



**HAL**  
open science

# Chronopolitics of crisis : a historical political ecology of seasonal air pollution in northern Thailand

M. Mostafanezhad, Olivier Evrard

► **To cite this version:**

M. Mostafanezhad, Olivier Evrard. Chronopolitics of crisis : a historical political ecology of seasonal air pollution in northern Thailand. *Geoforum*, 2021, 124, p. 400-408. 10.1016/j.geoforum.2020.05.011 . hal-04027825

**HAL Id: hal-04027825**

**<https://hal.science/hal-04027825v1>**

Submitted on 18 Oct 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NoDerivatives 4.0 International License

# Chronopolitics of crisis: A historical political ecology of seasonal air pollution in northern Thailand

Mary Mostafanezhad<sup>a,\*</sup>, Olivier Evrard<sup>b</sup>

<sup>a</sup> *Department of Geography, University of Hawaii at Mānoa, United States*

<sup>b</sup> *The French Research Institute for Development, France*

## ABSTRACT

Geographers' engagements with environmental crises have taken a number of forms. Some scholars argue that crises judgments are revelatory and expose the contradictions of modes of production through interruptions to socio-economic life that can no longer be ignored. Others contend that crises judgments conceal more than they reveal through the framing of crisis as “error” and the focus on technocratic solutions to political-economic problems. In this article, we argue that the judgment of seasonal air pollution as a crisis is contingent on con-testations over livelihoods and worldviews, and in doing so demonstrate how attention to chronopolitics reveals the nuanced ways people account for uncertainty in the causes and effects of anthropogenic environmental change. Based in northern Thailand, the paper focuses on what is described by many residents as the region's annually recurring “haze crisis”. In recent decades, broad shifts from subsistence farming to commercial agri-culture and increased volumes of agricultural biomass burning have reportedly exacerbated the production of air pollution in the form of haze—an airborne mixture of pollutants that includes gasses, fine soot particles and carbon dioxide. Once a quotidian phenomenon of relatively little concern, today seasonal air pollution is de-scribed as a haze crisis. While causal uncertainty exists surrounding the precise combination of the socio-eco-logical drivers of haze production, multiple narratives circulate throughout the region, in which blame is frequently placed on smallholder farmers who have recently entered into new market relations. Situated within broader regional agrarian transitions, we draw on mixed ethnographic, archival and geospatial methods to examine the chronopolitics of seasonal air pollution and by what mechanisms such pollution comes to be constituted as a crisis.

## 1. Introduction

In May of 2016, a fire in Doi Suthep-Pui National Park hovered brightly over the Chiang Mai-Lamphun valley threatening the most sacred and toured temple in northern Thailand and scorching 290 rai (114 acres) of forest. Urban residents took to the streets in protest of the fires that were rumored to have been set by villagers in search of wild vegetables. The Provincial forest fire chief contended that “local people needed to be more aware of the damage to the provincial economy, tourism and natural resources caused by fires which might be started out of carelessness and traditional slash-and-burn farming” ([Bangkok Post Reporters, 2016](#)). In that same month, the Thai government launched the *Haze Free Thailand Campaign* to address what is now widely described as the “smoky season” (*rudu mo khwan*) which occurs each year between February and April. During this period at the end of the dry season, highland farmers prepare their fields for the new

agricultural cycle as well as clear fallen leaves. While the smoky season was once a relatively minor concern among lowland residents, today it is increasingly described by residents, academics and in popular media as a haze “crisis” that demands urgent attention. Focusing on the social drivers and consequences of seasonal air pollution in northern Thailand, this paper contributes to emerging theories of environmental disasters by adding a temporal dimension to debates about the role of crisis in socio-political marginalization. We highlight the chronopolitics—or the politics of time—through which seasonal air pollution became a socially defined crisis. In doing so, this paper not only reveals how crisis narratives obscure the broader structural inequalities on which recurring disasters exist, but also addresses how they are coopted in ways that advance state power through the reinforcement of technologies of surveillance and the declaration of states of exception.

Air pollution now accounts for the premature death of one out of nine people globally including an estimated four to seven million

people in developing countries, a majority of which occur in Asia (Rowell and Rossman, 2015). Each year in northern Thailand, the smoky season costs the region an estimated 50 billion baht (USD 1.5 billion) in tourism revenue, contributes to the hospitalization of more than 81,000 residents (The Nation, 2010), and directly impacts the livelihoods of approximately 60 percent of the population that work in the tourism and agriculture industries, thus affecting the livelihoods of the majority of the region's residents, albeit, in sometimes diverse ways (The Nation; World Bank, 2016). A range of technocratic solutions have been enacted such as dumping water from planes, promoting biochar as an alternative to burning agricultural waste, dousing the street with water to settle the dust and blanket burning bans. Additionally, for many years policy and government actors have maintained a "wait-and-see" attitude towards seasonal air pollution. These solutions are often proposed in ways that either seek to band-aid the effects of seasonal air pollution or obscure the socio-economic livelihood challenges among rural agriculturalists, such as their dependence on shifting cultivation, their customary use of forests as well as the growing cost of production and reduced profits from increased competition from global markets.

Since the early 1950s, the "highland ecological crisis" narrative has framed public policies and debates surrounding the north, that have successively focused on national security (e.g. communist insurgency), opium production, shifting cultivation, forest protection and watershed management. Today, the discursive framing of seasonal air pollution as a crisis produces meaning and initiates critique of the smoky season in ways that echo these narratives and further marginalize the rural poor through a range of governance mechanisms that limit their access to resources and markets. Crisis judgements frame seasonal air pollution as an "error" and typically divert attention to the crisis itself rather than its political-economic roots (Masco, 2010, 2017; Roitman, 2013). Efforts by the state to control the crisis narrative are wide-ranging. For instance, in April of 2019, Prime Minister Prayut Chan-ocha visited Chiang Mai to announce that the fires would be over in seven days, thus declaring the end of the haze problem in the north (Bangkok Post, 2019).

When the Prime Minister announced that he would end the haze crisis by extinguishing even "the smallest (fire) in the villages" (Yee, 2019), he reinvigorated the highland ecological crisis (Forsyth and Walker, 2008) narrative by attributing blame to minority groups colloquially described as *chao khao* or "hill people". The category of *chao khao* was popularized in 1959 by the Hill Tribe Development and Welfare Program of the Department of Public Welfare and refers to several ethnically non-Tai and culturally heterogeneous populations, some of which are indigenous (e.g. Karen, Lua), and others that are relatively recent immigrants from the Southwestern Chinese regions (e.g. Hmong, Mien, Lahu, Lisu) (Evrard and Leepreecha, 2009). While the highland ecological crisis narrative signifies overlapping concerns regarding "hill people" and ecology, in practice the relationship is more nuanced as many organizations ascribe to the narrative and perceive the local ecological knowledge and practices of some ethnic groups to be beneficial to highland ecologies.

Today, the category of *chao khao* is widely criticized and in academic circles has been replaced with *chadtiphan* (ethnic groups). Yet, highland farmers including ethnic minority groups continue to be enrolled in struggles over land, rights and resources by NGOs and indigenous rights movements and a range of state interventions have sought to govern highland residents through market integration and the promotion of sedentary agriculture. Through these programs, highlanders have "become subjects governable under the formal authority of the Thai state (as well as the less formal authority of development programmes)" (McKinnon, 2008: 286). Today, "highland ecological crisis" and "hill tribe problem" narratives find new life in the haze crisis where ethnic highland residents are widely identified as the primary culprits in ways that obscure the structural discrimination through which they enact their lives and livelihoods.

Residents' shifting perceptions of the smoky season as a crisis over

the last decade offers an opportunity to develop new understandings of the material and social mechanisms through which people come to understand the causes and effects of anthropogenic environmental change as well as what constitutes a crisis. Through the lens of historical political ecology, we reflect on the historical making and response to seasonal air pollution and the implications of thinking through times of ecological crisis. In other words, we are concerned with how "things that are now considered to be disasters cease to be one and how are ones that are not become one?" (Bankoff, 2004: 29). Our ethnographic engagement with this scholarship is focused on what northern Thailand residents' growing recognition of the smoky season as a crisis reveals about the "deeper social grammar" of the region (Oliver-Smith and Hoffman, 2002).

