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Editorial

Reinvention: Interconnectedness, Interdisciplinarity & Sustainability

Auni Siukosaari, University of Warwick

Welcome to the latest edition of *Reinvention: An International Journal of Undergraduate Research,* volume 14, issue 1 (14.1). First and foremost, we hope all of our readers are safe and well despite the ongoing Covid-19 pandemic. Since our last publication, the pandemic has remained a constant in our lives, and the interconnectedness of our world has been more important than ever.

This issue brings you a unified yet diverse set of content with four original undergraduate research papers, two book reviews of *The Uninhabitable Earth: A Story of the Future* by David Wallace-Wells and a guest article that explores sustainable development as a theme in interdisciplinary undergraduate research. We do not publish themed editions at *Reinvention* , but this time around, the idea of sustainability, and its importance and versatility, has been highlighted. This idea is perfectly re ected in the cover of this issue by our assistant editors Yogen Mudgal and Karan Khagram as these concerns about our dynamic environment, political institutions and global relationships – and sustaining them – are extremely important to young academics, and this issue re ects those concerns and how to navigate our complex relationship with them.

Charlotte Sinden's paper 'Incorporating sustainability into the academic institution' explores the role that universities play in promoting sustainability by embedding it into their teaching and practices. The paper kicks off the issue by highlighting how vital education is in achieving a more sustainable future and the various complexities that this presents in the context of higher education.

Wai Cheung Tse and Lamia Makkar's 'Haiti: An ethnographic study of the effects of international aid on Haitian life' examines the impact that structural and emergency aid have had on Haitians. The ethnographic approach allows them to uplift the voices of Haitians and emphasise the importance of listening to those voices when planning aid programmes. This paper is an important look at the interconnectedness of the global world and the sustainability and effectiveness of aid.

Molly Lavery, Conor Hunter Murphy and Emma Bowman's 'Zombie-ant graveyard dynamics in Gunung Mulu National Park' investigates parasitic interactions between pathogenic fungi (*Ophiocordyceps*) and ants that manifest in zombie-ant graveyards in Gunung Mulu National Park in Malaysia. Their paper contributes to literature exploring the dynamics and sustainability of rainforest ecosystems and provides valuable insight into parasitic interactions.

The final paper is Onubha Hoque Syed's 'Investigating the factors behind differences in "lay" and "expert" medical knowledge in the context of fever treatment in Yangon, Myanmar', which explores the role of the experiences of patients and healthcare workers in the creation of health policy, with a specific focus on the interactions between 'lay' and 'expert' knowledge. Their paper demonstrates the value of contextualised solutions to healthcare problems, which will ultimately yield more sustainable and stronger relationships between people and healthcare that represent the diversity of narratives within health systems.

We also have the honour to present Professor Marco Haenssgen's guest article, where he comments on sustainable development and interdisciplinarity as major themes in undergraduate research and the importance of promoting these in the future.

The papers in this issue are directly complemented by our book reviews. Virginia Thomas-Pickles and Dr Valerie Kay's reviews of The Uninhabitable Earth: A Story of the Future by David Wallace-Wells provide an insight into our continuing struggle with climate change and the potential for collective and individual action in the face of this overwhelming global issue. Dr Kay is a teaching associate and interdisciplinary researcher focusing on climate change, public health and feminism at Monash University, and Thomas-Pickles is a Global Sustainable Development undergraduate at the University of Warwick. These reviews highlight different issues in the discussion around climate change – whether it be the balance between the individual and the collective or the importance of acknowledging the interconnectedness of global capitalism – and both urge us to engage with discourse and solutions to climate change and sustainability.

This issue presents a diverse range of content and themes that all comment on ideas of interconnectedness, interdisciplinarity and sustainability. I believe this directly reflects the academic climate and the growing interest in examining complexities in the relationships between people, countries and environments. *Reinvention* has always held the concepts of interdisciplinarity and internationality in the highest regard, and our mission is to continue to highlight their importance in academic research. This issue has demonstrated just how the combination of these approaches produces incredibly thought-provoking and inspiring research, and we hope this continues to be the trend.

I want to thank and congratulate everyone who contributed to this issue, especially during these unprecedented times. I hope this issue and the themes in it speak to our readers and give insight into the vast possibilities in undergraduate research. We look forward to new submissions, collaborations and projects for our next issue and beyond as we continue to explore these themes further.

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Incorporating Sustainability into the Academic Institution

Charlotte Sinden, Cardiff University

Abstract

This research examines environmental sustainability in the UK university context. Universities are prioritising sustainability commitments with many declaring a climate emergency, as well as recognising the importance of educating students about climate change. Using a case-study approach in which semi-structured interviews were coupled with secondary data analysis, this research highlights that universities are pivotal for greater environmental sustainability. The results reiterate the urgent need to significantly improve environmental performance and educate people in the field of sustainability, while also presenting the challenges and realities faced in doing so. It is recommended that in order to achieve optimal sustainability solutions, a cohesive approach is required to embed a common sustainability narrative for all.

Keywords: Responding to the climate emergency, climate change, environmental sustainability in higher-education institutions, incorporating sustainability into strategies

Introduction

Since emerging as a concept in the 1980s, sustainable development has become a central concept for our age (Sachs, 2015b). Often termed the 'Anthropocene', scientists believe we have now entered a new historical epoch in which humans themselves are the dominant force for planetary change (Crutzen, 2006). Sustainable development is both a way of understanding the world and a method for solving global problems (Sachs, 2015b). This research is timely given stark claims from the Intergovernmental Panel on Climate Change (IPCC) report (2018) that warned that allowing temperatures to rise more than 1.5°C will have catastrophic, and potentially irreversible, effects on the planet. The IPCC is a global body assessing the science relating to climate change and has not typically published such urgent warnings, thus indicating the severity of the situation. Based on this backdrop of mounting climate uncertainty, this research

assesses how environmental sustainability is incorporated in the higher-education context focusing on Cardiff University as a case study.

Many universities have prioritised sustainability in response to international conventions, such as the UN Sustainable Development Goals (SDGs) and the Paris Agreement (2015) (Soini *et al.,* 2018). The SDGs consist of 17 goals and 169 targets addressing all aspects of sustainability, becoming a global initiative to end poverty, protect the planet and to ensure peace and prosperity for all. Yet critical observers believe the SDGs adopt a neoliberal, anthropocentric vision whereby the environment is often assigned secondary value after economic and social concerns (Kopnina, 2016). O'Neill *et al.*, (2018) believe a more hopeful scenario would see the SDGs shift the agenda away from economic growth towards a new model where the goal is sustainable and equitable human wellbeing. Regardless of this, following government agendas to make the SDGs successful, Sachs (2015a) argues that universities globally should play a bold role in their implementation. Applying the SDGs at the national scale, the Welsh government has a clear legislative pathway for the SDGs and specifically for environmental sustainable development (see Figure 1).

A screenshot of a cell phone

Figure 1: Legislation for sustainable development to secure the long-term wellbeing of Wales (Welsh Assembly Government, 2016)

This research seeks to explore how Cardiff University engages with environmental sustainability, guided by the following research questions:

- How is sustainability researched and taught across the university?

- How is the university incorporating sustainability into its practical operations?

This research builds on existing academic literature regarding sustainability in the higher-education context, taking a social constructivist approach to explore new meanings and perspectives on the continuously evolving sustainability debate. As a research-intensive institution, Cardiff University has a clear vision to improve its environmental performance.

Literature review

Introducing sustainable development

Sustainable development remains a largely ambiguous concept (Pesqueux, 2009), yet acts as a driving force dominating global political discussion in the twenty-first century. The broad notion of sustainable development first emerged in the 1970s with the realisation that the economic boom of the 1950s and 1960s was having a destructive effect on the environment (Pesqueux, 2009: 231). Sustainable development is problematic to define, adopting different meanings in varying contexts (Pierantoni, 2004; Sikdar, 2012). The Brundtland Report (UNWCED, 1987) famously defined sustainable development as 'development which meets the needs of the present, without compromising the ability of future generations to meet their own needs' (UNWCED, 1987: 43). Conca *et al.*, (2001) criticise the Brundtland definition, asserting that what may constitute the 'needs of current and future populations' remain subjective and open to change. Over time, sustainability has evolved practically as well as philosophically – focusing less on intergenerational needs and more on the holistic approach linking economic development, social inclusion and environmental sustainability (Sachs, 2015b). However, economic development remains dominant in many definitions. Given the multifarious nature of sustainable development, this research focuses specifically on environmental sustainability.

Environmental sustainable development

Until the 1980s, it was commonly argued that economic and environmental aims were intrinsically opposed, with human development prioritised over the natural environment (Castree *et al.*, 2013). However, in the 1990s, the theory of ecological modernisation emerged as a new paradigm representing the possibility for economic growth that was, in theory, environmentally benign (Young, 2015). This sparked extensive debate regarding whether greening contemporary capitalism offers optimal

sustainability solutions or delays radical environmental reform (Mol and Spaargaren, 2000). Nevertheless, emissions have continued to rise, and Gills and Morgan (2020: 886) state that 'on a global basis, July 2019 was the hottest month ever recorded. NASA data on global warming indicates that 17 of the 18 hottest years ever recorded in the past 136 years were during 2001–2018'. Thus, many recognise the current state of the global natural environment as the most urgent and significant challenge in recent history (Ralph and Stubbs, 2013; McCullough *et al.*, 2016), suggesting the necessity of critical action.

Within this debate, there has been a transition from 'government' to 'governance', attempting to 'include wider parts of society through multi-level government involvement' (Berger, 2010: 231). Governance expresses that the state increasingly depends on other organisations to secure its intentions, deliver its policies and tackle the changing nature of complex environmental problems faced in the twenty-first century (Bevir, 2008). Huxley *et al.*, (2019) argue that governments can affect only a small percentage of emissions directly and must work in partnership to lower emissions. Essentially, environmental sustainability requires strong, sustained and interdisciplinary commitments to induce effective *transformative* change across environmental arenas (Sterling, 2013; Chowdhury *et al.*, 2019).

Environmental sustainability in policy frameworks

Governments and other actors have introduced policies to tackle environmental issues at a range of geographical scales. Policies such as the UN SDGs (2015) give direction, while the Paris Agreement encourages countries to demonstrate their Intended Nationally Determined Contributions for tackling climate change. Following the Earth Summit (1992) – a global conference held to reconcile worldwide economic development while limiting environmental degradation – recognition emerged that all levels of governance must be involved to achieve the proposed global plan for sustainable development (Evans and Theobald, 2003). These global-scale policies and Accords manifest in different ways at multiple scales: in Wales, the *Wellbeing of Future Generations Act* (2015) sets out how the SDGs should be implemented, making sustainability a national priority (Welsh Assembly Government, 2019).

Similarly, higher-education institutions have responded to calls for climate action by signing numerous declarations. The role of higher education in sustainability was first recognised at the first UN conference on the Human Environment, the Stockholm Conference (1972), which formally documented the role of higher education in

fostering environmental protection (Lozano *et al.*, 2011). This catalysed a series of subsequent declarations, such as the Talloires Declaration (1990): 10-point action plan addressing problems of environmental decline and the importance of embedding a sustainability narrative across higher-education institutions (ULSF, 1990). These declarations, although implementing sustainability programmes differently, lay the foundations for effective tailored sustainability policies within universities (Clarke and Kouri, 2009). The next section explores how universities translate environmental sustainability policies into practical operations and education.

Environmental sustainable development in higher education

An ecologically sound society requires strong support from universities (Wang *et al.*, 2013) as they can influence future generations (Piza *et al.*, 2018). Higher-education institutions appear to have a double role through research and teaching – creating knowledge for global benefits and integrating this in education, thus preparing students for their future societal roles (Stough *et al.*, 2016). Universities' transition to sustainability involves all areas of activity, meaning the process is long and often characterised by resistance – such as financial constraints and lack of enforcement (Hoover and Harder, 2015). Universities are beginning to re-orient their education, research and operations towards sustainability (Wals, 2014), but, despite progress, sustainability is yet to fully permeate all aspects of university practice and teaching.

Many efforts have been made to lessen environmental impacts while promoting sustainability at higher-education institutions, albeit often from an ecological modernisation approach. The greening of universities involves the process of reducing environmental impacts from campus activities, alongside raising awareness of how to act more sustainably (Creighton, 1999). Some universities have adopted a 'living lab' approach, addressing real-life sustainability problems through collaborative experiments that integrate users and various stakeholders as co-producers of knowledge (Evans *et al.*, 2015). As such, universities can teach and demonstrate how environmental protection play out on a day-to-day basis while highlighting future possible, more sustainable, worlds (Dahle, 2001). Universities have potential to represent a 'green model' by gathering and sharing innovative ideas of how to tackle environmental issues (Dahle, 2001: 154), acting as 'small cities' that can have substantial impact – and large influence – on their surroundings (Ragazzi and Ghidini, 2007: 112). Yet Sterling (2013) warns that where sustainability is acknowledged, it

cannot be bound to campus management alone; instead, it requires a full interdisciplinary transformation.

Thus, it is also important to explore environmental and climate literacy. During recent decades, education has emerged as critical in transforming societies towards a sustainable trajectory, as curricula incorporate sustainability (Ramos *et al.*, 2015). Ralph and Stubbs (2013: 73) demarcate a 'third wave of sustainability' in higher education: a movement focusing more on education than the greening of physical campus infrastructure. Curriculum change is driven by moral obligations to act on environmental issues but proves to be a complex task requiring a transformative shift in the topics that are researched and taught (Ralph and Stubbs, 2013). Lozano *et al.*, (2011: 12) identify what they see as the main reasons for universities lacking engagement in sustainable education: over-crowded curricula, little (perceived) relevance to the course, academic credibility and path dependency. Compartmentalisation of university disciplines also often makes it difficult to share knowledge and expertise across subject boundaries, resulting in constrained sustainability efforts (Adomßent *et al.*, 2019), despite scholars believing sustainability should be treated as an interdisciplinary concept (Moore, 2005). Further, Kopnina (2012) notes that education for sustainable development should not be confused with environmental education, as the former is deeply contested: building upon neoliberal paradigms that position environmental protection as an afterthought, in contrast to placing the environment to the fore.

Sustainable development is complex by nature, hard to define or measure, and yet imperative for education and research given existential threats such as climate change (Hamilton, 2016). This literature review suggests that, despite the interest of higher-education institutions in tackling environmental sustainability, the extent to which they incorporate sustainability varies. Highlighted by the '*Wellbeing of Future Generations Act'* (2015), Wales has a clear vision for sustainability. This research, then, examines how Cardiff University is tackling the abstruse concept of environmental sustainability in a country with a strong policy framework for sustainable development.

Research methods

This research employed semi-structured interviews, which generated detailed qualitative data to give an authentic insight into people's experiences, thus enabling rich examination of sustainability at Cardiff University (Silverman, 2001; Jamshed,

2014). Secondary data analysis of Cardiff University's sustainability strategies complemented the primary data, highlighting the importance of adopting a mixed-method approach. I developed an inductive thematic framework, so constructed themes that emerged from the primary research (Braun and Clarke, 2013). Adopting these methods allowed observation of how sustainability is conceptualised and operationalised across Cardiff University by different actors, enabling a discussion of the wider processes underpinning sustainability, but also with potential to undermine sustainability narratives in the higher-education context.

Semi-structured interviews

The main method used for this research was semi-structured interviews. I conducted 13 interviews with university staff, including those involved with implementing sustainable practice (estates-based participants) and experts who research and teach sustainability (i.e. professional services and academic faculty). Semi-structured interviews provide a flexible technique for small-scale research because questions can be adapted, allowing for unexpected answers while also clarifying the interviewee's response (Drever, 1995; Elliot *et al.*, 2016). This approach often facilitates a deeper insight into respondents' views (Taylor *et al.*, 2015). I developed two interview schedules to account for this practice and research distinction (see Appendices 1 and 2). Although many responses overlapped each research aim, separate schedules allowed for a deeper analysis depending on whether sustainability in education or sustainability in practical operations was being examined.

Interviewees were selected first through a purposive sampling technique. This involved selecting individuals that are especially knowledgeable about or experienced with environmental sustainability from multiple academic disciplines (Cresswell and Clark, 2011). Internet searches enabled me to identify professionals whose research and teaching specialises in sustainability, and estates-based staff who implement campus sustainability projects. I also used snowball sampling alongside purposive sampling as this provided a wider research cohort (Palinkas *et al.*, 2015). Vogt (1999) describes snowball sampling as one subject recruiting further suitable participants through their acquaintances, allowing the researcher access to participants who would have otherwise been unknown. Arguably, only interviewing sustainability professionals and not those who disregard environmental issues can be seen as a limitation in this study. Nevertheless, conducting semi-structured interviews using

these sampling techniques allowed a rich examination into sustainable development at Cardiff University, according to those interviewed.

Secondary data analysis

To complement this primary research, secondary sources such as the *Environmental Sustainability Enabling Strategy* (ESES) (Cardiff University, 2018) and the *Environmental Sustainability Action Plan* (ESAP) (Cardiff University, 2018) were analysed to explore strategic priorities and to identify gaps between policies and practice. As Elo and Kyngäs (2008: 114) note, secondary sources offer a 'snapshot' of activities occurring in institutions; thus, this complemented the primary research.

It is important to acknowledge the benefits and limitations of conducting a small-scale study. While focusing on one case study allows for a detailed examination into the topics discussed, the results cannot be generalised for the whole population, as subjective conclusions can be generated (Gerring, 2006). Nevertheless, the data analysis can be indicative of how sustainability is contextualised in the wider higher-education context while showing the complexities of incorporating it across governance structures within specific institutions. Secondary literature was integrated into the analysis to induce a more critical engagement with the interview responses while also limiting bias of focusing on a single case study. This, then, represents a call for action for *all* universities to embed sustainability across their institutions.

Data analysis

The analysis presented here adopts a thematic approach, combining key ideas with extant literature to explore environmental sustainability at Cardiff University. First, I explore academic staff perceptions regarding the importance of educating and researching sustainability and how this differs across the institution. Next, I look at how Cardiff University integrates environmental sustainability across their practical operations.

The role of education in achieving sustainability

Participants were asked about their understandings of sustainability and the significance of the concept to gain insight into the role and importance of incorporating it across the academic institution. All participants highlighted that researching and educating for sustainability is imperative. Participant 3 contends that:

> It is crucial to get students interested in this topic. If you look at the reports from the IPCC, it's clear we need to fundamentally change the way that we live so that sustainability is a central part of what we are doing and what we are thinking about.

For Participant 3, the IPCC is a key actor in guiding change, and, for this international climate change researcher, such change must be fundamental across all dimensions of society, suggesting a break from more incremental approaches typically found in policy (Aldunce *et al.*, 2016). Ensuring that students understand the findings of reports such as the IPCC report (2018) is critical: students need to be made aware of the implications of allowing temperatures to rise more than 1.5°C this century. Furthermore, Participant 12 stresses the need for balance discussing the global challenges and the kinds of solutions that might be possible:

> Our job as educators is not to just give out loads of information on how bad the world is, but to be aware of the history while trying to give solutions.

This is especially critical, as many scholars have noted the provision of information does not *automatically* lead to action and reflection (Blake, 1999; Shove, 2010), and education must reflect the need for critical thinking and action-oriented approaches. While the Secretary-General of the United Nations stated that, '*the capacity of teachers are key factors in empowering youth as a globally connected engine for change'* (United Nations Secretary General, 2014), this often focuses on techno-centric and neoliberal responses (Cam, 2004). Ideas such as degrowth are rarely discussed (Cosme *et al.*, 2017).

