Indonesia's Fire Crisis 2015
A Twofold Perturbation on the Ground

Flora Hartmann[1], Jennifer Merten[2], Michael Fink[3] & Heiko Faust[4]

[1-4] *University of Göttingen, Division of Human Geography, Goldschmidtstr. 5, 37077 Göttingen, Germany*

DOI: 10.23791/490411

Abstract: Wildfires in tropical rainforests and especially peat fires have abundant and wide-ranging negative effects on the economy, ecology and human health. Indonesia has large areas of peat swamp forests that recurrently burn. The use of fire is the most common method for land clearing in Indonesia. As a reaction to the devastating fire events of 2015, the provincial government of Jambi reimposed a more stringent version of the prohibition of burning land, delegalizing this land clearing method for smallholders. From a local perspective through qualitative research at the village level it becomes clear that this regulation is maladaptive as the underlying cause making land prone to fires, the sinking ground water table, remains unchanged by the ban. Further, the impacts of the new regulation vary for different groups of the local population, with severe land management restrictions for food crop farmers. The application of a framework on the political and material dimension of vulnerability reveals that the national policy unintentionally causes economic hardship and landscape changes at the local level. Hence, smallholders have experienced a two-fold perturbation caused by the fires' impacts and the reinforced ban on burning land.

Keywords: Indonesia, peat fires, vulnerability, maladaptation, governance

[Submitted as Scientific Paper: 12 January 2018, Acceptance of the revised manuscript: 15 February 2018]

Frequently, uncontrolled large-scale peat and forest fires in the tropics pose a threat to the affected regions' integrity regarding ecology, economy and human health (Alencar et al. 2006, Cochrane 2009, Gross 2015). As the resulting toxic haze contains an enormous amount of fine particulate matter (Koplitz et al. 2016) and does not stop at national borders, tensions between nations are likely. With the 1997 fire events which "blanketed" (Frankenberg et al. 2005: 109) large areas in South East Asia, the issue attracted attention from public, scientific and political actors for the first time (Carmenta et al. 2017, Davies & Unam 1999, Fanin & van der Werf 2017, Lin et al. 2017). Supranational institutions such as the Association of South East Asian Nations (ASEAN) reacted to the risks of fire and associated pollution and haze and have urged their member states to prevent fire events as with the 2002 Agreement on Transboundary Haze Pollution (Lin et. al. 2017). Nevertheless, large scale peat and forest fire events still occur, especially in Indonesia. Most recently, the fire events of 2015 caused the burning of 2.6 million ha of Indonesian land (World Bank 2016). Each day, the emissions caused by the fires in 2015 surpassed the daily emissions from the whole US (Carmenta et al. 2017). Ecosystems suffered (Lee et al. 2017) and the economic loss is estimated at USD 16.1 billion to Indonesia alone (World Bank 2016). The 2015 fire event coincided, like the one in 1997, with a strong El Niño Southern Oscillation, ENSO (also referred to as El Niño), that causes a prolongation of the dry season and a reduction in annual rainfall (Fanin & van der Werf 2017, Koplitz et al. 2016). Monsoonal winds carried the pollution haze to Malaysia and Singapore. Consequently, around 69 million people were exposed to an extremely high particulate pollution (Crippa et al. 2016) which led to the premature death of approximately 100,300 people (Koplitz et al. 2016). National and international pressure forced the Indonesian government to adopt adequate measures to prevent the burning of land. In Jambi province, one of the hotspots of the fires, a new regulation was issued that banned the burning of any land and imposed a penalty of up to ten years imprisonment.