In the following section, we engage with recent literature on the historical political ecology of air pollution and disaster and the politics of crisis narratives as well as the integral role they play in contemporary socio-environmental change. We then briefly outline the background and context of our study as well as our research methods. We begin our analysis with historical accounts of haze in northern Thailand to reveal the trajectory of residents' perceptions from indifference and vague annoyance to fear and resentment. We then address the range of representational practices through which air pollution is measured, mapped and otherwise accounted for. Finally, we address the chronopolitics of the haze crisis and demonstrate how the atmosphere has become the latest "ideological battleground" (Forsyth and Walker, 2008) upon which social relations are increasingly worked out.

## 2. Towards a historical political ecology of crisis, disaster and air pollution

Building on work in historical geography and environmental history, historical political ecologists home in on the political and economic drivers of environmental change, policy formation and environmental narratives (Davis, 2009). Scholarship examines "society-nature relations in the past... [and] how and why those relations have changed (or not changed) over time and space" (Offen, 2004: 21). This literature calls on political ecologists to "explore the complex links between stories of environmental change, the 'science' used to bolster those stories, the biophysical data, and the political and economic forces motivating the use of a particular story over another" (Davis, 2009: 286). Historical representations are important nodes of reference for understanding how crisis events are constituted and how people experience environmental crisis is deeply shaped by the 'mutuality' between nature and culture as well as time (Oliver-Smith, 1996). Postcolonial studies as well as the history of science and technology are integral to the study of historical political ecology which foregrounds tracing how specific histories and knowledges become dominant over time and to what ends (Davis, 2009: 285). While we use the concept of the "haze crisis" throughout this paper to account for its popular and academic representations, the haze "crisis" may also be described as a recurrent "disaster". The concepts of "crisis" and "disaster" are often used interchangeably, yet important distinctions exist between them (Faas and Barrios, 2015; Shaluf and Said, 2003). Barrios argues that crisis describes a historical judgment and marks an epochal transition while disaster refers to "the end result of historical processes by which human practices enhance the materially destructive and socially disruptive capacities of geophysical phenomena, technological malfunctions, and communicable diseases..." (Barrios, 2017: 151). Despite these differences, "crisis and change" are "always present in disasters" (Faas and Barrios, 2015: 290). In northern Thailand, seasonal air pollution is both a crisis in terms of widespread judgment of its transitional character, as well as a disaster insofar as it is the result of historically uneven urban-rural political and economic relations.

In his foundational text, "Man-made Disasters model", Turner describes the "disaster incubation period" which is an "accumulation... of a number of events which are at odds with the picture of the world and

its hazards represented by existing norms and beliefs (Pidgeon and O'Leary, 2000: 16). Turner and Hewitt, among others, argue that disasters frequently occur not because of their physical impacts, but the disruption of cultural beliefs and norms about hazards (Hewitt, 1983; Torry et al., 1979; Turner, 1979). Political ecology approaches to disaster build on these insights as well as the work of O'Keefe et al. (1976) who sought to denaturalize natural disasters through a focus not on the physical phenomenon but rather the social drivers and consequences of vulnerability. Building on earlier observations, this literature focuses on deforestation, underdevelopment, and biodiversity loss and is now intensely focused on climate change (Barnes and Dove, 2015; McElwee, 2015, 2016; Orr, Lansing, and Dove, 2015). In a similar vein, Richards argues that environmental problems are often largely driven by structural imbalances between rich and poor countries and that scholars should therefore replace “natural” with social or political disaster. In this vein, anthropologists Oliver-Smith and Hoffman identify disasters not as exceptional events but as the outcome of unequal social relations (Oliver-Smith, 1996; Oliver-Smith and Hoffman, 1999). While political ecologists have highlighted the socio-political drivers of disasters, we still know much less about how temporality shapes the framing and response to air pollution (Buzzelli, 2008; Véron, 2006).

Temporality is central to the process of capital accumulation, which in agrarian environments, is limited by the uncertainty and seasonality of surplus value accumulation (Li, 2017). In the context of the haze crisis, the rhythms of nature (dry/wet season) and of traditional rotational farming (where a parcel of forested land is burnt, cropped and then left fallow for seven to 15 years) and the market now interact at increasingly incompatible tempos. While political ecologists have long attended to the historical roots of environmental change, Bankoff argues for an “appreciation of time” and describes how time has become a factor in its own right and refers to a “temporally-produced state of vulnerability” to describe how, as socially produced vulnerabilities change over time, perceptions of human and material degradation may also shift accordingly. In the age of “on-rushing turbo capitalism”, slow violence accounts for accumulated toxic exposure to specific pollutants and contributes to attritional catastrophes (Nixon, 2011: 7). Building on literature at the intersection of slow violence and the politics of emergency, Anderson et al. (2019) develop the concept of “slow emergencies” to describes situations marked at least in part by attritional lethality, and the foreclosure of the capacity to become otherwise. The concept of “slow emergencies” is useful here because it accounts for how barely or unlivable conditions become indistinct from ordinariness and the process through which such conditions are enrolled into the constitution of crises. In this way, “a slow emergency is thus marked by the disjuncture between an emergency claim and the racializing assemblages that structure which subjects may claim a future in need of protection” (3). Air pollution in northern Thailand has become a slow emergency that is increasingly made legible not only through the new forms of measurement, but also new representational practices (sensors, real-time maps etc.). Thus, a temporally informed political ecology of air pollution accounts for the life-history of the recurring disaster and the socio-ecological context in which it occurs (Oliver-Smith and Hoffman, 1999). This article builds on the aforementioned work by contributing to a historical political ecology of seasonal air pollution to environmental debates.

### 3. The haze crisis in northern Thailand

Chiang Mai, the largest city in northern Thailand, is situated in the Chiang Mai-Lamphun Basin with an altitude of approximately 310 m above sea level at its lowest point. Surrounded by mountains, its geographical features create the conditions (temperature inversion, low wind velocity and a six-month period with low precipitation levels between November and April) that exacerbate haze during the dry season, especially during February and March (Chantara, 2012). During these months, a major source of air pollution is open burning at the

beginning and end of the agricultural cycle: in typical rotational swidden cultivation systems (mostly in the highlands), a portion of forested land that has been left fallow for many years (the duration depends on the quantity of land available) is cut down, the vegetation left to dry and then fire is used to prepare the fields before planting rice or cash crops), fire is also used to clear the fields from harvest residues and pests after the harvest. In urban areas, PM from biomass burning interacts with PM from other sources such as international combustion exhaust from vehicles.

Despite existing uncertainties around the precise factors of the haze crisis and their combination (geographic features, open burning, urban-based pollution, transboundary haze from Burma and Laos), the major policy response thus far has the 60-day burning ban between mid-February and mid-April. Instituted in 2015, penalties for breaking the ban include fines of up to 100,000 Baht (USD \$2,800) and a seven-year prison sentence. This policy disproportionately affects rural residents that are typically poorer than urban residents and has been critiqued by many for its limited effectiveness; while the number of fires recorded by satellites diminished in 2016 and 2017, they increased from 2018 to 2020 (MODIS), with each year being described in popular media reports as the worst on record. Despite these perceptions, air pollution measurements demonstrate a more nuanced reality. Still unsettled, debates persist regarding whether air pollution is indeed worsening or growing public awareness is the primary driver of the haze crisis.

