A Report by Langara UNited Assessments (LUNA)

Beating the Heat in Metro Vancouver and B.C.

Land Acknowledgement

Land acknowledgments aim to recognize and honour Indigenous peoples' history, culture, and ongoing relationship with the land that has been colonized and to challenge the settler myth of the land as an empty and available resource for exploitation. Awareness of the havoc of colonization, the impact of residential schools and the disproportionate ways Indigenous peoples and vulnerable populations have been affected by systemic inequalities and racism is the first step toward creating public policies and practices that treat everyone with kindness, compassion and respect.

Langara College is located on unceded Coast Salish land, the ancestral territories since time immemorial of groups such as səl̓ilwətaʔɬ təməxʷ (Tsleil-Waututh), Stz'uminus, Sḵwx̱wú7mesh (Squamish), and šxʷməθkʷəy̓əmaʔɬ təməxʷ (Musqueam) peoples.

snəẇeyəɬ leləm̓.
THE COLLEGE OF HIGHER LEARNING.

Langara.
THE COLLEGE OF HIGHER LEARNING.

We wish to acknowledge the invaluable support from Tawx'sin Yexwulla, which translates as: Splashing Eagle or "Splash." He also carries the name, Poolxtun, from his adopted father, Gerry Oleman, which he translates as: 'the spreading ripples from a splash of water.'

Splash is a carver and engraver from the Squamish Nation. He has carved house panels, entrance doors and house posts for Canada's Olympic Pavilions, BCIT and the Squamish Cultural Centre and works in jewelry engraving in Capilano Village. He is currently leading courses in Coast Salish Carving with Langara's Aboriginal Studies and Fine Arts Departments.

Splash was asked to speak to us about the experience of Indigenous people in Vancouver, the history of systemic racism, and the effect of residential schools. He encouraged us to "complete" the land acknowledgements by acknowledging ourselves. To announce who we are and our intentions while working on the ancestral lands of the Coast Salish Peoples. For his collaboration we are grateful.

Individual Acknowledgements

Daniel Blackmore

"With deep respect for the Stz'uminus, Tsawwassen, Kwantlen, Semiahmoo, Cayuse, Umatilla, Walla Walla, Musqueam, S'tó:lō peoples and the Hul'qumi'num treaty group, I would like to express my gratitude for the beautiful land on which I live. As a settler born in Ireland, I moved to this unceded land with my family to live a life that brings people together, and hopefully leave the world a better place. Much love to all my relations, and thank you!"

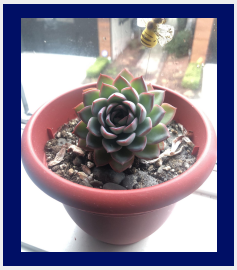
Kenny Cleban Crawford

"I was born in Nicaragua, and currently living and learning in Vancouver. I would like to acknowledge the unceded and traditional territories of the Musqueam, Squamish, and Tsleil-Waututh people. I am grateful for the shelter and opportunities this beautiful land has provided for me and my family."

Luciana Ferro Sardi

"From a place of honest respect for the caretakers of the traditional unceded territories of the Kwikwetlem First Nation peoples, I want to acknowledge and be grateful for this beautiful land and it's generous resources. This wonderful place where my family loves, lives, learns and plays. As an uninvited settler in this marvelous land, I want to express my sincere intentions of supporting life, nature, love and social justice. Also, I want to thank the Diaguitas and Tonocotes, the first communities that took care of the land in my province in Argentina. Thank you! To All my relations."

Liam Benjamin Higgs



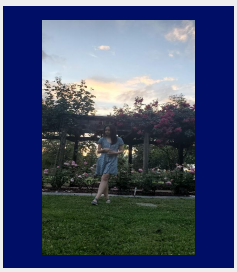
"For most of my life, I have lived on unceded territory- specifically Semiahmoo land. I was born in B.C. Children's Hospital, the home of the Tsleil-Waututh, Stz'uminus, and Musqueam peoples. I went to schools named after the Semiahmoo peoples, and now I spend time in the same ancestral territories I was born in. I am infinitely grateful to have been allowed to live on this land, and now I want to use this report to help better other people's lives in this region."

Sonampreet Kaur

"I would like to acknowledge the shared, unceded, and traditional territories of the Katzie, and Kwantlen People on whose land I live, and work. I am really grateful to live in such a beautiful land where I got a lot of opportunities to learn."

Joss Klinck

"I am a settler nonbinary person, living graciously on the land of the Musqueam, Tsleil-Waututh and Squamish peoples. I was raised on lands ancestral to the Stó:lō Nation of Chilliwack: Aitchelitz, Matsqui, Leq'á:mel, Shxwha:y, Squiala, Sumas and Yakweakwioose, and surrounding ancestral territories. In particular: Schelowat, Kwawkwawapilt, Tzeachten, Skwah, Ts'elxwéyeqw Tribe and the Seabird Island Nation. I was born on the lands of Anishinabewaki, Attiwonderonk and Mississauga Peoples in what is called London, Ontario, and lived on the land of the Odawa. I am a social historian, wanting to learn from the past and share what I know with others. I hope that my desire to heal can repay some of that kindness."



Nicole Lam

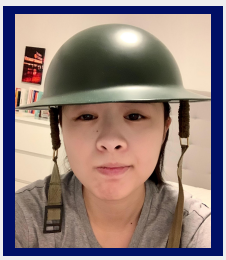
"My name is Nicole Lam, and I live in Vancouver, B.C. I would like to acknowledge the unceded territories of the Coast Salish and the Qayayt peoples. As a Asian Canadian, I'm grateful to be working on this land. For this project, I wish to help this land and to do my best to make a change in the world."

Kendell McCallum

"My name is Kendell McCallum, and I live in Vancouver, B.C. Canada and I would like to acknowledge the unceded territories of the Musqueam, Squamish, and Tsleil-Waututh first nations people. I have lived in Vancouver all my life and I am grateful to be able to attend school, and socialize with friends and family on this beautiful land."

Colin Mills

I was born in the small town of Ballymena, Northern Ireland. In the early 1970s, my family immigrated to Canada, removing ourselves from "the troubles" - a conflict born from cultural and territorial domination. I acknowledge where I now (Vancouver) live is also a place constructed from territorial and cultural domination. As a colonial settler I acknowledge that daily I benefit from the beauty and richness of the unceded and ancestral territories of the Musqueam, Tsleil-Waututh and Squamish peoples.

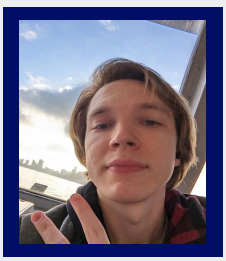


Kyla Mui

"For all my life, I have lived in Vancouver, B.C., Canada. I wish to acknowledge the ancestral, traditional and unceded territories of the xʷməθkwəy̓əm (Musqueam), Skwxwú7mesh Úxwumixw (Squamish), and Səl̓ilwətaɬ (Tsleil-Waututh) peoples on whose territories I work, live and play on. With this project, I hope to provide insight on how Vancouver can adapt to climate change and improve others' lives, especially for vulnerable populations. My guiding principle has always been to leave the world a better place than I found it."

Chung Yan Joanne Ngai

"From the traditional ceded territories "Tsawwassen First Nation Reserved Land," I would like to respectfully acknowledge and be grateful for Səwaθn Masteyaxʷ Tsawwassen People - 'People facing the sea' taking care of this beautiful land; and glad to hear that they reconciled their aboriginal rights and title and restored their right on this land after 14 years of negotiations. Their ancestors acted as stewards and guardians to preserve these lands and resources in order to protect the way of life I love and the chance to learn from nature. I would also like to thank the Tankas 'Boat People,' the first communities that took care of the land in my hometown, Hong Kong. Thank you to all my ancestors who took care of my hometown and home here in TFN."



Lawrence Rowland

"I lived in the tropics for most of my life, so heat is a concept I am acutely familiar with. I currently work, live, and learn on the unceded traditional territories of the Tsleil-Waututh, Musqueam and Squamish peoples of Turtle Island. My intentions with this project are to contribute as much as I can to making Vancouver a safer, more equitable city that will be able to adapt to our changing climate without sacrificing the lives of our most vulnerable. This can be possible if we take all the necessary steps to reconciliation and dismantle the systems of oppression created by my ancestors to restrict the Indigenous Peoples of this beautiful land I call home."

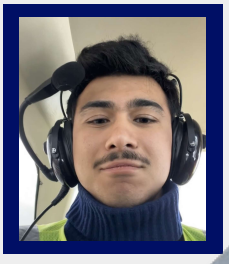
Saanya Shah

I was born and raised in Kenya, but currently am living, working and studying in Vancouver. I recognize the importance of acknowledging the Indigenous peoples of the land that I am interacting with. Vancouver is located on the unceded territories of the Coast Salish peoples, including the xʷməθkwəy̓əm (Musqueam), Skwxwú7mesh Úxwumixw (Squamish), and Səl̓ilwətaɬ (Tsleil-Waututh) Nations. I have learned that for generations, these Indigenous communities have lived and thrived on this land, practising their cultures, languages, and traditions. Their connection to this land runs deep and continues to this day.

Randeep Singh

"I was born on the land of India. In a small town of punjab called Mansa. One year ago I came to Canada as an International student. Now, I live in Surrey on the traditional territories of Kwantlen people, for those where I live and enjoy my life. I'm very grateful to have a part of these territories and have a good life to enjoy on this wonderful land."

Andrew Vidoni



"Living and working in Vancouver among various locations on Vancouver Island, I appreciate and recognize the unceded territories that are possessed by the peoples of Musqueam, Squamish, Stz'uminus, Semiahmoo, Kwantlen, S'ólh Téméxw, Snuneymuxw, Hul'qumi'num, Tla-o-qui-aht, Hupacasath, Homalco, and Kwakwaka'wakw Ąwi'nagwis nations. Your territories have provided me with peace, tranquility, friendships, opportunities and a place where I feel belonged. My purpose is to provide help and welcome everyone that comes my way, hopefully others can do the same so we can all live civilly in unity."

Acknowledgements

We would like to thank Vancouver Coastal Health, CityStudio Vancouver, and City of Vancouver for their contributions to this report.

VCH Healthy Environments Team

Wes Regan
Craig Brown
Laura Chow

CityStudio Vancouver

Emily Gorham

City of Vancouver

Leila Darwish

Vancouver Island, Daniel Blackmore

Table Of Contents

Foreword:

Class Workshop, Colin Mills

This remarkable report is the final project created by 14 students who came together in a second year college course to learn how to work as geographers, learn how to coordinate effectively as a team and learn how to apply their knowledge in a real-world setting.