Against this backdrop we claim that the prohibition on burning land is an insufficient attempt in the long-term prevention of large-scale fires in Indonesia. This article

builds on an in-depth qualitative case study. Its conceptual approach follows the basic idea of political vulnerability, which describes the translation of materialised harm into measurements undertaken by politicians. The ban on fire as an agricultural tool demonstrates how susceptibility to harm caused by change in the biophysical sphere is linked to political change. This change, in turn, is an example for a mismatch between its intention to reduce the local population's, and biophysical spheres' susceptibility to harm, and its outcome as it does not address root causes thus fostering unintended land use change. As a starting point, we analyse the effects the exceptional 2015 fire events had on income and health, referred to as material vulnerability, followed by the impact of the fire ban, and people's adaptation to it.

Maladaptation through Disconnected Scales in Policy Making

Our study of the fire events in 2015 builds on elements of vulnerability assessment literature. Within vulnerability research the focus is on socio-environmental relations, which we enrich with the concept of material and political dimensions of vulnerability (Simon & Dooling 2013). From this perspective human-environmental interactions are the core of the creation and manifestation of vulnerabilities. A widely adopted definition of vulnerability was developed by Adger (2006) who considers vulnerability as *"the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt"* (ibid. 268). Such an environmental or social change that forms a spike in pressure exceeding ordinary variability has often been referred to as perturbation (Gunderson 2000; Tomimatsu et al. 2013, Turner et al., 2003). An example of a perturbation is a longer than usual dry period.

Taking a context-oriented approach to vulnerability, we consider vulnerability as a recursive process that is dynamically formed through the combination and interaction of social, ecological, economic, and political structures and conditions (Adger 2006, O'Brien et al. 2007, Räsänen et al. 2016, Ribot 2014, Turner et al. 2003). Simon & Dooling (2013) have taken another important analytical step in vulnerability research by stating that it is not sufficient to discuss vulnerability in the singular but rather to distinguish between material and political vulnerability. The material vulnerability refers to material conditions that may be lived and experienced by local communities. The political vulnerability then represents its translation and interpretation by complex governance arrangements. This political response can take any form and can be e.g. a measurement, or even no action at all. Disconnections between the material and the political vulnerability may reduce the efficacy of formal policy and community responses and even lie at the heart of maladaptive outcomes. We understand maladaptation as outcomes of intentional adaptation policy that exacerbate peoples' conditions of material vulnerability (Juhola et al. 2016). Oftentimes, these are the result of non-representative and inequitable governance structures (Lynch 2012) across different scales. We regard this distinction as a means for pointing out the disconnection between the material and political vulnerability as it enables the identification of the underlying causes for vulnerability. In this paper, scales are not regarded as fixed levels or natural entities but as socially constructed (Anssi 2004, Hein et al. 2015). In our case study we consider the individual, household, provincial, national and global level as relevant. Perturbations and the impacts of adaptation measurements may arise from one scale and may manifest themselves in another one.

Introduction to the Study Site and Applied Methods

Field research was conducted in the village Seponjen in Jambbi province, situated in the south-central part of the island of Sumatra, Indonesia. An

