GLOBAL ENCOUNTERS: NEW VISIONS

GENV

JOURNAL OF GEOGRAPHY AND PLANNING
VOLUME 2 | MAY 2022

Table of contents

Letter from the editors

The Editorial Board is proud to present the second volume of Global Encounters: New Visions Journal. Launched in 2020, GENV Journal is an annual publication that brings together exemplary and diverse undergraduate geography work at Queen's University.

We want to extend a big thank you to the many students who submitted their papers for publication this year. 2021-22 presented us with a tremendous number of excellent papers, projects, and alternative scholarship to choose from – making the selection process a difficult one.

The submissions in this volume showcase all years of undergraduate work, and vary from examining the unprecedented COVID-19 effects, the energy sector, groundwater flow pathways, health distributions, film reviews and poetry. These pieces reveal the fast-pace change and adaptation of society, as well as the capacity for resilience and continued struggle for justice.

This second volume of GENV Journal would not have been possible without the collaborative efforts of our growing and dedicated editors, authors, and faculty advisor (Dr. Laura Jean Cameron) who took time during busy semesters to bring the journal together. We would also like to thank the Department of Geography and Planning at Queen's University in assisting us in the production of this journal. A particular thanks to Prof. Paul Treitz, interim Head of the department, who committed three years of funding to GENV Journal to be published in hard copy for authors, editors, and the department.

The Global Encounters: New Visions Journal Editorial Board

Contributors

Articles

Cody Rowe — ***The plight of the feathered pariah: The constructed values of conservation***

I am graduating with a Bachelor of Arts degree majoring in Geography and with certificates in urban planning studies, law, and global action and engagement. My interest lies in exploring animal-human relationships through the historical and political interactions that shape these relationships. Of particular interest, are designations of "pest" and "trophy" species and the motivations behind these titles. After graduation, I intend to further explore communities and their unique relationships with animals, alongside my partner.

Nathaniel Katz — ***The impact of geospatial socioeconomic inequalities: Exploring health inequalities in Rio de Janeiro***

Nathaniel Katz is a fourth year Sociology student at Queen's University, currently completing a Certificate in Urban and Regional Planning. In addition to his research on Rio de Janeiro, Nathaniel is also conducting an independent Study on the Canadian Housing and Mortgage Corporation under the supervision of Professor David Gordon. While Nathaniel has a wide range of research interests, he is particularly focused on issues of systemic inequality on the global and regional levels.

Kelachi Nsitem — ***The spatial distribution of asthma and its disproportional effect on BIPOC and marginalized communities in Canada***

Kelachi Nsitem is a third-year student in the Bachelor of Science Honours program at Queen's University, specializing in Environmental Life Sciences with a Certificate in Law. Her interest in health equity, epidemiology, and the pathophysiology of disease inspired her to join Queen's MedLife club where she will have the opportunity to volunteer with a local mobile clinic in Ecuador in the spring of 2022. She looks forward to further research in the areas of Global and Public Health, particularly related to health inequities across population groups. When she is not busy with her academics, she enjoys competing on the Queen's Varsity Fencing Club, dancing with African-Caribbean Students' Association dance team, discussing Black hair, fashion, and entrepreneurs with Queen's Black Fashion club, baking, and knitting.

Sophie Perrett — ***Investigating the genesis and flow pathways of groundwater seeps in a continuous permafrost setting using dissolved organic matter chemistry***

My name is Sophie Perrett. I came to Queens University in 2019 as third year exchange student from the University of Sheffield, UK. I completed my undergraduate degree in Geography obtaining a first class. I am now pursuing a master's degree at the University of Leeds in Sustainability and Consultancy.

Tabatha Rahman ***Investigating the genesis and flow pathways of groundwater seeps in a continuous permafrost setting using dissolved organic matter chemistry***

I am a first year PhD student in geography at Université Laval. I study permafrost and ground ice in the continuous permafrost zone of the Hudson Bay Lowlands of Northern Manitoba. In 2021, I completed my Master's with Dr. Scott Lamoureux at Queen's, where I worked on active layer thermal regimes at the Cape Bounty Arctic Watershed Observatory in the High Arctic. I was also a physical geography editor for the Global Encounters: New Visions Journal in 2020/2021.

Cedelle Pereira ***Investigating the genesis and flow pathways of groundwater seeps in a continuous permafrost setting using dissolved organic matter chemistry***

Cedelle Pereira is a PhD candidate who works in the FaBRECC lab under the supervision of Dr. Melissa Lafrenière. Her research investigates how different landscape cover (e.g., vegetation and permafrost disturbances) and seasonal hydrology influence carbon fluxes in High-Arctic Watersheds. Cedelle is hopeful to use her research to better comprehend how carbon composition and concentration vary in High-Arctic streams in response to climate change. In her free time she enjoys hiking, bird watching, and traveling.

Melissa Lafrenière ***Investigating the genesis and flow pathways of groundwater seeps in a continuous permafrost setting using dissolved organic matter chemistry***

Prof. Melissa Lafrenière is a professor of Geography at Queen's University. Her research program examines the impact of climate change and anthropogenic activities on the hydrology, water quality, and biochemical processes of glacial and permafrost watersheds.

Jake Erlanger ***The San Gorgonio Pass Wind Farm as a model for future projects***

Jake Erlanger is in his fifth year of undergraduate studies at Queen's University, graduating in spring 2022 with a Bachelor of Science (Honours), majoring in geography and minoring in mathematics. Jake's research interests are in atmospheric and aquatic sciences with curiosities in aviation meteorology and physical limnology. Outside the classroom, Jake enjoys spending time in the great outdoors by means of backcountry canoe trips and cycling, as well as immersing himself in foreign cultures via backpack traveling and learning languages. He is proficient in Spanish and plans to learn French next.

Film review

Megan Hoogaars ***Effects of the ecomodernist perspective:* RiverBlue *film falls short***

Megan Hoogaars is in her final year of her Bachelor of Arts at Queen's University. She is majoring in Global Development and is also a Concurrent Education student that will finish her Bachelor of Education in 2023. Megan found a passion for Human Geography and has taken many Geography courses as electives. She hopes to blend social justice with Geography in her future classroom.

Poster

Debbie Windholz ***Rotten on both ends***

I am a Canadian living in Japan and a third year student at Queen's University in the Liberal Studies program. I'm a returning student, having taken a considerably long time off for child-raising and work. I am interested in issues relating to educational environments and optimizing learning conditions. I hope to explore methods to enable learners to utilize their creativity and critical thinking skills. I frequently hike, make art, cook, and surf (the ocean and the net!).

Poetry

Danielle Hope Edwards ***From the roots I grow***

Danielle Hope Edwards, otherwise known as Danni, is a singer/songwriter from Southern Ontario, of Jamaican heritage. Danielle Hope is going into her 4th year at Queen's University in the Concurrent Education (teaching) program. She writes her songs, creates her art and written pieces to share her experiences with the intention of bringing awareness and hope to viewers. This poem "From The Roots I Grow" is inspired by George Ella Lyon's poem "Where I'm From". Danielle Hope was introduced to this piece by Queen's University Professor Laura Jean Cameron. "I hope you will follow along with me on this journey of Hope" - Danielle Hope.

Policy brief

Essi Amegbeto, Sara Din, Aria Goldin, and Sandra Masson ***Addressing chronic malnutrition and food insecurity in Madagascar through cricket farming***

Interview

Y. Kou, Shield Zhao, X. Chen, Rosella Meng, and Jennifer Hosek ***Queen's Chinese students' experiences of the pandemic's first year: A mid-summer 2021 discussion***

Y. Kou grew up in Wuhan, China and came to Canada in 2016. He is a fourth-year Politics Major and World Language Studies minor who did his first year at the Bader International Study Center in the UK before coming to Queen's main campus. Shield Zhao is third-year Linguistics major born and raised in a northern Chinese city near the capital. X. Chen is a 2021 Queen's graduate in Physics who lived in China until high school graduation. The epidemic has changed many of her previous views on the world and taught her "the importance of truly understanding others; I plan to learn more about different ideas from different regions in the future." Rosella Meng is a third-year biochemistry student. In her spare time, she enjoys watching dramas, reading fanfiction, and swimming. She hopes to go to graduate school and continue into research. Jennifer Ruth Hosek is a Queen's professor whose home department is Languages, Literatures, and Cultures. The four students in this discussion took her courses. Hopefully out of an abundance of caution, we decided that the students participate under pseudonym.

Cover illustration

Lee Nguyen

Lee is pursuing a Master of Science degree in Physical Geography with the Department of Geography and Planning at Queen's University. Their research examines the influence of permafrost on groundwater-surface water dynamics in Iqaluit, NU. In their spare time, they are fond of reading and sketching flowers in the understory of forests.

The plight of the feathered pariah: The constructed values of conservation

Cody Rowe

Abstract

In 2019, the Ontario government proposed legislation to open an unprecedented hunting season on double-crested cormorants. This legislation positioned cormorants as the only game bird species in Ontario without a possession limit or means to record the number of cormorants killed. The first hunting season resulted in birds left to spoil and the near-collapse of cormorant colonies in Ontario. The human construction of double-crested cormorants as an uncharismatic and nuisance species created support for the hunt and generated revenue for the multi-billion-dollar sport hunting industry. This article relates charismatic and uncharismatic species to nuisance species as they are experienced within conservation. The Numb-Nuisance framework is proposed to conceptualize the relationships with and between species to understand the impacts of human-imposed instrumental value on nuisance species. This article considers the use of language, life histories, and the construction of the pristine to explore the threshold between numb and nuisance species.

Introduction

In 2019, the Ontario government proposed legislation to open an unprecedented hunting season on double-crested cormorants within the province (MNRF, 2020a). This hunting season challenges the purpose of conservation as preserving the pristine and redefines human relationships with hunted species. Centuries of anger toward the double-crested cormorant have drawn justifications for the hunt despite a lack of scientific research (King, n.d.). As a result, the first open season resulted in the unrecorded deaths of countless birds (Ruiter, 2019). Through the case study of the double-crested cormorant, this paper seeks to unravel the complexities of the seasonal hunt to understand the role of subjective valuation within conservation in Ontario and the resulting financial benefits. An animal geographic lens is employed to explore the hierarchical classification of species labelled nuisances to tease apart the concept of the numb and introduce a framework that seeks to understand the inter-species relationships of humans and 'pests.' This paper begins with a review of current literature surrounding the valuation of species and a summary of the seasonal hunt. A discussion of how values are assigned through conservation follows the review and is succeeded by a review of the implemented legislation and its consequences. The paper concludes with the application of the Numb-Nuisance spectrum to the case of double-crested cormorants within Ontario.

Literature review

Animal geography

Animal geography provides a lens to understand animals as social beings, constructed through human interactions and shaped by power dynamics (Hovorka, 2018). Developed from the sociological concept of human networks and interactions within, animal geography views the animal as an active participant in the construction of their species (Despret, 2016; Hovorka, 2018). The spaces animals and humans occupy are realms of interaction, constructed by the participants of the situation. Hovorka explores this further with multispecies ethnographies that seek to unsettle human dualist ontologies to recognize agency of individual animals and social groups of animals. In human-animal interactions, humans assign social value to animals in ways thought appropriate by humans to construct a tolerable hierarchy of animals. Much research within animal geography has focused on pets, and species within the rural environment (Hovorka, 2018; Despret, 2016; Jerolmack, 2008). In this, a hierarchy is constructed without the inclusion of urban species.

Hovorka (2018) explores this hierarchy through the concept of the ladder of worth, where humans reside at the top, and 'bad animals' or nuisances are ranked at the bottom. The levels between are constructed through relationships and understandings of 'better animals' that increasingly become further from human through spatial and constructed relationships. That is, species "easily tamed, eager to learn, [and follow] human ways" are placed nearer the human while uncharismatic species, or those of poorer interactions, occur further from the human (Hovorka, 2018). Species' acceptance can be understood through this hierarchy where the higher the position, the more socially acceptable the presence of the species in human-defined spaces. In Ontario, the pet dog is constructed as more acceptable than the pigeon within cities, thereby allowing for a greater visual presence of the dog and on-going conflict in pigeon-human interactions (Jerolmack, 2008). Through situating an animal within this hierarchy, humans begin to assign value to such species.

The inter-species hierarchy is rooted in capitalistic and colonialist systems, where the drivers of species extinction are based on the labelling of charismatic species (Collard, 2013). Collard writes of the exotic pet trade through first-hand experience to discuss the construction of lively commodities as living beings who express value-adding virtues such as favourable actions. The lively commodity is constructed through degrees of separation from its original natural place; further degrees of separation increase the financial value of the individual (Collard, 2013). In wildlife trade, charismatic species face the furthest degrees of separation and highest position on the ladder, such as pet dogs, while uncharismatic species exist in the lower positions (Hovorka 2018; Collard, 2013). The value of a lively commodity is then the extent to which species are desirable to the public. This can be seen through the presence of zoos as spaces of viewing the 'exotic' and the proliferation of the 'exotic' wildlife trade (Fennel, 2012; Nuwer, 2018). Charismatic lively commodities are the species that provide the greatest benefit to humans once removed from the wild spaces (Nuwer, 2018). The construction of the charismatic begins in the spaces of first human interaction. Uncharismatic species are then relegated to the pristine 'wilderness' and unwelcome within human spaces (Loring, 2020; Jerolmack, 2008: 73).

The construction of uncharismatic species suggests a power dynamic deeply rooted within Western society which determines the acceptability of a species within human spaces. In his landmark essay, Cronon (1995) describes the American romanticism for the 'untouched wilderness' and explores the historical construction of nature as separate from humans. A species must be deemed charismatic within its home range to be removed and placed within human spaces to be reconstructed, such as bears in zoos (Collard, 2013; Nuwer, 2018). The wilderness represents the "sacred myth of origin" where species are seen to begin, initial interactions occur, and human influence is absent (Cronon, 1995). Cronon writes of the wilderness as a "place where we can see the world as it really is;" a space where species are constructed from human interactions (Cronon, 1995). Hays (1996) rebuts that the wilderness surrounds everyone regardless of physical space and interactions with wildlife begins in one's home and yard. Although the wilderness is all around one may imagine travelling to spaces to interact with more charismatic species than are found in one's own yard.

The construction of the wilderness as pristine obscures human influences such as pollution and climate change (Loring, 2020). The spaces where the wild is not subject to the consequences of the urban environment is the constructed pristine (Loring, 2020). In Finding our Niche, Loring shows the impacts of urbanization on wild spaces and notes visitors tend not to see these effects but focus on the charismatic features of the space (Nuwer, 2018; Loring, 2020). Conservation is then the preservation of the pristine at a hypothetical point instant increasing the believability that conservation is "less value-laden and more scientific" (Loring, 2020: 43). A common understanding of the species desired to be present, through analysis of an ideal history, is required to establish the 'pristine' image (Cronon, 1995). The subjective assessment of the species present and the species desired then creates the image of the baseline (Loring, 2020). As it is a human evaluator who assesses the species desired to be present, species perceived charismatic are more likely to be included in the baseline.

Human perception of the space establishes a baseline through their interpretation of the sensuality of nature and the evaluators' personal connection to nature (Abram, 2010). In our quest to see beyond the backyard we become numb to the everyday, desire the charismatic, and seek the sensual (Abram, 2010). Abram reflects on this through his life after dedicating years seeking the charismatic, only to discover the everyday holds equivalent charm. Once realized, he embarks to discover ways to break the numb and experience the genius loci (Abram, 2020). In this, numb is the human disconnect from nature or the true spirit of the place – the genius loci (Abram, 2020). Numbness develops through a repeated normal where deviation from the expected becomes highly noticeable. A break in the numbness then allows for the observer to experience the genius loci, or the spirit and authenticity of the place through ways once dulled (Abram, 2010). The route frequently travelled becomes the mundane as the observer becomes numb to the scenery, but should an element be modified or out of place then such an element is noticed. This numbness develops through the expectation of change, and it is this repetitiveness of the sensations that grows the degrees of numbness. The desire to go into the wild is to escape the numb and reconnect with one's 'origin,' a space engrossed with birdsong.

The omnipresence of birds signals the 'origin' as "few aspects of the natural world touch us as deeply as our interactions with birds" (Beatley, 2020: xi). The first interactions with wild animals begin with birds, more specifically birdsong; it is to this origin that humans seek to return (Beatley, 2020). Through an exploration of the urban environment and living with species, Beatley reinforces the acceptance of charismatic animals within city boundaries. Migratory birds are valuable as their presence is a welcome break the numb while non-migratory species become part of the mundane. Species that transition from migratory to year-round residents become permanent deviations from the scenery and may face acceptance or distaste from humans (Beatley, 2020; Abram, 2010). Canada Geese and Turkey Vultures within cities, once welcomed visitors, became permanent residents, and deemed nuisances in Canadian cities. During the same period species such as the European Starling and House Sparrow, both invasive species, blend into the everyday. While Beatley (2020) does not explore reasons of acceptance of certain species, a potential theory could lie in the level of charisma expressed by these species.

Nuisance species are constructed through discourses of their natural history, the media, and politics such as the case of urban pigeons (Jerolmack, 2008). Policy makers make claims which render the animal in a light that best suits their goal of the sanitary city (Jerolmack, 2008). Any species that visibly harms the sanitary city becomes a nuisance and must be controlled. Jerolmack (2008) compares the lived experiences of House sparrows (Passer domesticus) and pigeons (Columba livia). Pigeons, a native species, are deemed a nuisance with an industry developed to control their populations; while House sparrows, an invasive species, have rapidly expanded their range in North America have become part of the everyday (Jerolmack, 2008). Though pigeons are more charismatic and visible, Jerolmack (2008) argues that the language used in describing each species constructs a species' level of acceptability. Male House sparrows are described as a little man with a black beard and gray hat, whereas pigeons are "rats with wings" (Peterson, 2009; Jerolmack, 2008). This description allows House sparrow to disappear into the everyday while the pigeon becomes vilified with rats. Once constructed as a nuisance, population control becomes a priority to policy makers with financial value attached.

Wildlife management relies on sport hunting to maintain population control as it generates revenue for the management and maintains populations at stable levels. Fennell (2012) provides a history of European and settler-American sport hunting, the methods and practices undertaken, and the financial values associated through an animal geography lens. The author writes both in support and defence of sport hunting but acknowledges a trend where nuisance species, such as wolves, "are dirty [pests] that foul the landscape and hence need to have their numbers controlled" (Fennel, 2012: 166). This viewpoint is further constructed through policy campaigns where, "unless [nuisance species] are hunted they will breed to excess…degrade the habitat… and the game will be subject to starvation, parasitism and disease" (Fennel, 2012: 170). Hunting seasons are established to decrease the public expense and increase the revenue from taxes for the sale of hunting paraphernalia while controlling nuisance species. Sport hunting is a way to reconnect with nature, break the numb, and "remedy the ills of civilization" (Fennel, 2012: 157).

Seasonal hunts allow for sport hunters to

reconnect with nature while embracing wildlife management as directed by policy makers. The primary stakeholders of wildlife management as "those who use wild animals as economic and aesthetic resources" (Yarbrough, 2017: 111). This refers to individuals reconnecting with nostalgic memories, and the economic benefits of maintaining a space to match these memories. Despite a growing number of wildlife watchers, they are not primary stakeholders of wildlife management as their activities do not generate taxable income (Yarbrough, 2017; Fennel, 2012; Nibert, 2013). As such, the stakeholders primarily refer to those who frequent the spaces and advocate for its 'pristine-ness' while attempting to prove their prowess through hunting the most charismatic or scarce species (Yarbrough, 2017; Fennel, 2012). Both Fennel (2012) and Yarbrough (2017) review conservation goals in North America and the required role of sport hunters in maintaining these goals. In the human experience, wildlife management seeks to introduce individuals to the nature around them - though the methods of doing so are highly debated.

Through the application of animal geography, we may understand the points of interaction, relationships formed, and power dynamics present in shared spaces (Hovorka, 2018). The structure of these spaces is governed by the human-imposed inter-species hierarchy which places species within categories of acceptability and regulates their behaviours within the space (Hovorka, 2018). Charismatic species, such as those who become lively commodities, are allotted spaces near the top of the structure, while those less charismatic are relegated to the bottom rungs (Collard, 2013). The construction of charismatic species begins with interactions in the 'wild' or the pristine, where the behaviours of visible animals can dictate the expectations of all individuals within that space and divisions of the wild are drawn to exclude unwanted species from baseline measurements (Cronon, 1995; Hays, 1996, Loring, 2020). Through decisions to include or exclude species from what constitutes the 'wild,' evaluators effectively highlight the difference between charismatic species and the numb or species so familiar their presence fails to strike awe (Abram, 2010). Beatley (2020) furthers this concept where migratory bird species are deemed charismatic, but species who become non-migratory become part of the mosaic of the city – part of the everyday. From the numb, a species grows to nuisance through political and social construction made easier by perceived harms of the species presence, such as the defecation of pigeons on private structures (Jerolmack, 2008). Should traditional methods fail to control the population of species to 'manageable' numbers, hunting seasons open on the species for financial gain and population control (Fennel, 2012). In a win-win-win situation, opening a hunting season on species allows for hunters to connect with nature while contributing to the economy and bringing species' populations to manageable numbers (Yarbrough, 2017). At the base of wildlife management are the values assigned to spaces and species, and the construction of certain species as valued greater than others.

Values

In their work of environmental philosophy, Elliot (1992) constructed the indexical theory of intrinsic value (ITIV) to understand the hierarchical ordering of values within nature and conservation. Through a comparison of intrinsic and instrumental value, Elliot (1992) argues that it is the subjectivity of value that determines value-adding qualities of the thing

evaluated. The ITIV is the order in which these qualities are weighted within a value-adding system; however, the valuer may only evaluate instantaneously, or re-evaluations of the index are required. In this, Elliot (1992) posits that ecosystems have value- adding and -subtracting qualities that can be summed. The intrinsic value of species exists prior to and after a valuer's assignment and "if wild nature has intrinsic value, then there is an obligation to preserve it and restore it" for its value-adding qualities (Elliot, 1992: 148). As an ecosystem has intrinsic value, a goal of conservation is to ensure the net intrinsic value increases thus revoking the "despoiling" of nature and returning it to a state of continual increasing value. If an ecosystem has instrumental value, then the values may be added or subtracted in greater amounts for preferred and unfavourable species. The valuation of instrumental value is then subject to the valuer's interpretation of the ecosystem and its connections to and with human interactors.

To be worthy of protection within the Canadian conservation sector, the goals and costs associated must be justified. Sandler (2012) argues the simplest method is to justify costs and goals through the ecosystems' instrumental value. The intrinsic value exists before discovery by valuers, at which point the subjective usefulness is applied to the thing and its value is constructed within a hierarchy (Sandler, 2012). In conservation, the initial evaluator assigns the value to the species present through the intended usefulness; for example, old-growth forests are valued more than microscopic organisms despite them both having intrinsic value. The perceived value of the species from a baseline to the present while considering the life history of the species being evaluated is included in final valuations (Sandler, 2012). Constructed with the present instrumental value, a species presence or absence may be justified both financially and in conservation as a net-value. Under this system, species exist as a means to an end where the species can be replaced if the means remain or increase in intended value. Conservation is then justified through its goals and the types of species present a means to those goals; deviations are accepted if they add value to the system (Sandler, 2012). The financial value of a species or of conservation is then tangible manifestation of the species' intrinsic value through an interpreter's subjectivity.

The financial value of an ecosystem is dependent on its contribution to human welfare and instrumental value. To characterize the price of an ecosystem, a standardized model must be used to ensure the pricing remains consistent across ecosystems. To this, Barbier (2011) identifies two potential methods of pricing nature; one, the cost to restore and two, the ecological-economic model. The restorative method is the more simplistic model as the price of nature is determined by the real cost to replace the elements present within a space. This model relies heavily on an established baseline of pre-consumption and is frequently employed by conservation authorities as the cost crosses disciplines without much translation. The ecological-economic model considers all elements of a defined space, both natural and human development, to suggest price trends on proposed development and environmental changes and uses these trends to define a current price (Barbier, 2011). Though gaining traction in conservation, the use of this model is not fully realized. Both models use the assumption that the space is measured instantaneously to avoid the dynamic and unpredictable qualities of nature that provide challenges

to evaluators. While the ecosystem may be valued, it is the species present that add or subtract financial value which is the direct product of the species' scarcity and perceived charisma level (Collard, 2013; Nuwer, 2018). Through conservation, these values are reinforced through financial depictions of the evaluator's subjective biases.

Robertson (2006) provides on-the-ground perspective to the financial valuation of conservation while exploring the creation of a conservation banking system presented through their experiences with wetland surveying. Within the United States conservation sphere, a conservation credit banking system is employed that implies methods of financial valuation of a species' intrinsic value within a political sphere (Robertson, 2006). The use of a subjective points-based system shifts the natural to the financial where the presence or absence of species determines whether the points are awarded (Robertson, 2006). Through examples, Robertson highlights that different species have different point values and impact the net-value of the ecosystem uniquely: egrets add points, cormorants decrease points. The methods for awarding points and the weight of these points are determined by the party requesting the surveying (Robertson, 2006). As a result, a standardized method must be applied to account for the changing biota of an ecosystem and create a predictable investment for bankers (Robertson, 2006; Barbier, 2011). By bringing the natural to the financial through a points system, the revenue from conservation can be explored more deeply.

In Canada, the finances of conservation are reported through the economic impacts of hunting, angling, trapping and sport shooting, all of which generate the revenue for further conservation (CBoC, 2021). Through a survey, the Conference Board of Canada (2021) found most anglers and sport hunters embrace the activity primarily for the recreation value and the enjoyment of the outdoors. These groups contribute a combined $16 billion annually through the purchase of licenses and equipment propping up the $19 billion conservation industry. Although the number of sport hunters represents less than 15% of the population and is in decline, firearm purchases are increasing as has the total revenue from hunting and angling (CBoC, 2021; Hall, 2021). This revenue is then directed to natural spaces proportionally within Canada to maintain the aesthetic and 'pristine' image of the wilderness, thereby encouraging more users of these spaces (CBoC, 2021). The natural spaces are designed to cater to these groups as they generate the greatest amount of revenue, and their continued use guarantees continued income.

The use of natural spaces relies on the instrumental values attached to the space and the conservation methods present (Bell, Graham, and White, 2018). The authors found that the public tends to visit spaces with greater apparent biodiversity and compare the space to their expectations. Expectations increase for urban parks, where amenities, facilities, accessibility, and cleanliness become markers of a valuable space. Usability increases with built forms that encourage interaction, paths, benches, and opportunities to observe biodiversity while poorly maintained spaces are avoided (Bell et al., 2018). A natural space should be similar to the surrounding elements; under-managed urban spaces lose connections to the sanitary city, but over-management was seen to reduce biodiversity. Recreationally, more users prefer interesting natural spaces with

paths and guided routes through aesthetically pleasing scenes. Further, Bell et al. (2018) drew connections between biodiversity and recreation, where spaces perceived with higher levels of biodiversity encouraged greater numbers of users. Spaces of greater biodiversity fostered an emotional attachment to the space and users gained vested interest in the fate of these spaces (Bell et al., 2018). As such, Canadians feel that protecting the beauty and natural landscape are the most valuable goals of conservation and wish for more protection for natural spaces (Wright et al., 2019). However, the government is halted by the interests of private actors and their interpretation of the instrumental values of the natural spaces and species present.

The framework of the indexical theory of intrinsic value allows for a deeper understanding of the hierarchy of charismatic species, as instrumental value is integrated (Elliot, 1992; Collard, 2013). It is through this framework that conservation goals are valued by weight of the instrumental species present while the subjective human experience further reinforces these goals (Sandler, 2012). Barbier (2011) introduces the restoration cost model of financial valuation as a method to translate instrumental value to financial capital within the dynamic realm of conservation. However, the price associated with each species becomes a function of the species charisma and level of scarcity, as the more charismatic species are valued higher (Collard, 2013; Nuwer, 2018). To view this in practice, Robertson (2006) explains the financial valuations are derived from the subjective decisions of field surveyors and their employers. The impacts of these decisions are recorded as revenue generated by the groups who use the space for recreation, while adding value to spur greater revenue growth (CBoC, 2021). This revenue comes from the users who visit wildlife spaces with expectations that make their experience more enjoyable. These spaces must match or exceed the expectations of these groups, though they are heavily influenced by private actors with financial interests (Bell et al., 2018; Wright et al., 2019). In these spaces, uncharismatic species, such as the double-crested cormorant, decrease the overall financial value of the space.

Cormorants

Crow-duck; feathered pariah; old black Shag; the black plague. Devil Bird. The double-crested cormorant (henceforth "cormorant"), with its black, oily appearance and colonial nesting behaviour, has drawn ire throughout the English-speaking world for its habit of destroying the areas under its nests with guano and accusations of stealing fish. In Ontario, its reputation continues. As the only inland cormorant in North America, the double-crested cormorant is a black pelagic species with an orange mask and bill, and bright blue-green eyes. These cormorants are often found along coastlines, with wings out-stretched on human-made structures and rocky berms (Peterson, 2009). How this coastal species was granted a hunting season within Ontario requires an understanding of how we arrived at such a proposal.

Although few authors have referred to the cormorant, King (n.d.) compiled known mentions of cormorants to further explore their construction. Notable literature mentions include cormorant being used synonymously with greedy, insatiable, and ravenous in the works of Shakespeare (King, n.d.). Following Shakespeare, the cormorant is associated with Satan in Milton's Paradise Lost when Satan breaks into Paradise and sits on the Tree of Life "like a cormorant;

yet not true Life |Thereby regaind [sic], but sat visiting Death" (Milton, 1991: Book IV). Audubon, widely credited as the founding father of North American ornithology, had reported in December of 1820 that "we saw to day probably Millions of [cormorants]" (emphasis in original) (King, n.d.). Whether it was exaggeration or not, cormorants in North America have not been seen in these number since the journal entry was penned. A changing attitude is found in The Sea of Cortez where cormorants are described as "the flies in a perfect ecological ointment… they are considered interlopers, radicals, subversive forces against the perfect and God-set balance… they are rightly slaughtered" (King, n.d.). Despite DDT, the thinning of eggshells and a rapid decline in cormorants to the point where they were listed as special concern, double-crested cormorants are a constructed bane to humans and nature. In the most ridiculous example, The Cormorant published 1986 and later adapted to film, is the story of a young family who inherits a cottage along with their late uncle's pet cormorant who tears the face off a cat, ruins the life of a man, and causes the fiery death of the son (King, n.d.). More recent works (Sukha, 2013; Able et a., 1986; Bateman, 2002; Shaw, 1989) referring to cormorants attempt to reimagine the centuries of negative imagery; however, the ideas remain ingrained in society through storytelling.

As a corridor into Ontario, double-crested cormorants migrate through Port Weller annually to make the port a hub of cormorant research. The historic records compiled by Roy (2015) create an image of cormorants in Ontario. Around the turn of the 20th century, cormorants in the Great Lakes region were recorded as "somewhat uncommon" and "occurs rather sparingly" – a far cry from Audubon's "Millions" (Roy, 2015: 85). The first record of a cormorant in the Niagara region occurred in 1936, with 32 individuals recorded between 1950-1980. In 1984, 4 birds were sighted in Niagara Falls and by 2014, over 17,100 individuals were recorded at Rock Point Provincial Park. Roy (2015) credits this rapid growth to water bodies no longer freezing over winter. Despite low population numbers, the first Ontario study analyzing the impacts of cormorants on local fish stocks was published in 1946, and since, multiple papers have been published in debate (Roy, 2015). As colonial nesters, cormorants occupy a small selection of trees on sand while their acidic guano deteriorates the vegetation present. After three years of nesting, the cormorants successfully take over and the vegetation is effectively destroyed in their section of the sand spit (Roy, 2015). The rapid growth of cormorants within Ontario has caused fear for the potential environmental degradation caused by such an abundance of cormorants.

In 1995, Environment Canada published a report which sought to end the debate on the cormorants' impact and encourage further research on other sources of environmental harm. For more than forty years, cormorants in Ontario were constructed as fish-stealers reinforced by declining fish stocks that corresponded to the growing populations. In the 1960's, while eggs thinned from DDT use, the province used formaldehyde and soap to suffocate the eggs until cormorant numbers plummeted to 125 individuals (Environment Canada, 1995). This control was spurred by declining fish stocks throughout the 1950's; however, it was later reported that the decline was due to "heavy fishing, the invasion of the sea lamprey, [and] the loss of spawning areas," not the cormorants (Environment Canada, 1995: 6). With the decline of larger predatory species in 1980, the invasive alewife, a

favourite to cormorants due to its preference of shallow waters, became the most abundant fish in Lake Ontario resulting in the rapid growth of cormorant populations. Remarkably, this report found sport fishing on Lake Ontario to take 13.4% of prey fish while cormorants consumed 0.5% and ate only 5% of all fish consumed in the lake (Environment Canada, 1995). During this period, the Great Lakes also experienced an influx of invasive species including the round goby.

The deterioration of shorelines throughout the 1980's allowed the round goby to gain a foothold in Ontario. Somers et al., (2003) sought to understand the ecological relationship between the invasive round gobies and double-crested cormorants to determine whether cormorants are shifting their diets to the invasive species. In the lab and field, the round goby experienced rapid population growth, drove the native mottled sculpin (Cottus bairdi) to extirpation through nest usurping, directly competes with several native species for food, and eats the eggs of native fish species (Somers et al., 2003). The round goby also heavily preys on invasive zebra and Quagga mussels, to provide some benefit to coastlines. The authors found that as the round goby replaced the alewife, cormorants shifted their diet to include the most abundant species. Somers et al. (2003) concluded that cormorants are necessary to control the spread of invasive species within the Great Lakes. Despite this, the province had proposed to open a hunting season annually between March 15 to December 31, with a bag limit of 50 cormorants per day per hunter (CELA, 2019).

To address concerns of the commercial fishing industry and private property owners, the government of Ontario proposed a hunting season on cormorants without seasonal limits in 2019. The proposal was in response to the growing number of cormorants, yet the cormorant numbers remain a fraction of their historic population (CELA, 2021). Of note in the proposal were the bag limit of 50 cormorants per day, the requirement to hunt from a stationary boat, and the ability to allow cormorants to spoil; that is, to be killed without being collected (CELA, 2021). Within the proposal were justifications that double-crested cormorants are "detrimental to fish populations, island forest habitats, other species and aesthetics" which mirrored the arguments of the main lobbying groups (CELA, 2019: 3). Cormorants are seen to compete with sport and commercial anglers, destroy private property through nesting, and decrease levels of biodiversity by their presence (CELA, 2019). The hunting season as proposed was marketed as an effective method to increase the biodiversity within cormorant spaces since their removal would allow for other, more charismatic species, to take their place.

Hobson (2021) strongly disagreed with the justification of the hunt and published a commentary in response to the government's proposal. In it, Hobson (2021) dedicates a section to the top lobbying group for the hunt, Ontario Federation of Anglers and Hunters (OFAH), and their arguments of cormorants competing for fish, stealing fish food stocks, or destroying lakeshore vegetation (Hobson, 2021). The OFAH advocated for a split season the March to May, and September to December hunt to have a "more maximal impact" with the goals of killing cormorants before they can breed while maintaining a positive image of hunters (Hobson, 2021: 2). The OHAF refers to those hunting cormorants as ambassadors and celebrates their assistance in eradicating "this pest" (Hobson, 2021: 2). After over

forty years of researching, Hobson states that double-crested cormorants "pose no threat to sport or commercial fisheries" and notes that cormorants switch prey species in response to changing prey populations (2021:3). Hobson further explores the claims of cormorants destroying ecosystems, to which they concede that cormorants do cause vegetative damage within their colonies; however, this is highly localized and occurs in only 344 locations in Ontario. Hobson, along with dozens of wildlife experts, penned an open letter to the government to stop or reconsider the potential damage of implementing the cormorant hunt (Cotnam, 2020).

After 45 days of public consultation, the minimum required, the government of Ontario implemented the proposal. The amendments to the Fish and Wildlife Conservation Act, 1997 (FWCA) and supporting regulations, 665/98 and 670/98, were passed July 30, 2020, following the consultations (MNRF, 2020b). In this passing, the hunting season was decreased to 111 days from September 15 to December 31 to avoid the nesting season of other colonial species, and the bag limit was reduced to 15 birds per day. As a result of the public consultation, the government removed the spoilage clause, thereby requiring shot cormorants to be retrieved and disposed of as outlined by FWCA (MNRF, 2020b). In the consultations, concerns regarding aesthetics and cormorants depleting fish stocks, as well as a general concern that "cormorant population levels are too high" were brought up (MNRF, 2020b). While the defence argued the proposal lacked scientific support and the proposed bag limit was unjustified. All groups encouraged a cormorant monitoring system to ensure the hunt was effective. In their press release, the MNRF created divisions using language that further encouraged the cormorant hunt. The subheading for the press release read "fall harvest for double-crested cormorants introduced to protect local ecosystems" followed by the lead that spoke of the harmful impacts of double-crested cormorants (MNRF, 2020a). The report further explains populations of cormorants are increasing without acknowledgement of the known harms a hunt can have on colonies.

Public hunts have occurred throughout North America as a method to control cormorant populations, but the impacts of these hunts have lasting consequences (Hobson, 2021; Ewins and Weseloh, 1993). In 1993, Ewins and Weseloh were studying a cormorant population on Pigeon Island near Kingston, Ontario, when overnight 50 adult cormorants were shot. The authors shifted the focus of their study to document the harms of losing just 3% of the colony by way of nesting success. Through surveying the colony days after the hunting, they found a 30% reduction in occupied nests. The authors returned to the island to count the matured birds to determine the reproductive output of the birds and found that the number of surviving chicks was 10% compared to the control island at 35%. On the Ontario level, it would take less than 300 hunters taking 15 birds once, to result in this population decline. After the first year, concerns for the impacts of the hunt were amplified, mirroring the predictions of many biologists and wildlife experts.

The results of the first year were documented by various national news outlets expressing concern as the second season opened. The Financial Post (GlobalNewswire, 2021) reported that there was "random killing of the birds, piles of bodies being dumped on roadsides and small colonies being targeted," without a monitoring system, leaving the death toll unknown. A growing opposition

formed as fears of colonies becoming locally extinct was coupled with an unknown number of participating hunters (GlobalNewswire, 2021). The Canadian Broadcast Corporation reported a 50% decline in the Big Rideau Lake colony whose population was already in decline from disease (Andrews, 2021). A portion of birds killed in this colony were left to spoil. A spokesperson for the OFAH has stated that their intention was to target colonies on small inland lakes to maintain the aesthetics of the wild (Andrews, 2021). As the hunt nears the end of second season, opponents, including members of the OHAF, are calling for the government to embark on a positive image education campaign for the cormorants. Whether the hunt will continue for a third season remains unknown.

Through a history of English literature, cormorants have been negatively constructed as a disruptive force to a God-set balance and have been demonized to point that hunting seasons have been established (King, n.d.). Cormorants were recorded in Southern Ontario in the late 19th century until colonies were constructed (Roy, 2015). The populations faced decline throughout the 20th century only to spring back to establish further colonies, drawing anger for their perceived role in the decline of fish stocks (Environment Canada, 1995). In the late 1990's, the round goby arrived and decimated native small fish species through competition and in response, the double-crested cormorants shifted their diets to include the gobies (Somers et al., 2003). With food more abundant and the cormorant population rapidly increasing, the government of Ontario proposed an unprecedented hunting season to address the concerns of the OFAH (CELA, 2019; Hobson, 2021). The proposal passed with amendments made to the Fish and Wildlife Conservation Act, 1997, which allowed hunters to kill up to 15 birds per day over four months (MNRF, 2020b). A previous hunt killing only 3% of the population resulted in a dramatic decline in cormorants the following year, foreshadowing the potential impact of the hunting season (Ewins and Weseloh, 1993). The first season resulted in colonies facing collapse and carcasses left to spoil with no record of the number of birds killed (GlobalNewswire, 2021). The plight of the double-crested cormorant provides an understanding of conservation within the early 21st century and the role human-animal interactions play in the valuation of species.

Assigning values

Social constructs

Species versus species

Within conservation, the inter-species relationships are directed by the interpretations of the human observer. These interpretations rank species based on their instrumental value and as means to an end for humans (Sandler, 2012). Conservation is used for humans to escape 'back to nature' and create new interactions (Cronon, 1995). Nature is a space to visit with constructed expectations that lead to human enjoyment. The subjective ranking of species within these spaces correlates to the constructed social opinion of the species' place in the inter-species hierarchy (Hovorka, 2018). Charismatic species are sought out while uncharismatic species receive low social opinion (Collard, 2013; Abram, 2010). Prior to viewing the species, the human visitors impose expectations of species' behaviours constructed through media representations. These expectations then are ingrained through publicized portrayals to such an extent that species not portrayed become matter out of place (Jerolmack, 2008). Pelicans and

cormorants, both members of the order Pelecaniformes, highlight the influence of these expectations.