These discourses support the view of Sterling (2013) that education for sustainability in universities is pivotal, preparing future professionals with the tools and knowledge to drive change and instigate challenging debate, as embedded in SDG#4.7. These responses suggest an appetite for a common sustainability narrative across Cardiff University, yet this is not evident in all Schools or disciplines.

Researching and educating for sustainability

The need for a dual approach when researching and educating for sustainability is wholly agreed upon (Sterling, 2013; Ralph and Stubbs, 2013), yet sustainability is *not* fully incorporated into the curriculum across all disciplines at Cardiff University. Cardiff University is divided into 24 Schools based on disciplinary alignment.

Participant 1 outlined that environmental-related subjects (e.g. geography or environmental politics) are perhaps more likely to offer sustainability modules, while other disciplines tend to neglect sustainability. Some interviewees noted that it may be difficult to get people interested in sustainability if it seems to lack relevance to their studies. Often, university students receive little education about sustainability unless their subject specifically involves it (Martins *et al.,* 2006), and even then, it can be optional. However, as noted by Participant 3 above, climate change affects all aspects of life (Madden, 2019) and thus has relevance to all disciplines.

Understanding the importance of environmental sustainability, some staff pushed for sustainability-based modules in their curricula where these were previously absent. Participant 4 commented that:

> It met a lot of resistance in the School at first. Even people in the School didn't believe there was a market for it. However, the growing student numbers proves this to be wrong.

Given the recognition above that educating for sustainability is crucial, it is surprising that interviewees' responses failed to show evidence of this at Cardiff University. But, as mentioned, many universities have remained quite traditional in their methods, binding academic transitions to old mechanisms (Lozano *et al.*, 2011), which inevitably delays the process of making sustainability an integral part of academia. Participant 3 acknowledged the challenges faced in getting sustainability incorporated into the curricula, and asserts that '*elective modules in a few departments is far from instilling a sustainability narrative across the university'.* While it may be more challenging to educate students on sustainability in certain subjects, it is, nonetheless, necessary for a low-carbon transformation to occur. For instance, Participant 4 noted that:

> The majority of people who come to the Business School are leaning towards commercial success in their lives. They are ambitious for material wealth; protecting the environment is far down their list of priorities.

Writing almost 15 years ago, Martins *et al.* (2006) recommended higher-education institutions transform their educational systems to encourage the implementation of new courses and/or subjects in this area. Hence, to educate all students in sustainability at Cardiff University, training for those whose subjects are not directly based on sustainability must be considered. This seems to miss an opportunity, however, as transitioning business practice is just as important as transformations in

other areas – the concept of a Green Deal is finding traction (Knuth, 2018), and many businesses are established around the concept of green entrepreneurship (Gibbs and O'Neill, 2014). Embedding such thinking into the Business School curricula, for example, could thus go a long way in promoting sustainability and thinking about responses to climate change.

In terms of researching for sustainability, some participants felt that Cardiff University could be utilising their knowledge capabilities further to push the sustainability agenda. Participant 2 claims that research-led teaching is most effective in educating students, but vents frustration that researchers across Cardiff University do not work together with Schools coherently:

> The Sustainable Places Research Institute doesn't give enough of a contribution; they should give their research to the lecturers in order to teach the students through research.

The above dialogues suggest a lack of cohesion across Cardiff University, missing an opportunity to exploit research expertise to provide students with contemporary sustainability knowledge. Given that Cardiff University already has experts in sustainability, this could be delivered at a relatively low cost, while simultaneously achieving SDG#4 to provide quality education to all. Universities should prioritise research-led teaching across all departments, thus exposing students to contemporary sustainability research findings.

Linking to other prominent issues: the COVID-19 pandemic has rapidly changed existing practices in many ways, and in the higher-education context, this imposed a switch to online teaching (Bryson and Andres, 2020). Some argue that this gives a unique opportunity to improve student experience by introducing a bimodal approach, whereby the curation of learning experience is at the fore (Bryson and Andres, 2020). This, suggestively, highlights that rapid changes are possible, and that this transformation to education creates an opportunity to weave sustainability into the new learning approach, with potential to embed pro-environmental behaviour into students' minds.

Participant 12 asserts that in order to fully embed sustainability across Cardiff University there must be a '*complete shift in the way things are being done*'. In order to determine whether a transformative shift is underway, the following section analyses how Cardiff University is implementing sustainable practice in its operations.

Implementing sustainable practice

Regarding the second research question, exploring how Cardiff University is integrating sustainability into its practical operations, I interviewed the estates-based staff responsible for managing Cardiff University's physical infrastructure. A narrative around campus sustainability has emerged internationally (Gormally *et al.*, 2019: 124), suggesting that higher-education institutions are attempting to better their environmental performance.

'Green buildings' are recognised as essential in tackling climate change, given that buildings and construction account for some 45 per cent of total carbon emissions (Khan *et al.*, 2019; O'Neill and Gibbs, 2018). In the higher-education context, Participant 13 outlines the issues of Cardiff University's campus, stating:

> Not being a single-site university causes issues as people think of themselves as being in their own little silo – not thinking about the overall university agenda. Every site must be treated differently, because they are so different.

Operating over multiple sites can cause conflicting agendas, hindering the goal to embed a sustainability narrative across Cardiff University. This aligns with Adomßent *et al.'s,* (2019) observation that compartmentalisation of universities often makes it difficult for people to collaborate across departmental boundaries, constraining sustainability efforts to small islands of activity.

Cardiff University, like other older universities, has listed buildings, which, '*stops us from doing a lot of things that we would like to do'* (Participant 13). Similarly, Participant 12 recognises the barriers caused by listed buildings, but proclaims: '*if we can't retrofit these buildings in terms of changing structure, we can definitely try to get our energy from better sources'.* This corresponds to the university's ESAP (2018), which seeks to be carbon neutral for estates and campus facilities operations by 2023, ensuring renewable sources are adopted for all utilities. The adoption of renewable energy is especially critical to ensure SDG#9 is met: upgrading infrastructure to use clean and environmentally sound technologies (United Nations, 2015).

Given that Cardiff University is not (yet) operating in the most sustainable way, participants were asked what they felt the barriers to acting sustainably were. Participant 8 claims that, in terms of estates:

> Cost has a major impact on whether we will or won't do something. We know what we could do, but simply do not have the money at the moment.

A rapid transition from fossil fuels to low-carbon technologies will cost up to 3 per cent of global GDP, meaning the necessary investments are yet to materialise (Webster, 2018). But many suggest that the costs of *inaction* (such as unmitigated climate change) are far greater than the initial investment (Stern, 2006), meaning environmental sustainability should be prioritised now. Despite upfront costs, campuses can potentially reap benefits through saving money on more sustainable practices while demonstrating new and clean technologies (Dahle, 2001), although such approaches clearly align with ecological modernisation (Young, 2015). Cardiff University state in their *Carbon Management Plan 2014–2020* (2013) that investing in energy-efficient technologies will ensure over £1 million financial savings on their gas and electricity bills in 2019/20. Yet there are doubts concerning whether energy-efficiency improvements reduce overall resource use, with scholars proposing that such technological changes can produce a 'rebound effect' of increased overall energy consumption (Binswanger, 2001), ultimately resulting in higher energy consumption. While energy-efficient technology may cut costs, savings may be invested elsewhere (Chitnas *et al.*, 2014). Therefore, technological improvements cannot be considered without associated social change.

Some participants asserted that, although cost is an issue, better decisions could be made to prioritise sustainability. Participant 3 noted:

> Money is inevitably going to be the biggest issue, but people aren't looking at the long-term view. Today's money is restricted so we don't build the best building possible – we build something just so it's there. We are far too short-term with things.

Taking this approach locks future generations into higher emissions and being reliant on fossil fuels as buildings built today will have lifetimes of 50 years or more (Dahmen *et al.*, 2018). As Whitmarsh *et al.*, (2011) have argued, individuals often do not feel climate change poses a personal, prominent threat; instead, they see the impacts as distant and thus fail to act accordingly. This reiterates the necessity of enhanced education on sustainability to induce effective policy change. Essentially, investing in long-term strategies may be a more practical solution for universities to create more sustainable environments.

Additionally, Participants 8 and 13 emphasised that Cardiff University is a research-intensive institution requiring a lot of equipment, which is not necessarily 'good' for the environment but is nevertheless seen as essential for research activities. The 20 research-intensive institutions that belong to the Russell Group collectively contribute to over half of the UK's university carbon emissions (Gormally *et al.*, 2019). Being a Russell Group member, Cardiff University has departments whose research requires energy-consuming scientific equipment. Participant 13 noted:

> I understand a lot of departments are doing research which requires a lot of power, but there are definitely questions surrounding whether they are looking at lower power options or not.

Participant 8 concurred:

> Seeing as we are a research-intensive university, we should be investing in new environmentally friendly technologies.

These dialogues assert that Cardiff University could be seeking alternative technologies that will have less impact on the environment. Yet, often 'doing the science' overrules energy-related decisions (Gormally *et al.*, 2019), suggesting that research excellence competes with sustainability in the higher-education context and potentially challenges the role of universities as leaders in this field.

Cardiff University has recently signalled the importance of sustainability through the appointment of a new Dean of Sustainability, designated as a: '*high profile champion for environmental sustainability'* (Participant 3, 2019). Many interviewees emphasised the potential for this to ignite sustainability efforts, providing strategic direction for the environmental sustainability agenda at a senior level. As this is a new role, it is impossible to predict the exact outcome on sustainability trajectories. However, scholars assert that senior managerial support is crucial for long-term sustainability, yet organisations often fail to appoint a sustainability coordinator as they are perceived as a financial burden (Ávila *et al.*, 2017; Wright and Nyberg, 2014). Thus, the appointment of a senior role for sustainability indicates Cardiff University's commitment to sustainability across the institution, striving towards long-term environmental sustainable development. Following the appointment of the new Dean of Sustainability, Cardiff University declared a climate emergency, proclaiming that, '*the climate crisis requires urgent response and, from now on, we intend to do things differently'* (Cardiff University, 2019). This role has the potential to fix many

aforementioned issues, giving hope for future sustainability at Cardiff University, but the proof of *how* differently things will be done remains to be seen.

Conclusion

This research adds to the growing body of literature on the organisational sustainability debate, accentuating the complexity involved in incorporating sustainability in the higher-education context. In line with the existing literature, this paper elaborates on department-wide awareness regarding the importance of prioritising sustainable trajectories. Higher-education institutions undeniably have a moral responsibility to act on the global environmental crisis (Humphreys, 2019), with many declaring a climate emergency in response. However, they are still grappling with how best to proceed, delaying the process of translating climate declarations into positive action. This research discovers that environmental sustainability efforts, so far, have been hindered by a lack of clarity across departmental boundaries – regarding both educational and operational procedures. Universities must be empowered to catalyse and implement new paradigms; adopting a collaborative approach to embed sustainable development across all elements (Chowdhury *et al.*, 2019; Lozano *et al.*, 2011).

Notwithstanding this, the COVID-19 pandemic has drastically changed the way universities operate. Such changes have generally had a positive environmental impact so far, yet long-lasting impacts remain undetermined. There are several key 'axes of uncertainty' about how the pandemic will unfold, but it has nevertheless forced universities to implement radical operational transformations (Majowicz, 2020). Robinson and Maitra (2020: 4) note that 'the post-COVID-19 world offers a rare opportunity to reform the education sector for generations to come. It would be imprudent to miss that opportunity'. With their extensive research and knowledge capabilities, higher-education institutions could impose progressive strategies towards fostering ecologically sound institutions, in terms of both practical operations and environmental literacy. Embedding sustainability into the minds of students may be a promising step towards a sustainable future.

The changing role of stakeholders in the environmental arena has meant involvement from all levels of governance is necessary to achieve a sustainable society (Berger, 2010). Thus, further research on the sustainability debate is essential to understand how organisations are implementing this. This paper corroborates the effect higher-education institutions can have in adhering to better sustainable practice, while

simultaneously preparing students to be future sustainable citizens. Future research could compare the performance to other higher-education institutions. A cohesive strategy towards environmental sustainability could be developed, bringing universities together to form an alliance that embeds a common sustainability narrative, such as having a collective sustainability protocol for the Russell Group universities. This research effectively allowed for rich examination into sustainability in one university, and can hopefully assist other higher-education institutions to improve their environmental practice.

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Appendix

Appendix 1: Semi-structured interview guide 1 (estates-based participants)

1. What is your role at Cardiff University?
2. How long have you been at Cardiff University?
3. What interests you in the field of sustainability?
4. Why is acting sustainably important?
5. What factors are influencing sustainable practice?
6. Can you give examples of how your department/school are working towards better sustainable practice?
7. Do you consider your department/school to be sustainable?
8. Are there any barriers that stop you from acting sustainably?
9. Are you aware of the university's sustainability strategy? If so, how are you supporting it?
10. Do you have any future plans regarding sustainable practice?
11. Are there any institutional changes that would make a difference but are yet to be implemented?
12. Could changes in national policy have an impact on the way in which Cardiff University tackle sustainability?
13. Is there anything you would like to add or any questions you were expecting that I haven't asked?

Appendix 2: Semi-structured interview guide 2 (research- and education-based participants)

1. What is your role at Cardiff University?
2. How long have you been at Cardiff University?
3. What interests you in the field of sustainability?
4. What does your main research entail?
5. What are the key themes that you research and/or teach?
6. What do you think the importance of researching and educating people about sustainability is?

7. Why do you think people are interested in researching and studying sustainability?
8. Why do you think people aren't interested in researching and studying sustainability?
9. What do you think the barriers for getting people interested in the topic of sustainability are?
10. Given that environmental degradation is more of a concern to many in recent times, are you seeing an increase in the number of people interested in this topic?
11. Do you have any future plans regarding sustainability in your teaching and/or research?
12. Are there any barriers to your research?
13. Is there anything that you'd like to add or any questions you were expecting that I haven't asked?

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Haiti: An Ethnographic Study of the Effects of International Aid on Haitian Life

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Abstract

Haiti has seen an increasing number of non-governmental organisations (NGOs) and intergovernmental organisations (IGOs) providing structural and emergency aid in times of conflict and natural disasters (Laillet, 2020). This was intensified in 2010 when Haiti regained international attention from a ravaging earthquake that shook its core. This ethnographic study analyses the effects of NGOs and IGOs a decade after this natural disaster. We attempt to venture beyond the statistical evidence grounding most analyses provided by NGOs and IGOs to reveal perspectives from individual Haitians who have been impacted by the policies and decisions of these organisations. In doing so, we examine the local standard of living, the infrastructure and the social dynamics through four in-person interviews conducted in their respective geographic locations. These interviews set a basis for a discussion and examination of organisations' allocation, dependency on the organisation and the sustainability of an action once an organisation has decreased its input. The voices of local Haitians reveal that the profound yet subtle impacts under-represented in narratives are crucial to understanding the day-to-day challenges faced despite foreign aid. We conclude that Haitians face a stasis of social mobility, despite the copious work done by aid organisations that is often inconsistent and misaligned with the needs of Haitians.

Keywords: Haiti, foreign aid, sustainability, non-governmental organisations (NGO), intergovernmental organisations (IGO), ethnography

Introduction

In times of crisis, non-governmental organisations (NGOs) and intergovernmental organisations (IGOs) are a critical foundation for relief efforts. For Haiti – a Caribbean country with an intricate past – NGOs and IGOs have played a key role in the nation's recent history. Before the 2010 earthquake, the UN conservatively estimated that there

were already up to 10,000 NGOs established in the country (Edmonds, 2013: 2), earning the country the moniker the 'Republic of NGOs' (Farmer, 2011: 4). Since then, the number of organisations has surged – particularly following the 2010 earthquake, which killed an estimated 220,000 people and displaced another 1.5 million (UN Peacekeeping, 2018). Although considered 'the worst national disaster in the history of the Western hemisphere' (Birrell, 2012), this event gave Haiti the rare opportunity to rebuild and transform itself. The impressive international response to the earthquake saw over $2 billion donated to charities and another $6 billion pledged by governments and institutions (Birrell, 2012). However, despite the expectations from international bodies and Haitians alike that organisations would provide relief and stability for Haiti, the presence of NGOs and IGOs has instead aggravated violence, sexual assault and wealth disparity within the nation (Beeton, 2012). Following the earthquake, 'the dysfunctional system of humanitarian aid … good intentions aside, has become another obstacle to Haiti's recovery and sovereignty' (Farmer, 2011: 4). Haiti remains in stasis, seemingly unable to escape from the rubble it found itself in a decade ago. This incongruity between expectation and reality of foreign intervention highlights the severe effects that organisations have had on Haitian life.

Historical context

Throughout the late twentieth century, when Haiti's leadership changed frequently – in part by the hand of US interventions – political and social life was left unstable and vulnerable. Consequently, Haitian agricultural industries – the cornerstone of the Haitian economy – were unsupported by the government and became especially vulnerable to foreign actors. When the incumbent president-deemed-dictator Jean Claude 'Baby Doc' Duvalier was exiled and replaced by General Henri Namphy's military rule, the International Monetary Fund (IMF) pressured Namphy to cut rice tariffs that protected the local agricultural industry. The competition between foreign imports with heavy subsidies and local produce hindered local farmers, resulting in a significant diminishment of the agricultural workforce as they moved to cities in search of income (Kushner, 2012).

This large influx of a formally rural population, coupled with unemployment and Haiti's political instability, led to the coup d'état of Jean-Bertrand Aristide in 2004. However, given the copious resources in Haiti owned by the American government and nationals, instability in Haiti was unacceptable for US interests. This instigated the intervention of the UN Peacekeeping Force in Haiti, (MINUSTAH) under the premise of

maintaining peace and security, which was later dissolved and replaced with the United Nations Mission for Justice Support in Haiti (MINUJUSTH) in 2018 (United Nations Security Council, 2018). Before Haiti had a chance to salvage its economy and restructure its leadership, the 2010 7.0 magnitude earthquake devastated the country. Instability within the Haitian government, coupled with a lack of agricultural produce, rendered the nation unsustainable on its own and perpetuated recurring international intervention (Panchang, 2016).

Rationale for foreign intervention

Although the Haitian government is arguably more stable and structured now compared to 2004, internal corruption remains (Moreno *et al.*, 2012). Haiti additionally continues to be confronted by challenges, including over-population in the capital, Port-au-Prince, and violence incited by urban poverty and high unemployment (Congressional Research Service 2020; Justesen and Verner 2007; Marcelin, 2015). Although foreign governments are often a prominent source of funding for aid organisations, many find developing governments such as Haiti's to be frequently corrupt. As such, the funds pledged to aid the people rarely end up in the hands of those who need it; instead, they were never delivered, mismanaged by foreign organisations or used by government officials for extravagant lifestyles disproportionate to the commonwealth (Moreno *et al.*, 2012). With the redirection of funding towards aid organisations, there lacks a united coordination to direct funding and aid towards priority areas requested by local need (Laillet, 2020).