Geography 2275 - Applied Human Geography at Langara College is a unique WIL (work integrated learning) and project based course. Unlike many courses where students work on many projects in small groups, this course is structured as one class, one client, one report. For an entire term, all the students' efforts are focused on understanding a problem with the goal of delivering a consultant's report to their client at the end of term.

This term (Spring 2023), the students branded themselves as "LUNA" - ("Langara United Assessments"), a consulting agency focused on social sustainability. LUNA partnered with Vancouver Coastal Health and the City of Vancouver to address an issue of pressing concern.

In 2021 a "heat dome" formed over the city and province, causing 619 deaths. As a part of their response, VCH asked LUNA to research and provide options for how the city and its residents might become more resilient and survive future heat emergencies without further suffering and death.

Embracing the project the students divided into teams handling different aspects of organizing, researching and writing an options report for VCH. With some support, the students organized themselves and carried-out all aspects of researching, assembling and presenting this very detailed and comprehensive report.

As an educational experience, students have an opportunity to take their skills, knowledge and abilities and apply them to a real world problem for a real world client. Students applied and developed academic skills in research and analysis, but also developed skills in project management, leadership, teamwork, business practices, professional and public communications, design, public presentation and much more.

Foreword:

In this class, the students are evaluated on their individual contribution to research and understanding of the issue as well as their role as a team member and the ways they contributed to the processes necessary to complete the project, consistent with professional standards in the relevant industry for the client, on time.

The breadth of the heat deaths issue required the kind of cross-disciplinary thinking that human geographers engage in professionally. The project addressed issues spanning the breadth of the discipline and beyond. Core spatial knowledge and GIS capabilities are necessary for addressing issues of such as distance, space, regions and distributions. The human nature of the issues was at its core about the relationship of humans to their environment. As what is commonly described as a 'wicked problem,' climate emergencies are multi-factorial as such students engaged in conversations about urban planning, economics, politics, psychology, sociology, culture, urban studies, religion, architecture, demographics, marketing, engineering, climatology, meteorology, construction, horticulture, social and economic deprivation and marginalized people and ethics, morality and justice. We addressed issues of health, building codes, vulnerable populations, the effect of age, the role of urban greening, wealth and poverty, social isolation, the role of communities and society, cultural appropriateness, the availability, adaptability and cost of mechanical cooling devices, air circulation in buildings, global warming and urban heat islands to mention just a few issues the students touched on.

The class has had an opportunity to participate in something that has lasting value. Not only did it give students an opportunity to experience the kinds of knowledge sector work that will prepare them for future careers, but at some point in the future, they may be able to point to a policy, or a practice or a feature in the landscape or a building design and know that they were a part of bringing that about and helping create a city that is more livable and more sustainable. Congratulations everyone!

- Colin Mills

Group photo, Colin Mills

Executive Summary

As established by the BC Coroner's Service (BCCS), extreme heat events, also described as "heat domes," occur when an area of high pressure stays over the same area for days or even weeks, trapping hot air underneath. When one of these heat events occurs, temperatures rise far above the average for the time and place.

In the summer of 2021, British Columbia (BC) was devastated by one such event of unprecedented magnitude. Temperatures rose to record-breaking heights over the course of a few days, peaking over 40 degrees Celsius in many parts of the province, without the relief of the cooler nights BC citizens are used to.

From June 25-July 1st, the BCCS investigated 800 deaths, and 619 were identified to have been heat-related. Due to the unprecedented nature of the event and the aftermath, the Chief Coroner convened a death review panel to review the circumstances of these deaths and identify measures to prevent a reoccurrence of this deadly tragedy. The death review panel's key findings regarding disproportionately affected populations and the public's response were foundational to the solutions put forth in this options paper.

The common denominator for a majority of the cases where people died was isolation, but a lack of preparedness, lack of government coordination, inadequate housing, and preexisting chronic conditions also directly contributed to the unnecessary loss of life.

Since the release of the death review panel's findings, the BC provincial government, health authorities, and municipalities have taken steps toward addressing these issues. Preparing a coordinated response and making funds available for heat mitigation as climate change moves us toward a future where extreme heat events are likely to become more frequent and intense*.

Key initiatives by the BC gov*:

- BC Heat Alert Response System (BHARS): Pilot 2022
- Prepared BC Extreme Heat Preparedness Guide
- Community Emergency Preparedness Fund
- Heat Pumps for Low-Carbon Climate Resilience
- Mobilizing Building Adaptation and Resilience (MBAR)
- Extreme Weather Preparedness and Water Infrastructure for Agriculture
- Annual Climate Change Accountability Report

*Current provincial measures taken from Climate Preparedness and Adaptation Strategy: Actions for 2022-2025

Key pathways being taken by Vancouver**:

- Engaging with community organizations and advisory committees
    - Engaging with non-profits and communities to help seniors or people who don't live close to a cooling center by providing transportation from their homes to a nearby cooling center.
    - Reaching out to housing organizations prior to an extreme heat event, to share information about steps for reducing the risks of extreme heat.
- Assessing and updating response plans
    - From the 2021 plan, What Vancouver learned:
        1) Expanding on partnerships and response coordination, recommendations to recognize communities and their capacity response to extreme heat events. The role of the government has been enabling and supporting that effort.
        2) Indoor cooling, to increase the access and accessibility towards indoor cooling centers, as a primary measure to reduce the deaths from extreme heat events
        3) Access to water, washrooms, and outdoor cooling. The idea is to expand on the outside cooling fractures while getting access to water, shaded areas, and washrooms.
        4) Communication and Alerts, this recommendation is to focus on the opportunities to straighten dissemination. Increasing the information on extreme heat through translations, and clarifying the language for alerting Vancouver Coastal Health and Climate Change Canada
- Increasing extreme heat support delivered directly to residents and through community partners
    - Developing and implementing neighbourhood-based solutions for priority areas to improve the infrastructures to access water or cooling spaces (indoors and outdoor situations)
    - Helping the communities, who need financial support to provide for themselves or families during an extreme heat event
    - Working with partners and the community to provide public announcements in regard to heat events and provide warnings or alerts to the public

Due to lengthy wait times for BC Ambulance Service and BC Coroners Service response in 2021, Vancouver Fire and Rescue Services (VFRS) and Vancouver Police Department (VPD) saw substantial negative effects on service levels. For instance, VFRS crews were compelled to wait for an ambulance to arrive at the location of a medical emergency for a long time, and VPD police had to stay at the scene of a death until the BC Coroner could release them. Some police officers spent their whole shift at a death scene. While BC Ambulance Service and the BC Coroners Service have both enhanced resources and put strategies into place to minimise severe delays in upcoming heat events, VFRS and VPD have also updated extreme heat plans and processes to better manage resources.

VFRS

- **Activating the VFRS Department Operations Center in the early stages of an Extreme Heat Emergency to manage VFRS resources**
- **Staffing up additional units before the call volume increases**
- **Setting trigger points to discontinue response to low priority incidents**
- **Modifying unit allocation levels to limit the amount of apparatus that are dispatched to certain call types in order to preserve staff and equipment for higher priority calls**
- **Cycling units in and out of events experiencing long ambulance wait times so staff have recovery time**

VPD

- **Activating the VPD Department Operations Centre proactively when an Extreme Heat Emergency is called**
- **Staffing up additional units before call volumes increase**
- **Adjusting response protocols to ensure units are available for high-severity incidents**

*Updates to Extreme Heat Response Plans for 2022
*Council Memo - Planning for Extreme Heat and Air Quality Mitigation in Vancouver - RTS 14654

Many of the initiatives being taken by the province and municipalities like Vancouver are transformative and will have a significant impact on outcomes in future heat events. However, some of these targets and goals are vague, and our paper provides actionable solutions towards the goals of social sustainability, coordinated response, and climate resilience.

Major Findings

- Isolation was the primary difference between a life or death scenario for most cases
- Extreme heat events will become more frequent and intense over the coming decades
- First responders play a key role, but an informed response by the general public to protect and support vulnerable populations is the most effective method to mitigate unnecessary death
- Clearly defined roles and responsibilities must be adopted and adhered to by all levels of government
- Wellness checks and cooling centres must be adapted to deal with increased demand as extreme heat events become more frequent and intense
- Long-term changes to the built environment (such as urban greening) must be proactively implemented to address the urban heat island effect if municipalities want to prevent further health and economic impacts
- Building codes need to be adjusted to incentivize active and passive cooling design for buildings to reflect hotter summers
- District heating and cooling systems may be an effective long-term solution to retrofit urban areas where a significant portion of housing stock is inadequately equipped for extreme heat and individual air-conditioning units are too expensive or wasteful to distribute

Three key pathways to reduce heat-related deaths:

Social Sustainability	Climate Resilience	Coordinated Response

Recommendation 1: Social Sustainability

A) Public awareness campaigns about severity and seriousness of extreme heat events and who is vulnerable
B) Galvanize the general public to check in on their friends, family, and neighbours during extreme heat events through ads and outreach
C) Ensure BC citizens have easy access to information about cooling centres, at-home cooling practices, and other information included in the BC Extreme Heat Preparedness Guide
D) Distribute heat-health information to vulnerable populations through general practitioners and the healthcare system in the spring-summer months
E) Expand access to cooling centres, particularly in equity-denied communities such as East Vancouver

Recommendation 2: Climate Resilience

A) Adjust building codes to properly reflect the reality of climate projections, require adequate cooling in all rental units across BC.
B) Incentivize/subsidize heat pump installations in low-income communities and/or where housing stock is older
C) Acknowledge the role that the built environment plays in exacerbating the urban heat island effect within urban areas, and create a plan/framework to;
    a) Reduce pavement and asphalt wherever possible
    b) Expand blue/green infrastructure
    c) Expand and maintain the urban tree canopy through an equity lens
    d) Maximize the cooling potential of urban parks through design changes
    e) Prioritize space-efficient active transportation modes to allow for road diets and additional space for larger broadleaf street trees
D) Incentivize homeowners and developers to use green roof and reflective roof technology to reduce temperatures indoors and outdoors
E) Plan district energy systems in urban areas where housing stock is aging or has inadequate cooling design

Recommendation 3: Coordinated Response

A) Global information-sharing and cooperation are essential to meet climate resilience goals
B) Clear roles and responsibilities must be delegated across every level of government to ensure the most efficient response possible during extreme heat events
C) Communication networks and protocols must be established to prepare for extreme heat events
D) Federal and provincial governments must provide clear and accessible funding avenues to enable the necessary investments in infrastructure, technology, and community to combat isolation and extreme heat

Introduction

In late June 2021, British Columbia (B.C.) experienced an unprecedented heat dome which resulted in record temperatures across many parts of the province over several days. Temperatures started to rise on June 24 and continued increasing to a peak on June 28-29. At the peak, temperatures reached over 40°C in many parts of the province. Overnight temperatures were also uncharacteristically high.