Throughout Southeast Asia, lowlands have traditionally been the primary political and religious center associated with wet-rice cultivation and surrounded by semi-autonomous highland cultural and ecological margins where swidden cultivation—the cyclical clearing of fields for planting and/or the generation of nutrients for crops—prevailed. While in many cases, sharp distinctions were not clear-cut (swidden agriculture is also present in the lowlands and some highlanders farm rain-fed and irrigated terrace rice fields), swidden agriculture tends to be associated with highlanders of various ethnic backgrounds with relative political autonomy (Scott, 2009) who are often typified by cultural backwardness, rebellious attitudes toward central State and nomadism or ‘semi-nomadism’ (Evrard and Goudineau, 2004). Simultaneously, various state and non-state institutions have been developed to produce knowledge about the highlands (Buadaeng, 2006), promote alternative agricultural practices and markets (e.g. Royal Projects), and facilitate forest conservation and watershed management (e.g. National Parks). Current debates over air pollution echo many long-standing rural/urban, upland/lowland and Thai/ethnic social distinctions and are the latest enactment of governance discourses that have sought to justify anti-swidden politics. Existing within a long history of discursive formations of social difference, the haze crisis has become a key site where the legitimacy of agricultural livelihoods and urban–rural and ethnic relations are increasingly worked out.

#### 3.1. Methods

This article is based on ethnographic fieldwork conducted between 2018 and 2020 among rural agriculturalists, urban residents, scientists, Buddhist monks and policy makers in Chiang Mai city and in three peripheral districts, Mae Chaem, Chiang Dao and Mae Rim. Research participants were identified using convenience and snowball sampling. Ethnographic methods include participant observation and semi-structured interviews with 90 research participants. Fieldwork was carried out by the authors as well as three local research assistants. Qualitative interviews were audio recorded, transcribed and coded in NVivo, a qualitative data analysis software package. Data from interviews and fieldnotes from participant observations were approached using grounded theory methods and coded for recurrent and striking themes (Charmaz, 2006).

Additionally, archival research was conducted to investigate the historical representation of the haze crisis in popular media including

19th century historical accounts and more recent newspaper articles (1997-present). We conducted archival research in the three most widely read newspapers in Thailand, including the Thai language newspaper, *Matichon* as well as the English language newspapers, *Bangkok Post* and *The Nation*. Searches in these newspaper archives were conducted for the months of February and March, typically the height of the smoky season, using the keywords: haze, smog, air pollution and Chiang Mai and northern Thailand. Articles were coded for the reported causes, effects and solutions to haze.

### 3.2. Excavating air pollution narratives

Fire is the oldest known source of air pollution and is of particular concern in many parts of Southeast Asia where forest fires and other anthropogenic causes of air pollution have reached unprecedented levels (Pausas and Keeley, 2009; Peluso, Vandergeest, and Potter, 1995; Potter, 1996). Despite growing concern over air pollution, we still know very little about its social-historical production in the region. Our archival work suggests that one of the oldest descriptions of air pollution in northern Thailand exists in James McCarthy's 19th century travel memoir. James McCarthy was a British cartographer who spent three years surveying northern Siam and Laos and created land border maps of the region between 1881 and 1893. In his memoirs published in 1900, he described how low visibility due to haze and smoke during February and March rendered cartographic work impossible (McCarthy, 1902). In February 1892, he wrote that "having reached the peak Pubokat, I had it cleared of trees, but the haze was dense and nothing could be seen... (McCarthy, 1902: 160). Haze from agricultural waste burning was also widely observed during this period: "On April 20, I had hoped to get a good view, but the inhabitants, anxious about rice-clearings, had begun burning the old trees cut some months previously and kept the fires up night and day (McCarthy, 1902: 167). The impact of the winds on the haze was well understood by residents in that period and McCarthy and his team planned around the annual haze period: "A strong wind was blowing from the west, and, remembering the forecast of the signaler of the Indian Survey, I was hopeful. The Indian signaler always held that south and east wind increased haze, but that the west and north winds drove it away" (McCarthy, 1902: 132). The smoke was so thick that travel in mountainous areas became nearly impossible at some periods: "P'ia Sridi came to tell me he could discover no mountain where I had indicated one, as the haze and smoke had been so thick that nothing could be seen" (April of 1891) (McCarthy, 1902: 140). During this particular season, McCarthy noted the effect of the limited rainfall on the density of the haze: "For three of four years the rainfall all over Siam had been extraordinarily short and that's why local Chiang Mai inhabitants asked their chief to improve the roof of the Doi Suthep pagoda" (McCarthy, 1902: 147). This passage is significant not only because it describes the variability in rain and hence seasonality of haze episodes, but for its reference to Doi Suthep, the holy mountain which overlooks Chiang Mai. Today, Doi Suthep continues to serve as a reference point in the discourses of many residents for visually assessing air quality (City Life, 2018).

McCarthy's accounts are echoed, though in a different ecological and social context, by other explorers in Indonesia as early as the 1700s who described how the shorelines were often not visible to foreign ships because of thick haze at the ports (Damodaran et al., 2018). More recently, Charles Keyes described how in 1990 Thai Princess Sirindhorn traveled to Laos, yet she was unable to visit several eastern provinces because of a lack of visibility due to haze pollution: "Phoumi Vongvichit, the Acting President of Laos and her official host, told her that it was not possible to make trips... because there was too much haze caused by upland people burning fields for planes or helicopters to fly to them safely" (Keyes, 1990: 216). These descriptions support the views of some residents that Chiang Mai has always had a "smoky season", yet they do not fully account for how or when it came to be known as a crisis.

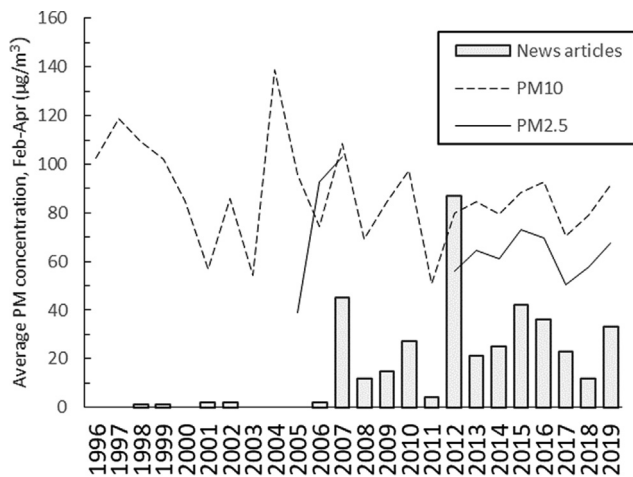
More recent popular media is one way to excavate the chronology of the haze crisis narrative. To track shifts in public consciousness of seasonal air pollution, we examined its coverage by *Matichon*, *Bangkok Post*, and *The Nation* and compared rates of coverage with the Pollution Control Department (PCD) measurements of air pollution in Chiang Mai (Fig. 2) since 1996 for PM10 and since 2012 for PM2.5 (PM2.5 measurements started in 2005 but were discontinued between 2007 and 2012 for unknown reasons).

Seasonal haze in northern Thailand was first reported in *Matichon* in 1998 following the exceptionally heavy 1997 haze season in Indonesia. The article explains that seasonal haze is becoming a serious concern throughout mainland Southeast Asia and especially for residents in northern Thailand and describes Chiang Mai University's public forum devoted to addressing the issue. Since 1998, the frequency and character of coverage in Thai language has been roughly equivalent to coverage in English language newspapers (in February and March from 1997 to 2019, *Matichon* (Thai) printed 188 articles and *The Nation* and the *Bangkok Post* (English) published 202 articles each on seasonal haze). Significantly, severe haze seasons in 1997 and 2004 as indicated by PCD data were not reported on in the three newspapers. By 2007, newspapers began reporting regularly on seasonal air pollution with a surge in articles following the more recent, 2006 severe haze episode in Indonesia. Prior to 2013, reporting on seasonal haze focused on either attributing its origins to elsewhere in Southeast Asia or a comparison of seasonal haze levels to previous years, both of which are narratives that continue to be widely shared. For instance, while in 2012, there was a surge in news coverage of air pollution in northern Thailand, PCD measurements indicate average levels and reports focused on comparing 2012 to the 2011 dry season in which there was high precipitation levels and numerous floods throughout the region.