Following the earthquake, large foreign aid organisations provided immediate relief to locals in the form of emergency aid such as food, water and shelter. For the purposes of this paper, the term 'foreign aid' is used to describe the large international humanitarian relief organisations focused on aid in post-disaster (environmental, human, political and other) contexts. Although some of the stated challenges exist in local, grass-roots, bottom-up and structural development organisations and projects, the discussion of these is beyond the scope of this study, given their key features and methods that differentiate them from large international relief NGOs and IGOs. While emergency aid is crucial to survival in times of humanitarian crisis, they are often unsustainable, and their persistence beyond times of crisis creates dependency (Beeton, 2012; Birrell, 2012). The transition from urgent emergency aid to longer-term development, however, has not been clear in Haiti, with many foreign aid organisations persisting beyond the immediate crisis and attempting to take on the

role of development organisations and government bodies. This ineffective planning and impractical execution results in minimal development, while also creating new threats to the Haitian people (*The Lancet*, 2016). Consequently, not only are many foreign aid organisations funded to continue unsustainable aid but also projects that are sustainable fall short of their expectations due to poor planning and management, and a top-down approach that does not recognise and address the needs of the supposed beneficiaries. This revelation within academic communities has led to scholarly research focused on the *intent* and *effects* of aid organisations in Haiti.

Intent and effects of aid

Scholars, including Beeton and Panchang, are sceptical of the intent of aid organisations in the country. Haiti has become extremely dependent on international organisations – most notably peacekeeping groups, organisations distributing food and water, and public health groups – as they provide services that its own government cannot (Pilinger *et al.*, 2016). When these organisations depart, they leave behind gaps of basic needs that the government is unequipped to fill. This large dependency on organisations thus creates an unequal power dynamic between the government and aid organisations, allowing the latter to have seemingly free rein in Haiti and ostensibly having the power to execute its own agenda on a foreign state. It is commonly known within local development circles that the large majority of international organisations operating in Haiti are not registered locally, which further limits oversight and cooperation between the government and aid organisations. Beeton (2012) even claims that organisations such as the UN are there for their own gain, profiting off Haiti's misfortune. Despite MINUSTAH's large budget of $1 billion per year (United Nations Security Council, 2017), most of its resources are spent maintaining its peacekeeping force. Further, money devoted to aid organisations is often not reinvested into the Haitian economy to create jobs and infrastructure. Instead, resources like MINUSTAH's are often spent hiring foreign staff and importing vehicles to Haiti and projects requiring construction are led by foreign companies with minimum wage jobs given to local Haitians (Panchang, 2016). These socio-economic hierarchies reveal why Haiti is so profitable for aid organisations, as they attempt to bolster their own country's economies (Beeton, 2012).

Limitations of current research

While there are numerous NGOs and IGOs operating in Haiti, research thus far has primarily centred around the ineffective structures and effects of the UN's intervention through observational and statistical analyses (Beeton, 2012; James, 2010; Panchang, 2016; *The Lancet*, 2006; *The Lancet*, 2016).

Accurate evidence of the inefficacy of international organisations has been difficult to attain as language barriers, power dynamics and scholar bias hinder data collection. James (2010) reveals the challenges faced during data collection with Haitians who faced mental and physical trauma, including falsified accounts. The exchange of personal narratives from Haitians for aid has driven both organisations and Haitians to misrepresent reality, highlighting the disproportionate power dynamics in aid that manifest in a coercion of the recipients' voices.

Panchang (2016) echoes this sentiment through his criticism of the 2010 cholera outbreak being blamed on Haitians, despite copious evidence showing that Nepalese UN peacekeepers caused the outbreak at their Mirebalais base (Chin *et al.* 2011). The media commonly depicts Haitians as unable to maintain sanitary and healthy living environments. This inaccurate depiction presents a façade to the international community of Haiti's helplessness without international intervention and, in turn, further perpetuates the justification for continued aid efforts.

Scholars have also turned to statistical data in hopes of minimising subjectivity and scholarly bias, involving quantitative analysis focusing on the criticism of large, well-known organisations such as the UN (Beeton, 2012; *The Lancet*, 2006; *The Lancet*, 2016). However, beyond statistical data, unreported accounts may go unexplained or without context, resulting in the misattribution of blame towards social phenomena and groups.

Consequently, we investigate the effects of non-UN international aid on Haitians in both rural and urban settings with a focus on portraying the challenges and realities faced by Haitians in both contexts.

Methodology

Data was collected through semi-structured interviews and observational research. This study was conducted as an ethnography, given the pressing need to add local experiences to the larger discussion of the efficacy of international aid and to supplement the current statistical data that makes up the majority of current

evaluations of Haitian aid. By centring Haitian voices, this study aims to highlight the effects of foreign aid on Haitian life.

Through the contacts and network of a local organisation, *Haiti: Hands On*, we travelled to different disadvantaged communities in Port-au-Prince and two rural villages, Terre Froide and Jean Jean (Figure 1). We interviewed community representatives of their own communities and used convenience sampling through contacts in the *Haiti: Hands On* network. The former is near Fonds-Verrettes and the latter near Léogâne, both of which are located in the south-east and south-west of Port-au-Prince, respectively. In Terre Froide, we interviewed a family and observed them in their daily lives as well as visited two schools and one clinic in surrounding communities. Although participant observation was conducted in Jean Jean, an unexpected community accident prevented us from being able to complete our planned interviews.

Figure 1: Map of interview sites in Haiti.

Our observations and interviews in urban settings centred around the greater Port-au-Prince area, including wealthy areas such as Pétion-Ville and less developed areas such as Canapé Vert and Croix-des-Bouquets. In all, we interviewed a housekeeper in Pétion-Ville, two members of the Terre Froide community and a Haitian NGO worker

in Canapé Vert, all ranging in age and gender. All four interviews were conducted in Creole with the presence of a translator and notes transcribed by summary. Our observations included those from different areas and informal conversations exchanged between Haitians, NGO workers and foreign travellers. This study is in-keeping with the American Anthropological Association code of ethics and approved by *Haiti: Hands On*. Verbal, informed consent for interviews was obtained in Creole. The interviewees' names were deidentified for confidentiality purposes.

Discussion

Impacts of aid organisations on Haitian Life

Who gets what?

In times of natural disasters and conflict-related emergencies, communities without adequate infrastructure and support systems are left most vulnerable. These impacts are especially pronounced in Haiti, where many communities are isolated geographically with poor infrastructure. Chedeline – a housekeeper working in Pétion-Ville – grew up in Jérémie, a rural community near the south of Haiti and moved to the capital 15 years ago in search of opportunities better than agricultural work. When Hurricane Matthew struck in 2016, impacting mainly the Southern part of Haiti, her parents' house and agricultural produce in Jérémie were destroyed. Chedeline's parents became dependent on her income in the capital to support them.

Despite Hurricane Matthew's ravaging impact on communities such as Jérémie in the south of Haiti, Chedeline does not recall any international aid being offered to her parents' community. She recounted that, after the hurricane, roads connecting to the south of Haiti became inaccessible and hazardous. As a result, aid organisations instead focused on the more easily accessible communities, despite being less impacted. However, since it was paramount for Chedeline to provide safe shelter for her parents regardless of whether aid to Jérémie was available, she not only had to purchase materials to rebuild their house, but also pay for transportation to move materials from the capital to their community. This situation indicates a discrepancy of aid distribution based on geographic accessibility, regardless of the level of impact.

There are communities in Haiti that have been aided by NGOs in times of humanitarian crisis. In Terre Froide, a rural community in the east, we interviewed Emmanuel, a farmer who has lived in the community since 1984. He recounted the

times his community was afflicted by natural disasters. In times of drought, like the spell from 2011 to 2015, an NGO came to their aid and occasionally – yet inconsistently – provided water for their crops and animals. Even though Terre Froide did receive aid, its erratic delivery did not provide the community with the resources to recover fully.

The issues presented by Chedeline and Emmanuel highlight the lack of consistent aid outside the capital, where many aid organisations have been concentrated since 2010 (Beeton, 2012). The vast presence of aid and funding within Haiti should suggest that aid should arrive in places of need at a duly time, thus highlighting problems lying not in resources or funding, but in the delivery of aid. However, many NGOs and IGOs present in Haiti are developmental and have limited capacity for providing emergency aid to communities in times of crisis. That being said, the uncertain presence of such aid in communities beyond the capital remains concerning for emergency or developmental aid.

Food, shelter and water are basic necessities. In Chedeline's case, the dangerous roads, which were damaged by the hurricane, did not impede her from finding a way to provide these necessities for her parents. The irony is that the work promised by aid organisations – the entire reason they are in Haiti in the first place – often falls in the hands of already vulnerable family members who are placed in even more precarious situations by virtue of helping. This highlights the false promises made to Haitians by these organisations by their very presence in the country. As many such crises result in the loss of life, or leave even those with comparative means, like Chedeline, unable to support their families, the reliance on immediate or extended family thus becomes impossible.

This failure by organisations to provide aid to Jérémie, despite their significant funding, underlines *The Lancet* Global Health's criticism (2016) on the ineffectiveness of aid organisations in providing Haitians with adequate and timely support during humanitarian crises. However, this disparity of aid not only suggests that NGOs decide aid based on a community's accessibility, but also implies that the intent of certain aid organisations may be to provide aid that is most economical and efficient for the organisation. This further corroborates Beeton's suggestion that these international organisations are using funds to further their own organisational and national economies (Beeton, 2012), and they are sustaining their presence by selectively choosing economical and accessible communities to show donors that they are, in fact, doing meaningful work in Haiti.

Transience of aid

Although aid organisations have been present in Terre Froide, Emmanuel noted that most would be inconsistent and would never stay for long periods of time for continued support of the issues they faced. While aid organisations have supplied water for farmers like Emmanuel in times of drought, it takes upwards of a decade for these rivers to return to their original ability to provide water to entire communities. However, as soon as rainfall restarted in 2015, the organisations previously providing support with water access discontinued their aid. As a result, Emmanuel's family now has to travel about 1 hour by foot in order to find sufficient water for their crops.

Kervens, another member of the Terre Froide community, echoes this sentiment by describing the times in which the NGOs working in neighbouring regions would spontaneously appear and disappear over the span of two to three years. A health clinic 30 minutes away from Terre Froide that was once opened by the UN, and provided healthcare for the surrounding communities, was operational for three years until it closed. We got in touch with the mayor there and travelled to the closed health clinic to find the building still operational, but no longer run by the UN. Instead, a small NGO uses this clinic as a malnutrition centre to distribute dietary supplements for malnourished children. The mayor explained that the clinic – originally staffed by doctors and nurses who provided care to the area – closed due to a re-prioritisation of funding. Now, people have to travel an hour by car to get health care, something that is not accessible for most families in Terre Froide. These trends that depict the scarcity and inconsistencies of international aid are discussed in the research of Beeton (2012), Pilinger *et al.* (2016), Panchang (2016) and *The Lancet* (2006), and suggest that the strategies adopted by aid organisations hinder their commitments towards communities beyond intermittent intervals.

Similar to Emmanuel and Kervens's daily challenges in Terre Froide, urban communities also have volatile relationships with aid organisations. In Port-au-Prince, we interviewed Robenson, a Haitian who does non-profit work in the capital's most disadvantaged areas. Robenson grew up in a squalid urban community built in the hills surrounding Port-au-Prince. He recounted that when there were large rainfalls, his area had to evacuate due to severe flooding. He noted that this instability within marginalised and deprived urban communities has worsened given the large influx of people from the rural areas in search of job opportunities and the relocation from neighbourhoods destroyed by the earthquake – the infrastructure of Port-au-Prince is unable to support a population of 2.6 million people.

While these natural disasters have caused significant infrastructural damage to Haiti, the most prominent effects have been due to the lack of education, health and nourishment. This slow erosion of wellbeing suggests that there is an underlying problem compounded by the social structures within Haiti that significantly impacts the quotidian life of Haitians. In all three of these cases (Emmanuel, Kervens and Robenson), little has been done to aid in the daily life of Haitians – despite many large NGOs and IGOs claiming to focus on these factors. Further, those that are involved in this work are often present for short periods of time – with an interventionist, top-down approach – giving communities a false sense of stability.

Why is aid so arbitrary?

In addition to being the founder of a Haitian non-profit organisation, Robenson worked for both the Haitian government and large foreign aid organisations. When asked about his experiences working with the latter, he stated that organisations in Haiti often have their own agendas that are contrary to the interests of Haiti. This begs the question of whether these aid organisations are there for Haitians or for their own benefit, supporting Pilinger *et al.*'s (2016) claim that international organisations are profiting from human suffering. Sharing Kervens's perspective in Terre Froide, Robenson noted that international aid projects often exhaust their funding after two to three years. He stated that aid organisations aim to create as many aid projects as possible in order to attract funding from large donors by demonstrating impact through statistics – an inaccurate measure of impact. Robenson noted that it is rare for large organisations to have reports of the lasting impacts on the community, corroborating our observations in the closed UN clinic in Terre Froide after operating for 3 years. This emphasis on superficial results and reductionism trickles down into the implementation of projects. Drawing upon the culture of superficiality in aid work, according to Robenson's experience as a field officer, the people on the front lines implementing change are discouraged from being receptive to feedback from communities. Instead, they are encouraged to report conflated results to align their reports with the consensus of people higher up in the organisation who have never been present in those same communities.

The emphasis on statistical representation within aid organisations has turned to value aid through quantity over quality. While *The Lancet* (2016) critiques the structure of aid organisations, it does little to elucidate the negative culture rampant within them. Robenson's observations while working in multiple aid organisations show that it is not only the ineffective bureaucracy but also the focus on providing

statistical representation that reduces and categorises aid's impact on Haitians. This results in false hope, complacency and dependency that ultimately harms Haitians in their ability to escape the daily challenges that persist beyond the initial impact of the crisis. Little has been done regarding improving the quality of aid by large foreign organisations, some of which are implicated through the interactions with interviewees.

Dependency

The dependency on foreign organisations for basic necessities – such as Doctors Without Borders and Partners in Health for free emergency healthcare – explains why the government has so little control over aid organisation work within Haiti. Organisations consequently are able to perpetuate systems of high-quantity, low-quality projects to Haitians. Like the government's dependency on aid organisations to provide basic services, communities have often developed a similar dependency.

Furthermore, the act of foreign intervention often shapes a Haitian image of foreigners, namely of the French, Americans and Canadians, as one rooted in aid. Coupled with the sole appearance of foreigners in the context of providing aid to the community, Haitians in rural communities often associate foreigners with help and thus expect it from those that interact with them. The negative experiences with aid described throughout this piece, coupled with the country's historical legacy of foreign colonisation, exploitation and violence by France, the United States and Western bodies such as the IMF have commonly, and understandably, resulted in a deeply rooted distrust towards foreigners and their intentions.

The manipulation of research through falsified accounts of Haitians who were sexually assaulted, as proposed by James's research, helps clarify the effects of continual interaction with foreigners under the context of aid and disproportionate power dynamics that result in misreporting of narratives (James, 2010). The Haitians interviewed for this study were aware of the actions needed to gain sympathy and support from foreigners. When projects fail and aid workers leave, it not only leaves behind empty buildings, disappointment and broken promises, but also perpetuates a distrust between communities and foreigners. This repetitious cycle of aid groups providing ineffective aid thus drives Haitians to make the most out of the duration of the project. While some Haitians are able to benefit in doing so, they are still unable to escape from the grasp of poor aid.

Sustainable aid through education

Given these pitfalls of international aid, certain local grass-roots projects like Robenson's and smaller bottom-up foreign organisations, have effectively addressed community needs through a community-based, bottom-up approach that centres the voices of those most affected by systemic issues. However, Robenson recounted that it is hard to find both people willing to work for small NGOs and donors willing to fund small projects without the same recognition as large foreign organisations.

The consistent failure of large international NGOs in Haiti over the course of a decade may explain why Chedeline, Emmanuel and Kervens – living in both urban and rural communities – state that they perceive little to nothing having changed within Haiti since the influx of aid organisations after the earthquake. Instead, they have emphasised trying to only rely on themselves and their own communities since aid is often transient and ineffective when most needed. This realisation has instigated a call for change in status quo, with education as a possible vehicle.

Why education?

All interviewees expressed that education is key to improving their own lives and Haiti's social discourse. Emmanuel, who works as a farmer and seamster, repeatedly emphasised that he does not want his children to follow in his footsteps. As a rural farmer, he is not only dependent on the climate of Haiti to nourish his crops but also on an economy that has consistently disadvantaged him. Emmanuel hopes his children will be able to escape this system that continues to deprive him by becoming doctors and teachers. He insinuated that he wants stability for his children, as well as safety from their being marginalised, and that their education could achieve that. When asked what it meant to be Haitian, his immediate response was the importance of education and perseverance. Since education is not free in Haiti, families have to pay exorbitant prices in order to educate all of their children (Beeton, 2012). In fact, the World Bank estimates that 80 per cent of schools in Haiti are privately owned or run by churches or NGOs (The World Bank, 2017). In Emmanuel's case, he has to pay for seven children to attend school. He hopes to send at least one of his children to university.

Chedeline's experiences have also taught her the importance of education. Growing up in Jérémie, she found that women did not have much choice other than to work in the fields and have a family. Instead, she aspired to be her own boss and create her own company. When she moved to Port-au-Prince in search of opportunities, however, she found that her primary education from Jérémie made it hard for her to find jobs and

opportunities that supported her aspirations. As a result, she went to culinary school and became a private chef and housekeeper for a wealthy Haitian-American family in Pétion-Ville. In retrospect, Chedeline wishes her parents understood the importance of breaking from this expected norm through education. People seemed to be discontented by the constant challenges they face in rural areas and, in response, seek means of escaping existing conditions through pathways of education and migration to a major city.

However, Kervens, a college student from Terre Froide studying political science and education in the capital observes large differences in the values held between urban and rural areas. Living in Port-au-Prince, he sees that his peers had a wide variety of dreams and aspirations, whereas in Terre Froide, dreams are more gender-specific: boys aspire to be drivers (stemming from a desired social mobility beyond less glorified agricultural work) while girls follow a defined path of having a family.

When people in both rural and urban communities face adversity, they have looked towards means of sustainability to support their aspirations, particularly in independently shaping their own future rather than relying on outsiders. It has become a consensus that education can provide not only a better standard of living and opportunities but also a more self-reliant future for Haitians as a collective. However, while people in both urban and rural communities have agreed on the importance of education, its effects vary between communities. We hypothesise that this difference of values observed by Kervens stems from the access of opportunities – where people within rural communities have not yet understood the possibilities of education and opportunities limited by their communities. Unless someone has gone beyond their community, like Kervens and Chedeline, they are unable to recognise the possibilities beyond the truck drivers passing by their communities.

Education: A curse and a blessing

In Haiti, individuals have contrasting views on education depending on their involvement with the system. Emmanuel and Chedeline think that education has improved since their educational years, whereas Kervens and Robenson believe that education is continually worsening Haiti's situation, despite the improvement in quality. Both Kervens and Robenson believe that the impacts of education cannot be felt by the Haitian community, as those who have graduated from Haitian universities often leave the country in search of a better life.

Robenson attributes this phenomenon to the idea of self-interest as a protective mechanism, still existing after a major disaster in Haiti. In Robenson's view, this reflex to care solely for individual shapes a social phenomenon manifested in competition and distrust, even after a disaster has passed. These sentiments, although compounded by natural disasters and recent crises, have historical roots in communal distrust during colonisation and dictatorship. Robenson supposes Haitians have adopted a headstrong, distrustful mentality to protect themselves from further exploitation. While this mentality is understandable and useful in times of extenuating circumstances, it prevents negotiation and understanding between groups. It also accentuates the underlying circumstantial rifts that continually influence meaningful partnerships between Haitians and aid organisations.

In the end, when asked what it meant to be Haitian, most interviewees responded with some paradoxical combination of resilience, perseverance, individuality and community.