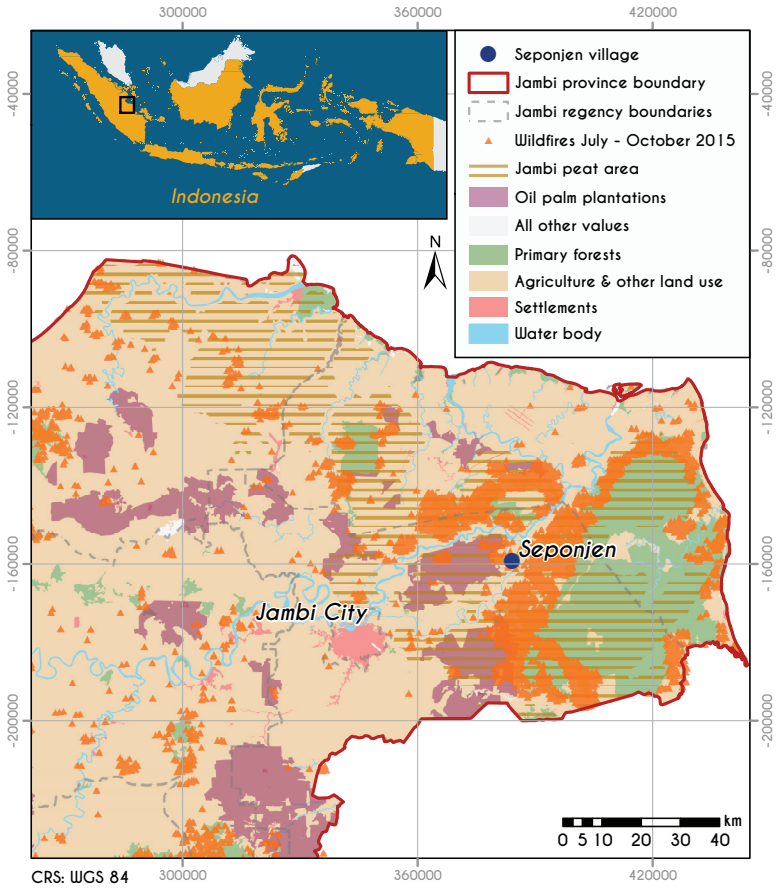


Figure 1: Localisation of the research village and forest fires 2015 in Jambi province.

Source: Local villager.

Figure 2: Haze during the day, September 2015

overview of the village's location is displayed in Figure 1. Jambi Province was chosen as a research region due to its comparatively rapid agricultural transformation processes. For the past 30 years, vast forest areas of agroforestry systems have been converted into oil palm plantations (Clough et al. 2015). In 2016, oil palm plantations extended over 474,000 ha (BPS Provinsi Jambi 2017), and rubber plantations over 664,000 ha (BPS 2017). Staple crop cultivations (rice, corn, soybean) in 2015 were only grown on 136,000 ha (BPS 2015) and are increasingly being replaced by more profitable plantation land use systems. The coastal areas in Jambi province are characterized by vast peat areas (Miettinen et al. 2016). The transformation of peat swamp forests into land suitable for agricultural purposes accords with the trend in Sumatra, Borneo and Papua Island. Formerly regarded as marginal agricultural land, peat land has experienced an increase in exploitation for plantation systems which is accompanied by drainage and degradation (Carmenta et al. 2017). The scarcity of land in Jambi Province has driven state promoted resettlements (Kunz et al. 2016), large-scale issuing of concession areas (Kunz et al. 2017) and spontaneous migration of independent smallholders seeking a better future in the plantation sector (Hein 2016; Kunz 2017). During the fire events burning from June until October 2015, 123.000 ha of land burned in Jambi province (World Bank, 2016), which lead to persistently hazardous levels of smoke (Koplitz et al., 2016), causing an economic damage of 866 million USD. Hereof, 210 million USD account to losses in agriculture (ibid.). An impression of the fire events in Jambi can be gained from Figure 2 3 and 4.

As can be seen from Figure 1, most of the fires occurred in Jambi's vast peat lands. Peat is an organic soil. It consists of partly decomposed plant remains holding less than 20-35% mineral content (Turetsky et al. 2015). The key regulator of peat accumulation and peatland decomposition is water-table depth. If the depth of the water-table is lowered, aerobic conditions stimulate decomposition; thus, peat carbon is released to the atmosphere (ibid.). Deforestation and drainage generate "*favourable conditions for the fires and amplify the hydrological drying processes in the aboveground fuels and the underlying organic soil*" as they influence the groundwater table (ibid. 1). Due to a high moisture content, the peat swamp forest in its pristine state is *"naturally protected from burning"* (ibid. 11), whereas large scale degradation by drainage makes peat flammable (Couwenberg et al. 2010) and transforms peat from a carbon sink into a carbon source (Carmenta et al. 2017). Considering the thickness and thus the volume of peat measured, Indonesia holds 46 Gt and 65% of all tropical peat mass (Page et al. 2011).

