Seasonality in the Anthropocene: On the construction of Southeast Asia's 'haze season'

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Abstract

'Seasons of the Anthropocene' - where human activities interact with biophysical cycles to create recurrent environmental phenomena that are often hazardous in nature - are emerging. This article offers the first problematisation of the emergence of a 'season of the Anthropocene'. We investigate the 'haze season' and its use to describe the almost annually recurrent air pollution caused by peatland burning in Indonesia, Malaysia, and Singapore. Analysing over 36,000 news articles published in the three countries in the last three decades, we demonstrate how 'haze season' has gained salience in public discourse, functioning as a heuristic device to structure both adaptation and mitigation behaviours. During polluted months, media coverage emphasises adaptive responses such as staying indoors and mask-wearing, while in clearer months it shifts to mitigative themes such as corporate sustainability, legislation, and diplomacy. We also uncover early signs of desensitisation, evident in satire and humour about haze recurrence, and an emerging preference for interventionist adaptive strategies, such as cloud seeding, which reinforce a crisis narrative and deflect attention from underlying causes. Our findings advance understanding of the political and institutional dynamics shaping environmental 'seasonalities' as contingent socio-material assemblages of ecological degradation, fire, and pollution. By conceptualising and empirically tracing how novel seasons are constructed and mobilised in discourse, we forge a new research agenda of studying 'seasonality' in the Anthropocene, as an important

lens through which we might better understand these mutually constructive relationships within the biophysical environment.

1. Introduction

Haze resulting from biomass burning in tropical peatlands has emerged as a persistent and escalating environmental concern in equatorial Southeast Asia. The air pollution phenomenon brings a distinct yellowish-brown smog that obscures visibility, accompanied by the strong odour of burnt wood or peat. Exposure to haze irritates the eyes, skin, and throat, and can lead to more severe acute and chronic health impacts, depending on the concentration of the pollutants (e.g. particulate matter) and length of exposure.

Haze episodes can be traced back to 1972 when Singapore experienced a notably prolonged air pollution crisis due to extensive deforestation in neighbouring Johor Bahru in Malaysia (Lee, M, 2015). Subsequently, recurrent air pollution arising from land clearance fires, frequently ignited on peatlands, has continued to afflict the equatorial states of Southeast Asia, encompassing Indonesia, Malaysia, and Singapore. Over the subsequent two decades, the escalation of peatland degradation and fires, associated with land clearance in response to the surging global demand for palm oil, particularly exacerbated during El Niño-induced dry periods (every 3–5 years), has intensified the prevalence of haze (Nichol, 1997; Remember Singapore, 2013). By the dawn of the new millennium, Singapore, Malaysia, and certain regions of Indonesia began to witness annual occurrences of haze, albeit varying in scale and magnitude (SIIA, 2020; Remember Singapore, 2013; WWF, 2019).

While a number of regions in Southeast Asia, particularly northern Thailand and the broader Mekong subregion (Mostafanezhad and Evrard, 2021; Mostafanezhad et al., 2025), have begun to experience pervasive and recurrent episodes of air pollution, the haze issue in equatorial Southeast Asia stands out. It stems from a distinct blend of irreversibly altered landscapes (Evers et al., 2017), characterised by tropical peatland deforestation and drainage, and fires that burn into peat soils. In contrast, haze in northern Southeast Asia emanates from the expansion and industrialisation of conventional agricultural burning on mineral soils (Pardthaisong et al., 2018), with minimal enduring disruption to the foundational landscape. The organic carbon emissions from peatland fires are also distinctive from the carbonaceous emissions from transport and industrial sources. An aerosol speciation monitoring campaign in Singapore revealed that atmospheric organic carbon from peatland fires peaked during the months of intense biomass burning activity in Indonesia (Budisulistiorini et al., 2018), a

seasonal spike that supplements a relatively steady year-round baseline of pollution from other sources.

Seasonal air pollution from peatland fires in equatorial Southeast Asia has also gained international attention as an early example of 'transboundary haze', given its extensive geographic impact and multifaceted origins of air pollution. Consequently, the Association of Southeast Asian Nations (ASEAN) acknowledged the gravity of this transboundary haze predicament and took the inaugural step of instituting a regional approach aimed at projecting and forestalling future occurrences (Varkkey, 2014).

Although the magnitude of the seasonal contribution varies year-on-year according to the scale of burning (Cochrane et al., 2009), there is growing evidence suggesting that the annual occurrence of haze in equatorial Southeast Asia has built an expectation in societies of when haze may occur. For example, a coalition of think tanks, NGOs, researchers and policy-makers have begun to conduct annual forecasts of the severity of annual haze based on a combination of quantitative meteorological data and qualitative stakeholder engagement methods (SIIA, 2019, 2020). A handful of academic publications have begun to adopt the term ‘haze season’: Hansen et al. (2019) define the season to lie between August and October when the particulate matter in the atmosphere spikes, while other studies have acknowledged how perceptions of health risks from air pollution become socially amplified during the ‘haze season’ (Ng et al., 2018; Yeo et al., 2014). However, there has yet to be any exploration of how the concept of ‘haze season’ has been constructed, defined, and popularised in social discourse, and how this relates to divergent public and institutional perceptions of air pollution risk, as well as subsequent mitigation or adaptive behaviours.

Coining recurrent anthropogenic environmental events as ‘seasons’ signifies a societal reaction to environmental change phenomena. Seasons, as a deceptively simple but highly relatable concept, are typically deployed as temporal frameworks for the expectation of recurrent environmental, social, and cultural events (Krause, 2013). In turn, the construction of ‘seasons’ indicates how societies organise the calendars of their livelihoods and activities around 'rhythms' of environmental life cycles (Ingold and Kurttila, 2000; Krause, 2013; Lefebvre, 2004). Thus, seasons can be interpreted as societal practices interwoven with the rhythms of other more-than-human activities (Ingold and Kurttila, 2000). Seasons are constructed through a social deliberation of which more-than-human phenomena to observe,

and how to assimilate such phenomena to serve matters of concern to particular societies and communities.

Through analysis of news media in Indonesia, Malaysia and Singapore, we investigate how the ‘haze season’ has been constructed over the past three decades as an indicator of evolving social perceptions and governmental stances on the issue (Forsyth, 2014; Liu et al., 2020). Through this case study, we interrogate how societies make sense of shifting environmental rhythms and patterns in the ‘Anthropocene’, an era of accelerating human impact (Witze, 2024), and the implications of labelling these recurrent anthropogenic environmental change phenomena as ‘seasons’. These countries were chosen as they share a common experience of transboundary haze caused by the industrial alteration of tropical peatlands. The increasing severity, regular recurrence, and negative implications on public health and economic development have spurred international, cross-sectoral pressure to address the issue (Cheong et al., 2019; Glover et al., 2003; Koplitz et al., 2016; Narayanan, 2002). While the root causes differ, we believe the lessons drawn from the feedback loop of social interpretation, perception, and the reaction to a ‘haze season’ in equatorial Southeast Asia are transferable to other seasonal anthropogenic environmental change phenomena globally . Specifically, this paper seeks to uncover:

(1) What time of the year does society define as the ‘haze season’?
(2) What are the key discourses surrounding the ‘haze season’?
(3) What role does the construction of a ‘haze season’ play in shaping people’s behaviour towards haze?

The findings of this paper contribute conceptually to reflections on the temporal challenges in the Anthropocene within the climate-vulnerable context of Southeast Asia. Building on a growing debate that calls for more nuanced and diverse understandings of time in the Anthropocene (Bensaude-Vincent, 2022; Yusoff, 2016), we put forward the concept of ‘Seasonality in the Anthropocene’, which captures the ways through which systemic anthropogenic environmental change is shifting and redefining the annual *rhythms* that human societies rely on to organise their socioeconomic and cultural activities. By understanding how the ‘haze season’ is constructed, we uncover whether and how ‘seasonality’ builds a collective understanding of the air pollution phenomenon, and subsequently motivates, galvanises, and justifies mitigative and/or adaptive (non)action. That

is, whether the conceptualisation of new seasons of the Anthropocene contributes to the construction of a ‘survivable future’ (Castree, 2014; Walshe et al., 2020).

The remainder of this paper will be organised as follows. The next section will introduce the conceptual framework of our study and provide a review of existing studies of haze seasonality in Southeast Asia. The third section details our methodology. The fourth section introduces three key findings relating to the construction of the haze season. The fifth section discusses the implications of our findings, followed by our conclusion.

2. Construction of Haze Season

The conceptual scaffolding of our approach for considering the construction of ‘haze season’ and ‘Seasons of the Anthropocene’ draws from literature on anthropogenic environmental change as multi-scalar and multi-species ‘assemblages’ (Mostafanezhad and Dressler, 2021; Ogden et al., 2013). Grounded in relational philosophy (Haraway 2008; Latour 2004), assemblage theory offers a dynamic approach to understanding the complex relationships among humans, non-humans, technologies, and institutions (Archambault, 2016; Matijevic, 2022), and how these interactions constantly shape anthropogenically altered socio-ecological landscapes (Gorman, 2017; Tsing, 2015). Conceptualising haze as an 'assemblage' helps make sense of its systemic causes, social responses, and future pathways; highlighting historic trends, macro-political economic factors, and interactions between human and non-human agents across various life cycles and timeframes.

2.1 The Haze Assemblage

The haze assemblage in equatorial Southeast Asia is an anthropogenic environmental change phenomenon rooted in a colonial history and ongoing patronage political-economic contexts of agroforestry governance and peatland exploitation (Manzo et al., 2020). Driven by global demand for palm oil, agroforestry actors seek to develop peatlands for plantations, where clearing and draining are necessary, exposing the organic peat soil to air and sunlight (Evers et al., 2017). This leads to rapid decomposition, carbon dioxide release, and an increased fire risk. Peatland fires, characterised by smouldering combustion, are challenging to extinguish and release toxic gases and thick smoke, contributing to haze that may affect neighbouring

countries due to prevailing wind directions (Hu et al., 2018). Over the past three decades, intensified peatland exploitation by agricultural conglomerates, driven by global palm oil demand, has contributed to the emergence of 'patronage politics' in the palm oil sector. Co-opted in patronage networks, governments and agroforestry corporations often turn a blind eye to peatland degradation, benefiting politically from corporate economic gains and resisted only by fragmented, under-funded grassroots environmental organisations (Varkkey, 2012).

The challenge of mitigating haze lies in the re-organisation of ever-evolving relationships between human (consumers, manufacturers, agroforestry actors, governments, NGOs) and non-human agents (peatland, oil palm, smoke particles) in the assemblage. The concept of ‘transboundary commons’ has emerged into prominence to problematise the governance of geographically dispersed environmental resources with no clearly defined property or jurisdictional boundaries (Miller, 2020). This includes clean air and tropical peatland ecosystems that deliver environmental, social, and economic benefits and risks across formal boundaries of jurisdiction and property rights (Miller et al., 2020).

Much of the focus in the literature has been on the *spatial* challenge of transboundary haze governance (e.g. Goldstein et al., 2020). Tracing those responsible for burning and peatland degradation has long proven to be difficult due to complex supply chains (Purnomo et al., 2018). Pollution from the in-situ biomass burning moves across state boundaries, as do investments, revenue, and traded commodities. Deep business links and strained geopolitics add political-economic and diplomatic complications to issues of environmental liability and responsibility (Varkkey, 2022). There have been attempts at the trans-national Association of Southeast Asian Nations (ASEAN) and national levels to implement policies, regulations, and legislation to eradicate haze by holding corporations accountable for deforestation, peatland degradation, and biomass burning (Heilmann, 2015; Jones, 2004; Lee, J. et al., 2016; Nguitragool, 2010; Varkkey, 2014), but success is often constrained by extra-territoriality, political tenure, and inter-state compromise (Hurley and Lee, 2021; Latif et al., 2018; Varkkey, 2011, 2022). These policy gaps of transnational governance have been partially bridged by ‘transboundary publics’ such as civil society organisations and think tanks, where private sector actors and the general public are engaged to complement and influence existing regulatory processes and mechanisms (Varkkey, 2022).