Limitations

Although this ethnography provides insights of the effects into foreign aid on Haitian life, its interview sample size remains limited. Interview participants were additionally recruited through *Haiti Hands On*'s network in their partner communities. Due to these factors, observations made in both rural and urban communities may thus be unrepresentative of the status quo. Observations made during participant observation in these communities in Haiti may also be biased, given the research team being foreigners, despite speaking fluent Creole. We have attempted to account for these potential limitations by recruiting interviewees in communities that have a long-standing and trusting relationship with *Haiti Hands On* as it allowed for a more candid dialogue about foreign intervention with the interviewers, despite their own positionality. That being said, the circulation of narratives involving suffering beyond fellow Haitians can cause areas of bias and misrepresentation beyond groups represented by our interviewees.

Conclusion

While this ethnography has corroborated the predominant research on the inefficiencies of international organisations in Haiti, little to no scholarly work had been done to seek out the voices of Haitians a decade after Haiti's devastating earthquake of 2010. This ethnography highlights the voices underpinning the deep-

seated desires of Haitians to be independent of foreign aid and the strong resilience of Haitians for family and community.

Haiti has a rich history that portrays strength in the face of all kinds of adversity, although this narrative is often excluded from mainstream accounts of the country. Instead, Haiti is portrayed as a country rampant with people unable to help themselves. This has shaped a donor culture that further perpetuates a superficial interpretation of impact within aid organisations. In turn, this image has trickled down to affect the Haitians that aid organisations are serving, resulting in an inefficient use of aid, preservation of exploitative power dynamics and change in attitude towards foreigners. This reality further perpetuates a continued influx of aid that has been present in Haiti for over a decade. Particularly given the growing global instability a decade after the 2010 earthquake, there is an increased need for effective development. By redirecting aid efforts and placing Haitian voices at the centre of their approach, Haiti may finally independently and sustainably tackle its challenges in the next decade.

Appendix

Interview questions

1. How long have you lived in (location)?
2. Describe your family.
3. What is your job? What do you work for?
4. How is your lifestyle in (location)?
5. What types of government support are available in your area?
6. How easy is it to get access to government support within your area?
7. How did the most recent hurricane impact you or your area?
8. Have you had any contact with NGOs, or did it require you to leave (location)? How is the city different from (location)?
9. Are there any NGOs that work in (location) and how is your experience with them?
10. Have you spent much time outside (location)?
11. What do you think about the Pétion-Ville (rich area of Haiti)? Have you been there?
12. How optimistic are you about the new UN mission, MINUJUSTH?
13. What political, economic and other changes have you noticed in recent years?

14. How does the education you received compare to the ones your children receive now?
15. What does it mean to be Haitian?
    1. What qualities would you associate with being Haitian?
    2. Who do you find as an inspirational figure?
    3. What is your favourite part of being Haitian?

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Zombie-ant graveyard dynamics in Gunung Mulu National Park

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Abstract

Ophiocordyceps is a genus of pathogenic fungi that predominantly parasitises insects of the tropics. While there is considerable research derived from alternative tropical regions, there is limited documentation of *Ophiocordyceps* fungi in Borneo. This paper investigates the spatial dynamics of zombie ant graveyards – a manifestation of the *Ophiocordyceps unilateralis* species – and explores the optimal height for spore dispersal in a Bornean rainforest. In the present study, an area of Gunung Mulu National Park was searched for *O. unilateralis*-infected ants. Once an infected ant had been located, the surrounding area was methodically searched to allow for the height and location of all surrounding ants to be recorded. Infected ants were found at variable heights between the four sites (means of 28.9–57.6cm), which was above the expected height laid out in similar studies (approximately 25cm). It is suggested that these heights may correspond to locations at which temperature and humidity are optimal for spore dispersal and fungal growth, and that these heights differ depending on unique features of the environment.

Keywords: *Ophiocordyceps unilateralis*, host-parasite interaction, entomopathogenic fungi, *formicidae* pathogen, fungal behavioural manipulation, *Ophiocordycipitaceae*

Introduction

Tropical regions are characterised by their high temperature and rainfall, with limited seasonality, as well as their remarkably high diversity (Brown, 2014). The Latitudinal Diversity Gradient (LDG) describes this phenomenon whereby biodiversity increases with lower latitudes (Jablonski *et al.*, 2006). Numerous hypotheses have been proposed to explain the LDG, with research largely suggesting that tropical conditions result in high productivity, thus allowing for a higher species richness to be maintained as more species are able to obtain sufficient resources (Brown, 2014; Fittkau and Klinge, 1973; Phillips *et al.*, 1994). This high density and diversity of organisms seen in the tropics is

particularly notable in the case of invertebrates, with researchers observing a significantly higher density of invertebrates per unit area relative to temperate and polar regions (Fittkau and Klinge, 1973). Ants, specifically, are found at their highest densities in tropical rainforests, making up approximately 25 per cent of rainforest biomass, with density estimates ranging from two to thirty nests per square metre (Baccaro and Ferraz, 2013: 103; Fittkau and Klinge, 1973: 11). While ants appear to thrive in tropical rainforests, so too do many ant parasites. Ants are parasitised by invertebrates such as *Polyergus breviceps*, trematodes including *Dicrocoelium dendriticum,* and fungi such as *Ophiocordyceps* (Araújo *et al.,* 2018; Martín-Vega *et al.,* 2018; Torres and Tsutsui, 2016).

Parasitism involves the physical takeover of a host individual and, in specific cases, can culminate in behavioural manipulation (Lefevre *et al.*, 2009; Poulin, 2000). These behaviours are extended phenotypes of the parasite that result in the increased fitness of the parasitic individual, which is detrimental to the host (Andersen *et al.*, 2009; Andersen and Hughes, 2012; Dawkins, 1982; Thomas *et al.*, 2005). The obligate fungal parasitoid *Ophiocordyceps* is a genus of particularly successful ant parasites, capable of wiping out entire colonies of over 10,000 individuals, and is an extreme example of adaptive manipulation (Andersen *et al.*, 2009; Evans and Samson, 1982: 445; Burchill and Moreau, 2016: 293; Evans *et al.,* 2011: 600). *Ophiocordyceps* fungi are widespread within tropical forest environments, but are largely uncommon within temperate ecosystems (Araújo *et al.,* 2018; Pontoppidan *et al.,* 2009). It has been suggested that this pattern of distribution results from the fungi's requirements for the high temperatures and humidity typical of tropical rainforests (Evans *et al.,* 2011).

Ophiocordyceps directly infects worker ants while they are foraging on the forest floor. Spores from previously infected ants litter the ground and, when they are walked across, adhere to and subsequently penetrate the ant's cuticle (Pontoppidan *et al.,* 2009: 2). Once infected, ants begin to walk and climb in random directions in place of their typical coordinated movements (Hughes *et al.,* 2011: 4), earning them the name 'zombie ants'. They then repeatedly convulse, frequently causing them to fall to the forest floor (Hughes *et al.,* 2011: 6). The infected ants become increasingly disoriented over the following three to six days and ultimately ascend into the vegetation (Pontoppidan *et al.,* 2009: 2). Immediately prior to being killed by the fungus, the disoriented ants will perform the 'death grip', which involves the infected ant biting into vegetation permanently via their mandibles (Andersen *et al.,* 2009: 424). This 'death grip' results in the atrophy of the ant's mandibular muscles, preventing it from releasing its grip, thereby leading to its immobilisation and eventual death (Hughes *et*

al., 2011: 8). The fungi's manipulation of the hosts' behaviour is, in effect, an expression of fungal behaviour as prescribed in the fungal genome, and is designed to optimise the subsequent spread of infection (Andersen *et al.,* 2009; Araújo *et al.,* 2018). Despite aerial spore dispersal, the immobilisation and eventual death of ants are typically undertaken in areas where the cadavers of previously manipulated ants are abundant, leading to the formation of ant graveyards (Pontoppidan *et al.*, 2009). It is within these graveyards that the infecting fungus has been seen to grow; the stroma and perithecial plate of the fungus emerge from the ant's head soon after it dies (Figure 1), dispersing spores that go on to infect additional individuals and colonies (de Bekker *et al.,* 2014). The spatial distribution of graveyards consisting of the host genus *Camponotus* appear to accommodate the fungal parasite within a stable microclimatic niche suitable to support fungal growth and aerial spore dispersal (Andersen *et al.,* 2009, Hughes *et al.,* 2011). This spatial niche of infected ants is distinct from that of the healthy ants. These environments are highly specific: typically, between 94 and 95 per cent humidity, 20 to 30 °C, and on the underside of northward facing leaves (Andersen *et al.,* 2009: 428). Andersen and colleagues (2009: 424) suggest that outside of this optimal zone, parasite fitness is significantly lower in terms of spore development and transmission potential, and this is a driver of the dense culmination of zombie ant graveyards in ideal locations (Evans, 1974; Pontoppidan *et al.,* 2009). Once spores are released, they are deposited on the forest floor, where they lose infectiousness quickly; thus, infection must occur soon after dispersal (Sobczak *et al.*, 2017: 1262). Pontoppidan *et al.,* (2009: 5) suggests that foraging host ants of this species actively avoid graveyards, meaning that infection rates may be low without effective aerial dispersal, highlighting the importance of host manipulation and optimal relocation. The knowledge we have of the interaction between *O. unilateralis* and *C. leonardi* has resulted primarily from recent studies of zombie ants within Thai rainforests (Andersen *et al.,* 2009; Hughes *et al.,* 2011). The zombie ant communities in the Bornean rainforests of Sarawak are yet to be explored, and thus this study aims to investigate the characteristics of these communities. Consequently, we aim to build on the previous findings and determine the optimal height for *O. unilateralis* spore dispersal in Bornean rainforest conditions. Additionally, we aim to re-examine the effect of biotic and abiotic factors on the distribution of *O. unilateralis*-infected *Camponotus leonardi* ants and assess which factors influence the density and distribution of infected ants. By recording environmental conditions and the presence and density of infected ants, we endeavour to establish the typical distribution of *Ophiocordyceps*-infected ants within Gunung

Mulu National Park, Borneo. It is hypothesised that there will be optimal conditions for zombie-ant occurrence as dictated by the *Ophiocordyceps* genome.

Figure 1: Photograph of *Camponotus leonardi* infected with *Ophiocordyceps unilateralis*, securely attached to the underside of a leaf. The fungus can be seen emerging from the dorsal region of the ant's head. The arrow indicates the perithecial plate, which sits upon the stroma of the fungus and releases spores, spreading infection. Image from the author's own collection

Methods

The study was conducted in a tropical dipterocarp forest within Gunung Mulu National Park in Sarawak, Borneo (over 528 km^2) at an altitude of approximately 50m. The study was undertaken on 26 and 27 September at the beginning of the wet season (average September temperature approximately 30°C and average September precipitation approximately 285mm).

Sites were identified by inspecting *Ophiocordyceps*-infected ants on the undersides of low-hanging leaves located along select walking paths throughout the forest. Three sites were located on the Paku Valley Walk (Site 1 at 4.03109, 114.81765; Site 2 at 4.03144, 114.81818; Site 3 at 4.003210, 114.81863) and one on the Night Walk (Site 4

at 4.04356, 114.81516) (Figure 2). All sites were classified as dipterocarp forests, composed of multiple vegetation types. Site 2 and 3 had dense understories with sparse canopies, while Sites 1 and 4 had sparser understories with dense canopies. Once an infected ant had been identified, the surrounding leaves were checked within a 5-metre radius for additional infected ants. If additional ants were located in the immediate area, the coordinates were taken and flags were placed to mark the site.

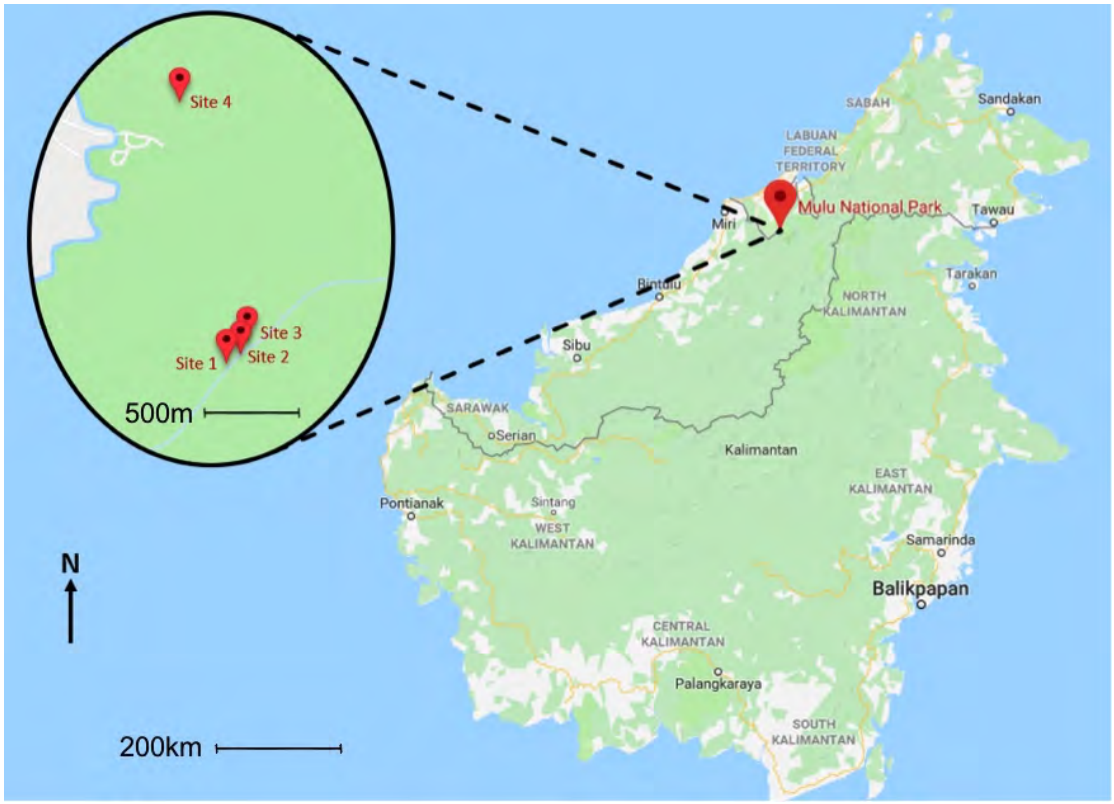


Figure 2: Map depicting locations of Sites 1–4 within Gunung Mulu National Park, Borneo

Quadrats of $1m^2$ were searched outwards from the initially located ant at point (0, 0) extending in northern, eastern, southern and western directions. Each quadrat was marked out using raffia tape to clearly define its boundary. Every shrub, tree or other plant in that quadrat was carefully inspected for infected ants. Each leaf was gently overturned to ensure both surfaces of the leaves were searched, and all surfaces of plant stems and trunks were examined. The entire area of the quadrat was inspected up to a height that could no longer be reached without further equipment; this corresponded to a maximum height of approximately two metres. During the search, a few individual ants were observed at heights beyond this but were not included in the dataset as they were very uncommon and difficult to measure accurately. The location of each infected ant was recorded, in addition to its height above the ground. If one or

more infected ants were located in a quadrat, the two subsequent quadrats in all directions were searched, until two successive quadrats were empty; this was considered the edge of the graveyard. Three sample specimens were retained and identified as ants of the *Camponotus leonardi* species*,* infected by *Ophiocordyceps unilateralis.* Subsequent ants were compared to these identified specimens, and it was concluded all graveyards consisted of the same ant species infected by the same parasitic fungus.

Environmental conditions at each site were measured and recorded. This included temperature, relative humidity taken at a height of ~1.5 m, wind speed at 10cm height intervals, and light levels. Light levels included PAR (Photosynthetically Active Radiation), PAR LAI (Leaf Area Index) and Sunflecks, and were measured using a ceptometer. PAR refers to the amount of sunlight that is intercepted, only taking into account light of wavelengths 400-700nm, as this is the portion of the light spectrum that plants utilise for energy via photosynthesis (Navrátil *et al.* 2007: 311). LAI is a measure of the total leaf area per unit of ground area; thus PAR LAI is a measure of how much usable light reaches the leaves, per unit area. Sunflecks are the small patches of intense light that briefly reach the ground level of vegetation. They occur when branches in the canopy sway, or the angle of the sun changes and allows small amounts of light to penetrate to the ground completely unobstructed. Measurements of temperature, wind speed and relative humidity were taken using a Kestrel meter once during the day and once at night. These measurements were taken at midday and midnight on the final day of data collection (27 September). Distance to the nearest water body was later measured using aerial images, as proximity to water, and thus a source of evaporation, may play an important role in humidity levels. Data was collated and analysis conducted using RStudio and Microsoft Excel (2019). The site map was created using Google Maps*.*

To determine patterns in the vertical distribution of ants within the reserve, the heights at which infected ants were found were compared across the four sites using independent samples t-tests. Kendall correlation analyses were performed to determine if there was a significant effect of temperature or humidity on the mean height of infected ants with a significance set at 0.05. In order to visually represent the spatial distribution of infected ants located at each site, density maps were created to illustrate the density of infected ants per quadrat in each site.

Results

Following data collection, the four sites were compared in terms of environmental factors, the height at which ants were found, and their relative similarity to each other site. All sites were largely similar in all measured environmental conditions (temperature, relative humidity, wind speed, PAR, PAR LAI, Sunflecks; Table 1). Of particular interest was temperature and humidity, which were measured day and night using a Kestrel meter, with temperature varying by a maximum of 2 ℃ between sites and humidity by a maximum of 7 per cent (Table 1). Mean temperature across the sites was 29.78 °C (±0.14) during the day and 27.23 °C (±0.44) during the night. Mean humidity across sites was 90.05 per cent (±0.99) in the day and 90.01 per cent (±1.12) at night. Temperature and humidity measurements were taken at a single height; however, the study may have benefitted from these measurements being recorded at multiple points on a vertical gradient where variations may have been more obvious due to vertical vegetation structure.

The height of infected ants within each quadrat was measured up to a height of 2m with the mean and median ant height varying significantly between all sites except Sites 2 and 3 (Table 2, Figures 3 and 4). Sites were compared in terms of height by conducting six independent samples t-tests (Figure 3). The Kendall correlation analyses showed a significant but weak association of temperature and humidity on the mean height of infected ants across the four sites (Table 3). This indicates that temperature and humidity at each site significantly influences the mean height at which infected ants were found.

There was a positive trend between distance from water and average height above ground (R^2=0.90; Figure 5); however, the speculated link to humidity gradients is not supported by the correlation analyses.

The majority of infected ants were found within a somewhat small vertical range across the four sites, with 75 per cent occurring below 55cm (Figure 4). This may indicate that the fungus favours certain heights due to host factors or environmental factors, which influence the fungi's reproductive success. The density maps (Figure 6) illustrate the three-dimensional size and shape of each hot spot. Additionally, the density plots (Figure 7), generated using R Studio, illustrate the density variation between sites relative to height. Sites 2 and 3 show similar density variation across heights, peaking at approximately 25cm above ground, whereas Site 1 and Site 4 show a wider spread, peaking at approximately 30cm (Figure 7). This may be indicative of environmental differences, including geographical factors such as site location and distance from the nearest water body.