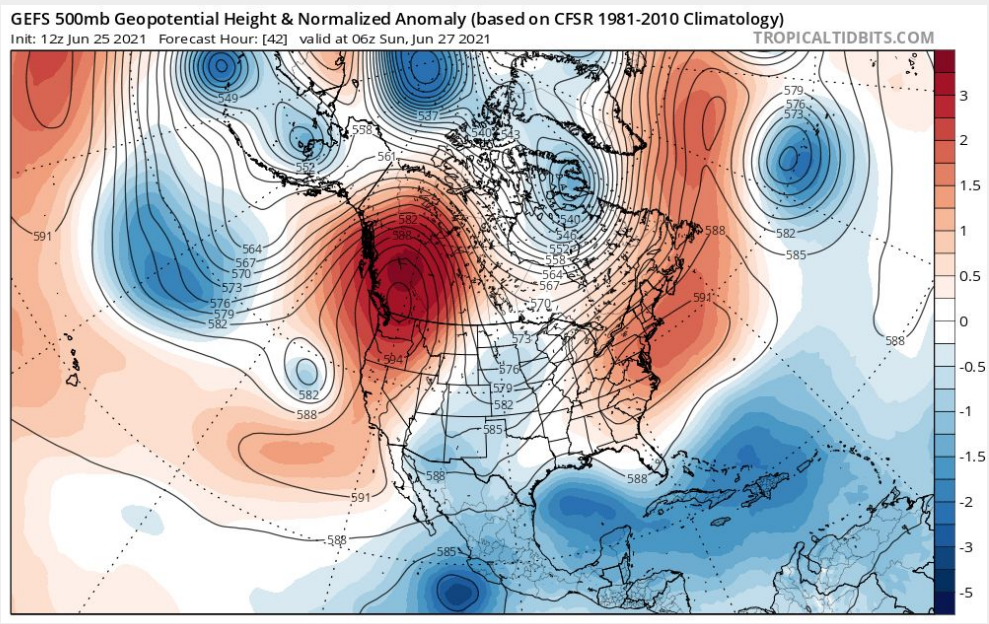
The prominent discoveries in the Extreme Heat & Human Mortality report to the Chief Coroner of British Columbia were that 98% of deaths occurred indoors, there was a delay of the heat alerts issued by Environment and Climate Change Canada among other public agencies, heat-related deaths were higher among people with predisposed health conditions, more than 60% of decedents had seen a medical professional within the month prior to their death, approximately 67% of decedents were of 70 years of age or older, and over half of the descendants lived alone.

Our report outlines various solutions towards mitigating heat deaths. Some of the recommendations can be conducted individually, through a community, or with assistance from municipal governments. Certain recommendations can help an individual and others can help an entire community. Some options are short-term and can temporarily mask the heat, while others are long-term and may require extensive planning for optimal results and waste mitigation.

Heat Domes and 2021

Heat domes are a recurrent meteorological issue across the world. Heat waves and heat domes in Vancouver stand to worsen over the next few years as a result of climate change. Heat waves and the effects of urban heat islands can exacerbate warming conditions. Many conditions are involved in making heat domes as impactful as they are. Heat domes are a result of high-pressure atmospheric conditions combining with pre-existing influences such as La Niña (NOAA, What is a Heat Dome?). One condition, in particular, is known as a Rex Block, which is "...characterized by a high-pressure system located pole-ward of a low-pressure system" (NOAA, Basic Wave Patterns). Airflow will be restricted during a rex block and flow in a reverse S shape pattern. During the 2021 heat dome, a rex block had settled over British Columbia. From Swain, "The combination of long-duration offshore flow aloft, very strong subsidence, and near-cloudless skies will produce an incredibly hot airmass..." (Swain, 2021). Swain's prediction was correct. Heat domes occur naturally, but their impact may be worsened by climate change and rising global temperatures. These combined factors have created several weather anomalies in the Greater Vancouver Area, including heat domes and atmospheric rivers.

The effects of the 2021 B.C. heat dome was exacerbated by many factors, but the 3 main issues were isolation, housing design, and the urban heat island effect. Isolation and disconnect from others led to fewer people seeking help when the temperatures spiked during the 2021 heat dome. Housing design, such as designs in condiminiums, is not suited to hot temperatures. As Akua Schatz states in Braich, 2021, "[Condominiums] aren't designed to both have open airflow and really take in the heat."



Urban heat islands, a result of concrete and a lack of urban greening in cities, contribute to extreme heat events. The effects of heat islands and heat waves can be mitigated with the proposed solutions in this report.

Image From Swain, Daniel. "California Dodges Worst of Historic Pacific Northwest Heatwave, but Long-Duration Heatwave Still Likely Inland. plus: Significant Monsoonal Surge next Week?" *Weather West*, Weather West, 25 June 2021, https://weatherwest.com/archives/9778

During the Catastrophic 2021 Heat Wave...

619

Decedents

606

Died indoors

90%

Of decedents over 60

56%

Lived alone

(Egilson et al. 5)

Community, Society & Culture

- **The built environment influences our society, culture, and ability to form resilient communities**
- **Social isolation correlates with heat deaths**
- **People-friendly streets allow for the formation of neighbourhood communities, that are critical in preventing heat deaths**
- **Inclusive spaces allow socialization of isolated demographics**

Community, Society, and Culture During Heatwaves

The built environment and the way we design our cities both reflects and influences Vancouver as a whole. From an individual perspective, it influences our mode of transportation, where we live, where we spend our time, and ultimately, the quality and quantity of our relationships. It is often taken for granted that our environment profoundly impacts the direction of our lives through these daily activities. On a societal scale, the urban environment influences our culture direction, ability to form communities and resilience to challenging situations.

The materially deprived downtown east side had much fewer heat deaths than expected, likely because of the strong community connections that already exist (Egilson et al. 26).

Community, Society and Culture each have an important role to play in Vancouver's response to heatwaves. Communities, as will be explored further in the "Wellness Checks" section of the report, are well positioned to target and lend aid to the most vulnerable individuals. Society provides the specialization and resources needed to prepare for the event; healthcare workers and adequate information dissemination are impossible without a coordinated, caring society. Culture is slow to change but, over time, will begin to incorporate practices to combat routine heatwaves. Western, individualistic cultures often prize independence, and view the act of asking for help as shameful. This varies between individuals, but it is a potentially dangerous ideal that may have stopped vulnerable people from seeking aid. By critically analyzing Vancouver's current communal-societal-cultural relations, changes can be made to create a more resilient society. A society that strengthens under pressure rather than collapses. Our social connections, communities, and culture's response to extreme heat emergencies can be the difference between life and death.

Social Isolation and Heat Deaths

Social isolation, the absence or minimization of social interactions and relationships, greatly increases the likelihood of death during an extreme heat emergency. The numerous causes of social isolation, poor mental health, geographical location, physical disabilities etc., make the demographic naturally vulnerable. A report found that in the 2021 B.C. heatwave, 56% of all descendants lived alone (Egilson et al. 5). The same report found that 33% of all heat deaths occurred in neighbourhoods of the most socially deprived quintile. While only 7.3% happened in neighbourhoods of the least socially deprived quintile (Egilson et al. 16, 38). These statistics show a clear correlation between heat deaths and social isolation. Socially isolated people are likely to feel uncomfortable or embarrassed reaching out to a stranger for aid, diminishing the chance they receive the help they need. These people may also have less access to information about the risk of extreme heat and ways to combat it. Strengthening social connections will decrease the possibility of death during heat emergencies.

Combating Isolation, and Building Resilient Communities

To prevent a heat death, only one strong social connection is needed. Visits or phone calls are generally the most straightforward ways to prevent unnecessary death. Elderly citizens are both vulnerable to heat deaths and social isolation, with an estimated 16% of Canadian seniors being socially deprived (National Seniors Council). Socialization can be encouraged in a variety of ways that will be discussed further in the report, such as improved transport infrastructure, built environment improvements and the creation of "third places" that become social melting pots.

The term "third place" refers to a public space for citizens to enjoy that isn't their home or place of work, such as parks, cafés, gyms, bars or any other publicly accessible space. Vancouver already has a large variety of places to socialize, but for some, there are barriers preventing access. These obstacles can be both physical and psychological. For those unable to drive or have physical disabilities, getting out of the house and socializing can be difficult without sufficient transport alternatives. Changes to the built environment that increase mixed use development, "third places," and people-friendly streets are critical for forming neighbourhood communities. These neighborhood connections form the same communities that are well-positioned to care for vulnerable people during a heat crisis. Neighbourhoods with slow moving traffic (slower than 30km/h), less parking, and positive environmental qualities are excellent for allowing neighborhood connections, social inclusion, and personal development (Sauter and Huettonmoser 78).

Psychological barriers, concerns of safety, acceptance, or ageism are also important to consider. Canada's National Seniors Council recommends the creation of age-friendly communities, that promotes social inclusion of seniors by considering transportation, communication, respect and more. Principles that create age-friendly spaces can also be applied to other marginalized, socially isolated communities. In a heatwave, these centers can also become vulnerable people's primary place to rest or contact about concerns. Changes to our built environment will increase social inclusion for all, while inclusive spaces provide important resources for socially isolated demographics. (Canada, Employment and Social Development, 2017)

Cowan, Amanda. "Vancouver Cooling Centre." *The Columbian*, Vancouver, 28 June 2021, https://www.columbian.com/news/2021/jun/28/vancouver-cooling-centers-offer-refuge-help-those-in-need-stay-safe-cool/. Accessed 2023.