Expectations are constructed through available media portrayals. In literature, Milton refers to Satan sitting "like a cormorant" contrasting to Dante' representation of Jesus Christ "Of him our Pelican; and this is he to the great office from the cross elected" (Milton, 1991: Book IV; Alighieri, 1307: 170). While the religious connotations go beyond the scope of this paper, the importance of this juxtaposition cannot be understated as it reappears in the construction of cormorants in Ontario. As piscivorous species, both have faced questions of fish-stealing; however, pelicans, which eat 1.5-2 times more fish than cormorants, only required one study to cast them as an eater of 'undesirable' fish (Peterson, 1957; Roy, 2015). Despite this, the public discourse constructs cormorants as fish stealers, among other things (see Appendix A). In Birds of America (Shaw, 1989) within 160 pages there are seven images of pelicans in majestic poses without a single image of cormorants regardless of stating that "North America is well off for cormorants" (11). This is repeated over the decades since the cormorant's population increase (Peterson, 1957; Reader's Digest, 1979; Able et al., 1986; Bateman, 2002; Sukha, 2013). Cormorants are simply not constructed to be part of nature.

Cormorants and pelicans both occupy space within Ontario, though the pelican is scarcer, and the cormorant is often sighted. As Beatley (2021) discusses, the novelty of a species becomes a nuisance only when it has overstayed its welcome by becoming a year-round resident. However, in spaces where pelicans are year-round residents, they remain an exciting, charismatic, and sought-after species (Sukha, 2013). The cormorant does not experience this in Ontario, rather it is constructed as a damaging, out-of-place species that "serves as the convenient scapegoat for all ecological ills of our society" (Hobson, 2021: 6). By this, Hobson (2021) refers to environmental degradation, fish stock declines, the influx of invasive species, and the destruction of shorelines; all of which work to ensure the species is valued less than the space.

Species versus spaces

In conservation, spaces are valued by their instrumental value, then categorized by inherent value (Elliot, 1992). Conservation is seen to protect the beauty of the space while being a source of economic benefits (Wright et al., 2019). Protecting beauty instills the human-nature dualism, where the beautiful natural space is used to break the numb and further reconstruct it through visits (Abrams, 2010; Cronon, 1995). Beauty exists only in one's perception of the beautiful as a small lake in a forest contrasts with the urban wetland, both are inherently beautiful, yet it is the use, or perceived use, of the space that renders its conservation value. In this, the value is created by a usable and aesthetically pleasing space. Usability requires the space to be accessible and available for a wide range of activities, while the aesthetics relate to the overall cleanliness and perceived biodiversity of the space (Bell et al., 2018). Species chosen to remain in this space must adhere to the guidelines of the space or be a reason to visit the space. Cormorants are constructed as deviants of the guidelines, suggesting that the ideal image of the space is greater than the physical space.

The parks movement developed through concern that the rampant killing of species and urban spread would erase nature (Nibert,

2013). Conservation then served to preserve the pristine with species gatekept by those with power and influence (Cronon, 1995; Nibert, 2013). This can be seen where animals exist freely within park boundaries but are trapped, hunted, or relocated once passed these boundaries. The most charismatic species become staple images of the space, such as wolves or buffalo, while the uncharismatic species are pushed to the edges. The natural space is then zoo-like, where visitors can see their favourite species, while pushing uncharismatic species to the background - the numb (Fennel, 2012; Abram, 2010). This is the natural space remembered, the space Cronon (1995) argued is dangerous in its erasure of beings. It is a space of the charismatic, the pristine, that only exists in visits or memories. Charismatic species break the numb, are more memorable, and create the illusion of a more biodiverse space (Bell et al., 2018). Cormorants disrupt the untouched-by-time natural balance as their colonies destroy the remembered vegetation of the pristine. Taken this way, a hierarchy begins to form with species valued the lowest, spaces central, and the imagined space the highest.

Financial constructs

Cost

The cost of maintaining the manufactured image requires a hierarchy of values and assigned financial value. The indexical theory of intrinsic values (ITIV) allows the value of ecosystems to be added or subtracted due to the contents in that ecosystem (Elliot, 1992). One can imagine two wetlands, where one is healthy and species-rich and the other unhealthy and species-sparse, at any instance these ecosystems hold different intrinsic values. Not due to health and the idea of a whole, but to the contents within the ecosystem. If an animal were to be added to both, their net intrinsic value would increase equally just as the removal would decrease. With this foundation, a cost to maintain can be applied.

In the instantaneous restoration cost, it is assumed that all elements have intrinsic value and instrumentally they are valuable to the present whole (Barbier, 2011). The cost to restore requires a consensus on the baseline and instantaneous value of the species present (Barbier, 2011; Loring, 2020). The cost of damage mitigation is proportional to the classification of such a land by potentially influenced scientists and must not be influenced by market participants (Robertson, 2006). The scoring system of ecosystem banking relies on valuing species on their instrumental value and assigning a price to this; damage to the imagined pristine then becomes a deterrent for investment (Robertson, 2006).

When cormorants destroy the vegetation around their colonies, they decrease the financial value of the site. The loss of vegetation then renders the land 'less' in the eyes of the market, requiring the removal of cormorants to return value. In assigning points, financial impact is considered as charismatic species are granted points while cormorants decrease points (Robertson, 2006). Nuisance species create negative dollar values, and their extermination or reduction is justified to increase the potential financial gain from the space.

Revenue

To maintain a natural space to the level of pristine desired, a stream of revenue is required lest the space become developed. In Ontario, this revenue comes from the membership fees that support

all Conservation Ontario operations (Conservation Ontario, 2019). This membership is a $12 Ontario Outdoors Card, a summary license which ranges from $22-36, and the appropriate tags ranging from $10 for coyotes up to $200 for a bull moose (Ontario, 2021c). In the pricing regime coyotes, a socially declared nuisance, are valued with the lowest price tag, while the bull moose, so charismatic it appears on currency, is the highest valued species. The membership fees of Ontario's 1.4 million anglers and 470,000 hunters maintain the natural spaces, and despite representing only 12% of the Ontario population remain a powerful influence in decisions (CBC News, 2018). Whereas wildlife viewers do not purchase these memberships and do not hold financial stake in the processes of conservation in Ontario (Fennel, 2012). The open season on cormorants' sheds light on the role that revenue plays in conservation decisions.

As revenue is derived from hunters and anglers, they are granted the ability to decide which species remain in conservation spaces and which do not belong. In controlling the cormorant populations, the sport hunting season was seen to further protect the natural spaces (Cotnam, 2020). Cormorant hunting is then a service to conservation as their removal will spur more biodiversity and, by extension, more paying visitors (Cotnam, 2020; Bell et al., 2018). Users who generate the most revenue decide the fate of the space and desire more variety in the species present (CBoC, 2021). The ecological issues for which cormorants are blamed, are fantasized to disappear with the cormorants, allowing for more charismatic species to reside in the spaces. With greater biodiversity, the population of anglers and hunters will increase as the spaces have become 'pristine.'

The implemented policy

Legislation and amendments

The government of Ontario proposed changes and amended the Fish and Wildlife Conservation Act, 1997 alongside Regulations 665/98 and 670/98. Under the FWCA, an amendment was made to allow double-crested cormorants to spoil to the point that its flesh becomes "unsuitable for human consumption" (FWCA, 1997: s36 (2.1)). Cormorants are now the only species allowed to spoil in Ontario, presumably to allow for burial and proper disposal but as previously noted, this was not the case (GlobalNewswire, 2021). Regulation 665/95 furthers this by listing the ways in which cormorants may be disposed (2021: s34.1,2). Hunting seasons of species are outlined in Regulation 670/98, where cormorants possess the highest bag limit of all game bird species (2021, table 7). Lacking in these policy changes are the possession limits for cormorants, which for other species are recorded through the purchase of tags (FWCA, 1997). Because of this, cormorants remain the only legally hunted species without an active monitoring program.

These policies were justified to cleanse the environment of cormorants through public means after private control measures, such as egg-oiling, failed to produce desired results. Cormorants are constructed as an invasive species in Ontario as a way to justify past practices such as egg-oiling, and private and government-sanctioned culls (Hobson, 2021; Ruiter, 2019).Officially, justification for the hunt was a variation of: "in response to concerns raised by some hunters and stakeholders, including commercial fishers, about the potential harmful impacts of cormorants on fish populations and shoreline habitats" (Wittnebel, 2021; Hobson, 2021;

MNRF 2021a; MNRF, 2021b; Ruiter, 2019; Bell, 2020). With the announcement of the hunt, the OFAH celebrated a victory twenty years in the making and disclosed that this "is just the first step in controlling cormorant populations" and they "will continue to seek additional management actions that will contribute to cormorant control where hunting or discharge of firearms is restricted" (Zoneadmin, 2020). While the goals of the amendments are unknown, it is speculated that the intention was near-full removal of cormorants in Ontario.

Impacts of the policy

Social impacts

The impacts of the amendments reshape the inter-species hierarchy through a reclassification of nuisance to the extent necessary to remove these individuals. Self-assigned human dominance is reified through the hunt, where the cormorants, unrecorded and inedible, are constructed as worthless beings and their presence intolerable (Yarbrough, 2017; Bell, 2020). The apparent clumsiness of their terrestrial movements and large size makes them excellent targets and the amendments render the hunt a convenience without "Fair Chase" (Fennel, 2012). Without Fair Chase, the species becomes killable without consequence (Despret, 2016). The ability to sit in a motorboat next to a colony and kill cormorants removes all elements of the sport, creating an image of destruction that challenges us to rethink our relationship with the natural world (CELA, 2019). Conservation was designed for the benefit of the elite few to protect the species desired, but as natural spaces become more accessible and diverse, we must decide for whom conservation is catered (Fennel, 2012).

Animal geographers posit that the spaces of animals should be directed by the species who reside accounting for all representatives. Cormorants share their space, not only with other colonial nesters, but with humans as well (CELA, 2019). In consideration of the amendment, select actors were consulted and the opinions of residents, including cormorants and other species, were not heard. Cormorants live beyond human settlement, in spaces that pose the least risk and benefit to their colonies, yet their very presence remains a threat to the human-imagined sanitary and pristine.

Financial impacts

As the Ontario government faced a declining interest base and stream of revenue, the hunt became a solution. A decline in the number of hunters annually is matched by more visitors opting for non-violent interactions that do not provide the proportional revenue required (Fennel, 2012; Hall, 2020; CBoC, 2021). As the operational costs of conservation rely on the revenue from licensing and membership, there were few potential avenues for the government to take. Ontario had the option to raise the price of their day passes to fund natural spaces, however this would bar low-income visitors and was not chosen (Ontario Parks, 2021). As a profit-earning option a hunting season on cormorants was implemented, building off the deep-seeded anger toward cormorants while catering to those who provide revenue to the government. Cormorants are placed as a kill of convenience, a consolation prize killed in the name of cleaning the pristine (Hall, 2021; Hobson, 2021). The hunting season encourages the participation of new hunters or individuals who hold anger toward the cormorants. This is demonstrated through the blatant disregard of the OFAH code of ethics and desire to cast hunting in a positive light as cormorant bodies littered natural

spaces (OFAH, 2020; GlobeNewswire, 2021). This suggests that several cormorants were shot by new or inexperienced hunters, who provided revenue from the hunt through the fees of the Outdoors Card and small game license. Although the revenue from the 2020-2021 has yet to be reported, it is anticipated the trend will continue with the decrease of licenses, though not as drastic as the previous decades.

The amendments show a changing perception of conservation in the wake of an increase of users. While the space remains a place of human consumption and species are organized by their instrumental value, the place of nuisance species has become redefined. Where once the species could exist, albeit privately controlled, now species deemed nuisances within Ontario are faced with the threat of extirpation. The situation is exacerbated by the fact double-crested cormorants remain migratory within Ontario and will not cease to exist in the province. The regionality of the hunt fails to consider the impacts beyond Ontario and the relationships formed between cormorants and other species within their colonies. It is the strong public outcry at the passing of the season that brings an encouraging shift in human-animal relationships. The biologists who penned a letter, the revoking of arguments by the OFAH, and the public's changing perception of the hunt is providing a new way to understand conservation within Ontario and the relationships of nuisance species (Cotnam, 2020; OHAF, 2020).

Numb-nuisance spectrum

The case of the cormorant highlights the need for a way to understand human-animal relationships when species are declared nuisances. Building on the works of Cronon (1995), Loring (2020), Jerolmack (2008), Beatley (2020), Hovorka (2008) and Abram (2010), I aim to conceptualize a framework to understand the relationship between the numb and the nuisance as it relates within the natural spaces of Ontario. I aim to further explore the concepts of the imagined pristine, tolerance, numb, and nuisance to propose a spectrum in which cormorants can be found.

For the pristine to exist, a reference must be established and confirmed through subjective means. The pristine remains an imagined image in which to return to through the employment of conservation policies (Cronon, 1995). To establish the baseline, an ideal image of the pristine must be constructed and agreed upon (Barbier, 2011). The image is the collective agreement of influential actors, such as the OHFA, that includes imagined spaces and species present. From there, the onus is on the in-situ evaluator to determine the true baseline for the ecosystem based on their interpretation of the present space. As a rather difficult endeavour, the evaluator will choose the most charismatic qualities to include in the baseline while ignoring or minimizing the uncharismatic qualities. A moose is more likely to be included in the baseline than a cabbage white simply because the moose is subjectively more impressive (Robertson, 2006). The imagination paints the ideal baseline, then the in-situ evaluators are tasked with creating an in-situ baseline that resembles this image. This remains true for literary and artistic representations where cormorants are not included, yet pelicans appear on multiple pages and in majestic ways (Sukha, 2013; Able et a., 1986; Bateman, 2002; Shaw, 1989; Reader's Digest, 1979; Peterson, 1957). Absent from these images are the presence of humans, the spaces in which species exist are void of human presence. The image of the pristine is then a suggestion of species that

should be present while omitting the species that should not be present or are deemed insignificant by some other form of valuation.

In traditional conservation, the pristine does not include humans or signs of human impacts. Throughout their essay, Cronon (1995) argues the pristine is seen as the Frontier, a space to be explored and constructed void of human influence yet designed for conquest. In this space, only the charismatic and the numb are present to allow for an undistracted connection to nature as desired by urban dwellers (Cronon, 1995). Hays (1996) furthers this to argue that nature is all around and is infiltrated with human influence; therefore, the pristine is a myth. If the pristine exists only without human influence and it is assumed human influence has impacted all spaces, then the pristine cannot exist. However, the pristine concept of a space desired has been reconstructed as a sanitary space. The sanitary is a clean, manicured space, complete with regulated and desired species. In parks, the sanitary is manifested through the acceptance of appropriate species that comprise the numb and charismatic species. This space is clean, inviting, and appears to have greater biodiversity than is found in rural settings because species are at the forefront with less spaces to hide (Bell et al. 2018). The pristine exists, though it is transformed into the expected sanitary.

Uncharismatic species and those not deemed nuisances, comprise the numb. Species such as the cabbage white exist as part of the scenery, blending into the pristine image, and selectively tracked by the observer. Abram (2010) describes this state as the numb. If the pristine image is broken down, the charismatic species standout and draw focus while the background is perceived as a blurred image. This is experienced daily as elements of the background become mundane and the viewer becomes accustomed to the scenery passed everyday, only new or unknown aspects pop from this scenery. In this, the human body is "a wild creature whose life is contingent on the multiple other lives that surround it, and the shifting flows that surge through it." (Abram, 2010; 110). The human body requires its participation in the harmony of other systems to survive. These other systems, though, are constructed within Western ideology to be at the end of the human experience, irrelevant unless sought out and manipulated by design. The shifting flows are silenced to make way for the development of the ideal space, a space free of undesirable and uncharismatic species. The subdued characteristics are the numb.

The numb is the background of the pristine where the charismatic are projected. Pelicans are the projected charismatic while the three-dimensional spaces around the pelicans are the numb. If the pelicans are in the sky, once they have passed, the sky becomes the expected - the numb. Uncharismatic species exist within the everyday without notice. House sparrows proliferate within urbanized spaces, yet their presence has become so ingrained to human residents that they are acknowledged in passing, if acknowledged at all (Jerolmack, 2008). Everyday species face little human complaint as they blend in (CELA, 2019). Different environments are seen to have different expectations, where the everyday changes depend on the perceiver's life history and position (Sukha, 2013). Charismatic species exist within all spaces, though their charisma is interpreted differently by the perceiver. Through the perception of the species who belong within the numb develops the nuisance.
An uncharismatic species deemed pest is

constructed into nuisance. The presence of nuisance species is increasingly noticed as they become "matter out of place" (Jerolmack, 2008). Urban pigeons, once invited into cities, have reached population sizes where their presence is increasingly noticed, marked through droppings. Nuisance species have caused the creation of an industry to control the urban pigeon (Jerolmack, 2008). In a review of North American attitudes, Loring (2020) asserts that "the Wild is welcome… as long as it doesn't become a nuisance to the human visitors" (53). Nuisance species begin as the everyday but as their numbers increase, they become nuisances. This pattern repeats through Canadian cities in examples of Canada geese or turkey vultures, until the population decreases to perceived everyday levels (Beatley, 2020). A defining feature of the nuisance species is that the growing population harms or disrupts the sanitary image (Jerolmack, 2008). This harm is acceptable to the point where it breaks the numb and begins to deteriorate the image of the sanitary or pristine. It is here that the nuisance label is applied.

The shift from numb to nuisance can be seen in the example of the double-crested cormorant within Ontario. Cormorants were met with excitement in the early 20th century as they passed through Ontario on migration and began to overwinter (Roy, 2015). Cormorants were a charismatic species in Ontario and their presence was enjoyable. However, in the 1940's they became nuisances and the subject of scientific inquiry (Roy, 2015). As the populations declined between 1950-1980, alongside other charismatic species like the common loon, bald eagle, and peregrine falcon as a result of DDE and egg-shell thinning, the cormorants became the subject of concern over fears of their extirpation (Roy, 2015; Hobson, 2021). These attitudes demonstrate that through this period, cormorants existed as charismatic species. The species then began to settle and become part of the background mosaic. By the 1940's there was also speculation that the species was becoming a nuisance, not through aesthetic harm but as a contributor to the loss of fish stocks (Roy, 2015; Hobson, 2021). Perhaps the cormorants' saving grace was a decline between 1950-1980, as the events have repeated to 2020.

In the 1980's cormorant populations grew through renewed conservation policies and the cessation of DDT (Environment Canada, 1995). The cormorant populations exploded once they began to recolonize the spaces previously held, where by 2000 nearly 115,000 breeding pairs resided in Ontario (Roy, 2015). This increase was largely fuelled by the government stocking the regional waters for recreational angling (King, n.d.). In this time, the cormorants were part of the numb. If they were considered nuisances, the loss of fish stocks would have driven a push for cormorant control, but the decisions were to restock the fish instead. Therefore, cormorants were not constructed as the reason the stocks had declined and they had existed in the background. However, in 2000, localized cormorant control methods were implemented in spaces where cormorants were labelled nuisances (Roy, 2015). In 2019, with more than 145,000 breeding pairs, the government announced public control measures, labelling the cormorant as a pest, and constructing it as a destroyer of the pristine (MNRF, 2020a). Between 2000 and 2019, cormorants existed in some spaces as the background, but once their impacts passed the threshold of tolerable, they became publicly hunted. The first hunting season decreased numbers to the numb, however the hunt continued in a second season (Ruiter,

2019). As it is unlikely that cormorants will become extirpated in Ontario, it is understood that conservation is the goal of keeping the Wild within the numb range.

To further understand the interactions between humans and animals within Ontario, I propose the spectrum of numb to nuisance. Nature, as it exists, is a blank slate in which humans project their ideal imagery upon. The intrinsic value of nature is irrelevant in this sense because the image of the ideal nature erases all elements of the natural. The nature in which no construction has been projected, or seeks to transform into the human ideal, is the numb. That is to say that the numb is what remains when the imagined image of nature is placed upon nature itself and the gaps filled in. The spaces are the species of the numb, uncharismatic, and forgotten within the image of nature. Charismatic species jut out from the image but are included both in the image and in the numb. Therefore, the numb is a place oft not thought of, it simply exists as background for the charismatic or desired, a place holder for the inspiring. The nuisance is then the species that break through the ideal image and are seen to pose a threat to the image itself. Much in the way a candle is feared to damage a canvas if given the chance to catch. Conservation is then the act of removing nuisance individuals to maintain the image; selectively removing enough of the population to ensure time is given to recover from the damage of the break. The way humans evaluate nature ultimately determines the roles species have, as the threshold of numb-nuisance is human-defined. The subjective creation of the image determines whether a species is charismatic, numb, or a nuisance, with infinite interpretations of this image. However, it is those with power who render the image in a way best suited to them. The numb-nuisance spectrum provides a method to understand the way species are constructed and the impacts that this will have on the species themselves.

Interpretations of the ideal baseline image are heavily influenced by powerful stakeholders. In the case of the cormorant, the OFAH directed the ideal imagery to construct cormorants as the flame to canvas, yet it is the public that questioned this rendering. The concerted efforts of hundreds of supporters worked to impose an image with cormorants present; cormorants existing within the numb (Bell, 2020; Ruiter, 2019). This rising tide begins to reimagine nuisance species as the numb and inspires the re-construction of human-animal relationships as they relate to nuisance species. The public outcry suggests that the concept of the nuisance species may become extinct before the cormorant, and our relationships with animals may cause a permanent break in the numb with each species deemed charismatic. Species outcast may re-enter human-defined spaces to re-construct their lives with humans rather than live in fear of human aversion tactics (Collard, 2013). Conservation may shift to recognize the role of nuisance species in maintaining the pristine and encourage their presence to construct a modified and inclusive pristine, without nuisance designations. The Numb-Nuisance spectrum allows us to conceptualize the current tolerable thresholds of nuisance species while challenging us to re-evaluate the construction of these thresholds. Although cormorants continue to be hunted, perhaps one day we will recognize the value of the Devil Bird.

References

Able et al. 1986. The Birds Around Us. Ortho Books.

Abram, D. 2010. Becoming Animal: An Earthly Cosmology. Vintage Books; New York.

Alighieri, D. 1307. Paradiso. Translated by H. W. Longfellow.

Andrews, B. 2021. Biologists decry continued cormorant hunt as local population appears to dwindle. CBC News. November 21, 2021. https://www.cbc.ca/news/canada/ottawa/cormorants-big-rideau-lake-fish-1.6256892

Animal Alliance of Canada. 2020. Ontario's New Cormorant-killing Hunting Regulation. The Animal Alliance of Canada. August 19, 2020. https://www.animalalliance.ca/killing-cormorants-in-ontario/

Archers & Bowhunters Association of Manitoba. 2016. Bowhunting Principles. http://archerymanitoba.ca/wp-content/uploads/2016/08/ABAM-Bowhunting-Principles.pdf

Barbier, E. 2011. Pricing nature. Annual Review of Resource Economic 3: 337-353. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2062348

Bateman, R. 2002. Birds. Firefly Press.

Bekiempis, V. 2021. Wisconsin hunters kill 216 wolves in less than 60 hours, sparking uproar. The Guardian. March 3, 2021. https://www.theguardian.com/us-news/2021/mar/03/wisconsin-hunters-kill-216-wolves-less-than-60-hours-uproar

Bell, A. 2020. Ontario's cormorant hunt: setting the record straight. Ontario Nature. August 6, 2020. https://ontarionature.org/ontarios-cormorants/

Bell, S., Graham, H., and White, P. 2018. The role of managed natural spaces in connecting people with urban nature: a comparison of local user, researcher, and provider views. Urban Ecosystems, 211: 875-886. https://link.springer.com/article/10.1007/s11252-018-0762-x

Canadian Environmental Law Association. 2019. Ontario's proposal to establish hunting season for the double-crested cormorant (EBR Registry No. 013-4124). The Canadian Environmental Law Association. https://cela.ca/wp-content/uploads/2019/07/Submission-from-CELA-Proposed-Cormorant-Hunting-Season-EBR-013-4124.pdf

CBC News. 2018. Check your outdoors card before fishing or hunting this year, province says. CBC News. January 18, 2018. https://www.cbc.ca/news/canada/thunder-bay/expired-outdoors-card-2017-1.4491030

Collard, R. C. 2013. Putting animals back together, taking commodities apart. Annals of the Association of American Geographers, 104(1): 151-165. DOI: 10.1080/00045608.2013.847750

Conference Board of Canada. 2021. The economic footprint of angling, hunting, trapping and sport shooting in Canada. The Conference Board of Canada. https://www.ofah.org/wp-content/uploads/2019/09/Economic-Footprint-Analysis-of-AHTS.pdf

Conservation Ontario. 2019. Conservation Ontario 2019 Annual Report. https://conservationontario.ca/fileadmin/pdf/annual_report/2019_CO_Annual_Report_Web.pdf

Cotnam, H. 2020. Local hunter defends controversial cormorant hunt. CBC News. September 18, 2020. https://www.cbc.ca/news/canada/ottawa/cormorant-hunter-1.5727779

Cronon, W. 1995. The trouble with Wilderness; or, Getting back to the wrong Nature. In Cronon, W. (ed)., Uncommon Ground: Rethinking the Human Place in Nature. New York: W. W. Norton & Co. pp 69-90. Retrieved from: https://www.williamcronon.net/writing/Trouble_with_Wilderness_Main.html

Despret, V. 2016. What would animals say if we asked the right questions? University of Minnesota Pres. Translated by Bret Buchanan.

Elliot, R. 1992. Intrinsic value, environmental obligation and naturalness. Monist 75(2):138-161. https://www-jstor-org.proxy.queensu.ca/stable/27903283?seq=1

Environment Canada. 1995. The rise of the double-crested cormorant on the Great Lakes: Winning the war against contaminants. Authority of the Minister of

Environment. https://ontarionature.org/wp-content/uploads/2016/07/En40-222-2-1995E.pdf

Ewins, P., and Weseloh, D. 1994. Effects on productivity of shooting of double-crested cormorants (Phalacrocorax auratus) on Pigeon Island, Lake Ontario, in 1993. Journal of Great Lakes Research, 20(4): 761-767. https://doi.org/10.1016/S0380-1330(94)71193-X

Fairclough, N. 2001. Critical discourse analysis as a method in social scientific research. In R Wodak and M Meyer Methods of Critical Discourse Analysis. ISBN: 9780857028020

Fennell, D. 2012. Animals pursued for sport and subsistence. In D. Fennell Tourism and Animal Ethics. Routledge.

Fish and Wildlife Conservation Act, 1997, S.O. 1997, c. 41. https://www.ontario.ca/laws/statute/97f41/v14

GlobeNewswire. 2021. Infamous cormorant hunting season starts again Great Lakes Cormorants formed to bring common-sense and science in aid of Ontario's cormorants. Financial Post. September 16, 2021. https://financialpost.com/globe-newswire/infamous-cormorant-hunting-season-starts-again-great-lakes-cormorants-formed-to-bring-common-sense-and-science-in-aid-of-ontarios-cormorants

Hall, M. 2020. Hunting in Canada – Looking back on 2019 and forward to 2020. Hunter Conservationist. January 7, 2020. https://thehunterconservationist.com/hunt-fish/hunting-in-canada-looking-back-on-2019-and-forward-to-2020/

Hays, S. 1996. Comment: The trouble with Bill Cronon's wilderness. Environmental History 1(1): 29-34.

Hobson, K. 2021. Ontario's decision for the province-wide cull of Double-crested Cormorants. Avian Conservation & Ecology 16(1):24. https://doi.org/10.5751/ACE-01949-160124

Hovorka, A. 2018. Animal geographies III: Species relations of power. Progress in Human Geography 43(4). https://doi-org.proxy.queensu.ca/10.1177/0309132518775837

King, R. n.d. To kill a cormorant. Natural History Magazine. https://www.naturalhistorymag.com/features/19298/to-kill-a-cormorant

Loring, P. 2020. Finding Our Niche: Toward a Restorative Human Ecology. Fernwood Publishing.

Milton, J. 1991 [1667]. Paradise Lost. The Project Gutenberg. https://www.gutenberg.org/cache/epub/20/pg20-images.html

Ministry of Natural Resources and Forestry. 2020a. Ontario taking steps to protect fish and wildlife habitat. Ontario. News Release July 31, 2020.

Ministry of Natural Resources and Forestry. 2020b. Proposal to establish a hunting season for double-crested cormorants in Ontario. Ontario. https://ero.ontario.ca/notice/013-4124

Nuwer, R. 2018. Poached: Inside the Dark World of Wildlife Trafficking. New York, NY. Da Capo Press.
Ontario Regulation 665/98: HUNTING under Fish and Wildlife Conservation Act, 1997, S.O. 1997, c. 41
Ontario Regulation 670/98: OPEN SEASONS – WILDLIFE under Fish and Wildlife Conservation Act, 1997, S.O. 1997, c. 41

Ontario Federation of Anglers and Hunters. 2020. Annual Report. https://www.ofah.org/report/2020/2020_OFAH_Annual_Report_FINAL.pdf

Ontario Parks. 2021. Day Use Fees – 2021. Ontario Parks. https://www.ontarioparks.com/fees/dayuse/2021

Ontario. 2014. Ontario Regulatory Policy. https://www.ontariocanada.com/registry/downloads/Ontario%20Regulatory%20Policy.pdf

Ontario. 2021a. 2021 Hunting regulations summary: Fall 2021 – Spring 2022. Government of Ontario. https://www.ontario.ca/document/ontario-hunting-regulations-summary/small-game-and-furbearing-mammals#section-6

Ontario. 2021b. How fishing and hunting fees are used. https://www.ontario.ca/page/how-fishing-and-hunting-fees-are-used

Ontario. 2021c. Hunting license (Ontario residents).

Ontario. https://www.ontario.ca/page/hunting-licence-ontario-residents

Peterson, R. 1957. How to know the birds. Signet.

Peterson, R. 2009. Field Guide to Birds of North America. New York, NY. Houghton Mifflin Company.

Reader's Digest. 1979. Birds: Their Life, Their Ways, Their World. The Reader's Digest Association.

Robertson, M. M. 2006. The Nature That Capital Can See: Science, State, and Market in the Commodification of Ecosystem Services. Environment and Planning D: Society and Space, 24(3), 367–387.

Roy, K. 2015. Double-crested cormorants at Port Weller, St. Catharines, Niagara, Ontario. Ontario Birds 33(2): 82-97. http://www.ofo.ca/library/view/id/100

Ruiter, Z. 2019. Killing cormorants: Is Ontario's feathered pariah about to be culled out of existence? Now Toronto. March 24, 2019. https://nowtoronto.com/news/cormorants-doug-ford-hunting-ontario

Sandler, R. 2012. Intrinsic value, ecology, and conservation. Nature Education Knowledge 3(10). https://www.nature.com/scitable/knowledge/library/intrinsic-value-ecology-and-conservation-25815400/

Shaw, F. 1989. Birds of America. Arch Cape Press.

Somers, C., Lozer, M., Kjoss, V., and Quinn, J. 2003. The invasive round goby (Neogobius melanostomus) in the diet of nestling double-crested cormorants (Phalacrocorax auritus) in Hamilton Harbour, Lake Ontario. Journal of Great Lakes Research, 29(3): 392-399. https://doi.org/10.1016/S0380-1330(03)70446-8

Sukha, C. 2013. The Mini-Mentor Guide to Birdwatching for Beginners. Inkling Press.

Wittnebel, J. 2021. 'A bird that can't speak back': The Ford government's mass killing of the double-crested cormorant reveals its true stripes. The Pointer. October 16, 2021. https://thepointer.com/article/2021-10-16/a-bird-that-can-t-speak-back-the-ford-government-s-mass-killing-of-the-double-crested-cormorant-reveals-its-true-stripes

Wright, P., Moghimehfar, F., and Woodley, A. 2019. Canadians' perspectives on how much space nature needs. Facets, 4(1). https://www.facetsjournal.com/doi/10.1139/facets-2018-0030

Yarbroug, A. 2017. Species, race, and culture in the space of wildlife management. In K. Gillespie and R. C. Collard Critical Animal Geographies Politics, intersection and hierarchies in a multispecies world. Routeledge. pp. 108-126.

Zoneadmin. 2020. Ontario takes important first step in cormorant control. OFAH Zone J. July 31, 2020. https://www.ofah.org/zonej/ontario-takes-important-first-step-in-cormorant-control/

The impact of geospatial socioeconomic inequalities: Exploring health inequalities in Rio de Janeiro

Nathaniel Katz

Abstract

Health inequalities in Rio de Janeiro follow clear geographic lines, with individuals living in low-income favela ('slum') areas having significantly poorer health outcomes than those living in middle- and high-income areas of the city. Since the 1960s, Brazilian governments have recognized the need to provide free and accessible healthcare to impoverished communities in Brazil. Over the last several decades, efforts have been underway to develop a comprehensive nation-wide primary healthcare system that is accessible to all. However, a lack of adequate public funding, government corruption, and ideological dissonance have meant that whereas many individuals living in Rio de Janeiro now have access to public healthcare, those living in low-income marginalized neighborhoods disproportionately lack access to primary healthcare. Low-income favela dwellers are more likely to experience communicable diseases, such as Tuberculosis and HIV; non-communicable diseases, including obesity and malnutrition; and violent victimization and homicide, because of overcrowding, unsanitary conditions, and poor lifestyles in the favelas. While efforts are currently underway to improve the health and wellbeing of favela residents, more must be done to effectively address the inequalities in healthcare access and health outcomes. Efforts that must be undertaken include providing greater funding to local health units, improving health education in the favelas, and addressing upstream determinants of health. The ongoing COVID-19 pandemic has had a disproportionate impact on low-income favela dwellers: Lockdowns have led to worker lay-offs and overcrowding in favelas which have exacerbated existing health issues and facilitated the spread of the coronavirus due to unsanitary conditions.

Introduction

The city of Rio de Janeiro, Brazil is characterized by significant geographically dispersed socioeconomic inequalities. Northern and eastern parts of the city are more likely to be home to low- and middle-income Cariocas (residents of Rio de Janeiro), whereas individuals living in neighbourhoods in the south and central parts of the city are more likely to be affluent (Bortz et al., 2015). This disparity in wealth correlates closely with inequalities in life expectancy and health outcomes (Szwarcwald, 1999). Although Brazil prides itself on its Unified Healthcare System, one of the largest public healthcare programs in the world, because of budget constraints, local corruption and embezzlement, and difficulty servicing the favelas ('slums'), a significant percentage of low-income Cariocas lack access to adequate primary healthcare (Campos, Cohn, Brandao, 2016; Cabral et al., 2020). Concurrently, marginalized low-income individuals living in poor and underserved neighbourhoods of Rio de Janeiro are significantly more likely to have poor health than other Cariocas (Cabral et al., 2020). These individuals are more likely to experience communicable

and non-communicable diseases, die by violence and accidents as a result of their poor living conditions, and lack of access to adequate primary health care. The present article will (1) provide a historical examination of healthcare access in Rio de Janeiro, highlighting the lack of funding for public healthcare over the last three decades; (2) examine issues contributing to lower life expectancies in and around Rio de Janeiro's favelas; (3) propose methods of improving health outcomes in the favelas, and (4) investigate the efforts of community activists to protect the health of favela residents during the COVID-19 pandemic.

Historical healthcare overview: The path to universal coverage

Publicly provided healthcare has existed in Rio for over a century, originally developed to address disease and epidemic-related issues (Campos, Cohn and Brandao, 2016). It was not until the 1960s, however, that the city began to acknowledge the reality of its poor population's healthcare needs (Campos, Cohn and Brandao, 2016). In the 1960s, funding provided from the Alliance for Progress, a U.S. foreign aid initiative directed at Latin American states, allowed for the development of a greater number of Municipal Health Centres in Rio de Janeiro (Campos, Cohn and Brandao, 2016). In 1978, Brazil signed onto the World Health Organization's Alma-Ata Declaration, agreeing to seek the goal of "health for all" by the year 2000 (Massuda, Titton and Neto, 2018, p. 7). In the decade that followed, primary healthcare (a model of comprehensive care based on identifying and addressing medical problems before they become too serious) became a central focus for Brazil's health system, new medical services were implemented, and a new generation of medical and para-medical workers facilitated health reforms (Campos, Cohn and Brandao, 2016). Twenty-seven new Health Centres were added to the city's low-income neighbourhoods, and some older facilities were refurbished (Campos, Cohn and Brandao, 2016). Unfortunately, despite the principle of equity underlying the new model of healthcare, many low-income favela communities were excluded from expansions of primary healthcare services. This was in part due to excessive bureaucracy in the expansion of the healthcare network and a "culture of patronage politics", with politicians favouring certain areas over others to receive government funds (Campos, Cohn and Brandao, 2016, p. 1357).

In 1988, out of a desire to provide more equitable care and reach Brazilians who had previously been unable to access primary healthcare, the Brazilian government developed the Unified Healthcare System, known in Portuguese as the Sistema Único de Saúde (SUS) (Porto et al., 2008). As part of the SUS, the federal government created the Family Health Strategy specifically designated to provide services for vulnerable segments of the population (Campos, Cohn, Brandao, 2016). This system was extremely effective in smaller cities where public primary healthcare programs had not previously existed and it increased medical coverage across Brazil from 4.4% to 54% (Andrade et al., 2018). However, in Rio de Janeiro, along with other cities where healthcare programs were already in place, the Family Health Strategy faced significant corporate and ideological opposition (Campos, Cohn and Brandao, 2016). According to Savignon de Nadai (2020), recommendations from the World Bank reinforced the neoliberal ideology that the state should not be responsible for providing public services and led local corporations in Rio de Janeiro to believe that

the number of healthcare systems already in place were adequate to effectively support Cariocas. In Rio, as late as 2009, the bulk of health department resources (88% in 2008) were spent on funding local hospital networks (Mello et al., 2017). In addition to large amounts of municipal embezzlement, overspending on hospitals meant that from the 1990s to 2009, Rio de Janeiro's primary healthcare system was left poorly constructed and underfunded (Mello et al., 2017). Prior to 2009, only 7% of Cariocas had access to primary healthcare (Mello et al., 2017). Most of these individuals were from higher-income communities where there was more likely to be appropriately funded public health care centres or private medical centres (Mello et al., 2017). But for most Cariocas, minor health issues were often left unaddressed because of lack of access to care, until they became serious enough to require emergency attention at a hospital (Mello et al., 2017). As a result, emergency wards and other secondary healthcare facilities, especially in low-income communities became overburdened by individuals with chronic diseases (Mello et al., 2017).

After studying healthcare coverage in other global cities, including London and Barcelona, Rio de Janeiro's municipal government recognized the essential role of providing primary healthcare for all citizens (Mello et al., 2017). Reforms to the municipal healthcare system meant that between 2009 and 2012, the number of family health teams in Rio de Janeiro increased from 67 to over 600. As a result, the percentage of Cariocas covered by primary health care providers increased from 7% to 40% (Mello et al., 2017). By the end of 2016, 52% of the population was covered by primary care providers, unfortunately still significantly below municipal goal of 70% coverage by 2016, set out in the 2013 Rio de Janeiro Town Hall Strategic Plan (Mello et al., 2017). The deficiency in primary health coverage in the 2010s resulted from (1) inadequate investment in health infrastructure from the federal and municipal governments and (2) a shortage of primary care doctors. While data could not be found on rates of primary health coverage in Rio de Janeiro since 2016, primary health coverage in Brazil as a whole has remained relatively stable since 2016, at 74.6% (Fava and Lapão, 2021). There is still a long way to go in improving the healthcare coverage of Rio de Janeiro's most impoverished community members, as will be discussed later. Alongside the public health system, numerous non-governmental healthcare organizations operate in the favelas, ranging from major international charities such as UNICEF to independent local grassroots organizations like the Ibiss Foundation (Devi, 2010; Burgos, 2016). The residence associations of individual favelas often also run ambulatory healthcare clinics to provide limited primary care to favela residents (Burgos 2016). Unfortunately, these non-governmental organizations and residence associations tend to have small, inadequate budgets leading to staffing shortages and an inability to help all individuals who need medical care (Burgos, 2016).