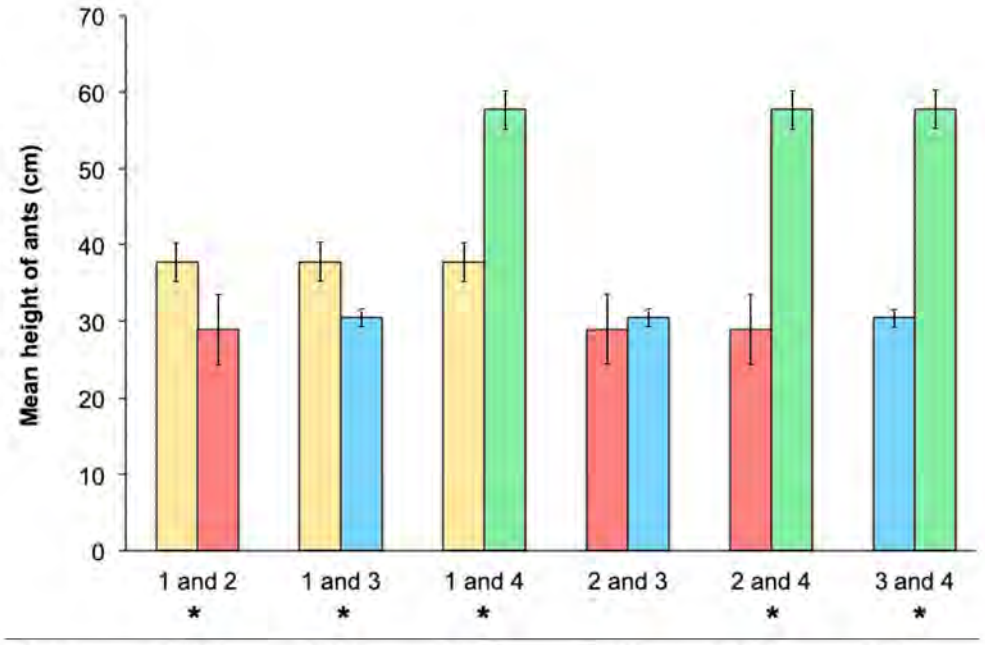
Table 1: Summary of environmental conditions at Sites 1–4 in Gunung Mulu National Park, Borneo. Wind speeds refer to the average wind speed at each site per time of day, measured on a vertical gradient of 0-200 cm at 10 cm intervals

	Site 1	Site 2	Site 3	Site 4
Temperature – day (^{o}C)	29.1	29.2	28.6	29.5
Temperature – night (^{o}C)	26	27.2	27.9	27.8
Humidity – day (%)	96.5	90.1	93	89.9
Humidity – night (%)	91.8	92.4	88.2	87.9
Distance from body of water (m)	18	16	6	160
Day wind (km/hr)	0	0	0	0
Night wind (km/hr)	0	0	0	0
PAR	11.1	11.1	5.8	4.5
PAR LAI	5.7	5.7	6.4	6.7

	Site 1	Site 2	Site 3	Site 4
Sunflecks	0	0	0	0

Table 2: Summary of graveyard characteristics at Sites 1–4 in Gunung Mulu National Park, Borneo

	Site 1	Site 2	Site 3	Site 4
Number of ants	59	20	176	292
Area (m^2)	45	22	124	299
Mean (±SE) ant height (cm)	38.42 ± 2.45	28.9 ± 4.53	30.47 ± 1.14	57.78 ± 2.54
Median ant height (cm)	35	24.5	27.5	45
Mean density (ants/m^2)	1.31	0.91	1.42	0.98



t value	1.996	1.971	1.965	2.007	1.983	1.966
df	67	212	430	52	100	368

Figure 3: T-test statistics comparing mean height of zombie ants at four sites in Gunung Mulu National Park. Significant level set at $p < 0.05$. Statistical significance indicated by *. Site 1 = yellow, Site 2 = red, Site 3 = blue, Site 4 = green

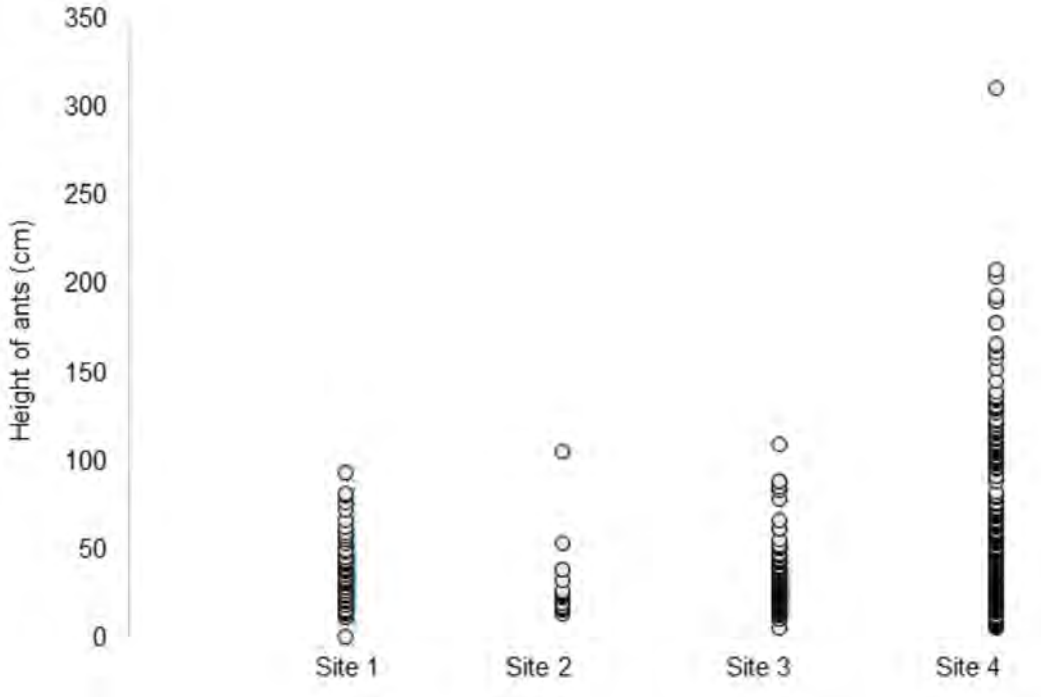


Figure 4: Height at which *Ophiocordyceps unilateralis*-infected *Camponotus leonardi* were observed at Sites 1–4 in Gunung Mulu National Park, Borneo. Site 1: n = 59; Site 2: n = 20; Site 3: n = 176; Site 4 n = 292<

Table 3: Kendall rank correlations for temperature and humidity at Sites 1–4 in Gunung Mulu National Park, Borneo. Significant level set at $p < 0.05$.

Kendall rank correlation	τ	p
Height vs. Day temperature	-0.184	<0.01
Height vs. Night temperature	-0.207	<0.01
Height vs. Day humidity	0.279	<0.01
Height vs. Night humidity	-0.155	<0.01

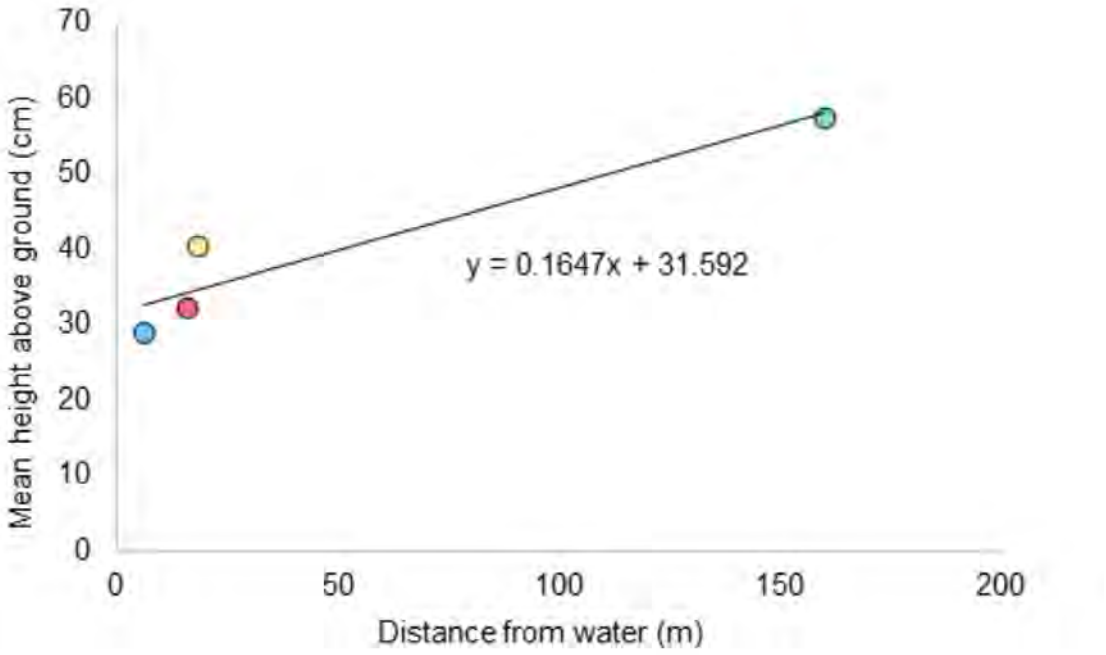
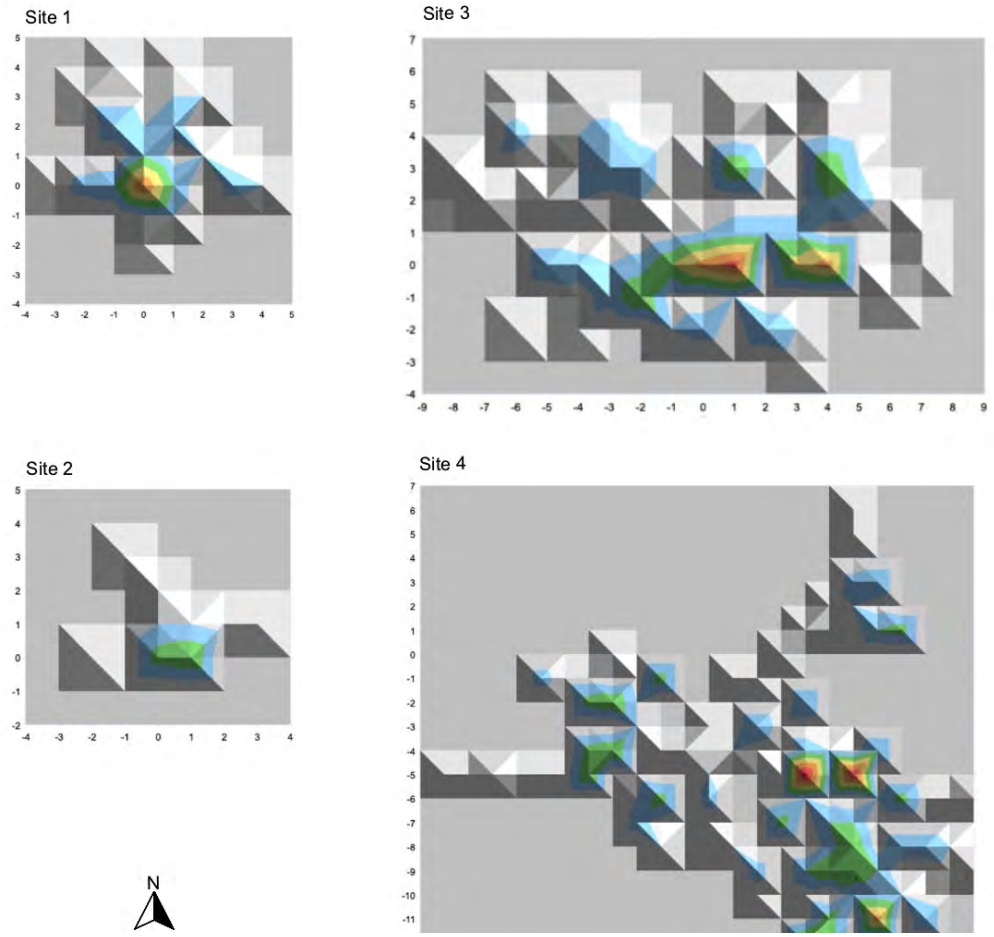


Figure 5: Scatter plot showing the relationship between mean height above ground of ants and distance from the nearest water body of four sites in Gunung Mulu National Park (R^2 = 0.90). Site 1 = yellow, Site 2 = red, Site 3 = blue, Site 4 = green



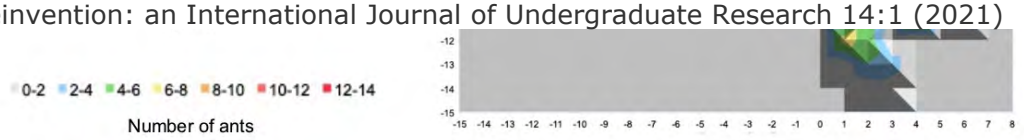


Figure 6: Density maps of sites illustrating the number of *Ophiocordyceps unilateralis*-infected *Camponotus leonardi* found per $1m^2$ quadrat in Gunung Mulu National Park, Borneo. The first ant found within each graveyard defines point (0,0). Horizontal distribution represented on x- and y-axes, measured as distance from initial survey point (m). Density is indicated by colour, measured as number of ants found in each quadrat

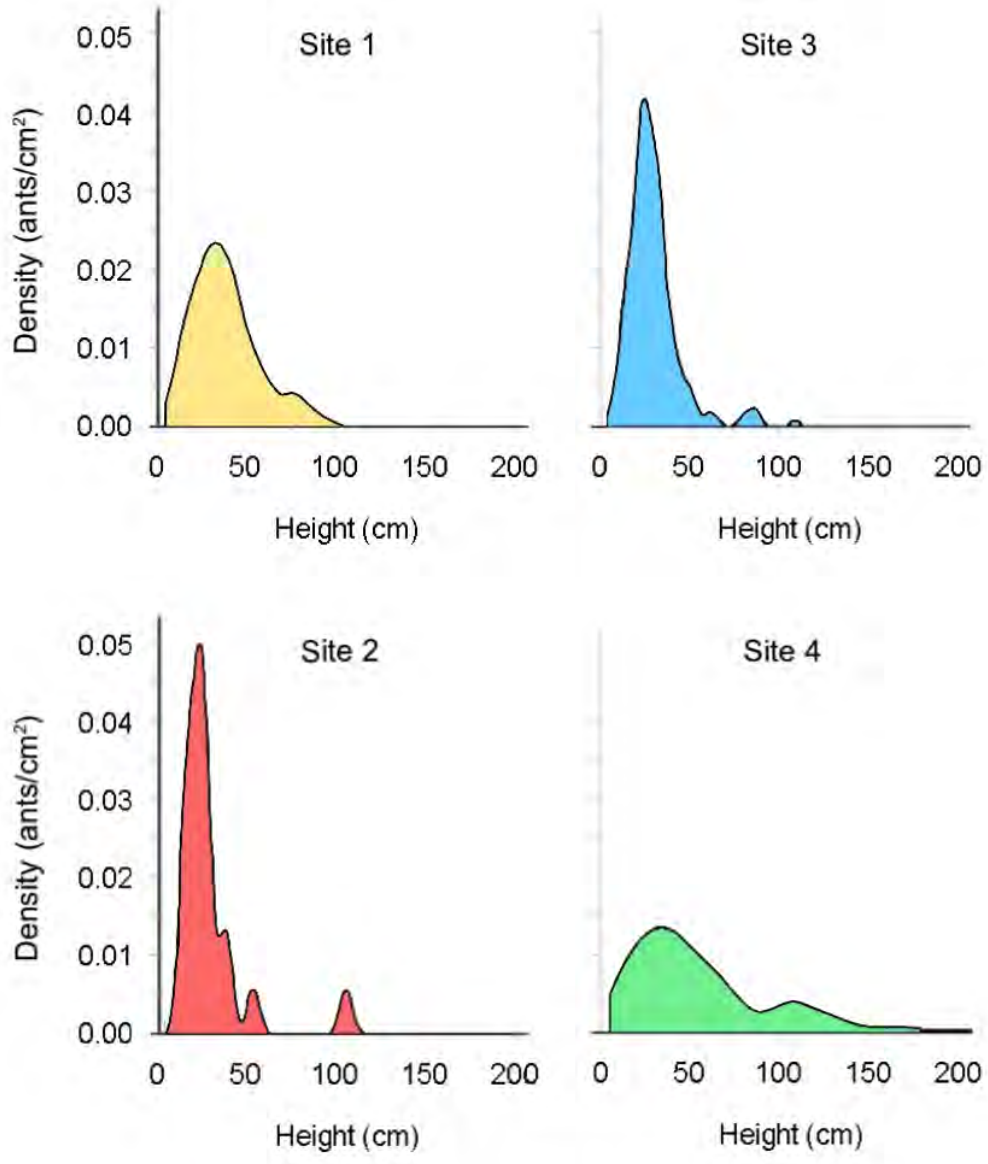


Figure 6: Density plots of zombie ants at different heights at Sites 1–4. Site 1: n = 59; Site 2: n = 20; Site 3: n = 176; Site 4: n = 292

Discussion

Density maps of the graveyards revealed a patchy distribution of *Camponotus leonardi* ants infected with *Ophiocordyceps unilateralis* fungi, with small areas containing high numbers of infected ants surrounded by areas with comparatively few numbers**.** The average heights of zombie ants in each site were consistently higher than that found by Andersen *et al.* (2009) (25.20 ±2.46cm), although there was a broad range in heights, with one ant found at ground level and three ants observed at a height of over 2m. The averages in Sites 1, 2 and 4 were also higher than the upper limit of the 95 per cent confidence interval of 20.38 to 30.02cm (Andersen *et al.,* 2009). Only Sites 1 and 4 had median values above 30cm, with a peak density at ~30cm. This can be contrasted to Sites 2 and 3, which had a peak ant density at ~25cm. This indicates that the optimal height of *C. leonardi* zombie ants in Gunung Mulu National Park may be closer to 25–30cm than the calculated mean values due to inflation from upper values. Potentially, the graveyards at Gunung Mulu had a greater vertical distribution than the sites in Thailand, therefore driving the mean up comparatively. Otherwise, it may be possible that environmental conditions in the tropical forest in Gunung Mulu and Thailand were different – for example, a greater humidity in Gunung Mulu – resulting in a shift in the optimum height at which zombie ants die. This suggests that there is not one optimum height across all environments per se, but an optimal micro-climate that varies in height according to the conditions of a specific environment.

Site area appeared to be positively associated with the maximum height at which zombie ants were found. This potentially results from chance due to higher total numbers of ants present. Most likely, this association is a result of variation in the existing environmental conditions at each site. Two measurable factors clearly distinguished Site 4 from the other sites: its distant location in relation to the other sites, and its distance from the nearest water body. Distance enhances the likelihood of variable conditions in comparison to the other sites due to the effects of natural geographical variation. The strong correlation between distance from water and average height of zombie ants is particularly interesting as this has been previously unexplored. It is possible that proximity to water, and thus a source of evaporation, could be important within a tropical forest as it affects the vertical and horizontal humidity gradients, particularly in the wake of frequent rain and air movement.