2.2 Temporality, Seasonality, and the Haze Assemblage

There is a scarcity of literature exploring the *temporality* that underpins haze governance, addressing the important question of *when* the opportune moments are to intervene in the complex dynamics of the transboundary haze assemblage. While restoration of drained and burned tropical peatland may take decades or even centuries (Evers et al., 2017), fire prevention efforts could be implemented at temporally strategic junctures before the arrival of dry seasons, and the extent of preparation could be determined by forecasts of El Niño and precipitation patterns (c.f. SIIA 2020). Various policy, regulatory, and legislative changes can be sensitive to electoral cycles, as governments may be reluctant to implement stringent fire monitoring or forest protection regimes that could be seen as hostile to rural economic development (Zhang and Savage, 2019). Political leadership changes can disrupt land management regimes and undermine forest protection efforts (Jong, 2024). Effectiveness of non-state environmental governance strategies are heavily dependent on peaks and troughs of public attention and political legitimacy (Varkkey, 2022). Engagement within the private sector is dependent on juncture points in business cycles where external stakeholders can leverage shareholder rights, lender pressures, and procurement expectations to drive change. As such, an understanding of these temporal dimensions that influence environmental governance is critical for explaining the efficacy of interventions in haze management.

As a shared inherent marker of time, we focus on the significance of labelling an annual recurring anthropogenic event – haze – as a 'season'. We hypothesise that the construction of a 'haze season' can impact the contingent relationships within the transboundary haze assemblage, to the ends of enhancing social resilience and/or eradication of the air pollution phenomenon.

A common interpretation of 'seasons' is that they are temporal blocks that are organised around environmental changes. Typically, one season follows another, each of which would bear specific characteristics specific to physical and cultural geographies (Mauss, 1950; Orlove, 2003; Young, 1988), such as the association of summer in the UK with warmth and strawberries, and winter with cold and Christmas. In this way, seasons are characterised by cyclical biophysical conditions, and humans attach linguistically- and culturally-influenced labels to them. However, this conceptualisation assumes that humans are purely reactive to

environmental change and social activities are in some way determined by the physical environment (Harris, 1998). In the Anthropocene, when human activities are increasingly out of sync with non-human entities and systems (Smith and Liu, 2025), social rhythms should not be conceived as distinct from the environment but are mutually influential (Bastian and Hawitt, 2023; Goudie, 2017). It becomes crucial to adopt a framework that conceptualises social life in the Anthropocene as a polyphony of other rhythms inscribed in communities' 'timescapes' (Adam, 2005).

A more nuanced reading conceptualises seasons as 'rhythms' of life cycles (Harris, 1998; Ingold and Kurttila, 2000; Krause, 2004; Lefebvre, 2004). According to this view, seasons are economic, social, and cultural practices interwoven with the rhythms of other more-than-human activities, including the activities of animals, plant growth and decay, weather patterns such as temperature, precipitation, and snowfall, the waxing and waning of the moon, changes in the timing and length of day and night, ocean currents, and the ebb and flow of the tides (Ingold and Kurttila, 2000). Thus, seasons are not limited to physical patterns of environmental change. Instead, they may reflect broader patterns of life, as seen in the emergence of a 'tourist season' in the Mediterranean when warmer months coincide with school holidays in the rest of Europe (Bimonte and Faralla, 2016), the 'ruin season' when resort towns suffer from deprivation as tourist footfall drops in the colder months (Arboleda, 2023), or the 'silly season' during holiday periods when less intense news content dominates the headlines (Fernández-Muñoz et al., 2022; Lima et al., 2022). These seasons demarcate rhythms of social and political activities, with underlying biophysical environmental factors influencing their timing.

As such, the social construction of a 'season' reflects ongoing deliberation and contestation of societal perceptions of such recurring phenomena. This constitutes place-based, context-specific 'timescapes' that entail local and regional challenges and opportunities for social and environmental governance (Bensaude-Vincent, 2022). As human activities are irreversibly altering the Earth's geophysical environment, 'seasons' continue to serve an important socio-political framework for societies and communities to acknowledge, communicate, and attribute meanings to shifting biogeochemical cycles. For example, Whitehouse (2017) describes how the observation of birdsong has become a means for birdwatchers to determine seasons, highlighting how relationships between human activities and more-than-human processes are maintained, even for societies that now inhabit a mostly

indoors, controlled environment. In the urban context of Chiang Mai, Thailand, Mostafanezhad and Evrard (2021) noted that the emergence of the 'smoky season' in northern Thailand between January and April plays a role in accentuating existing socio-ethnic and rural-urban tensions in environmental politics. In response to a growing body of literature on the influence of culturally-constructed temporal frameworks and their influence on communities' capacity to adapt to environmental change, Bremer and Schneider (2024) offered a novel conceptual framework of 'seasonal cultures'. This contends that socially perceived rhythmic patterns serve as a heuristic tool for communities to enhance their resilience against environmental change by facilitating the identification of seasonal variability and pattern shifts, adoption of 'season-proof' activities, and recalibration of socio-cultural activities to adapt to anthropogenically-altered environments.

Our conceptual framework builds upon Bremer and Schneider's (2024) to argue that, in addition to anthropogenically *shifting* seasonal patterns (e.g. Gao et al., 2022), novel 'Seasons of the Anthropocene' are emerging as the result of the entanglement of anthropogenic effects with more-than-human rhythms. That is, human activities are creating new environmental seasons. The construction of 'haze season' in equatorial Southeast Asia presents an ideal case study of such an anthropogenically forged season. Societies in equatorial Southeast Asia have traditionally made sense of temporal patterns in life through constructing 'seasons' around social and economic activities associated with the arrival and departure of 'wet' and 'dry' seasons (Mauss, 1950; Orlove, 2003; Young, 1988). In recent decades, as the result of urbanisation and poor drainage management, the 'wet' season has gradually become acknowledged as a 'flood' season (Safiah et al., 2020). These evolving seasonal labels testify to the social sensitivity and responsiveness to shifting geophysical patterns. As different sectors of equatorial Southeast Asian society are increasingly adopting the term 'haze season' at a time of year that would usually be acknowledged as the 'dry season' we believe it is timely to define this new season and explore the implications of this seasonal construction in public discourse.

Bremer and Schneider (2024) argue that shifting concepts of *pre-existing* seasons manifest their influence in ways that could enhance social resilience and preparedness for environmental change. However, we extend this to *emergent* seasonalities through our conceptual framework (Fig. 1). Applying this to the 'haze season' in equatorial Southeast Asia, we investigate whether this novel anthropogenic season has driven proactive measures

to mitigate the future onset of haze, or whether the seasonal construct inspires passive adaptive measures or tolerative non-action, which may facilitate or enhance recurrent 'haze seasons'.

Through our case study of the 'haze season' and its implications for socio-environmental impacts, we propose that our framework may be applied to shed light on other recurrent anthropogenic environmental phenomena and their potential seasonal constructs. In other words, we aim to understand how discourse about seasons frames future human activities and attribute meaning to future environmental change events. As human activities continue to shape and change the biophysical environment, the notion of 'seasons' could be one of the conceptual tools to help societies perceive and make sense of the (lasting) changes humans have made to the environment (left hand side of Fig. 1). The construction of 'seasonalities' in public discourse could set in motion this socio-environmental feedback loop, leading to changes in the timing and/or severity of emergent seasons through mitigative or adaptive actions (right hand side of Fig. 1). This ultimately has the potential to eliminate, moderate, or accentuate the new season itself.

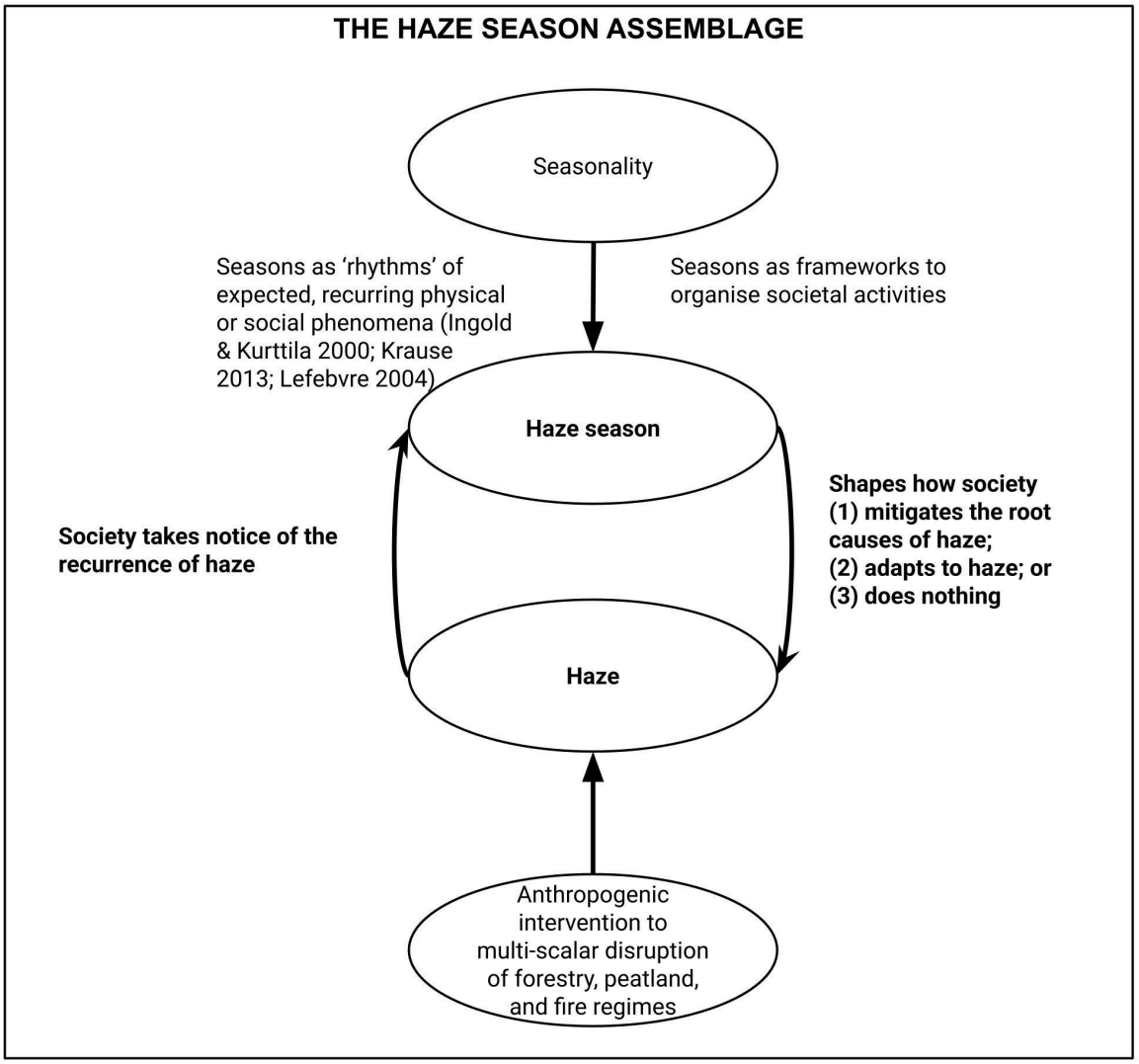


Figure 1. Our framework for conceptualising the relationship between the haze assemblage, seasonality, and the potential for socio-environmental feedbacks.

3. Methodology

Our study focuses on printed and online media portrayals of haze and the ‘’haze season’, specifically to determine how ‘haze season’ as a concept emerged and evolved in Indonesia, Malaysia and Singapore. We have chosen these three countries as they are economically involved in the Southeast Asian agroforestry sector and are concurrently affected by haze caused by the unsustainable practices of the sector.

Our focus on traditional media follows past studies of public discourse and social perception of air pollution and the agroforestry sector in Southeast Asia (Forsyth, 2014; Liu et al., 2020;

Massey, 2000; McLellan, 2001; Manzo et al., 2019). The media plays a critical mediative role in portraying and communicating complex environmental issues to the general public, especially when the issue demands collective mitigative or adaptive behavioural changes (Berkhout, 2010).

Moreover, analysis of content from state-owned or state-influenced media will provide further indication of policy direction on key matters of concern. There is evidence from media analyses-based studies of environmental denialism in Southeast Asia, where members of the patronage network deploy their porous control over traditional media outlets to amplify their divergent environmental knowledge (Goldstein, 2016), whilst disarming civil society from holding powerful stakeholders accountable (Forsyth, 2014; Liu et al., 2020, Manzo et al., 2019). To this end, media analyses provide a window into the complex landscape of environmental public discourse.

Our methodology follows five key steps that consequentially answer our research questions. First, we conducted a search on Factiva and Lexis Nexis for English-, Bahasa Melayu-, and Bahasa Indonesia-language articles containing ‘haze’ and ‘haze season’ (and corresponding translations) between 1998-2021, published in Indonesia, Malaysia and Singapore. These are the main languages spoken in the selected countries. This time frame was chosen because we could find no mentions of ‘haze season’ before 2001. We selected a three-year buffer to include 1998, which was the year after the most pronounced widespread haze season affecting the region in 1997 (van der Werf et al., 2004). The articles were then separated into two main corpora, further separated by languages. The first corpus identified articles that included the phrase ‘haze season’. The second corpus included any article with the word ‘haze’ but excluded any articles with the phrase ‘haze season’. Duplicate articles and false-positive articles (for instance, where the phrase ‘haze season’ appeared in a link to another article) were removed before analysis.