While some scholars have argued that PM10 levels have increased since 2006 with the highest levels in 2007, data since 1996 does not indicate a long-term trend (Fig. 1). Moreover, data from the PCD shows that the long-term trend does not significantly vary for PM10. Rather, data suggests that PM10 and PM2.5 average levels between February and April have been relatively stable with only minor variations. For instance, measured continuously since 2012, PM2.5 measurements also do not demonstrate a clear trend except for the correlation with PM10 as well as the precipitation levels during the dry season. In 2019, which has been widely reported on in the media as the worst haze season on record, PM10 and PM2.5 levels did not reach levels in 1997, 2004, 2007 or 2010. Moreover, there has been a notable decrease in the number of hotspots as well as number of days with excessive PM10 level from 2017 to 2018 (from 38 days to 27 days according to PCD) (Wipatoyotin and Tangprasert, 2018). Thus, PCD data as well as historical accounts tend to support the perspective that seasonal haze is a



Fig. 1. "Bringing in the big guns: Thailand's Prime Minister Gen Prayut Chan-ocha (centre) holds a leaf blower at an army base in Chiang Mai on Tuesday" (Bangkok Post, 2019).



**Fig. 2.** The average concentrations of PM10 and PM2.5 in Chiang Mai over the haze episode (February – April) in 1996 – 2019 compared with the number of news articles (February–March). Sources: Pollution Control Department for PM10 and PM2.5; archives of the Chiang Mai University library for news articles (*Matchon, The Nation and Bangkok Post*).

longtime occurrence in the region. However, these perspectives do not account for the potential shift in the chemical composition and biochemical nature of the haze over the last several decades due to the presence of polycyclic aromatic hydrocarbons (or PAH's, chemically-related organic compounds with various levels of toxicity and carcinogenic potential that bind PM) from vehicle traffic, pesticide use and coal plants, for which there is a lack of consistent, reliable data.

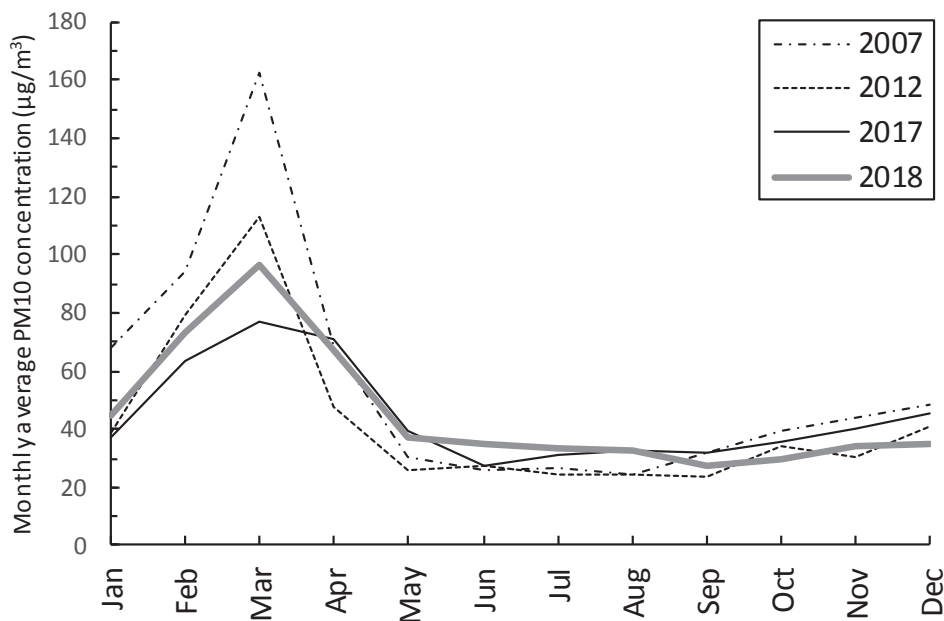
### 3.3. Hazy measurements and the seasonality of crisis

The haze crisis is both widely viewed as a recent phenomenon and linked to traditional forest burning practices that have existed in the region for at least two centuries. As Nin, an agricultural specialist and Chiang Mai resident recalls: “I think they [highlanders] have burned the fields and forest for a long time, but it did not produce as much smoke as it does these days. There is much more smoke, and it increases every year”. Significantly, most public discourse tends to focus on forest

fires rather than urban pollution while, omitting questions of the chemical composition and carcinogenic properties of PM. This bias is reflected in the narratives of the haze crisis that attributes blame to highlanders. Yet, recent studies conducted on the chemical composition of PM and its relationship to PAH come predominantly from vehicles during the rainy season, while during the dry season biomass burning is a major source of PAH's (Tsai et al., 2013; Pongpiachan et al., 2017). These studies suggest the possibility that increased traffic over the course of the last two decades contributes to the aggravation of air pollution, both in terms of quantity of PM as well as toxicity levels.

While relatively less frequent, some residents speculate on the urban role of air pollution. For example, while Nin locates the primary causes of the smoky season in the highlands, she also explains how she thinks that air pollution may be caused by urban dwellers: “Currently, there are more vehicles that produce more air pollution. As the air pollution in the city increases, it mixes with the smoke during the smoky season and this doubles the air pollution”. In a similar vein, Aat, a wild honey retailer and a Buddhist meditation instructor at a temple in Mae Rim explained to us how he saw the haze crisis as a result of unbridled economic development: “If some people say that we burnt the forest like this since the time of our ancestors, why didn't they have the same problems we do? I think today we have more factors that cause the haze including more industries, factories, traffic and a lot of cars and other forms of burning that are driven by economic greed”. In addition to growing urban pollution, haze is also triggered by a range of climatic factors, annual variations may be caused by changes in humidity, and the level and precocity of precipitation during the rainy season. For instance, between 2003 and 2004 levels of PM10 doubled and then dropped by 40 percent between 2010 and 2011.

The seasonal and spatial variations of PM are significant because the highest concentrations are typically measured during the first two weeks of March (Fig. 3). While the background level of PM10 is relatively constant and primarily linked to traffic and industrial pollutants, seasonal variation between the dry and wet seasons is distinct. By mid-April air pollution levels typically decrease with the beginning of the rainy season that clears the atmosphere while in the dry season, high air pressure, low precipitation levels and the absence of wind lead to the accumulation of air pollutants (Chantara, 2012: 226). By the end of November, PM10 concentrations start to increase as a result of open burning in agricultural areas, first in the lowlands after the harvest between November and December (Wiriya et al., 2013: 112) and



**Fig. 3.** The seasonal variation of PM10 in Chiang Mai within a year in Sources: Pollution Control Department.

thereafter in February and March in the uplands. These seasonal dynamics are often cited as evidence that open burning is the primary source of seasonal air pollution. Yet, it is notable that there has been a recent surge in public discourse of the seasonal haze crisis despite PCD measurements which suggest that air pollution is not dramatically trending upwards.

### 3.4. Pollution fatigue

Whether the haze crisis is getting worse or better continues to be hotly debated among scientists, policy makers and residents in northern Thailand. Yet, as Pimchan, a journalist for a popular local magazine explained to us, because of the temporary nature of the smoky season, many people get “pollution fatigue” and do not want to talk or read about the haze crisis after April. Corroborating her sentiment, a recent article in *Chiang Mai City life* surmised, that “As the rains come, it is tempting for us all to allow it to wash away the suffocating stress of the recent haze season, instead enjoying the fresh breeze and clean air... knowing full well that the cycle will begin again. It’s inevitable” (Werayutwattana, 2019). Each year, Pimchan surmises, the same debates start again with repetitions of phases of acute consciousness and forgetting. At the end of each smoky season, she explained: “we want to write about it, but no one wants to read it... Now [May 2018] we won’t write an article on the haze because readers won’t read it. We will be silent because there is not much to talk about now”. As a result, reporting on the haze crisis is not profitable outside of the smoky season and with just three full time editors on staff, they must conserve their resources. This is because, as she sees it, “We have the relief of the rain. When the rain comes it whitewashes our memory. And we all act shocked when it comes each year”. For instance, she recalled childhood memories of the smoky season: “I remember the days going home with nose bleeds and ughhhh... This year was bad because it is was so long”. The intermittent nature of the crisis is significant insofar as it coincides with burning periods in the highlands and it tends to obliterate other potential (meteorological) causes that can account for the severity of concentrated haze episodes that engender social forgetting during the rest of the year. In this sense, social memory of seasonal air pollution is mediated by cultural as much as data driven judgments. The surge of reports about the haze in 2012 was less related to the measured severity of the haze episode than to the contrast with 2011, which experienced extraordinary rainfall throughout the dry season. The haze crisis in this way is also a subjective event “that can be privileged or erased according to a sense of selective memory or collective amnesia” (Bankoff, 2004: 34). It also points to how the seasonality of the haze crisis affects people’s phenomenological experiences of it in ways that often overshadow the broader historical environmental narratives of upland and lowland relations in which it exists.