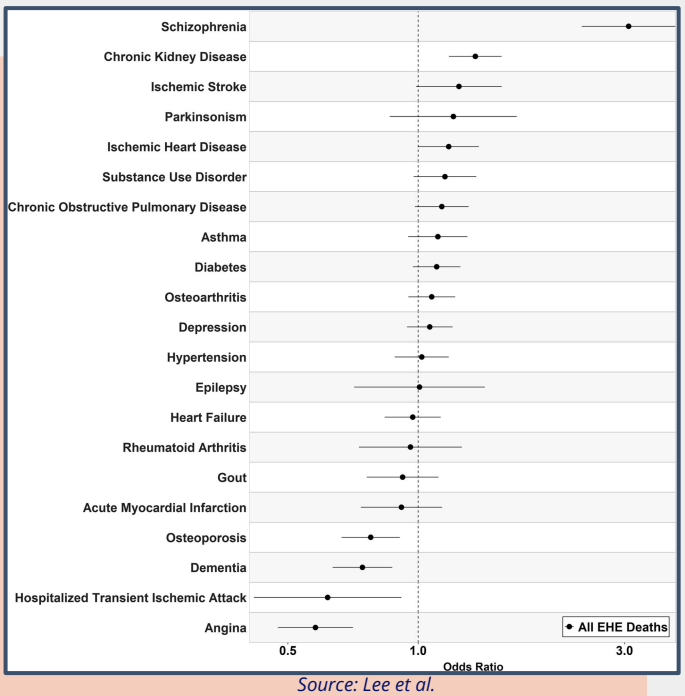
Short-Term Solutions:

Community Responses

General Awareness

Heatwaves and Health Complications

Heat waves are difficult to manage at many levels, especially for health organizations and levels of government. At the individual level, however, some people are unable to get the help they need, such as those with disabilities. Disability is a known factor, but which specific illnesses constitute the highest risk during a heat event is not popular knowledge. Lee et al. released a study which explains how people with schizophrenia experienced a **higher risk** of death or severe heat illnesses during an extreme heat event.



Source: Lee et al.

Chronic kidney disease and ischemic stroke have higher odds of death during an extreme heat event, but schizophrenic people have as much as 3 times the odds of death because the illness affects their hypothalamus, which helps regulate temperature through sweating and shivering. In other words, during extreme heat, a person with schizophrenia can't tell when they are extremely hot and needs to hydrate and/or take cooling measures, like taking off warm clothes.

This report also mentions that "...Adelaide, Australia, hospital admissions for renal disease and acute renal failure were heightened during heat wave periods" (Hansen, Bi, Ryan, et al., 2008, cited in Lee, Michael et at., 2023).

General Awareness Campaigns

General awareness campaigns increase the likelihood of chronically ill individuals knowing what to do in an extreme heat event, decreasing the likelihood of heat-related illnesses or death.

Many tactics and technologies are used during heat events to reduce temperatures inside buildings. Several well-known methods that do not use air conditioning include applying cold water or ice to key points on the body, wearing more breathable clothing, and moving less (Stinson and Varma, 2022). Sleeping may also prove difficult in hot temperatures- one solution is to use cotton sheets, as Shin et al. recommended in their study analyzing the effects of bedding and sleepwear. The study showed that sleeping in cotton sleepwear at temperatures of 22 degrees Celsius offered more comfort to people resting, but cotton sheets and bedding had no effect. However, these methods and cooling strategies are not widely known by the entire population.

When it comes to general awareness, distributing information to those that need it is important.

Cell phones are a common information distribution method, whether through news articles or social media. While around 92.9% of British Columbian households have access to a cell phone, 45.1% don't have a landline telephone (Landline and cellular telephone use by province, 2019). Additionally, heat waves can arrive with little warning, so sufficiently preparing residents for an extreme heat event is vital. One solution to this is putting warnings out long before any temperature spikes or weather abnormalities occur. Some methods for doing this would be through newspapers, which can be delivered to doorsteps and marketplaces like convenience stores or grocery stores. Magazines or other reusable materials that can be distributed and re-circulated are ideal for disseminating these messages.

When it comes to general awareness, specific demographics still need to be warned about the effects of heat. The elderly, people with mental/physical health complications like schizophrenia or Chronic Kidney Disease, and those who live alone are at a higher risk.

Information at Doctors Offices

Mental health, pre-existing health conditions and physical health can also play a role in more severe heat illnesses. Being able to warn these demographics effectively will save lives. Studies of the decedent's in 2021 showed that most visited a doctor less than 30 days before passing, with over 30% visiting within the last 7 days (Egilson et al. 15). One solution is to create pamphlets warning about signs of heat illnesses which would be kept in hospitals, general practitioner's offices, and other medical facilities for easy access.

> "Studies of the decedent's in 2021 showed that most visited a doctor less than 30 days before passing, with over 30% visiting within the last 7 days (Egilson et al. 15)."

If someone susceptible to heat-related illness goes to one of these locations, they can pick up a pamphlet, or a doctor can mention heat-related illnesses to them. Some people live in rural areas, along with some Indigenous communities that do not have sufficient resources to cope with the heat. Some may not get information on how to cope with heat waves in time. It's essential to remember smaller, more isolated communities, as these communities may have people with pre-existing health conditions who cannot make their way to a hospital or doctor.

Making Information Accessible

British Columbia's government has already put out several resources to prepare people for extreme heat, such as the Extreme Heat Preparedness Guide. Additionally, these resources identify who is most at risk. These resources are in several languages, which makes them more accessible to more demographics.

However, since the scale of recent heat waves is unprecedented, many residents do not take the warnings and preparations seriously. Being able to guide individuals on how to protect themselves and prevent visits to the hospital would drastically reduce the strain on public health systems.

Preparing for a heat wave is not common knowledge. Heat domes are a relatively new phenomenon to the Pacific Northwest, or at least their severity is new. Informing the public of preparation techniques through the mail, through posters, and through announcements would be one way to help prepare the population.

Umbrellas and Parasols

Umbrellas and parasols effectively provide shade from the sun and fend off the heat. However, as time has progressed, the history and purpose of these items have changed. In North America, umbrellas are largely associated with rain and bad weather, yet the umbrella is employed in other parts of the world to ward off the sun and heat. The umbrella acts as a personal shield providing two benefits. The first benefit is acting as a portable shade offering relief from the heat, and the second benefit is blocked ultraviolet rays that also help reduce a person's risk of skin cancer.

Parasols and umbrellas have the ability to create a kind of microclimate. On average, the shade provided can make one feel approximately 5°C to 8°C (10°F to 15°F) cooler than in direct sunlight, offering a short period of relief that can make one feel better (Lozzio). If one uses an umbrella to keep the rain off in poorer weather, why not also use it to ward off the sun in times of great weather? Umbrellas and parasols can be utilized for a significant span of the year while living in a city like ours, as we have a large range of climates. Encouraging the public to use umbrellas in the heat can make a real difference in their health.

People carry parasols to protect themselves from the heat as they walk near Tokyo Station (KYODO).

International Examples

Heat action plans have been implemented in other countries and cities to help and inform the public are, such as **"The Long Live the Elderly"** plan practised in some urban areas of Italy. The plan aims to combat social isolation among the elderly by maintaining frequent contact with those over 75 years old to carry out health promotion campaigns. This strengthens the community network around sick and socially isolated individuals by involving people living, or working near them in volunteer care action.

In Philadelphia, an education program about heat-related illnesses was also carried out, and senior centres were kept open for longer to provide support. Phoenix released comprehensive heat alerts, and Toronto executed training on heat-related illnesses and treatment for community and agency staff and volunteers. A study in Southern Australia provided tangible material resources with messages such as health cards, fridge magnets, and fact sheets to intervention groups and found that a higher number of people in the intervention group made the necessary lifestyle changes in terms of cooling methods over the summer (Hasan, Fariha, et al. 8-9).

Public Mobilization Challenges

Some challenges these plans faced were that they are reactive, heat waves are hard to predict when exactly they will happen or with little time to react once it happens. These plans also rely on volunteers to physically go outside, or door-to-door, to inform or check on the vulnerable population, exposing themselves to the heat.

The low-risk perception of vulnerable groups observed in Europe and elsewhere is of particular concern, suggesting that while plans and alert systems may raise awareness, they may be unable to prompt self-protective actions. Social norms campaigns designed to increase the acceptability of free use of cool spaces such as banks or supermarkets without purchasing anything were found to be needed in Japan (Robine).

> Tangible material resources, such as fridge magnets and health cards have been proven to create lifestyle changes to help cool down (Hasan, Fariha, et al. 8-9).

Simões, Pedro Ribeiro. "Warming the Bones." *Flickr*, Portugal, 15 Feb. 2007, https://www.flickr.com/photos/pedrosimoes7/393217457/in/photolist-pkghd9-grR7Fw-StpEbd-4KnhWC-CDhRBC-eecb4j-arXw9-hWX3qc-fGKzNv-6Evm4K-AKkRk-r7Bk2h-pcgzp-87MUbh-RkuhVb-rE5LRQ-86fDK3-dZRjFE-adQARM-HMJbs2-98jbn9-RZfrKa-8TCqwt-bMKnSK-RpBpdJ-8WkU4J-96kGLD-QKiE9n-9LRcmd-RZfqYa-LwfyRe-GMxdXs-GoKg9T-hionbD-a32pzF-9uXQ6z. Accessed 2023.

Heat Response Plans

Introduction to Heat Response Plans

Many countries, besides Canada, are experiencing heat waves and extreme heat events, such as countries in Europe and Asia. One way that these countries are mitigating the damage that heat waves cause is by implementing heat health warning systems. By distributing guides that warn people about the dangers of heat, such as the Extreme Heat Preparedness Guide, governments can reduce the death toll during a given heat event. Preparedness is essential to saving lives during these events, as they end almost as fast as they arrived.

Methods of Alerting the Public

Heat health warning systems can also involve using technology to alert people to weather conditions. Alert systems are already in use by the Ministry of Emergency Management and Climate Readiness. From the Government of B.C., "The Ministry of Emergency Management and Climate Readiness (EMCR) can issue emergency alerts at the request of a Local Government, First Nation partner agency or Province...". They can alert the general populace if there are emergencies such as tsunamis, high flood risks, and fire evacuations, as well as extreme heat emergencies. Environment and Climate Change Canada are also able to issue alerts. Both of these authorities use the Wireless Alert Ready system in order to notify the general public of emergencies. The Alert Ready system is compatible with numerous network providers, including TELUS, Bell, and Shaw (Wireless Alert). Alongside this, emergency alerts can be displayed on televisions, radios, cable and satellite operators (Wireless Public Alert Awareness FAQs). Some billboards in Vancouver are digital, so putting warnings on these screens would also help alert people who are outdoors and without a phone. If there is enough time to print out flyers or letters to put in people's mailboxes before an extreme heat event begins, the flyers would reach those without a reliable internet connection or televisions.

Heat Response in Healthcare

While heat response plans are essential on the individual level, they are also needed on a larger level, such as businesses, corporations, and health organizations Being able to safely and quickly react to heat events will help preserve the function of organizations and prevent issues that may appear, such as machinery malfunction. Items can also have degraded quality during an extreme heat event.