One distinctive reason why fires were so intensively combustible in 2015, distinguishing it from all preceding El Niño years with prolonged droughts, is the advanced degradation of peatlands and the ongoing change in land-use. Taufik et al. (2017) link the hydrological drought to the fire-proneness of the humid tropics in Jambi.

The village Seponjen was selected for our case study due to its proximity to several hotspots of the 2015 fire events. The dominant soil type in the village are peat soils with a depth of up to four metres, however there are scattered fields on mineral soil or thin peat layers that are already degraded. The village is populated by different ethnic groups, the native Malay people, immigrated Bugis from Southern Sulawesi and other migrant groups from Java. The main income for local households is derived from agriculture. While most farmers focus on oil palm business, some also cultivate maize which became popular in the village with the arrival of the Bugis people in the late 90s and is still dominantly grown by them. Illegal logging of nearby peat swamp forest was a major source of income until the early 2000s. An industrial oil palm plantation concession borders the village; here villagers offer their labour power (interviews with villagers during February and March 2017).

During a two-month field stay in Jambi province we conducted thirty semi-structured and unstructured interviews in February and March 2017 with villagers in Seponjen. Interviews were conducted in Bahasa Indonesia and translated with the help of a field assistant. To acknowledge the heterogeneity of the village population we interviewed a variety of villagers, from village leader to the head of customs to common farmers of different ethnicities and landless families. The main topic discussed during the interviews was the prevailing impacts of the fires to local livelihoods and people's adaptation strategies to prevent future fire outbreaks. During the field visit it became apparent that apart from immediate impacts of the fires, the new provincial regulation on the prevention of forest and land fires had major impacts on local land management strategies. Hence, these dynamics became a second and unforeseen topic of research. All interviews were recorded, partly transcribed and documented in detail. Interview data was further supported by participative

observation, photographs taken by our respondents, as well as a review of government regulations.

Results: Ground Perspectives on Pertubations

The first Perturbation: Immediate Impacts of the Fire

As the agricultural sector is the main income for villagers of Seponjen, economic losses caused by the fires largely manifested there. This situation was intensified by low crop yield of the forgone months brought about by the outstandingly long drought. Without exception, all oil palm smallholders reported their fruits had become trek, an expression that describes the phenomenon when fruits of the fresh fruit bunches become lighter and smaller. However, the impacts on plantation productivity differed depending on farmers' management practices as well as whether plantations were only impacted by drought and pollution haze or also suffered tree loss due to fire. A lower production was reported to have had lasted up to three months after the fire incidents. Such losses in income put smallholders under financial pressure. These circumstances were intensified by extra expenses mitigating adverse effects of the drought and fires. Additional costs included spending on medical treatments and clean water for washing, bathing and drinking. Natural water resources, usually serving these purposes, were polluted by dust and particles, and wells ran dry. The severity with which the income losses affected the households varied widely from simply a shortfall in savings to a need for actions such as gaining additional income from other sources and cutting expenses. The most popular method to compensate for the income losses was to gain income as a day labourer on either another farmers' or companies oil palm plantations. Along with the endeavour to counterbalance the losses, cutting on expenses stands to reason. Most popular was cutting down on food costs by a change in nutrition habits, a reduction in quantity of food and a forego of non-vegetarian sustenance. Further, a common strategy among parents was to consume less, thereby leaving enough food for their children. Chemical fertilisers generally required for the management of oil palm plantations were often intermitted during the 2015 fire events due to their high cost, causing further decreases in productivity of the palm trees in the following months.

Source: Jennifer Merten 2015.