Second, we identified the monthly distribution of newspaper articles mentioning ‘haze’ and ‘haze season’.

Third, to establish the unique discursive contexts in which the term ‘haze season’ appeared, we used the corpus management and text analysis platform, SketchEngine, to identify keywords associated with ‘haze season’ by comparing the words found in the articles

mentioning the term ‘haze season’ with a corpus of words drawn from general web usage in the year 2020 (enTenTen20; SketchEngine.eu, nd), a corpus containing over 38 billion words. Using this, we identified a list of words and parts of speech that are statistically significantly prevalent in articles covering ‘haze season’. For Bahasa (‘*musim jerebu*’ and ‘*musim asap*’), there was no general linguistic corpus available, so we conducted manual coding (Forsyth, 2014; Liu et al., 2020) to pick out keywords and themes emerging from the articles that mention these two terms.

Fourth, to compare the differences between our two distinct textual corpora (‘haze’-only and ‘haze season’) we conducted a relative frequency ‘keyness’ analysis between the two corpora to identify associated divergent themes (Gabrielatos, 2018). The keyness between the ‘haze’ and ‘haze season’ corpora was compiled using the Quanteda software package within the R software suite. However, Quanteda does not calculate the Bayesian Information Criterion (BIC) score (see below), so the analysis was supplemented using an algorithm developed by Paul Rayson (Lancaster University), allowing calculations of additional metrics (Rayson, n.d.).

A relative frequency difference analysis requires both an effect-size metric and a statistical significance value (Gabrielatos, 2018; Rayson and Garside, 2000). Effect-size metrics use a log-likelihood formula for calculation, while statistical significance is given using a BIC score. Before calculating the scores, common words such as ‘the’ or ‘as’, which provide little comparative insight, were systematically removed from the corpora. The words in the corpora also had their endings truncated to allow for better comparison among words with slightly different endings. The Quanteda software then calculated the frequency scores between words in each corpus. Frequency scores were then thresholded based on a words-per-million frequency. Words occurring more than 80 per million times in either corpus had BIC scores and a log-likelihood score calculated using the Rayson approach. For the statistical significance of difference analysis, any BIC score greater than 6 shows strong evidence against H_0 [the null hypothesis, i.e., a difference between the two corpora] and scores greater than ten show very strong evidence against H_0 (Rayson, n.d.). For the effect size, the log-likelihood method was used to calculate the scores.

Finally, we conducted Structural Topic Modelling (STM) to identify and analyse key thematics and covariates presented in the media within and outside ‘haze seasons’. This

method has been used in social science research to identify correlations between document-topic and topic-word distributions with certain metadata information in the document that corresponds to or operationalises the independent variables of interest.

We performed an STM analysis of English language articles published in Singapore, Malaysia and Indonesia that mention 'haze' to obtain structural topic models of the three language corpora. We first specified the number of topics to conduct the STM analysis. For each corpus, we tested a range of model specifications to identify the number of topics that produces the most semantically distinct and coherent topics. For instance, for the Singaporean corpus, we decided on six topics. Fewer topics led to topics merging (e.g. 'air pollution' merging with 'health'), while more topics would lead to overlapping themes contained in multiple topics. The STM method reveals the words with the highest probability in the topic, and the *frex*, which refers to the words that are frequent and exclusive to the topic. The topic labels were determined subjectively by the authors, as informed by the highest probability words and the *frex*. Since there still exists an element of subjectivity in deciding semantic coherence, we further validated our topic labels using word-intrusion and topic-intrusion tests (Chan and Saltzer, 2020). We then investigated how the distribution of topics in each corpus changed throughout the year, with particular attention on whether certain topics were over- or under-represented during the 'haze season' period from June to October (elaborated in Section 4.1, Fig. 2). To do so, we created a binary metadata category for each article to denote whether it had been published during the 'haze season'. This allowed us to identify differences in the topic prevalence of an article published during and outside the 'haze season'. We found only a small number of newspaper articles mentioning '*musim jerebu*' (n=49) and '*musim asap*' (n=1), which prevented a meaningful STM analysis. Instead, we manually coded these articles in our results and discussion.

4. The Emergence of a Haze Season

4.1 The temporality of the 'haze season'

We found articles mentioning 'haze' (n = 36580) and 'haze season' (n = 371), as well as '*musim jerebu*' (n=49) and '*musim asap*' (n=1). 7% of the articles were opinion or editorial articles. The number of articles mentioning both 'haze' and 'haze season' peak between June to October, temporally aligned with the peaks of forest fire hotspots in Indonesia (as depicted

by NASA's MODIS) and air pollution (Pollutant Standards Index, or PSI) in Singapore, which could be used as a proxy for haze episodes (see Fig. 2). This indicates a seasonal organisation of social discourse around haze episodes, which is also captured in the following quote from a 2000 article published in the *International Herald Tribune* suggests its emergence:

> "There are two seasons in most of Southeast Asia – wet and dry – but in recent years some countries have come to expect a third: the "hazy" season, when fires set by farmers and plantation owners to clear brush send thick clouds of smoke across parts of Indonesia, Malaysia, Singapore, Brunei and southern Thailand. What was once an intermittent annoyance, occurring mostly during exceptionally dry years, is now an annual event." (International Herald Tribune, 2000)

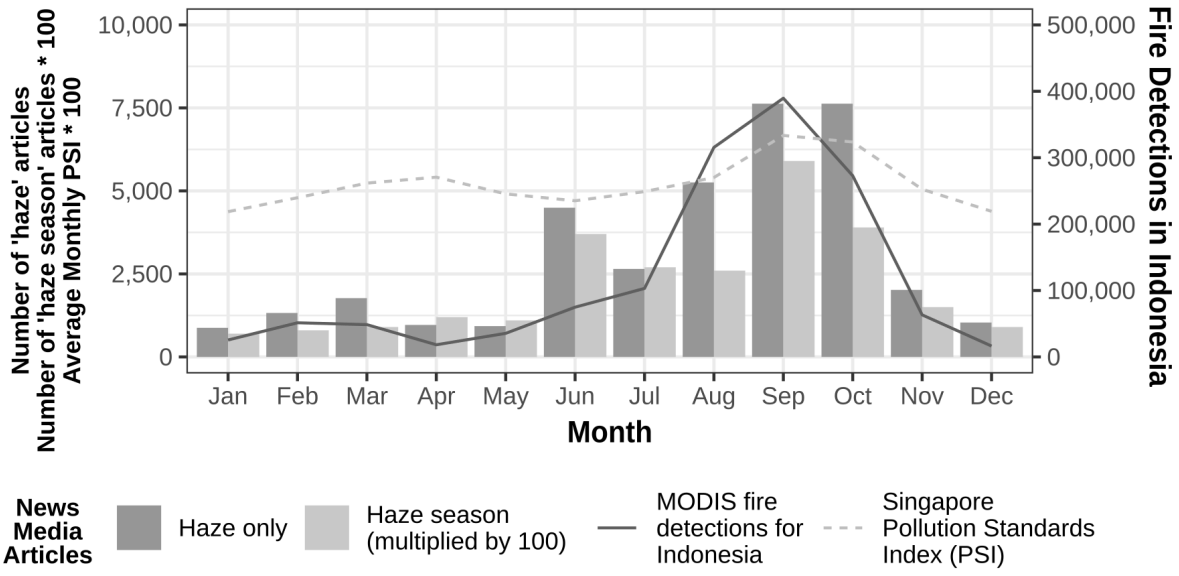


Figure 2. News media articles mentioning 'haze' only (dark grey bars) and 'haze season' (light grey bars) by month, compared with Singapore's monthly mean Pollution Standards Index (PSI, dashed line) and summed monthly NASA MODIS fire hotspot detections in Indonesia (solid line). For comparative purposes, 'haze season' articles and PSI have been multiplied by 100 to scale with the primary x-axis.

By 2006, we find evidence that haze had been socialised and normalised as an expected annual occurrence, as suggested by this quote in *Today Singapore*:

> "The traditional haze season from June is expected to end by the middle of next month [July]." (Today Singapore 2006)

By 2019, the recurring haze had become normalised to a point that a Malaysia newspaper *Berita Harian* quoted an online joke that Malaysia has three seasons:

> "There is a joke that was shared online not long ago about the three seasons in Malaysia - the rainy season, the haze season and the durian season" (Berita Harian, translated by authors, 2019a)

It is worth noting that articles mentioning both 'haze' and 'haze season' are increasing over time (Fig. 3), and most articles mentioning 'haze season' were published after 2013 (n=361), suggesting the issue and its associated season were gaining traction as a matter of concern in society.

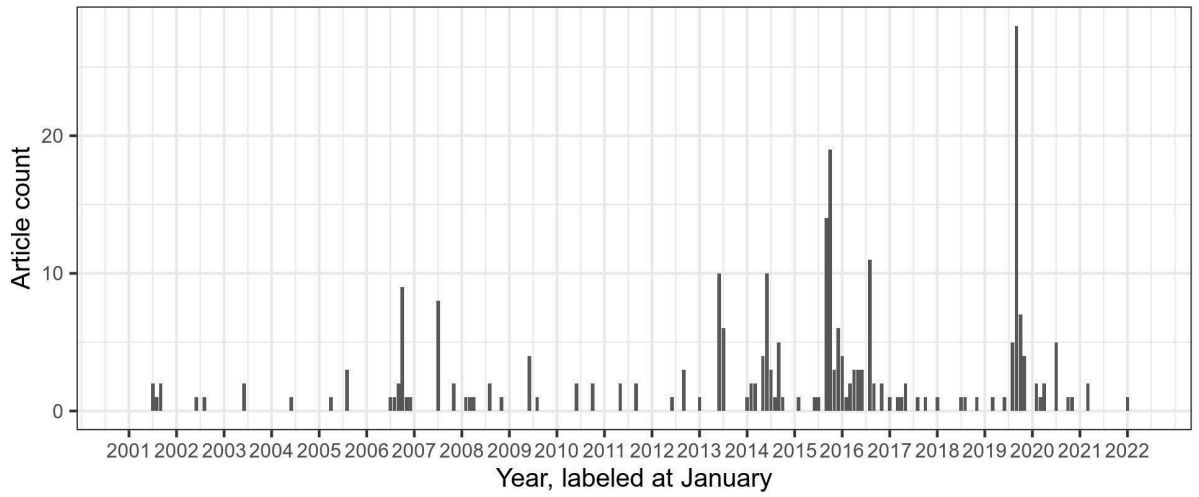


Figure 3. Mention of 'haze season' by month between 2001-2022; we could not find any articles that use the term 'haze season' published before 2001. Alternative versions of this plot for 'haze'-only articles can be found in Supplementary Materials

4.2 Divergent discourses around 'haze' and 'haze season'

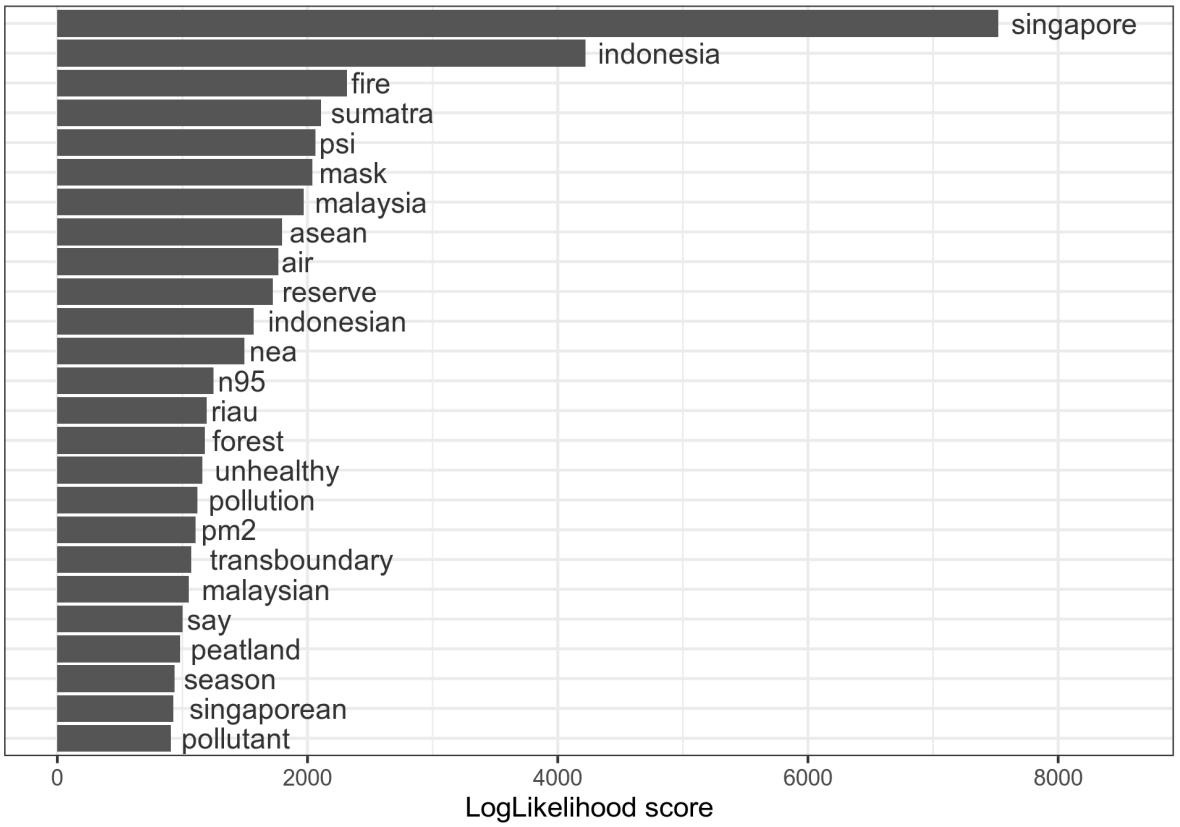


Figure 4. Top 20 most-used words in the 'haze season' corpus compared to the 2020 standard English corpus.