High temperatures can adversely affect medication in storage- as many medications need to be stored under a specific temperature. In Heelon's article, it's stated that "Most medicines should be stored at 59 to 77 degrees °F in a cool, dry place... The chemicals and components of some drugs can be changed when exposed to different temperatures" (Learn How to Store Medicines Safely, Even in Hot Weather, 2021). The article also states that drugs containing hormones may be less effective if exposed to temperatures that are too high or too low. Additionally, food items can spoil or go bad at high temperatures. The Heatwave Plan for England (2011 edition) suggests moving items to cooler places during a heatwave, which can prevent both medication and food items from going bad. This would lessen the damages of products and items, and it could prevent medical shortages.

Many heat response plans are short-term only, but some discuss long-term alternatives as well. Hong, et al. discuss France and Seoul's heatwave prevention plans, which includes responses to heatwaves. Both city governments use 4 levels of warning, much like the B.C. Heat Alert and Response System. These levels of warning can be discussed with healthcare workers and First Aid personnel.

Type of warning	Heat response level
Level 1: Heat warning	**Level 1 heat response** • Activate cooling centres • Monitor outdoor spaces for people suffering from heat-related illness • Implement a support plan for tenants in our non-market housing (including wellness checks, bottled water and fans) • Provide heat safety information to community partners and SROs
Level 2: Extreme heat emergency	**Level 2 heat response** • All Level 1 measures • Extension of hours at some cooling centres • Activate additional outdoor cooling locations such as heavy water misters and irrigation systems in 15 parks

Vancouver's Current Heat Plan, Source: City of Vancouver

Cooling Centres

What is a Cooling Center?

Cooling centres aim to ensure the public a safe, cool and accessible place to protect public health by providing resources to stay cool and healthy during extreme heat and heat emergencies. In Vancouver, they are most often located in community centers and libraries. Air Conditioning, Water and hydration materials (hydrating salts, electrolytes, glucose), Rest areas, First aid services, Information services and Entertainment are essential variables that make up a cooling centre.

Metro Vancouver cooling locations, CityNews

Barriers to Using Cooling Centers

The following reasons stop people from taking greater advantage of the cooling centre facilities. These factors all affect the behaviours of an individual's decision-making to seek necessary action. Awareness and Motivation, Access and Opportunity, Attitudes and Intention, Social support and Self-efficacy.

1. People are unaware of the threat of heat events or heat waves. They have yet to have any prior preparation or information in tackling the heat.
2. People are aware of the risks posed but have yet to be aware of the intervention centres available (cooling centres) that can help facilitate them and lower the risk of adverse outcomes.
3. People don't consider themselves the 'vulnerable population" even though they fall under those categories.
4. Individuals prefer their own chosen spaces to cool off rather than going somewhere. Others resist going in because they worry they won't have anything to do there.
5. People are aware of the cooling centres but cannot access them easily due to the location of the cooling centre and the transit system. E.g. People might not be able to afford to travel to certain locations.
6. The timings of accessibility of the cooling centres do not fit everyone's needs as most are open during the day or during business hours.

The information above is a summary of information from an article written in 2022 by Bedi et al. ("The Role of Cooling Centers in Protecting Vulnerable Individuals From Extreme Heat")

Improvements to help prepare cooling centres for a future of intense use:

a) Information distribution about cooling centres should be maximized to reach all scales of the population. This information includes:

- Locations of cooling centres
- Transit routes that lead to cooling centres
- Days and hours that cooling centres are open
- Additional services provided by the centres

This can be done through increased advertisements in frequently used public spaces, social media pop-up alerts, and mandatory distribution of pamphlets through mail to all populations, (including homeless shelters). Extra effort to relay the message to elderly populations with door-to-door visits assigned to social workers with extended communication through phone calls.

b) Census checks to be obtained by the government or social health workers before heat months to find out whether individuals in the population fall under the bracket of "vulnerable population" or "general population." This will help all individuals understand what population bracket they fall under and help the city by providing a clear picture of how many people will be at severe risk or part of the "vulnerable population" on the day of a crisis. Prior preparation for such numbers can be facilitated to overcome the effects.

People may be aware of cooling centers, but unable to access them due to insufficient transit or physical disabilities.

c) Small-scale cooling centres should be mandatory within the workspaces where individuals work during a heat event. If such measures fail to be obtained, there should be a fine, penalty or closure of the institution due to health risks. This can be done by segregating sections and rooms in the workspace and converting them into cool areas. It should be made that business complexes cover windows on specific days of extreme heat to reflect the sun's light away from the building.

d) Subsidised fees or fee cuts for using the transit system during a heat event. As well as extending the transit system to provide specific bus numbers only travelling to cooling centres.

e) Increase the number of cooling centres enabling all populations to reach them. Smaller size cooling centres within neighbourhoods should be acquired to enable a larger spread out in the number of cooling centres available for people to visit.

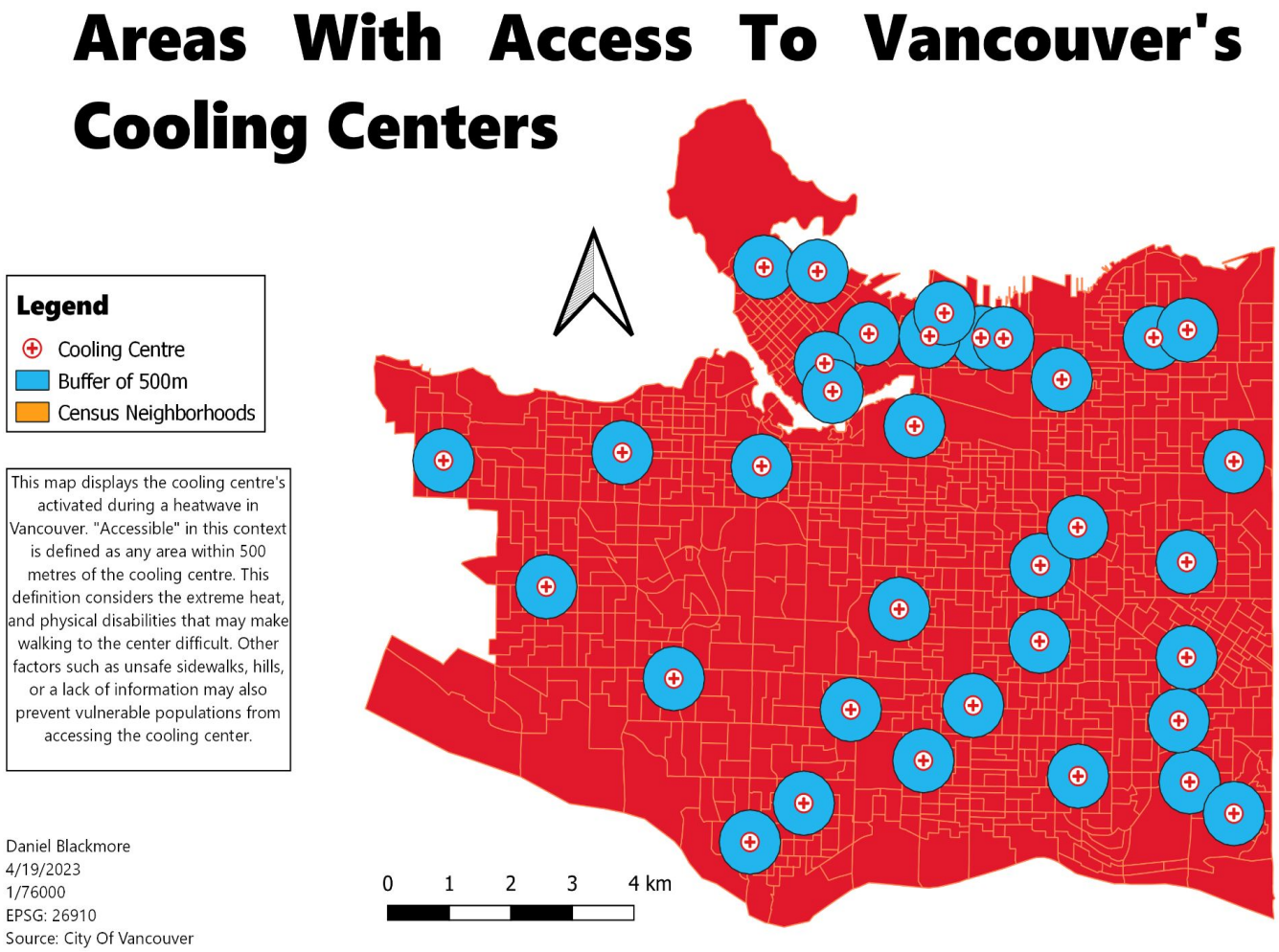
f) Cooling centres can be organized to function on a longer schedule by increasing hours of operation. It is important for people to have a cool place to rest overnight.

g) Government to provide incentives to the public to encourage the general population, to help out at a time of need. This will increase the amount of support within the community by increasing individuals to provide services at cooling centres. This will ensure there won't be any shortage to staff, at cooling centres.

These changes will be beneficial for the economy once the public has efficient options to rely on for intervention in times of extreme heat. The adverse effects will be maintained and managed in hopes that people are still able to continue with basic normal activities. Cooling centres are an important tool to greatly reduce the adverse outcomes of severe heat, but other necessary changes can increase the knowledge and can increase the bearability of the daily heat levels during months of summer.

The scale of change will vary from single homes to city-wide, from passing information to all households and collecting data on vulnerable populations to improving cooling centres and transit systems to accommodate everyone.

Just 20.6% of Vancouver residents have access to cooling centers according to geographic analysis sourced from our map below.



Wellness Checks

What are Wellness Checks?

A wellness check is the act of physically or virtually ensuring the safety of an individual and providing aid. Public wellness checks can help identify vulnerable individuals and ensure they have the resources and support to stay cool and hydrated during extreme heat. These can be done formally, by government officials or volunteers and informally by friends and family.

Volunteerism and Neighborhood Connections in Wellness Checks

Volunteers usually help deliver essentials, combat social isolation via telephone support and online social activities, and address impacts in the community to the local government (Mao et al., 4). These functions can also be applied to B.C. in facing extreme heat events.

Studies found that 46.7% of respondents in a survey want to "become more involved in the neighbourhood in the future" (Mao et al., 5), and this creation of "micro-groups" can help to build trust within communities (Mao et al., 5).