Figure 3: Reduced visibility due to the haze, August 2015

Health issues proceeded from people's exposure to the pollution haze and smouldering peat which contained high concentrations of Particulate Matter (PM) with diameters of less than 10 and 2.5 µm, also referred to as PM_{10} and $PM_{2.5}$ (Koplitz et. al 2016). From the beginning of September 2015 until the end of December the same year, air quality in Jambi's peatlands regularly reached very unhealthy or even hazardous levels according to measurements of the Pollutant Standard Index (PSI) (see Crippa et al. 2016 for more details). Every respondent experienced breathing problems; all experienced sore eyes, some suffered from psychological trauma. Additionally, a decline in water quality lead to several cases of diarrhoea. Exposure of and sensitivity to the pollution haze and smouldering peat and access to coping were largely determined by three factors: (1) age (2) time spent exposed to the pollution haze and (3) economic background. Young and elderly people, as well as those with pre-existing lung or heart diseases, are a high-risk group as they are particularly susceptible to harm (WHO 2013). The duration people spent exposed to pollution haze varied, so did awareness and knowledge of associated health risks. Further, profession and economic background mattered as different occupations involve outdoor activities, such as being a farmer. As most people of Seponjen are farmers they were under economic necessity to work on their fields and plantations or to guard them, thus enduring exposure to pollution haze. Given the fact that economic resources determine the amount of money available for quality

Source: Jennifer Merten 2015.

Figure 4: Smouldering fire, August 2015

Source: Local villager.

Figure 5: Maize cultivated on land cleared by fire

construction materials, people with less financial capital tend to live in houses made of wood compared to wealthier people living in houses made of concrete. These types of houses differ strongly in their efficiency to exclude outdoor air as the houses made of wood have a high number of interstices between the wooden boards forming the walls and the floor. Less tangible is the phenomenon of psychic trauma, which were relived in cases where people had experienced losses caused by burnings of their fields and plantations in previous times. Hence, the individual's exposure and sensitivity towards perturbations varied.

The Second Perturbation: The Prohibition on the Use of Fire

As a reaction to the fires, the provincial government of Jambi issued a regional regulation which specifies penalties for burning land and forests (Peraturan Daerah 2-2016). The regulation defines the exact modes of the implementation of the national laws No 41/1999, No. 32/2009 and No 30/2014, and goes further as it prohibits burning any size of land, although national law actually states that a person is allowed to burn land of up to 2ha (UU 32/2009). The ban on fire as an agricultural tool to clear or prepare land was introduced in Jambi in March 2016, shortly after the fires had stopped. This ban is a major interference with the farmers' custom, as burning is an integral element of their land-clearing practice. A major problem for the smallholder that comes along with the ban is the disposal of organic material, for which they know of no alternative to burning. That problem concerned seasonal crop farmers immediately since it was their method of preparing their fields every year prior to a new growing cycle. The government proposed collecting organic material manually and then burning it in a barrel as an alternative to clearing the land with fire. The disadvantages to this proposed method are (1) it is very time consuming, (2) is lacks accuracy, and (3) the loss of the fertilizing function. According to villagers interviewed, before the ban on fire one person could manage to clear 2-3 ha of field on his or her own, but without the use of fire in the same time one could only manage 0.5 ha. By reason of the lessened accuracy of land clearing an increase in pesticides was predicted by the smallholders. Commonly used pesticides are glyphosate and paraquat, with paraquat being banned throughout the whole European Union (ECCHR, n.d.). Further, the temporarily fertilising function of clearing land by burning is lost, too. One respondent freely shared his documentation of the maize growth which can be seen in Figure 5 and 6, his proof of the fertilizing function of burning above-ground biomass. The maize seedlings in both figures were planted on the same day, but only one field had been cleared with fire. While farmers highlight the fertilizing and pH-buffering function of burning organic matter on organic and peat soil, this practice contradicts scientific evidence. The fertilizing effect of burning the above-ground biomass which impels a rapid release of nutrients into the soil is only temporarily (Glaser et al. 2002). The burning of peat soil is also problematic as it creates unfavourable conditions for cultivation on the already nutrient-poor soil in the long term and causes peat oxidation (Dikici & Yilmaz 2006; Hirano et al. 2014).

