/j.eist.2020.04.003>.
- Whatmore, S., 2006. Materialist returns: practising cultural geography in and for a more-than-human world. *Cult. Geogr.* 13, 600–609. <https://doi.org/10.1191/1474474006cgj377oa>.
- White, S.C., 1996. Depoliticising development: The uses and abuses of participation. *Dev. Pract.* 6, 6–15. <https://doi.org/10.1080/0961452961000157564>.
- Williams, G., 2004. Evaluating participatory development: Tyranny, power and (re) politicisation. *Third World Q.* 25, 557–578. <https://doi.org/10.1080/0143659042000191438>.
- Wong, G.Y., Moeliono, M., Bong, I.W., Pham, T.T., Sahide, M.A.K., Naito, D., Brockhaus, M., 2020. Social forestry in Southeast Asia: Evolving interests, discourses and the many notions of equity. *Geoforum* 117, 246–258. <https://doi.org/10.1016/j.geoforum.2020.10.010>.
- Wooster, M.J., Gaveau, D.L.A., Salim, M.A., Zhang, T., Xu, W., Green, D.C., Huijnen, V., Murdiyarso, D., Gunawan, D., Borchard, N., Schirrmann, M., Main, B., Sepriando, A., 2018. New tropical peatland gas and particulate emissions factors indicate 2015 Indonesian fires released far more particulate matter (but Less Methane) than current inventories imply. *Remote Sens.* 10, 1–31. <https://doi.org/10.3390/rs10040495>.