We identified the top 20 most-used keywords in the 'haze season' corpus compared to the general English corpus (Fig. 4). These keywords reflected places that are affected by haze (e.g., Singapore, Indonesia, transboundary), sources of haze (e.g., fire, reserve, forest, peatland, Sumatra, Riau), description of the pollution episodes (e.g., PSI, air, pollution, unhealthy, PM2, pollutant), adaptation measures (e.g., mask, N95), and authorities that could tackle the problem (e.g., NEA - The National Environmental Agency of Singapore, ASEAN). This suggests that the season is defined by the different facets of the shared, lived experience of haze. Interestingly, in this 'haze season' corpus, only a limited number of keywords related to haze mitigation strategies, besides the mentions of The National Environmental Agency of Singapore and ASEAN. Similarly, air pollution (n=42) and health (n=18) were two of the most prominent keywords found in the Bahasa articles. Ten of the 50 Bahasa articles mention keywords such as 'forest', 'peat' and/or 'fire', while six articles mention keywords related to ASEAN, and only one article refers to palm oil.

The relative frequency keyness analysis identified keywords that appeared significantly more frequently in ‘haze season’ articles rather than articles that referred only to ‘haze’ (Fig. 5). ‘Haze season’ articles mention words associated with pollution at a much higher level of statistical significance, including mask-related words such as “*n95*” and air quality words such as “*1-hr*”, “*pm2.5*”, and “*concentr*[ation]”, as well as words related to adaptation to the pollution, such as “*filter*” and “*purify*[cation]”. In contrast, keywords from the ‘haze’-only corpus have very low chi-squared scores, meaning they do not appear in the ‘haze’-only corpus more than the ‘haze season’ corpus in a statistically significant manner. The highest-scored words in the ‘haze’-only corpus suggest a higher tendency of discussing institutional mitigative solutions to haze, such as “*meet*”, “*minist[er/ry]*”, “*financi[al]*”, and “*cooper[ation]*”. We note that ‘choice’ appeared as the most unique keyword in the ‘haze season’ corpus. This is because ‘haze season’ was mentioned in a consumer/shopping article reviewing ‘editors’’ and ‘readers’ choices’ on various digital appliances in the context of reviewing a mask with a built-in micro-ventilator which readers have found to be useful in coping with air pollution during the haze season (the word ‘choice’ appears 48 times in this article, explaining the skew in keyness for this word).

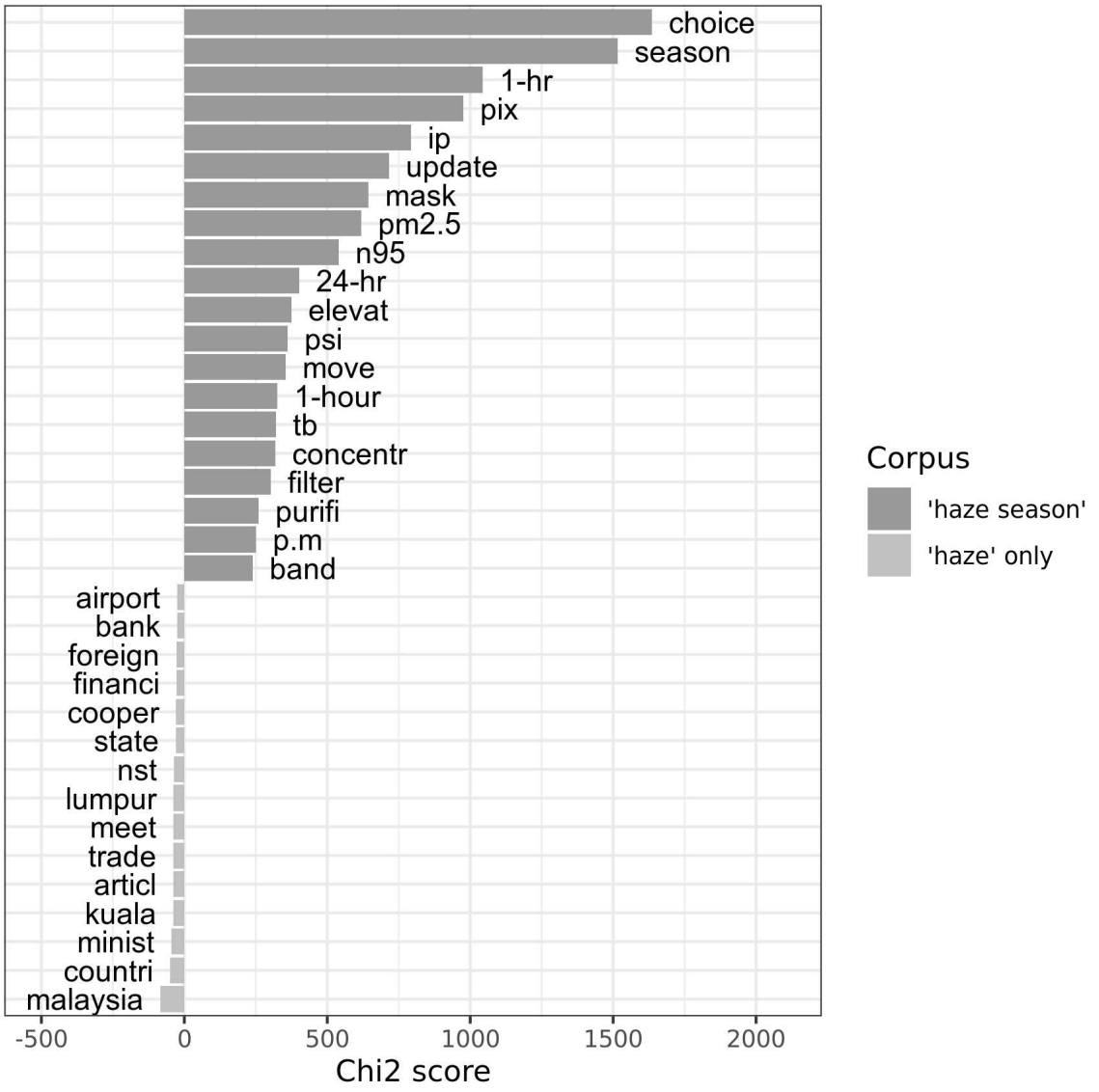


Figure 5. Chi-squared scores for most distinct words in 'haze season' and 'haze' only corpora for words occurring more than 100 times in each corpus

4.3 Seasonal approaches to the discussion of Haze

Our STM analysis provides more granular insights into the seasonality of topics associated with the term 'haze' (Table 1, Fig. 5 & 6, and Supplementary Materials). Five topics were identified for Indonesia and Malaysia, and six for Singapore (see Table 1 for Singapore 'haze' article topics). "*Air pollution*", "*ASEAN*", "*palm oil industry*", and "*peat burning*" were common topics across the three countries, while the "health" topic was only identified for articles published in Singapore.

Table 1. Structural topic models for the corpus of Singaporean newspaper articles (see structural topic models for the Indonesian and Malaysian newspaper articles corpus in Supplementary Materials).

Topic Cluster	Highest probability	FREX (frequent and exclusive words)
Topic 1: ASEAN	ASEAN, minist, countri, develop, region, issu, govern	ASEAN, aec, parnham, arf, nds, rds, ASEAN-china
Topic 2: Air pollution	air, psi, nea, qualiti, pollut, read, unhealthi	mss, -hr, thunderi, inter-monsoon, myenv, souther, mid-sect
Topic 3: Health	mask, health, air, peopl, school, use, work	needi, ecda, allerg
Topic 4: Noise	like, say, last, time, just, get, day	album, chef, esplanad, guitar, comedi, film-mak, finalist
Topic 5: Palm oil industry	per, compani, cent, busi, market, oil, product	y-oy, sgdbn, rmb, inbound, chg, biodiesel, cpi
Topic 6: Peat burning	fire, forest, compani, land, minist, problem, pollut	balthasar, kambuaya, sarwono, foead, arrmanatha, susilo, inti

Different topics were prevalent within and outside the 'haze season' (See Fig. 6 & 7). Fig. 6 illustrates the topic prevalence differences for the Singaporean, Malaysian and Indonesian corpora. In all cases, topics were significantly associated with either the 'haze season' (June to October) or 'clear' seasons (November to May), as indicated by the lack of overlap of the confidence intervals, which suggests a high probability (95%) that the topic was more prevalent in one of either two periods. For all countries, the articles appeared more focused on immediate air pollution concerns *during* the haze season, which was associated with the 'peat burning' topic in Singaporean and Indonesian articles, and the 'health' topic for Singaporean articles. Topics addressing the root causes and mitigation of transboundary haze, such as 'ASEAN' and the 'oil palm industry', were more prevalent during the 'clear' season, which respectively refer to regional policy coordination through ASEAN and issues of palm oil sustainability.

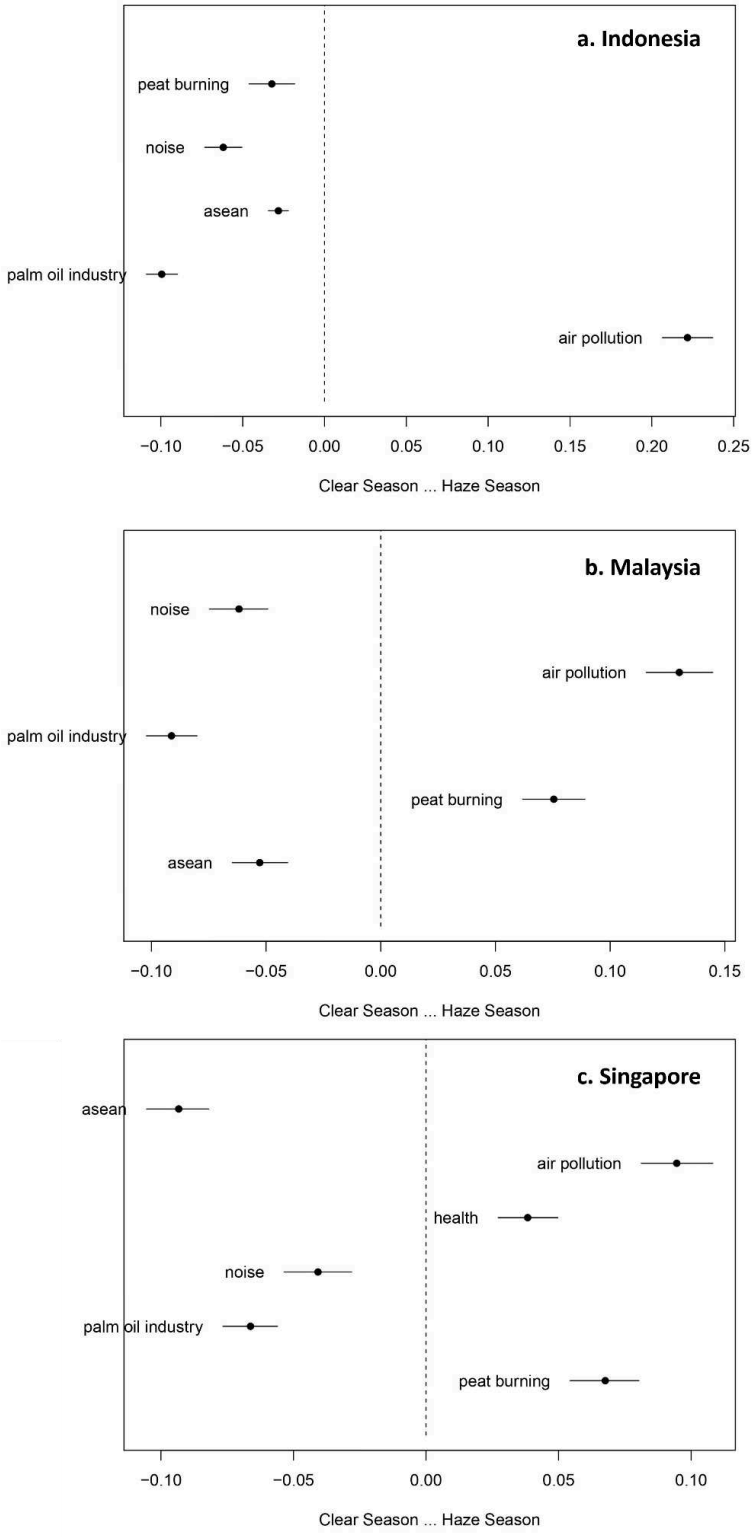


Figure 6. Effect of haze season on topic prevalence for Indonesian, Malaysian and Singaporean haze articles from 1997-2021 (from top to bottom). The values were produced by regressing on the binary variable of the article's publication during the haze season (Haze Season/Clear Season) on the topic prevalence generated by the STM model. Topics on the right were more likely to have been published in the haze season (June to October), while topics on the left were more likely to be covered in the