As can be seen in Figure 6, the distribution of infected ants appears to be patchy and irregular, with occasional clusters of high ant density. Pontoppidan *et al.* (2009: 3)

obtained similar results in Southern Thailand, observing densities of up to 26 ants/m^2 in areas just metres away from quadrats with no infected ants. The maximum observed density in the present study was comparatively lower, at 13 ants/m^2; however, the distribution appeared similar, with these high-density regions occurring adjacent to low-density regions. This may suggest that zombie ant graveyards are somewhat dynamic, with the areas of highest infection shifting frequently. Pontoppidan *et al.* (2009: 3–5) observed that, over time, many of the high-density areas became low density, while conversely, many low-density areas became high density, supporting their hypothesis of a spatially dynamic graveyard. To further explore this hypothesis, it may be beneficial to reassess the same locations at a later date to allow for the analysis of graveyards over time. Andersen *et al.* (2009: 429) have noted that the spores of the *O. unilateralis* are too heavy for effective wind dispersal, and thus releasing spores from a greater height is not reproductively beneficial. Instead, spores are actively released to the area immediately below the infected ant, which creates a small but highly infectious region (Andersen *et al.,* 2009). This may be a key factor driving the clumped distribution commonly described, whereby small, highly infectious areas promote the accumulation of deceased and dying infected ants. While this study considered two successive empty quadrats as an edge to the ant graveyard, future researchers may elect to redefine this. By sampling a wider area – for example, continuing until five successive quadrats are empty – it may be observed that graveyard sites eventually overlap. If this were the case, it could be possible that the entire forest or a large area of the forest may correspond to a single extended graveyard, with distinct hotspots of high zombie-ant density. The understanding of the graveyard dynamics across a larger area, as well as assessing the graveyards over time, may provide further insight into the mechanisms of host manipulation and subsequent dispersal success of *Ophiocordyceps* fungi.

Andersen *et al.* (2009: 428) noted that when deceased ants were relocated, successful spore dispersal was drastically reduced. It is possible that what appears to be behavioural manipulation is in fact environmental selection of viable graveyards, whereby the habitat selection of ants is in fact random and unsuccessful dispersal simply fails to result in graveyard formation. Due to the tendency of infected ants to lock their jaw irreversibly on the underside of the leaves on which they die (Evans and Samson, 1982: 432), cadavers occurring in micro-environments that are unsuitable to spore dispersal would likely still be observable with a thorough search of the environment. As the graveyards we identified were primarily via a survey of leaves directly adjacent to the path, it is possible that solitary cadavers were missed, and it is

suggested that future studies survey habitats systematically prior to the identification of graveyards. However, the primary focus of this study is the vertical spatial distribution of ants within the graveyard, which does show a trend in the occurrence of cadavers within a particular height range. This suggests that there is a mechanism of manipulation that is encouraging ants to be positioned optimally within the vertical gradient.

The four sites had a weak but significant association of temperature and humidity on the mean height of infected ants. This suggests that micro-climate factors, including temperature and humidity, could have some influence on the height of ant cadavers – although other factors may also have an effect, such as vegetation structure. This also indicates that height may not be incidental to cadaver selection and that environmental conditions could instead be intimately related to the spatial dynamics of ant graveyards. However, these measurements were not replicated throughout the study so do not account for any fluctuations present throughout the study period. Measuring temperature and humidity over a longer period may strengthen the validity of these results in the future.

Mean humidity was approximately 90 per cent across sites, which is slightly lower than the optimum level suggested by Andersen *et al.* (2009) of 94 to 95 per cent. However, the humidity and temperature measurements in this study were taken at standing height at ~1.5m. The study may have benefitted from these measurements being recorded at multiple points on a vertical gradient, where variations may have been more obvious due to vertical vegetation structure. Colonies of *C. leonardi* nest within the canopy where abiotic conditions are highly variable. In contrast, zombie ants are located close to the ground where temperature is consistently low and humidity consistently high. This illustrates the integral role that stable optimal conditions play in the growth of entomopathogenic fungal spores, whereby fluctuations in humidity and temperature may negatively impact spore development (Andersen *et al.,* 2009; Oduor *et al.,* 1996; Arthurs and Thomas, 2001). Sites 1 and 4, which had the highest relative humidity at standing height, also had greater average heights of zombie-ant occurrence and vertical distributions compared to Sites 2 and 3. It is suggested that high relative humidity (around 94–95 per cent) may result in denser and more widely dispersed zombie graveyards. Dipterocarp forests tend to be an integration of multiple vegetation types and structures; Site 4 had a relatively sparse understory and a tall, dense canopy, particularly compared to Sites 2 and 3, which had dense understories with greater light exposure. Tall, dense canopies can trap moisture released from evaporation and transpiration within the understory, creating a micro-climate of

increased humidity (Parker, 1995). This may explain why there was a particularly tall vertical distribution of zombie ants in Site 4, as *O. unilateralis* would have been better supported by the higher vertical humidity levels.

Interestingly, we observed only two live infected ants within the graveyards, both of which occurred at Site 4. These ants had bitten into vegetation and appeared close to death. As the presence of the graveyard suggested recent spore dispersal and infection of ants within the vicinity, it was expected that more live infected ants would be found displaying signs of infection such as random directionless movement or body convulsions (Hughes *et al.,* 2011). Andersen *et al.* (2009: 428) and Pontoppidan *et al.* (2009: 1) noted that *C. leonardi* typically nest high within the canopy, well above this study's upper sample limit of 2m. This may have contributed to the reduced numbers of live ants observed, particularly those in the early stages of infection. Pontoppidan *et al.* (2009: 1) reported that infected ants spent minimal time below the canopy, which suggests that ants in the early stages of infection may have still resided within the canopy at the sites surveyed within this study. It is also possible that the convulsions, known to result in infected ants falling from the canopy (Hughes *et al.*, 2011: 6), occur relatively soon before they ascend into the vegetation and perform the 'death grip'. This lack of forest floor activity may be evidence of a defensive mechanism, whereby *C. leonardi* spend most of their time in the canopy to reduce the risk of infection. It may be beneficial to conduct a canopy search to locate live ant nests and current foraging trails to further explore the graveyard spatial dynamics. This could include live ant colonies that may be susceptible to infection in the near future.

Conclusion

The horizontal distribution of infected ants was found to be patchy within graveyard sites. The mean height of infected ants varied between sites, ranging from 28.9 in Site 3 to 57.6 at Site 4. Across all sites combined, 75 per cent of ants were found below 55cm. Our findings suggest that these heights correspond to specific zones of temperature and humidity that optimise spore dispersal and fungal growth, corresponding to the highest levels of subsequent fungal infection. These findings suggest that the behavioural manipulation of *O. unilateralis* is both intricate and possibly of great importance to the fungi's success as a parasite. It may be beneficial to further explore the dynamics of zombie-ant graveyards by examining graveyards at a greater horizontal and vertical scale, as well as investigating graveyards over a period of time. It should also be considered that the monitoring of forest areas near existing graveyards could give insight into the emergence of new graveyards and how they

develop spatially and temporally. This may expand our understanding of zombie-ant graveyards and potentially reveal how the location, size and density of ant graveyards shift over time, shedding further light on the dynamics of rainforest ecosystems as a whole. It would also aid in better defining zombie-ant graveyards in terms of distinguishing environmental conditions and ant densities.

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Investigating the factors behind differences in 'lay' and 'expert' medical knowledge in the context of fever treatment in Yangon, Myanmar

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Abstract

Greater social research aiming to understand the qualitative experiences of patients and healthcare workers is necessary in order to create informed health policies. A key aspect of this is acknowledging and uncovering how 'lay' and 'expert' medical knowledge interact and co-exist. This paper uses the context of fever treatment in Yangon, Myanmar, to investigate the factors behind differences between 'lay' and 'expert' medical knowledge.

This cross-sectional study conducts a deductive thematic analysis of secondary qualitative data from both patients and medical doctors using an adapted form of Amartya Sen's capability approach framework. Results uncover how education, socially rooted collective knowledge and unregulated pharmacies drive differences between 'lay' and 'expert' medical knowledge.

The results of this paper highlight the interdisciplinary nature of health, meaning health systems should be considered within their sociological, political and economic contexts. Appreciating the complexity of how health is understood by populations can allow policymakers to form a stronger health system by creating contextualised policies and health interventions for the general public that cater to the diversity of narratives within health systems and beliefs.

Keywords: Social medicine, expert biomedical knowledge in fever treatment, layman beliefs in medicine, traditional Burmese medicine, capability approach, Myanmar.

Introduction

There has been great interest in social literature to better understand 'layman' beliefs of treatment and medicine. This interest may stem from the changes occurring in the interactions between 'expert' and 'lay' actors within health systems. The importance of patient narratives in diagnosing illnesses had been reduced during the rise of biomedicine in the nineteenth century. The increased use of laboratories and modern hospitals aided the conceptual separation of patients from their illnesses, meaning 'expert' translation was increasingly essential for patients to understand their bodies (Bury, 2001: 266). During the late twentieth century, however, greater emphasis was placed on healthcare workers to be more open to 'lay' beliefs than previously. Consequently, social research has been interested in uncovering what 'lay' knowledge can offer to different understandings of health (Prior, 2003: 43). However, 'lay' beliefs should not be considered in isolation, as patient knowledge and treatment preferences are heavily influenced by 'expert' healthcare workers and healthcare institutions (McClean and Shaw, 2005: 746; Lambert *et al.*, 2019). Therefore, this paper examines 'lay' medical knowledge in conjunction with 'expert' medical knowledge to investigate what drives the differences in the two discourses. This expansive area of research is significant because when the qualitative experiences of healthcare workers and patients are not recognised as credible sources of knowledge, their social power to influence public policy is diminished. Thus, these actors may be deprived of their entitled share of collective financial and medical resources (Moes *et al.*, 2020: 2).

Myanmar (Figure 1) was chosen as the geographical focus of this paper as traditional medical practices are thriving in both public and private sectors (Sein *et al.*, 2014: 32). Additionally, Yangon (the second-largest city in Myanmar) is where biomedicine is most widely available relative to all regions/states in the country. This is exemplified by Yangon having the highest number of total hospital beds (10,249) available in primary, secondary and tertiary curative care out of all the Burmese regions/states in 2012, as well as having the highest rate of delivery in healthcare facilities at 69 per cent (Sein *et al.*, 2014). Thus, Yangon provides a context of both biomedical and traditional medical discourses, both relatively plentiful in supply, existing together.

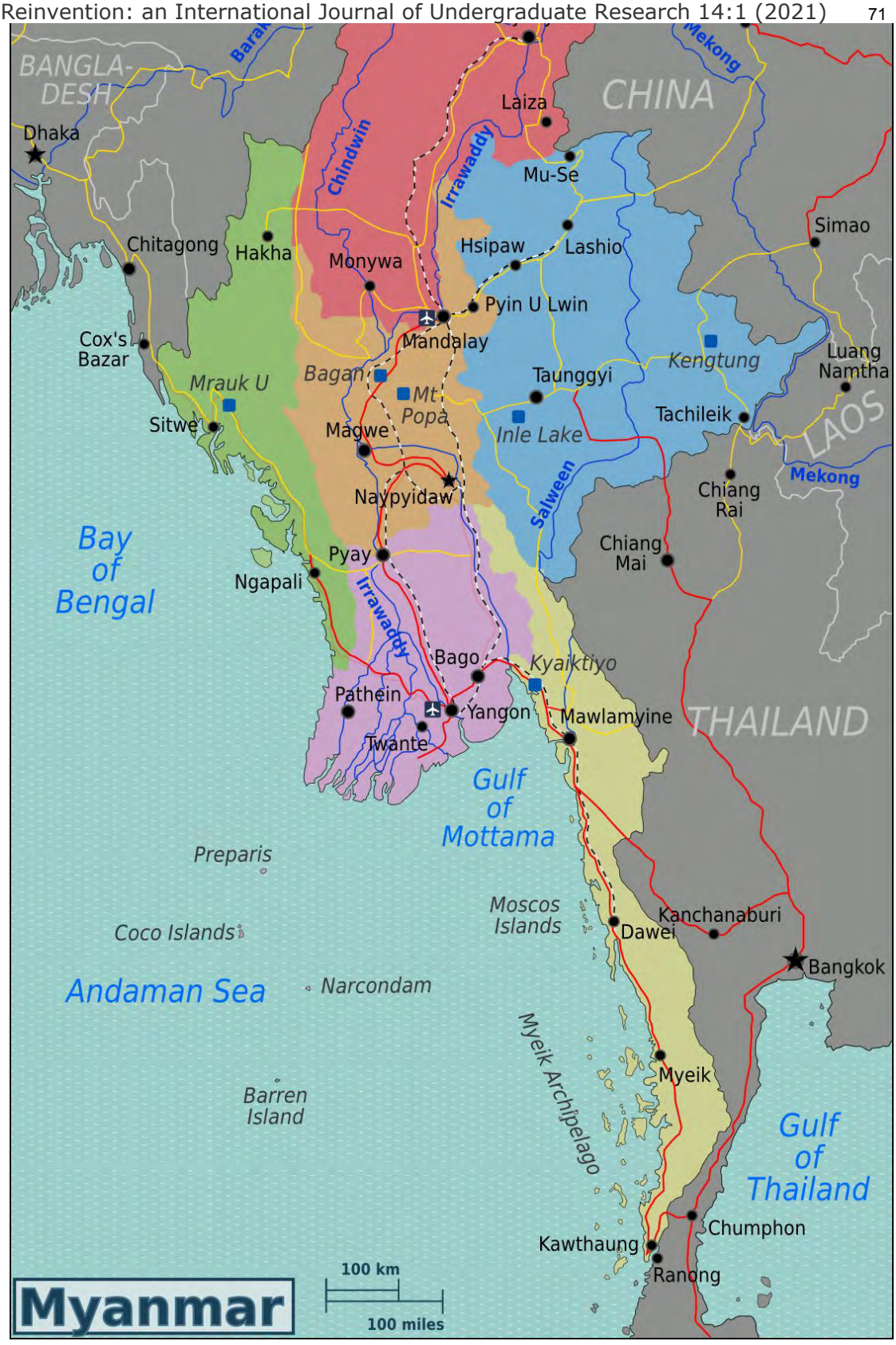

Figure 1: Map of Myanmar, source: Wikimedia Commons, 2009

When discussing 'expert' knowledge, this research is referring to biomedical knowledge – which, in the context of Yangon, is also referred to as 'Western'.

Biomedical knowledge / biomedicine denotes the branch of medicine based principally on biology (Oxford English Dictionary, 2020). It has become the dominant medical discourse around the world, in part due to most governments using biomedicine to decide on health matters (Wiseman, 2004). In contrast, 'lay' knowledge in this paper is referring to the views, knowledge, beliefs and understanding of patients (Prior, 2003) and context-specific collective knowledge. This includes the use of Burmese traditional medicine, defined as national medicine shaped by Myanmar's culture, customs, traditions and geography (Shwe, 2010, cited in Coderey, 2021: 524). Although traditional medicine is a medical discourse in its own right, its use is included under the theme of socially derived lay knowledge in this research since traditional medicine can be seen as intertwined with social and familial networks. As a result, while there seems to be a distinction between traditional medicine and lay knowledge, the relationship between the two warrants the inclusion of references to traditional medicine to be included under themes relating to lay knowledge in this study.

This paper seeks to investigate the dynamics between 'lay' and 'expert' medical knowledge within a context of multiple medical discourses that co-exist in order to highlight how potentially contrasting understandings of health and treatment coincide. The secondary dataset analysed in this paper is on the treatment of fever at a primary-care level. The original study occurred alongside a clinical trial for diagnostic biomarker testing, designed to reduce the prescribing of antibiotics. This context is noteworthy as participants were often asked about, or made reference to, their antibiotic use (as either patients using antibiotics or as doctors prescribing antibiotics), meaning the understanding and beliefs related to biomedical treatments for a fever from both 'lay' and 'expert' viewpoints were strongly discussed.

In order to investigate what factors are behind the differences between 'lay' and 'expert' medical knowledge, a capability approach framework (CAF) was applied; this was originally developed by economist Amartya Sen to measure standards of living (Figure 2). This framework measures a good standard of living as one where an individual has the opportunity to live life in the way they wish to.

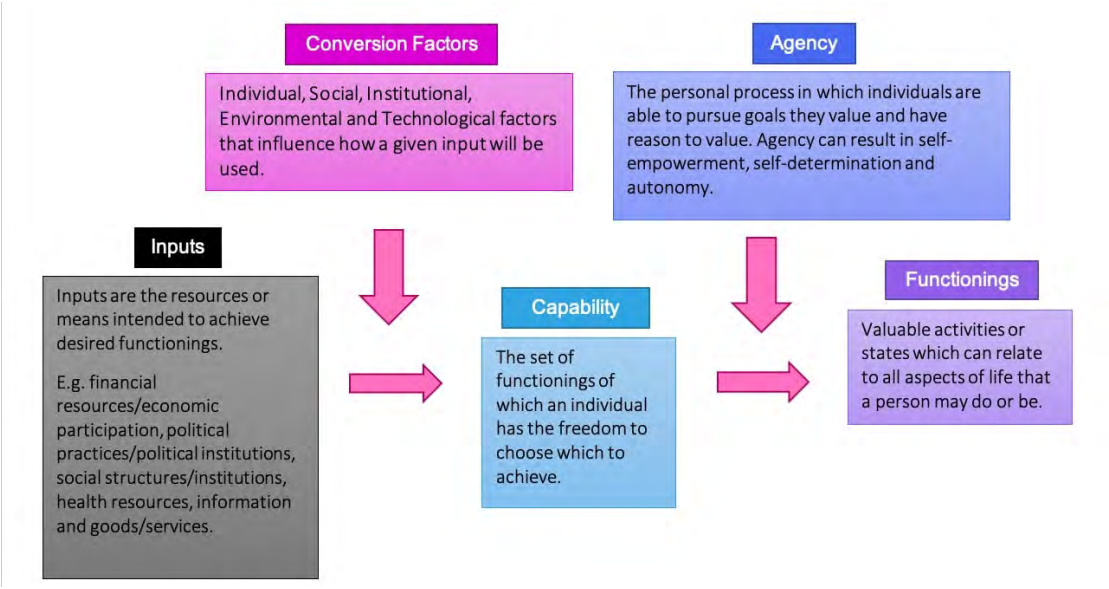

Figure 2: Basic outline of the CAF; diagram constructed by author, adapted from Alkire and Deneulin, 2009; Haenssgen, 2020; Haenssgen and Ariana, 2017; Robeyns, 2005

The CAF is used to make assessments on the multi-dimensional wellbeing of individuals and to evaluate the impact of development practices on people (Haenssgen and Ariana, 2017; Robeyns 2005; Robeyns, 2006). It was chosen as the analytical framework for this research because, in its adapted form, it relays the experiences of key actors (healthcare workers and service users in this context) within health systems in their own words, while also capturing respondents' own definitions of health and wellbeing. Furthermore, the framework allows for greater appreciation of the interdisciplinary nature of health, including the multiple factors involved in accessing health services that exist outside of the health system.

Little literature exists on Burmese knowledge gaps in health, barring Thu *et al.* (2012) and Lwin *et al.* (2014) who used cross-sectional studies to assess knowledge of tuberculosis (TB) and malaria, respectively. Thu *et al.*'s study using a questionnaire, interviews and focus group discussions with factory workers in Yangon, Myanmar, to assess understandings of TB highlighted high levels of misconception surrounding TB transmission. Lwin *et al.* used a quantitative household survey to analyse the effectiveness of the Sun Primary Health (SPH) franchise programme on the diffusion of malaria knowledge by comparing the knowledge and health practices of those within and not within SPH intervention areas. Findings suggested that areas with SPH providers (volunteer health workers trained to give basic health services) had higher rates of malaria knowledge and were more likely to go to (biomedically) trained providers. While these are both valuable contributions to the literature, there is a

distinctive lack of research using the CAF to understand 'lay' knowledge of health and treatment.

Peltzer *et al.* (2016) investigated the use of traditional medicine used by chronic disease patients in Myanmar; contrastingly, Khaing *et al.* (2015); Risso-Gill *et al.* (2013); Sommanustweechai *et al.* (2016) and Zaw *et al.* (2015) analysed Myanmar's health system and the disparities within it while maintaining a focus on biomedicine. The aforementioned literature, however, in its focus on a specific medical discourse fail to acknowledge the role of other medical discourses, despite Myanmar being heavily influenced by both biomedicine and traditional medicine.