In the villagers' opinion, the law is a heavy burden for smallholders and highly impracticable. Out of fear, the majority of the respondents stated they will, nevertheless, obey. Well known is the case when a farmer of a neighbouring village used fire to clear his land, whereupon he was sought by the police but ran off. His land became state property. In spite of this story, some villagers admitted planning to burn secretly due to a lack of alternatives. In general, opinions on the law among the villagers interviewed were deeply divided.

In 2014, Seponjen was the largest maize production site in the district Muaro Jambi (interviews with villagers during February and March 2017). Where the land for maize cultivation, carried out primarily by Bugis farmers, must be absolutely clear and follow a strict schedule as it can only be planted once a year in Seponjen, oil palm smallholders are more flexible in their proceeding and the oil palm's requirements concerning the clearness of the land are lower. An advantage of burning land is the rapidity and thoroughness which cannot be achieved via manual weeding. The timeslot when maize seedlings have to be planted is very short. Usually, cultivation starts in May when the annual flooding is over. If weeds are cut manually and planting is then postponed, the harvest may fail as monsoon starts and the fields are frequently inundated. Hence, it is not just the accuracy in land clearing that is a major problem for maize cultivation but the timing which is gravely hampered by the ban on fire. As explained by some farmers, this is a reason why the ban might have an influence on crop choice and even

trigger land-use change from maize to oil palm. Another concern about a side effect of the law were raised by some interviewees. Attempts in cultivating maize despite the given circumstances or the transformation of maize fields to fallow land might lead to an increase in available organic fuel which plays an essential role in the uncontrolled spread of fires.

After the reinforcement of the ban in 2016, around 20 people cultivated 60 ha of maize. Prior to the ban, about 80 people cultivated 200 ha maize. These numbers only refer to maize farmers organised in farmer groups who may apply for free seedlings from the local government. At the time of our research in March 2017 one farmer group of Seponjen had already withdrawn their proposal for maize seedlings, as it was likewise considered by another farmer group. Individuals had already resigned from maize farmer groups. Other farmers wanted to wait and see whether the prohibition of burning land would be altered again in the coming season and, if the prohibition was unchanged, stop cultivating maize. It is expected that the land formerly used for maize cultivation is either transformed to fallow land or changed to another crop like the oil palm. A change to another seasonal crop like watermelon or pineapple with less organic waste production is not an option as knowledge on how to cultivate other crops and profitable land use options is not a given. Other crops are rarely cultivated as there is a long history of private and state-owned oil palm companies in Jambi where farmers often received training. Also, farmers would incur high investment costs for other seedlings as maize seedlings are governmentally funded for members of farmer groups, although these costs vary depending on seedling and fertilizer quality chosen.

Similarly to the impact of the first perturbation, villagers are affected differently. The degree to which the law disadvantages smallholders is explained in the village's specific cropping pattern. Especially affected are maize farmers, more precisely the ethnicity of the Bugis as they are the main maize cultivators in Seponjen. Hence, the law causes unintended dynamics leaving foremost maize farmers, and thus most Bugis the worst off.

Source: Local villager.