Volunteers can be very useful in providing information to the community. As in the COVID-19 pandemic, the volunteers in the UK in a program called "COVID-19 Community Champion Scheme "were given the latest information about COVID-19 and were asked to share this information in their community, whilst feeding back which communications are effective" (Mao et al., 11). By asking help from volunteering from other mutual aid groups, studies found that this kind of decentralized organizing model is "faster and more agile than the centralised model" (Mao et al., 5).

These community organizations can further act as a communication bridge between the community and local government. In the UK, "95% of council leaders and chief executives saw community groups as being significant or very significant in their COVID-19 response" (Mao et al., 10).

Landlords and Governmental Action

Apart from volunteering, "property owners and managers [also] play a coordinating role in helping entire multi-unit residential buildings plan for extreme heat" (Labbe). They can "provide information to help tenants adapt, identify and support vulnerable occupants and develop an extreme-heat emergency plan with the building's residents" (Labbe).

Landlords can install "a backup generator to maintain air conditioning in designated cool rooms" (Labbe) and arrange a backup water supply.

In Montreal, "the public health authority keeps a list of addresses and phone numbers of vulnerable people" (Labbé), and the "public security [can check] in on residents through door-to-door visits and automated calls" (Labbé). This also can be performed here in Vancouver through volunteering. Public services and medical support are essential in the face of a critical extreme heat event, as research shows that rates of violence, aggression and suicide rise as the temperature heats up (Labbé).

Options for Improving Wellness Checks

Creating a "Wellness Police" (this might include Medical Clinic offices and their Healthcare Practitioners, landlords/Strata management, recreational centre managers, and concerned citizens) could also be a valuable tool for educating the public on the risks and seriousness of extreme heat and how to stay safe.

Establishing clear protocols for responding to heat-related emergencies is crucial, including the roles and responsibilities of public services such as ambulances, fire stations, and police. Heat-related emergencies take much of the city's resources due to disruption of electrical power, more 911 calls, and the demand for water increases tremendously (Egilson et al. 5). The fire departments overwork due to wildfire, poor air quality, and an increased risk of thunderstorms and flash flooding (Labbé).

Expanding the medical support via the 811 hotlines can be an effective pre-hospital measure for responding to heat-related emergencies. The Health Safe B.C. 811 phone message still offers guidelines and resources related to COVID-19 questions. Certainly, it could be adapted to spread information and aid in tackling heat. By providing access to medical professionals via telephone, individuals can receive timely advice and support for managing heat-related illnesses and avoiding hospitalizations while staying safe.

Property owners and managers can "provide information to help tenants adapt, identify and support vulnerable occupants and develop an extreme-heat emergency plan with the building's residents" (Labbe).

Long-Term Solutions:

Planning Responses

Vancouver's heat problem will not be fixed overnight. The Urban Heat Island effect is incredibly complex, and Vancouver's aging housing stock simply wasn't built for the types of extreme heat events we are seeing today as a consequence of climate change. However, with a set of targeted policy and planning changes, Vancouver's future can be much safer. Building code changes can incentivize greener building construction and retrofits, more effective cooling systems, and modern passive cooling design techniques. Plus, a framework to rapidly increase the Urban Tree Canopy (UTC) across the Lower Mainland could drastically reduce average surface temperatures. These long-term planning solutions are incredibly effective from a cost-benefit perspective, as the co-benefits; such as reduced operating costs, positive health outcomes, and a reduction in GHG emissions outweigh the initial investment cost for local governments.

Bridal Falls, Andrew Vidoni

Building Code Changes

During an urban heat event, the typical solution is to have residents move to cooler locations such as cooling centres. Moving people around during an extreme heat event is not the ideal long-term solution. However, a resident has complained to CBC News that living in a “high rise condo – framed with floor-to-ceiling windows” turned her place into an oven (Braich). Overall, the goal is to reduce heat deaths. To achieve this, the following list of building code changes are suggested, following a further explanation.

1. Non-structural changes/installation:
1.1. Encouraging the use of heat pumps
1.2. Retrofitting with new technology proven to lower a room’s temperature
1.3. Methods to DIY a cool roof (Green net/misting/gravel)
1.4. Yard Landscaping
2. Structural changes in buildings:
2.1. Adjusting the design of glass/windows for natural ventilation
2.2. Applying new buildings with natural ventilation (windcatchers/solar chimneys)
2.3. Orienting homes in particular directions during construction
2.4. Passive solar housing design
2.5. Installing cool walls (thermoplastic/heat insulation tiles/colours with high albedo)
2.6. Green roof and green wall

1.1. Encouraging the use of heat pumps

Although the term “heat pump” may be misleading, and some think it is a device that generates only heat, it is actually an alternative device to help cool the indoors. This method is already being promoted and subsidized by the BC Gov and BC Hydro. At the same time, heat pumps help reduce the impact of climate change compared to traditional air conditioners (Christophe). A model made by Mcdiarmid and Parker with a database of 44,463 home energy profiles in Waterloo Region, Canada, shows that “included electric heat pumps achieved greenhouse gas emission reduction of 90% or more (McDiarmid and Parker, 756). “Installing a heat pump can both cool and heat a home.” At the same time, heat pumps “are up to 50 percent more energy efficient compared to a typical window A/C unit” (Braich). However, as Christophe mentioned in the Vox Youtube video, the installation of a heat pump is much more expensive than a typical furnace or an A/C unit, which may discourage homeowners from purchasing one. Heat pump installation is essential in newly built apartments to reduce energy consumption during the winter months and provide cool air in the summer months to reduce greenhouse gas emissions. “In Canada, onsite fuel consumption from the residential sector represents 12% of total GHGe,” and “decarbonization of residential buildings” is one of the major ways “to achieve a climate-safe future” (McDiarmid and Parker, 757). Increasing subsidizations for installing heat pumps would encourage the replacement of fossil fuels and natural gas-consuming heaters in homes.

1.2. Using different materials to lower the room temperature

The main objective of these building code changes is to reduce indoor temperatures. As Hogan said, "It wasn’t about not feeling hot, but rather about avoiding getting to levels where the body would be stressed physically” (Hogan). One way to do this is by closing windows in the morning and fully shading them from the sun. You can use foam, cardboard, wood panels or other opaque materials so the air does not circulate with the hot window surface (Hogan). Another way is to install radiant cooling on walls. “Radiant cooling uses special panels with chilled water to cool down walls and ceilings” (Braich), as it can absorb ambient heat from the outside. Radiant cooling can save about 25% to 60% of energy compared to a typical AC unit (Braich). One suggestion is to put ice or cold water in front of a fan while using it, which can cool the circulated air. Homeowners can change from fluorescent light bulbs to LEDs, increasing energy efficiency and lowering the room temperature. In his blog, Dubovoy suggested using different kinds of easy techniques to passively cool a room. For example, “use a damp sheet as a cover to stay cool” and use cooling mattresses and pillows or only use cotton sheets on beds as it is more breathable (Dubovoy). The main goal of these suggestions is to “move [indoor temperatures] away from a “danger” zone and... toward a “caution” level” (Hogan).

Building Code Changes

1.3. Ways to DIY a cool roof (Green net / misting / gravel)
While residents in apartments might not be able to alter the exterior of the buildings; residents of houses, townhouses, or duplexes can use the following techniques to lower their homes' temperature.

The government of India and their National Disaster Management Authority have listed various solutions for cooling their homes by creating cool roofs since "roofs contribute up to 70% of the heat gain from a building during high temperatures" (National Disaster Management Authority, 5). Their main objective is to use "reflective materials and techniques" to "reduce heat absorption and improve overall thermal comfort in the building" (National Disaster Management Authority, 5). Their suggested materials and techniques are as follows:

> The first suggestion is to put a mist cooling system on the roof, as shown in Figure 1. This will "reduce the roof surface temperature by spraying an extremely small amount of water across the roof" (National Disaster Management Authority, 9).
>
> A second suggestion is to apply gravel, marble chips, or porcelain on the roof, preferably using pale materials. This will increase the albedo levels on the roof, which will decrease direct solar radiation being absorbed (National Disaster Management Authority, 11, 20).
>
> A third option is to increase thermal insulation by using heat insulation tiles or hollow terracotta tiles (National Disaster Management Authority, 14-15). A cheaper way to increase thermal insulation is by using inverted earth clay pots as the middle layer on the roof (National Disaster Management Authority, 16). Alternatively, using polystyrene foam as a middle layer of the roof can be a good insulating material, but this may also have a noise-cancelling effect.

1.4. Landscaping
"Shading with trees (along with evaporation) can reduce the ambient temperature near outer walls by 2°C to 5°C" (National Disaster Management Authority, 29). By creating vertical green on the walls of the houses, house owners can "reduce building and internal temperatures by 2°C to 8°C" (National Disaster Management Authority, 29). On the other hand, creating pergola or creepers outside of the houses can provide shading and reduce "the direct impact of solar radiations" as a result of lowering indoor temperatures (National Disaster Management Authority, 29).

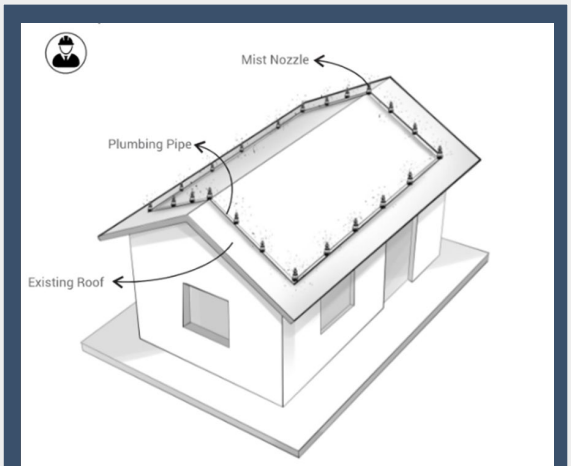


Figure 1 Roof Misting Cooling ("Heatwave", 9)

2.1. Adjusting the design of glasses / windows for natural ventilation

One of the major problems here in Vancouver is that condos can turn into ovens during extreme heat events due to their window design. As mentioned at the beginning of this section, Brenda Perez, who is from Mexico, thought that the heat here in Vancouver would be lower than it is in Mexico; however, due to the floor-to-ceiling windows in her highrise condo, she felt like she was baking inside an oven (Braich).

Most condos in Vancouver are designed with windows that don't open all the way. Since the large windows are designed for winters, this design "allow[s] both cool air to easily escape and that reflect hot air into the building, according to BC Hydro" (Braich). However, non-openable windows trap too much heat during the summer. Hence, a solution to this is to have "smaller floor-to-ceiling windows, which allow more insulation on exterior walls" (Braich), and at the same time, turn them into openable windows to create passive natural ventilation.