'clear season' (November to May). Confidence intervals (95%) account for the regression and measurement uncertainty of the STM model. Noise refers to articles that could not be meaningfully classified into a topic.

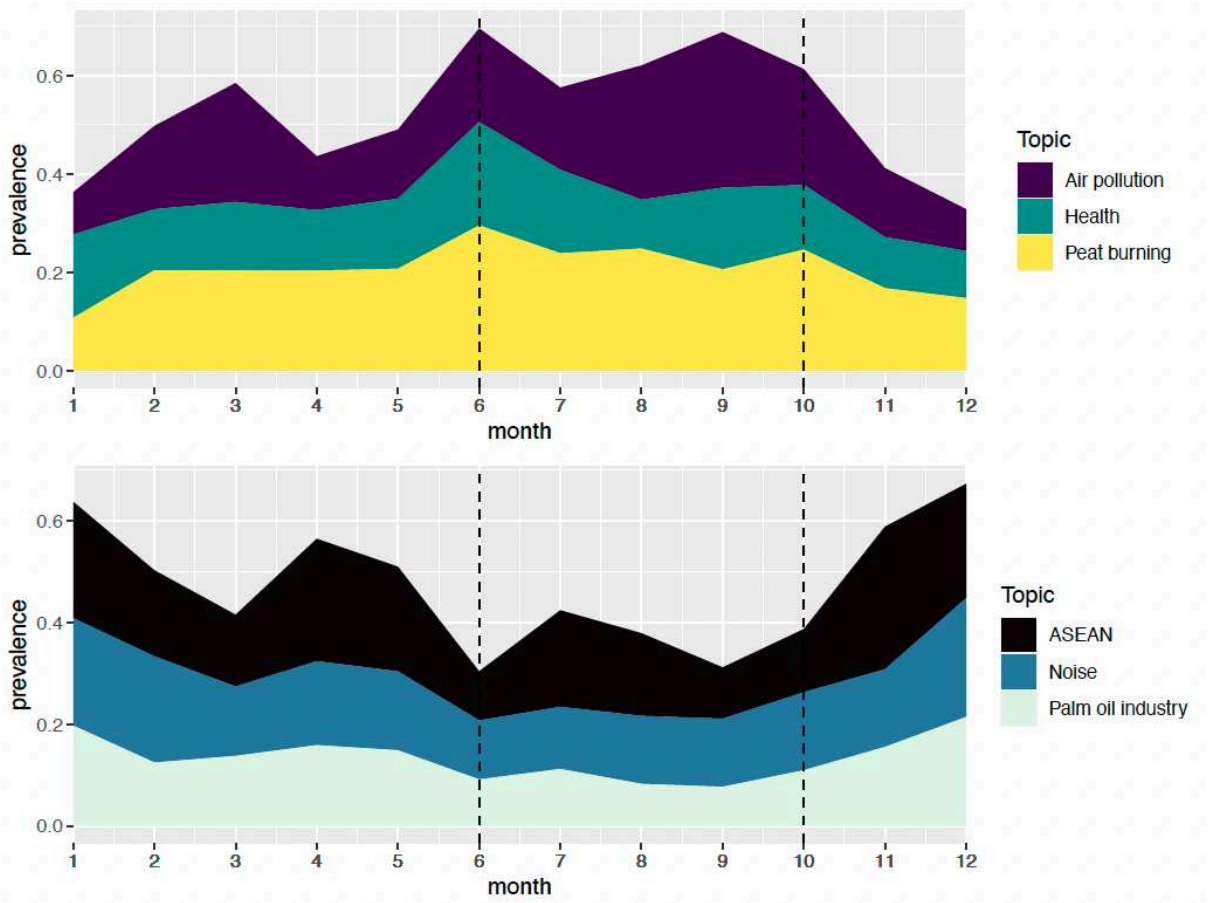


Figure 7. Monthly distribution of Singaporean media article topics (1997-2021) that mention 'haze' (equivalent plots for Indonesia and Malaysia can be found in the Supplementary Materials)

5. Discussion

Our analysis suggests that the 'haze season' has emerged in public discourse in Indonesia, Malaysia, and Singapore in the past three decades. The consolidation of 'haze season' in public discourse concurs with the recurrent tropical peatland burning and air pollution episodes affecting these equatorial Southeast Asian states, suggesting that this recurrent pattern of environmental change phenomenon has become a new seasonal reality integrated into 'rhythmic' cycles of societies and communities (Ingold, 2000; Krause, 2004; Lefebvre, 2004). Unlike a broad body of literature that focuses on the human influence on *shifting*

seasonal timings and intensities (e.g. Gao et al., 2022), our findings have uncovered the social construction of a novel anthropogenic environmental season. Drawing from contestations over the 'social construction of nature' (Demeritt, 2002; Escobar, 1996), the social construction of 'Seasons of the Anthropocene' consists of human disruption (and reconstruction) of natural cycles to meet anthropocentric expectations. In this case, haze is constructed by the multi-scalar disruption of forestry, peatland, and fire regimes to maximise profits of the palm oil sector and to maintain patronage political relationships.

We argue that the construction of this 'Season of the Anthropocene' signifies a focal point to the haze assemblage. Drawing from Gan and Tsing's (2018) metaphor of the matsutake mushroom in organising relations between Japanese satoyama forests (the unique ecosystem where the sought-after mushrooms can grow) and capitalists (high-end restauranteurs, hospitality firms, and consumers seeking out the luxury ingredient), a temporal 'knot' that organises the construction and re-construction of the haze assemblage.

The implications of the construction of 'seasonality' to the haze assemblage and to our broader understanding of social perceptions of localised environmental change events are five-fold. First, unlike studies of 'weather memories' that typically found a mismatch between the 'scientific' measurement of changes in physical phenomena and the societal memory of environmental changes (e.g., Adamson and Rapson, 2024; Broomell et al., 2020; Goebbert et al., 2012; Kahan, 2014; Walshe et al., 2020), our findings suggest an alignment between environmental monitoring of air pollution and satellite fire hotspot detections with the societal acknowledgement of 'haze season'. Haze affects a wider geographical area and a large population during each episode, and each annual episode reinforces collective experiences and memories of 'haze', leading to the construction of multi-scalar responses. This suggests that haze 'seasonality' has become a heuristic tool to coordinate local knowledge of environmental change to inform more appropriately-timed mitigative and adaptive interventions to haze.

Second, similar to 'cyclone season', 'bushfire season' and 'flood season' (Paton et al., 2006; Peters-Guarin et al., 2012; Walshe et al., 2020), the construction of 'haze season' is associated with the preparation for an environmental hazard. In line with Bremer and Schneider (2024) who find that societal acknowledgement of seasonal shifts could play a crucial role in enhancing adaptive capacity to changing environmental patterns, we find that

media discourses on ‘haze season’, as opposed to just ‘haze’, are primarily focussed on adaptation. Particularly, on how individuals and households might minimise their exposure to air pollution and/or reduce discomfort.

Uniquely, we find an evolution in the usage of ‘haze season’ over time, with respect to different societal groups. Earlier articles (2006–2013) focus on at-risk groups, such as children, athletes, and outdoor workers, with measures such as school closures and limiting working hours. Concurring with earlier research by De Pretto et al. (2015), the experience and memory of haze are uneven. Groups that regularly engage in outdoor activities, such as athletes, are particularly aware of the seasonal recurrence of haze. After consecutive, severe episodes since 2013, by 2015, ‘haze season’ articles began to report or even recommend adaptation measures. Interestingly, some of these recommendations were also implicitly linked to increasing consumption, such as wearing (purchasing) masks, attending indoor activities such as ‘staycations’, using (purchasing) indoor air purification devices, as well as purchasing private health insurance. This suggests that certain corporate actors are capitalising on the ‘haze crisis’ (Varkkey et al., 2025).

As haze continued to return, the adaptive measures covered by the newspapers became increasingly interventionist. By 2019, the active use of cloud seeding to clean the air with precipitation was mentioned for the first time. What appear to be technologically-sophisticated (especially in the case of cloud-seeding) ‘season-proofing’ strategies (Bremer and Schneide, 2024) in fact present only a short-term ‘technical fix’ (cf. Fox, 2023). These increasingly interventionist adaptation strategies serve to maintain a crisis narrative (Masco, 2017) that focuses on the impact of haze *during* haze season, to justify resource deployment towards short-term or fantastical adaptive strategies that address the symptoms rather than the root causes of haze. To this end, the building of preparedness and resilience for haze that results from the construction of an expectation of its seasonal recurrence may present a moral hazard of mitigation inertia (cf. Jebari et al., 2021).

Third, we found a *temporally sensitive* deployment of the haze season narrative that both galvanises mitigative action or justifies non-action by a myriad of actors, including NGOs, businesses, national governments, and ASEAN-level authorities, depending on the time of year. During the peak of fire hotspot activities and air pollution, the bulk of the discourse surrounding ‘haze season’ is focused on various adaptive strategies, as detailed previously

(Fig. 7). Comparatively, during the clear months, the discourse surrounding haze season tends to be focussed on mitigative measures, ranging from regional policy coordination, regulations, finance and improvement in agricultural practices. This period acts as a window of opportunity for broader behavioural and policy changes (Hajer, 1995), as discourse turns to reflecting on the experience of the past 'haze season' to inform the prevention and preparation for the next 'haze season'. This indicates the time sensitivity of altering the relationships in the haze assemblage to enhance social resilience and mobilise to eradicate or at least minimise the severity of the next haze season.

Fourth, and closely-related to the third point, our analysis expands on the conceptualisation of seasonality by highlighting a further step in the social construction of Anthropocene seasonality through a socio-environmental feedback effect (Smith and Varkkey, 2022; Varkkey et al., 2025). Unlike adaptation measures that do not fundamentally interfere with the human and non-human interactions that gave rise to the new season, mitigative measures (or the obstruction thereof) create feedback that affects either the severity or eradication of the environmental change phenomenon itself (see Fig. 1, right-hand side). However, although a myriad of mitigative solutions are reported and discussed during the clear months,there is significantly thinner coverage of the haze issue generally during clear months, diluting the messages at the time of least concern. As a result, public interest and momentum to take mitigative actions is generally low.

We also found conflicting narratives that could counter the feedback effect of seasonally deployed mitigative discourse. As society becomes accustomed to the recurrence of haze and how to prepare for it –-but also accept that it is a crisis that comes and goes (Varkkey et al., 2025) – we found that societies and communities begin to 'normalise' its recurrence:

> "It's become such a normal part of our lives that children growing up today might not believe that there was a time when we didn't have to breathe smoke particles at least once a year…So now we have a rainy season, a hot season, a durian season and a haze season." (Yap, 2006 in *New Straits Times*)

As this quote suggests, as the seasonal memory of 'haze free' dry seasons fades, society becomes desensitised to the anthropogenic environmental degradation and underlying capitalist-patronage institutional configuration that gave rise to haze in the first place

(Varkkey, 2012). The construction of ‘haze season’ has therefore created a positive feedback effect that perpetuates haze.