## 4. Towards a chronopolitics of crisis

The upland crisis narrative in northern Thailand has historically focused on deforestation and water management (Forsyth and Walker, 2008). Today, market driven commercial expansion into the region is seen as a continuation of state-led development policies since the 1950s that have sought to reduce dependence on shifting cultivation in favor of sedentary farming of cash crops (Forsyth and Walker, 2008, 2014). These state incentives are combined with market incentives for maize production including the sale of seeds and pesticides to farmers at discounted rates and fixed prices for their crops from large agribusiness companies. While maize production in Thailand peaked at two million rai during the late 1980s and has since decreased to approximately one million rai today, there has been a broad geographic shift in production from central to northern Thailand, especially in Nan, Tak and Chiang Mai (Hayward, 2018). Additionally, while maize production is not new to the highlands and maize is not a high value crop, the growing demand for animal feed has driven this growth in the north. State efforts

to reduce rotational swidden cultivation (including reduction of available areas, and therefore of fallow duration) has encouraged farmers to compensate by investing in cash crops. Yet, not all villages accept offers by middlemen to produce maize and some instead turn to higher value cash crops such as coffee.

Over the last 30 years, maize production in Thailand has been driven by research in both the academic and private sectors which has identified the crop as ideal for highland cultivation because it needs less water than rice and is familiar to highlanders (highlanders have long cultivated maize on a small scale for animal feed). Largely a successful campaign, recent reports indicate that between 2008 and 2016, there was a clear shift of maize production from central and northeastern Thailand to northern Thailand which now accounts for more than 70 percent of maize production in the country (especially in Nan, Tak and Chiang Mai) (Hayward, 2018: 11–12). The campaign also, albeit inadvertently incentivized farmers to develop industrialized mono-cropping and to burn and clear new forest land. In April of 2015, Witoon Lianchamrong, the spokesperson for the Thai Network for Community Rights and Biodiversity (Bio Thai) explained in *Bangkok Post* and *The Nation* that “smog in Chiang Mai became a national issue only after 2007, when maize prices rose and new clearances were encouraged, with the number of forest fires reaching a peak in 2012 before prices dropped. Blame is also placed on the farmers for burning maize stubble at the end of the harvest to clear an area of unneeded plants and weeds, kill pests and returning nutrients to the soil” (Hayward, 2018: 15), thereby contributing to open-burning twice, rather than once per year (before planting and after harvest). While many farmers prioritize commercial agriculture, they also use fire to prepare the fields and clear agricultural waste after the harvest since fire is often the cheapest and most efficient way to clear land both for small-scale farmers and for large-scale agribusiness (Anderson, 2017; Dearden, 1995; Forsyth, 2014; Forsyth and Walker, 2014; Fox et al., 2009; Murdiyarso et al., 2004). As the director of a local environmental activist group, Sakda Darawan observes, the haze is created by “practices stemming from the ‘Old Days,’ where small farmers burned by-product without consequence” (Stuart, 2018). Thus, fire abides by the market, not in spite of it.

### 4.1. Atmospheric enclosure

While highland farmers have become increasingly integrated into global markets, their participation has been vilified by burning bans that criminalize shifting cultivation and biomass burning. Additionally, the securitization of the highlands to monitor biomass burning and enclose the atmosphere threatens highland farmers’ livelihoods and reignites long-standing narratives of “irresponsible hill tribes” (Buergin, 2000; Dearden et al., 1996). Practices of forest territoriality emerged in Thailand in the 19th century, notably with the development of teak plantations, and colonial forestry regimes which proliferated throughout the late colonial period through the Cold-War (Peluso and Vandergeest, 2001). Today, the spatial history of Thailand’s political forests are increasingly shaped by surveillance mechanisms through which atmospheres are enclosed. Fires and air pollution invite new strategies of forest control that attend to its vertical and volumetric dimensions. In this context, Elden asks us to reconsider how we think about the politics of space by accounting for “volume, height and depth instead of surfaces, three dimensions instead of areas” (Elden, 2013: 35). He further points to how the growing use of the political technology of territory such as aerial photography, surveillance, satellite images, Google Earth and military surveillance which represent the “range of strategies are used to secure the air, and through that, the ground” (Elden, 2013: 40). Atmospheric enclosure becomes an effect of efforts to mitigate air pollution from biomass burning. Whitehead, for instance, argues that our understanding of air pollution requires a historical perspective of the relationship between atmospheric science and the state and that atmospheric governance is shaped through both

science and political regimes (Whitehead, 2011). Thus, the growing use of calculative technologies in environmental governance of forest fires depoliticize the broader context in which fires occur. By accounting for forest fires as a series of algorithms through which securitization measures are enacted, forest fire surveillance mechanisms are politicized in both implicit and explicit ways. As they make fires visible, they also obscure their range of interpretations and enable ‘conservation by algorithm’ or “the automation of conservation decisions” (Adams, 2019: 337).

In northern Thailand, forest enclosures are increasingly driven by atmospheric enclosures in ways that give new meaning to the “hill tribe problem”. Contemporary efforts to ameliorate forest burning in the highlands “take place in a social and political landscape that has been shaped by many years of development work that originated with a concern for the problematic hill tribes” (McKinnon, 2008: 285). Entry into new markets has challenged this narrative and today the “hill tribe problem” is not only being dealt with on terrestrial ground, but the progressive enclosure of the atmosphere through a range of surveillance techniques. Remote sensing data, for instance, is used in real time in ways that foreclose alternative narratives of the causes of forest fires and legitimize securitization of the region. Geospatial data has become increasingly available to a range of state and non-state actors through free government software programs that provide data on hotspots and other geospatial intelligence (Goldstein, 2019). What was previously carried out on foot and through aerial photographs is now being re-purposed to monitor not only fires and deforestation, but also its aftereffects in the atmosphere. As Goldstein points out, “Near-real time remote sensing draws new extra-state and non-state actors into forest politics, enabling anyone with a stable internet connection to ‘see’ like a state (Li, 2005; Scott, 1998), even those who may never set foot in the forest in question since remote sensing is—by definition—monitoring at a distance” (Goldstein, 2019: 3). In northern Thailand, visualization tools used by academic, non-governmental and governmental actors, among others, document hotspots and locate the coordinates of forest fires (Fig. 4).

Hotspot maps are used by government officials to assess the success or failure of haze mitigation policies. However, this technique is limited in numerous ways: detections occur once or twice a day at fixed hours; satellites can record false burning signals or conversely miss small fires; and scientists cannot always translate aerosol optical depth into levels of PM (Moran et al., 2019: 6). Additionally, many “forest fires” are located on agricultural fallows (which from the satellites look like young forests) or at least on forest land claimed by local villagers even if the State does not formally recognize their land rights. At the same time, growing access to smartphones, surveillance and environmental data have facilitated opportunities for rural residents to avoid detection. For instance, highlanders frequently described to us how some residents plan burning periods around the circulation of the satellites which surveil the region.