Inequalities in health outcomes: Rio de Janeiro's favelas

Rio de Janeiro is home to over 750 favelas (Nunes, 2021). Although the exact data is difficult to collect because of the informality and lack of authority in many favelas, it is estimated that approximately 2 million individuals currently reside in the favelas (Nunes, 2021). Rio de Janeiro's favelas are the poorest areas in the city and correspondingly have the lowest population health statuses

(Szwarcwald et al., 2011; Szwarcwald, 2000). In the most deprived favelas in Rio de Janeiro, life expectancy for males is approximately 12.8 years shorter than in the wealthiest areas of the city, resulting from inadequate primary health coverage and poor living conditions (Szwarcwald et al., 2011). It should be noted that not all individuals who live in the favelas are impoverished, and many favelas now have running water, electricity, paved streets, and brick houses (Riley et al., 2007). As the life experiences and health outcomes of favela dwellers differ significantly based on their particular socioeconomic statuses and geographic locations, favela dwellers should not be seen as a homogenous group (Ruley et al., 2007). However, data on health and disease in favelas is commonly collected by various agencies on an aggregated level, such as administrative regions or census tracts, making it challenging to examine health on an individual favela level (Barcellos and Zaluar, 2014; Mello et al. 2017; Szwarcwald, 2000).

Communicable diseases

Individuals living in favelas are significantly more likely to have communicable and non-communicable diseases than those outside favelas, a major contributing factor to the difference in life expectancy (Bortz et al., 2015). Communicable diseases are those are directly transmissible through contact with other humans or animals, and include dengue, tuberculosis, and HIV/AIDS, among others (Bortz et al. 2015). The overcrowded, unplanned and unsanitary nature of favelas has facilitated the spread of communicable diseases between favela dwellers and has made it more difficult for infected individuals to recover (Bortz et al., 2015). Despite Brazil having one of the most developed antiretroviral treatment programs in place among middle-income nations, socioeconomic-based inequality in HIV mortality in Rio de Janeiro continues to rise (Bortz et al., 2015). Similarly, while tuberculosis rates are decreasing in Brazil, a 2011 study found that the incidence of tuberculosis in Rio de Janeiro's favelas are at 300 cases per 100,000 residents, approximately four times higher than the city's average (Vigna, 2016). Beginning in the early 2000s, a state-sponsored program was initiated to "upgrade" hundreds of favelas and improve the health and wellbeing of favela dwellers by adding municipal services and modernizing infrastructure such as water and sewage systems (Burgos, 2016; Corburn and Sverdlik, 2017). It is too early to know the extent to which this program has improved the health of favela dwellers at large, especially as many favelas have only received upgrades in the last few years. However, infrastructure improvements in slums similar to those of Rio de Janeiro have been shown to reduce water-borne illnesses and infections, improve infant and child mortality rates, and improve flood and landslide control (Jazaieri et al., 2020; Burgos 2016).

Non-communicable diseases

Impoverished urban populations, such as individuals living in Rio de Janeiro's favelas, are significantly more likely to contract noncommunicable diseases as a result of poor diets and inactive lifestyles (Hone et al., 2020). Noncommunicable diseases are those that are not directly transmissible between humans or animals (Hone et al., 2020) and include heart disease, strokes, cancers, diabetes, among others. In the most impoverished favelas, few individuals can afford healthy foods, leading these communities to have diets low in protein and minerals, and high in fats and carbohydrates (Hone et al., 2020; Silveria et al., 2010). In a study of the eating habits of impoverished families living in the Manguinhos favela, Gama et al. (2015) found

that 32.4% of food spending "went towards simple sugars, especially soft drinks and processed juices" (p. 428). A lack of access to healthy food options has resulted in high rates of obesity and malnutrition among adults and children residing in the favelas (Silveria et al., 2010; Marins et al., 2004). In Silveria et al.'s (2010) study of the favelas of Maceió, Rio de Janeiro, 8.6% of sampled children under the age of six were found to be moderately to severely malnourished and 11.3% were reported to be overweight or obese (Silveria et al. 2010). Silveria et al. (2010) also found that 45.6% of mothers sampled were overweight. Silveria et al. (2010) and Marins et al. (2004) both suggest intrafamilial correlations exist between parental obesity and child malnourishment: Mothers who are overweight, have low socioeconomic statuses, have limited education, and live in poorly built houses are more significantly more likely to have overweight or malnourished children (Silveria et al., 2010; Marins et al., 2004). As long as favela residents remain unable to access healthy foods, obesity and malnutrition will remain an ever-growing health disparity in Rio de Janeiro (Marins et al., 2004).

Violent victimization and homicide

Rates of violent victimization and homicide are higher among low-income individuals living in impoverished areas than among other demographic groups in Rio de Janeiro, contributing to inequalities in life expectancy (Szwarcwald et al., 2011). High rates of gang activity in the favelas are responsible for introducing vulnerable young men to firearms and gang participation, leading to favelas becoming "hot spots of premature death" (Barcellos and Zaluar 2014, p. 98). Somewhat surprisingly, Barcellos and Zaluar (2014) found that in 2009, the homicide rate inside Rio de Janeiro's favelas was 34 per 100,000 individuals, significantly lower than the homicide rate for the city as a whole, at 52 per 100,000 individuals. In areas within 100 meters of the borders of the favelas, however, homicide rates increase to 48-129 per 100,000 (Barcellos and Zaluar, 2014). The authors provide three possible explanations for the unexpected homicide rates they observed: (1) some statistics relating to homicide are based on where the victim's listed residence is located, and in many cases the only listed residence for favela dwellers are addresses of residence associations or other businesses outside the favelas; (2) tyrannical control over particular favelas by militias and/or Pacifying Police Unit (UPP) limits violence within the favela; and (3) criminal factions holding strong control over favelas prohibit drug gangs from operating inside favelas, forcing gangs to use the areas surrounding the favelas for trading and conflicts (Barcellos and Zaluar, 2014). Burgos (2016) suggests that the implementation in 2008 of the UPP, a police force tasked with limiting violence and decreasing the control of criminal factions in the favelas has had a positive effect on decreasing the rate of violence within the favelas. However, as only 7% of favelas had UPP presence by 2014, it is still too early to tell what role this police force will play in improving life expectancy (Barcellos and Zauler, 2014).

Mental health and mental illness

Individuals living in Rio de Janeiro's favelas are more likely to experience mental distress and mental health symptoms compared to global averages, resulting in part from high rates of poverty and a constant fear of victimization in the favelas (Cruz et al. 2021, p, 1). In a study of 1,211 favela residents living in areas currently controlled by gangs, Cruz et al. (2021) found that 21.1% of respondents "experienced someone close being shot or killed" and 11.5% "had their house invaded by criminals or police" (p. 4). According to the authors, experiences such as these have contributed to increased fear

and uncertainty and a poorer quality of life among these favela residents (Cruz et al. 2021). Athié and Fortes (2015) found that high rates of mental illness in the favelas may also result from heightened experiences of stigmatization or family dysfunction. With the onset of the COVID-19 pandemic, as will be discussed further, the mental health and quality of life of favela dwellers has worsened to significantly below pre-pandemic global averages, particularly for those who have lacked social contact and who have had difficulty accessing primary care (Vernaglia et al. 2021).

Improving health outcomes in low-income favela communities

While rates of communicable and noncommunicable disease-related deaths remain high in the favelas, the advancement in primary medical care coverage in the last decade has contributed to improvements in health outcomes for various diseases (Bortz et al., 2014). To further improve the health outcomes of favela communities, more funding for municipal primary healthcare is necessary. With greater funding, the large number of old and deteriorating public healthcare centres can be replaced and additional centres can be added into low-income neighbourhoods (Mello et al., 2017). Additional funding for primary healthcare would also allow local health centres to purchase advanced technologies such as ultrasounds and x-rays, and hire additional staff (Mello et al., 2017).

As healthcare education has been shown to improve community health, the municipal government should ensure that health-related education is available to favela residents (Nunes, 2021; Devi, 2010). Educational programs include teaching impoverished youth about safe-sex practices or teaching older community members how to identify signs of disease (Devi, 2010). One example of a successful educational program that could be implemented on a wider basis in the favelas is a community healthcare training program run by the Ibiss NGO. In the 1990s, Ibiss began to train interested favela dwellers "one-and-a-half days a week for nine months in the early detection of diseases, how to seek treatment and how to get a prescription" (Devi, 2010, p. 84). After training, these favela dwellers serve as health contacts for individuals who are unable to access formal primary medical care. The implementation of these types of programs have increased the likelihood that individuals will seek out medical care for diseases (Devi 2010).

Like impoverished communities around the globe, the greatest improvements in health outcomes of favela residents require changing upstream social determinants of health (Bharmal et al., 2015). Educational attainment is the basis for successful employment, a sense of control, and social support --- all of which contribute to improving an individual's health outcomes. Thus, the government must ensure that primary and secondary education is provided to all Cariocas (Bharmal et al., 2015). To decrease the likelihood of work-related injury, disease, or mental illness, the government should ensure safe working conditions for all Cariocas and require employers to provide paid sick leave and employment security (Bharmal et al., 2015). Unfortunately, the Rio de Janeiro municipal government does not have the capacity to ensure many upstream social determinants of health are provided, especially for workers in precarious or illegal employment (Campos, Cohn, Brandao, 2016).

COVID-19 impact on the favelas: Community activism

When the COVID-19 pandemic hit in March 2020, Brazil's public healthcare and social support systems were already stretched to theirs limits (Guedes et al., 2021). The Ministry of Health initially took an approach of "denial" to the pandemic by not imposing strict guidelines or giving clear instructions to primary health care workers (Guides et al., 2021). As most favelas lack public policies on infrastructure, housing, or sanitation, there were few to no contingency plans in place in these communities in anticipation of the pandemic (Nunes, 2021). Unlike other parts of Rio de Janeiro, where Cariocas have access to running water, cleaning supplies, and enough space to self-isolate, Cariocas in the favelas were unable to follow many COVID-19 guidelines (Nunes, 2021). As a result, between the start of the pandemic and late February 2022, there were approximately 7,979 COVID-19 related deaths in favelas within the Rio de Janeiro Metropolitan Area (Catalytic Communities, 2022). While data is not currently available on the total number of COVID-19 related deaths in the Rio de Janeiro Metropolitan Area, it is likely that the death rate inside the favelas is significantly higher than outside (Catalytic Communities, 2022).

COVID-19 lockdowns led many favela residents to be laid off from employment and many schools to be shut down, resulting in large numbers of adults and children who continue to be stuck at home in the favelas during the day (Nunes, 2021). Not only does this facilitate the spread of COVID-19 as a result of overcrowding, it also means that many families are unable to afford food and basic supplies and that children are unable to attend school (Nunes, 2021). Local community activists have developed organizations, such as the Maré Mobilization Front, to respond to COVID-19-related social and health issues in the favelas. These volunteer organizations are responsible for distributing information from health authorities and dispelling fake news; fundraising for the neediest of residents, including the elderly and single-parent families; collecting and distributing food and supplies; and providing mental and physical health support to individuals in isolation (Nunes, 2021). Local activists have led campaigns to add public sinks and handwashing stations in favela alleyways to decrease the risk of disease spread. More recently, these organizations have been responsible for aiding medical staff at local schools and health centres in providing vaccines (Bambridge-Sutton, 2021). While courageous volunteers have made living during the pandemic easier and safer for many favela residents, the government has not done enough protect Rio de Janeiro's most marginalized citizens (Guedes et al., 2021).

Conclusion

Despite improvements in the availability of primary healthcare services to low-income marginalized Cariocas over the last three decades, there continue to be significant socioeconomic and geographic disparities in health outcomes in Rio de Janeiro (Hone et al., 2020; Szwarcwald, 2000). Impoverished individuals living in favelas continue to experience higher rates of disease, violent victimization, mental illness and other health disorders that have contributed to lower life expectancy (Szwarcwald, 2000; Bossan et al., 2007; Oliveira, Santos and Silva, 2015; Bortz et al., 2015). The COVID-19 pandemic has placed a spotlight on the inequalities in health and social support in Rio de Janeiro and demonstrated the power of citizens

to advocate and care for their neighbours (Nunes, 2021; UNIC Rio, 2021). As Brazil emerges from the pandemic, the lessons learned from this shock to the healthcare system may, sadly, have little effect on improving the health situation of low-income Cariocas. Greater change must continue to be made in ensuring health equity for all individuals in Rio de Janeiro.

References

Andrade, M. V., Coelho, A. Q., Xavier Neto, M., De Carvalho, L. R., Atun, R., & Castro, M. C. (2018). Brazil's Family Health Strategy: Factors associated with programme uptake and coverage expansion over 15 years (1998-2012). Health Policy and Planning, 33(3), 368–380. https://doi.org/10.1093/heapol/czx189

Athié, K., & Fortes, S. (2015). Severe mental health problems in Rio de Janeiro slums: Rethinking mental health services. Mental Health Innovation Network. Atuesta, L. H., & Soares, Y. (2018). Urban upgrading in Rio de Janeiro: Evidence from the Favela-Bairro programme. Urban Studies, 55(1), 53–70. https://doi.org/10.1177/0042098016669290

Bambridge-Sutton, A. (2021). Rio de Janeiro is Vaccinating Mare's Favelass. Retrieved from The Borgen Project website: https://borgenproject.org/vaccinating-mares-favelas/

Barcellos, C., & Zaluar, A. (2014). Homicides and territorial struggles in Rio de Janeiro favelas. Revista de Saude Publica, 48(1), 94–102. https://doi.org/10.1590/S0034-8910.2014048004822

Bharmal, N., Derose, K. P., Felician, M., & Weden, M. M. (2015). Understanding the social determinants of health. In RAND Social Determinants of Health Interest Group. https://doi.org/10.1080/15245004.2000.9961120

Bortz, M., Kano, M., Ramroth, H., Barcellos, C., Weaver, S. R., Rothenberg, R., & Magalhães, M. (2015). Disaggregating health inequalities within Rio de Janeiro, Brazil, 2002-2010, by applying an urban health inequality index. Cadernos de Saúde Pública, 31(suppl 1), 107–119. https://doi.org/10.1590/0102-311X00081214

Bossan, F. M., Anjos, L. A. dos, Vasconcellos, M. T. L. de, & Wahrlich, V. (2007). Nutritional status of the adult population in Niterói, Rio de Janeiro, Brazil: the Nutrition, Physical Activity, and Health Survey TT - Estado nutricional da população adulta de Niterói, Rio de Janeiro, Brasil: resultados da Pesquisa de Nutrição, Atividade Física e Saúde. Cadernos de Saúde Pública, 23(8), 1867–1876. Retrieved from http://www.scielo.br/pdf/csp/v23n8/13.pdf

Burgos, M. D. (2016). Development, Security and Displacement: An Ethnographic Case Study of

Rocinha and other Key Favelas in Rio de Janeiro. ProQuest Dissertations and Theses.

Cabral, L. M., Peres, A. M., Rodrigues, P. H., Caldas, M., Magalhães, M., Hill, D., … Osório, S. (2020). Regional support in the health regions of Rio de Janeiro state: a strategy for strengthening SUS. European Journal of Public Health, 30(Supplement_5), 2020. https://doi.org/10.1093/eurpub/ckaa166.177

Campos, C. E. A., Cohn, A., & Brandão, A. L. (2016). The historical trajectory of the city of rio de Janeiro's health system: 1916-2015. One hundred years of innovations and achievements. Ciência & Saúde Coletiva, 21(5), 1351–1364. https://doi.org/10.1590/1413-81232015215.00242016

Catalytic Communities. (2022, February 26). Painel Unificador Covid-19 nas Favelas do Rio de Janeiro. Retrieved from https://experience.arcgis.com/experience/8b055bf091b742bca021221e8ca73cd7/

Corburn, J., & Sverdlik, A. (2017). Slum Upgrading and Health Equity. International Journal of Environmental Research and Public Health, Vol. 14. https://doi.org/10.3390/ijerph14040342

Cruz, M. S., Silva, E. S., Jakaite, Z., Krenzinger, M., Valiati, L., Gonçalves, D., … Priebe, S. (2021). Experience of neighbourhood violence and mental distress in Brazilian favelas: a cross-sectional household survey. The Lancet Regional Health - Americas, 4, 100067. https://doi.org/10.1016/j.lana.2021.100067

Devi, S. (2010). Innovation and education improve health in Rio's favelas. The Lancet, 376(9735), 83–84. https://doi.org/10.1016/S0140-6736(10)61064-1

Fava, V. M. D., & Lapão, L. V. (2021). Towards Universal Health Coverage in Brazil: analysis of programs to expand the supply of doctors in primary health care. Journal of Global Health Reports, 5, 1–8. https://doi.org/10.29392/001c.19143

Gama, S. R., Cardoso, L. de O., Rubinsztajn, I. K., Fischer, A., & Carvalho, M. S. (2015). Feeding children in a favela in Rio de Janeiro, Brazil: how much is spent and what would be the cost of a healthy diet? Revista Brasileira de Saúde Materno Infantil, 15(4), 425–434. https://doi.org/10.1590/s1519-38292015000400006

Guedes, M. B. O. G., de Assis, S. J. C., Sanchis, G. J. B., Araujo, D. N., da Costa Oliveira, A. G. R., & Lopes, J. M. (2021). COVID-19 in Brazilian cities: Impact of social determinants, coverage and quality of primary health care. PLoS ONE, 16(9 September), 1–12. https://doi.org/10.1371/journal.pone.0257347

Hone, T., Saraceni, V., Coeli, C. M., Trajman, A., Rasella, D., Millett, C., & Durovni, B. (2020). Primary healthcare expansion and mortality in Brazil's urban poor: A cohort analysis of 1.2 million adults. PLoS Medicine, 17(10), 1–20. https://doi.org/10.1371/journal.pmed.1003357

Jazaieri, H., Lee, I. A., McGonigal, K., Jinpa, T., Doty, J. R., Gross, J. J., & Goldin, P. R. (2016). A wandering mind is a less caring mind: Daily experience sampling during compassion meditation training. The Journal of Positive Psychology, 11(1), 37–50. https://doi.org/10.1080/17439760.2015.1025418

Massuda, A., Titton, C. M. S., & Neto, P. P. (2018). Remembering Alma-Ata: challenges and innovations in primary health care in a middle-income city in Latin America. Revista Panamericana de Salud Pública, 42. https://doi.org/10.26633/RPSP.2018.157

Mello, L. de A. F. de, Tonini, T., Silva, A. S. da S., Dutt-Ross, S., & Velasque, L. (2017). Evaluation of Primary Health Care Units in the Rio De Janeiro City According to the Results of PMAQ 2012. Journal of Ambulatory Care Management, 40(2), S71–S82.

Nunes, N. R. D. A. (2021). The power that comes from within: female leaders of Rio de Janeiro's favelas in times of pandemic. Global Health Promotion, 28(2), 38–45. https://doi.org/10.1177/1757975921994690

Oliveira, M. L. De, Santos, L. M. P., & Silvada, E. N. (2015). Direct healthcare cost of obesity in brazil: An application of the cost-of-illness method from the perspective of the public health system in 2011. PLoS ONE, 10(4), 1–15. https://doi.org/10.1371/journal.pone.0121160

Porto, Â., Sanglard, G., Fonseca, M. R. F. da, & Costa, R. da G.-R. (2008). History of Health in Rio de Janeiro: institutions and architectural heritage (Fiocruz, Ed.). https://doi.org/10.7476/9788575415993.0011

Ramos de Marins, V. M., Almeida, R. M. V. R., Pereira, R. A., & de Azevedo Barros, M. B. (2004). The relationship between parental nutritional status and overweight children/adolescents in Rio de Janeiro, Brazil. Public Health, 118(1), 43–49. https://doi.

org/10.1016/S0033-3506(03)00145-8

Riley, L. W., Ko, A. I., Unger, A., & Reis, M. G. (2007). Slum health: Diseases of neglected populations. BMC International Health and Human Rights, 7, 1–6. https://doi.org/10.1186/1472-698X-7-2

Scruggs, G. R., & Acoca-Pidolle, A. (2013). Rio de Janeiro Residents Associations and Recent Favela Real Estate Trends. Cambridge, MA. Lincoln Institute of Land Policy.

Savignon de Nadai, M. (2020). Território de Saúde e Políticas Públicas: da Reforma à Reorganização da Atenção Primária à Saúde no Município do Rio de Janeiro. Oswaldo Cruz Foundation.

Silveira, K. B. R., Alves, J. F. R., Ferreira, H. S., Sawaya, A. L., & Florêncio, T. M. M. T. (2010). Association between malnutrition in children living in favelas, maternal nutritional status, and environmental factors. Jornal de Pediatria, 86(3), 215–220. https://doi.org/10.2223/JPED.1991

Szwarcwald, C. L., Bastos, F. I., Barcellos, C., De Fátima Pina, M., & Esteves, M. A. P. (2000). Health conditions and residential concentration of poverty: A study in Rio de Janeiro, Brazil. Journal of Epidemiology and Community Health, 54(7), 530–536. https://doi.org/10.1136/jech.54.7.530

Szwarcwald, C. L., Mota, J. C. Da, Damacena, G. N., & Pereira, T. G. S. (2011). Health inequalities in rio de janeiro, Brazil: Lower healthy life expectancy in socioeconomically disadvantaged areas. American Journal of Public Health, 101(3), 517–523. https://doi.org/10.2105/AJPH.2010.195453

UNIC Rio. (2021). Brazil's favelas organize to fight Covid-19. Retrieved from https://www.un.org/en/coronavirus/brazil%E2%80%99s-favelas-organize-fight-covid-19

Vernaglia, T. V. C., Paravidino, V. B., Silva, E. S., Valiati, L., Heritage, P., Priebe, S., & Cruz, M. S. (2021). The impacts on the mental health of residents of 16 favelas observed during the coronavirus pandemic in Brazil. Research, Society and Development, 10(13), e583101321508. https://doi.org/10.33448/rsd-v10i13.21508

Vigna, A. (2016, June 16). Rio's Forgotten Health Crisis. Americas Quarterly. Retrieved from https://www.americasquarterly.org/content/rios-forgotten-health-crisis

The spatial distribution of asthma and its disproportional effect on BIPOC and marginalized communities in Canada

Kelachi Nsitem

Abstract

Across Canada, BIPOC and marginalized communities are disproportionately affected by both communicable and non-communicable diseases, one of them being asthma. Currently, limited race-based data collection in Canada means there is little knowledge on the reason for these trends and possible avenues to mitigate these health inequities. Although asthma is a result of both genetic and environmental factors, significant contributors include spatial displacement, socio-economic status, lack of accessible health care services, and disproportionate exposure to pollutants. Geographic Informational System (GIS) techniques and population-based data collection support the connection between traffic and industrial proximity, environmental pollutants, and asthma prevalence. This relationship along with a higher concentration of BIPOC and marginalized communities found in poorly invested and deteriorating sections of cities in Canada, highlights the theme of environmental justice. The disproportionate disposition of BIPOC and marginalized communities to factors that influence asthma symptoms, diagnoses, and emergency department visits, demonstrates the interconnectedness of identity, location, and health. Furthermore, this disposition highlights asthma's multi-faceted nature and how it negatively affects BIPOC and marginalized communities more than other populations.

Introduction

Asthma, one of the most common non-communicable respiratory diseases, causes impaired quality of life, disability, and many avoidable deaths in children and young adults (Papi et al., 2018). This condition is heterogenous, thus it stems from both genetic and environmental factors. Symptoms include tightening and thickening of airways, oedema or fluid in the lungs, and difficulty breathing. Exacerbations can be triggered by many factors including allergens, pollution, the environment, and infections (Papi et al., 2018).

It has been well documented in Canada that BIPOC and other marginalized communities face challenges in terms of access to education, healthcare, and even equitable treatment in various institutions (Serrano-Lomelin et al., 2020). Though there is a lack in Canada's race-based data, the relationship between BIPOC and marginalized communities to their spatial distribution, location, and economic environment highlight their disproportionate disposition to asthma inducing factors, thus emphasizing themes of environmental injustices and health inequities in Canada.
Race-based data collection in Canada is very sparse. This leads to challenges when analyzing the spatial distribution of diseases and how they may disproportionally affect BIPOC and marginalized communities. This is especially important in the context of environmental injustice, a common

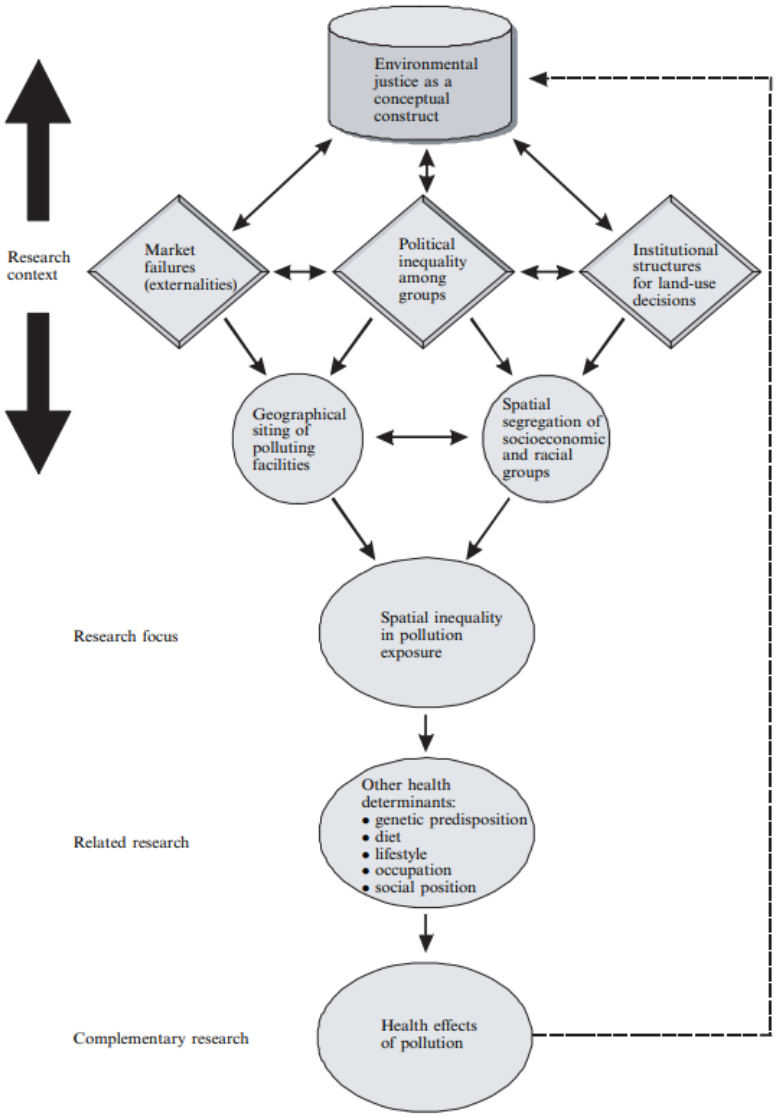


Figure 1. The environmental justice framework from A GIS–Environmental Justice Analysis of Particulate Air Pollution in Hamilton, Canada (M. Jerrett et al., 2001).

theme that prevails throughout this paper. Environmental justice is a conceptual construct that includes environmental equity, equality, and racism. It influences the spatial distribution of pollution, polluting facilities, and hazards in relation to population demographics and socioeconomic groups (M. Jerrett et al., 2001). Environmental justice relates to the main question being evaluated in this paper as inequitable distribution and exposure to pollution may result in BIPOC and marginalized communities facing negative health effects, including but not limited to the development of asthma.

This paper will argue that asthma is more prevalent in BIPOC and other marginalized communities due to poor access to healthcare services and environmental injustices including spatial distribution and exposure to pollutants. An environmental justice interpretive framework, seen in figure 1, will be used to illustrate the multi-faceted contributors to asthma and its relationship to BIPOC and marginalized communities.

The complexity of asthma and the spatial separation of BIPOC

Firstly, it is important to gain a deeper understanding of the complexity of asthma and the general spatial analysis of the disease. It is understood that asthma is a respiratory disease characterized by airway inflammation and is a consequence of its complex gene-environment interactions (Papi et al., 2018). As such, when evaluating the prevalence of the disease, the geographic, spatial, and socioeconomic influences are all equally as important as the biological influence. There are numerous treatments for both mild and chronic asthma, however, asthma diagnosis and access to medical treatments may vary. This could be due in part to socioeconomic or lifestyle factors which limit an individual's access to healthcare services. Furthermore, asthma hot spots are concentrated in areas known for air pollution, industrial development, and those that face environmental challenges (Crighton et al., 2012).

Before reviewing and analyzing the contributors to asthma, it is essential to first appreciate the geographic distribution of BIPOC and marginalized communities in Canada. Of the three major determinants of spatial separation evaluated by Fong and Shibuya, racial and ethnic segregation and urban renewal and redevelopment are found to have more influence on spatial separation in Canadian cities than economic segregation (2000). Canadian municipalities are involved in ensuring affordable housing for most residents, which inevitably results in pockets of poverty for visible minorities coexisting with upscale neighbourhoods (Fong & Shibuya, 2000). Additionally, ethnic minorities are more vulnerable than other groups when their environment is subject to redevelopment. As minority groups, their smaller numbers and limited resources lead to many of their socio-economic concerns being overlooked (Fong & Shibuya, 2000). The higher concentration of BIPOC and marginalized communities in poorly invested and deteriorating sections of cities in Canada may disproportionally expose them to factors that can impact their health, as indicated by the construct of environmental justice.

The spatial relationship between the environment, location, and asthma

The effect of air quality and pollution has been highly researched in terms of its relationship with asthma. A study done through the Ontario Population Health and Environment Cohort indicates that NO2 (nitrogen dioxide) and PM2.5 (particulate matter pollutant of diameter 2.5 micrometers) may contribute to increases in the incidence of adult-onset asthma, irrespective of other factors (Weichenthal et al., 2017). Coupled with these polluting chemicals, there are positive associations between ambient levels of SO2 (sulfur dioxide) and CO (carbon monoxide), and increased emergency department (ED) visits for asthma. Most of these strong associations are seen amongst children of ages 2-14 specifically in the summer when these air pollutants are highest (Lavigne et al., 2012). Air pollution exposure has been found to contribute to ED visits, hospital admissions, and new-onset asthma (Jerrett et al., 2008). The four chemicals discussed above are known as industrial pollutants and are also regarded as markers of vehicular traffic. In a case-crossover study in northern Alberta, the reduction of these emissions and outdoor pollutants was found to be accompanied by a decrease in the number of ED and hospital visits for asthma (Villeneuve et al., 2007). The findings in the above research studies clearly demonstrate the

association of these industrial pollutants with the development of asthma.
To further understand this trend, the relationship between location and asthma has been assessed. In comparing non-rural, rural non-farming, and farming neighbourhoods, an increased risk of asthma incidences in children living in non-rural environments may have been related to the traffic-generated pollutants (Parsons et al., 2016). While controlling for demographic, economic, neighbourhood, and transportation characteristics, the proximity to major roadways was found to be a strong predictor of childhood asthma hospitalization (Newcomb & Li, 2008). There are also interconnections between poverty and race in relation to housing, which is consistent with topics discussed in environmental justice. Historically, mostly low-income minority groups have been displaced to areas that are highly polluted and congested, contributing to health disparities (Newcomb & Li, 2008).

Impacted communities based on the distribution of asthma

The link between lower-income households, geographic inequalities, and respiratory health is a significant topic, but one that has been difficult to evaluate. The geography of health inequalities explores how places of residence shape health gaps and health inequalities (Serrano-Lomelin et al., 2020). Communities impacted by a high incidence of asthma face inequities in the structural determinants of asthma including social, political, environmental, and economic forces. Marginalized communities face higher psychosocial stress, pollution, financial constraints, and other environmental injustices that ultimately produce asthma disparities (Hunleth et al., 2020). Using population-level data in Ontario, the geographic distribution of asthma morbidity was examined, where hot spots indicated high asthma morbidity, and cold spots low morbidity. The research identified hot spots for ages 10-14 centered in areas known for industrial development, hot spots for ages 30-39 centered in rural areas, and cold spots centered in the North and rural South of Ontario (Crighton et al., 2012). The location of cold spots may not necessarily reflect low asthma incidence, but rather the presence of protective factors improving primary health. These findings are consistent with literature examining the relationship between socio-economic status (SES) and asthma prevalence. A socio-spatial study in Calgary demonstrated that low-income areas have high concentrations of visible minority immigrants who may have difficulty accessing health care facilities due to limited English language skills (Serrano-Lomelin et al., 2020). SES may affect health through lifestyle, structural, and material factors in addition to socio-behavioural variables like willingness to seek medical help (Lin et al., 2004). The effect SES and other structural determinants have on the prevalence of asthma found in these studies, exemplify how BIPOC and other marginalized communities are disproportionally impacted by this noncommunicable respiratory disease.

Geographic health inequalities and respiratory health

Trends documented throughout this paper highlight the link between geographic health inequalities and asthma. However, there is limited data related to this topic when examining the Indigenous population in Canada. Unlike non-Indigenous populations, there is strong provincial variability in asthma prevalence among urban and rural Indigenous residents, as well as geographic differences seen between those living on reserve and

those living off-reserve in urban areas in Ontario (Crighton et al., 2010). Indigenous children and adolescents living in urban locations were significantly more likely to report diagnoses of asthma than their rural counterparts or those living in regions such as Yukon, NWT, and Nunavut (Karunanayake et al., 2020). This phenomenon was further examined in a population-based study that found that when compared to non-Indigenous children in the northern territories of Canada, Indigenous children had a significantly lower prevalence of diagnosed asthma. However, there is a higher prevalence of asthma-like symptoms (such as wheezing) within Indigenous communities in the Northern Territories of Canada (Gao et al., 2008). Across the literature, similar conclusions were reached when examining the cause for the significantly lower rates of asthma diagnoses in Indigenous communities, specifically in rural communities and northern territories in comparison to their urban counterpart and non-Indigenous populations. Contributing factors may include poor housing conditions, income, and low SES variables such as education (Koleade et al., 2018). Moreover, the prevalence of asthma-related ED visits, symptoms, and hospitalizations can be attributed to the geographic and socioeconomic circumstances in which Indigenous peoples live, in addition to less access to health care and lower doctor-patient communication (Crighton et al., 2010). This can be seen particularly when comparing the Indigenous and non-Indigenous population in the northern territories of Canada. The higher rate of asthma-like symptoms and lower rates of asthma diagnoses in the Indigenous communities of these territories can be attributed to the fact that Indigenous children and communities have reduced access to adequate and consistent health care services (Gao et al., 2008). The interconnectedness between both identity and location plays a considerable role in respiratory health, notably in Indigenous communities. SES, location, and identity all influence the health services, doctor-patient relationship, and ultimately asthma diagnosis. It appears that a certain disadvantage develops due to this relationship that is not equally nor equitably experienced by all populations in Canada. This illustrates that BIPOC, and marginalized communities are unfortunately disproportionally affected by asthma.

The economic environment and the prevalence of asthma

The economic environment of cities is often connected to some form of development, whether that is industrial, technological, or infrastructural. Researchers identified areas of high risk based on their proximity to a coal-fired power plant (CFPP) in Edmonton, Alberta, and the effect of wind direction. Through GIS technology it was observed that the areas in the city that presented with high ED visits for children with asthma were situated in the path of wind movement carrying pollutants from the CFPP. Distance to the plant and potency of the pollutants was considered to detect directional effects of the pollution. In Figure 2, it is noted that the east and southeast of the CFPP have the highest density of ED visits in children (Rodriguez-Villamizar et al., 2017).

Similar trends were observed near an aluminum smelter in the Province of Quebec. Both proximity to the aluminum smelter and time spent downwind of the smelter were positively associated with hospitalizations for asthma in young children (ages 0-4). Monitoring of pollutants from the smelter, carried by wind, allowed for pollutant exposure to be measured. These pollutants

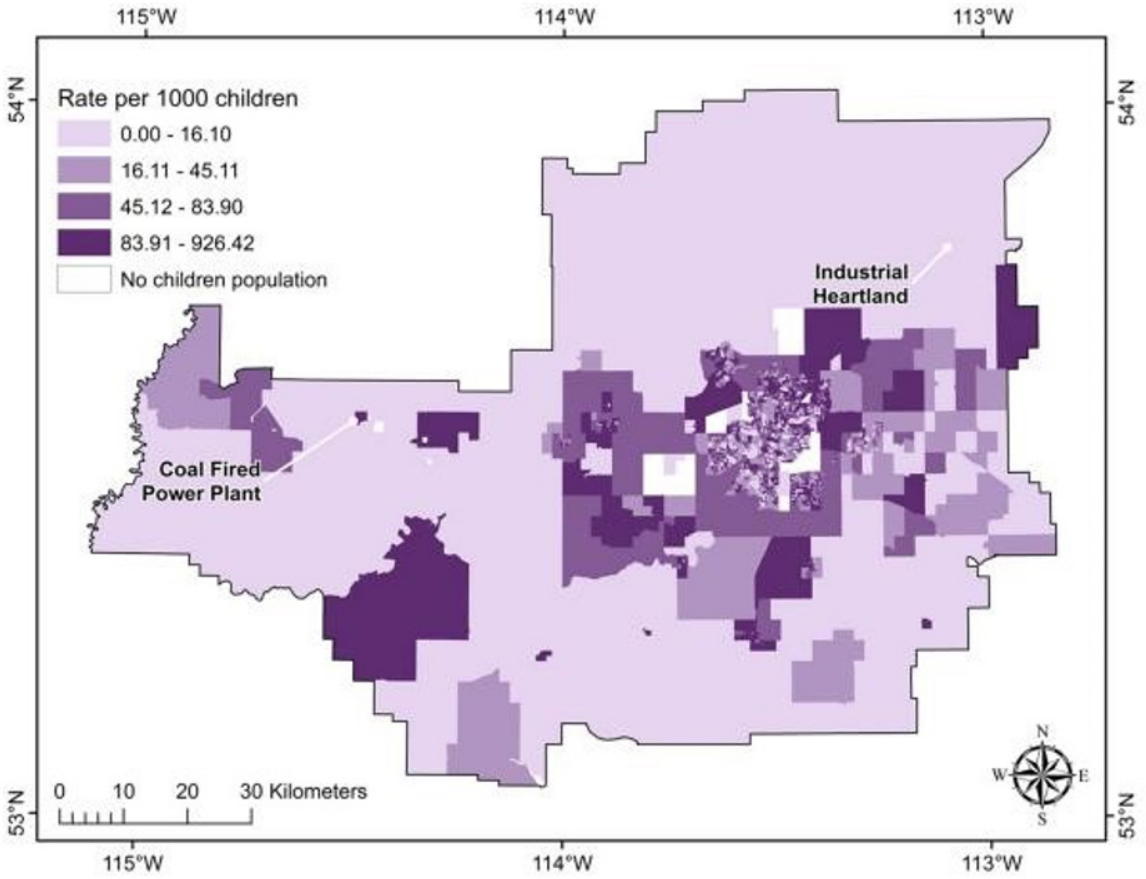


Figure 2. Rates of emergency department visits for children with acute asthma in the Census Metropolitan Area of Edmonton from 2004 to 2010 (Rodriguez-Villamizar et al., 2017).

included SO2 and PM2.5, that have both been found to induce asthma, mainly in young children (Lewin et al., 2013). Daily exposure to these emissions was accompanied by an increase in hospitalization rates. The data in Table 1 demonstrates how the total number of hospitalisations for asthma increased as the proximity to the smelter and time spent downwind of the smelter increased.

Lemke et al. linked the economic environment of Windsor to acute asthma events (2014). The city's strong tie to the automotive industry has led to it becoming a city with one of the highest in air pollution levels in Canada. The high air pollution levels were found to impact asthma events in the city. Using the Geospatial Determinants of Health Outcomes Consortium study, associations between NO2 and acute asthma events were found, linking asthma morbidity to higher levels of this pollutant (Lemke et al., 2014). This article is consistent with the preceding findings of proximity to industrial plants and asthma events, furthering the understanding that geographical location can have a grave impact on the health of an individual. These studies, however, did not evaluate the sensitivity of the association between levels of air pollution and SES and marginalized

Age group (years)	**Number total of hospitalisations**	**Percent hours spent downwind of the aluminum smelter (h/day)**
	7.5 km buffer around the aluminum smelter	
0-4	396	25% (6 hrs)
0-1	293	29% (7 hrs)
2-4	103	21% (5 hrs)
	2.5 km buffer around the aluminum smelter	
0-4	109	25% (6 hrs)
0-1	81	27 % (6.5 hrs)
2-4	28	17 % (4 hrs)

Table 1. Hospitalizations for asthma or bronchitis in children aged 0-4 versus percentage of hours spent downwind of the aluminum smelter (Lewin et al., 2013).

communities. An article by Jerrett, et al. used GIS and related geostatistical techniques in combination with fixed-site air pollution monitors to understand if populations with low SES were more likely to be exposed to high levels of pollution in Hamilton, Ontario, Canada. Disadvantaged groups who live in low-cost housing and groups of lower SES were found to be exposed to higher levels of air pollution (Jerrett et al., 2001). There is a consensus between the findings of the literature reviewed in this section and the subject matter of environmental justice. It is demonstrated that industrial plants release toxins that cause asthma in young children, and this results in an increase in ED visits and hospitalizations for asthma. It is also demonstrated that exposure to these asthma-inducing toxins is experienced more by BIPOC and marginalized communities due to their spatial displacement and SES, undeniably putting these groups at a higher risk of asthma and negative health effects.