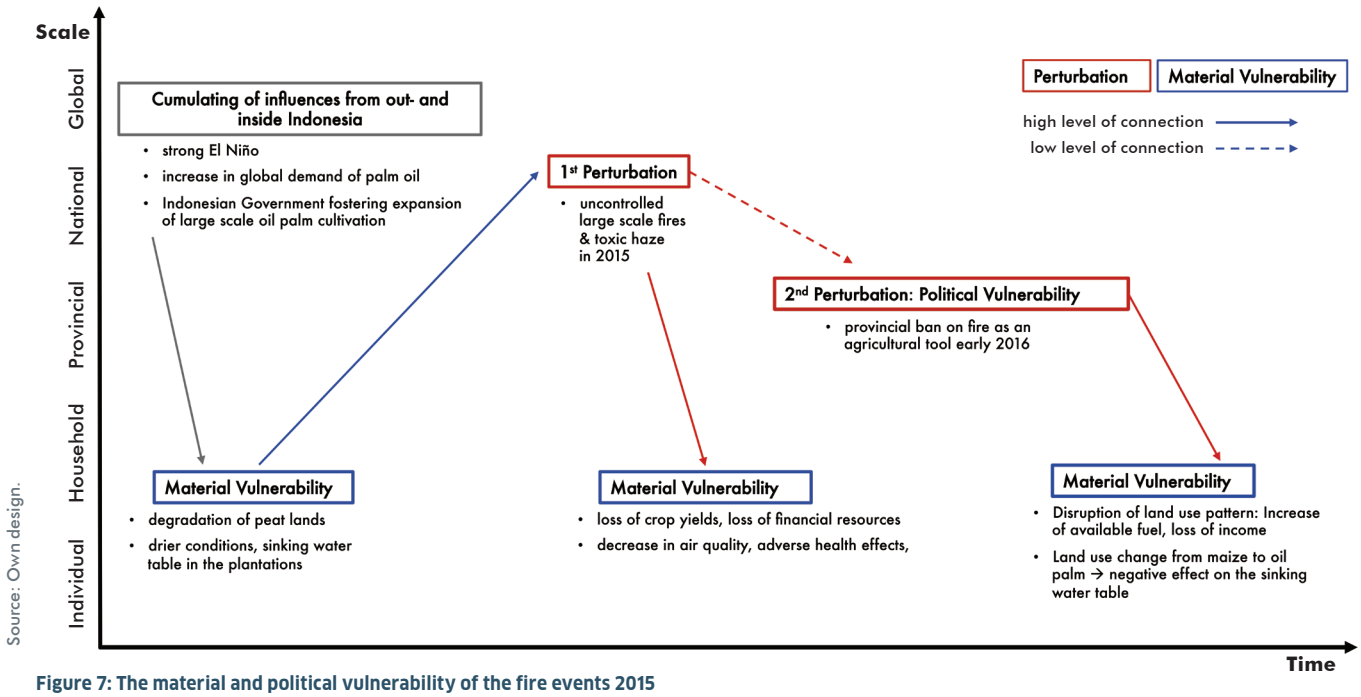
Figure 6: Maize cultivated on land not cleared by fire

Discussion

So far, analysis of the ecological, economic and health impacts of the fires 2015 remained on a national or regional scale (World Bank 2016, Lee et al. 2017, Crippa et al. 2016), leaving a blind spot on how the impacts manifested themselves on the ground. The drying of peat soil has been associated with the creation of conditions that favour the spread of fires (Turetsky et al. 2015, Couwenberg et al. 2010), but has not yet been considered with regard to fire policy. Only with the knowledge of both an understanding of the changes the law brings about in the village and an awareness of characteristics of peat soil can the significance of the ban become clear and demonstrates how it fails to address the underlying causes for the outbreak of fires. To reiterate, a combination of influences out- and inside the village area, namely the expansion of oil palm monocultures on peat land caused the degradation of peat swamp through drainage, fostered by, among others, the Indonesian national government due to land scarcity and a growing global demand in palm oil. Private plantations in Seponjen and an oil palm concession bordering the village on peat soil are an outcome of these influences. These conditions created on the local scale an environment that favoured the outbreak of fires, as dry peat is easy flammable. The dryness of the peat is intensified by the phenomenon El Niño which manifested itself as a prolonged drought. These changed environmental conditions are the Material Vulnerability in Figure 7. How the twofold perturbation of the fire crises in 2015 is fostered by and connected to influences out- and inside the village is depicted in Figure 7. This figure is a timeline connecting a simplification of the events on the household/individual scale to the local and provincial/national and global scale. The arrows connect the different events, the arrow's line informs about the quality of the scales' connectedness. Whereas an unbroken line illustrates a high level of connectedness, a broken line indicates inconsistencies. If an ideal connectedness is a given, the political translation of the material vulnerability meets the aim to reduce vulnerabilities, hence the material vulnerability is mitigated.