In the context of the haze crisis in northern Thailand, PM is integrated into social relations and indexes a long history of political economic injustices. The further securitization of the atmosphere through constant monitoring has left many highlanders on edge as they struggle to eke out an already precarious livelihood. While maize was originally proposed as a profitable alternative to subsistence farming, many farmers are now indebted to large agribusiness as a result of reduced prices since 2012, diminishing yields due to soil degradation, and skyrocketing costs after the withdrawal of initial subsidies. For instance, Ansee, a 65-year-old farmer in Mae Chaem explained to us how a middleman in Kong Kaek subdistrict recruited him to grow maize. He explained that he thought the recruiter worked for a large company and offered him a contract price of about 13 baht/kg. Yet, recently, the price dropped to around 4 baht/kg and as a result, he accumulated significant debt. Ansee’s experience is not uncommon as maize production has tended to increase social and economic inequalities, with the benefits being enjoyed primarily by wealthier families who have

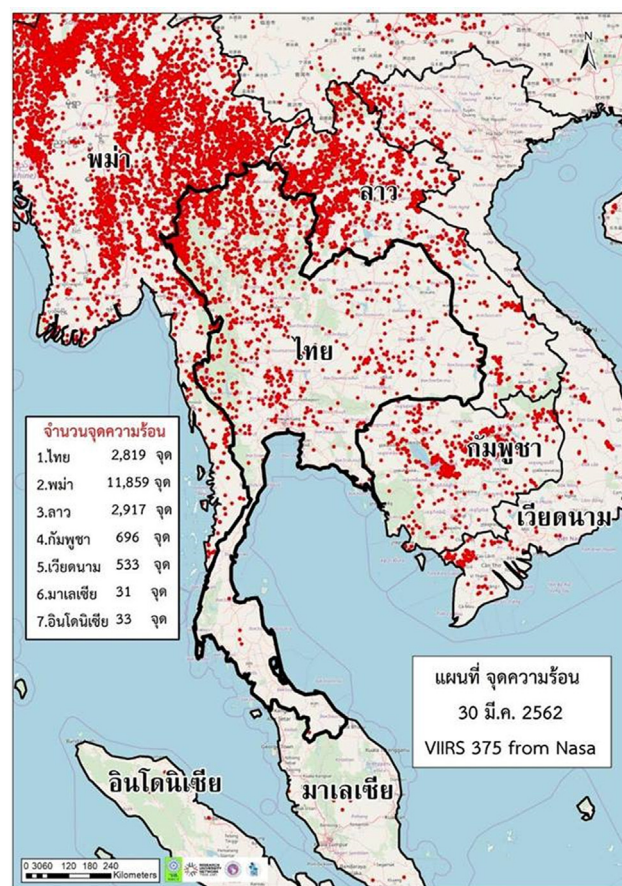


Fig. 4. Hotspots on March 30, 2019, NASA-VIIRS-MODIS. Source: Haze Free Thailand Program, School of Public Policy, Chiang Mai University.

access to land titles and are able to rely on their own capital rather than loans from middlemen (Hayward, 2018: 21).

Thus, despite the ongoing securitization of the highlands, most policy prescriptions have proven to be largely ineffective as most resort to calls for highlanders to enter livelihoods that are unviable and/or unsustainable. Numerous proposals include calls for transitions from farming to tourism or the use of time-consuming techniques such as biochar that are often difficult to implement in the highlands without a widespread, coordinated effort. O’Lear argues that “in addition to examining the process of how issues are securitized, it is also important to consider why a particular issue is being securitized and who will benefit from that arrangement” (O’Lear, 2018: 3). Securitization of the atmosphere through a range of enclosure mechanisms has in many cases enhanced political economic inequalities as well as exacerbated the haze production. As Dang, a Thai-British clean air activist explained, the burning ban has essentially extended the smoky season from three to five months. Similarly, Craig Houston, an environmental engineer and long-time Chiang Mai resident noted in 2018 that “We do know the burn ban started later this year (March 1 vs. February 21), however our data does not show any significant reduction in PM2.5 levels during the ban. In fact, most of the highest pollution days occur while the burn ban is in place” (Houston, 2018). This is partly because fire is still the main technique to clear land.

Rather than abide by the ban which has not seen viable results, many farmers now work around the ban, often starting fires in the late afternoon, after the surveillance satellite passes over their village. Additionally, the criminalization of forest fires has triggered rural incendiaryism as a form of state resistance (Dressler et al., 2010; Goldstein, 2019; Kuhlken, 1999; Kull, 2002, 2004). After several consecutive years of the burning ban with no visible impact on air pollution levels, many



farmers have experienced growing resentment for being vilified for the haze crisis. In 2019, after three years of continuous reduction not matched by a similar decrease of measured PM10 and PM2.5, the quantity of hotspots has again increased dramatically. Reports abound of villagers having purposely set fires to seek revenge for the impact the ban has had on their lives and livelihoods, thus echoing Kuhlken's observations of the use of fire as a weapon of peasant resistance and protest by the oppressed or disempowered (Kuhlken, 1999: 343).

Fire in inhabited landscapes are complex, especially when the perceived antidote is the criminalization of forest dwellers who are widely seen as "ignorant and destructive fire setters". These narratives exist despite ample evidence which suggests that fires have historically been a deliberate and controlled sustainable agricultural practice throughout the world (Mathews, 2005), especially in dry semi-deciduous dipterocarp forests like in Thailand. In Thai forests, villagers regularly burn the ground in order to remove unwanted leaves and avoid uncontrolled fires. In this sense, the full-scale assault on fire to clear forests and dispose of biomass addresses the symptoms rather than the causes of the haze crisis: agricultural intensification without technical innovations, growing economic inequalities and a lack of access to land rights are all culpable.

## 5. Conclusion

In March of 2020, Chiang Mai once again recorded the highest Air Quality Index in the world which at its peak was 40 times higher than international standards. During this period, forest fires newly broke out around Doi Suthep, triggering residents to repeat their calls for urgent action to ameliorate the recurring disaster. By turning "the so-called 'Rose of the North' into the most polluted city in the world" (Ekachai, 2020) for several consecutive days, the atmosphere was again in crisis. While crisis produces meaning, crisis also produces knowledge through the kinds of socio-cultural effects and affects it invokes. In this way, the sociality of seasonal air pollution in northern Thailand is intimately linked to the sociality of knowledge. As Wolf (1990) points out, "The arrangements of society become most visible when challenged by crisis." In this article, we examined the recurring disaster of seasonal air pollution and the chronology of crisis production in northern Thailand from a historical political ecology framework. What makes air pollution register as a crisis for some actors and not for others is a productive way into the analysis of the broader, historical, political, ecological and cultural drivers of socio-ecological change. The significance of this framing extends well beyond seasonal air pollution as it reveals how crisis narratives are coopted in ways that advance state power through the reinforcement of technologies of surveillance and the permanent declaration of states of exception.

In the context of northern Thailand, the characterization of seasonal air pollution as a crisis developed over many decades. Both the seasonal and long-term tempo through which air pollution is experienced is met with varied responses from highland and lowland residents who are differently situated within the broader political ecology of the region. The slow violence of air pollution from vehicular and industrial pollutants converges with periodic biomass burning in the highlands that defines the seasonality of the haze crisis and the reactions of northern Thai residents. It also reveals how judgments of crisis are historically and culturally mediated in ways that temporally generate their "own forms of vulnerability in both influencing how a hazard is selectively remembered and in determining what is perceived to be a disaster" (Bankoff, 2004: 36). As a result of this temporality, efforts to subdue the haze crisis are met with technocratic solutions to political and economic problems. Policy solutions, for instance, have typically focused on agricultural fires as the sole culprits of the haze. As such, lessons learned from the haze crisis are relevant to a wide range of situations where responses to risk are focused on temporary, technological Band-Aids that obscure rather than address the festering structural wounds through which they occur.

Environmental policy, Swyngedouw (2013) reminds us, requires the selection of one narrative over another. Depending, in large part, on public opinion, environmental policy is affected by social judgments of environmental change as a crisis. As Mary Douglas's classic anthropological framings of risk revealed more than five decades ago, while all social groups address social and natural hazards, they also must select which ones are most meaningful and this selection is based on a range of cultural and political relations within and between groups (Alaszewski, 2015; Douglas, 2003; Faas and Barrios, 2015).