Discussion and conculsions

Throughout this paper an environmental justice interpretive framework was used to analyze and review the multi-faceted disease, asthma. Although this framework allowed for each major contributor to the prevalence of asthma to be explored in relation to asthma, there are some limitations. When reviewing literature within geographic health inequality and respiratory health, Indigenous versus non-Indigenous and on and off-reserve populations were compared and the broad understanding of the interconnectedness between identity and place was discovered. Although this is an important factor contributing to the prevalence of asthma, the relationship is quite complex, and the details of these relationships were not explored. This framework also relied on population-based data to understand the geo-spatial distribution of BIPOC and marginalized communities. Due to limited race-based data collection in Canada, there were few pieces of literature that could have been reviewed to analyze this distribution pattern.

The various statistical measurement and data collection techniques (GIS, location specific, and large-scaled population-based analysis) are strengths of the literature reviewed in this paper; an important aspect for two specific topics discussed. The first being the connection between pollutants and the prevalence of asthma, and the second being the relationship between these pollutants and both traffic and industrial proximity. Additionally, the literature was able to analyze the various contributing factors of asthma such as spatial displacement, socio-economic status, lack of accessible health care services, and disproportionate exposure to pollutants. A review of the literature illustrated notable characteristics of asthma either looking at location in a broad context or a specific context. This allows for the conclusions of the paper to be highly representative of trends in Canada as a whole.

Similar to the environmental justice interpretive framework used throughout this paper, a limitation of the literature used is the lack of race-based data. This is specifically important when analyzing asthma prevalence in Indigenous and Black populations as the relationship between identity and location strongly influences health and health care access. For example, the difference between asthma prevalence on-reserve, off-reserve, and in rural and urban environments was not explored due to the lack of data. In a like manner, data analyzing SES is largely based on surveys. One limitation in survey-based data collection is response bias which can lead to variability in observed versus expected data. Nonetheless, various measures were used in the studies reviewed to minimize confounding variables.

The review of the five key contributors to asthma revealed a connection between poor access to healthcare and environmental injustices experienced by BIPOC and marginalized communities, and the higher prevalence of asthma they experience. The complexity of asthma and the spatial separation of different racial and ethnic groups found that BIPOC and marginalized communities are concentrated in deteriorating areas of cities that may expose them to higher levels of pollutants. The spatial relationship of the environment, location, and asthma highlighted the specific types of pollutants that are associated with asthma ED visits, prevalence, and hospitalization, and their sources. Through the review of the impacted communities based on the distribution of asthma, the connection between SES, structural determinants of health, and asthma was observed. Analyzing geographic health inequality and respiratory health, the interconnectedness of identity and location was brought to light. Finally, the economic environment and the prevalence of asthma led to the understanding that proximity to industrial plants in tandem with the movement of wind increases asthma events, specifically in young children. The findings from these five significant contributors demonstrate that BIPOC and marginalized communities are disproportionately affected by asthma. Equally important, they relate to the theme of environmental justice discussed throughout the paper, as inequity in environmental displacement and exposure has negatively affected BIPOC and marginalized communities more than others.

It is important to continue research in reference to environmental justice and geography to reduce the inequality seen in exposure to environments that negatively contribute to the health of a certain

populations. Further research on this topic can be especially helpful when discussing the impact of development on Indigenous lands and whether the development of industrial operations disproportionately exposes Indigenous communities to toxins that will in turn negatively impact their health. To improve research and analysis on this topic in the future, race-based data collection needs to be strengthened. With a better understanding of the geo-spatial relationship of BIPOC and marginalized communities a clearer picture can be made about the environmental injustice, and affirmative solutions can begin to take place.

References

Crighton, E. J., Feng, J., Gershon, A., Guan, J., & To, T. (2012). A spatial analysis of asthma prevalence in Ontario. Canadian Journal of Public Health, 103(5), 384–390. https://go-gale-com.proxy.queensu.ca/ps/i.do?p=AONE&sw=w&issn=00084263&v=2.1&it=r&id=GALE%7CA313707120&sid=googleScholar&linkaccess=fulltext

Crighton, E. J., Wilson, K., & Senècal, S. (2010). The relationship between socio-economic and geographic factors and asthma among Canada's Aboriginal populations The relationship between socio-economic and geographic factors and asthma among Canada's Aboriginal populations. International Journal of Circumpolar Health, 69(2), 138–150. https://doi.org/10.3402/ijch.v69i2.17435

Fong, E., & Shibuya, K. (2000). The spatial separation of the poor in Canadian cities. Demography, 37(4), 449–459. https://www.proquest.com/docview/222962228/fulltextPDF/45C9641024B0412BPQ/1?accountid=6180

Gao, Z., Rowe, B. H., Majaesic, C., O'Hara, C., & Senthilselvan, A. (2008). Prevalence of Asthma and Risk Factors for Asthma-Like Symptoms in Aboriginal and Non-Aboriginal Children in the Northern Territories of Canada. Canadian Respiratory Journal, 15(3), 139–145. https://doi.org/10.1155/2008/302407

Hunleth, J., Spray, J., Ruiz, S., Maki, J., Fedele, D. A., Prabhakaran, S., Forsyth, R. B., Sykes, C., Crepps, K., Shepperd, J., Bowen, D., & Waters, E. A. (2020). Situating household management of children's asthma in the context of social, economic, and environmental injustice. The Journal of Asthma, 59(1), 70–78. https://doi.org/10.1080/02770903.2020.1837159

Jerrett, M., Burnett, R. T., Kanaroglou, P., Eyles, J., Finkelstein, N., Giovis, C., & Brook, J. R. (2001). A GIS–Environmental justice analysis of particulate air pollution in Hamilton, Canada. Environment and Planning, 33(6), 955–973. https://doi.org/10.1068/A33137

Jerrett, M., Shankardass, K., Berhane, K., Gauderman, W. J., Künzli, N., Avol, E., Gilliland, F., Lurmann, F., Molitor, J. N., Molitor, J. T., Thomas, D. C., Peters, J., & McConnell, R. (2008). Traffic-related air pollution and asthma onset in children: a prospective cohort study with individual exposure measurement. Environmental Health Perspectives, 116(10), 1433–1439. https://doi.

org/10.1289/EHP.10968

Karunanayake, C. P., Amin, K., Abonyi, S., Dosman, J. A., & Pahwa, P. (2020). Prevalence and determinants of asthma among aboriginal adolescents in Canada. Journal of Asthma, 57(1), 40–46. https://doi.org/10.1080/02770903.2018.1541354

Koleade, A., Farrell, J., Mugford, G., & Gao, Z. (2018). Prevalence and risk factors of ACO (asthma-COPD Overlap) in Aboriginal people. Journal of Environmental and Public Health, 2018. https://doi.org/10.1155/2018/4657420

Lavigne, E., Villeneuve, P. J., & Cakmak, S. (2012). Air pollution and emergency department visits for asthma in Windsor, Canada. Canadian Journal of Public Health, 103(1), 4–9. https://go-gale-com.proxy.queensu.ca/ps/i.do?p=AONE&sw=w&issn=00084263&v=2.1&it=r&id=GALE%7CA278760606&sid=googleScholar&linkaccess=fulltext

Lemke, L. D., Lamerato, L. E., Xu, X., Booza, J. C., John J. Reiners, J., Delbert M. Raymond, I., Villeneuve, P. J., Lavigne, E., Larkin, D., & Krouse, H. J. (2014). Geospatial relationships of air pollution and acute asthma events across the Detroit-Windsor international border: study design and preliminary results. Journal of Exposure Science and Environmental Epidemiology, 24(4), 346–358. https://doi.org/10.1038/JES.2013.78

Lewin, A., Buteau, S., Brand, A., Kosatsky, T., & Smargiassi, A. (2013). Short-term risk of hospitalization for asthma or bronchiolitis in children living near an aluminum smelter. Journal of Exposure Science and Environmental Epidemiology, 23(5), 474–480. https://doi.org/10.1038/JES.2013.27

Lin, M., Chen, Y., Villeneuve, P. J., Burnett, R. T., Lemyre, L., Hertzman, C., McGrail, K. M., & Krewski, D. (2004). Gaseous air pollutants and asthma hospitalization of children with low household income in Vancouver, British Columbia, Canada. American Journal of Epidemiology, 159(3), 294–303. https://doi.org/10.1093/AJE/KWH043

Newcomb, P., & Li, J. (2008). Predicting admissions for childhood asthma based on proximity to major roadways. Journal of Nursing Scholarship, 40(4), 319–325. https://doi.org/10.1111/J.1547-5069.2008.00245.X
Papi, A., Brightling, C., Pedersen, S. E., & Reddel, H. K. (2018). Asthma. The Lancet, 391(10122), 783–800. https://doi.org/10.1016/S0140-6736(17)33311-1

Parsons, M. A., Beach, J., & Senthilselvan, A. (2016). Association of living in a farming environment with asthma incidence in Canadian children. Journal of Asthma, 54(3), 239–249. https://doi.org/10.1080/02770903.2016.1206564

Rodriguez-Villamizar, L. A., Rosychuk, R. J., Osornio-Vargas, A., Villeneuve, P. J., & Rowe, B. H. (2017). Proximity to two main sources of industrial outdoor air pollution and emergency department visits for childhood asthma in Edmonton, Canada. Canadian Journal of Public Health, 108(5–6), e523–e529. https://doi.org/10.17269/CJPH.108.6136

Serrano-Lomelin, J., Nielsen, C. C., Hicks, A., Crawford, S., Bakal, J. A., & Ospina, M. B. (2020). Geographic inequalities of respiratory health services utilization during childhood in Edmonton and Calgary, Canada: A tale of two cities. International Journal of Environmental Research and Public Health 2020, Vol. 17, Page 8973, 17(23), 8973. https://doi.org/10.3390/IJERPH17238973

Villeneuve, P. J., Chen, L., Rowe, B. H., & Coates, F. (2007). Outdoor air pollution and emergency department visits for asthma among children and adults: A case-crossover study in northern Alberta, Canada. Environmental Health: A Global Access Science Source, 6, 55. https://doi.org/10.1186/1476-069X-6-40

Weichenthal, S., Bai, L., Hatzopoulou, M., Ryswyk, K. Van, Kwong, J. C., Jerrett, M., Donkelaar, A. van, Martin, R. V., Burnett, R. T., Lu, H., & Chen, H. (2017). Long-term exposure to ambient ultrafine particles and respiratory disease incidence in in Toronto, Canada: a cohort study. Environmental Health: A Global Access Science Source, 16(1). https://doi.org/10.1186/S12940-017-0276-7

Investigating the genesis and flow pathways of groundwater seeps in a continuous permafrost setting using dissolved organic matter chemistry

Sophie Perrett, Tabatha Rahman, Cedelle Pereira, and Melissa Lafrenière

Abstract

The Arctic landscape is being modified due to climate change with rising temperatures, increased precipitation, thickening of the active layer, and the potential mobilisation of carbon as permafrost thaws. It is likely the concentrations and composition of dissolved organic matter (DOM) will change as a result. This study uses the optical and chemical characterisation of DOM within five seeps to investigate the hydrological and active layer processes responsible for the spatial variability and seasonal evolution of exfiltrating subsurface waters in a continuous permafrost watershed in the Canadian High Arctic. Water samples from the seeps were collected from the 4th of July to the 9th of August , 2019 and DOM was characterized using fluorescence spectroscopy and PARAFAC modelling to separate the individual fluorescent components identified in each sample. Two protein-like components (C2 and C3) and one humic-like component (C1) were identified in the samples. A protein tyrosine-like component (C3) was most dominant in all the sites but one, Pond 4 Seep, where a humic-like component (C1) was predominant. Fluorescence indices including the fluorescence and biological index suggest the DOM was primarily derived from terrestrial, allochthonous sources, however there was a lack of correlation between the optical properties and nutrient concentrations implying different pools of DOM and modes of subsurface flow. Two potential hydrological processes were identified to control the seeps: a shallow ice conduit and a deep porous flow matrix.

Introduction

Permafrost is defined as ground that has been frozen below 0°C for two consecutive years and is a vital store of carbon, with ~1300 Gt of organic carbon contained within the Arctic (Schuur et al., 2008 and Hugelius et al., 2014). Much of this carbon is stored in soils and is susceptible to mobilisation as dissolved organic matter (DOM), which is widely accepted to play an integral role in the biogeochemistry of aquatic systems (Bolan et al., 2011). Several studies have examined variations in DOM storage, transport, chemical composition, and cycling throughout permafrost regions (Holmes et al., 2012; Koch et al., 2013 and Wang et al., 2018). Climate change induced temperature increases are causing permafrost thaw, which is modifying subsurface permafrost hydrology, and leading to mobilization of older carbon as dissolved organic carbon (DOC) and is linked to differences in fluvial DOM properties (Benner et al., 2004). In addition, changes in DOC and total dissolved nitrogen (TDN) concentrations have been detected (Guo et al., 2007). Permafrost thaw can have detrimental implications for water quality and aquatic systems due to permafrost soils contributing elevated mineral solute loads (Lamhonwah et al., 2017), as well as nutrient and higher

proportions of potentially labile DOM following the alteration of groundwater flow paths and increases in groundwater contributions to rivers (Lamhonwah et al., 2017 and Walvoord and Kurylyk, 2016).

Studying DOM quality and quantity in seeps can provide useful insights into changing permafrost hydrology, and potential consequences with respect to the permafrost carbon-climate feedback. Soil water flows through the active layer that discharges to surface water bodies supporting river flow and supplies water to tundra ponds and lakes. Alternatively, it can be discharged as springs or seeps where the groundwater table or flow pathways rise above the ground surface (Woo, 2012). Seeps can be sporadic, spreading over an area of interconnected subsurface preferential flow pathways defined by the intensity of the water supply including rainfall or snowmelt (Quinton and Marsh, 1999; Carey and Woo, 2000). Subsurface water flows are the result of a descending frost table, cryostructure features such as ice lenses, and the saturation of the active layer (Quinton and Baltzer, 2013). Soil pipes are a similar network of channels that appear at breaks in hillslopes and provide water to surface streams which could be mechanism contributing to seeps (Quinton and Marsh, 1999). Although research on seeps is lacking, it is understood that the seeps at Cape Bounty are the result of preferential flow pathways due to seasonal persistence, timing of their activation and localised discharge points (Carey and Woo, 2000; Woo, 2012). To characterise the nature and chemical composition of seeps it is important to understand their casual mechanisms they originate from.

Several studies aim to quantify the amount of DOM by determining the DOC concentrations; however, the importance of DOM chemical characterisation is becoming recognised in the field of biogeochemistry (Hudson et al., 2007; Jaffe et al., 2008 and Fellman et al., 2010). This is because it helps to identify the source of the DOM and indicates how it will react in the environment (Liang and Singer 2003; Minor et al., 2014; McKnight et al., 2001; Stedmon et al., 2003; Kraus et al., 2011). Studies in terrestrial environments, such as wetlands and forests, have shown that soil types, land use hydrological conditions, and geomorphology affect the source and chemical structure of DOM. Among others, processes such as microbial degradation, consumption, soil sorption and desorption contribute to this change in DOM (Kalbitz et al., 2000; Oni et al., 2012; Wilson and Xenopoulos, 2009). However, in the Arctic, DOM tracing and characterisation is limited due to geographical and logistical constraints (Herrault et al., 2016).

This study examines the optical properties and the concentrations of DOC and TDN in samples from five subsurface seeps in the Cape Bounty Arctic Watershed in the Canadian High Arctic from early July to the start of August 2019. Optical spectroscopy can deduce the source, quantity, and characteristics of DOM. This is because the optical properties of DOM depend on their weight, aromaticity, and structural configuration, which can be obtained through spectroscopic techniques (Fouché et al., 2017). Fluorescence and absorbance measurements are also time and cost-effective, allowing for large amounts of spatial and temporal analysis, compared to molecular level analysis (Hansen et al., 2016). Most knowledge about DOM characterisation comes from previous work in the Subarctic. Less information is available from the High Arctic due to its shorter growing seasons, cooler summers, and

reduced diversity of flora and fauna (Wang et al., 2018). Despite, limitations, Arctic DOM is an abundant source of organic carbon and an extremely valuable to research involving modelling carbon, pollutant, and nutrient cycling (Battin et al., 2009 and Wang et al., 2018). An in-depth analysis of DOM characteristics in the Arctic will lead to a better understanding of the impacts of climate change presently and in the future (Herrault et al., 2016).

Methods

Study site: Cape Bounty Arctic Watershed Observatory (CBAWO)

The CBAWO is situated on the south-central coast of Melville Island, Nunavut, Canada (74°54'N, 109°35'W). The area consists of wet sedge, mesic tundra, polar desert and polar semi-desert landcover classes. CBAWO also contains paired glacierised watersheds, unofficially named East and West which measure 11.6 and 8.0 km2 respectively, which are the subject of various studies (Lewis et al., 2011; Cockburn and Lamoureux 2008), as well as two lakes within each watershed which are separated by a 17 m deep sill: East Lake which has a 30 m deep base, and West Lake. Both lakes are approximately 1.5 km2 and reach maximum depth of 30 m and 34 m respectively (Lapointe et al., 2012). The climate of CBAWO is characterised by cold temperatures and low precipitation with mean monthly temperatures in the summer ranging from 1.5 °C - 4 °C between 2013 and 2016. Annual precipitation falls mainly as snow (120 mm) and is varied in summer with an average of 29 mm in June and July (Lamoureux and Lafrenière, 2018). Above the thick continuous layer of permafrost, the active layer in Cape Bounty can reach depth of 70-90 cm depth by late August depending on thaw conditions. Thawing season takes place between June and August with limited rainfall (<50 mm) (Paquette et al., 2020).

Sample collection

The samples were collected by Tabatha Rahman from Queen's University (Canada) over the of Summer of 2019. Samples came from five seep sites, the two most prominent being Bedrock Seep (BRS) and Upper Goose Seep (UGS). The other three sites were unofficially labelled Camp Seep (CS), Active Layer Detachment Seep (ALD Seep) and Pond 4 Seep (P4S). Bedrock Seep and Upper Goose Seep were more active throughout the summer so were prioritized and investigated more frequently. Water samples from the seeps were collected at least every three days in amber HDPE bottles, with no headspace to avoid as much interaction with air as possible. Samples were vacuum filtered using glass filtration apparatus with a 0.7µm pre-combusted glass fibre filter, within approximately three hours of collection to reduce the risk of any chemical weathering or biological reactions changing the sample composition. The filtered sample was collected in pre-cleaned (carbon free) amber glass vials. EC (corrected to 25°C in µS/cm) and temperature of the water (°C) was also monitored at 15-minute interval (at the Upper Goose Seep and Bedrock Seep) using a YSI 600LS water level sonde, a Global Water EC sensor, and/or a HOBO water level sensor. EC and temperature measurements at the other sites were only taken at the time of sampling using a handheld ThermoOrion Star A322 meter and probe. Samples were kept cool and shipped to Queen's University, where they were refrigerated until processed seven months after collection. Precipitation and air temperature data was obtained from a local meteorological station less than one kilometre

from the study sites.

Seep description

Data for Bedrock Seep was collected between 10th July and the 9th of August 2019. The location of Bedrock Seep is on a gentle slope characterised by moss, bare rock, and sedges as shown. Upper Goose Seep is the most active and heavily researched seep; in 2019 data was collected between 4th July and the 9th of August. Upper Goose Seep is located within polar semi-desert tundra at the base of a gentle slope and is surrounded by other seeps, none of which are as prominent. ALD Seep is located at the side of an active layer detachment, samples were collected from the 30th of July to the 9th of August 2019. Although ALD Seep flows into the disturbance caused by the active layer detachment, the disturbance is not believed to trigger the seep, as the seep is located at the perimeter of the disturbance. Camp Seep was one of many seeps located in sand separated by boulders (5-30 cm) and sparse vegetation.

Data for Camp Seep was collected from the 20th of July to the 9th of August 2019. Pond 4 Seep is a pond fed by several seeps; data was unattainable from individual seeps explaining why the pond was used instead. Pond 4 Seep was located at the base of a muddy slope surrounded by no vegetation suggesting the water is inhospitable for certain biotic activity.

Laboratory analysis

All laboratory analysis was carried out in the Department of Geography and Planning at Queen's University. All the compiled data in the supplemental information.

Optical spectroscopy

A Horiba Aqualog was used to measure UV-visible absorbance and fluorescence and to create emission excitation matrices (EEMs). The samples were placed one at a time in a 1 cm path length quartz cuvette and ran through the Aqualog to create individual EEMs. Cuvettes were triple rinsed with Milli-Q water and again in between each sample analysis, and then stored in 3% nitric acid (H2NO3) overnight. EEMs were generated by a collecting a series of emission wavelengths ranging from 240-600 nm and excitation wavelengths ranging from 214-621 nm at increments of 3 nm. The integration time varies from 2-4 seconds depending on the fluorescence intensity of the sample. For example, some samples had higher concentrations of fluorescent organic matter, therefore, required a shorter integration time. Blank EEMs using Milli-Q water at integration times of 1-4 s were acquired daily, for the resultant sample EEMs to be blank subtracted.

The EEMs were corrected for inner filter effects and first and second-order Raman and Rayleigh scattering. Inner filter effects occur when radiation is absorbed by the surface of the sample, therefore reducing the amount of radiation absorbed by fluorophores in the centre of the cuvette (Murphy et al., 2013). The EEMs are then normalised to a quinone sulphate standard following established procedures (McKnight et al., 2001; Murphy et al., 2010). The quinone sulphate was made up of 0.05 mol L-1 H2SO4 and ran daily to calibrate the instrument and to normalize the sample measurements. All fluorescence is reported as Quinone Sulphate Units (QSU). All pre-processing and corrections were carried out using the Horiba Aqualog software.

Dissolved Organic Carbon (DOC) and Total Dissolved Nitrogen (TDN) measurements

DOC and TDN concentrations were measured using a TOC-VPCH/TNM system (Shimadzu, Kyoto, Japan). TDN was measured using a nitrogen chemiluminescence detection unit. DOC was measured as non-purgeable organic carbon through combustion at 720 °C. Milli-Q water blanks and method check standards were repeated at least 3 times throughout a sample run to ensure consistency of results. All samples were run until 3 of 5 injections had a standard deviation of less than 0.1 ppm or coefficient variation of less than 2%. If after 5 injections the sample failed to meet these criteria, the sample was repeated in a later run.

Data analysis

PARAFAC Modelling

The EEMs generated were used to conduct a parallel factor analysis (PARAFAC) to identify the major fluorescent components present in the set of samples. All EEMs, including repeats (n = 137), were included in the initial PARAFAC analysis. While three EEMs were removed as outliers, the final model represented 88.22% of the full dataset (n=134). Outliers were removed based on which samples had higher leverages and therefore disproportionately influenced the model. Unusual samples with leverages closer to one were removed. The best models come from datasets where leverages are approximately the same (Murphy et al., 2010). PARAFAC analysis was performed in MATLAB using the DrEEM toolbox following the procedures set out by Stedmon and Bro (2008). The number of components suitable for the model was determined using the core consistencies tool. Core consistencies start at 100% and drop abruptly when too many components are fitted. The core consistency for the 3-component model used in this study was 70%. Murphy et al., (2010) found the core consistency diagnostic provided protection against overfitting a model but was less able to identify underfitting. This is usually because there are fluorophores present in low levels of DOM and samples containing covarying components, hence why a 3-component model was used.

The model output was validated by residual and spectral sum of square error analysis and split-half analysis. Split half analysis involves splitting the samples into sub-datasets and rerunning the model to ensure it is reproduced identically each time. For this study each sample is assigned to one of four splits, then the four splits are assigned to six combined splits. Each combination contains half the samples which then produces three validation tests. The 3-component model was validated for all comparisons, however, the contour plot showed unusual peaks at smaller wavelengths because of scattering. Consequently, the range of emission wavelengths considered was reduced to 268 nm – 621 nm, and the excitation wavelength range was reduced to 279 nm – 600 nm. The previous steps were repeated and a 3-component model with reduced wavelengths was validated. The spectral loadings for the 3-component model can be found in the supplementary information.

Fluorescence indices and peak ratios

The fluorescence data was used to calculate various indices to provide a deeper characterisation of the DOM. The fluorescence index was originally

$$Fluorescence\ Index = \frac{I_{em470,ex370}}{I_{em520,ex370}}$$

Equation 1.

$$Biological\ Index = \frac{I_{em380,ex310}}{I_{em430,ex310}}$$

Equation 2.

developed by McKnight et al., (2001) and further investigated by Cory et al., (2010) and indicates whether DOM comes from terrestrial or microbial sources. The fluorescence index is calculated as the ratio of fluorescence intensity (I) at an emission wavelength of 470-520 nm and an excitation wavelength of 370 nm (Equation 1).

The biological index indicates the presence of the β fluorophore which indicates autochthonous production, higher values imply more recently derived DOM (Fouché et al., 2017). The biological index is calculated by dividing the fluorescence intensity (I) at emission wavelength of 380 nm by an emission wavelength of 430 nm at an excitation wavelength of 310 nm (Equation 2) (Huguet et al., 2009).

Peak ratios were calculated looking at three primary peaks, A, C, and T (see Coble's (1996) fluorescence peaks in the supplementary information). The ratios were calculated using the peak picking tool within the DrEEM toolbox in Matlab. Peak ratios C:T and A:T compare the amount of humic-like DOM to the amount of fresh to protein-like DOM. The ratio of peak C to peak A indicates the concentrations of humic-like DOM versus the concentrations of fulvic-like DOM within a sample (Baker et al., 2008).

Statistical analysis

To scrutinise and compare the different seep sites in terms of TDN, DOC concentrations, and the fluorescence indices, a Kruskal-Wallis test was run on all samples using Matlab. The Kruskal-Wallis is a nonparametric test that compares sample means of data to assess if samples come from the same population. The Kruskal-Wallis test provides an overall P-value as a measure of significance and uses a series of boxplots to demonstrate what sites are significantly different from each other. To analyse how TDN, DOC, the fluorescence indices, and peak ratios changed over the sampling period, a linear regression model was implemented using Microsoft Excel. Although the dataset did not meet the assumption of normality; assumptions of

linearity, homoscedasticity, and independence were met providing enough basis to carry out the linear regression.

Results

Temperature, EC, pH, and turbidity

Upper Goose Seep (UGS) was the first seep to begin discharging in the summer season, with flow and monitoring beginning on the 4th of July. This seep had the lowest temperature (2.1±1.18°C) with moderate specific conductance (193.7±67.59 µS/cm), and the lowest turbidity (310.3±283.0 NTU). The cold temperatures, and lower SpC are suggestive of a deeper underground water source, and/or interaction with ground ice. The Bedrock Seep (BRS) was the second seep to begin discharging (flow starting between 3rd – 7th of July) and had the lowest specific conductance (37.6±3.85 µS/cm) of all the seeps, with elevated temperature (4.9±2.26 °C) and turbidity (981.9±327.31 NTU), and low pH (6.5±0.20). Monitoring of Camp Seep (CS) began on 20th of July, and it had low temperatures (3.5±1.89 °C) and specific conductance (119.6±38.99 µS/cm) but had the most elevated turbidity (3203.8±604.24 NTU) of all sites, approximately 10 times higher than that of Upper Goose Seep (UGS). Pond 4 Seep (P4S) by far had highest temperature, pH, and electrical conductivity values (8.2±2.53 °C, .9±0.26 and 1064.3±558.14 µS/cm).

Dissolved Organic Carbon (DOC) and Total Dissolved Nitrogen (TDN) concentrations

The concentrations of TDN were higher at Bedrock Seep compared to other sites. TDN at Bedrock Seep increased by 70%, compared to ALD Seep, which had the lowest concentration (Figure 1B). Compared to Pond 4 Seep and Camp Seep, Bedrock Seep had 20% more TDN. Overall levels of TDN across all sites ranged from 0.098 to 0.616 mg L-1. A Kruskal-Wallis test was carried out to test if the site levels of TDN and DOC were significantly different from each other. The results showed the concentrations of TDN at some sites were significantly different from each other ($P = 8.6019 \times 10\text{-}12$). Results indicate more sites were significantly different in TDN concentrations, whereas DOC concentrations were less varied between sites. For Bedrock Seep, there was a significant decrease of TDN over the sampling period ($R2 = 0.19$, $P = 0.02$). TDN at Pond 4 Seep showed a significant increase over the period of observation ($R2 = 0.51$, $P = 0.0004$). There was no significant change in TDN for Camp Seep, Upper Goose Seep and ALD Seep over the period of observation. Figure 1B and 1C show the peaks in TDN at Camp Seep and Bedrock Seep over the observation period correspond with precipitation. DOC quantities ranged from 1.05 to 5.46 mg L-1 across all sites, with Bedrock Seep, Pond 4 Seep, and Upper Goose Seep containing higher concentrations. ALD Seep contained 45% less DOC compared to Camp Seep and 67% less than Upper Goose Seep. All sites except Bedrock Seep did not significantly change over the sampling period. Bedrock Seep DOC quantities peaked throughout mid-July and dropped later in the sampling period. There was a significant change between the start and the end of the period ($R2 = 0.20$, $P = 0.02$).

Interestingly, regarding DOC concentrations it was Upper Goose Seep and Bedrock Seep that were most responsive to rainfall (Figure 1A and 1C). According to Spearman's rank, there was a significant weak positive correlation between DOC and TDN for

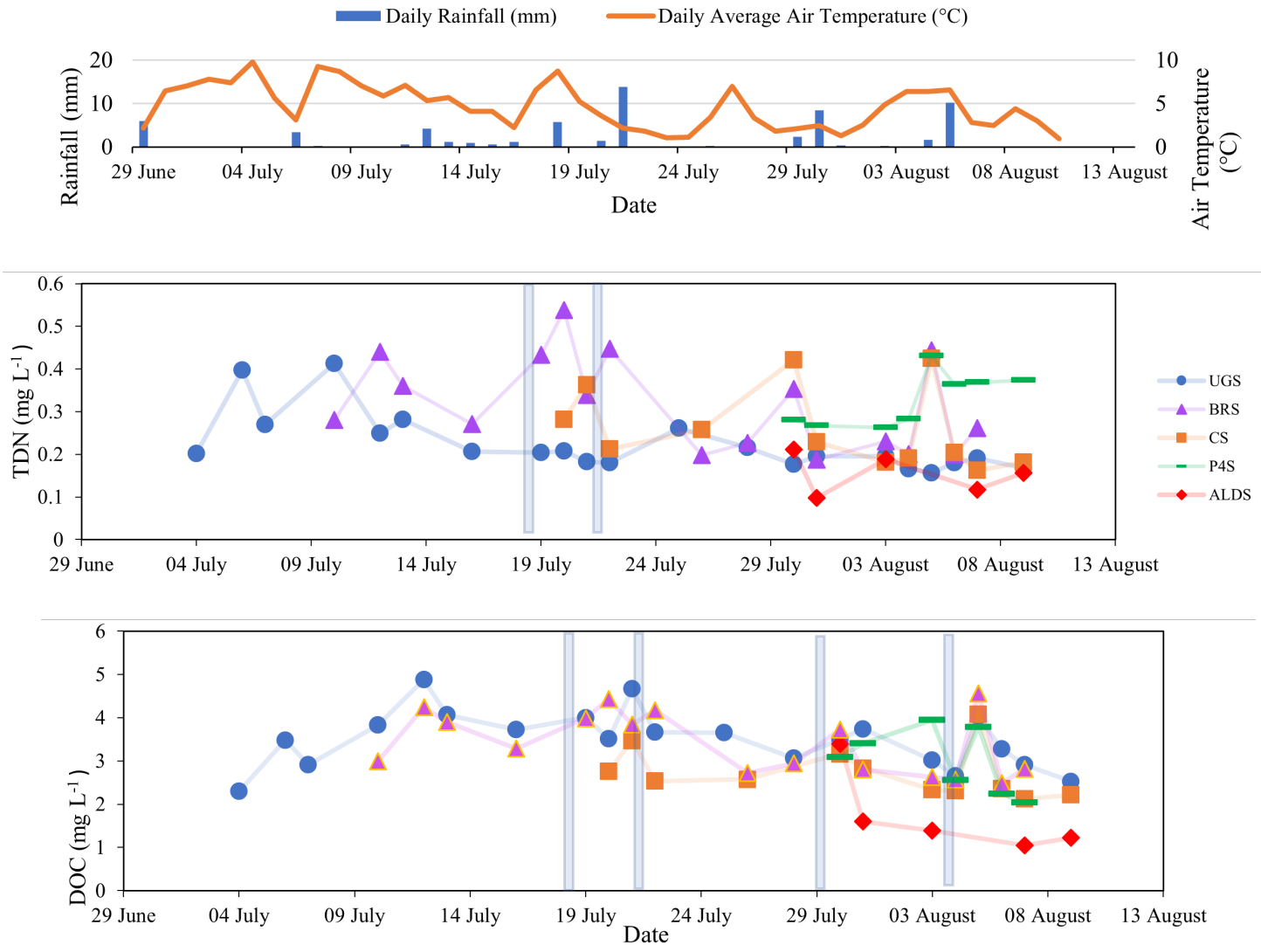


Figure 1: (A) The rainfall (mm) and air temperature recorded at Cape Bounty from the 29th of June to the 10th of August (B) The concentrations of TDN over the sampling period for each seep (Upper Goose Seep (UGS), Bedrock seep (BRS), Camp Seep (CS), Pond 4 Seep (P4S), and active layer detachment seep (ALD). (C) The concentrations of DOC over the sampling period for each site.

all sites ($r = 0.41$, $P < 0.01$). Individually, Camp Seep and Bedrock Seep showed strong positive correlations between TDN and DOC ($r = 0.91$, $P < 0.01$ and $r = 0.95$, $P < 0$.

Fluorescence characterisation of DOM by PARAFAC modelling

Three components were recognised in the PARAFAC model, all of which match or show resemblance to DOM fluorophores previously identified. Component 1 (C1) was comparable to an Arctic fjord study in the

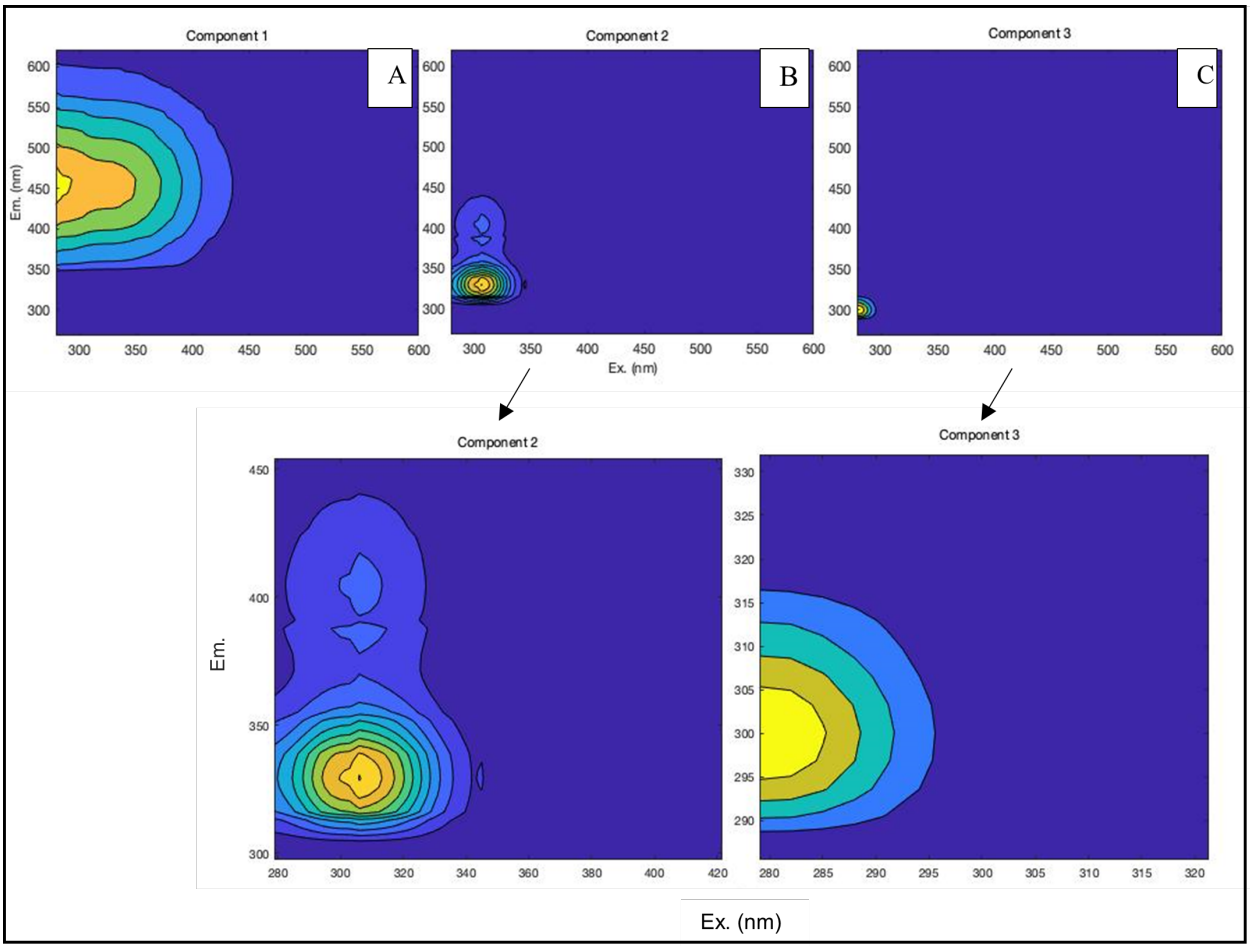


Figure 2: Emission excitation matrices (EEMs) of (A) component 1, (B) component 2 and, (C) component 3 in the PARAFAC model and identified at the five seep sites. The EEMs below B and C are close up versions of components 2 and 3.

OpenFluor database (Brogi et al., 2019). The components are displayed in Figure 2. C1 exhibited an excitation maximum at 280 nm and emission maxima at 450 nm, indicating a high molecular weight (Figure 2A). According to Fellman et al., (2010) C1 corresponds to a UVC humic-like structure. C1 comes from a terrestrial source, contains aromatic humic content, and tends to be widespread but is mostly found in wetlands and forested environments (Fellman et al., 2010).

Component 2 (C2) was characterized by peaks at 310 nm excitation and 330 nm emission wavelengths and most resembles a tryptophan-like structure which is associated with amino acids free or bound in proteins (Figure 2B). The fluorescence indicates intact proteins or less degraded peptide material (Fellman et al., 2010). C2 is a result of autochthonous production from a terrestrial plant source. Component 3 (C3) was smaller showing an excitation maximum of 279 nm and an emission wavelength of 300 nm, resembling a tyrosine-like structure (Figure 2C). Low emission wavelengths are associated with low molecular weight derived from terrestrial plants or soil organic matter. C3

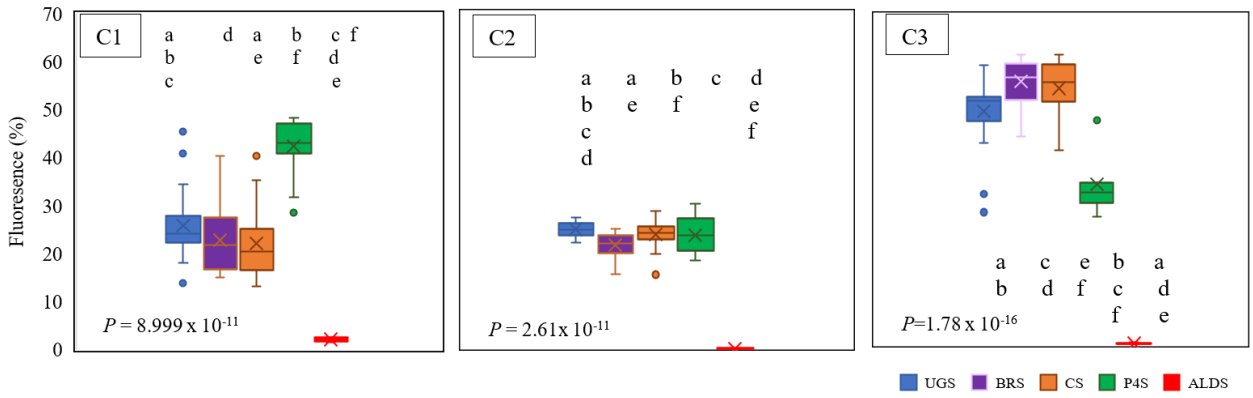


Figure 3: The box plots summarize the distribution of the percentage of component 1 (C1), component 2 (C2) and component 3 (C3) found at each site. Letters indicate what sites were significantly different to each other in the Kruskal-Wallis test. The overall P-values are from each of the Kruskal- Wallis test is shown for each component.