In consideration to the given evidence, it is apparent that the major cause making land prone to fires – the sinking ground water table through drainage – is not corrected by the regulation on not burning organic matter on land. Thus, the fires are the driver of the first perturbation the local population went through. This first perturbation is the direct cause for the Material Vulnerability at the household and individual scale which manifested themselves as the explained adverse effects.

The reaction on the regional scale the ban on the use of fires as a political



Source: Own design.

Figure 7: The material and political vulnerability of the fire events 2015

translation of the material vulnerability is highly disconnected from the local reality. The ban does not tackle the changes that made the land so prone to fires – the sinking ground water table in peat lands through drainage. It is clear that without any kind of compensation or further assistance the ban is highly impractical, hence it is titled as a second perturbation to the villagers as it brings about adverse impacts on their income and makes them more susceptible to economic shocks. A further consequence of the ban is its potential to drive the change from seasonal crops to oil palm. However, this change does not provide a solution to all the villagers' problems as it is not financially viable for everyone and the pressing issue of the disposal of organic matter is not eliminated but adjourned. Maize farmers in particular are hindered by the regulation as their organic disposal comes in high quantities. If the ban on fire is to be successful, the needs of the people on the local scale must be addressed as there is currently no known alternative in land clearing methods. The potential magnitude of future fires is also affected by the varying acceptance of the ban among the villagers. While some plan to obey, others state they will ignore the law as they recognise no danger in burning their land beyond the disadvantages associated with the regulation. Exactly here lies a danger. If the ban is obeyed only by a few people, more dried organic matter remains on the fields or fallow land which is, in case of an uncontrolled fire, easily flammable fuel.

Hence, vulnerability has increased in terms of (1) susceptibility to economic shocks for the local people and (2) susceptibility to fire due to an increase of available fuel. As the ban also fails in tackling root causes that make the land so prone to fire, the ban on fire-clearing as an agricultural tool is a maladaptation.

Conclusion

The reality at the local level, and policy making on the national level, are highly disconnected in terms of the Indonesian fires of 2015. Further, the roots of components of the complex set of factors that make Indonesia so prone to fires are inscribed in its recent past. Identification of the dynamics on different scales that have created and will create the current and future situation offers an answer to some whys and hows of Indonesia's fire problem.

The next El Niño phenomenon will certainly happen, and the frequency of the occurrence of extreme El Niño events is predicted to increase due to global warming (Cai et al. 2015). Thus, the Indonesian fire issue is even more pressing. An avoidance of a repetition of the Indonesian fires 2015 is of global significance, as the impact's scope reaches everyone, may it be through positive radiative forcing, economic losses or adverse health effects. However, a ban on fire as an agricultural tool is not the ultimate solution. The given example of a two-fold perturbation shows that the discourse in vulnerability is in need of political approaches that recognize how vulnerabilities arise due to a disconnection of local realities and political measurements, as well as how vulnerabilities are created that constitute the initial situations prone to perturbations.

Acknowledgements

This study is part of the Collaborative Research Center 990 'Ecological and Socioeconomic Functions of Tropical Rainforest Transformation Systems in Sumatra, Indonesia' (EFForTS) funded by the German Research Foundation (DFG). We are grateful to the many people who have contributed in a variety of ways to this study. We particularly extend our sincere thanks to our diligent field assistant Winda Januarista and to all interviewees who generously contributed valuable time and information.

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Corresponding Author: Flora Hartmann [F.Hartmann3@stud.uni-goettingen.de] is a graduate of the study program B.Sc. Geography at the University of Göttingen, Germany. The presented paper is based on research she conducted for her Bachelor Thesis.