Fifth, the construction of ‘Seasons of the Anthropocene’ is a politically-charged process. Government-corporate patronage networks have control over mainstream media outlets, and thus influence over how the ‘haze season’ is portrayed. We find that these outlets tend to focus on the short-term impacts of haze and the fact that haze will eventually dissipate (Varkkey et al., 2025), which may act to minimise their responsibility for causing haze episodes, their liability to compensate for the environmental losses it brings, and/or take mitigative action to reverse the environmental damage (ibid). In contrast, civil society organisations, with considerably fewer resources and political power, have acted strategically to curate their environmentalist narration to highlight the underlying perversion of the ‘haze season’. Their efforts seek to move forward a longer-term mitigative and social resilience agenda, while also maintaining their political legitimacy to operate (Varkkey, 2022). The relentless recurrence of haze, including the pronounced season in 2023 (Graham et al., 2024), is at least partly due to non-action that results from this seasonal construct (Varkkey et al., 2025).

Thus, ‘Seasons of the Anthropocene’ presents a discursive framework and temporal concept that allows individuals, communities, and societies to acknowledge, communicate, attribute meanings, and establish relationality to emergent biogeochemical cycles. By galvanising and justifying the deployment of different types of adaptive, mitigative, or non-action at different juncture points by different actors, the construction of ‘haze season’ connects different groups of human and non-human entities that otherwise would not directly interact, but nonetheless are implicated in the haze assemblage and thereby influenced by each others’ cycles and rhythms. By understanding how the ‘haze season’ is constructed, we also gain insight into who gains and loses economic, social, and environmental benefits as the result of haze recurrence, based on who is deploying the ‘seasonality framework’, at what time, and to what ends.

6. Conclusion

In this article, we argue that new 'Seasons of the Anthropocene' are emerging. We exemplified this with the emergence of the 'haze season' in public discourse in Indonesia, Malaysia, and Singapore. Drawing from media analysis, we found that discourse surrounding both 'haze' and 'haze season' peaks annually from June to October, in line with trends in satellite detections of fire hotspots, and air pollution monitoring indices in the region.

The seasonal heuristic informs how communities and societies organise their activities around 'haze'. This framework (Fig. 1) helps to explain the perpetuation of an assemblage of unsustainable interactions between human and non-human agents contributing to its recurrence. Crucially, we find a significant difference between the language used in media articles that cover the haze issue compared with those that specifically refer to the term 'haze season' (Fig. 5). The overwhelming prevalence of adaptation terminology in the 'haze season' corpus enables us to conclude that the seasonal construct may divert attention from the root causes of haze pollution, acting to normalise recurrent haze episodes.

We find that haze discourse is also seasonal, with an annual cycle (Fig. 7) that reflects how society problematises 'haze' at different times of the year. We find that these discourses reflect the temporality of the divergent priorities held by societal and community actors who are 1) responding to the air pollution phenomenon; 2) resolving and capturing the socio-economic impacts and opportunities it brings; and 3) addressing the underlying political-ecological causes of the haze phenomenon.

Unlike global collective issues such as climate change and biodiversity loss, haze is a tangible, localised environmental hazard that is witnessed directly and experienced physically (Bickerstaff and Walker, 2001). At the same time, its root causes and related effects still relate to these broader global collective anthropogenic challenges. Our findings add temporal and rhythmic dimensions to literature that highlight the importance of the 'localisation' of environmental risk to people's understanding of the physical, social and cultural landscape, and the development of effective environmental management (Birkerstaff and Walker, 2001). Our framework represents a mechanism through which the deployment of local and cultural knowledge of environmental change is manifested into mitigation and/or adaptation planning

and action (Naess, 2013). To this end, through our analysis of the ‘haze season’, we propose that careful consideration of the social construction of seasonality offers a new avenue to critically engage with temporality in the Anthropocene as a socially-, culturally- and politically-laden topic (Brondizio et al., 2016; Lövbrand et al., 2015).

The construction of the ‘haze season’ in Southeast Asia is an example of how society makes sense of the lasting changes humans have made to the environment, through constructing a common language that aids the understanding of a society-induced, recurrent environmental change phenomenon. We contend that more ‘Seasons of the Anthropocene’ will emerge as human activities, such as forest clearance, agricultural burning, mining, domestic waste, and industrial pollution, interact with biophysical cycles, including seasonal pressure systems, wind patterns, and ocean currents, to create recurrent environmental phenomena that are often hazardous in nature. As a discursive tool and temporal concept, ‘seasonality’ holds the power for organising and justifying policy pathways that enhance or undermine the equitable distribution of societal resilience, as well as creating feedback loops that could eradicate or worsen the cyclical anthropogenic environmental phenomena.

Who controls the narrative surrounding these emergent seasons ultimately shapes whether the feedback loops serve to mitigate the underlying issues or perpetuate them. Historical examples such as the ‘pea-souper’ smog seasons of early-to-mid 20th century Britain illustrate how public advocacy and progressive movements—culminating in legislative milestones like the UK Clean Air Acts—can drive meaningful mitigation (Smith and Liu, 2025). In contrast, our findings from the media analysis in this paper and further investigations into the framing of the ‘haze season’ by government and corporate actors (Varkkey et al., 2025) suggest a narrative dominated by entrenched patronage networks with vested interests in maintaining business-as-usual. This has resulted in rhetorical normalisation rather than transformative action, reinforcing inaction and diluting accountability.

Human relationships with the more-than-human environment have changed from being that of a species that has had to adapt to changes in its environment to one that has become a driving force in the planetary system (Zalasiewicz et al., 2011). We argue that seasonality can be an important lens through which we might better understand these mutually constructive relationships within the biophysical environment in the Anthropocene. Understanding how novel seasons are constructed and communicated will hold an important key to enhancing

social resilience and motivating collective action to contribute to the construction of a survivable, or even desirable future (Castree, 2014).

Supplementary materials

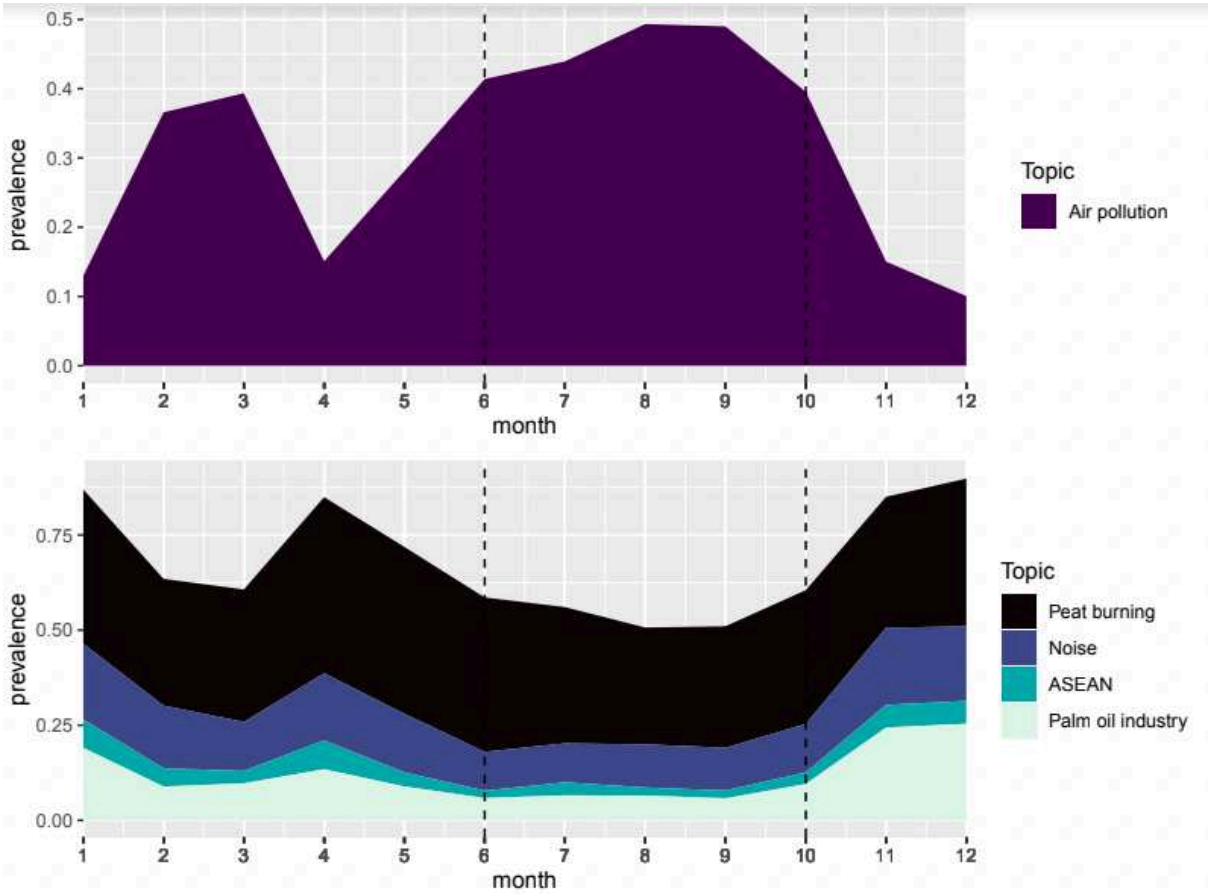
Table 1. Structural topic models for the corpus of Malaysian newspaper articles mentioning 'haze'

Topic Cluster	Highest probability	FREX (frequent and exclusive words)
Topic 1: Noise	time, game, like, peopl, may, make, day	articlebh, music, album, film, letternst, sebang, fragranc
Topic 2: Air pollution	air, read, api, depart, bernama, area, unhealthi	samarahan, seberang, rambai, manjung, sarikei, perai, baram
Topic 3: Palm oil industry	oil, palm, per, market, million, industri, compani , product	output, cpo, rspo, biodiesel, biofuel, rhb, chg
Topic 4: Peat burning	fire, forest, burn, pollut, land, smoke, air	france-press, afpr, kaban, sutopo, bnpb, dpa, nugroho
Topic 5: Palm oil ASEAN	asean, minist, countri, govern, meet, nation, environ	mou, asean', megawati, bilater, arf, aathp, asean-china

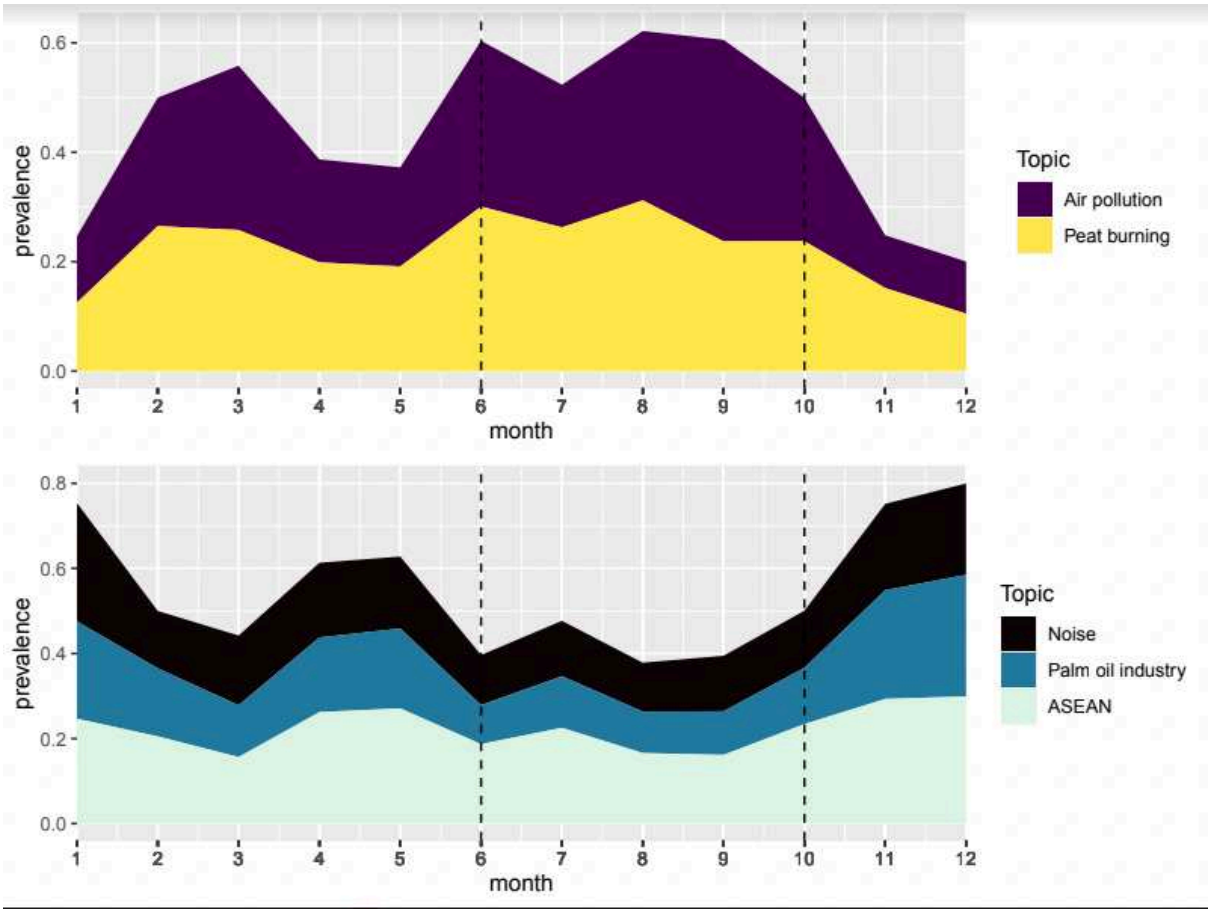
Table 2. Structural topic models for the corpus of Indonesian newspaper articles mentioning 'haze'