By vilifying the burning practices of highland farmers without addressing its historical, political and economic drivers, the chronopolitics of crisis are systematically obscured. Additionally, as technocratic solutions such as spraying water on the roads, artificial rain and the installation of air purifying towers (Bangkok Post Reporters, 2019) continue to be implemented, addressing the structural drivers of seasonal air pollution seems to be progressively swept out of sight. By consistently falling short of addressing the longstanding historically contingent relationships between agriculture producers and consumers, these technocratic solutions conceal the historical political ecology of upland-lowland relationships in the region. This investigation of the chronopolitics of haze crisis in northern Thailand offers opportunities to develop new understandings of the temporal mechanisms through which people come to understand the causes and effects of anthropogenic environmental change as well as the political-ecological implications and means by which such change is constituted as a crisis.

## CRedit authorship contribution statement

**Mary Mostafanezhad:** Conceptualization, Writing - review & editing. **Olivier Evrard:** Conceptualization, Writing - review & editing.

## References

- Adams, W.M., 2019. Geographies of conservation II: Technology, surveillance and conservation by algorithm. *Prog. Hum. Geogr.* 43 (2), 337–350.
- Alaszewski, A., 2015. Anthropology and risk: insights into uncertainty, danger and blame from other cultures—A review essay. *Health, Risk & Soc.* 17 (3–4), 205–225.
- Anderson, B., 2017. People, land and poppy: the political ecology of opium and the historical impact of alternative development in northwest Thailand. *Forest Soc.* 1, 48–59.
- Anderson, B., Grove, K., Rickards, L., Kearnes, M., 2019. Slow emergencies: Temporality and the racialized biopolitics of emergency governance. *Prog. Hum. Geography*. Online May 16, 2019.
- Bangkok Post Reporters. May 9, 2016. Fire blackens 290 rai of Doi Suthep-Pui National Park. Bangkok Post. <https://www.bangkokpost.com/news/general/965489>.
- Bangkok Post Reporters. April 2, 2019. In choking Chiang Mai, Prayut orders fires out in 7 days. Bangkok Post. <https://www.bangkokpost.com/thailand/general/1655280/in-choking-chiang-mai-prayut-orders-fires-out-in-7-days>.
- Bankoff, G., 2004. Time is of the essence: disasters, vulnerability and history. *Int. J. Mass Emergencies Disasters* 22 (3), 23–42.
- Barnes, J., Dove, M.R., 2015. *Climate Cultures: Anthropological Perspectives on Climate Change*. Yale University Press, New Haven.
- Barrios, R.E., 2017. What does catastrophe reveal for whom? The anthropology of crises and disasters in a Post-Truth World. *Ann. Rev. Anthropology* 46 (1).
- Buadaeng, K., 2006. The rise and fall of the Tribal Research Institute (TRD). *Japan. J. Southeast Asian Stud.* 44 (3), 359–384.
- Buergin, R., 2000. 'Hill Tribes' and Forests: Minority Policies and Resource Conflicts in Thailand. University of Freiburg Press, Freiburg.
- Buzzelli, M., 2008. A political ecology of scale in urban air pollution monitoring. *Trans. Inst. Br. Geographers* 33 (4), 502–517.
- Chantara, S., 2012. PM10 and its chemical composition: a case study in Chiang Mai, Thailand. *Air Quality-monitoring and Modeling*. IntechOpen, Chiang Mai.
- Charmaz, Kathy, 2006. *Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis*. Sage, London.
- City Life, 2018. Explaining Chiang Mai's Smoke Pollution With Real Data. April 1, 2018. Chiang Mai City Life. <https://www.chiangmaicitylife.com/clg/our-city/city-issues/explaining-chiang-mais-smoke-pollution-with-real-data/>.
- Damodaran, V., Allan, R., Ogilvie, A.E., Demarée, G.R., Gergis, J., Mikami, T., Hamilton, J., 2018. The 1780s: Global climate anomalies, floods, droughts, and famines. In: *The Palgrave Handbook of Climate History*. Palgrave Macmillan, London, pp. 517–550.
- Davis, D.K., 2009. Historical political ecology: On the importance of looking back to move forward. *Geoforum* 3 (40), 285–286.
- Dearden, P., 1995. Development, the environment and social differentiation in northern Thailand. *Counting the costs: economic growth and environmental change in Thailand* 111–130.