---

fluorescence insinuates free amino acids or amino acids locked within proteins. Generally, tyrosine-like components indicate more degraded peptide material (Fellman et al., 2010)

All components were identified at each site, with the tyrosine-like C3 being the dominant constituent for all sites except Pond 4 Seep, where the humic like C1 was most evident. The Kruskal-Wallis test demonstrated that although C3 was predominant in most sites, the concentrations of the components were statistically different in each site (Figure 3). The only significant correlation found between the components was a strong inverse correlation between C1 and C3 (r = -0.95, P = 6.32 x 10-56). Pond 4 Seep exhibited the highest concentrations of humic- like DOM, with C1 reaching a high of 48%. Bedrock Seep shows proportions of C1, with increases of up to 40 % on the 26th of July, subsequently followed by a steep decrease. Pond 4 Seep had the lowest concentration of DOM overall, with C1 not exceeding 50%. Upper Goose (58%), Bedrock (60%) and Camp Seep (61%) exhibit the highest percentage of C3. All DOM component concentrations fluctuate over the observation period, C2 being the most stable with concentrations not exceeding the 15-30 % bracket.

Optical properties of the DOM

Fluorescence indices were calculated to provide a deeper characterisation of the DOM, the average values for each site are exhibited in Table 1.

The fluorescence index indicates the source of the DOM, either derived from terrestrial matter or microbial compounds. The fluorescence index values across all sites

Site	Fluorescence Index	Biological Index	C:A	A:T
Upper Goose Seep (n=38)	1.53±0.04	0.73±0.08	0.79±0.03	2.78±0.53
Bedrock Seep (n=30)	1.31±0.12	0.57±0.17	0.77±0.03	3.32±0.97
Camp Seep (n=22)	1.39±0.24	0.67±0.25	0.73±0.07	2.61±0.83
Pond 4 Seep (n=11)	1.51±0.05	0.73±0.06	0.75±0.05	3.12±0.81
ALD Seep (n=4)	1.54±0.20	0.78±0.56	0.74±0.03	2.83±0.50

Table 1: The sample number, mean and standard deviation for fluorescence indices and peak ratios for all sites.

ranged from 1.23 to 1.68 and are therefore considered to be low values (Figure 4). Low values suggest the DOM is dominated by terrestrial inputs for example plant and soil organic matter (McKnight et al., 2001; Hansen et al., 2016). Upper Goose Seep has the highest values (1.4-1.6) and a constant value, with decreases associated with major rainfall events. Bedrock Seep shows initial increasing trends in fluorescence index through July, that are interrupted by decreases roughly a day following major rainfall events, then overall lower values in August, indicating an increase in terrestrial inputs. On the other hand, ALD seep fluorescence index values increased suggesting an influx of microbially sourced (autochthonous) DOM through late July into August, while Pond 4 Seep fluorescence index values decrease from a peak value of about 1.57 on August 4th to a minimum of 1.33 on August 9th.

The biological index (BIX) values ranged from 0.51 to 1.04 across all sites, Bedrock Seep having lower values compared to other sites (0.51-0.62), indicating an intermediate allochthonous component (Huguet et al., 2009). BIX values for ALD Seep and Pond 4 Seep increased over the observation period, signifying an increase in freshness (higher contribution of recently produced DOM) whereas Bedrock Seep, Camp Seep, and Upper Goose Seep values remained relatively constant. Overall, the sites displayed low values which are associated with high allochthonous components of terrestrial origin (Heslop et al., 2020). Identical to the fluorescence index values, the Kruskal-Wallis test shows all sites are significantly different from Upper Goose Seep ($P = 4.99 \times 10^{-16}$) for the biological index values. Also identical to the fluorescence index, ALD Seep is significantly different from Bedrock Seep, Camp Seep and Upper Goose Seep.

Discussion

Trends in DOC and TDN concentrations

It is anticipated that more DOC will be discharged from thawing permafrost into rivers and streams through subsurface channels in response to climate warming,

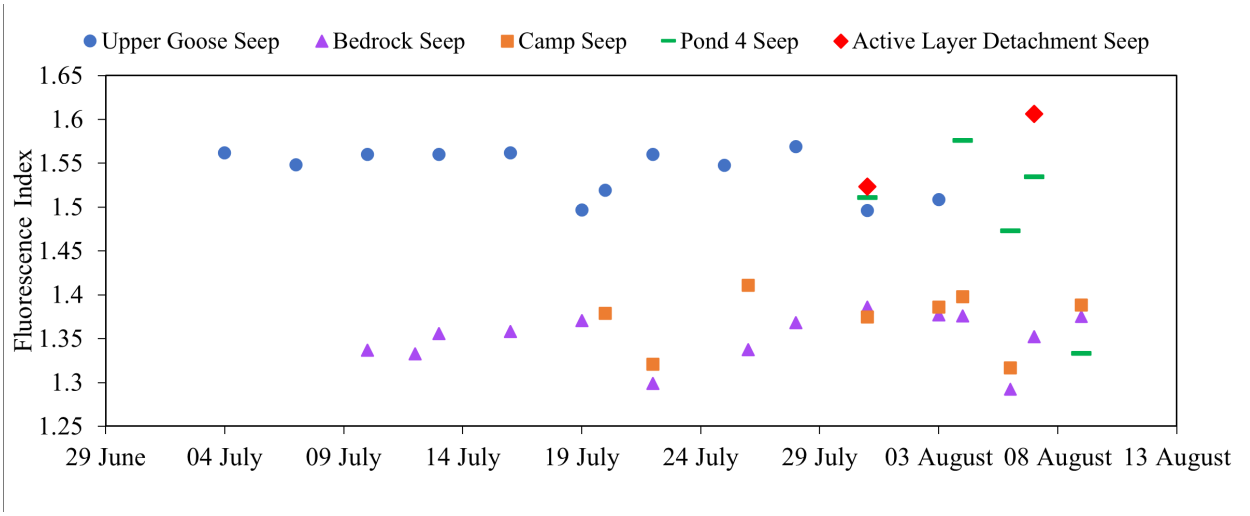


Figure 4: The fluorescence index over the sampling period for each site.

hence the importance and need to quantify DOC concentrations in seeps to examine their role in the immediate landscape (Frampton et al., 2013). The seep DOC concentrations ranged from 1.05- 4.98 mg L-1 with ALD Seep having the lowest concentrations and Upper Goose Seep having the highest. Compared to other Arctic locations and studies at the CBAWO, the overall DOC concentrations were lower (8.0 ± 4.9 mg L−1 in Hershel Island, Coch et al., 2018; 0.87 – 15.8 mg L-1, Heslop et al., 2020 and 1.73 – 9.67 mg L-1, Fouché et al., 2017). Heslop et al., (2020) and Beel et al., (2021) discovered sites affected by active layer detachments (ALDs), hence a deeper active layer, had consistently lower levels of DOC in comparison to undisturbed sites. The results of this study showed ALD Seep had the lowest concentration of DOC, which supports that this seep comes from deeper active layer soils relative to the other sites.

The concentrations of TDN in the subsurface seeps ranged from 0.154- 0.318 mg L-1, which is like previous concentrations reported in Cape Bounty surface ponds (0.11 – 2.80 mg L- 1; Heslop et al., 2020 and 0.13- 8.4 mg L- 1; Thiel, 2018). The concentrations of TDN at the seep sites were also comparable to Coch et al., (2018) who reported average TDN concentrations of 0.5 mg L−1, and 0.7 mg L−1 from Herschel Island (Yukon Territory) in 2016.
TDN is the sum of dissolved organic nitrogen (DON) and dissolved inorganic nitrogen (DIN) constituents (NO3- and NH4+). Hence, TDN concentration may increase as a result of increases in DON, in which case the TDN concentrations would follow the DOC concentrations, or TDN may increase due to increases in mineral/inorganic N species, which would be expected when increasing TDN follows the concentration of other mineral ions, or electrical conductivity (Lewis et al., 2011).

The Bedrock Seep showed the highest TDN concentrations but showed a significant decrease over the observation period. Since this decrease in TDN is consistent with the decrease in DOC at this site, it suggests that

the decrease in TDN is due to a decrease in DON as the seasonal active layer deepens into horizons with limited organic matter, and limited mineral N sources, which is consistent with the very low electrical conductivity at this site. In contrast Pond 4 Seep showed an increase in TDN over the observation period. The fact that the DOC concentrations are decreasing, and the electrical conductivity increases during this time, supports that the higher TDN at this seep is driven by increases in inorganic N, and not DON. Interestingly the days TDN rose at Pond 4 Seep correspond to the peaks in C2, the tyrosine-like component associated with amino acids, which collectively alongside peptides and amides, which could indicate a possible source of mineral nitrogen (e.g. NH4+)(Stewart et al., 2014).

Relating optical properties to DOM composition and source

The results of this study showed a protein-like tyrosine component (C3) to be the most dominant in subsurface seeps at Cape Bounty. The tyrosine component is part of three fluorescent amino acids, another of which was identified in this study, tryptophan (C2). The protein-like components of DOM are generally understood to be of microbial origin (e.g., cell alls of algae, phytoplankton) (Stedmon and Markager, 2005). The high abundance of protein-like DOM found in this study is in line with recent studies at this site by Fouché et al., (2017) and Heslop et al., (2020), which found that surface waters affected by active layer detachments (ALDs) had higher proportions of protein-like, autochthonous DOM. Fouché et al., (2017) did not identify a tyrosine-like component in their PARAFAC analysis, instead they found an increase in low molecular weight humic-like components and tryptophan-like components derived from terrestrial sources.

Low biological index (low freshness) and fluorescence index (allocthonous DOM) values for most sites also supports that degraded terrestrially (allocthonous) derived DOM is discharged at the seeps. Terrestrial inputs are common in rivers and streams at the CBAWO (Grewer et al., 2015). Woods et al., (2011) demonstrate sources of stream terrestrial DOM at Cape Bounty are derived from non-woody angiosperm vegetation. Seep sources could be of similar nature. Fouché et al., (2017), found undisturbed streams contained more humic-like DOM originating from shallow organic rich soil which differs from the protein- like DOM found at the majority of seeps. Furthermore, Heslop et al., (2020) concluded undisturbed ponds in Cape Bounty had higher concentrations of allochthonous DOM and therefore conforms with the results of this study.

Upper Goose Seep was significantly higher from all the other sites in terms of the fluorescence index and biological index. Higher values suggest recently produced (fresh) in situ DOM production (autochthonous) and microbial processing (Heslop et al., 2020). Furthermore, Upper Goose Seep had the lowest temperature (2.1°C on average) which is suggest the presence of ice or very cold soils along the flow pathway. All these factors, alongside the prevalence of a protein-like component, show the mechanisms controlling water flow to Upper Goose Seep differ from other sites. The low temperatures could also point towards a much deeper flow pathway and DOM source, for example Wang et al., (2018) compared the DOM components from the active layer and the permafrost layer and found the permafrost layer contained a higher proportion of protein-like DOM. The source

of Upper Goose Seep could be linked to the upper permafrost layer; however, this seems unlikely given the low electrical conductivity, the very rapid response to rainfall and the very low turbidity, relative to what would be expected if flow was from deeper in the active layer (Lafrenière and Lamoureux, 2013).

Unlike the other four sites, Pond 4 Seep had a higher concentration of C1, a high molecular weight, UVC humic-like component. Although, the Kruskal-Wallis test did not identify Pond 4 Seep to be statistically different from other sites, C1 is the most prominent at this site, unlike other locations. The findings for the optical properties of Pond 4 Seep in this study agree with findings of Wang et al., (2018) found a higher concentration of more humic-like and aromatic components in undisturbed ponds fed by seeps like this one at Cape Bounty.

The relative abundance of C1 over the season fluctuated the most dramatically at both Pond 4 Seep and at other sites, for example on the 12th and 28th of July at Bedrock Seep and on the 26th of July at Camp Seep. These peaks correspond to rainfall events occurring from the 13th to the 30th of July coinciding with Ishii and Boyer's (2012) observation that an increase in C1 was the result of precipitation due to an influx of terrestrial inputs via runoff. The C1 increased at Bedrock Seep, Camp Seep and Upper Goose Seep on the 5th of August, the same day as one of the largest rainfall events. A further investigation into the influence of rainfall would have provided useful insights into the hydrological connectivity of the seeps and is a point for further research. The abundance of the components tended to recover following rainfall events, returning to the amount at the start of the observation period, this was the same for all sites and components suggesting the source of the DOM remained constant, and that this source was diluted by influx of rainfall runoff. In other words, the fluxes in humic-like DOM would have come from allochthonous sources and obtained during the subsurface flow (Wu et al., 2007).

The likely hydrologic nature of the seeps

The results show there are a few potential flow methods for the seeps, shallow ice conduits, and deep soil pipes or deep porous matrix flow. Upper Goose Seep shows the characteristics of a shallow conduit (Figure 7) whereas Pond 4 Seep lends itself to a deep porous matrix flow mechanism. The other sites are harder to pinpoint, therefore it could be a combination.

The cold temperature, low turbidity, and the low the SpC of Upper Goose samples plus the sustained flow and rapid response of flow to rainfall events over the summer period at Upper Goose Seep suggests the water travels through a shallow, but highly conductive conduit, which may be gravel layers, thawed ice, or ice lenses (Figure 5) (Paul et al., 2021). The flow levels and fluorescence components at Upper Goose Seep are reactive to rainfall which suggests the flow path is transmits infiltrating water rapidly. However, that fact that the seep is active from the start of the thaw season when the active layer is thin, and the frost table is high, supports that this flow pathway is relatively shallow. It is expected the conduit is shallow and may be connected to the surface waters in a different location because the fluorescence index is high suggesting primary production and DOC mobilisation elsewhere followed by transportation along the conduit. Bedrock Seep is likely to derive from a fast-flowing shallow conduit due to the low SpC and early

flow start compared to Camp Seep, Pond 4 Seep and ALDs. The soil interacting with the conduit its organic rich based on the high concentrations of dissolved nitrogen and organic carbon, further demonstrated by flow fluorescent and biological index values, signifying terrestrial and degraded DOM. Camp Seep has a low to moderate SpC which can be explained by a fast-flowing conduit with minimal rock contact or contact with a material that isn't weatherable. Camp Seep has the lowest concentration of TDN and DOC and high turbidity implying the pathway is mineral rich and contains an abundance of clay and silt.

In contrast, Pond 4 Seep had high EC, turbidity, and in comparison, to other sites high levels of TDN and DOC suggesting a deeper flow path rich in soluble ions and nutrients (Wickland et al., 2012) (Figure 6). This is further supported by the dominance of C1, a terrestrial, humic-like fluorophore. All factors suggest the water has moved for an extended period through the active layer mineral soils (ie. Either slow flowing or a long/deep pathway), leaching mineral solutes and nutrients from the soil as it travels downslope (Carey and Woo, 2002). The late season activation of flow (30th of July) at Pond 4 Seep, suggests that the flow path is deep (activating only when the active layers is at its thickest) and the elevated EC suggest that the flow path allows for high rock: water contact time, and thus is likely to flow through smaller conduits, or through a saturated porous medium (Vonk et al., 2015).

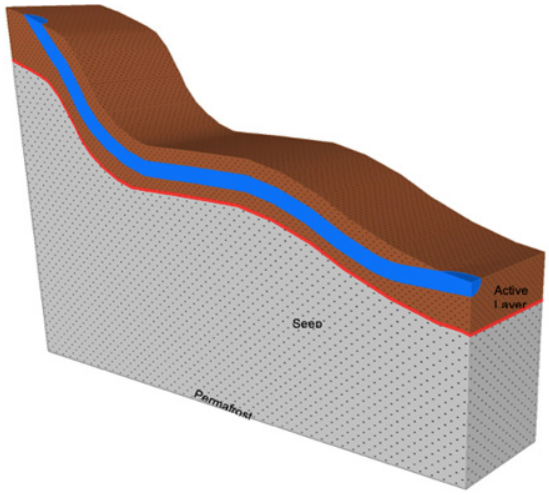


Figure 5: Conceptual diagrams of the potential flow mechanisms a shallow ice conduit. The frost table is depicted in red.

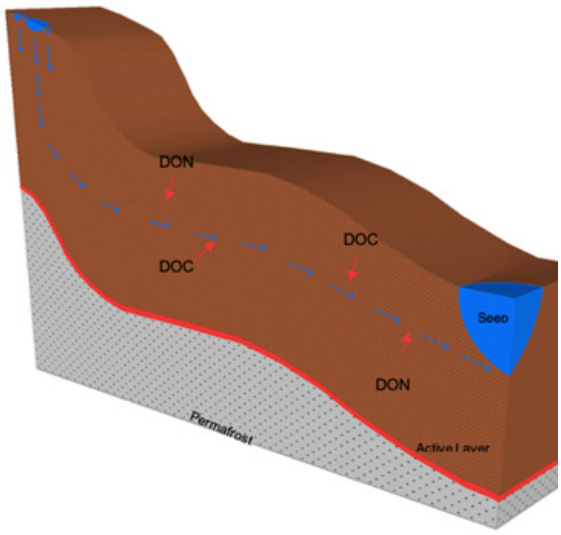


Figure 6: Conceptual diagram of a deep porous flow matrix. The frost table is depicted in red.

Conclusion

The optical and biogeochemical characterisation using PARAFAC modelling, fluorescence indices, peak ratios as well as DOC and TDN concentrations provide a well-rounded, rigorous summary of the sources of DOM and pathways in subsurface seeps. This research has presented two potential hydrological mechanisms for the seeps and provided temporal and spatial synopses to depict the processes taking place. Findings indicate that at most of the sites the DOM is dominated by protein-like components, with Pond 4 Seep as an exception. The fluorescence and biological indices suggest the DOM in the seeps is from degraded terrestrial, allochthonous sources. There is substantial variability between the different seeps and their hydrology. Each seep appeared at different times containing conflicting concentrations of DOC, TDN and variable fluorescent properties. The turbidity, temperature and electrical conductivity data also demonstrated the individuality of the seeps and allowed general flow pathway models to be interpretated, with each appearing at different dates DOM properties showing their complex nature and the numerous influencing factors such as rainfall and models. Two general pathways were identified. Results suggest that a shallow transmittable conduit is the mechanism behind Upper Goose Seep and Bedrock Seep as they were quick to react to surface inputs, whereas Pond 4 Seep and Camp Seep demonstrated signs of a deeper pathway which flows through ion rich soils. Future research should focus on higher resolution of the seasonal changes in the DOM composition and especially during and following rainfall events, in combination with analyses such as water stable isotopes to better understand the hydrological flow pathways and how these influence the mobilization of permafrost derived DOC and its composition.

Acknowledgements

I would like to thank the Inuit for permission to conduct this research on their lands, we hope this work helps contribute to their knowledge and understanding of climate driven changes to water and water quality in the region. I would also like to acknowledge support from ArcticNet, NSERC for funding for this research, and the Polar Continental Shelf Program for logistics support Furthermore, I would like to thank Prof. Melissa Lafrenière for introducing us to the topic, providing constant support and welcoming us into the CBAWO family. I would like to thank Dr. Tom Pering for his guidance and support throughout this project.

References

Baker, A., Bolton, L., Newson, M. and Spencer, R.G., (2008). Spectrophotometric properties of surface water dissolved organic matter in an afforested upland peat catchment. Hydrological Processes: An International Journal, 22(13), 2325-2336.

Battin, T.J., Luyssaert, S., Kaplan, L.A., Aufdenkampe, A.K., Richter, A. and Tranvik, L.J., (2009). The boundless carbon cycle. Nature Geoscience, 2(9), 598-600.

Beel, C.R., Heslop, J.K., Orwin, J.F., Pope, M.A., Schevers, A.J., Hung, J.K.Y., Lafrenière, M.J. and Lamoureux, S.F., (2021). Emerging dominance of summer rainfall driving High Arctic terrestrial-aquatic connectivity. Nature Communications, 12, 1-9.

Benner, R., Benitez-Nelson, B., Kaiser, K. and Amon, R.M., (2004). Export of young terrigenous dissolved organic carbon from rivers to the Arctic Ocean. Geophysical Research Letters, 31(5).

Bolan, N.S., Adriano, D.C., Kunhikrishnan, A., James, T., McDowell, R. and Senesi, N., (2011). Dissolved organic matter: biogeochemistry, dynamics, and environmental significance in soils. Advances in Agronomy, 110, 1-75

Brogi, S.R., Jung, J.Y., Ha, S.Y. and Hur, J., (2019). Seasonal differences in dissolved organic matter properties and sources in an Arctic fjord: Implications for future conditions. Science of The Total Environment, 694.

Carey, S.K. and Woo, M.K., (2000). The role of soil pipes as a slope runoff mechanism, Subarctic Yukon, Canada. Journal of Hydrology, 233(1-4), 206-222.

Carey, S.K. and Woo, M.K., (2002). Hydrogeomorphic relations among soil pipes, flow pathways, and soil detachments within a permafrost hillslope. Physical Geography, 23(2), 95-114.

Coble, P.G., (1996). Characterization of marine and terrestrial DOM in seawater using excitation-emission matrix spectroscopy. Marine Chemistry, 51(4), 325-346.

Coch, C., Lamoureux, S.F., Knoblauch, C., Eischeid, I., Fritz, M., Obu, J. and Lantuit, H., (2018). Summer rainfall dissolved organic carbon, solute, and sediment fluxes in a small Arctic coastal catchment on Herschel Island (Yukon Territory, Canada). Arctic Science, 4(4), 750-780.

Cockburn, J.M. and Lamoureux, S.F., (2008). Inflow and lake controls on short-term mass accumulation and sedimentary particle size in a High Arctic lake: implications for interpreting varved lacustrine sedimentary records. Journal of Paleolimnology, 40(3), 923-942.

Cory, R.M., Miller, M.P., McKnight, D.M., Guerard, J.J. and Miller, P.L., (2010). Effect of instrument-specific response on the analysis of fulvic acid fluorescence spectra. Limnology and Oceanography: Methods, 8(2), 67-78.

Fellman, J.B., D'Amore, D.V., Hood, E. and Boone, R.D., (2008). Fluorescence characteristics and biodegradability of dissolved organic matter in forest and wetland soils from coastal temperate watersheds in southeast Alaska. Biogeochemistry, 88, 169-184.

Fellman, J.B., Hood, E. and Spencer, R.G., (2010). Fluorescence spectroscopy opens new windows into dissolved organic matter dynamics in freshwater ecosystems: A review. Limnology and Oceanography, 55(6), 2452-2462.

Fouché, J., Lafrenière, M.J., Rutherford, K. and Lamoureux, S., (2017). Seasonal hydrology and permafrost disturbance impacts on dissolved organic matter composition in High Arctic headwater catchments. Arctic Science, 3(2), 378-405.

Fouché, J., Christiansen, C.T., Lafrenière, M.J., Grogan, P. and Lamoureux, S.F., (2020). Canadian permafrost stores large pools of ammonium and optically distinct dissolved organic matter. Nature Communications, 11(1), 1-11.

Frampton, A., Painter, S., Lyon, S.W. and Destouni, G., (2011). Non-isothermal, three-phase simulations of near-surface flows in a model permafrost system under seasonal variability and climate change. Journal of Hydrology, 403(3-4),352-359.

Frampton, A., Painter, S.L. and Destouni, G., (2013). Permafrost degradation and subsurface-flow changes caused by surface warming trends. Hydrogeology Journal, 21(1), 271-280.

Frey, K.E. and McClelland, J.W., (2009). Impacts of permafrost degradation on arctic river

biogeochemistry. Hydrological Processes: An International Journal, 23(1),169-182.

Grewer, D.M., Lafrenière, M.J., Lamoureux, S.F. and Simpson, M.J., (2015). Potential shifts in Canadian High Arctic sedimentary organic matter composition with permafrost active layer detachments. Organic Geochemistry, 79, 1-13.

Guo, L., Ping, C.L. and Macdonald, R.W., (2007). Mobilization pathways of organic carbon from permafrost to arctic rivers in a changing climate. Geophysical Research Letters, 34(13).

Hansen, A.M., Kraus, T.E., Pellerin, B.A., Fleck, J.A., Downing, B.D. and Bergamaschi, B.A., (2016). Optical properties of dissolved organic matter (DOM): Effects of biological and photolytic degradation. Limnology and Oceanography, 61(3), 1015-1032.

Harms, T.K. and Jones Jr, J.B., (2012). Thaw depth determines reaction and transport of inorganic nitrogen in valley bottom permafrost soils: Nitrogen cycling in permafrost soils. Global Change Biology, 18(9), 2958-2968.

Herrault, P.A., Gandois, L., Gascoin, S., Tananaev, N., Le Dantec, T. and Teisserenc, R., (2016). Using high spatio-temporal optical remote sensing to monitor dissolved organic carbon in the Arctic river Yenisei. Remote Sensing, 8(10).

Heslop, J.K., Hung, J.K., Tong, H., Simpson, M.J., Chapman, F.M., Roulet, N., Lafreniere, M.J. and Lamoureux, S.F., (2020). Diverging pond dissolved organic matter characteristics yield similar CO2 flux potentials in a disturbed High Arctic landscape. Environmental Research Letters.

Holmes, R.M., McClelland, J.W., Peterson, B.J., Tank, S.E., Bulygina, E., Eglinton, T.I., Gordeev, V.V., Gurtovaya, T.Y., Raymond, P.A., Repeta, D.J. and Staples, R., (2012). Seasonal and annual fluxes of nutrients and organic matter from large rivers to the Arctic Ocean and surrounding seas. Estuaries and Coasts, 35, 369-382.

Hudson, N., Baker, A. and Reynolds, D., (2007). Fluorescence analysis of dissolved organic matter in natural, waste and polluted waters—a review. River Research and Applications, 23(6), 631-649.

Hugelius, G., Strauss, J., Zubrzycki, S., Harden, J.W., Schuur, E.A.G., Ping, C.L., Schirrmeister, L., Grosse, G., Michaelson, G.J., Koven, C.D. and O'Donnell, J.A., (2014). Estimated stocks of circumpolar permafrost carbon with quantified uncertainty ranges and identified data gaps. Biogeosciences, 11(23), 6573-6593.

Huguet, A., Vacher, L., Relexans, S., Saubusse, S., Froidefond, J.M. and Parlanti, E., (2009). Properties of fluorescent dissolved organic matter in the Gironde Estuary. Organic Geochemistry, 40(6), 706-719.

Ishii, S.K. and Boyer, T.H., (2012). Behavior of reoccurring PARAFAC components in fluorescent dissolved organic matter in natural and engineered systems: a critical review. Environmental science & technology, 46(4), 2006-2017.

Jaffé, R., McKnight, D., Maie, N., Cory, R., McDowell, W.H. and Campbell, J.L., (2008). Spatial and temporal variations in DOM composition in ecosystems: The importance of long-term monitoring of optical properties. Journal of Geophysical Research: Biogeosciences, 113(G4).

Kalbitz, K., Solinger, S., Park, J.H., Michalzik, B. and Matzner, E., (2000). Controls on the dynamics of dissolved organic matter in soils: a review. Soil science, 165(4), 277-304.

Koch, J.C., Runkel, R.L., Striegl, R. and McKnight, D.M., (2013). Hydrologic controls on the transport and cycling of carbon and nitrogen in a boreal catchment underlain by continuous permafrost. Journal of Geophysical Research: Biogeosciences, 118(2), 698-712.

Kraus, T.E., Bergamaschi, B.A., Hernes, P.J., Doctor, D., Kendall, C., Downing, B.D. and Losee, R.F., (2011). How reservoirs alter drinking water quality: organic matter sources, sinks, and transformations. Lake and Reservoir Management, 27(3), 205-219.

Lafrenière, M.J. and Lamoureux, S.F., (2013). Thermal perturbation and rainfall runoff have greater impact on seasonal solute loads than physical disturbance of the active layer. Permafrost and Periglacial Processes, 24(3), 241-251.

Lamoureux, S.F. and Lafrenière, M.J., (2018). More than just snowmelt: integrated watershed science for changing climate and permafrost at the Cape Bounty Arctic Watershed Observatory. Wiley Interdisciplinary Reviews: Water, 5(1).

Lamhonwah, D., Lafrenière, M.J., Lamoureux, S.F. and Wolfe, B.B., (2017). Evaluating the hydrological and hydrochemical responses of a High Arctic catchment during an exceptionally warm summer. Hydrological Processes, 31(12), 2296-2313.

Lewis, T., Lafrenière, M.J. and Lamoureux, S.F., (2011). Hydrochemical and sedimentary responses of paired High Arctic watersheds to unusual climate and permafrost disturbance, Cape Bounty, Melville Island, Canada. Hydrological Processes, 26(13), 2003-2018.

Liang, L. and Singer, P.C., (2003). Factors influencing the formation and relative distribution of haloacetic acids and trihalomethanes in drinking water. Environmental Science & Technology, 37(13), 2920-2928.

McKnight, D.M., Boyer, E.W., Westerhoff, P.K., Doran, P.T., Kulbe, T. and Andersen, D.T., (2001). Spectrofluorometric characterization of dissolved organic matter for indication of precursor organic material and aromaticity. Limnology and Oceanography, 46(1), 38-48.

Minor, E.C., Swenson, M.M., Mattson, B.M. and Oyler, A.R., (2014). Structural characterization of dissolved organic matter: a review of current techniques for isolation and analysis. Environmental Science: Processes & Impacts, 16(9), 2064-2079.

Murphy, K.R., Butler, K.D., Spencer, R.G., Stedmon, C.A., Boehme, J.R. and Aiken, G.R., (2010). Measurement of dissolved organic matter fluorescence in aquatic environments: an interlaboratory comparison. Environmental Science & Technology, 44(24), 9405-9412.

Murphy, K.R., Stedmon, C.A., Graeber, D. and Bro, R., (2013). Fluorescence spectroscopy and multi-way techniques. PARAFAC. Analytical Methods, 5(23), 6557-6566.

Oni, S.K., Futter, M.N., Molot, L.A. and Dillon, P.J., (2012). Adjacent catchments with similar patterns of land use and climate have markedly different dissolved organic carbon concentration and runoff dynamics. Hydrological Processes, 28(3), 1436-1449.

Paquette, M., Rudy, A.C., Fortier, D. and Lamoureux, S.F., (2020). Multi-scale site evaluation of a relict active layer detachment in a High Arctic landscape. Geomorphology, 359, 107159.

Paul, J.R., Kokelj, S.V. and Baltzer, J.L., (2021). Spatial and stratigraphic variation of near-surface ground ice in discontinuous permafrost of the taiga shield. Permafrost and Periglacial Processes, 32(1), 3-18.

Quinton, W.L. and Baltzer, J.L., (2013). The active-layer hydrology of a peat plateau with thawing permafrost (Scotty Creek, Canada). Hydrogeology Journal, 21(1), 201-220.

Quinton, W.L. and Marsh, P., (1999). A conceptual framework for runoff generation in a permafrost environment. Hydrological Processes, 13(16), 2563-2581.

Schuur, E.A., Bockheim, J., Canadell, J.G., Euskirchen, E., Field, C.B., Goryachkin, S.V., Hagemann, S., Kuhry, P., Lafleur, P.M., Lee, H. and Mazhitova, G., (2008). Vulnerability of permafrost carbon to climate change: Implications for the global carbon cycle. BioScience, 58(8), 701-714.

Stedmon, C.A., Markager, S. and Bro, R., (2003). Tracing dissolved organic matter in aquatic environments using a new approach to fluorescence spectroscopy. Marine Chemistry, 82(3-4), 239-254.

Stedmon, C.A. and Markager, S., (2005). Resolving the variability in dissolved organic matter fluorescence in a temperate estuary and its catchment using PARAFAC analysis. Limnology and Oceanography, 50(2), 686-697.

Stedmon, C.A. and Bro, R., (2008). Characterizing dissolved organic matter fluorescence with parallel factor analysis: a tutorial. Limnology and Oceanography: Methods, 6(11), 572-579.

Stewart, K.J., Grogan, P., Coxson, D.S. and Siciliano, S.D., (2014). Topography as a key factor driving atmospheric nitrogen exchanges in arctic terrestrial ecosystems. Soil Biology and Biochemistry, 70, 96-112.

Thiel, G., (2018). Investigating dissolved organic matter cycling in High Arctic ponds and soils. Ph.D thesis, Queens University.

Vonk, J.E., Tank, S.E., Bowden, W.B., Laurion, I., Vincent, W.F., Alekseychik, P., Amyot, M., Billet, M.F., Canário, J., Cory, R.M. and Deshpande, B.N., (2015). Reviews and syntheses: Effects of permafrost thaw on Arctic aquatic ecosystems. Biogeosciences, 12(23), 7129-7167.

Walvoord, M.A. and Kurylyk, B.L., (2016). Hydrologic impacts of thawing permafrost—A review. Vadose Zone Journal, 15(6), 1-20.

Wang, J.J., Lafrenière, M.J., Lamoureux, S.F., Simpson, A.J., Gélinas, Y. and Simpson, M.J., (2018). Differences in riverine and pond water dissolved organic matter composition and sources in Canadian high Arctic watersheds affected by active layer detachments. Environmental Science & Technology, 52(3), 1062-1071.

Wickland, K.P., Aiken, G.R., Butler, K., Dornblaser, M.M., Spencer, R.G.M. and Striegl, R.G., (2012). Biodegradability of dissolved organic carbon in the Yukon River and its tributaries: Seasonality and importance of inorganic nitrogen. Global Biogeochemical Cycles, 26(4).

Wilson, H.F. and Xenopoulos, M.A., (2009). Effects of agricultural land use on the composition of fluvial dissolved organic matter. Nature Geoscience, 2(1), 37-41.

Woo M., (2012) Permafrost Hydrology. Heidelberg, Germany: Springer.
Woods, G.C., Simpson, M.J., Koerner, P.J., Napoli, A. and Simpson, A.J., (2011). HILIC-NMR: toward the identification of individual molecular components in dissolved organic matter. Environmental Science & Technology, 45(9), 3880-3886.

Wu, F.C., Kothawala, D.N., Evans, R.D., Dillon, P.J. and Cai, Y.R., (2007). Relationships between DOC concentration, molecular size and fluorescence properties of DOM in a stream. Applied Geochemistry, 22(8), 1659-1667.

The San Gorgonio Pass Wind Farm as a model for future projects

Jake Erlanger

Abstract

This article explores the practicality of the implementation of wind farms from both the physical and human geographical standpoints. It uses the San Gorgonio Pass Wind Farm as a case study for its optimal geographic location, conducive to the presence of wind, as well as its proximity to major urban centres. The atmospheric physics of the San Gorgonio Pass are detailed in the article, describing the ideal wind tunnel in which it exists, situated between the San Bernardino and San Jacinto Mountains to the north and south respectively, as well as the Great Basin and the Pacific Ocean, to the east and to the west. The wind farm also acts as a major power source for densely populated Southern California urban centres, including Los Angeles, San Diego, and the Coachella Valley, conveniently situated near all three. The article summarizes how various wind farms in Alberta, as well as the Wolfe Island Wind Farm in Ontario, have implemented similar tactics to optimize the energy infrastructure, and as such, explores the feasibility of replication in other regions around the world.

Wind power is a form of renewable energy that uses wind as a source of mechanical power to turn electrical generators to produce electricity (Natural Resources Canada [NRCan], 2020). The geography of the San Gorgonio Pass is an ideal setting for the use of wind power, as it sits at 790 meters above sea level, between the San Bernardino and the San Jacinto Mountains, Southern California's two highest mountain ranges (Yule, 2009). The location of the pass is also conveniently situated with respect to its densely populated surrounding Southern California urban centres including Los Angeles, San Diego, and the Coachella Valley (Southern California Association of Governments [SCAG], 2016). Standing up to 46 meters in height (Solaripedia, 2009), the turbines of the San Gorgonio Pass Wind Farm have transitioned from eyesores to icons since their introduction to the region, prevailing as a point of interest on the drive along Interstate 10 (I-10) between Los Angeles, California and Phoenix, Arizona. The continuous success of this project remains as an example that can be applied to other similar regions around the world; this may include some parts of Canada, such as Southern Alberta and Wolfe Island in Ontario, where infrastructure already exists (NRCan, 2020). Similar geographies and energy demands offer prime opportunities for wind power, and the San Gorgonio Pass Wind Farm acts as a case study from which much can be learned.

Wind power (also referred to as wind energy), is the process by which wind is used to produce electricity though mechanical generation (NRCan, 2020). Wind is a phenomenon in which air moves across an atmospheric pressure gradient, from an area of high pressure to an area of low pressure (U.S. Energy Information Administration, 2021). Atmospheric pressure gradients are created in one

Figure 1. The San Gorgonio Pass Wind Farm in 2019 viewed from the north while traveling westbound on I-10 from Palm Springs, California. Photo provided by the author.

---

of two ways: by either diabatic processes, or by adiabatic processes, the latter of which fuels the wind in the San Gorgonio Pass. Diabatic processes occur when a parcel of air experiences a change in pressure, because of an input or a removal of heat (Glossary of Meteorology, 2012). Convection, an example of a diabatic process, occurs when a surface is heated. As the surface heats, hot air rises, and then laterally adjacent air moves in to replace the air that has risen away from the surface, in turn causing wind. On the contrary, adiabatic processes, such as those that occur in the San Gorgonio Pass, occur when an air parcel changes pressure due to processes occurring in its surroundings (Glossary of Meteorology, 2019). When the ambient air pressure around an air parcel changes, the air parcel experiences a change in volume, as per the ideal gas law.

A common example of an adiabatic process is the orographic effect, a result that occurs when a parcel of air is forced upward upon encountering a physical barrier – generally a mountain or a mountain range (Arthur & Saffer, 2022). As the air parcel rises, it expands due to a decrease in pressure and, in turn, cools until it reaches its dew point (the temperature at which water droplets begin to condense), according to local conditions of atmospheric pressure and humidity. At this point, a large proportion of the cooled and condensed air precipitates, as it rises the mountain. Subsequently, the parcel of air, now depleted of moisture, sinks, and increases in temperature on the leeward slope of the mountain, the opposite slope along which it initially rose. Although the San Gorgonio Pass Wind Farm, as presented in Figure 1, specifically is an example of a setting where wind power is produced by adiabatic process, wind power generation is feasible in any location where wind exists, no matter of the process by which it occurs.

As shown in Figure 2, the geography of the San Gorgonio Pass facilitates an ideal setting for the generation of wind power. The pass

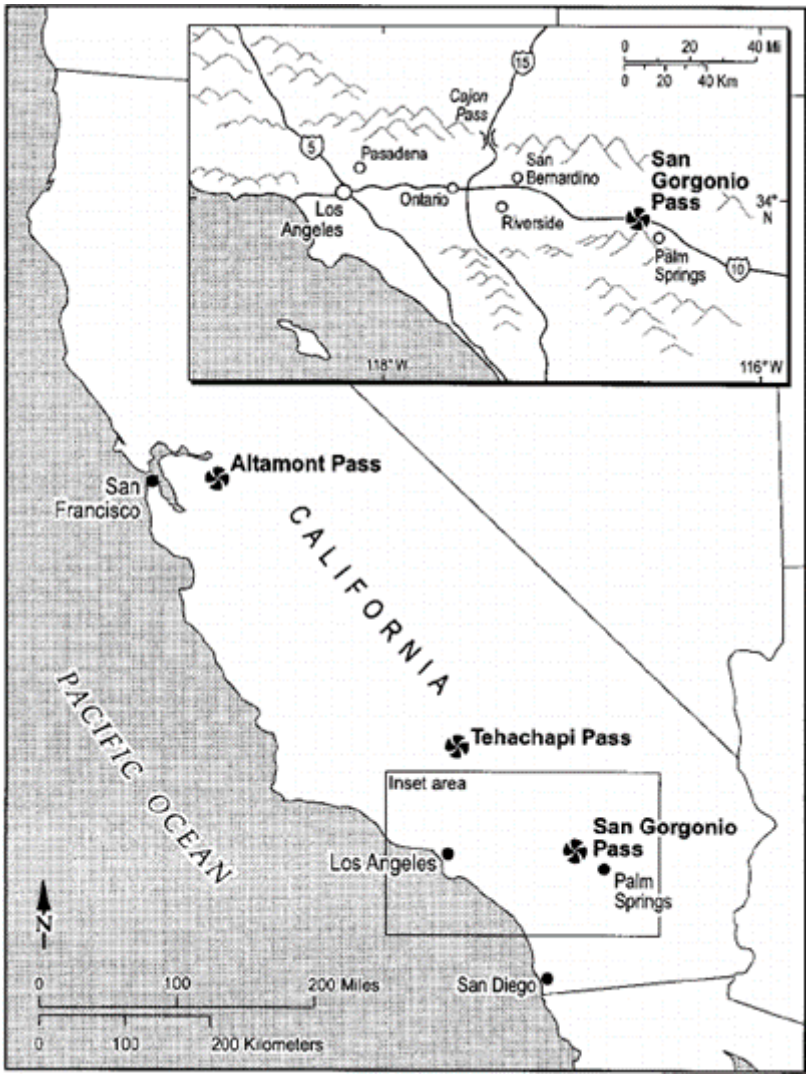


Figure 2. The San Gorgonio Pass is a principal wind area of Southern California. From "Wind energy landscapes: Society and technology in the California Desert," by M. J. Pasqualetti, 2001, Society & Natural Resources, 14(8), p. 690. Copyright 2001 by Taylor & Francis.