Building Code Changes

Condo homeowners may not get the chance to choose their windows' orientation. Still, it is suggested that construction companies consider the orientation of the houses and the locations of windows since these can affect the efficiency of natural ventilation (National Disaster Management Authority, 24).

Condos usually only have one side facing outwards, where single-sided ventilation can occur, as shown in Figure 2. Single-sided ventilation allows "[t]he high-pressure (due to wind) from one side of the building pushes air into the building, while the air then exits on the low-pressure side" (Ahmed et al., 3).

Houses can apply cross ventilation which "is usually seen as more effective" (Ahmed et al., 3). It is "characterised by openings located on two or more facades" (Ahmed et al., 3), and studies have shown that "cross-ventilation contributed to temperature reductions of 1.5°C and 14 times higher ventilation rates when compared to single-sided ventilation in . . . Athens, Greece" (Ahmed et al., 7).

2.2. Applying new buildings with natural ventilation setup (windcatchers / solar chimneys)

Apart from using the location of windows, we could make use of different structural designs to improve natural ventilation in buildings. Wind catchers, solar chimneys, and evaporative cooling here are all actively used in buildings in other countries and can lower indoor temperatures.

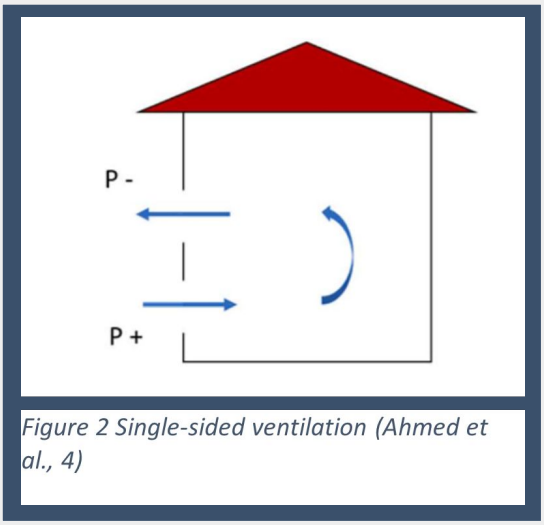


Figure 2 Single-sided ventilation (Ahmed et al., 4)

Figure 3 and Figure 4 are the modern windcatchers in the UK. Windcatchers "resemble[s] chimneys and aim to "catch" the outdoor wind, usually at high elevation" (Ahmed et al., 3). Windcatchers are mainly generated by a difference in pressure and buoyancy. In the daytime, the air enters the building on the positive pressure side and escapes through the negative side. During the night, air movement will be driven by buoyancy, where cool air sinks into the building and hot air rise and escapes- as shown in Figure 5.

Figure 3 (Left) modern windcatcher (Royal Chelsea hospital, London, UK) Figure 4 (Right) modern windcatcher (Seaside school, Lancing, UK) (Ahmed et al., 4)

Building Code Changes

Some studies suggest that by "combining the use of wind catchers with single-sided ventilation in a building (Athens, Greece)" (Ahmed et al., 7) can contribute to a "reduction of internal temperature by 2° C. Meanwhile, by adding water evaporation cooling to the windcatcher, such as water tank or wetted column, the internal temperatures can reduce up to 4°C when the outdoor temperature was 26°C" (Ahmed et al., 7). They tested on a windcatcher with water spray for evaporative cooling and can contribute up to a reduction of 10°C - 15°C (Ahmed et al., 7).

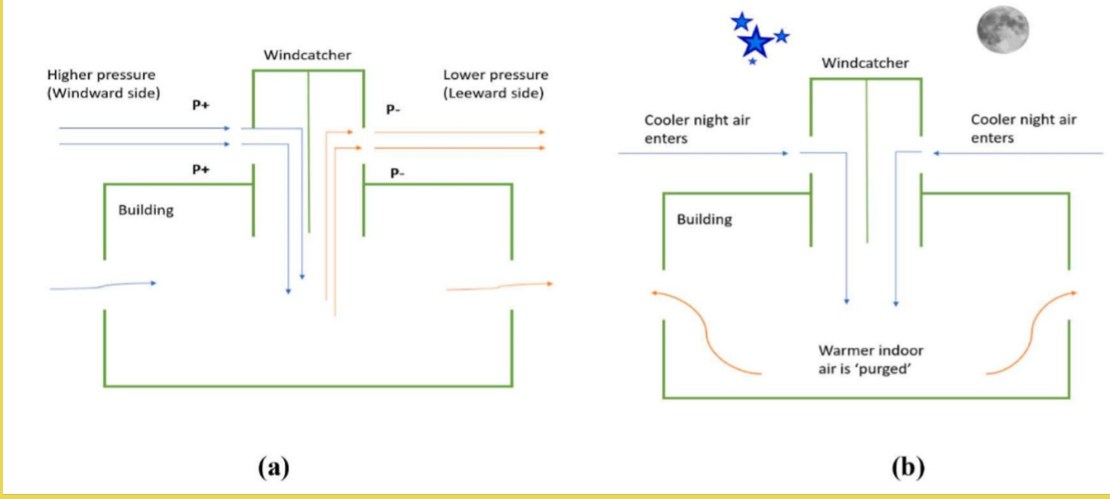


Figure 5 (a) daytime, (b) nighttime (Ahmed et al., 4)

The solar chimney, also called a thermal chimney, "is a vertical shaft that utilises the radiation of the sun to drive ventilation through a building" (Ahmed et al., 5), as shown in Figure 6. The mechanism of a solar chimney is to warm up the air in the chimney as a result of creating uplift and drawing fresh air from the windows down in the building (Ahmed et al., 5). The chimney needs to be "covered by absorber material" (Ahmed et al., 5) to increase the airflow rate, so it works best with "good heat absorbers, such as glass or black paint" (Ahmed et al., 5).

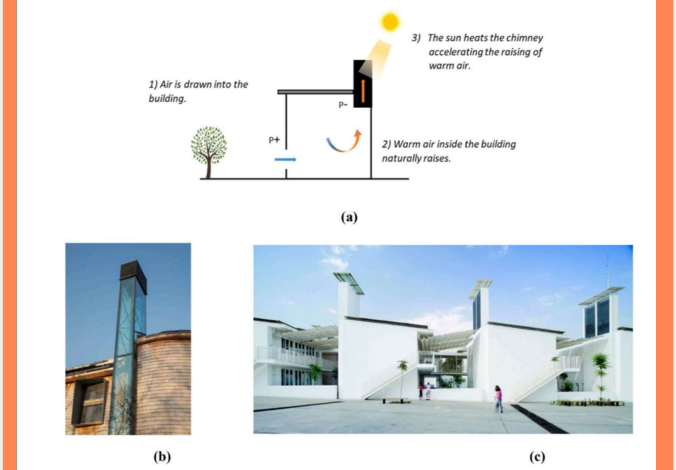


Figure 6 (a) solar chimney operating principle. (b) Solar chimney in an office building in Cambridge, USA. (c) Solar chimney at a school in Damascus, Syria. (Ahmed et al., 5)

A solar chimney can work together with the windcatcher, especially in locations with little wind, to increase indoor wind speeds. Studies suggested that "under low outside wind conditions, using a solar chimney with a windcatcher . . . as a viable solution to heat stress" (Ahmed et al., 10). They simulated that a solar chimney with evaporative cooling can successfully "reduce the internal temperatures by up to 8°C . . . With a mean outdoor temperature of 35°C" (Ahmed et al., 8).

Building Code Changes

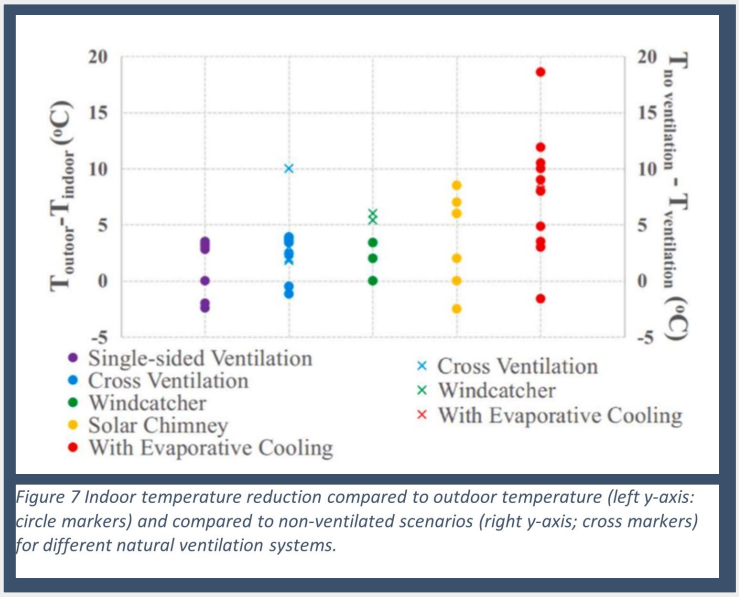


Figure 7 Indoor temperature reduction compared to outdoor temperature (left y-axis: circle markers) and compared to non-ventilated scenarios (right y-axis; cross markers) for different natural ventilation systems.

Figure 7 shows the indoor temperature reduction with all the natural ventilation systems mentioned on the previous page.

2.3. Orienting homes during construction

The orientation of the above suggested that natural ventilation systems are essential. For example, in the design and setup of windcatchers, orientation, location, shape, and size must be considered (Ahmed et al. 3). When people start to build their homes, the orientation of the windows is also one of the main issues affecting how much heat can be trapped indoors. To reduce direct sunlight into the house, "try to minimize the number of east and west facing windows" ("passive").

Apart from orientation, UBC-based urban design expert Patrick Condon also suggested that prioritizing mid-rise buildings is preferable to sky-high ones because the buildings themselves can "shade each other, particularly on the west sides" (Braich).

2.4. Passive solar housing design

Shading is an excellent way to reduce temperatures in houses. However, improper shading might also affect a house's heating during winter. By carefully designing an "overhang or other devices such as awnings, shutters and trellises" (Passive Solar Design), we can block the sun's rays during the summer. This still allows sunshine into the house during the winter since the sun is at a lower angle during winters. However, if the windows are facing east and west, overhangs cannot work efficiently due to changing angles of the sun during sunset and sunrise. Figure 8 is an example of an overhang usage named "Control."

The government of India has also suggested different ways to create shading to the windows, as listed below in Figure 9.