Topic Cluster	Highest probability	FREX (frequent and exclusive words)
Topic 1: Peat burning	fire, forest, compani, govern, minist, land, countri	pulp, errant, brg, zero-burn, foead, concess, thpa
Topic 2: Noise	peopl, say, world, presid, now, news, dayi	stout, milit, hornbil, artist, balines, cup, afghan
Topic 3: ASEAN	asean, develop, cooper, group, parti, intern, includ	nederland, financial, unfccc, rossa, postbus, us-, vert
Topic 4: Palm oil industry	oil, palm, product, temperatur, normal, emiss, increas	thundershow, anomali, heaviest, biodiesel, djcs, tonightshow, outlookscatt
Topic 5: Air pollution	fire, air, forest, agenc, kalimantan, provinc, riau	psi, bmkg, klang, indragiri, songkhla, satun, kasim

Supplementary Figure 1. Monthly distribution of topics in ‘haze’ and ‘clear’ seasons in Indonesia throughout the year



Supplementary Figure 2. Monthly distribution of topics in ‘haze’ and ‘clear’ seasons in Malaysia throughout the year



References

Adam, B. (2005). *Timescapes of modernity: The environment and invisible hazards*. Routledge.

Adamson, G., & Rapson, J. (2024). Weather, heritage, and memory. Wiley Interdisciplinary Reviews: Climate Change, 15(6), e913.

Arboleda, P. (2023). Cyclical ruins. In Sanchez-Fuarros, I, Paiva, D., Calvo, D. M. (2023) (Eds.) *Ambiance, Tourism and the City*, Routledge, Oxon, 95.

Archambault, J. S. (2016). Taking love seriously in human-plant relations in Mozambique: Toward an anthropology of affective encounters. *Cultural Anthropology*, *31*(2), 244-271.

Bastian, M., & Bayliss Hawitt, R. (2023). Multi-species, ecological and climate change temporalities: Opening a dialogue with phenology. *Environment and Planning E: Nature and Space*, *6*(2), 1074-1097.

Berkhout, F. (2010). Reconstructing boundaries and reason in the climate debate. *Global Environmental Change*, *20*(4), 565-569.

Bensaude-Vincent, B. (2022). Rethinking time in response to the Anthropocene: From timescales to timescapes. *The Anthropocene Review*, *9*(2), 206-219.

Berita Harian. (2019a). *Bersuka ria main air susah sampai undang derita.* Published 4th November 2019. Source: Lexis Nexis

Berita Harian. (2019b) *Guna akal, nilai sesuatu perkara berdasarkan fakta*. Published 21st September 2019. Source: Lexis Nexis

Bickerstaff, K., & Walker, G. (2001). Public understandings of air pollution: the 'localisation'of environmental risk. *Global Environmental Change*, *11*(2), 133-145.

Bimonte, S., & Faralla, V. (2016). Does residents' perceived life satisfaction vary with tourist season? A two-step survey in a Mediterranean destination. *Tourism Management*, *55*, 199-208.

Bremer, S., & Schneider, P. (2024). How seasonal cultures shape adaptation on Aotearoa–New Zealand's Coromandel Peninsula. *Global Environmental Change*, *85*, 102822.

Brondizio, E. S., O'brien, K., Bai, X., Biermann, F., Steffen, W., Berkhout, F., ... & Chen, C. T. A. (2016). Re-conceptualizing the Anthropocene: A call for collaboration. *Global Environmental Change*, *39*, 318-327.

Broomell, S. B., Wong-Parodi, G., Morss, R. E., & Demuth, J. L. (2020). Do we know our own tornado season? A psychological investigation of perceived tornado likelihood in the southeast United States. *Weather, Climate, and Society*, *12*(4), 771-788.

Budisulistiorini, S. H., Riva, M., Williams, M., Miyakawa, T., Chen, J., Itoh, M., ... & Kuwata, M. (2018). Dominant contribution of oxygenated organic aerosol to haze particles from real-time observation in Singapore during an Indonesian wildfire event in 2015. *Atmospheric Chemistry and Physics*, *18*(22), 16481-16498

Castree, N. (2014). The Anthropocene and geography III: Future directions. *Geography Compass*, *8*(7), 464-476.

Chan & Saltzer (2020). oolong: An R package for validating automated content analysis tools. https://www.theoj.org/joss-papers/joss.02461/10.21105.joss.02461.pdf

Cheong, K. H., Ngiam, N. J., Morgan, G. G., Pek, P. P., Tan, B. Y. Q., Lai, J. W., ... & Ho, A. F. W. (2019). Acute health impacts of the Southeast Asian transboundary haze problem—A review. *International Journal of Environmental Research and Public Health*, *16*(18), 3286.

Cochrane, Mark A., Susan Page, Agata Hoscilo, Andreas Langner, Kevin Tansey, Florian Siegert, Suwido Limin, and Jack Rieley. "Tropical peatland fires in Southeast Asia." Tropical fire ecology: climate change, land use, and ecosystem dynamics (2009): 263-287.

Demeritt, D. (2002). What is the 'social construction of nature'? A typology and sympathetic critique. *Progress in human geography*, *26*(6), 767-790

De Pretto, L., Acreman, S., Ashfold, M. J., Mohankumar, S. K., & Campos-Arceiz, A. (2015). The link between knowledge, attitudes and practices in relation to atmospheric haze pollution in Peninsular Malaysia. *PloS one*, *10*(12), e0143655.

Escobar, A. 1996: Constructing nature: elements for a post-structural political ecology. In Peet, R., editor, Liberation ecology, New York: Routledge, 46-68.

Evers, S., Yule, C. M., Padfield, R., O'Reilly, P., & Varkkey, H. (2017). Keep wetlands wet: the myth of sustainable development of tropical peatlands–implications for policies and management. Global Change Biology, 23(2), 534-549.

Fernández-Muñoz, C., Rubio-Moraga, Á. L., & Álvarez-Rivas, D. (2022). The Multiplier Effect on the Dissemination of False Speeches on Social Networks: Experiment during the Silly Season in Spain. Combating Fake News with Computational Intelligence Techniques, 245-258.

Forsyth, T. (2014). Public concerns about transboundary haze: A comparison of Indonesia, Singapore, and Malaysia. *Global Environmental Change*, *25*, 76-86.

Fox, N. J. (2023). Green capitalism, climate change and the technological fix: A more-than-human assessment. The Sociological Review, 71(5), 1115-1134

Gabrielatos, C. (2018). Keyness analysis: Nature, metrics and techniques. In Taylor, C., & Marchi, A. (Eds.). (2018). *Corpus Approaches to Discourse. A Critical Review*. London: Routledge. 225-258.

Gan, E., & Tsing, A. (2018). How things hold: a diagram of coordination in a Satoyama forest. *Social Analysis*, *62*(4), 102-145.

Gao, S., Liang, E., Liu, R., Babst, F., Camarero, J. J., Fu, Y. H., ... & Peñuelas, J. (2022). An earlier start of the thermal growing season enhances tree growth in cold humid areas but not in dry areas. Nature Ecology & Evolution, 6(4), 397-404.

Glover, D., Jessup, T., Banks, G. (2003) Indonesia's fires and haze: the cost of catastrophe. Review of Indonesian and Malaysian Affairs 37, 150-152.

Goebbert, K., Jenkins-Smith, H.C., Klockow, K., Nowlin, M.C., Silva, C.L., 2012. Weather, climate, and worldviews: The sources and consequences of public perceptions of changes in local weather patterns. Weather, Climate, and Society 4, 132–144

Goldstein, J. E., Graham, L., Ansori, S., Vetrita, Y., Thomas, A., Applegate, G., ... & Cochrane, M. A. (2020). Beyond slash‐and‐burn: The roles of human activities, altered hydrology and fuels in peat fires in Central Kalimantan, Indonesia. Singapore Journal of Tropical Geography, 41(2), 190-208.

Goldstein, J. E. (2016). Knowing the subterranean: Land grabbing, oil palm, and divergent expertise in Indonesia's peat soil. *Environment and Planning A: Economy and Space*, *48*(4), 754-770.

Gorman, R. (2017). Therapeutic landscapes and non-human animals: the roles and contested positions of animals within care farming assemblages. *Social & Cultural Geography*, *18*(3), 315-335.

Goudie AS (2017) The integration of human and physical geography revisited. The Canadian Geographer / Le Géographe Canadien 61: 19–27.

Graham, A. M., McQuaid, J. B., Smith, T. E., Nurrahmawati, H., Ayona, D., Mulawarman, H., ... & Choiruzzad, S. A. (2024). Updated Exposure Estimate for Indonesian Peatland Fire Smoke using Network of Low-cost Purple Air PM2. 5 sensors (No. EGU24-6077). Copernicus Meetings

Hajer, M. A. (1995). *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process*. Oxon: Clarendon Press.

Hansen, A. B., Witham, C. S., Chong, W. M., Kendall, E., Chew, B. N., Gan, C., ... & Lee, S. Y. (2019). Haze in Singapore–source attribution of biomass burning PM 10 from Southeast Asia. *Atmospheric Chemistry and Physics*, *19*(8), 5363-5385.

Haraway, D. J. (2008) *When Species Meet*. Minneapolis: University of Minnesota Press.

Harris, M. (1998). The Rhythm of Life on the Amazon Floodplain: Seasonality and Sociality in a Riverine Village. *The Journal of the Royal Anthropological Institute*, *4*(1), 65–82.

Heilmann, D. (2015), After Indonesia's Ratification: The ASEAN Agreement on Transboundary Haze Pollution and Its Effectiveness As a Regional Environmental Governance Tool, *Journal of Current Southeast Asian Affairs*, *34*(3), 95–121.

Hu, Y., Fernandez-Anez, N., Smith, T. E., & Rein, G. (2018). Review of emissions from smouldering peat fires and their contribution to regional haze episodes. *International Journal of Wildland Fire*, *27*(5), 293-312.

Hurley, A., & Lee, T. (2021). Delayed ratification in environmental regimes: Indonesia's ratification of the ASEAN agreement on transboundary haze pollution. The Pacific Review, 34(6), 1108-1137.

Ingold, T., & Kurttila, T. (2000). Perceiving the environment in Finnish Lapland. *Body & Society*, *6*(3-4), 183-196.

International Herald Tribune (2000). Environmentalists Burn Over Malaysia's Refusal to Release Air. Available at: https://www.nytimes.com/2000/07/21/news/environmentalists-burn-over-malaysias-refusal-to-release-air-data.html. [Last access: 10th November 2022].

Jebari, J., Táíwò, O. O., Andrews, T. M., Aquila, V., Beckage, B., Belaia, M., ... & Trisos, C. H. (2021). From moral hazard to risk-response feedback. Climate Risk Management, 33, 100324.

Jones, D. S. (2004). ASEAN initiatives to combat haze pollution: an assessment of regional cooperation in public policy‐making. *Asian Journal of Political Science*, *12*(2), 59-77.