---

sits with the San Bernardino Mountains to the north, the San Jacinto mountains to the south, the Great Basin to the east, and the Pacific Ocean to the west (Yule, 2009). The Great Basin is a high elevation desert and is a source of semipermanent high-pressure air that flows in a clockwise direction down a pressure gradient from the Sierra Nevada Mountains to the Pacific Ocean (U.S. Department of the Interior, 2021). Along its journey, the air compresses, in turn adiabatically heating, as it decreases in elevation. As this air flows down to the sea, it creates a powerful wind tunnel as it is funneled between The San Bernardino and San Jacinto Mountains. This process facilitates the phenomenon known as the Santa Ana Winds, known for fanning Southern California's wildfires, which is another example of the orographic effect. Although the Santa Ana winds are responsible

for the winds in the San Gorgonio Pass, winds created by adiabatic processes are not unique to Southern California and its surrounding regions. In Canada, Southern Alberta's Chinook winds occur because of the adiabatic heating of air masses that originate from the Pacific Ocean and blow down the leeward slope of the Rocky Mountains. The Chinooks are responsible for Southern Alberta's spurs of warm weather throughout its winter. Although not quite as constant as San Gorgonio's Santa Ana winds, they are consistent enough to provide ample opportunity for implementing numerous wind farms, including the Castle Rock Ridge Wind Farm, the Riverview Wind Project, and Castle River, which help significantly to contribute to Alberta's total 1467-MW capacity of wind power produced in 2017 (Canada Energy Regulator, 2021). On the other hand, Ontario's Wolfe Island Wind Farm, with its 86 wind turbines and 198-MW capacity (TransAlta Renewables, 2018), takes advantage of winds produced by the diabatic process of convection. During the day, the land on Wolfe Island heats faster than the lake's water due to differences in the thermal properties of the surface materials, creating a phenomenon called a convection cell. This causes air above the land to rise faster than air above the water, in turn creating an atmospheric pressure gradient. As a result, air from the lake moves toward the land, creating the phenomenon known as a lake breeze. During the night, the opposite process occurs, when the land cools faster than the lake, causing the convection cell to reverse, and a land breeze to occur. Surrounded by water on all sides, the Wolfe Island Wind Farm takes advantage of this lake breeze-land breeze phenomenon, providing ample opportunity for the generation of power from wind throughout the diurnal cycle. Like the San Gorgonio Pass Wind Farm, various regions of Canada exhibit opportunities for the potential of wind power by means of various types of atmospheric processes.

The location of the San Gorgonio Pass Wind Farm is optimally situated in proximity to California's densely populated urban centres of Los Angeles, San Diego, and the Coachella Valley (SCAG, 2016). The need for extensive infrastructure to transport power produced at the San Gorgonio Pass Wind Farm is minimized since the production site is located directly between these three major population centres, all with great demands for energy on both residential and commercial levels. In Alberta, it has been elected that most wind farms be built in the southern part of the province, near Calgary, Canada's third largest city. Like the San Gorgonio Pass Wind Farm, wind farms in Southern Alberta and Wolfe Island have been strategically located to minimize necessary transportation resources for this energy to arrive at locations at which it can be readily used. Jurisdictions around the world may follow the strategy of wind power production in Alberta and Ontario, by using the San Gorgonio Pass Wind Farm as an example to examine site locations of potential wind farms, while considering their proximity to dense population centres.

The San Gorgonio Pass Wind Farm is an ideal example of a site of wind power production that may be used as a case study by jurisdictions around the world. The wind farm has also pioneered the transition from thinking of wind turbines and wind farms as eyesores to viewing them as environmental masterpieces. Wind farm projects in Canada have used the similar physical and human geographies of the San Gorgonio Pass Wind Farm as examples to cultivate parallel outcomes of energy efficiency through both cost and sustainability. The types

of geographies outlined in this article are certainly not unique to Southern California, nor to the United States or Canada. There are various types of processes constantly occurring across the world that facilitate wind – and where there is wind, there is potential to produce power. There exists an ever-increasing global demand for energy, and the continuous success of the San Gorgonio Pass Wind Farm remains an exemplar that should be replicated at any available opportunity.

References

Arthur, M. & Saffer, D. (2021). The orographic effect. The Pennsylvania State University. https://www.e-education.psu.edu/earth111/node/751#:~:text=The%20orographic%20effect%20occurs%20when,the%20direction%20of%20storm%20tracks

Canada Energy Regulator (2021). Canada's Renewable Power – Alberta. https://www.cer-rec.gc.ca/en/data-analysis/energy-commodities/electricity/report/canadas-renewable-power/canadas-renewable-power/provinces/renewable-power-canada-alberta.html

Glossary of Meteorology. (2012). Diabatic process. American Meteorological Society. https://glossary.ametsoc.org/wiki/Diabatic_process

Glossary of Meteorology. (2019). Adiabatic process. American Meteorological Society. https://glossary.ametsoc.org/wiki/Adiabatic_process

Natural Resources Canada. (2020). Wind Energy. Government of Canada. https://www.nrcan.gc.ca/energy/energy-sources-distribution/renewables/wind-energy/7299

Pasqualetti, M. J. (2001). Wind energy landscapes: Society and technology in the California Desert. Society & Natural Resources, 14(8), 689–699. https://doi.org/10.1080/08941920117490

Solaripedia. (2009). San Gorgonio Wind Farm Produces 893 GWh. http://www.solaripedia.com/13/160/san_gorgonio_wind_farm_produces_893_gwh.html

Southern California Association of Governments. (2016). 2016 Land Use Information for Riverside County. ArcGIS Online. https://gisdata-scag.opendata.arcgis.com/datasets/41c090c8d9a342c49a6a656638ebc1a5_0/explore

TransAlta Renewables. (2018). Wolfe Island. https://www.transaltarenewables.com/plants-operation/wolfe-island/

U.S. Department of the Interior. (2021). The Great Basin. National Park Service. https://www.nps.gov/grba/planyourvisit/the-great-basin.htm

U.S. Energy Information Administration. (2021). Wind explained. https://www.eia.gov/energyexplained/wind/

Yule, D. (2009). The enigmatic San Gorgonio Pass. Geology, 37(2), 191-192. https://doi.org/10.1130/focus022009.1

Effects of the ecomodernist perspective: *RiverBlue* film falls short

Megan Hoogaars

Abstract

This paper examines the ecomodernist perspective underpinning the advocacy documentary film *RiverBlue* that causes it to fall short in offering adequate solutions to the fashion industry's multifaceted, global problem of river pollution. This paper argues that if *RiverBlue* had taken a political ecologist perspective, it would have questioned and challenged the power relationship involved in the fashion industry. Furthermore, if the film had taken a political ecologist approach, it would have offered solutions that were more approachable and accessible by all, which would be more likely to create sustainable change. First, this paper will define and explore the solutions of ecomodernism and political ecology to situate the film within ecomodernism. Then, it will compare the ecomodernist and the political ecology stance on the Anthropocene, nature, and water to show the differences in their views and the problems associated with the ecomodernist view suggested in the film. Finally, this paper will explore political ecologist solutions and the benefits.

Introduction

How many pairs of jeans are hanging in your closet? Fashion United found that women on average own seven pairs of jeans. Whereas, the average man owns six pairs. Despite this, we only wear four pairs that we own (How Many Pairs of Jeans is Too Many?, 2019). The market value for denim fabric was 21.8 billion U.S. dollars in 2020 and is expected to increase to over 26 billion U.S. dollars by 2026 (Shahbandeh, 2021)! Evidently, jean production is a massive industry we all take part in, but have you taken time to think about the impact it has on our environment? *RiverBlue* is a thought-provoking advocacy documentary film directed by Roger Williams and David McIlvride (2017). The film follows international river conservationist Mark Angel around the world as he infiltrates the world's most pollutive industry, fashion. The first half of the documentary exposes viewers to the shocking reality that harsh chemical manufacturing processes and the irresponsible disposal of toxic chemical waste resulting from the production of jeans has destroyed rivers and negatively impacted the lives of people who count on these waterways for their survival.

In the second half of the film, viewers are introduced to some potential answers to the main question of the film 'Can fashion save the planet?' through interviews with researchers and two companies who are planning safer means of achieving the same distressed look of jeans. To show how this can be accomplished, the film takes us to Italdenim, a tactile company that was one of the first companies to embrace Greenpeace's detox campaign. Italdenim has adopted new technology to change the way denim is produced by creating chitosan to enhance the dying power

of denim. Viewers also see a small jean company called Jeanologia who is replacing traditional polluting methods of distressing jeans using light and air technology and machinery (Williams et al, 2017). Although, "the film shows (that) fast-fashion is the cause of the problem…. it chooses to stay within the fashion industry to solve the problem" (Caliborn, 2021), suggesting a top-down approach. The film's proposed solutions suggest that the "decoupling of human welfare from environmental impacts will require a sustained commitment to technological progress" (Asafu-Adjaye, J. et al., 2015, p. 29). The film's position is within the ecomodernist perspective because it advocates that advancement in sophisticated technologies will let businesses be more profitable, efficient, safer, and environmentally friendly (Hussain, 2020). However, this ecomodernist view neglects the fact that "environmental change and ecological conditions are the product of political processes" (Robbins, 2012, p. 19-20). Although *RiverBlue* acknowledged the multifaceted and global aspects of river pollution by the fashion industry, the film falls short of offering adequate solutions because of its narrow, ecomodernist perspective. The perspective reflects a western view of nature and modernization, limiting the applicability of the solutions. If the film had taken on a political ecologist perspective, it would have taken a bottom-up approach that questions and challenges the power relationship involved in the fashion industry. To prove this, this paper will first define and explore the solutions of ecomodernism and political ecology to situate the film within ecomodernism. Then, it will compare the ecomodernist and the political ecology stance on the Anthropocene, nature, and water to show the differences in their views and the problems associated with the ecomodernist view suggested in the film. Finally, the paper will explore political ecologist solutions and the benefits to these. This will show that by taking a bottom-up political ecologist approach that questions and challenges the power relationship involved in the fashion industry, political ecologist solutions would be more approachable, accessible, and more likely to create sustainable change.

Defining ecomodernism and situating *RiverBlue* within it

Ecomodernism is an environmental philosophy centred on the belief that the use and development of technologies will reduce environmental impacts while enabling the continuation of the current economic growth and high standard of living. They believe that technology will enable humans to decouple from the environment. Decoupling occurs when economic growth does not increase environmental pressure (Asafu-Adjaye et al., 2015, p. 11). By decoupling, they mean using fewer resources for the same economic output and development through using the resources wisely and breaking the link between economic growth, resource use, and environmental impact (UN Environment Programme, 2015). Ecomodernists believe that decoupling will enable humans to "make more room for nature" and bring about "a good Anthropocene" (Asafu-Adjaye, p. 6-7). Therefore, ecomodernists feel that technology should "not simply (be used) for the sake of innovation, but to improve and address the real needs of consumers and reengineer the value chain" (Hussain, 2020) enabling humans to decouple for the environment. Through decoupling human well-being from environmental destruction, ecomodernist believe that "a future of human prosperity and an ecologically vibrant planet can exist

separately" (Asafu-Adaye et al., 2015, p. 31). This hypothetical path of environmentally friendly economic growth is known as 'green growth' (Hickle, 2018a).

The film *RiverBlue* takes on an ecomodernist perspective in its solutions to the pollutive nature of denim production. For instance, the film shows that to mitigate the environmental effects of denim production, Italdenim adopted new technology to change the way denim is produced. They turned to the ocean and advanced technology to change the standard chemical processing of jeans by using the exoskeleton of shellfish crushed into a fine powder called chitosan, which enhances the dying power of denim. Italdenim found that using chitosan reduces the number of chemicals needed to make blue jeans blue and is a non-toxic and recycled environmentally friendly material. Similarly, the film also showed how a small jean company called Jeanologia is on the cutting edge of an eco-friendly blue jean processing method of distressing jeans using light and air. Jeanologia is using light via lasers to eliminate the raw blue colour in denim and give it the desired distressed look. They have also taken water out of the equation by loading jeans into what looks like a commercial washing machine to give jeans the washed out and worn look through air rather than stonewashing. The film is showing that these technologies make it so that "innovation is changing" how a "simple wardrobe staple… (that had) dirty beginnings" (Besma, 2015) can be changed simply through technological advancements. Therefore, by using the example of two highly sophisticated and technologically advanced companies, *RiverBlue* suggests that jean production and consumption should continue as is and the solution is technology, which will help decouple economic growth from the environmental impacts of jean production.

Defining political ecology

On the other hand, the environmental philosophy of political ecology would examine the relationship between economic, social, and political factors within the environmental issue of jean production and the changes that have led to them (Robbins, 2012, p. 13). Political ecology is an explicit alternative to ecomodernism, which notes that ecomodernism is "apolitical ecology" (Robbins, 2012, p. 14). Political ecology is concerned with the connections between "social systems, biological processes, technological change, ecosystems, economic power and environmental transformation" (Whitehead, 2014, p. 73). It "address(es) the condition and change of social/environmental systems, with explicit consideration of relations of power" (Robbins, 2012, p. 20). They say that ecomodernists overlook the most fundamental problem of current ecology by "ignore(ing) the significant influence of political-economic forces" (ibid, p. 19). Instead, political ecologists would "advocate (for) fundamental changes in the management of nature and the rights of people….to challenge current conditions" (ibid, p. 13) and effects of jean production.

Perspectives on the anthropocene

Political ecology and ecomodernism are two opposing environmental philosophies, therefore, their views of the Anthropocene, nature and water are distinctly different. Through understanding the ecomodernist position on these three topics, it will be clear that RiverBlue is portraying an ecomodernist perspective that reflects a western view of nature and modernization, limiting the applicability of their solutions. The Anthropocene refers to a new geological era in which humans have become the

driving force of global environmental change (Whitehead, 2014, p.1). The term has been used since the 1960s with a different meaning, until 2000 when the term was widely popularized by Paul J Crutzen, an atmospheric chemist who studies the influence of human behaviour on Earth's atmosphere (Whitehead, 2014, p.1-2). For ecomodernists, a good Anthropocene demands that humans use their growing social, economic, and technological powers to make life better for people, stabilize the climate, and protect the natural world (Asafu-Adjaye et al., 2015, p. 6). They feel that "to embrace technologies is to find paths to a good Anthropocene" (ibid, p. 17) and that their approach offers a "progressive and humanist vision of the Anthropocene, one in which publicly funded innovation has made possible both universal prosperity and planetary-scale rewilding" (Karlsson, 2020, p. 91).

However, for a political ecologist, the ecomodernist discourse of an Anthropocene is seen as a "notion of a unique, Western appreciation of nature that legitimized" (McAfree, 2016, p. 67) political decisions that often favour the Western view over others. They would share that the Anthropocene was intensified by a small group of capitalists in the West who helped create the foundation for the fossil economy, which created a highly inequitable global process (Robbins, 2012, p. 6). Political ecologists would say that there is a problem with thinking about environmental problems in global terms alone because "although we live in an interconnected biosphere, we experience very different ecological fate" (Whitehead, 2014, p.7). Thus, political ecologists would say that "it is important to recognize the lines of geographical connection that join" (Whitehead, 2014, p. 9) the global norths mass consumption of jeans with the water degradation and health hazards created from the factories producing these jeans.

Perspectives on nature

Ecomodernist view nature as needing to be detached from humans and believe that it should be separated through decoupling (Asafu-Adjaye, J. et al., 2015, p. 29) are distinctly different from political ecology. Ecomodernist believe that intensifying many human activities so that they interfere less with the natural world is the key to decoupling human development from economic impact. They feel that nature will not be protected or enhanced by the expansion of humankind's dependence upon them for sustenance and well-being (Asafu-Adjaye et al., 2015, p. 7). Therefore, "while traditional environmentalism seeks to re-embed society in nature, ecomodernism advocates greater separation as a pathway to planetary-scale rewilding" (Karlsson, 2020, p. 94). Ecomodernist and RiverBlue propose that technology will allow humans to conquer and bend nature at our will and decouple human development from environmental impacts. However, this is contrary to William Cronon's view of nature. Cronon would argue that ecomodernists are "reproduce(ing) the dualism that sets humanity and nature at opposite poles" (1995, p. 80), which helps "produce a deep fascination for remote ecosystems, where it is easier to imagine that nature might somehow be "left alone" to flourish by its own pristine devices" (ibid, p. 81). The ecomodernist view is dangerous because its privilege(s) certain aspects of nature at the cost of others (ibid, p. 85). The dualism ecomodernists are encouraging "denies us a middle ground in which responsible use and non-use might attain some kind of balanced, sustainable

relationship" (ibid, p.85).

On the other hand, political ecologists take on Cronon's suggested middle-ground stance on nature in hopes that "by exploring this middle ground they will learn ways of imagining a better world …. for humanity in all its diversity and for all the rest of nature too" (Cronon, 1995, p. 85). Political ecologists feel "that our survival depends not on domination, but on harmony" (Hickle, 2018a) with nature. Aside from the dualist implication that humans can free themselves from nature, what would centrally concern political ecologists is the ecomodernist "statement's self-centered homogenizing of the human species (Robbins, 2012, p. 69). Rather, the notion of political ecology "is as much about bringing nature into the work of social scientists as it is about bringing a human perspective into studies of nature" (Whitehead, 2014, p. 75). In his book Social Nature, Noel Castree describes nature as fundamentally a social construct that people define, engage and remake in a variety of ways (Castree, 2005, p. 10). This is the view that political ecologists take up. Like Castree, political ecologists would begin by noting that "environmental change and ecological conditions are the product of political processes" (Robbins, 2012, p. 19-20). They seek to expose flaws in dominant approaches to nature favoured by corporate, state, and international authorities, to demonstrate the undesirable impacts especially from the point of view of local people, marginal groups, and vulnerable populations (ibid, p. 99).

Perspectives on water and political ecology's solutions

Again, *RiverBlue* explicitly shows an ecomodernist perspective of water, which is unmistakably divergent from a political ecologist viewpoint of water. Like the ecomodernist perspective, *RiverBlue* portrays the belief that depolluting the waters and creating cleaner waters is possible with technological advancements that enable the same intensification of jean production to remain. The film's solutions staying within the fashion industry shows this. Ecomodernist and *RiverBlue* believe that meaningful climate mitigation is fundamentally a technological challenge and that "dramatic limits to per capita global consumption would be insufficient to achieve significant climate mitigation" (Asafu-Adjaye et al., 2015, p. 20). Ecomodernist also believe that intensification of production will lead to "the total human impact on the environment….to peak and decline this century" (ibid, p. 14). By *RiverBlue* being framed in an ecomodernist perspective, the underlying belief of the relationship between jean production and water pollution and usage is that the intensifying production will inevitably lead to protection and conservation of water.

Conversely, a political ecologist would argue that ecomodernist claims that modern technologies can optimize production and lead to conservation and environmental benefits, has proven historically questionable (Robbins, 2012, p. 19). They would also point out that "if you count all the water extraction involved in producing and shipping the imports that the US consumes, American water use is going up, not down" (Hickle, 2018b). Instead, political ecologists would advocate for sustainable degrowth in the production and consumption of jeans and other fast-fashion products polluting the waters and negatively affecting the health of the poor. Sustainable degrowth refers to "socially sustainable and equitable reduction (and eventually stabilisation) of society's…. materials and energy" production, extraction

and consumption (Kallis, 2011, p. 874). Political ecologists advocate for a new system to emerge that does not need limitless exponential growth to work, "rather than cling to the (ecomodernist) false hope of "green growth" fantasies" (Hickle, 2018a).

Political ecologists would also encourage global social justice movements to help share information on the various water crises and injustices caused by fast-fashion to change the existing realities (Sultana, 2018, p. 487). Thus, a political ecologist would agree with the first half of *RiverBlue* as it exposes a global audience to the environmental and health issues associated with the fast-fashion industry. However, because political ecologists would examine the situation through a hydrosocial cycle (a social-natural process by which water and nature make and remake one another) lens, they would suggest water justice and water democracy as solutions. A political ecologist would advocate for water justice because it acknowledges "water's connection to broader issues of democracy, citizenship and development" and requires "broader recognition that they are inherently ecological, political and social issues" (Sultana, 2018, p. 487). Using water justice, a political ecologist would push for anti-privatization movements, re-municipalisation efforts, ensuring safe water for all, democratizing water governance, recognizing struggles, and addressing equity and social injustice (ibid). Political ecologists would also call for water democracy as a solution because democratizing how water is managed and governed includes various voices and allows them to be heard (ibid, p. 490). The participation of people in water pollution issues can cultivate ways to increase knowledge about local watersheds, which will lead to them undertaking exercises to protect them.

Conclusively, the solutions a political ecologist would suggest for the water pollution issues caused by the fast-fashion industry highlighted in *RiverBlue* would be to create sustainable degrowth of the industry through activities like consumers purchasing used jeans, creating water justice initiatives that recognize and address the injustice and inequalities of the issue, and encourage water democracy initiative as it will bring various voices and solutions to the table. From examining the ecomodernist perspective taken by *RiverBlue* in comparison to the possible political ecology perspective the film could have taken, this essay shows that decoupling humans from the environment and the technological solutions suggested in the film are impossible, inadequate, and unavailable to many businesses in the Global South. For instance, a study of the garment industry in Bangladesh by Sakamoto et al. found that effluent treatment plants, which were advocated in the film, are unavailable in local markets and the import taxes are extremely high (2019). Similarly, a study by Haque and Azmat of businesses in the ready-made garment industry in Bangladesh found that they focus only on their economic goals rather than on their "legal and ethical responsibilities" (2015, p. 182) to protect the natural environment and their workers from hazards including chemicals. Overall, if *RiverBlue* had taken on a bottom-up political ecologist perspective in proposing solutions to the issue of water pollution they highlighted, their solutions would have been more approachable and accessible by all, and more likely to create sustainable change.

References

Asafu-Adjaye, J., Blomqvist, L., Brand, S., Brook, B., Defries, R., Ellis, E., Foreman, C., …. Teague, P. (2015, Apr.) An Ecomodernist Manifesto. https://static1.squarespace.com/static/5515d9f9e4b04d5c3198b7bb/t/552d37bbe4b07a7dd69fcdbb/1429026747046/An+Ecomodernist+Manifesto.pdf

Besma, C. (2018, Jan. 19). What I learned from RiverBlue. Curiously Conscious. https://www.curiouslyconscious.com/2018/01/riverblue-documentary-film-review.html/.

Caliborn, E. (2021, Aug. 22). RiverBlue: can fashion save the planet?. Water Alternatives Blog. https://www.water-alternatives.org/index.php/cwd/item/163-riverblue.

Castree, N. (2005). Preface & Strange Natures. Nature, Routledge, XVII-44.

Cronon, W. (1995). The Trouble with Wilderness; or, Getting Back to the Wrong Nature. Uncommon Ground: Rethinking the Human Place in Nature, New York: W. W. Norton & Co., 69-90.

Haque, M. Z., & Azmat, F. (2015). Corporate social responsibility, economic globalization and developing countries: A case study of the ready-made garments industry in Bangladesh. Sustainability Accounting, Management and Policy Journal (Print), 6(2), 166–189. https://doi.org/10.1108/SAMPJ-04-2014-0028.

Hickle, J. (2018a, Mar. 26). Better Technology Isn't the Solution to Ecological Collapse. Fast Company. https://www.fastcompany.com/40548564/better-technology-isnt-the-solution-to-ecological-collapse.

Hickle, J. (2018b, Apr. 4). The Magical Thinking of Ecomodernism. JacksonHickle.org. https://www.jasonhickel.org/blog/2018/4/4/the-magical-thinking-of-ecomodernism.

How Many Pairs of Jeans is Too Many? (2019, Oct. 19). Holé Button Covers. https://holebuttoncover.com/blogs/the-hole-story/how-many-pairs-of-jeans-is-too-many.

Hussain, A. (2020, Feb. 21). Agriculture 4.0: The savior for the global agriculture - Et Auto. https://auto.economictimes.indiatimes.com/news/automotive/farm-equipment/agriculture-4-0-the-savior-for-the-global-agriculture/74245646.

Kallis, G. (2011). In defence of degrowth. Ecological Economics, 70(5), 873–880. https://doi.org/10.1016/j.ecolecon.2010.12.007.

Karlsson, R. (2020, Aug.). Conflicting Temporalities and the Ecomodernist Vision of Rewilding. In Pereira J., Saramago A. (eds) Non-Human in World Politics, Springer, 91-109. DOI: https://doi.org/10.1007/978-3-030-49496-4_6.

McAfee, K. (2016). The Politics of Nature in the Anthropocene. RCC Perspectives (Internet), 2, 65–72. Robbins, P. (2012) Selections from Political Ecology: A Critical Introduction. Oxford: Blackwell Press.

Sakamoto, M., Ahmed, T., Begum, S., & Huq, H. (2019). Water pollution and the textile industry in Bangladesh: Flawed corporate practices or restrictive opportunities? Sustainability (Basel, Switzerland), 11(7). https://doi.org/10.3390/su11071951.

Shahbandeh, M. (2021, Aug. 5). Global denim market - statistics & fact. Statista. https://www.statista.com/topics/5959/denim-market-worldwide/#dossierKeyfigures.

Sultana, F. (2018). Water justice: why it matters and how to achieve it. Water International, 43(4), 483–493. UN Environment Programme (July 6, 2015).

Decoupling - A Video from the International Resource Panel [Video]. YouTube. Retrieved from https://www.youtube.com/watch?v=Gh-q5nVpEck&t=4s.

Whitehead, M. (2014). Environmental transformations: A geography of the Anthropocene, 65-80. ProQuest eBook Central https://ebookcentral-proquest-com.proxy.queensu.ca.

Williams, R., & Mazzotta, L. (Producers), & McIlvride, D., & Williams, R. (Directors). (2017). RiverBlue [Streaming video]. Canada: Global Environmental Justice. Retrieved September 24, 2021, from https://docuseek2-com.proxy.queensu.ca/gj-037a.

Rotten on both ends

Debbie Windholz

Abstract

This research project explores the ongoing labour exploitation and environmental destruction involved in the commodity chain of bananas produced in the Philippines and exported to Japan. While the exploitive nature of food production and export to wealthier countries is well documented, the unequal wealth distribution of the importing country is often overlooked as a contributor to unethical practices taking place in the commodity chain. Bananas in the Philippines are grown with toxic chemicals, cause deforestation in rural communities and take advantage of the precarious labour of local workers. The wealth gap and food insecurity in Japan have led to an increase in demand for cheap bananas. Once consumed, unnecessary packaging is then ineffectively "recycled," causing even more environmental destruction. The entire process is rife with inequality and ecological harm.

Introduction

As a single mother in Japan with unstable food security, bananas have been an affordable and nutritious food source for my family. Meeting many immigrants to Japan from the Philippines, and traveling to the Philippines, has influenced me to explore the commodity chain of bananas. Based on my own everyday experience interacting with local stores and people working under precarious conditions, it is evident that the cheap labor of workers employed in the banana industry is as much of a commodity as the bananas. The exploitation of labour and destruction of the environment on both the production and consumption end of the chain are directly interconnected.

Production

Environmental and health damage

"The banana industry consumes more agrochemicals than any other in the world, except cotton" (BananaLink 2021).

Monoculture and the pesticides needed to support it cause both human and environmental damage. Nearly all commercial banana producers cultivate a single variety, making the viability of the entire industry susceptible to pests and disease. The vast amount of chemicals needed to counteract these threats contaminate the soil and the water (Koeppel, 2008). Some key environmental impacts of large-scale banana farming include: contamination of watercourses, massive levels of plastic waste,

soil erosion, increased risk of flooding, deforestation, destruction of coral reefs, and the loss of soil fertility (BananaLink 2021). Pesticide use has been linked to thyroid disorders (Cortes-Maramba et al., 2004), cancers, respiratory problems, and birth defects (BananaLink 2021). Aerial pesticide spraying, in particular, has wide-ranging health impacts, as the sprayed pesticides contaminate houses and roads, exposing not only workers but also others, including children who walk to school (Jansen & Nikol, 2020). Workers in poorer agricultural areas have disproportionate health impacts from agrochemicals. Illiterate workers cannot read safety instructions, protective clothing may be unaffordable or ill-suited to the local climate, and washing facilities to remove chemical residues may be non-existent (Chiong-Javier, 2009). Sadly, some of these chemicals are only used to preserve the appearance of bananas and are not even necessary for farming (BananaLink 2019).

Labour exploitation on banana plantations

"The bananas produced and being sold by Sumifru has the blood of the workers," Jamila Seno, union organizer and plantation worker.

The majority of bananas exported to Japan — 60% of which are grown by two large companies, Sumifru and Farmind, on the island of Mindanao in the Philippines — are Cavendish Bananas. Workers on these plantations suffer terrible injustices. They are often on short-term contracts with low wages, long hours, and no benefits. There are many layers of sub-contractors to avoid labour laws and corporate responsibility (Ormiston, 2018). These are the same tactics that large companies use domestically in Japan to save money (Gordon 2017). There is harassment of union organizers and their families, murders of outspoken union members, and the burning down of union offices and workers' homes. Sumifru has recently refused to comply with orders from the Department of Labour to reinstate workers it had fired for striking. In 2017, the company refused to obey a Philippines Supreme Court order to recognize the workers' union (BananaLink 2019). There are also underage children working illegally on plantations and doing hazardous work (Ormiston, 2018).

This exploitation of workers and disregard for their basic safety is entrenched in the economic and legal system of the Philippines (Jansen & Nikol, 2020). The Philippines has much of its power concentrated in elite families whose rule extends back to the Spanish colonial era. This has led to corrupt authoritarian leadership and weak state institutions such as the courts and regulatory agencies (Jansen & Nikol, 2020). This allows an entrenched business class to extract the wealth of the country without adherence to laws or concern about penalties (Jansen & Nikol, 2020). Export banana production is thus jointly controlled by multinational corporations and local elites that operate much like cartels. While the court system acknowledges issues, it doesn't have the power to enforce changes (Jansen & Nikol, 2020). Some common solutions to the ethical issues of production are not very effective. For example, fair trade and organic designations are expensive for both the producers and the consumers and often only benefit the companies in-between, with none of the money reaching the plantation workers (Araki, 2007).

The continuation of this labour exploitation is ethically unsustainable, and workers

continue their fight for safe and fair working conditions.

Transportation

Bananas from the Philippines are shipped about 3000 km to Japan on cold storage vessels and kept at 13-14 °C during transportation (JBIA 2021). Based on an average of 8.4 gCO2/tonne-km for container shipping, the carbon footprint would be approximately 25,000 g/tonnes (ECTA 2011). Transportation contributes to the environmental impact of this commodity as more than half of a banana's carbon footprint is from the consumption of heavy fuel oil (Iriarte, 2014).
After clearing customs, bananas are kept in a warehouse under strict temperature and humidity controls where they are exposed to small amounts of ethylene to accelerate ripening. They are then distributed nationwide by truck.

According to The Japan Times (2019), Japan has one of the lowest food self-sufficiency rates among major world economies. In 2018, Japan's food self-sufficiency rate fell to a record low of 37 percent. This situation with food self-sufficiency necessitates importing food. Thus, the impact of importing bananas is no worse than most other food choices.

Distribution

Distribution and promotion

High-end supermarkets rarely sell bananas, but discount grocery stores prominently display large quantities of cheap bananas. Fruit in Japan tends to be quite expensive. Posh markets sell melons and bunches of grapes that can cost tens of dollars. These stores occasionally sell specialty bananas for high prices, but the bulk of bananas from the Philippines are sold at regular or discount supermarkets. In 2019, apples sold for an average of $6.10/kg, and oranges for $7.80/kg, so bananas at $2.90/kg are a good deal (JBIA 2019). They are also sold individually at convenience stores, making them easy to buy for people who work long hours and don't have time to cook.

The Japanese Banana Association is presently promoting bananas as a health, beauty, and diet food. Their website features recipes, dieting advice, and beauty tips in an effort to brand bananas as desirable, to women in particular. Many of the testimonials are about replacing whole meals with a banana.

Consumption

Question: Who are buying the bulk of bananas in Japan? Answer: The poor.

The rise of neoliberal labour policies and the widening wealth gap have increased food insecurity to the degree that many low-income households rely on the cheapest possible foods to survive (Abe, 2017). This includes bananas, the cheap price of which is due to the exploitive nature of their production Araki, 2007).

The people most affected by food insecurity tend to buy cheap convenient foods in small quantities. With the exception of bananas, fruit in Japan is considered a luxury food and beyond the means of many people. Bananas are comparatively cheap, easily found in small quantities (often even sold singly), filling, and convenient. About 80% of all bananas imported to Japan are from the Philippines and they are among the cheapest available produce (JBIA, 2021). According to the Japanese Banana Association (JBIA, 2021),

banana consumption is increasing as the price drops, and when consumers buy bananas, the low cost is their main consideration, far above other reasons like taste and nutrition. In 2017, ten percent of families with children in Tokyo reported that they are not able to buy enough food for financial reasons (Abe, 2017). The same survey found that between three to six percent of children were found to be eating vegetables, fish, or meat once per week or less. The situation now is even more dire. As many people are losing their financial security due to COVID, sales of bananas have further increased (Akama, 2021).). According to the largest food bank in Japan (Second Harvest Japan, 2021), the increase in non-contract workers and lack of government interest or support, is contributing to increased levels of malnutrition. The most affected by food insecurity in Japan are single-parent households (Kimura, 2018), of which 50.8% are living in poverty (Japanese Ministry of Health and Welfare, 2011).

Starting from the 1980s, job security in Japan has steadily decreased. There are two tiers of workers and the number of "non-regular workers" has increased from 15% in 1982 to about 40% now (Gordon, 2017) and in 2019, 56% of women workers were of the non-regular type (JILPT, 2017). Regular workers have lifetime employment contracts and seniority-oriented pay systems and hourly wages that average 60% more than non-regular workers. There is also a disparity in opportunities for advancement and skill development and a much higher probability of falling into poverty, especially for female workers (JILPT, 2017).

Another factor in the inability of low-income families to access adequate food is a culture of shame. Means testing for public assistance includes assessing the ability of relatives to provide help, as, under the Japanese social welfare system, they have a legal responsibility to do so (Sutton et al., 2014). There is also a reluctance to apply for support to which people are entitled due to the caseworkers' attitudes and infringements on privacy. Economic deprivation and lack of an accessible social safety net greatly affect the health of those in poverty (Kondo et al., 2008). With few affordable choices, the low cost and nutritional benefits of bananas make them an important daily food staple that many in poverty rely on (JBIA, 2021).

For a commodity like bananas, ethical issues on the production side are well documented and well known, but problems on the consumption side are less so. The present system forces the poor of one country to exploit the poor of another. If there were no issues with poverty and food insecurity of the consumption side, the production side would also benefit, as such consumers would have the luxury of paying fair prices and making ethical buying choices.

Waste

Most bananas sold in Japan are wrapped in thin plastic bags. According to the Japan Banana Importers Association (2021), this is for three reasons: to have a conveniently located bar code for tracking; to prominently display brand names and other information about the bananas; and "to keep them warm and protected because they come from a tropical country." According to local retailers that I spoke to, it is also because some customers don't want their produce directly touched by other people. These reasons are environmentally short-sighted and, when compared to how bananas are sold in other countries, obviously unnecessary. Banana peels are of course biodegradable and not

much of a waste concern, but the plastic packaging is collected as a recyclable material. Consumers in Japan carefully separate such plastics and dispose of them in a highly regulated manner. Despite this step, most soft plastics are then disposed of in the same way as the "combustible" category of waste from which it was separated, and then it is "thermal recycled" which involves burning the plastic and harnessing the heat as energy. This process is not considered recycling in other countries (Huma, 2019).

Figure 1. Pesticide Spraying

Figure 2. Bananas in a Vending Machine Individually wrapped in plastic

References

Academic & Peer-reviewed

Araki, H. (2007). Global commodity chain approach and geography. Jimburn Chiri/Human Geography, 59(2), 41-61. DOI: 10.4200/jjhg.59.2_151

Chiong-Javier, M. (2009). Health consequences of rural women's productive role in agriculture in the Philippines and other developing countries. Journal of International Women's Studies, 10(4).

Cortes-Maramba, N., Dioquino, C., Francisco-Rivera, A., Ho, H., Manglicmot-Yabes, A., Panganiban, L., & Suplido, M.L. (2004). Correlation between blood ethylenethiourea and thyroid gland disorders among banana plantation workers in the Philippines. Environmental Health Perspectives, 112(1), 42–45. https://doi.org/10.1289/ehp.6499

Gordon, A. (2017). New and enduring dual structures of employment in Japan: The rise of non-regular labor, 1980s–2010s, Social Science Japan Journal, 20(1), 9–36. https://doi.org/10.1093/ssjj/jyw042

Iriarte, A., Almeida, M., & Villalobos, P. (2014). Carbon footprint of premium quality export bananas: Case study in Ecuador, the world's largest exporter. The Science of the Total Environment, 472, 1082–1088. https://doi.org/10.1016/j.scitotenv.2013.11.072

Jansen, K., & Nikol, L. (2020). The politics of counter-expertise on aerial spraying: social movements denouncing pesticide risk governance in the Philippines. Journal of Contemporary Asia, 50(1), 99–124. https://doi.org/10.1080/00472336.2018.1551962

Kimura, A. (2018). Hungry in Japan: Food insecurity and ethical citizenship. The Journal of Asian Studies, 77(2), 475–493. https://doi.org/10.1017/S0021911818000037

Kondo, N., Kawachi, I., Subramanian, S., Takeda, Y., & Yamagata, Z. (2008). Do social comparisons explain the association between income inequality and health?: Relative deprivation and perceived health among male and female Japanese individuals. Social Science & Medicine, 67(6), 982–987. https://doi.org/10.1016/j.socscimed.2008.06.002

Ormiston, C. (2018). Holding transnational corporations to account in New Zealand for human rights abuses committed overseas. Canterbury Law Review, 24(Nov 2018), 137–170.

Sutton, E., Pemberton, S., Fahmy, E., & Tamiya, Y. (2014). Stigma, shame and the experience of poverty in Japan and the United Kingdom. Social Policy and Society, 13, 143-154.

Advocacy
BananaLink. (2019, July 8). Sumitomo sells its stake in Sumifru Philippines amid allegations of labour rights abuses. https://www.bananalink.org.uk/news/sumitomo-sells-its-stake-in-sumifru-philippines-amid-allegations-of-labour-rights-abuses/

Second Harvest Japan. (n.d.). Information about poverty in Japan. http://2hj.org/english/

Book
Koeppel, D. (2008). Banana: The fate of the fruit that changed the world. Plume.

Commercial Source
ECTA. (2011). Guidelines for measuring and managing CO2 emission from freight transport operations. https://www.ecta.com/resources/Documents/Best%20Practices%20Guidelines/guideline_for_measuring_and_managing_co2.pdf
Japan Banana Importers Association (JBIA). (n.d.). バナナ大学 - バナナの情報総合サイト. https://www.banana.co.jp/

Government
Japanese Ministry of Health and Welfare. (2011, July 12). Income per household. https://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa10/2-7.html

Japan Institute for Labour Policy and Training (JILPT). (2017). The work and lives of Japanese non-regular workers in the "mid-prime-age" bracket (age 35-44). https://www.jil.go.jp/english/lsj/detailed/2016-2017/chapter1.pdf

News
Abe, A. (2017, May 24). Social spotlight: School lunches and child poverty in Japan. The Mainichi. https://mainichi.jp/english/articles/20170524/p2a/00m/0na/009000c

Akama, K. (2021, February 6). Imports of bananas up, tapioca down as coronavirus sways trade in Japan. The Mainichi. https://mainichi.jp/english/articles/20210205/p2a/00m/0bu/018000c

Huma, K. (2019, January 10). The actual situation of Japan's "plastic waste recycling rate 84% that deviates from the world standard. Forbes Japan. https://forbesjapan.com/articles/detail/24796/1/1/1

The Japan Times (2019, August 6). Japan's food self-sufficiency rate hits lowest level in 25 years due to drop in wheat production. https://www.japantimes.co.jp/news/2019/08/06/national/japans-food-self-sufficiency-rate-hits-lowest-level-25-years-due-drop-wheat-production/

Figures
[A crop duster plane spraying pesticide over a banana plantation]. (n.d.) https://delmontebananas.weebly.com/working-conditions.html
[Nature's perfect package]. (n.d.) https://www.japantimes.co.jp/news/2016/03/26/business/japan-fruits-bow-top-banana/

View the full poster

To view Windholz's full poster, please visit the GENV website (https://globalencounters.wixsite.com/mysite).