Ariana and Naveed (2014) uniquely provide an excellent overview of how the capability approach can be used to investigate health outcomes by assessing how each component of the original capability approach can be translated to a factor impacting either the supply or demand for healthcare. This publication created the background for the adapted capability approach used in this paper. While Ariana and Naveed provide a meaningful contribution to the literature, there are still few examples of where the CAF has been applied to real-world health problems/context.

As a result of the limitations highlighted above, this research paper seeks to contribute to the literature the exposure of factors driving differences in 'lay' and 'expert' medical knowledge on fever treatment in Yangon, Myanmar. This was achieved by conducting a deductive thematic analysis of qualitative data, guided by the CAF. The CAF illustrated (Figure 2) was adapted to the context of fever treatment in Yangon to examine each stage of the treatment-seeking process from access to healthcare to being cured of a fever / relieved of symptoms.

Methods

This research paper investigates the factors contributing to tensions between 'lay' and 'expert' medical knowledge in Yangon, Myanmar, through a cross-sectional study using secondary qualitative data on the treatment of fever in a hospital and clinics (including a free-of-charge non-governmental organisation (NGO) clinic) providing primary health services. Semi-structured interviews (SSIs) with medical doctors and female patients (or female guardians of patients) of the NGO clinic and from a focus group discussion (FGD) with female patients who visited other clinics and hospitals had been conducted between December 2016 and January 2017 (see Table 1).

Respondent	Age	Education
Patient 1 (SSI)	30	10th grade
Patient 2 (SSI)	30	10th grade
Patient 3 (SSI)	32	Bachelor's degree in Burmese language
Patient 4 (FGD)	50	None
Patient 5 (FGD)	51	Bachelor's degree in History
Patient 6 (FGD)	45	None
Patient 7 (FGD)	50	Primary education
Patient 8 (FGD)	25	None
Medical Doctor 1 (SSI)	N/A	7 years of medical school and 1-month of CMV (Cytomegalovirus – eye screening program) and HIV training
Medical Doctor 2 (SSI)	N/A	6.5 years of medical school and 1-month of training for HIV and management skills.
Medical Doctor 3 (SSI)	N/A	6 years of medical school

Table 1: Table illustrating the characteristics of the study population for both the SSIs and FGDs

The data analysed in this paper is part of the mixed-method research project 'The impact of C-reactive protein testing on antibiotic prescription in febrile patients attending primary care in low-resource settings', [1] whereby I build specifically on qualitative data collected under the leadership of Dr Marco J Haenssgen alongside a clinical trial of diagnostic biomarker tests to reduce antibiotic prescription on the primary-care level. For the qualitative data, written informed consent was obtained from all participants, and the research was approved by the University of Oxford Tropical Research Ethics Committee[2] and the Myanmar Department of Medical Research.[3] The analysis in this manuscript constitutes originally intended secondary

qualitative work that has taken place under the supervision of the lead social scientist Dr Haenssgen, and therefore falls within the remit and intentions of the original social research to inform our understanding of patient–physician interactions in the context of antibiotic use in Yangon. The data analysed was thus fully anonymised to safeguard the participants and comprised a sub-sample of only female research participants to suit the scope of undergraduate coursework research. The full dataset is analysed in Haenssgen *et al.* (2019).

Originally, qualitative data from 130 interview and focus group participants across Myanmar, Thailand and Vietnam was collected alongside a clinical trial for C-reactive protein (CRP) biomarker testing. Respondents from Yangon in the original study were recruited from three clinics and one public hospital. The primary research team included native Burmese speakers, meaning translation errors were minimised. Detailed information on data collection and sampling in the primary study can be found in Haenssgen *et al.* (2019) and Zaw *et al.* (2018). CRP-biomarker testing intends to reduce the over-prescription of antibiotics at a primary-care level by using a finger-prick blood test to indicate whether a patient is likely to have a bacterial infection. Prescribing antibiotics are discouraged if a patient's test results are below a certain threshold, therefore indicating that the patient does not have a bacterial infection. Haenssgen *et al.*'s (2019) cross-case comparison study found that perceived infectious-disease risks, health-system factors and the demand-side context influenced the outcomes of the CRP-biomarker clinical trial. These results highlight the importance of appreciating context when designing anti-microbial resistance interventions.

The analysis of this paper differs from the original study – firstly, by it being a cross-sectional study rather than using the original cross-case comparison research design. This choice was made in order to focus on one context in particular detail. Secondly, this paper uses the CAF to guide thematic analysis, thereby using respondent-led understandings of health.

Deductive thematic analysis was conducted by utilising the CAF to extract and sort themes concerning the tensions between 'lay' and 'expert' medical knowledge. This process was repeated until data saturation was reached, defined as when no new or relevant information emerged. Reaching data saturation was made easier by the data sample being cohesive (relating specifically to patients and doctors undergoing or prescribing fever treatment within formal primary-care facilities in Yangon), as the findings from this study are not aiming to be transferrable to the general population (Fusch and Ness, 2015: 1413; Given, 2012). This method informs the research question

as it analyses discourses surrounding the treatment of a fever from both patients and medical doctors, explained in their own words. Due to the resource constraints associated with undergraduate research, the researcher was solely involved in the coding of data.

Results

Capability approach

The results of thematic analysis are summarised in Figure 3 and expanded upon in this section.

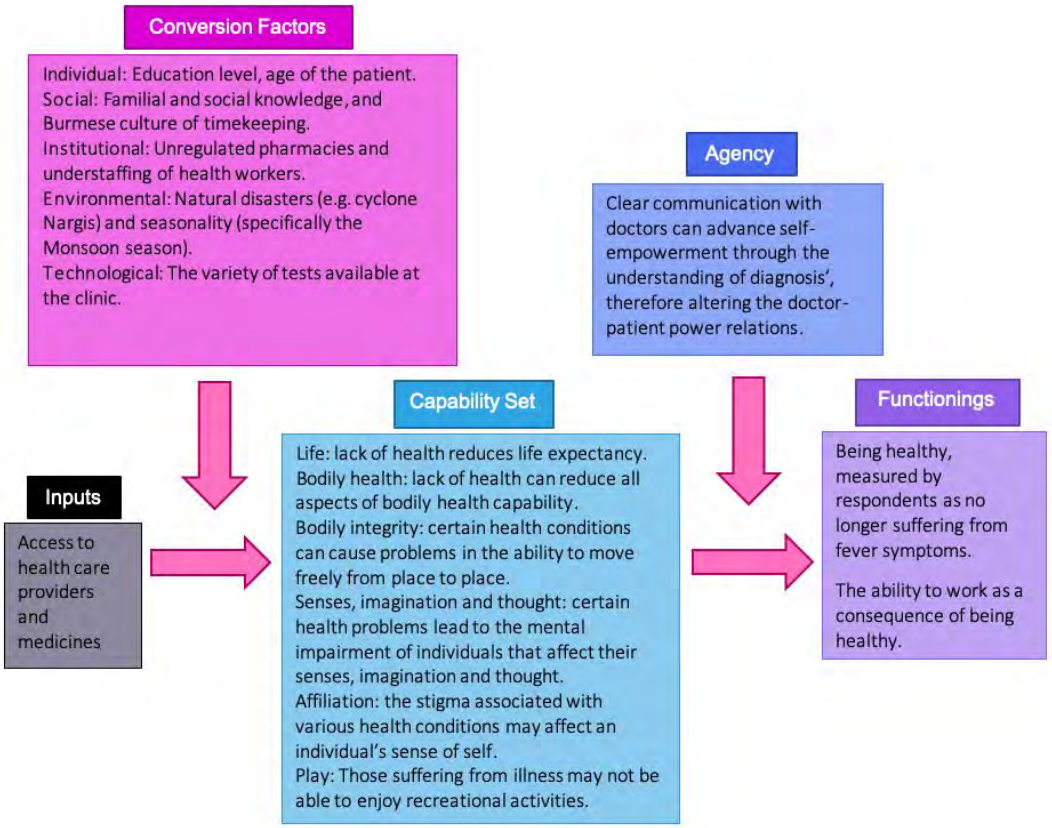

Figure 3: An illustration of the capability approach adapted to the case of fever treatment in Yangon, Myanmar. Diagram constructed by the author, adapted from Alkire and Deneulin, 2009; Ariana and Naveed, 2009; Haenssgen, 2020; Haenssgen and Ariana, 2017; Robeyns, 2005

Inputs

Access to healthcare providers and medicines is an input to the capability approach adapted to the realm of health (Ariana and Naveed, 2009) and can be seen in the context of Yangon, with most respondents living within close distance to a clinic:

> From the house, it's about 10 minutes [by motorcycle]
> — (Patient 4, FGD)

Conversion factors:

Conversion factors that may change the way health inputs are used by individuals can be split into the following categories: individual, social, institutional, environmental and technological.

Individual

The age of the patient in question can determine how a fever is treated by patients. The following quote illustrates how guardians of children are more careful with treatment for children in comparison to themselves:

> For myself, I take the medicine [...] but for the kids [...] we go to someone who knows better than us.
> — (Patient 1, SSI)

This may be due to a fear of the consequences that may arise by self-treating an illness using 'lay' knowledge.

The level of education of the patient was found to drive differences between 'expert' and 'lay' knowledge.

Social

A doctor described how the Burmese culture concerning timekeeping, which includes patients wanting to be first in receiving treatment, affects the service provided in clinics:

> Burmese people, they want to be first in getting treatment, so they come in crowds as soon as the clinic opens [...] that makes us stressed.
> — (Doctor 1, SSI)

Being pressured by crowds of patients consequently makes consultation times shorter, meaning patients feel rushed and unable to ask questions concerning their diagnosis:

> when [doctors] do check-ups [...] [I] didn't even [have] time to ask [questions]
> — (Patient 7, FGD)

Therefore, this Burmese habit can reduce patient/'layman' understanding of the doctor's diagnosis / 'expert' biomedical knowledge.

Institutional

One institutional conversion factor is unregulated private pharmacies. This is where mixed medicines, antibiotics, Western medicines and traditional medicines can be bought at an out-of-pocket cost by consumers (Sein *et al.*, 2014).

The critical understaffing of healthcare workers (Sommanustweechai *et al.*, 2016), possibly due to the low salaries for public healthcare workers relative to costs of living (Sein *et al.*, 2014) means doctors have excessive workloads, with only:

> ...four doctors for about 200 [patients].
> — (Doctor 3, SSI)

This can contribute to the short interaction times between doctors and patients referred to in the social conversion factor section, in which patients feel unable to ask questions regarding their diagnosis:

> [my doctor] couldn't stand on her feet and she fainted a lot [due to the high number of patients] [...] she couldn't wait any longer [before moving on to the next patient], so we went [home].
> — (Patient 2, SSI)

As a result, differences between 'lay' and 'expert' medical knowledge can be driven by patients being unable to rely on 'expert' explanations of their illnesses or symptoms, as well as doctors being closed off from understanding 'lay' beliefs during this diagnosis period because of the limited interaction time between doctors and patients.

Environmental

Environmental factors bring differing levels of disease. Therefore, workload pressures vary seasonally:

> during winter [...] there is more upper respiratory infection [...] and more flu. Summer [has] much less consultation overall.
> — (Doctor 2, SSI)

> In Monsoon it's more crowded [...]. I have to examine faster [...], so [...] I am scared that I might miss out on something.
> — (Doctor 3, SSI)

Natural disasters have similar impacts, such as when:

> many moved [...] to [redacted district name] after the cyclone Nargis and some would bring back their parents from their regions
> — (Doctor 1, SSI)

Natural disasters consequently contribute to doctors' already burdening workload. Cyclone Nargis, the largest natural disaster in Myanmar's recent history, initially occurring 280km south-west of Yangon before working itself further inland, caused:

> the destruction of 130 healthcare facilities [...] and [had] a severe impact on the health system and its capacity to deliver essential services
> — (Sein *et al.*, 2014: 28)

Therefore, seasonality and natural disasters cause greater work pressure for doctors, longer waiting times discussed as both social and institutional conversion factors, and can significantly impact the ability of the healthcare system to deliver services. These impacts can all influence the diffusion of knowledge from 'expert' to 'layman' and vice versa as a consequence of reduced interaction between doctors and patients.

Technological

Patients felt that more testing constituted better treatment as there is more certainty in diagnosis:

> When I [get tested], I know that they would give me something that is for my illness.
> — (Patient 2, SSI)

> We get to know [if] there is a disease or not. I appreciate it.
> — (Patient 5, FGD)

Test results, therefore, enable a stronger belief in 'expert' diagnosis because patients feel that they have been thoroughly examined and accurately diagnosed. Doctors felt similarly; in the context of the CRP clinical trial, they shared that:

> [if my] clinical assessment and the CRP test both matches and shows the need for antibiotic[s] [...] then I have more confidence
> — (Doctor 2, SSI)

Technology can provide confidence and certainty in 'expert' knowledge to both doctors and patients. With technology being unevenly spread through the health system, however, it can change the type of treatment provided to patients following their choice or option of clinic.

These individual, social, institutional, environmental and technological conversion factors highlight that the way 'lay' and 'expert' knowledge interact is highly dependent on the individual patient and doctor/clinic in question. Therefore, the social and environmental context heavily influences what differences may exist between the two discourses.

Capability set

The capability set used for this framework was adapted from the philosopher Martha Nussbaum's list of ten essential human capabilities. Nussbaum, one of the most influential scholars within the capability approach discourse, argues that these ten capabilities are essential for humans to enjoy a good standard of living (Alkire and Deneulin, 2009). Ariana and Naveed (2009) modified Nussbaum's list to the sphere of health (an edited version of six capabilities that are appropriate for the context provided by SSIs and the FDG is shown in Figure 3). This capability set encompasses several fundamental health goals that would contribute to a healthy and attainable standard of living in the context of Yangon.

Agency

Agency – concerning the individual process of achieving freedom that may involve/result in self-expression and autonomy – can be exercised through communication with healthcare workers. An example being when the guardian of a then seven-month-old patient felt treatment for a fever was not being correctly carried out:

> I went to the Head of the Hospital and told him [...] don't you have to change the cannula every week? Now the kid's leg [...] [is] swollen and there is liquid coming out [...]. Then the nurses got scolded [...]. As soon as it came off, the kid [looked] more active.
> — (Patient 1, SSI)

The exercising of agency illustrates how 'lay' knowledge of the patient is communicated to the 'experts' during fever treatment, with the consequence being a movement beyond the typical paternalist doctor–patient relationship (Goodyear-Smith and Buetow, 2001).

Functionings

Having the characteristic of being only a functioning if the individual in question values the activity or state themselves, functionings identified from SSIs and the FGD were 'being healthy' and 'being able to work as a consequence of having a healthy body'. These functionings are exemplified by respondents:

> A good treatment is when the symptoms we are feeling [are] somehow, relieved [...].
> — (Patient 2, SSI)

> It's because of health that we can work so the main importance is health.
> — (Patient 1, SSI)

These functionings indicate that as long as the symptoms of illness subside, the type of medical knowledge utilised for treatment (e.g. 'lay' knowledge as opposed to 'expert') is not of great importance.

Factors behind differences in 'lay' and 'expert' medical knowledge

In response to the research question of what factors are behind the differences between 'lay' and 'expert' medical knowledge in the context of fever treatment in Yangon, Myanmar, this study finds that the three main factors are: the education level of patients, familial knowledge passed down through generations and unregulated pharmacies.

Education

The education level of patients was persistently brought up by doctors as being a barrier to communicating 'expert' knowledge during diagnosis:

> we have many patients who are non-educated, so when they give the history, it's not precise [...] so then there is difficulty in giving medicines.
> — (Doctor 1, SSI)

Additionally, post-consultation during the purchasing of medicine, a lack of formal education continues to prevent the diffusion of 'expert' knowledge to patients:

> The medicine counter [gives the medicine] with instructions, but since they don't have much education, they might not understand it all. [...]. Then some patients could [wrongly] take the medicine.
> — (Doctor 1, SSI)

Following this lack of understanding of 'expert' knowledge:

> Patients [...] don't take [the] full course [of antibiotics]. No matter how much we explain it to them [...]. It would be better if we could give [the public] a good education.
> — (Doctor 3, SSI)

Although patients feel their diagnosis can be rushed at times (see social and institutional conversion factors), the above quotes suggest that time is not the only factor preventing adequate 'expert' explanation of patients' condition. A lack of formal education makes explaining a diagnosis to patients difficult for healthcare workers and makes it harder for patients to interpret 'expert' advice. The resulting miscommunication may be falsely identified as patients knowingly carrying out actions against doctor's advice and acting irrationally (especially at a policymaker level).

Social and familial knowledge

'Lay' knowledge can be linked to social or collective knowledge, with the use of traditional medicine being influenced by familial and social networks. This is exemplified by the following respondent:

> [their great aunt] buys the Burmese medicine. There is the instruction written on it. [E.g.] stomach pains, gastric problems [...] and if it correspond[s] to what I am feeling [...] then I take it
> — (Patient 3, SSI)

The diffusion of traditional medicine, which is intertwined with socially produced 'lay' knowledge, is highlighted here:

> [their great aunt recommends traditional medicine] to others and then they get better.
> — (Patient 3, SSI)

This illustrates the dispersion of traditional medicine as 'lay' knowledge because the respondent's great aunt shares treatment with their community, adding to or maintaining the pool of 'lay' knowledge.

Another respondent (a guardian of a patient) similarly shared their experience of the older generation of their family encouraging the use of traditional medicine in fever

treatment, even if that respondent preferred biomedicine and would not necessarily use traditional methods themselves:

> [the patient's] grandmother gave him a bath made from boiled betel leaves [...] they said it [works]. Well, they are the elderly. As long as they don't feed him, I let them do it to make them happy.
> — (Patient 1, SSI)

This highlights the role of familial obligations and dynamics in 'layman' treatment using traditional medicine, and how the diffusion of 'lay' knowledge may be socially rooted.

Unregulated pharmacies

Unregulated pharmacies are another source of 'expert' knowledge in the sphere of health. However, due to the lax enforcement of regulations and a lack of adherence to the qualifications needed to run pharmacies (Sein *et al.,* 2014), the information provided by unregulated pharmacies can be misleading or incorrect. The confusion this can cause patients by impacting their 'lay' understanding of illness is exemplified by the following experience of a respondent:

> the clinic gave me this [prescription], I went to the pharmacy to buy this and [...] the salesperson told [me] that it was for cancer. And I got scared.
> — (Patient 4, FGD)

According to the interviewer, the prescription in question was likely to be for vitamins. The incorrect 'expert' knowledge provided by unregulated pharmacies resulted in the respondent being shaken from the experience, explaining that:

> since they told me it was cancer, I was shocked [...] I couldn't sleep all night because I was so worried.
> — (Patient 4, FGD)

Although this situation occurred in part due to a lack of communication with the patient's doctor who did not explain the diagnosis or medicine to her, doctors nonetheless feel that pharmacies need stricter regulations to tackle both misinformation and antibiotic resistance:

> Doctors mainly have limitations, but [...] the drug stores are out of control.
> — (Doctor 3, SSI)

> To reduce [antibiotic resistance], the main thing is [...] to put strict regulations to the pharmacies. Like only those who received training or those who have a licence can open up pharmacies.
> — (Doctor 1, SSI)

Tackling antibiotic resistance with stricter enforcement of regulation could also reduce the diffusion of false information that is potentially understood by patients as 'expert' knowledge.