- Dearden, P., Chettamart, S., Emphandu, D., Tanakanjana, N., 1996. National parks and hill tribes in northern Thailand: a case study of Doi Inthanon. *Soc. Natural Resour.* 9 (2), 125–141.
- Douglas, M., 2003. *Purity and Danger: An Analysis of Concepts of Pollution and Taboo*. Routledge, New York.
- Dressler, W., Büscher, B., Schoon, M., Brockington, D., Hayes, T., Kull, C.A., Shrestha, K., 2010. From hope to crisis and back again? A critical history of the global CBNRM narrative. *Environ. Conserv.* 37 (01), 5–15.
- Elden, S., 2013. Secure the volume: Vertical geopolitics and the depth of power. *Political Geography* 34, 35–51.
- Ekachai, S., 2020. Forests doomed by power and prejudice. April 2, 2020. The Bangkok Post. [https://www.bangkokpost.com/opinion/opinion/1891350/forests-doomed-by-power-and-prejudice?fbclid=IwAR0Y\\_kYe-RYZhNijYQ2u6LKAiK6HMTNCNZUtmz1wvvpQvtvblNeMMQevX0SO](https://www.bangkokpost.com/opinion/opinion/1891350/forests-doomed-by-power-and-prejudice?fbclid=IwAR0Y_kYe-RYZhNijYQ2u6LKAiK6HMTNCNZUtmz1wvvpQvtvblNeMMQevX0SO).
- Evrard, O., Goudineau, Y., 2004. Planned resettlement, unexpected migrations and cultural trauma in Laos. *Development and Change* 35 (5), 937–962.
- Evrard, O., Leepreecha, P., 2009. Monks, monarchs and mountain folks: Domestic tourism and internal colonialism in northern Thailand. *Critique of Anthropology* 29 (3), 300–323.
- Faas, A.J., Barrios, Roberto E., 2015. Applied anthropology of risk, hazards, and disasters. *Human Organization* 74 (4), 287–295. <https://doi.org/10.17730/0018-7259-74.4.287>.
- Forsyth, T., 2014. Sustainable land use and rural development in Southeast Asia: innovations and policies for mountainous areas. *Mt. Res. Dev.* 34 (1), 76–77.
- Forsyth, T., Walker, A., 2008. *Forest Guardians, Forest Destroyers: the Politics of Environmental Knowledge in Northern Thailand*. University of Washington Press, Seattle.
- Forsyth, T., Walker, A., 2014. Hidden alliances: rethinking environmentality and the politics of knowledge in Thailand's campaign for community forestry. *Conservation Soc.* 12 (4), 408.
- Fox, J., Fujita, Y., Ngidang, D., Peluso, N., Potter, L., Sakuntaladewi, N., Thomas, D., 2009. Policies, political-economy, and swidden in Southeast Asia. *Hum. Ecol.* 37 (3), 305–322.
- Goldstein, J.E., 2019. The volumetric political forest: territory, satellite fire mapping, and Indonesia's burning Peatland. *Antipode*. Online 1–23.
- Hayward, D., 2018. From Maize to Meat: Placing maize production in Thailand within a global poultry value chain. May 2018. Greenpeace, Southeast Asia, Thailand.
- Hewitt, K., 1983. The idea of calamity in a technocratic age. *Interpretations of Calamity from the Viewpoint of Human Ecology* 1, 3–32.
- Houston, Craig, 2018. Chiang Mai Air. <http://www.chiangmaiair.org/analysis-2017v2018.html>.
- Keyes, C.F., 1990. Buddhist practical morality in a changing agrarian world: A case from northeastern Thailand. In: *Ethics, Wealth, and Salvation: A Study in Buddhist Social Ethics*, pp. 170–189.
- Kuhlken, R., 1999. Settling 'the woods on fire: rural incendiarism as protest. *Geogr. Rev.* 89 (3), 343–363.
- Kull, C.A., 2002. Madagascar's burning issue: the persistent conflict over fire. *Environ.: Sci. Policy Sustain. Dev.* 44 (3), 8–19.
- Kull, C.A., 2004. *Isle of Fire: The Political Ecology of Landscape Burning in Madagascar*. University of Chicago Press, Chicago.
- Li, T.M., 2005. Beyond "the state" and failed schemes. *Am. Anthropol.* 107 (3), 383–394.
- Li, T.M., 2017. Rendering land investible: Five notes on time. *Geoforum* 82, 276–278.
- Mathews, A.S., 2005. Power/knowledge, power/ignorance: forest fires and the state in Mexico. *Hum. Ecol.* 33 (6), 795–820.
- Masco, J., 2010. Bad weather: On planetary crisis. *Soc. Stud. Sci.* 40 (1), 7–40.
- Masco, J., 2017. The crisis in crisis. *Curr. Anthropology* 58 (S15), S65–S76.
- McCarthy, J., 1902. *Surveying and Exploring in Siam*. Royal Geographical Society, London.
- McElwee, P., 2015. From conservation and development to climate change: anthropological engagements with REDD+ in Vietnam. *Anthropological Perspectives on Climate Change, Climate Cultures*, pp. 82–106.
- McElwee, P.D., 2016. *Forests are Gold: Trees, People, and Environmental Rule in Vietnam*. University of Washington Press, Seattle.
- McKinnon, K., 2008. Taking post-development theory to the field: Issues in development research, Northern Thailand. *Asia Pacific Viewpoint* 49 (3), 281–293.
- Moran, J., NaSuwan, C., Poocharoen, O.O., 2019. The haze problem in Northern Thailand and policies to combat it: a review. *Environ. Sci. Policy* 97, 1–15.
- Murdiyoso, D., Lebel, L., Gintings, A.N., Tampubolon, S.M.H., Heil, A., Wasson, M., 2004. Policy responses to complex environmental problems: insights from a science-policy activity on transboundary haze from vegetation fires in Southeast Asia. *Agric. Ecosyst. Environ.* 104 (1), 47–56.
- Nixon, R., 2011. *Slow Violence and the Environmentalism of the Poor*. Harvard University Press, Boston.
- O'Leary, S., 2018. *Environmental Geopolitics*. Rowman & Littlefield, London.
- Offen, K.H., 2004. Historical political ecology: an introduction. *Historical Geography* 32, 19–42.
- O'Keefe, P., Westgate, K., Wisner, B., 1976. Taking the naturalness out of natural disasters. *Nature* 260 (5552), 566–567.
- Oliver-Smith, A., 1996. Anthropological research on hazards and disasters. *Ann. Rev. Anthropology* 25 (1), 303–328.
- Oliver-Smith, A., Hoffman, S.M., 1999. *The Angry Earth: Disaster in Anthropological Perspective*. Psychology Press, New York.
- Oliver-Smith, A., Hoffman, S.M., 2002. Introduction: why anthropologists should study disasters. *Catastrophe and culture: The anthropology of disaster* 3–22.
- Orr, Yancey, Lansing, J., Stephen, Dove, Michael R., 2015. Environmental anthropology: systemic perspectives. *Annu. Rev. Anthropol.* 44 (1), 153–168. <https://doi.org/10.1146/annurev-anthro-102214-014159>.
- Pausas, J.G., Keeley, J.E., 2009. A burning story: the role of fire in the history of life. *Bioscience* 59 (7), 593–601.
- Peluso, N.L., Vanderveest, P., 2001. Genealogies of the political forest and customary rights in Indonesia, Malaysia, and Thailand. *The J. Asian Stud.* 60 (3), 761–812.
- Peluso, N.L., Vanderveest, P., Potter, L., 1995. Social aspects of forestry in Southeast Asia: a review of postwar trends in the scholarly literature. *J. Southeast Asian Stud.* 26 (1), 196–218.
- Pidgeon, N., O'Leary, M., 2000. Man-made disasters: why technology and organizations (sometimes) fail. *Saf. Sci.* 34 (1–3), 15–30.
- Pongpiachan, Siwatt, Hattayanone, Mattanawadee, Cao, Junji, 2017. Effect of agricultural waste burning season on PM2.5-bound polycyclic aromatic hydrocarbon (PAH) levels in Northern Thailand. *Atmos. Pollut. Res.* 8 (6), 1069–1080.
- Potter, L.M., 1996. *Forest Degradation, Deforestation, and Reforestation in Kalimantan: Towards A Sustainable Land Use?* Oxford University Press, Oxford.
- Roitman, J., 2013. *Anti-crisis*. Durham: Duke University Press.
- Rowell, Erika and Rossman, Julie. November, 15, 2015. A brief history of air pollution. <https://theweek.com/articles/586863/brief-history-air-pollution>.
- Scott, J.C., 1998. *Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed*. Yale University Press, New Haven.
- Scott, J.C., 2009. *The Art of Not being Governed: An Anarchist History of Upland Southeast Asia*. Yale University Press, New Haven.
- Shaluf, I.M., Said, A.M., 2003. A review of disaster and crisis. *Disaster Prevention Manage.: Int. J.*
- Stuart, Ayden. 1 April 2018. Explaining Chiang Mai's Smoke Pollution With Real Data. Chiang Mai City Life. <http://www.chiangmaicitylife.com/citylife-articles/explaining-chiang-mais-smoke-pollution-real-data/>.
- Swyngedouw, E., 2013. The non-political politics of climate change. *ACME: Int. J. Crit. Geogr.* 12 (1), 1–8.
- The Nation, 2010. Smog Eases in Most of the North After Rains. March 10, 2010. *The Nation*.
- Torry, W.I., Anderson, W.A., Bain, D., Otway, H.J., Baker, R., D'Souza, F., Turton, D., 1979. Anthropological studies in hazardous environments: Past trends and new horizons [and comments and reply]. *Curr. Anthropology* 20 (3), 517–540.
- Tsai, S.S., Chang, C.C., Yang, C.Y., 2013. Fine particulate air pollution and hospital admissions for chronic obstructive pulmonary disease: a case-crossover study in Taipei. *Int. J. Environ. Res. Publ. Health* 10 (11), 6015–6026.
- Turner, B.A., 1979. The social aetiology of disasters. *Disasters* 3 (1), 53–59.
- Véron, R., 2006. Remaking urban environments: the political ecology of air pollution in Delhi. *Environ. Planning A* 38 (11), 2093–2109.
- Werayutwattana, T., 2019. From Haze to Climate Change: A talk with a CMU Scientist. June 1, 2019. Chiang Mai City Life. <https://www.chiangmaicitylife.com/citylife-articles/haze-climate-change-talk-cmu-scientist/>.
- Whitehead, M., 2011. *State, Science and the Skies: Governmentalities of the British Atmosphere*. John Wiley & Sons, New York.
- Wipatoyatoin, Apinya and Tangprasert, Prasit, 2018. PCD claims success in restricting haze in northern provinces. April 14, 2018. Bangkok Post. <https://www.bangkokpost.com/news/general/1445875/pcd-claims-success-in-restricting-haze-in-northern-provinces>.
- Wiriya, W., Prapamontol, T., Chantara, S., 2013. PM10-bound polycyclic aromatic hydrocarbons in Chiang Mai (Thailand): seasonal variations, source identification, health risk assessment and their relationship to air-mass movement. *Atmos. Res.* 124, 109–122.
- Wolf, E.R., 1990. Distinguished lecture: Facing power-old insights, new questions. *Am. Anthropol.* 586–596.
- Yee, T.H., 2019. Prayut promises to ease smog in northern Thailand in a week. April 2, 2019. *The Straits Times*. <https://www.straitstimes.com/asia/se-asia/chiang-mai-haze-thai-king-urges-volunteers-to-help-pm-prayut-set-to-visit-smog-hit-city>.