From the roots I grow

Danielle Hope Edwards

I am from shea butter

From ginger and lemon

I am from the basement school room (quiet, cold, and with the smell of age-old paper)

I am from the maple tree, tiger lily, the dark brown earth that blends richly into my melanin

I am from cookouts and hearty laughs
from family and soul

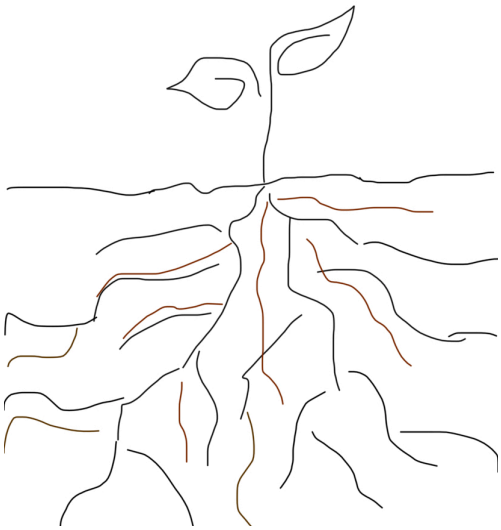
I am from the musically inclined
and the people-pleasers

From "I love you" and "don't be so sensitive"

I am from Pentecostal post-meal naps
and strength taught through prayers

I am from Havelock and the Edwards,

Fried yellow plantains and rice and peas with oxtail



From my Papa's [grandfather] immigration to Canada to be a carpenter,
from my mother's first published book

In the dining room behind the glass doors of the wooden cabinet, lay about a dozen full photo albums
and an old Bible with our ancestor's names as far back as we have access to.

I am from those memories

That I knew so well, but have forgotten over the years

The opportunities left in my hands to grow and live.

Addressing chronic malnutrition and food insecurity in Madagascar through cricket farming

Essi Amegbeto, Sara Din, Aria Goldin, and Sandra Masson

Abstract

Addressing the high rates of food insecurity and malnutrition in the Mahafaly region in Southern Madagascar has proven to be very challenging due to the region's harsh geographical setting, higher temperatures, and increased periods of drought caused by climate change. National governments and intergovernmental bodies have recently begun emphasizing the potential of insects to serve as an ecologically sustainable protein source to meet populations' nutritional needs. With many aspects of cricket farming especially applicable to the Mahafaly region, this policy brief presents two methods for advancing cricket consumption to address nutritional needs within the region.

Executive summary

This policy brief presents options to address high rates of food insecurity and malnutrition in the Mahafaly region in Southern Madagascar. By providing the means to secure nutrients/proteins currently lacking in the diets of these Malagasy populations, this brief presents potential avenues through which to decrease the harmful health effects of malnutrition and food insecurity experienced in the region (Neudert et al., 2015; Andriamparany et al., 2014).

Meeting nutritional needs has proved difficult due to the region's harsh geographical setting, higher temperatures, and increased periods of drought caused by global climate change (Andriamparany et al., 2014; Feldt et al., 2016; Fritz-Vietta et al., 2017; Neudert et al., 2015). In addition, climate change has deeply impacted crop and livestock production in the region (Andriamparany et al., 2014; Feldt et al., 2016; Fritz-Vietta et al., 2017; 2016; Neudert et al., 2015).

Further issues in meeting nutritional needs have been linked to the region's soil being incompatible with growing foods that contain necessary nutrients (Balasubramanian et al., 1995).

While policies have been implemented to address malnutrition and food insecurity, they have ultimately failed in their attempts. Recently, national governments and intergovernmental bodies have begun to recognize the potential of insects to serve as a protein source to meet populations' nutritional needs (Hanboonsong, Jamjanya & Durst, 2013; Hanboonsong & Durst, 2014; Halloran et al., 2017b). Insects provide protein rates comparable to some traditional livestock (Hanboonsong & Durst, 2014; Tao and Li, 2018). They have also been argued to serve as more "ecologically sustainable" protein sources, though there are disputes about the significance of these comparative

benefits (Itterbeek, 2019, p. 2; Halloran et al., 2017a; Lundy & Parrella, 2015). With many aspects of cricket farming especially applicable to the Mahafaly region, this policy brief will be centred on methods of advancing cricket consumption to address nutritional needs within the region.

The first method advances practicable technologies and government-led policy options designed for local-level implementation on small-scale farms in the Mahafaly region. According to relevant research, two main policy options are presented: dissemination programs to ensure local farmers may develop expert knowledge on cricket farming and the development of farmers' associations to allow for community-specific innovation and knowledge sharing. The second method presents a larger-scale approach for implementing cricket farming in various provinces across the country. The policy options for this method include: partnering with African Leaders for Nutrition (ALN) initiatives and ensuring substantial financing from aid programs and the national government. Ultimately, cricket farming presents an opportunity and solution through which to secure a substantial and sustainable protein solution for the Mahafaly region and, eventually, Madagascar.

Background

Geographical context

The Mahafaly Plateau is located within Atsimo Andrefana, a region located on the southwestern end of the island. The Mahafaly Plateau has a semi-arid and highly seasonal climate making it particularly vulnerable to climate change (Neudert et al., 2015). This has been a larger concern for farmers who comprise approximately 70% of the region's population, as even minor climatic changes can drastically affect crop yield and production (Dostie et al., 2002). With farmers heavily relying on crop yield to meet their family's needs, any loss in production makes this more difficult (FAO, 2019; Tao & Li, 2018). Furthermore, agriculture is an essential aspect of the country's economy, accounting for more than one-fourth of the country's GDP (Harvey et al., 2014). Agriculture in the region is highly dependent on rain due to the lack of alternative irrigation sources. Unfortunately, the increased variability of rainfall due to climate change is putting agriculture under increased stress (Neudert et al., 2015; FAO, 2021). This ultimately increases food insecurity and famine, specifically in Southern areas, including the Mahafaly region (Neudert et al., 2015).

Madagascar's history of political unrest conflated with rapid urbanization and unemployment further deepens economic distress and poverty, where as much as 39% of households in Mahafaly are deemed poor (Tao & Li, 2018; FAO, 2021; Neudert et al., 2015). Households also lack access to electricity and water supply systems and are frequently hit by cyclones (Neudert et al., 2015). Definitively, the Mahafaly region contends with various challenges that inhibit food security and nutrition for its population.

Sources regarding insect consumption utilized

This brief provides a thorough analysis of the efficacy of cricket farming, drawing upon literature relating to existing initiatives and credible research on the practices of insect farming. The research contributing to this brief is obtained from reputable sources such as the Food and Agriculture Organization (FAO) and various scientific journals, ensuring

accurate identification of the current socio-economic challenges faced in the Mahafaly region.

Previous and current policies and technological strategies

Current status of malnutrition and food insecurity

Low-income countries have a high prevalence of food insecurity, particularly Madagascar. Malnutrition and environmental degradation also pose significant challenges for these nations with over 800 million people suffering from malnourishment as of 2017 (Herrera et al., 2021). Madagascar shows many of these challenges being marked by health and economic inequality, severe weather patterns and unsustainable agricultural practices all of which have implications for the high levels of food insecurity within the country (Herrera et al., 2021). Currently, 53% of Malagasy people do not consume enough food needed to live a healthy lifestyle. Indeed, according to one study, only 20% or less of Malagasy children surveyed were found to have had access to food rich in vitamins and minerals (WPF and UNICEF, 2011, as cited in Tao & Li 2018). Untreated malnourishment can lead to many problems and its impacts infiltrate into all aspects of an individual's life.

According to the Food and Agriculture Organization (FAO), food scarcity is the leading cause of malnutrition (Rakotosamimanana et al., 2015). Food scarcity results from geographic inaccessibility, when food is not available, or from economic inaccessibility, when food is available but too expensive for the population to buy it (Rakotosamimanana et al., 2015).

Furthermore, according to Herrera et al. (2021), socioeconomic factors, such as variation in wealth and poor health and economic opportunities, are inextricably tied to food insecurity. Other factors include land tenure insecurity for women, despite their legal rights to own land and inaccessibility to education in rural communities (Widman, 2014; Herrera et al., 2021). Unsustainable farming practices, including slash and burn techniques and the use of fertilizers, also degrade the land and threaten many animal species (Herrera et al., 2021; Clark, 2012). Constant deforestation for new agriculture further degrades the ecosystem, with 50% to 90% of its forests now removed (Clark, 2012). Intensified agriculture declines soil health, leading to reduced crop yields (Herrera et al., 2021). Accordingly, extreme weather patterns also heavily impact food security (Herrera et al., 2021). More notably, the Kere, a recurrent famine causing catastrophic starvation, largely affects the regions in Madagascar's "deep south", including Androy and Atsimo-Andrefana (Ralaingita et al., 2022). While food insecurity and malnutrition are global issues, Madagascar, particularly its southern regions, has experienced heightened rates (Dostie et al., 2002). Despite Madagascar having abundant resources, they are not accessible to the lowest income households (Dostie et al., 2002).

Some of the main foods consumed in Madagascar are rice, vegetables, and tubers like cassava. They are consumed approximately 4 to 6 times a week, whereas proteins are only eaten 1 to 2 times a week (Tao & Li, 2018). Cassava, one of the most commonly consumed foods in the southern regions, is grown because it can tolerate infertile soils and low precipitation levels. During seasonal poverty, rice is replaced by cassava roots in poor rural households,

which worsens the nutritional situation (Rakotosamimanana et al., 2015; Neudert et al., 2015). Unfortunately, despite having a higher amount of carbohydrates, cassava and many of the other common roots incorporated in people's diets have a lower nutritional value, making it a major underlying cause of protein-energy malnutrition and food insecurity in the region (Neudert et al., 2015).

Current technological strategies

With malnutrition and food insecurity being such a pressing issue in Madagascar, particularly in southern regions such as Mahafaly, the government has made it a priority to implement policies and programmes to reduce its severity. Along with common interventions such as seasonal income transfers to poor households, seasonal food imports, and increasing agricultural productivity, one crucial policy measure was the creation of the government-run National Nutrition Programme (Weber, Galasso & Fernald, 2019). The article relates that approaches such as intensive counseling and strongly emphasized dietary diversity and the promotion and consumption of animal source foods, that were not part of the programme in Madagascar. The programme was designed in the late 1990s based on the best evidence available at the time and was centered on community-based, monthly growth-monitoring sessions and nutrition education, with the objective of reducing weight faltering but not length. The evidence on the effectiveness of these approaches in improving child nutrition is mixed. For example, evidence from other studies has demonstrated that the best outcomes for linear growth have involved intensive counseling and strongly emphasized dietary diversity and the promotion and consumption of animal source foods (Dewey & Adu-Afarwuah, 2008; Imdad, Yakoob, & Bhutta, 2011). This community-based program included monthly growth-monitoring sessions and nutrition education (Weber, Galasso & Fernald, 2019). Despite some improvements in the first phase, there was no evidence of impact in communities that joined during the second phase of programme expansion (Weber, Galasso & Fernald, 2019).

Other strategies to address the issue of malnutrition include the Community-Led Total Sanitation (CLTS) campaign for open defecation in the southern regions (Gaya et al., 2015). Open defecation along with poor sanitation is responsible for causing 90% of diarrheal disease cases, which directly influences the high rates of malnutrition (Gaya et al., 2015). However, due to restrictive cultural practices and social norms this campaign was unsuccessful in creating effective strategies to combat food insecurity and malnutrition (Gaya et al., 2015). A significant behavioral factor included people's preference for open defecation (Venkataramanan et al, 2018). The discussion about defecation is also still highly regarded as a private matter and the use of a shared latrine (Venkataramanan et al, 2018). Another study found that excreta management systems introduced in certain locations in Madagascar were met with cultural and behavioral barriers as there are certain taboos surrounding the storage of waste underground, where it could potentially contaminate the dead (Jewitt, 2011). Initiatives like those aforementioned are some of many aimed at addressing the identified issues, however, there is a need for a more effective and narrowed approach that will add to current strategies.

Insect/animal	Energy (kcal)	Protein (g)	Carbohydrate (g)	Fat (g)	Calcium (mg)	Iron (mg)
House cricket	134	12.9	8.1	5.5	76	9.5
Grasshopper	96	14.3	2.2	3.3	27.5	3
Silkworm pupae	127	12.2	4	7	42	1.8
Scarab beetle	98	13.4	7.9	1.4	23	6.4
Giant water bug	182	19.8	7.1	8.3	44	13.6
Beef (boiled)	218	27.6	0	12	11.4	3.5
Fish (boiled)	130	19.2	0	5.9	108.5	0.6
Eggs (boiled)	143	12.5	0.3	10.3	57	2.5

Table 1. Comparative nutritional rates of insects and traditionally consumed livestock. This table was produced by the Hanboonsong and Durst in 2014 (p. 29). It shows a comparison for commonly consumed animals in Laos. The unit of measurement is per 100g. From Hanboonsong, Y., & Durst, P.B.. (2014). Edible insects in Lao PDR: Building on tradition to enhance food security (Rep.). Food and Agriculture Organization of the United Nations (FAO).

Benefits of insect consumption and the potential of cricket farming

National governments, intergovernmental bodies, and academic researchers alike have begun to recognize and advocate for the potential of insect farming to serve as an approach through which to combat food insecurity and malnutrition (Hanboonsong, Jamjanya & Durst, 2013; Hanboonsong & Durst, 2014; Itterbeek et al., 2019; Halloran et al., 2017b). The FAO has stated, "there is good reason to believe that promoting insect consumption can help combat malnutrition [and] alleviate food insecurity" as it can "provide essential macronutrients and micronutrients that are frequently lacking in diets" (Hanboonsong & Durst, 2014, p. ix). Refer to Table 1 for an idea of the nutritional benefits of insect consumption in relation to other sources of protein.

Research specific to the Malagasy context establishes a strong cultural basis for advancing insect consumption in the Mahafaly region (Itterbeck et al., 2019; Weber, Galasso & Fernald, 2019). With many aspects of cricket farming especially suitable to the region, for instance, cricket's minimal risk to crops grown in Madagascar, this policy brief centers crickets as the primary insect through

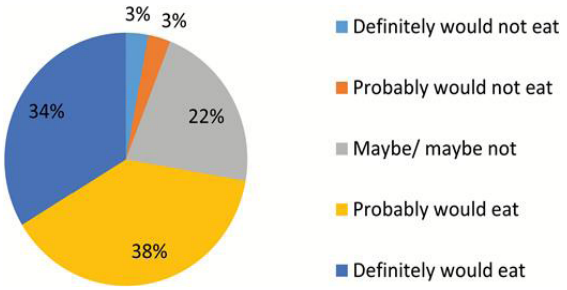


Figure 1. Future willingness to consume edible insects. This figure was produced by Tao and Li in 2018 (p. 23). From Tao, J., & Li, Y. O. (2018). Edible insects as a means to address global malnutrition and food insecurity issues. *Food Quality and Safety*, 2(1), 17-26.

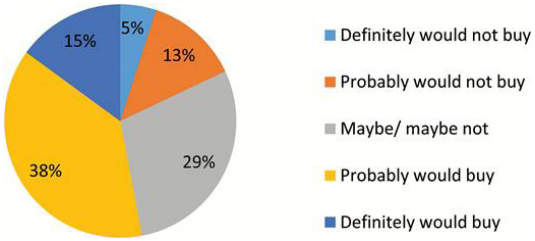


Figure 2. Future willingness to purchase edible insect products. This figure was produced by Tao and Li in 2018 (p. 23). From Tao, J., & Li, Y. O. (2018). Edible insects as a means to address global malnutrition and food insecurity issues. *Food Quality and Safety*, 2(1), 17-26.

which to address the unmet nutritional needs of the population (Itterbeek et al., 2019). Figure 1 and Figure 2 highlight the feasibility and efficacy of incorporating edible insects such as crickets, as it is demonstrated to be successful with acceptable willingness of the population (Tao and Li 2018).

Strategic approaches and policy options

Overview

This policy brief presents two strategic approaches and linked policy options to address malnutrition and food insecurity through cricket farming. While the strategic approaches and policy options have been selected with a consideration of their particular regional applicability and potential for success, it is acknowledged that other methods of implementation, which are outside the scope of this paper, might also hold significant promise. Option one presents technologies and policy options designed for local-level implementation on small-scale rural farms. Option two presents cricket farming implementation at a larger-scale approach through various provinces within the country.

The strategic approaches and policy options are evaluated in terms of the feasibility of their implementation, their ability to create direct nutritional benefits for rural

populations in the Mahafaly region, careful consideration of their associated risks and uncertainties, and their potential to address the root causes of malnutrition and food insecurity.

Strategic approach 1: Local level cricket farming for small scale farmers

The adoption of low-cost insect farming technology by small-scale farmers in rural regions has a record of success, with farmers in Laos and Thailand benefiting from implementation (Hanboonsong & Durst, 2014; Halloran et al., 2017b). Indeed, the FAO has described the breeding of crickets to be "particularly easy to manage, requir[ing] little time and ensur[ing] quick and prolific production" (Hanboonsong & Durst, 2014, p. 20). As such, there is reason to believe that cricket farming can be implemented by individual farmers in the Mahafaly region with relative ease and can potentially meet the protein needs of the region's population.

Structure

Cricket farming utilizes two primary structures: either concrete and cement tanks or wooden boxes (Hanboonsong & Durst, 2014; Halloran et al., 2017b). While both can sustain healthy environments, rearing crickets in wooden boxes has been linked with higher yields (Hanboonsong & Durst, 2014). According to a report by the FAO, the inside of the structures must include areas for crickets to hide and shed their skin, bedding for crickets to sleep in, and shallow water dishes for crickets to drink from without drowning (Hanboonsong & Durst, 2014). Bedding and hiding spots can be manufactured with materials such as cardboard, egg cartons, or rice husks as is visible in Figure 3 (Hanboonsong & Durst, 2014). Finally, to protect crickets from predators and to prevent escape, it is common practice to cover the structures with mosquito nets, securing them in place with a sticky material (Hanboonsong & Durst, 2014). A depiction is provided in Figure 4.

Figure 3. Inside of Concrete Cricket Farming Structure. This figure was produced by Hanboonsong and Durst in 2014 (p. 26). It shows egg cartons utilized for bedding along with hiding spots where crickets can take refuge and shed their skin. From Hanboonsong, Y., & Durst, P.B.. (2014). *Edible insects in Lao PDR: Building on tradition to enhance food security* (Rep.). Food and Agriculture Organization of the United Nations (FAO).

Figure 4. Protective Nets on Wooden Cricket Farming Structure. This figure was produced by Hanboonsong and Durst (2014 p. 26). The blue netting covering the cricket farming structures in the background serves as a crucial method to ensure that crickets are secured from predators and escape.

Procuring crickets

While farmers can purchase crickets from breeders, they may also collect them from surrounding environments (Hanboonsong & Durst, 2014; Halloran et al., 2017b). There are currently at least 11 species of wild crickets which are consumed in Madagascar and could be collected for farming purposes (Itterbeeck et al., 2019). However, for various reasons, including the desire to ensure that wild populations are not depleted, purchasing crickets from suppliers is regarded as a preferable method (Hanboonsong & Durst, 2014; Halloran et al., 2017b).

Labour input

Research states that small-scale cricket farming requires low-time investment (Hanboonsong & Durst, 2014; Halloran et al., 2017b). Additional labour time will be necessary during the initial construction of farming structures and during the breeding season (Hanboonsong & Durst, 2014). On average caring for crickets on a small-scale farm requires a commitment of approximately one hour a day (Hanboonsong & Durst, 2014). This time consists mainly of feeding the crickets; therefore additional time may need to be allocated for tasks such as purchasing feed and ensuring the cleanliness of the structures (Hanboonsong & Durst, 2014).

Feeding the crickets

Research establishes that crickets can be raised on certain types of food waste, including "a human refuse diet" consisting of food products such as rice, pasta, meat, and bread (Lundy & Parrella, 2017, p.8). Their diets can also be supplemented, for instance, with "cassava leaves [and] maize powder" (Hanboonsong & Durst, 2014, p.20). However, it is chicken feed that is most commonly used to fulfill cricket's dietary needs (Hanboonsong & Durst, 2014; Halloran et al., 2017a; Halloran et al., 2017b; Lundy & Parrella, 2017). In Thailand, where cricket farming has been adopted by many rural farmers, purchasing chicken feed has been described as expensive (Halloran et al., 2017b). However, the use of grain-based chicken feed remains dominant as it results in crickets with higher biomass, greater protein rates, and quicker maturation, allowing for more efficient production times (Halloran et al., 2017a; Lundy & Parella, 2017). As depicted below, crickets that were fed a diet of poultry feed consistently achieved higher

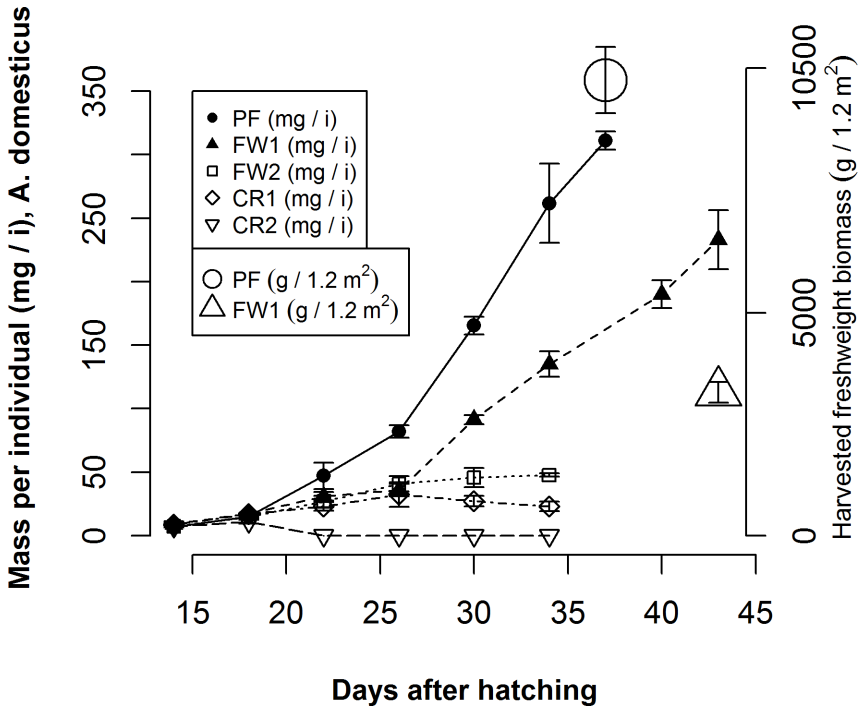


Figure 5. Biomass of Crickets Based on Feed Type. The graph was produced by Lundy and Parrella in 2015 (p. 6). Tracing the relationship between cricket biomass from the time of hatching and feed type, this graph illustrates that crickets reared on a diet of PF (Poultry Feed) resulted in the highest gains of biomass. The FW1 (Food Waste 1) diet, consisting of processed grocery store waste was associated with relatively positive biomass gains, while the remaining three feed types: FW2 (Food Waste 2), CR1 (Crop Residue 1), and CR2 (Crop Residue 2) resulted in negligible gains and a failure to reach harvestable size. From Lundy, M. E., & Parrella, M. P. (2015). Crickets are not a free lunch: Protein capture from scalable organic side-streams via high-density populations of acheta domesticus. PLOS ONE, 10(4).

biomass than those reared on alternative diets making the incorporation of alternative feed types unsuited for maximizing productivity and yield sizes (Lundy & Parella, 2017).

Preventing disease

One of the primary challenges faced by small-scale cricket farmers is the iridovirus disease (Halloran et al., 2017b). The disease occurs due to unsanitary habitat conditions and can render entire cricket yields unfit for consumption (Halloran et al., 2017b). It is possible to prevent the disease through routine cleaning of the cricket housing structures (Halloran et al., 2017b). Another common challenge relates to high levels of generational inbreeding among crickets (Hanboonsong & Durst, 2014; Halloran et al., 2017b). The failure to ensure genetic diversity can lead to cricket populations with health problems and declining productivity rates (Halloran et al., 2017b; Hanboonsong & Durst, 2014). To ensure that genetic

diversity is maintained farmers can engage in trading eggs amongst each other or regularly purchasing new cricket supplies (Hanboonsong & Durst, 2014; Halloran et al., 2017b).

Implication for policy: Importance of communicating standard breeding and rearing practices

It is evident that there are various imperative steps and practices that must be followed by cricket farmers to ensure a healthy and productive cricket population. It will be essential to consider practical, reliable methods, through which knowledge about rearing and breeding crickets can be transferred to local communities. With research demonstrating that educational support was directly linked to better outcomes, the importance of addressing this area of concern cannot be overstated (Halloran et al., 2017b).

Policy option 1: Information dissemination programs and advancing capacity

Collaboration within communities

To adequately support local level small-scale insect farming as a solution to malnutrition and food insecurity it will be necessary to establish information dissemination programs. This aims to provide local farmers with expert knowledge on cricket farming and foster the development of farmers' associations to allow for community-specific innovation and knowledge-sharing.

Information dissemination programs

Lack of knowledge about standard rearing and breeding practices can hinder the potential of cricket farming (Halloran et al., 2017b; Hanboonsong & Durst, 2014). Implementing government educational programs to communicate up-to-date cricket farming practices to local farmers can mitigate this challenge (Halloran et al., 2017b; Hanboonsong & Durst, 2014). Educational programs which provided farmers with training regarding both cricket farming and insect farming at large have already been met with successful outcomes in rural areas of developing nations (Halloran et al., 2017b; Hanboonsong & Durst, 2014).

Farmers assocations

The development of farmers associations will make it possible to counter potential concerns farmers may have in relation to the relatively top-down model of information dissemination stated above. Importantly, farmers' associations have also been shown to be beneficial in advancing local level innovation on cricket farms and in supporting knowledge sharing among farmers (Halloran et al., 2017b). While it will be important to advocate against the potential limitations of such groups, including potentially restrictive membership rules, fostering farmers associations will be key to ensuring local level community buy-in and commitment (Halloran et al., 2017b).

Disadvantages

A potential lack of public buy-in

Pursuit of local level cricket farming to address malnutrition and food insecurity was chosen in large part due to broad cultural acceptance of insect consumption (Itterbeeck et al., 2019; Weber, Galasso & Fernald 2019). However, an assumption is being made that recreational insect consumption will translate to a large-scale desire to adopt cricket farming technology. This is especially relevant when considering the social and cultural importance of traditional livestock such as cattle (Feldt et al., 2016; Neudert et al., 2015). While small-scale cricket farming is intended to supplement rather than replace traditional livestock, its implementation may nonetheless meet resistance.

Overreliance on information dissemination

The success of cricket farming as a reliable protein source depends on ensuring that breeding and rearing practices are communicated to local farmers. However, the remoteness of the region along with the lack of communication infrastructure makes the case that information dissemination may not occur as frequently or effectively as needed (Feldt et al., 2016; Neudert et al., 2015). Lack of communication on important matters such as preventing the spread of disease among insects and limiting inbreeding will therefore likely present challenges moving forward.

Currently limited as an ecologically-sustainable protein source

A root cause of malnutrition and food insecurity in the Mahafaly region is the prolonged dry season and increased temperature caused by global climate change (Andriamparany et al. 2014; Feldt et al., 2016; Fritz-Vietta et al., 2017; Neudert et al., 2015). While farming crickets utilizes fewer resources than traditional livestock making it more efficient, its high reliance on grain-based chicken feed makes cricket farming dependent on an ecologically destructive feed source (Halloran et al., 2017a; Lundy & Parrella, 2015). Studies have stated that unless farmers adopt alternative feed sources, which are currently associated with crickets having lower biomass and protein rates (see figure 5), cricket farming will not serve as a meaningful avenue through which to counteract climate change (Halloran et al., 2017a; Lundy & Parrella, 2015)

Advantages

Increased diversity and efficiency

Crickets utilize less feed and water compared to some traditional types of livestock (Lundy & Parrella, 2015). This is especially relevant with worsening periods of drought and increasing temperature expected to further hinder traditional sources of agriculture and livestock in the Mahafaly region (Andriamparany et al. 2014; Feldt et al., 2016; Fritz-Vietta et al., 2017; Neudert et al., 2015). Therefore, having access to an additional protein source, one which can be cultivated using fewer resources and can thus better contend with the expected limitations of climate change, presents a significant advantage.

Justifiable level of uncertainty

Predicting outcomes related to environmental systems poses significant challenges due to the complex interplay of various uncontrollable factors (Wynne, 1992). However, introducing cricket populations to local farms can be accounted for with a justifiable level of uncertainty for all the cricket species recorded in a recent study of edible insects in Madagascar were found to pose no threat to crops (Itterbeeck et al., 2019). To safeguard against potential changes in cricket behavior that perhaps may unexpectedly occur due to the introduction of new crops or the impacts of climate change, simple techniques such as utilizing mosquito nets to safely secure crickets in their enclosures can be emphasized.

Strategic approach 2: Large scale industrial cricket farming

Adopting a large-scale, regional industrial cricket farm in Madagascar highlights the feasibility and efficacy of incorporating edible insect flours from crickets, as it is "demonstrated to be successful with acceptable shelf stability and sensory characteristics" (Tao and Li, 2018). Moreover, large-scale industrial cricket farming in each of Madagascar's six provinces can help to address the entire population who are at risk of chronic malnutrition and food insecurity (Weber, Galasso and Fernald, 2019). In order to properly examine this strategic approach, understanding what a regional cricket farm will look like and consist of is of utmost importance.

Large-scale industrial cricket farming

Not only does large-scale industrial cricket farming influence those who suffer from food insecurity and chronic malnutrition to generate nutrition and food security, but it also provides a foundation for productive human capital. As seen in a study done in Thailand, it is clear that market opportunities, profitability, institutional support, contribution to livelihoods and food safety are connected to large-scale industrial cricket farming (Hanboonsong, Jamjanya & Durst, 2013).

Technological implementation

In order to reach Madagascar's six provinces – Antananarivo, Antsiranana, Fianarantsoa, Mahajanga, Toamasina, and Toilara – as seen in Figure 6, the technological implementation must be effectively outlined in terms of their capacities to reach populations and provide suitable incomes. The implementation of large-scale cricket farming must adequately reach all of the populations, where income generation is of the utmost importance. Although government officials must be in charge of where it can be placed, providing access to an improved income generation strategy through this program is proven to be efficacious.

Total costs for large-scale cricket farm implementation

A farmer in Loei Province with seven years of farming experience since 2001 determines the expenses for cricket production at high-scale farming. The costs of cricket production are notably smaller in comparison to cattle farming for example, which necessitates large and expensive equipment for farming. Instead, cricket farming, as displayed in 'Table 2', is cost effective and requires more basic materials such as egg cartons and cardboard boxes. Larger-scale cricket farming may

Figure 6. Map of Madagascar's six provinces. This figure was produced by World Atlas in 2021. From WorldAtlas. (2021, February 24). Madagascar Maps & Facts.

necessitate more equipment and thus, raise the expenses of cricket production, however, it is one of the most feasible mechanisms of production and labor output, as illustrated throughout this report. The same farmer mentioned above their net profits of large-scale cricket farming in Table 2. As seen in Table 3, with a total cost of $4682 US dollars for a single cricket farm over one harvesting cycle and a net profit of $66,000, the Madagascar government can expect to see a surplus of profits from one harvesting cycle. The introduction of 6 large-scale cricket farms to Madagascar's provinces will not only benefit the government but the people employed on these farms as well. However, it is important to understand the technological implications of wholesale cricket farming in Madagascar and the particulars of regional implementation.

Cricket breeding farm products

Below, Figure 7 examines the product and marketing networks for crickets in Thailand, however, extrapolated to Madagascar, this setup deems cricket farms as a source of human capital for Madagascar's poor. As Hanboonsong, Jamjanya & Durst (2013, p.12) state "the net profit for each harvesting cycle is about 50 percent of the gross income if farmers sell directly to wholesale buyers", there is an entrepreneurial aspect of introducing cricket farming to Madagascar's society. As there is a whole range of different consumer items that can be produced with crickets, this is a beneficial way to stir capital.

Government policymaker decisions

The government of Madagascar and its President, Andry Rajoelina, highlight "if people have severe malnutrition, it has an impact on their brains. That is why we need to work on grey matter infrastructure" (African Development Bank Group, 2019). With the start-up for six cricket farms in each of the country's six provinces, the government can then decide if they would like to scale up for more cricket farm implementations in some of the larger or smaller cities. However, it is important that the government incentivize these farms as the annual income for most of Madagascar's population does not reach the sufficient capital to start their own large-scale farms.

Expense items	Amount/ unit	THB/unit	Total cost/unit	Usable life (year)	Depreciation/ one harvesting cycle (THB)
Fixed costs					
Concrete block pen (size 2.2 x 4.8 x 0.6 m)	1	1 000	1 000	15	16
Cricket nursery/shed	1	70 000	7 000 (10 pens)	20	87.50
Variable costs					
Rearing materials					
Egg cartons	500	1	500	1	125
Plastic bowls for egg	35	10	350	2	43
Harvesting					
Food trays	16	10	160	2	20
Food grinding machine	1	4 500	4 500	10	112
Tape	1	28	28	1	7
Nylon net	1	250	250	5	12
Cricket eggs		50	1750	2	218
Miscellaneous costs					
Electricity, water, packing		500	50		50
Cricket feed	9	400	3 600		3 600
Labour	1	7.5 THB200/ 3hr/day used	337.50 (45 days)		337.5
Total cost					4 682
One pen can produce 100 kilograms of crickets; production cost = THB46/kg					

Note: Farmer can carry out four harvesting cycles/year.

Table 2. Total expenses for cricket production. This table was produced by Hanboonsong, Jamjanya and Durst in 2013. From Hanboonsong, Y., Jamjanya, T., & Durst, P. B. (2013). *Six-legged Livestock: Edible Insect Farming, Collection and Marketing in Thailand* (Rep.). This table exemplifies the total expenses for large-scale cricket production.

Sales	Total production (kg)	Sale price/ kg (THB)	Cost/kg (THB)	Gross income (THB)	Total cost (THB)	Net profit per one harvesting cycle (THB)
Wholesale	950	110	46	104 500	43 700	60 800
Retail	50	150	46	7 500	2 300	5 200
Total	**1 000**			**112 000**	**46 000**	**66 000**

Table 3. Net incomes and profits. This table was produced by Hanboonsong, Jamjanya and Durst in 2013. From Hanboonsong, Y., Jamjanya, T., & Durst, P. B. (2013). *Six-legged Livestock: Edible Insect Farming, Collection and Marketing in Thailand* (Rep.). This table helps to corroborate the total expenses and labor outputs associated with cricket farming at large-scale implementation.

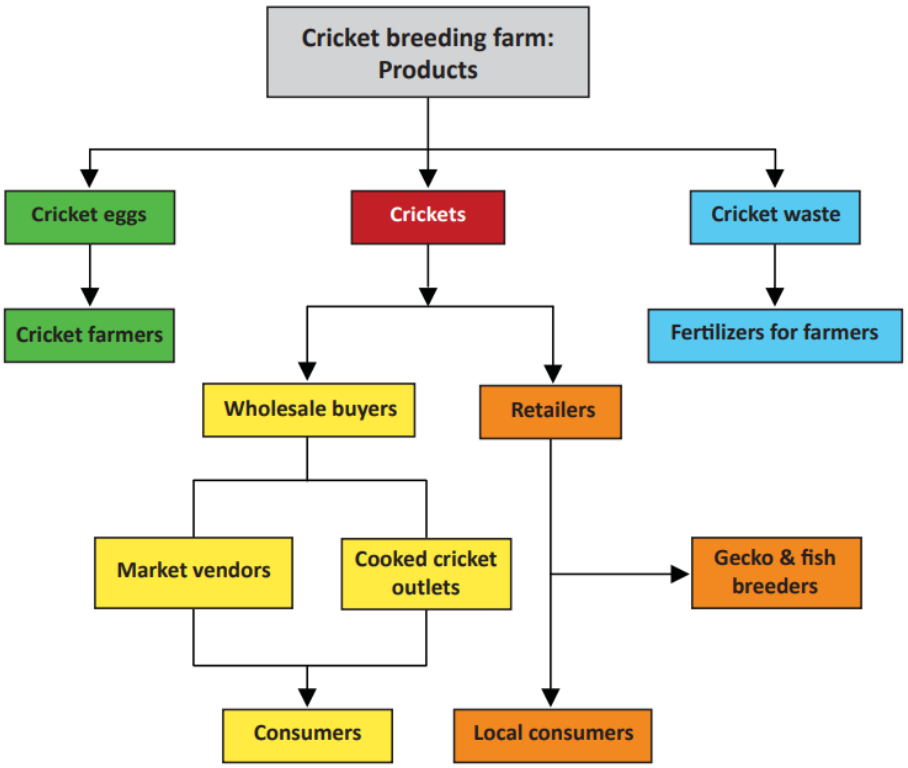


Figure 7. Large-scale cricket farming in each province of Madagascar. This figure was produced by Hanboonsong, Jamjanya and Durst in 2013. From Hanboonsong, Y., Jamjanya, T., & Durst, P. B. (2013). *Six-legged Livestock: Edible Insect Farming, Collection and Marketing in Thailand* (Rep.). Figure 7 displays items which are non-expensive and provide relative ease in terms of implementation. Moreover, farms can decrease production costs, especially for cricket feed, "by using the appropriate ratio of protein feed … to suit cricket growth development" (Hanboonsong, Jamjanya & Durst, 2013, p. 12). This diagram illustrates the working productions of a cricket breeding farm, determining the multi-dimensional ways that labor output can equate to more effective production costs. The many facets of cricket consumption can be seen from this chart, ranging outside of human consumption to fertilizers and gecko and fish breeders, for example.

Policy option 2: Regional approach

Address the African Leaders for Nutrition (ALN)

"The African Leaders for Nutrition initiative is a platform for high-level political engagement to advance nutrition in Africa" (AFDB, 2021). The ALN initiative aims to "generate innovative investments towards nutrition and food security that will build a foundation for productive human capital in Africa" (AFDB, 2021). Thus, the policy option is to build upon the ALN initiative to incentivize cricket farms with the Madagascar government to seek support under the larger umbrella of their program. We will address the ALN Champions, "compromising

Figure 8a. Display concrete cylinders

Figure 8b. Concrete blocks

Figure 8c. Plywood boxes

Figure 8d. Plastic drawers

Figure 8. What a large-scale cricket farm would look like. These images were used by Hanboonsong, Jamjanya and Durst in 2013. From Hanboonsong, Y., Jamjanya, T., & Durst, P. B. (2013). *Six-legged Livestock: Edible Insect Farming, Collection and Marketing in Thailand* (Rep.) The above photographs represent the necessary materials for large-scale cricket farming, and corroborate our findings regarding inexpensive infrastructure that lowers overall production costs.

current and former heads of state, finance ministers and eminent leaders with the power to catalyze and sustain high-level political leadership and commitment to end malnutrition in Africa" (AFDB, 2021).

Financing: World Bank with World Food Programme support and government

Co-financing through the national budget

To finance large-scale cricket farming implementation in all of Madagascar's six provinces we aim to assist in the representation of Madagascar's government on the international platform to approach the World Bank with the support of the World Food Programme. Co-finance from the World Bank through the national budget, will further fortify the strategy and increase the success rate of these projects. The finance products of the World bank targeted are the Investment Project Financing, which invests in activities that create the physical/social infrastructure necessary to reduce poverty and create sustainable development, and the Program-for-Results, which would help improve the implementation of our development programs (Financing, n.d.).

Advantages

Reduced environmental implications as compared with traditional livestock

Research establishes that insects, rich in proteins, vitamins, and minerals have greater efficiency and conversation ratios as compared with traditional livestock (Hanboonsong, Jamjanya & Durst, 2013; (Lundy & Parrella, 2015). In other words, they provide access to key nutrients with a reduced level of associated resource use and environmental impact. This is shown most starkly perhaps through comparison with the efficiency ratios of beef cattle, which are six times less efficient than insects (Hanboonsong, Jamjanya & Durst, 2013). Among other benefits, this can translate to a capacity for a reduction of carbon emissions (Hanboonsong, Jamjanya & Durst, 2013). It is important to note that the potential for meaningfully contributing to sustainable practices is hindered through the ongoing use of grain-based chicken feed, with grain production for animal consumption implicated in significant ecological costs (Lundy & Parrella, 2017). While the increase in scale required for large-scale cricket farming will require higher levels of electricity input due to the need for temperature regulation, such modifications allow for increased levels of efficiency, including maximizing production cycles and feed usage (Halloran et al., 2017a). Overall, even accounting for the limitations in regards to sustainability, the implementation of large-scale cricket farms in each of Madagascar's provinces, can be expected to increase access to protein sources with reduced environmental implications, in a manner that certainly would not be possible with the increase production of traditional livestock.