Jong. (2024). Jokowi's land reform initiative hits roadblock as conflicts nearly double, report shows. Mongabay. Available at: https://www.eco-business.com/news/jokowis-land-reform-initiative-hits-roadblock-as-conflicts-nearly-double-report-shows/

Kahan, D.M., 2014. Making Climate-Science Communication Evidence - based — All the Way Down, in: Crow, D.A., Boykoff, M.T. (Eds.), Culture, Politics and Climate Change: How Information Shapes Our Common Future. Routledge, London, 203–220

Koplitz, S. N., Mickley, L. J., Marlier, M. E., Buonocore, J. J., Kim, P. S., Liu, T., ... & Myers, S. S. (2016). Public health impacts of the severe haze in Equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure. *Environmental Research Letters*, *11*(9), 094023.

Krause, F. (2013). Seasons as rhythms on the Kemi River in Finnish Lapland. *Ethnos*, *78*(1), 23-46.

Latif, M. T., Othman, M., Idris, N., Juneng, L., Abdullah, A. M., Hamzah, W. P., ... & Jaafar, A. B. (2018). Impact of regional haze towards air quality in Malaysia: A review. Atmospheric Environment, 177, 28-44.

Latour, B. (2004). How to talk about the body? The normative dimension of science studies. *Body & society*, *10*(2-3), 205-229.

Lee, J. S. H., Jaafar, Z., Tan, A. K. J., Carrasco, L. R., Ewing, J. J., Bickford, D. P., ... & Koh, L. P. (2016). Toward clearer skies: Challenges in regulating transboundary haze in Southeast Asia. *Environmental Science & Policy*, *55*, 87-95

Lee, M. M. (2015) Haze in Singapore. in *The Straits Times*. Available online: . [Last access: 10th November 2022].

Lefebvre, H. (2004). *Rhythmanalysis: Space, Time and Everyday life*. New York: A&C Black..

Lima, A. M., Teixeira, S. F., & Barbosa, B. (2022). Newspaper Digital Content During and After the Silly Season: A Case Study. In *Implementing Automation Initiatives in Companies to Create Better-Connected Experiences* (pp. 215-232). IGI Global

Liu, F. H. M., Ganesan, V., & Smith, T. E. L. (2020). Contrasting communications of sustainability science in the media coverage of palm oil agriculture on tropical peatlands in Indonesia, Malaysia and Singapore. *Environmental Science & Policy*, *114*, 162-169.

Lövbrand, E., Beck, S., Chilvers, J., Forsyth, T., Hedrén, J., Hulme, M., ... & Vasileiadou, E. (2015). Who speaks for the future of Earth? How critical social science can extend the conversation on the Anthropocene. *Global Environmental Change*, *32*, 211-218.

Manzo, K., Padfield, R., & Varkkey, H. (2020). Envisioning tropical environments: Representations of peatlands in Malaysian media. *Environment and Planning E: Nature and Space*, *3*(3), 857-884.

Masco, J. (2017). The crisis in crisis. Current anthropology, 58(S15), S65-S76.

Massey, B. L. (2000). How three Southeast‐Asian newspapers framed the haze'of 1997–98. *Asian Journal of Communication*, *10*(1), 72-94.Matijevic, P. (2022). Searching for the plot: narrative self-making and urban agriculture during the economic crisis in Slovenia. Agriculture and Human Values, 39(1), 301-314.

Matijevic, P. (2022). Searching for the plot: narrative self-making and urban agriculture during the economic crisis in Slovenia. *Agriculture and Human Values*, *39*(1), 301-314.

Mauss, M. (1979 [1950]). *Seasonal Variations of the Eskimo: A Study in Social Morphology*. London: Routledge & Kegan Paul.

McLellan, J. (2001). From denial to debate—And back again! Malaysian press coverage of the air pollution and 'haze' episodes, July 1997–July 1999. In *Forest fires and haze in Southeast Asia*. New York: Nova Science Publishers. 253-262

Miller, M. A., Middleton, C., Rigg, J., & Taylor, D. (2020). Hybrid governance of transboundary commons: Insights from Southeast Asia. *Annals of the American Association of Geographers*, *110*(1), 297-313.

Miller, M. A. (2020). B/ordering the environmental commons. Progress in Human Geography, 44(3), 473-491.

Mostafanezhad, M., & Evrard, O. (2021). Chronopolitics of crisis: A historical political ecology of seasonal air pollution in northern Thailand. *Geoforum*, *124*, 400-408.

Mostafanezhad, M., & Dressler, W. (2021). Violent atmospheres: Political ecologies of livelihoods and crises in Southeast Asia. *Geoforum*, *124*, 343-347.

Mostafanezhad, M., Vaddhanaphuti, C., & Evrard, O. (2025). Making air pollution legible: Environmental‐health data and the naturalization of the smoky season in Northern Thailand. *Singapore Journal of Tropical Geography*.

Naess, L. O. (2013). The role of local knowledge in adaptation to climate change. Wiley Interdisciplinary Reviews: Climate Change, 4(2), 99-106.

Narayanan, S. (2002) Assessing the economic damage from Indonesian fires and the haze: a conceptual note. *Singapore Economic Review*. *47*(02), 229-241

NASA (2022) MODIS Collection 6 Hotspot / Active Fire Detections MCD14ML distributed from NASA FIRMS. Available online: doi:10.5067/FIRMS/MODIS/MCD14ML. [Last access: 10th November 2022]

National Environment Agency. (NEA). (2022). Historical PSI Readings. Available online: https://www.haze.gov.sg/resources/historical-readings. [Last access: 10th November 2022]

New Straits Times. (2006). Find a permanent solution. 10th October 2006. Source: Factiva.

Ng, Y. J., Yang, Z. J., & Vishwanath, A. (2018). To fear or not to fear? Applying the social amplification of risk framework on two environmental health risks in Singapore. Journal of Risk Research, 21(12), 1487-1501.

Nguitragool, P. (2010). Environmental cooperation in Southeast Asia: ASEAN's regime for trans-boundary haze pollution. Routledge.

Nichol, J. (1997). Bioclimatic impacts of the 1994 smoke haze event in Southeast Asia. Atmospheric Environment, 31(8), 1209-1219.

Ogden, L., Heynen, N., Oslender, U., West, P., Kassam, K. A., & Robbins, P. (2013). Global assemblages, resilience, and Earth Stewardship in the Anthropocene. Frontiers in Ecology and the Environment, 11(7), 341-347.

Orlove, B. (2003). “How People Name Seasons”. In Strauss, S. & Orlove B. (Eds.). (2021). *Weather, Climate, Culture*, Edited by: Strauss, Sarah and Orlove, Ben. Oxon: Berg. 121–40.

Pardthaisong, L., Sin-Ampol, P., Suwanprasit, C., & Charoenpanyanet, A. (2018). Haze pollution in Chiang Mai, Thailand: a road to resilience. *Procedia engineering*, *212*, 85-92.

Paton, D., Kelly, G., Burgelt, P. T., & Doherty, M. (2006). Preparing for bushfires: understanding intentions. *Disaster Prevention and Management: An International Journal*, *15*(4), 566-575

Peters‐Guarin, G., McCall, M. K., & van Westen, C. (2012). Coping strategies and risk manageability: using participatory geographical information systems to represent local knowledge. *Disasters*, *36*(1), 1-27.

Purnomo, H., Okarda, B., Dewayani, A. A., Ali, M., Achdiawan, R., Kartodihardjo, H., ... & Juniwaty, K. S. (2018). Reducing forest and land fires through good palm oil value chain governance. *Forest policy and economics*, *91*, 94-106.

Rayson, P., & Garside, R. (2000, October). Comparing corpora using frequency profiling. In Proceeeings of *The Workshop on Comparing Corpora*. Available online: doi:10.3115/1117729.1117730. [Last access: 10th November 2022]

Rayson, P. (n.d.). Log-likelihood and effect size calculator. Available online: http://ucrel.lancs.ac.uk/llwizard.html. [Last access: 10th November 2022]

Remember Singapore. (2013). Haze - A Burning Issue for Four Decades. Available online: https://remembersingapore.org/2013/06/19/a-hazy-problem-for-40-years/. [Last access: 10th November 2022]

Safiah Yusmah, M. Y., Bracken, L. J., Sahdan, Z., Norhaslina, H., Melasutra, M. D., Ghaffarianhoseini, A., ... & Shereen Farisha, A. S. (2020). Understanding urban flood vulnerability and resilience: a case study of Kuantan, Pahang, Malaysia. Natural Hazards, 101, 551-571.

SketchEngine. (N.D.) enTenTen: Corpus of the English Web. Available at: https://www.sketchengine.eu/ententen-english-corpus/

Singapore Institute of International Affairs. (SIIA). (2020). SIIA Haze Outlook 2020. Available online: http://www.siiaonline.org/wp-content/uploads/2020/06/SIIA-Haze-Outlook-2020.pdf. [Last access: 10th November 2022]

Singapore Institute of International Affairs. (SIIA). (2019). SIIA Haze Outlook 2019. Available online: http://www.siiaonline.org/wp-content/uploads/2019/05/SIIA-Haze-Outlook-Summary-Report.pdf. [Last access: 10th November 2022]

Smith, T. E.L., & Liu, F. H. M. (2025). Seasons and the Anthropocene. *Progress in Environmental Geography*, 27539687251348470.

Smith T. & Varkkey H. 2022. Southeast Asian haze and socio-environmental–epidemiological feedback. In: Shin, H et al (eds.), COVID-19 in Southeast Asia. London: LSE Press. DOI: https://doi.org/10.31389/lsepress.cov.j

Today Singapore. (2006). Highest haze levels this year. Published 29th September 2006. Source: Factiva.

Tsing, A. 2015. The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins. Princeton, NJ: Princeton University Press

Varkkey, H. (2012). Patronage politics as a driver of economic regionalisation: The Indonesian oil palm sector and transboundary haze. *Asia Pacific Viewpoint*, *53*(3), 314-329.

Van Der Werf, G. R., Randerson, J. T., Collatz, G. J., Giglio, L., Kasibhatla, P. S., Arellano Jr, A. F., ... & Kasischke, E. S. (2004). Continental-scale partitioning of fire emissions during the 1997 to 2001 El Nino/La Nina period. *Science*, *303*(5654), 73-76.

Varkkey, H. (2011). Addressing transboundary haze through ASEAN: Singapore's normative constraints. Journal of International Studies, 7(2011), 83-101

Varkkey, H. (2012). Patronage politics as a driver of economic regionalisation: The Indonesian oil palm sector and transboundary haze. Asia Pacific Viewpoint, 53(3), 314-329.

Varkkey, H. (2014). Regional cooperation, patronage and the ASEAN Agreement on transboundary haze pollution. *International Environmental Agreements: Politics, Law and Economics*, *14*, 65-81

Varkkey, H. (2022). Emergent geographies of chronic air pollution governance in Southeast Asia: Transboundary publics in Singapore. *Environmental Policy and Governance*, *32*(4), 348-361.

Varkkey, H., Liu, F.H.M., Smith, T.E.L., & Trott, S. (2025). 'Seasons of the Anthropocene': Politicization of the haze season in Southeast Asia. *Singapore Journal of Tropical Geography*, *46*(1), 116-137.

Walshe, R. A., Adamson, G. C., & Kelman, I. (2020). Helices of disaster memory: How forgetting and remembering influence tropical cyclone response in Mauritius. *International Journal of Disaster Risk Reduction*, 50, 101901.

Whitehouse, A. (2017). Loudly sing cuckoo: More-than-human seasonalities in Britain. *The Sociological Review*, *65*(1_suppl), 171-187.

Witze, A. (2024). Geologists reject the Anthropocene as Earth's new epoch-after 15 years of debate. *Nature*.

World Wide Fund for Nature. (WWF). (2019). WWF-Malaysia calls for greater efforts in combating the haze. Available online: https://www.wwf.org.my/?27285/WWF-Malaysia-calls-for-greater-efforts-in-combatting-the-haze. [Last access: 10th November 2022]

Yap, B (2006), 'Go straight to the source of the problem', New Straits Times, Kuala Lumpur, 11 October, p. 25

Yeo, B., Liew, C. F., & Oon, H. H. (2014). Clinical experience and impact of a community-led volunteer atmospheric haze clinic in Singapore. Southeast Asian Journal of Tropical Medicine and Public Health, *45*(6), 1448.

Young, M. (1988). *The Metronomic Society: Natural Rhythms and Human Timetables*. London: Thames & Hudson.

Yusoff, K. (2016). Anthropogenesis: Origins and endings in the Anthropocene. *Theory, Culture & Society*, *33*(2), 3-28

Zalasiewicz, J., Williams, M., Haywood, A., & Ellis, M. (2011). The Anthropocene: a new epoch of geological time?. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *369*(1938), 835-841.

Zhang, J. J., & Savage, V. R. (2019). Southeast Asia's transboundary haze pollution: Unravelling the inconvenient truth. Asia Pacific Viewpoint, 60(3), 355-369.