Discussion

The objective of this paper was to investigate the factors that drive the differences in 'lay' and 'expert' medical knowledge in the context of fever treatment in Yangon, Myanmar. Findings of this study show that the level of education of patients, the collective knowledge of the community that can be tied to familial knowledge, and the knowledge contributed by unregulated pharmacies are the key factors that enable differences between 'lay' and 'expert' medical knowledge.

Broadly, the capability approach illustrates that following the generally good access to healthcare providers and medicines in Yangon, several conversion factors define how each individual chooses to be treated for a fever, as well as change the way healthcare providers work to deliver treatment and medicine. Conversion factors are the context-specific reasons as to why the fever treatment and the outcomes of treatment can differ from patient to patient and healthcare worker to healthcare worker. These factors are individual (the age and education of patients), social (socially rooted/familial knowledge as well as the Burmese culture of arriving early to clinics), institutional (the lack of pharmacy regulation and understaffing of healthcare workers), environmental (variations in demand for health services due to seasonality and occurrence of natural disasters) and technological (the types and variety of tests offered by clinics) in nature. The list of possible actions or states that the patient has the freedom to choose to work towards achieving is the capability set. Having good health ensures that patients can choose to achieve what Nussbaum, adapted by Ariana and Naveed (2009), defines as the fundamental aspects of a good life (high life expectancy; bodily health capability; bodily integrity/the ability of the body to move freely; senses, imagination and thought; a lack of affiliation to an illness that can affect an individual's sense of self; and play/participation in recreational activities). The results of this study show that patients felt being relieved from fever symptoms and being healthy enough to work are the desired outcomes of treatment and what

they value in life (functionings). The journey towards achieving functionings can involve the exercising of agency. This can be achieved through communicating 'lay' knowledge with doctors, which can then enable a move beyond typical paternalistic doctor–patient relationships.

The social research of this study is helpful for highlighting what 'lay' knowledge can offer to understandings of health, as well as the complex interactions existing between 'lay' and 'expert' knowledge. Therefore, this study contributes to the growing literature on the qualitative experiences of healthcare workers and patients to illustrate their importance in informing public policy.

A limitation to this research, however, is possible construction bias, as highlighted by Robeyns (2006). Using secondary data that was not collected with the intention of inputting into the CAF means these findings are not derived from an optimal dataset. To rectify this for future research, collecting data created for the inputting to the CAF would lead to more reliable results.

Additionally, as the nature of the capability approach is 'radically underspecified' (Robeyns, 2006: 371), the adaptation of the capability approach is highly individual and open to interpretation – to the extent that even when reproduced using the same data, another researcher may find completely different results. This raises the question of how useful such a framework is for real-world application – in the field of policymaking, for example – if outcomes of a study are highly dependent on the researcher and researcher's background. However, if in future research, researchers from multiple backgrounds interpreted the same dataset, an aggregated form of the capability approach could be constructed to fulfil the multi-disciplinary nature of the framework.

Conclusion

This research highlights the usefulness of communication with healthcare workers and patients to understand their interactions with health in their own words. Factors such as the education of patients, the pool of collective 'lay' knowledge and institutional context must be considered by policymakers when designing biomedical health policies and interventions. Although unintended consequences are inevitable, considering such factors can improve the likeliness of successful health intervention and policies.

Further research in the form of an ethnography could be undertaken to investigate the variations of knowledge across Myanmar. Observing the behaviour described by respondents in their interviews and focus groups, as well as collecting data from a number of regions and for a greater variety of illnesses, would allow a more comprehensive understanding of Myanmar's health system on a national scale. Furthermore, data should be collected from both males and females as, although only data from female participants was provided by Haenssgen *et al.* (2019), studying how both sexes interact with their local environments and knowledge bases would provide a more accurate overview of Myanmar's health system.

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Endnotes

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[2] Ref. 49–15

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Commentary: sustainable development as theme and platform for interdisciplinary undergraduate research

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A striking theme among the inspiring contributions in this issue of *Reinvention* is 'sustainability'. As faculty member at the Division of Global Sustainable Development (GSD) at the University of Warwick, it is indeed a moment of joy but also an opportunity for reflection as the journal hosts two new pieces from our student body: Onubha Hoque Syed writes on the global health priority of drug-resistant infections in 'Investigating the factors behind differences in “lay” and “expert” medical knowledge in the context of fever treatment in Yangon, Myanmar' (Hoque Syed, this issue), and Virginia Thomas-Pickles, University of Warwick student, reviews the book *The Uninhabitable Earth: A Story of the Future* by David Wallace-Wells (Thomas-Pickles, this issue;) alongside Valerie Kay of Monash University (Kay, this issue). Other contributions to this wonderful issue touch on the notion of 'sustainable development' as well: ecosystem dynamics in Gunung Mulu National Park in Malaysia, the consequences – intended as well as unintended – of international humanitarian responses in Haiti, and the question of how environmental sustainability manifests in higher-education structures as well as curricula.

The presence of this theme in *Reinvention* is no coincidence: Sustainable development is an interdisciplinary – sometimes transdisciplinary! – endeavour which recognises that the challenges facing our world cannot be solved with just one set of tools, nor with the narrow analytical focus often introduced by rigid disciplinary boundaries. To illustrate this point, let us consider the topics covered by the GSD student contributions in this issue. Both drug resistance and climate change are commonly framed as the next great topics that the world will have to grapple – orders of magnitude more significant than even the impact of the COVID-19 pandemic, essentially in whichever metric we wish to apply (e.g. death toll, economic losses or

impact on social organisation of humanity). However, the scope of GSD as a transdisciplinary field – superseding the conventional boundaries of any one discipline – helps us to understand how interrelated these subjects in fact are, rather than presenting as separate development challenges.

Research and thinking about drug resistance are intuitively dominated by medical perspectives (Haenssgen *et al.*, 2019) – perhaps, for many, naturally so. After all, we are talking here about illness, pharmaceuticals and how we provide health care. But very recently, a range of studies into the subject has uncovered how drug resistance is not merely a biological process (one in which microbes develop a tolerance against pharmaceuticals through evolutionary selection processes that could fundamentally undermine pillars of modern medicine). From an interdisciplinary perspective, we begin to see drug-resistant infections as a global, social and even environmental phenomenon that we can link to micro-level interactions between doctors and patients as well as to macro-level patterns of the economic organisation of societies and inequalities – and the widespread dependence on antibiotics and other 'modern' pharmaceuticals could even reinforce these inequalities (Tompson *et al.*, 2021).

Onubha Hoque Syed's work exemplifies what we can learn from taking medical science perspectives out of focus and instead consider the dynamics embedded in patient–doctor interactions (Hoque Syed: this issue). By interpreting qualitative data from Myanmar through the capability approach (Sen, 1999), we see not only heterogeneous personal priorities but also distinct forms of knowledge and sensemaking that shape how patients access and use medical treatment. If the assertion of autonomy and dignity, conflicting ways of thinking about health, and the importation of Western solutions into a new context drive the use of antibiotics (and, biologically speaking, expose microbes to more evolutionary pressure), can we still regard drug resistance as a medical topic in which seemingly needless antibiotic use is all too often framed as 'irrational' or outright 'laziness' (Littmann and Viens, 2015: 215)?

And yet, it would be similarly limiting to consider drug resistance only as a social science subject. Should we indeed regard disciplinary boundaries at all, or rather define the specific layers and threads of analysis that are important for our understanding of such global development problems? The development of drug resistance is, for instance, amplified by environmental factors. Contaminated sewage (owing to lax or non-existent regulations or perverse economic incentives) can encourage the development of drug-resistant pathogens (Booton *et al.*, 2021). These pathogens could subsequently spread locally and across borders – perhaps even

entailing the next global health crisis – as we resume our pre-pandemic travel patterns or as the microbes themselves adhere to and travel with the now ubiquitous microplastic particles that have come to represent the scale of anthropogenic activity (Liu *et al.*, 2021; WWF, 2019). Likewise, the micro-level social interactions examined by Onubha Hoque Syed are partly a reflection of local cultural contexts, but they can also be driven by the stress, uncertainty, and hardship induced directly and indirectly by global climate change (Doherty and Clayton, 2011; Mushavi *et al.*, 2020). Is it, therefore, even possible to frame and study a concept such as drug resistance *solely* as a biological, medical, social or environmental phenomenon?

That these considerations are not limited or specific to drug resistance becomes clear if we shift our focus to climate change as another GSD challenge. Climate change is clearly one of the most significant issues that the world will be facing in the twenty-first century, but it is not separated from other major challenges such as global inequalities, hegemonic systems of thought or – as we have just seen – drug-resistant infections. The reviews by Virginia Thomas-Pickles and Valerie Kay (this issue) highlight not only the apocalyptic threats and kaleidoscopic uncertainties that arise from climate change and that can undermine individual and collective action, but they also illustrate powerfully that global economic organisation and geopolitical structures at the same time enable and obscure the climate-change trajectory on which we find ourselves. The corollary of these considerations is that the tools and solutions of past mono-disciplinary research are insufficient to accommodate and manage the complex interrelatedness of global development challenges that inter- and transdisciplinary perspectives bring to the fore.

But cultivating such perspectives is no mean feat. Academic reward systems often require scholars to identify in accordance with traditional disciplinary niches, and ever more competition in the academic labour market will rather drive specialisation than generalisation (Haenssgen, 2020). The polarised debates and disciplinary turf wars that such specialisation entails are evident in growing references to 'epistemic trespassing' (Ballantyne, 2019) that delegitimise 'non-expert' viewpoints outside one's own area of expertise – as if knowledge were siloed and absolute. To engage in interdisciplinary conversation and nuanced analysis, we need to cultivate humility about our own partial knowledge and training, as well as openness towards the partial insights we gain from other disciplines and individuals (who also need not be academics or 'experts'). As Sinden (this issue) illustrates, universities play a central and growing role in this context by training and demonstrating sustainability – environmental or otherwise. *Reinvention*, too, asserts its critical role in this space as a

platform to cultivate the interdisciplinary thinking that is so vital for constructive engagement and for solving the problems of the future.

About the author

Marco J Haenssgen is Assistant Professor in Global Sustainable Development at the University of Warwick, where he teaches health and sustainable development, research methods and supervises interdisciplinary dissertation research on the undergraduate level. A social scientist by training, he works at the intersection of development, wellbeing and socio-technological change. Marco has led and implemented interdisciplinary research projects across Asia with as many as 30 international collaborators and research team members, using a wide range of research methods spanning surveys, qualitative research, policy evaluation and participatory techniques. In his recent book *Interdisciplinary Qualitative Research In Global Development: A Concise Guide*, he provides concrete guidance for how newcomers can navigate the at times obscure and contentious space of academic publishing in interdisciplinary research projects.

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The Uninhabitable Earth: A Story of the Future

David Wallace-Wells (2019), *The Uninhabitable Earth: A Story of the Future*, London: Penguin Books,
320 pp, ISBN: 978-0-141-98887-0 (paperback)
ISBN: 978-0-525-57670-9 (hardback)

Valerie Kay, Climate Change and Public Health, Monash University, Australia

David Wallace-Wells says that he 'is not an environmentalist' and does not think of himself as 'a nature person' (Wallace-Wells, 2019: 6). However, he collected stories and evidence about climate change for years, and thought that climate change was not receiving the attention it merited. He wrote an article in the *New York Magazine* in 2017 that generated great interest – and some controversy (Matthews, 2019). He then went on to write *The Uninhabitable Earth*, which has become a best seller.

The success of the book is a testament to the author's ability to create an effective story about climate change. I teach graduate students about climate change and health, and part of my work involves updating teaching materials to make climate science accessible. I envy the author's ability to create a gripping and coherent narrative; this is particularly seen in Chapters 1 to 12, which deal with the impact of climate change on heat, hunger, oceans, disasters, air quality, conflict and more.

I was also struck by this statement, made in response to the former governor of California talking about devastating wildfires as a 'new normal':

> The truth is actually much scarier. That is, the end of normal, never normal again.
> — (Wallace-Wells, 2019: 18)

This particularly hit home because of recent conversations with students about extreme heat, (virtual conversations, of course, as we are in a pandemic of a new zoonotic disease; a phenomenon that is expected to become more frequent due to ecological degradation and climate change; United Nations Environment Programme and International Livestock Research Institute, 2020). Those of us who live in the Asia-Pacific region may think we are used to heat, that we can cope with it. It is hard

to accept that some parts of our region may experience essentially unsurvivable heatwaves this century. (Im, Pal and Eltahir, 2017).

Some climate scientists objected to what they saw as a catastrophic or 'doomist' tone – a focus on low-probability worst-case outcomes – in the original 2017 article, and to some extent in the book (Matthews, 2019). There are concerns that scaring people can paralyse them and make constructive action less likely. Wallace-Wells, however, suggests people need to be scared to make them aware.

I have to admit there are some things about this book I do not like. I am not the intended audience, and the good it appears to be doing by informing people about climate change probably far outweighs any concerns I have. Nevertheless, I have some.

When preparing this review, I looked through recent issues of this journal, and saw a review of *Invisible Women* (Dolamulla and Tosun, 2020), which resonated. One of my concerns about *The Uninhabitable Earth* is that women are largely invisible in the book.

Gender, and intersectional factors around race, imperialism, class and indigeneity, is very relevant to climate change. Empirically, organisations and societies where women are more involved do more to address climate change (Ergas and York, 2012; Buckingham, 2010; Ben-Amar *et al.*, 2017), while conversely, conservative white men are most likely to be climate change deniers (McCright and Dunlap, 2011). Historically, there is a nexus between capitalism (which the author acknowledges), imperialism and racism (which he partially acknowledges) and patriarchy (which he does not acknowledge) in contributing to ecological degradation. Wallace-Wells cites a key scholar in this area, Carolyn Merchant, but does not mention her work on the nexus of patriarchy and capitalism (Merchant, 1989).

Other concerns are the frequent throwaway digs at 'liberals' and 'progressives' for trying to do something about climate change, and apparent suggestions that individual action is somehow opposed to collective action. (The latter is a persistent and misleading trope in climate discussions, although admittedly this makes more sense in the US where a person might conceivably – at a stretch – feel something like 'I purchase green wellness products in the supermarket, therefore I don't need to vote', than in Australia, where voting is compulsory). The author's tendency to have digs at others may have something to do with his confession in the introduction:

> I toss out tons of wasted food and hardly ever recycle; I leave my air-conditioning on; I bought into Bitcoin at the peak of the market
> — (Wallace-Wells, 2019: 33)

It might have been more enlightening if this confessional theme had been followed through, and the author had examined why he acted like this, rather than expressing apparently patronising views about people trying to do the right thing:

> Western liberals have comforted themselves by contorting their own consumption patterns into performances of moral or environmental purity – less beef, more Teslas, fewer transatlantic flights
> — (Wallace-Wells, 2019: 32)

I admit, I am one of the people doing those things (although I do not have a Tesla, or even a car; I have a bike, and it is not even electric, although it is a pretty good bike). But I am not doing this because of moral purity, I am doing it because I would like my children and my grandchildren, and everyone else's, to have a decent – habitable – world to live in.

In general, reduction in consumption does not seem to be seriously considered in the book, in spite of evidence that wealthy, high-consuming people are responsible for high proportions of emissions (Ivanova and Wood, 2020). A minor but seemingly telling point is that Dr Jason Hickel, a researcher on sustainable economies, is included in a chapter that focuses on fringe views, even though Hickel is described as an 'incisive' theorist (Wallace-Wells, 2019: 207).

I suggest people read Chapters 1 to 12 to get a gripping picture of what climate change is doing and will do in the future if we don't act as soon and do as much as possible to mitigate it, and then browse the rest of the book for interest. Throughout, however, I recommend ignoring the digs at people who are trying to do something about climate change. The major barriers to action on climate change are political (as the author acknowledges, by urging people to vote), supported by the building coalitions of people who are trying to do the right thing, which seems more useful than patronising them.

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The title of this book, *The Uninhabitable Earth: A Story of the Future*, offers a suggestion about the bleak picture its contents will paint. Split into four sections, the book considers the future of human civilisation in this age of climate change. The first section, 'Cascades', sets the scene, discussing increasing greenhouse gas emissions

against the backdrop of unsuccessful climate policies. In this section, Wallace-Wells challenges the idea that carbon emissions are mainly historical, noting that over half of these emissions have been produced since 1992 (p. 4), therefore highlighting how humanity has continued generating carbon emissions, despite being aware of the consequences.

Moving away from downplayed climate-change threats portrayed in the media and politics, this book delves deeper into a wide range of lesser-known impacts alongside the commonly known impact of sea-level rise. Cleverly, scientific concepts are interwoven throughout these threats, explained in an easily accessible way. One impact discussed is the response of bacteria in the human body to changing climatic conditions. Wallace-Wells recounts the unforeseen deaths of saiga (a species of antelope) following intense heat leading to usually harmless bacteria in their bodies overwhelming their organs (pp. 113–14). While some may criticise the presentation of these impacts as alarmist, such shocking details provide a wake-up call to the reader. The full extent of the impact of climate change is unknown – so action is needed now.

Repeatedly, the reliance on technology to offset emissions is discussed. Wallace-Wells argues that technology is not the barrier to action; instead, it is the socio-political will to overhaul current systems. With continually growing societal consumption, technology cannot undo the damage being caused. This critique of reliance on technology, and subsequent failings of societies to change their actions, relates to previous chapters, noting how the need for international governance has not been fulfilled and criticising the failings of international treaties to instigate significant change. This emphasises the central theme of the book: civilisation lacks – and must recognise the urgency of – the collective will needed to change its actions to prevent the severest impacts of climate change. This theme continually incites reflection on current individual lifestyles and on the actions of wider society.

Interestingly, Wallace-Wells devises the term 'Climate Kaleidoscope' to explain how civilisation is 'mesmerised by the threat directly in front of us without ever perceiving it clearly' (p. 143). I find this term enlightening and a true reflection of the problem that society must overcome. This links nicely into the short final section, 'The Anthropic Principle', which considers why humanity is aware of the horrors of climate change yet seemingly ignores it. Wallace-Wells argues that society should be empowered to act by the existence of civilisation and how unlikely it was to emerge, thus using collective choices to limit climate change – again returning to the underlying central theme of the book. I had not encountered this argument before and

was dismissive of it at first, but found that, over time, it really provoked reflection. The Earth will continue with or without humanity, so it is up to us collectively to ensure our civilisation lives on, by taking advantage of the mathematically extremely unlikely existence of mankind, and therefore the unique opportunity we have.

A substantial amount of credible secondary research was conducted in the writing of this book, amounting to 65 pages of references. While I praise this, and many other aspects of the book, I do have one over-arching criticism. Throughout the book, 'we' is used to highlight how everyone is responsible for ensuring that the impacts and suffering climate change will cause do not prevail. While useful for provoking thought, this arguably neglects the marginalisation, unequal voice and unequal contributions briefly touched on at the start of the book. Furthermore, China is repeatedly mentioned as a large greenhouse gas emitter. However, while true, the narrative neglected to discuss the causes of this. It fails to note how a significant proportion of these emissions are exported, driven by the demands of consumption-driven nations such as the US and UK. I feel this is a missed opportunity; such a discussion would have added further weighting to the argument of issues in current societies.

Overall, however, this book is a refreshing take on the climate-change debate. Through his engaging, passionate writing style, Wallace-Wells coherently presents his views on the climate issue. He leaves the reader with optimism that, collectively, we *can* overcome climate change. This book is a great introduction to the complexities and future consequences of climate change. It also provides an interesting, thought-provoking perspective that raises different considerations for those already with insight who want to know more.

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