Foundation for productive human capital

As large-scale cricket farming, shown above, will build productive human capital and provide nutritional sources of protein for Madagascar, this is the grey-matter infrastructure required that the ALN initiative highlights. As cricket farming is not only a source of high protein for malnutrition and chronic food insecurity, but large-scale cricket

farming will also introduce an abundance of new jobs for Madagascar's citizens. Moreover, it will provide entrepreneurship for Madagascar's citizens, as there are many different types of cricket-based products that can be made from wholesale crickets and cricket powders. Madagascar's citizens can utilize their entrepreneurial spirit to incentivize new cricket-based products.

Disadvantages

Potential lack of maintenance during scaling-up

If program quality is not maintained during the scaling-up process for the establishment of large-scale industrial cricket farms it could lose its effectiveness. (Weber, Galasso and Fernald, 2019). Future programme expansion in Madagascar's six provinces without attention to quality can undermine programmatic effectiveness in the long run (Weber, Galasso and Fernald, 2019). If there is an insufficiently trained workforce and a low quality of training when implementing and maintaining cricket farms, it may result in a failed-scale-up effort with the ALN and co-financing partners.

Cyclones destroying infrastructure

Madagascar experiences an average of 1.5 cyclones yearly. Each strong cyclone can affect up to 700,000 of its citizens (OCHA, 2021). However, with the strength and intensity of these cyclones, large-scale cricket farms may be negatively hit. As there is no solution to combat the cyclones in Madagascar, it is an inherent disadvantage to the large-scale farms that may be at risk depending on the nature and force of the cyclones.

Conclusions and recommendations

It is recommended that small-scale, local-level cricket farming be implemented in the Mahafaly region due to the greater potential it holds in providing a reliable, accessible protein source and in allowing small-scale farmers to meet their own nutritional needs through climate change attuned diversification of livestock. As has been demonstrated, meeting the nutritional requirements of populations within the region has been significantly hindered as a result of implications of climate change which has hindered crop production due to increased periods of drought and rising temperatures (Andriamparany et al., 2014; Feldt et al., 2016; Fritz-Vietta et al., 2017; Neudert et al., 2015). Accordingly, a shift to consumption practices such as cricket farming, which can better contend with the impacts of climate change (e.g., require less water input) hold significant value, ensuring that even as traditional food sources become increasingly unreliable, a consistent source of nutrient and protein-rich food will nonetheless be available.

To successfully implement this approach it is recommended that governments establish information dissemination programs that not only communicate the benefits of cricket farming to the population but which also provide farmers with the foundation of knowledge necessary to productively rear crickets (Hanboonsong & Durst, 2014; Halloran 2017b). Oral transmission of knowledge is deeply relevant to cultures within the Mahafaly region, as such in-person training and communication are recommended (Fritz-Vietta et al., 2017). Additionally, governments should support the development of farmers' associations, crucial not only to ensuring that local farmers can build support networks within their remote

communities but also in ensuring that local level innovation specific to concerns of the region may be developed (Hanboonsong & Durst, 2014; Halloran 2017b). By focusing on in-community capacity development it will also become possible to advance the long-term viability of cricket farming in the region, ensuring that even with disruption of government support, local-level partnerships and cross-community knowledge sharing will be able to mitigate associated harms (Halloran et al., 2017b). Overall, small-scale cricket farming implemented in the Mahafaly region can be expected not only to combat chronic malnutrition and food insecurity, but it would do so positively by improving the long-term nutritional and socioeconomic prospects of the people in this region.

References

African Development Bank Group. (2019). African leaders for Nutrition Initiative. Retrieved from https://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/african-leaders-for-nut rition-initiative.

African Development Bank Group. (2019). 'African Development Bank Adesina invites Madagascar President Rajoelina to become a Nutrition Champion.' https://www.afdb.org/fr/news-and-events/african-development-bank-adesina-invites-mad agascar-president-rajoelina-become-nutrition-champion-24479.

Andriamparany, J. N., Brinkmann, K., Jeannoda, V., & Buerkert, A. (2014). Effects of socio-economic household characteristics on traditional knowledge and usage of wild yams and medicinal plants in the Mahafaly region of south-western Madagascar. Journal of Ethnobiology and Ethnomedicine, 10(1), 1-21.

Balasubramanian, V., Rabeson, R., Razafinjara, L., & Ratsimandresy, J. (1995, February). Rice soil constraints and fertility management in the highlands of Madagascar. In Fragile Lives in Fragile Ecosystems: Proceedings of the International Rice Research Conference (pp. 313-324). IRRI Los Baños, Philippines.

Clark, M. (2012). Deforestation in Madagascar: Consequences of population growth and unsustainable agricultural processes. Global Majority E-Journal, 3(1), 61-71.

Dostie, B., Haggblade, S., & Randriamamonjy, J. (2002). Seasonal poverty in Madagascar: Magnitude and solutions. Food Policy, 27(5-6), 493-518. doi:10.1016/s0306-9192(02)00063-5

Encyclopedia Britannica. (2021, March 10). Madagascar. Retrieved from https://www.britannica.com/place/Madagascar

Feldt, T., Neudert, R., Fust, P., & Schlecht, E. (2016). Reproductive and economic performance of local livestock in southwestern madagascar: Potentials and constraints of a highly extensive system. Agricultural Systems, 149, 54-64. doi:10.1016/j.agsy.2016.08.007

Financing: World Bank with World Food Programme Support and Government Co-Financing Through the National Budget (n.d.). World Bank. https://www.worldbank.org/en/what-we-do/

products-and-services/financing-instruments

Food and Agriculture Organization (FAO). (2019). Impact of Early Warning Early Action (Rep.). Retrieved http://www.fao.org/3/ca3933en/ca3933en.pdf

Food and Agriculture Organization (FAO). (2021). Madagascar. Retrieved from http://www.fao.org/emergencies/countries/detail/en/c/161541

Fritz-Vietta, N. V., Tahirindraza, H. S., & Stoll-Kleemann, S. (2017). Local people's knowledge with regard to land use activities in southwest Madagascar – conceptual insights for sustainable land management. Journal of Environmental Management, 199, 126-138. doi:10.1016/j.jenvman.2017.05.034

Gaya, S., Balfour, N., & Thomas, A. (2015, October). Using Social Norms Theory to Strengthen CLTS in Southern Madagascar (Rep.). Retrieved https://www.pseau.org/outils/ouvrages/unicef_unicef_using_social_norms_theory_to_stre ngthen_clts_in_southern_madagascar_2015.pdf

Halloran, A., Hanboonsong, Y., Roos, N., & Bruun, S. (2017a). Life cycle assessment of cricket farming in North-eastern Thailand. Journal of Cleaner Production, 156, 83-94. doi:10.1016/j.jclepro.2017.04.017

Halloran, A., Roos, N., & Hanboonsong, Y. (2017b). Cricket farming as a LIVELIHOOD strategy in Thailand. The Geographical Journal, 183(1), 112-124. doi:10.1111/geoj.12184

Hanboonsong, Y., Jamjanya, T., & Durst, P. B. (2013). Six-legged Livestock: Edible Insect Farming, Collection and Marketing in Thailand (Rep.). Retrieved http://www.fao.org/3/i3246e/i3246e.pdf?fbclid=IwAR1ut8qhURAvU2v8aJQ3jh9LdcEcmpxnLc0ObpZs05Zu71jYaia1N_j_7Rg

Hanboonsong, Y., & Durst, P.B.. (2014). Edible insects in Lao PDR: Building on tradition to enhance food security (Rep.). Food and Agriculture Organization of the United Nations (FAO).

Harvey, C. A., Rakotobe, Z. L., Rao, N. S., Dave, R., Razafimahatratra, H., Rabarijohn, R. H., . . . MacKinnon, J. L. (2014). Extreme vulnerability of smallholder farmers to AGRICULTURAL risks and climate change in Madagascar. Philosophical Transactions of the Royal Society B: Biological Sciences, 369(1639), 20130089. doi:10.1098/rstb.2013.0089

Herrera, J. P., Rabezara, J. Y., Ravelomanantsoa, N. A. F., Metz, M., France, C., Owens, A., ... & Kramer, R. A. (2021). Food insecurity related to agricultural practices and household characteristics in rural communities of northeast Madagascar. Food security, 13(6), 1393-1405.

Jewitt, S. (2011). Geographies of shit: Spatial and temporal variations in attitudes towards human waste. Progress in Human Geography, 35(5), 608-626.

Lundy, M. E., & Parrella, M. P. (2015). Crickets are not a free lunch: Protein capture from scalable organic side-streams via high-density populations of acheta domesticus. PLOS ONE, 10(4). doi:10.1371/journal.pone.0118785

Neudert, R., Goetter, J. F., Andriamparany, J. N., & Rakotoarisoa, M. (2015). Income diversification, wealth, education and well-being in rural south-western Madagascar: Results from the Mahafaly Region. Development Southern Africa, 32(6), 758-784. doi:10.1080/0376835x.2015.1063982

Ralaingita, M., Ennis, G., Russell-Smith, J., Sangha, K., & Razanakoto, T. (2022). The Kere of Madagascar: a qualitative exploration of community experiences and perspectives. Ecology and Society, 27(1).

Ramaroson Rakotosamimanana, V., Valentin, D., & Arvisenet, G. (2015). How to use local resources to fight malnutrition in Madagascar? A study combining a survey and a consumer test. Appetite, 95, 533-543. doi:10.1016/j.appet.2015.08.011

Tao, J., & Li, Y. O. (2018). Edible insects as a means to address global malnutrition and food insecurity issues. Food Quality and Safety, 2(1), 17-26.

United Nations Office for the Coordination of Humanitarian Affairs (OCHA). (2019, May 29). Madagascar. Retrieved April 18, 2021, from https://www.unocha.org/southern-and-eastern-africa-rosea/madagascar?fbclid=IwAR1rN

Van Itterbeeck, J., Rakotomalala Andrianavalona, I. N., Rajemison, F. I., Rakotondrasoa, J. F., Ralantoarinaivo, V. R., Hugel, S., & Fisher, B. L. (2019). Diversity and use of Edible Grasshoppers, Locusts, crickets, and Katydids (Orthoptera) in Madagascar. Foods, 8(12),

666. doi:10.3390/foods8120666

Venkataramanan, V., Crocker, J., Karon, A., & Bartram, J. (2018). Community-led total sanitation: a mixed-methods systematic review of evidence and its quality. Environmental health perspectives, 126(2), 026001.

Weber, A. M., Galasso, E., & Fernald, L. C. (2019). Perils of scaling up: Effects of expanding a nutrition programme in Madagascar. Maternal & Child Nutrition, 15. doi:10.1111/mcn.12715

WorldAtlas. (2021, February 24). Madagascar Maps & Facts. Retrieved April 18, 2021, from https://www.worldatlas.com/maps/madagascar?fbclid=IwAR0AVkaJjjcVjyU2xkdkQUj0zTt-QaOrkCESspa_ax9NcRoNquaaaT97Srw

Widman, M. (2014). Land tenure insecurity and formalizing land rights in Madagascar: A gender perspective on the certification program. Feminist Economics, 20(1), 130-154.

Wynne, B. (1992). Uncertainty and environmental learning: reconceiving science and policy in the preventive paradigm. Global environmental change, 2(2), 111-127.

Queen's Chinese students' experiences of the pandemic's first year: A mid-summer 2021 discussion

Y. Kou, Shield Zhao, X. Chen, Rosella Meng, and Jennifer Ruth Hosek

Abstract

Our contribution furthers understandings of the Covid-19 pandemic in two ways. First, this discussion with four Queen's students helps give voice to a large demographic of people who are experiencing an uptick in racialized violence, in Canada and in most countries outside of Asia. Second, it offers first-hand, experiential and analytic insights on our "war against the virus" from young people whose points of view are profoundly shaped by their relationships to China as well as Canada. Several leitmotifs thread through the conversation as we engage topics ranging from unexcused class absences because of voluntary self-isolation, to the Queen's "student ghetto" Corona party, and travelling food bloggers in Wuhan. These motivs include definitions of liberty, community, and selfhood; volunteerism and everyday heroes; the influence of governmental, societal and economic structures, STEM education, and media messaging on pandemic response; national and local pride; the politicization of public and private health care; and questions around freedom of expression and action.

Introduction

Despite popular insistence that "we're all in this together," Queen's community members continue to live the pandemic very differently. For instance, while most students make their primary homes in Canada, for others, heart home is abroad.

As campus closed in early 2020, many international students first balanced in limbo, then eventually undertook challenging travel to their countries, neighborhoods, and families. Their experiences and assessments of the pandemic are often quite different from those of their Canada-based peers.

This curated "snapshot" of a long virtual discussion on July 7, 2021 between several Chinese and Chinese-Canadian students and their professor enriches understandings of the pandemic. With it, we, the discussants, hope to further recognition of and openness towards each other's unique circumstances and the insights that they engender. At this time when zenophobia and hatred are impeding our global ability to best the virus, listening to each other is particularly important.

Jennifer Ruth Hosek (JRH) – Languages, Literatures, and Cultures Professor
Y. Kou (YK) – fourth-year Politics major
Shield Zhao (SZ) – third-year Linguistics major
X. Chen (XC)– 2021 Queen's graduate in Physics
Rosella Meng (RM)– third-year biochemistry major

JRH Hi, Y. We are the first people here on-line. How are you?

YK Great. I have a part-time job in the Department of Media Relations in a bank in Guangxi province in Guilin City. My parents are in Wuhan.

JRH You're going into work physically?

YK Yes. Few jobs need to be done remotely now. Everything is back to normal, so you do everything as before. You go to karaoke with friends and to the bar with your colleagues. Inside.

JRH Wow. How much of that is due to vaccination?

YK China has focussed on vaccinating as fast as possible. Because there are 1.4 billion people, it is still taking a long time, but we produce our own vaccines, so we don't have shortages. If you want to get it, you just go line up. There aren't any age limitations except for infants now. The vaccines have tested safe for the elderly. We do not separate by age because Covid rates are now very low, so it's not a question of individual safety in the same way as in other parts of the world. We are continuing to research new candidates simultaneously, including mRNA, to optimize the vaccines for different people.

JRH It's interesting that Chinese labs are now working on mRNA. Western media outlets emphasize that efficacies of the current Chinese vaccine candidates are not as high as those of the Western mRNA vaccine candidates. On the other hand, Sinovac and Sinopharm jabs were approved before the variants emerged and were available much sooner and to more people in more countries. The idea was to use existing technology and move quickly to eradicate the virus before variants of concern spread. Unfortunately, humans have lost that round to the virus; as an international community we were too slow.

Hi, Shield! How are you?

SZ Hi. I'm doing great. I'm in Datong City in Shanxi province north of Beijing. Nobody in the province has Covid right now. We are no longer wearing masks except in some public facilities like hospitals and museums.

JRH Hi, how are you?

XC Hi, Dr J. It's been a long time. I'm in Xi'an, a city of about a million people near the place of the terracotta warriors in the middle of China. Besides wearing masks and using sanitisers, everything is normal. There are zero cases in my city.

JRH It's very different here! Canada can't produce vaccine and we have been waiting for deliveries from abroad. My friend got married yesterday, actually, and it was live streamed. Only a very small, masked-up group could be inside the church.

Well, let's start our discussion session by introducing ourselves.

I am Professor Jennifer Hosek and I have taught and learned with each of you during Queen's remote semesters.

XC My name is X. Chen. I was born and raised in China. I came to Queen's to enlarge my skill set and enrich my experiences, for instance by meeting people from different backgrounds. I majored in physics.

SZ My name is Shield. I'm a third-year international student from China, majoring in linguistics. I was born and raised in a small northern city close to Beijing. I stayed in Canada for the last year and a half when the pandemic was spreading globally. It wasn't until two months ago that I finally got back to China.

YK My name is Y. Kou. I was born and raised in Wuhan. I went to Queen's because my parents did not want me to undergo the intensely competitive Chinese university entrance exams.

So, I went to Canada when I was 16, entered 10th grade, and mostly stayed in Canada except for vacations. I am studying political science and I want to become a public servant in China.

RM Hi everyone! My name is Rosella and I am going into my third year of a biochemistry specialization this September. I was born in Yantai, China and moved to Canada when I was five. I live with my parents and sister in the Greater Toronto Area. After graduation, I plan to pursue a PhD in biochemistry, focussing on research or pharmaceuticals. I would like to go back to China someday.

JRH What were your initial experiences of the pandemic as students who were in Kingston when the pandemic started?

YK When I was in Kingston, I felt that Canadians did not care that much about Covid. I still remember that there was a "Corona party" held in Queen's.

I dared not tell others that I come from Wuhan because a lot of the Canadians, including the Queen's students, became more biased against Chinese. Sometimes I was afraid they would see me as a carrier.

I went back to China in June. The Covid situation was already very serious in Canada, but still many people weren't wearing masks. In September or October, I saw on the

YK (cont) news that the Covid rates in Canada were increasing by 3,000 to 5,000 every day. To be honest, I was really not surprised, because I had seen people's attitudes towards such a serious and dangerous thing.

XC Several days before my flight from China for the start of the semester, I had seen the news about confirmed cases in China. I was very worried about myself and about infecting other people, so I started to self-quarantine at Queen's. Happily, I got some support. International students and also students of Chinese background delivered fruit to my door so that I did not feel so alone. I was really grateful because during that period, I was totally crazy with panic. It's really hard to tell you about these feelings, but that was my experience.

Also, when I told my instructor why I couldn't attend lecture, he was confused. A couple of weeks later, though, he told me, "You were right." It took a long time for people here to be aware of the severity of Covid, which had really negative impacts on travellers and international students.

SZ Despite the general lag time in Canada, I think that the government did pretty well with the lockdown. It started a little late, near March of 2020 after the first death in Ontario, but it still helped curb the spread.

Canada could have done better at mask mandates. Wearing masks is not just about protecting yourself. Asymptomatic people can be carrying the virus. Wearing a mask is protecting others, especially the weakest.

RM I don't think the Canadian government took the virus very seriously at first. I think they underestimated the virus' transmission capability and believed China's initial difficulty with handling a novel virus to be a result of China's status as a developing and non-western country. During the lockdown, many Canadians were worried about their livelihoods, although some financial assistance programs were being put into place. Quarantine after travel was not enforced well. The news reported on people exiting their hotel room and walking around the city. Also, people protested on the street, saying that the measures infringed upon their personal freedoms. Such actions are highly irresponsible as by disregarding the hygiene regulations, people were exposing many others to risk.

YK Unlike Shield, what disappointed me the most was the lockdown. It was not effective. If it had been, Ontario would not still have 200 cases right now.

Furthermore, Canadian officials were not responsible to the people. Indeed, the Ontario Minister of Finance secretly went travelling during lockdown!

YK (cont) In Canada, the only form of punishment seems to be through the ballot box. But that's not a very strong punishment. If that had happened in China, the Minister would have been sent to jail.

The Canadian government has not done very well by the Canadian people either in making policies or in mobilising resources. Maybe I say this because I am from Wuhan. All my parents and friends experienced strict quarantine and now we are benefitting from it.

In contrast, nearly one and a half years later after Covid began in Canada there are 300,000 cases currently. There are only about 30 million people! This is an unbelievable percentage. It's irresponsible.

XC Canada's current hotel quarantine is three days, followed up by home quarantine. A three-day quarantine is not compatible with the virus variant's 20-day latency. Also, people, for instance international students, should be helped to find a safe place for self-quarantine, which also would help ensure the safety of Canada's own citizens.

YK I'm not sure if you all are reading the domestic news in China, but I have noticed a very interesting policy shift. In 2019, the government started to encourage private hospitals, but now, it is again encouraging publicly funded ones in order to successfully confront this new situation.

In comparison, in Canada, the government is finding it hard to get for-profit entities to join the war against the virus. Also, the C$3,000 hotel quarantine simply reflects PCR test turnaround time and stay-at-home quarantine is not policed. What is the point? The entire Canadian government is acting irresponsibly.

I still remember when Pierre Trudeau "suggested" on Twitter that everyone stay at home and self-quarantine. Suggest means that it's not enforced. Faced with the Canadian sense of personal freedom, the government really can't do much.

JRH Analysists have been talking about a new Cold War between China and Western nations. Meanwhile, in China itself, patriotism and popular support for the government and the Party is up. What are your opinions about national and local responses to Covid? What did the government do well and what could they have done better?

SZ The Chinese government did well with instructions about hygiene measures. They reported on local infection rates and on where the infected people had been. There was systematic testing. My father got tested every day for three months when he went to work until there were absolutely no cases in my province. The testing policy was for everyone. Every person who wanted to enter a building or public transport got tested. If you tested negative, you could enter.

XC China acted quickly. The information related to Covid is very transparent and real-time. Everything is well-ordered. For example, I went to the hospital, and the fever department is separate from the normal one and every medical worker was protected with PPE.

Before I left Canada, in the clinic, they didn't separate the fever patients from the normal ones. Not everyone wore a mask; you could not avoid contact. I was confused because it was so inefficient.

JRH To your point about public health measures, my research on covid and Cuba has shirred my frustration with North America and Europe. From very early on, the Cuban health service issued science-based instructions through the media about how to make masks at home and mask-wearing was mandated.

But what about the argument that the Chinese pandemic response crushed individuals? Everybody had to stay at home no matter how hard it was. People with domestic abuse problems, people with mental health issues, it just didn't matter, they had to stay home. Critics might say that that was an abridgment of human rights, of civil rights, that it's government overreach.

YK Well, we are in a war against the virus. China made some mistakes in the beginning. At first, in my hometown of Wuhan, the government was too relaxed and slow-moving. Of course, it was a totally new disease, but that is why the situation in Wuhan become that serious.

But after that, we got immense support. First, in terms of medical services, in two weeks, two fully equipped hospitals were built. Doctors from other provinces came as volunteers, giving up their spring festival to help

Second, as you know, Wuhan was in a total lockdown. China's very robust delivery network was mobilized to provide people all their necessities.

Third, in Wuhan all manufacturing was stopped except for the mask factories so that workers could stay home. Food, medical equipment, and other essentials were sold and donated to Wuhan from other provinces. Many drivers volunteered to bring them.

Fourth, government officials and Party members helped because it was an emergency. They had front-line tasks, along with the medical personnel. As leaders, they were expected to stay in the city, no matter how dangerous. They were not volunteers, rather, they were doing their sworn duty.

SZ I want to add something to Y.'s comments about what the Party members did during the pandemic. I would like to say it's something based in our culture. We need to take care of each other.

SZ (cont) My father is not a party member, but he went back to the university to comfort and relocate the students. Many volunteers—including students—helped in other ways. And, when they need it, others will help them back. I think that such actions show a very high sense of responsibility, a strong connection.

And collaboration. As X. is saying, it's not only the government and Party. Many in the community wanted to help.

XC Yes, I think that for most of the young people in China, when facing the virus, we think that we are all ordinary. I have two friends who participated in epidemic control in the outbreak. they were responsible for a transportation junction. Their work included maintaining order and checking the potentially infected. In that period, PPE was in short supply and the tracing system was less developed. Everything needed to be done manually and they were at high risk of exposure to the virus. It is hard to express my feelings, as those with whom I had played before were now facing an unknown virus. I was scared that I would lose healthy friends and we would never see each other again. But they all comforted me "We are strong to protect people like you. The epidemic must end."

Many people in China did what they could do against the epidemic. Donating masks, foods, and goods for the frontline people, free delivery for those who cannot travel, these are common things in China. Some people may fight the virus for honour, however, for most, especially the young, it's just the hustle in their veins. Even as a native Chinese, I cannot understand many things that happened in Covid. I was just moved and cheered by such people. The Chinese government's action has been effective to control the virus spread in China, but the action of the public has been more indispensable.

Actually, I'd like to talk about medical resources and technology.

It surprised me that some rich countries did not have enough infrastructure to confront the pandemic. For instance, an analysis of Covid spread in Italy showed weaknesses in Italy's medical system. Its public health care system has been underfunded in the last decades. At the beginning of the pandemic, there were insufficient PCR tests everywhere. In China, we used CT scanning instead in order to see lung abnormalities. But Italy lacked basic medical infrastructure and couldn't even do CT scanning. They also did not have enough medical personnel. Actually, as you probably know Dr. J, many Cuban doctors came to Lombardy to help. Especially considering China's large population, China did really well in terms of medical infrastructure and access to care. In fact, in access to care, China is second in the world behind Switzerland.

Also, China uses technology to combat the virus. In Guangzhou, unmanned automatic delivery cars are being used to reduce the chance of infection. An unmanned automatic vaccination machine is in development.

JRH Interesting. Is there vaccine hesitancy in China? That personal touch when administering jabs calms a lot of nervous people.

SZ About encouraging vaccine, I heard that in Shanghai, if people get vaccine, they get a free Disney ticket. About smiling doctors and nurses; they're not really smiling. They have been there all day, vaccinating people, so they are pretty tired.

XC I'm really fascinated by the automatic vaccine machine because I'm a tech person. And, I agree with Shield, it would be a release for the medical staff. They're really tired.

The acceptance of this machine is another question, but if an epidemic is severe enough, it may be welcomed.

YK About vaccine hesitancy. I just checked. According to the People's Daily, as of September 11, 2021, the day before yesterday, more than 1.1 billion people were vaccinated in China.

When the vaccine came out in January or February, the universities asked the students get vaccinated. Many of my friends weren't so much hesitant, rather they thought vaccine unnecessary because there hadn't been any cases in Wuhan since the previous June. But then there were educational campaigns. I still remember walking out of the gate of my community and a person standing there suggesting to me that I go get vaccinated because there was a lot of vaccine available. That made me realise that the propaganda was about not only about my own health but about everyone's health. Also, who knew what the future would bring?

JRH What differences do you see between Canada's and China's responses and why?

XC China provides a 50-page digital booklet. It is far more detailed than what I have found on Canadian websites.

Why? Well, we got a lesson from SARS. We lost a lot of life 2002-2003.

SZ I agree with X. about the instructions and information. Some people hesitated before taking the vaccine. But the medical institutions responded to fears, for instance by explaining who might be allergic and what you should do or shouldn't do during, before, or after taking vaccine.

RM I have spoken to my family members in many areas of China--Shandong, Shaanxi, and Gansu and Hubei--about it[1]. Once the government realized the severity of this novel virus, it responded quickly and seriously. Patrols made sure people adhered to lockdown and government workers delivered food. Some people grew vegetables on the roofs of their apartment buildings (Takeuchi, 2020). Methods of detection and isolation were tailored to the circumstances.

RM (cont) In the cities, everyone has a phone app that shows their health status. This is very useful for contact tracing and determining which areas need to be sealed off when a case is discovered. For example, the app will display a green colour if a person is healthy but if this person has been in an area that has cases or is high-risk, the colour will change. If it changes to red, this person will not be allowed to enter some places. The government says that this information is securely held and used only for health purposes, although average people cannot know whether this is true. Quarantine policy is dependent on the risk level. After going to high-risk provinces for business, my uncle was required by the app to quarantine in a hotel. Later, when he was travelling in the province where he is living, he quarantined at home.

In the countryside, government workers visit homes. They test for Covid, check temperatures, see if people are displaying symptoms, inform residents about precautions, and encourage them to get vaccinated. News travels more slowly in the countryside. Most people have phones. However, people tend to be older and may not know how to use apps. People are often not as educated and so may not take a scientific approach to the virus; thus, the education these government workers provide is extremely important.

The isolation system measures depend on probability of transmission. When risk is high, if even a few cases are discovered, a neighbourhood will be sealed, and everyone will get tested. In my aunt's family's house in the countryside in Hubei, they put up a row of colourful little flags to signify that someone in their house is isolating. People must go to hospital if they have symptoms; this is to prevent people from staying home and potentially infecting family members. It is more secure to quarantine in a hospital. This also speaks to the ability of hospitals to handle Covid patients.

People took the virus very seriously from very early on. They did not politicize it. They understood that if they broke the rules it could result in someone else becoming ill. That is not to say that everyone was happy with lockdown, there were even protests.

---

[1]RM: My statements are informed by extensive discussions with five family members from June to mid-August, all of whom live in cities of three to more than eight million in China including Yantai in Shandong, Xi'an in Shaanxi, Lanzhou in Gansu, and a city close to Wuhan in Hubei; all of these places except for Hubei are in northern China. Some of them come from the countryside or have family who live in the countryside. These interlocuters all have a university or college education and range from late twenties to mid-fifties in age and are all professionals. In my responses, I have highlighted instances in which my interlocutors' experiences differed. While this sampling is not representative and data saturation was not reached, it is notable that many of the reported experiences were similar, the varied positionalities of my interlocutors notwithstanding. I believe that these first-hand, real-time reports from interlocutors with whom I have relationships of long-standing trust and respect offer unique, reliable, and invaluable on-the-ground information.

RM (cont) But health officials did a lot of educational outreach to help people understand how be responsible citizens.

Some people were hesitant about getting vaccinated, especially where there was basically no Covid. However, whenever an area experiences a rise in cases, there are lines of people scrambling to get vaccinated. It is mandatory to be vaccinated to attend school. Companies also encourage their employees to get the shots.

The Chinese public respects the medical workers. I follow a group of travelling food bloggers called Daoyueshe (盗月社). They visited and filmed different parts of Wuhan in 2020, including wall murals dedicated to the people who aided in the anti-pandemic efforts (盗月社食遇记-Chinese Food Discover, 2020). One mural depicts two doctors, Zhong Nanshan and Li Lanjuan, who came to Wuhan with their own teams to help out. Zhong Nanshan was crucial in identifying the new virus. The mural reads "The pandemic is a battlefield" and incorporates Zhong Nanshan's quote, "The people of Wuhan are a heroic people." This is a stark contrast with news I saw last year of lockdown protesters in their cars facing down medical workers.

YK In response to X.'s statement, in fact, Canada was heavily impacted by SARS and its government reacted very quickly. But this experience has not helped Canada deal effectively with Covid. Why?

I think one reason is de-industrialisation. Unlike countries like China, Canada outsourced capacities such as mask making and vaccine production.

Another reason is the difference in political systems. Western countries follow democracy, freedom, and equality, which means they support small government whereby the government shouldn't interfere too much in normal life. After many decades of education in such ideas, when crises like Covid happen, society is not well prepared. The Canadian government could not force people to stay home, or wear masks, or do the 14-day quarantines. Under these circumstances the virus gained a lot of traction.

Finally, ideologies. Most Western countries are under capitalism. Most of their social institutions have been privatised and big companies can shift the decisions of government.

Western governments consider the economy very important. In Ontario, Premiere Ford has said that we need to reopen Toronto, even though there are still a lot of new cases and deaths every day, because people need to shop.

In contrast, in China, there is an idiom that says, a people's life is greater than heaven. In China, nothing is more important than stopping the pandemic.

An influencing factor here is that Western countries generally have credit-based

YK (cont) economies. When the US government laid down quarantine measures, people protested that they needed to work in order not to starve. In contrast, many Chinese people could quarantine without too much financial hardship because our families save for disasters. There are also government programs that encourage us to save for future emergencies.

Finally, policy making. In Canada, policies need to go through the House of Commons, then the Senate, then the Prime Minister, then the Governor General. In emergencies, this takes too much time. Why doesn't the Canadian government use the War Measures Act? This would make the whole government more effective. They did it with the 1972 riots in Quebec.

XC Actually, I don't completely agree with Y.'s perspectives on the economic situation. It's a bit one-sided to say that the credit economies of Western countries are exacerbating the severity of the epidemic because people have to work to continue to pay off debt. I think that in Western countries, the middle and upper classes have solid economic foundations. Even if not everyone is used to saving money, i.e., to have an emergency cash flow, they have wealth such as properties, trust funds, and investments that they can cash out. Actually, many investors have been making a lot of money in the stock market during the pandemic.

As for China, a lot of Chinese people also rely heavily on credit economics. Many people, including those of the upper class, have loans. People in China need loans for housing, car, company financing and the like. Housing in particular is very expensive to afford for most of the young. And in Chinese culture, housing is a pre-requisite for marriage. So many young people have housing loans. Also, affected by consumerism, many young people these days prefer to go into debt in order to consume, to live the high life like those internet celebrities posted on Instagram. With this I wish to say that credit economies are not just a Western phenomenon. During the outbreak, due to the lockdown and unemployment a number of people defaulted on their loans. Anecdotally, my favourite sushi restaurant went under. Many industries had to transform themselves to survive. Such situations are similar to what I have seen in Canada. And people in the lower classes are more vulnerable everywhere in the world.

However, the poor people in China are better protected than those in the Western world. Mainly, the gap between the rich and the poor is less embodied in daily life. There are two main reasons for this.

One, the price of essential services and goods is lower. For instance, doctor's visits and transportation--such as bus, metro, and even bicycle share--are nearly free compared with the average wage. As for commodities, the prices remained stable during the epidemic because the prices of necessities are under macro-based market adjustment controls. For example, the price of medical masks is and remains around one yuan in China (circa 0.2 CAD). However, there is simultaneously quality control; the cheap price doesn't mean cheap quality—that idea is a kind of prejudice. Besides maintaining productivity,

XC (cont) this system benefits from preferential policies towards market fluctuation and strict punishment against market speculation. Therefore, the price is controlled well to meet all of people's needs.

Two, critical amenities are accessible to all classes in China. Policies aimed at public welfare are decreasing the number of "underdeveloped" regions and increasing welfare facilities. China provides affordable housing. For these reasons, living in the same city, people are not so clearly divided by class.

The Chinese market is under macro-control, as was seen in cases of speculation in the Covid period. Due to such controls, even in the emergency period, the basic cost of living allowance could be satisfied and stabilized.

RM R. raised a good point; deindustrialization has prevented many countries from being self-sufficient. In China, factories were repurposed. The electric car and battery company BYD became the world's largest mask plant.

XC I want to mention that countries with mask cultures—such as Japan--adapted more easily.

Also, media plays really different roles in countries. Media in Europe and North American were less effective in persuading the public to pay attention to Covid and to use the mask.

YK There is also cultural background. East Asian countries belong to what we call a Confucianism culture circle. Our notion towards some things, including disaster, is the same. These countries controlled Covid better.

Western countries have a history of a culture of total freedom and democracy. When it comes to disaster, "free" can become a bad thing. In my opinion, Western countries have anarchy without discipline. The ideology of freedom has taken over. What is free? Free to die? Free to kill others? Free to let others die?

Colonialization is also influential. Many countries who were colonized have not recovered very well. So, when the Covid pandemic spread, they could not react adequately. In contrast, the colonising countries could even use resources to mitigate ineffective responses. A great example is the United States. With their ability to invent and roll out vaccine, they have managed to control the situation to some extent. But many countries have none of these resources and they are being made to wait. I think that the World Health Organization is working to improve this situation.

JRH You all have been saying that in China everyone's life matters when it comes to the pandemic. Does that assessment account for class and other differences?

YK The socialist structure implicates equality and the government's ability to intervene during emergencies. We have big government, and with it, a different social welfare system and different market economy system. For instance, when people hoarded and resold masks the government intervened and set mask prices.

There are certainly rich and poor people, but for nearly all people, the health system, especially in Covid, is the same. There is always corruption and I'm not saying every single square metre of China is equal. But we are trying to care for everyone as equals.

JRH I've been fixated on how some lives seem more important than others. Service workers seem to be disposable. Their working conditions are seldom made safer. Slaughterhouses and migrant farmworkers' housing units have been epicentres of viral spread. Amazon and other warehouse workers are in danger.

YK Earlier I was trying to make the point that in China, most workers were protected, Delivery of groceries was contact-free. Factories in areas of high Covid rates were closed unless they were making masks. Workers had PPE.

SZ Yes. My hometown is just a small city. We don't have many cases and there's no need for us to lockdown. The supermarket and some factories remained open, and the mail handlers were working. But those workers exposed to danger are well-protected and they get tested. If there is anything wrong, they quarantine and get medical support.

JRH What do you think should be done to prepare for future pandemics locally, nationally, and globally?

XC General health awareness standards need to be raised because people need to be prepared to deploy scientifically sounds ways of protecting themselves.

Nations need appropriate strategies of pandemic preparedness. Due to different cultures and economic situations, they may act differently, but they all need to act for the health of all.

It is necessary to promote intercultural competency. For example, in regards to mask culture, not everyone in the world will easily accept wearing masks themselves, but at least everyone can respect those wearing masks.

SZ Countries need to fight the pandemic together, no matter their economic status, their political backgrounds. It's just something we need to do together.

JRH I'm so grateful for this discussion. Do you have anything to add?

YK The whole pandemic really brought huge changes to everyone. It has revealed weaknesses in societies everywhere. And problems, such as Asian hatred in North

YK (cont) America, especially towards Chinese people. I hope that, thanks to this pandemic, those problems get better.

In China, there is a saying that danger and luck are connected. I hope this experience will help people improve and bring more equality for different religions, races, and peoples. That would be great.

XC I think it's not so much luck behind the bad, but that bad situations make us realise the drawbacks of the current situation, and that we need to improve it and overcome it so we can have a bright future.

SZ Yes, I personally champion the saying that goes more like there are always possibilities behind every situation.

References

Works cited

盗月社食遇记-Chinese Food Discover. (2020, Aug 31). 武汉人有多耿直?火爆当地的热干面，老板却让我别吃 ?? The most popular local food is Regan noodles. Why the restaurant owner told me do not eat it ?? [Video]. YouTube. Retrieved from https://www.youtube.com/watch?v=G8kCYCagE5s

Takeuchi R. (2020, June 26). Post-Pandemic Wuhan Through the Lens of a Japanese Director【Long Time No See, Wuhan】[Video]. Hezhimeng Workshop. YouTube. Retrieved October 1, 2021 from 一位日本导演的武汉十日纪实 -- 好久不见，武汉| Post-Pandemic Wuhan Through the Lens of a Japanese Director |日本人監督が見た武漢

Background sources

山西省疫情防控政策. 疫情防控政策措施. (n.d.). Retrieved October 20, 2021, from https://webvpn.swun.edu.cn/_vpn_/http/www.shanxi.gov.cn/ztjj/yqfkzccs/sjzccs/.

首支国产mRNA新冠疫苗接近III期临床 将实现我国零突破. (2021, April 13). Retrieved October 18, 2021, from http://www.zj.gov.cn/art/2021/4/13/art_1228996607_59095214.html.

第002版. (2021, September 21). 我国新冠疫苗接种覆盖人数达11亿. Retrieved October 25, 2021, from http://paper.people.com.cn/rmrb/html/2021-09/20/nw.D110000renmrb_20210920_3-02.htm.

CGTN. (2020). The lockdown: One month in Wuhan. Retrieved October 19, 2021, from https://www.youtube.com/watch?v=XU9FVqwO4TM&t=358s.

关于印发促进社会办医持续健康规范发展意见的通知. 关于印发促进社会办医持续健康规范发展意见的通知_部门政务_中国政府网. (2019, June 12). Retrieved October 19, 2021, from http://www.gov.cn/xinwen/2019-06/12/content_5399740.htm.

国务院办公厅关于推动公立医院高质量发展的意见（国办发〔2021〕18号）_政府信息公开专栏. (2021, June 4). Retrieved October 19, 2021, from http://www.gov.cn/zhengce/content/2021-06/04/content_5615473.htm.

Ontario Extending Stay-at-Home Order across Most of the Province to Save Lives. (n.d.). Retrieved October 19, 2021, from https://news.ontario.ca/en/release/60261/ontario-extending-stay-at-home-order-across-most-of-the-province-to-save-lives.

Thomala, L. L. (2021, October 18). Greater china: Coronavirus statistics by region. Statista. Retrieved October 20, 2021, from https://www.statista.com/statistics/1090007/china-confirmed-and-suspected-wuhan-coronavirus-cases-region/.

Further reading

Queen's Contagion Cultures webinar series: https://www.queensu.ca/sps/events/contagion-cultures Particularly Miller, J. (2021, January 14). Responses to Covid-19: Perspectives from a Sino-US Joint Venture. Retrieved January 25, 2021, from https://www.youtube.com/watch?v=_v0YfftZGpw&list=PL57JJtmhwgXn-J1PUhmwJUcJ41Ta4whsuH&index=33

The Conversation: https://theconversation.com/ca Particularly: Wu. C. How Chinese citizens view their government's coronavirus response. The Conversation. (2020, June 4). Retrieved August 15, 2021, from https://theconversation.com/how-chinese-citizens-view-their-governments-coronavirus-response-139176