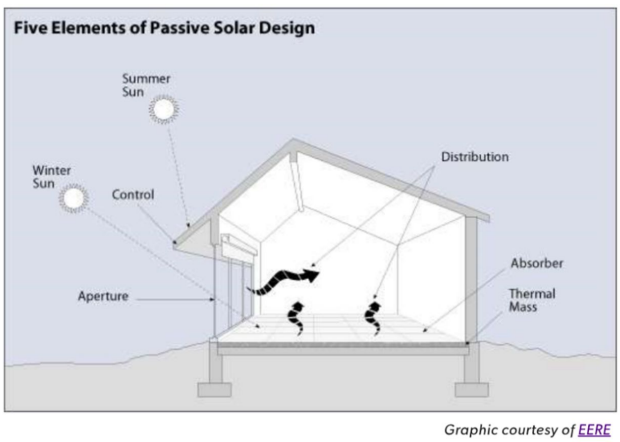


Figure 8 Passive Solar Design ("Passive")

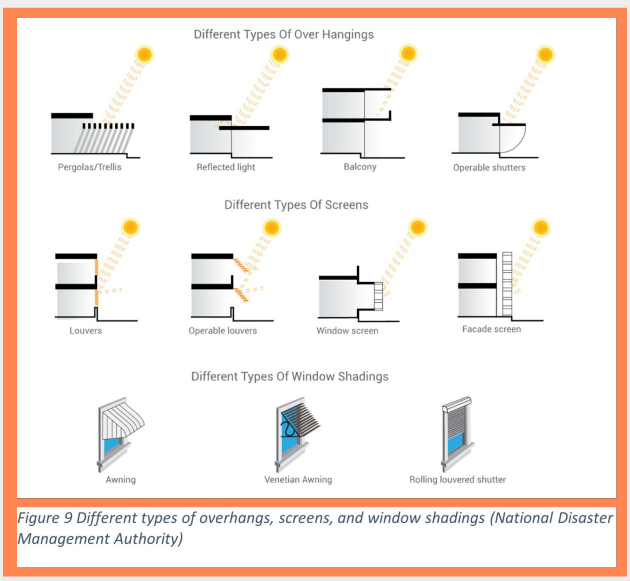


Figure 9 Different types of overhangs, screens, and window shadings (National Disaster Management Authority)

Building Code Changes

2.5. Installing cool walls (thermoplastic / heat insulation tiles / colours with high albedo)

India's government has suggested ways to reduce the heat absorbed via the walls. Firstly, by building hollow walls which “create cavities in walls” (National Disaster Management Authority). They suggested house owners use hollow blocks or Autoclaved aerated concrete (AAC) to construct their homes. These two methods introduce air space in traditionally solid materials to increase insulation. However, these methods do not apply to mid-rise or high-rise buildings.

Using more reflective colours is also a way to increase the reflectivity of the walls and, as a result, increase insulation.

2.6. Green roof and green wall

Lastly, using a green roof and a green wall is an effective way to lower indoor temperatures. Studies suggest that “shading with trees . . . can reduce the ambient temperature near outer walls by 2°C to 5°C (National Disaster Management Authority). Green walls, green roofs and rooftop gardens help reduce solar energy hitting the walls, reducing indoor temperatures.

“Most... literature suggests that green walls have great potential to cool surfaces and reduce energy consumption in building[s] during summer” (Oquendo-Di Cosola et al., 2), as studies suggest that “green walls . . . are capable of creating a microclimate in the zone adjacent to the building” (Oquendo-Di Cosola et al., 5). One finding is that continuous green walls can reduce temperatures by up to 15.5°C in oceanic climates.

Built Environment

The public realm in an urban area mainly consists of public buildings, parks, plazas, and its transportation network: streets, roads, bike paths, waterways, and public transportation. Through the government, the people have collective ownership over the organization of that land. The way cities organize that space determines our urban tree canopy. Paved surfaces heat cities, while trees cool them down in various ways.

Ideally, municipalities should be paving surfaces only when necessary and integrating greenery wherever possible to mitigate the Urban Heat Island effect. To do this, we need to look at our transportation networks that rely on pavement in a way that focuses on space efficiency and synergy with nature. Walking is the most space-efficient way to travel short distances, cycling is best for middling distances, and public/mass transit is the most space-efficient way to travel long distances. Therefore, the region should prioritize these modes of transportation going forward.

Increasing the albedo of residential roofs directly cools the environment, while encouraging mixed-use development reduces car dependency and asphalt surface area. Solutions to the urban heat island require adaptation in all aspects of city planning and design.

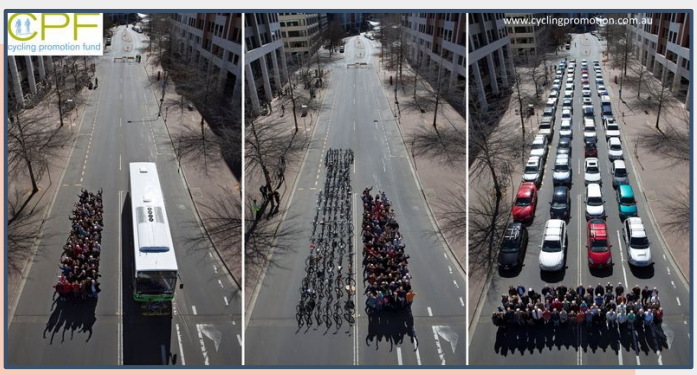
Cars vs Active Transportation

Understanding the relationship between the built environment and the ways we move around our city:

Space in cities, especially in Metro Vancouver, is scarce. Vancouver has an **Urban Containment Boundary** that prevents the city from expanding into lands designated for agriculture and nature. As Metro Vancouver continues to attract people from around the world and the population increases, we must look within the city to find the space to accommodate future citizens and the space required for them to move around the city. From a space-efficiency perspective, **mass transit** is one of the most effective methods of moving people from place to place. As we move into a future of increasingly frequent heat events, we must make transformational changes to how much pavement, concrete, and asphalt are used in our cities. Suppose we want to be able to accomplish this. In that case, we must acknowledge that planning a transportation network around the dominance of personal vehicles (the least space-efficient transportation mode) will not work.

A transportation network that promotes the use of personal vehicles over alternative modes has many negative implications, such as; increased congestion, less resilient infrastructure, high maintenance costs, poor accessibility, and encourages increasingly sedentary lifestyles that have costly impacts on our public healthcare system. We associate cars and car ownership with personal freedom, but when you design a network to prioritize car traffic above all else, you incentivize everyone to own and use a car through a concept called **induced demand**.

The lifecycle of any heavily-used roads is also much shorter than the respective mass/active transportation infrastructure despite car lanes generally having a much lower carrying capacity per hour, making it far more expensive for the government to maintain over the long term. The **Downs-Thomson paradox** proves that drivers benefit from a system that prioritizes alternatives to cars through decreased traffic, leading to cost and time savings.“If buses and trams get stuck in traffic, so it can never be faster to take the bus, then what happens to car traffic? Well, it increases, almost indefinitely” (Slaughter).



This image from the Australian Cycling Promotion Fund helps us visualize the argument of space-efficiency. Look at how much space we dedicate to cars in our city because they are prioritized and demand is induced, all that asphalt and concrete has enormous impacts on surface temperature in urban areas

From the Federation of Canadian Municipalities: “People are quick to agree that active transportation is vital to sustainable, healthy communities. It’s easy to see why—when people walk and cycle, they create desirable communities with less traffic, livelier streets and cleaner air." (Plan H).

A transportation network focusing less on giving cars priority benefits everyone in society: Drivers get stuck in traffic less because there are faster alternatives and fewer conflicts with other modes like bicycles and buses. Transit users don’t have to worry about buses, trains and trams getting stuck behind cars. Cyclists and pedestrians of all ages and abilities can get around the city comfortably without having to worry about sharing space with personal vehicles that could kill them if a collision occurs. Most importantly, for the context of this report, giving priority to safer, space-efficient modes of transportation means we don’t need as much asphalt or concrete in our city, creating space to increase the city’s green space and Urban Tree Canopy coverage.

Public Transportation:
Improving transit in Vancouver is a key priority when dealing with a heat event or emergency. Through research, we found that a majority of the heat-related deaths occurred in the elderly demographic, where these people were living by themselves and should have been checked on more due to how vulnerable the population is. Transit can help with this because most TransLink fleet transit vehicles are equipped with air-conditioning onboard. This creates a cool environment for all passengers. However, not all seniors and passengers have access to a nearby cooling centre, and some have to walk many blocks to access these facilities around Vancouver. That is why having a shuttle to transport the vulnerable populations to these cooling centres is essential to alleviate deaths from the heat. This would be simple to implement because TransLink operates HandyDart. This service shuttles seniors and other people who have difficulty accessing transit. It can also be used by riders whose living situation does not have access to air conditioning. Adjusting HandyDart would assist in creating a cool and safe environment where someone would watch over them.

Active Transportation

- **Investing in active transit infrastructure is economically beneficial for society**
- **Allowing active transit improves the health of the population, reducing the chance of heat deaths**
- **E-Bikes and other assisted modes of active transit are a critical tool for seniors**
- **Half-measures for creating active transport infrastructure are not sufficient for the elderly**

Background and General Benefits

Active transport is a form of movement that requires the person to expend energy beyond their daily activities. Encouraging the use of active transit not only cools our cities through a reduction in particulate air pollution, but also provides a variety of other benefits. Active transit accessibility is absolutely essential for a modern city. Demographics that have trouble using private automobiles, such as children, disabled people or the elderly, deserve safe and reliable methods to travel. Designing urban areas to accommodate active modes of transport, such as walking or biking, reduces the need for paved surfaces that heat up the air (Vox). This allows space to be used more efficiently and gives room for businesses, housing, and parks, which cools our environment. A cost-benefit analysis that included health, safety, time costs, and more found that private automobile infrastructure is 6 times more expensive to society than biking infrastructure and is becoming more expensive every year (Gössling and Choi). Encouraging active transport is a "win-win" and is necessary for an equitable society.

> "If all Canadians engaged in 60 minutes of physical activity per day, 33% of all deaths related to coronary heart disease, 25% of deaths related to stroke, 20% of deaths related to Type 2 diabetes, and 20% of deaths related to hypertension could be avoided." (Plan H).

These changes can lead to an improved economy, better overall health, livability, accessibility, cost-efficient forms of movement, and increased sustainability. The government's investment will be on a medium to large scale due to the necessary reorganization of walking paths and bike lanes, which will be region-wide. However, this investment will be paid back in long-term benefits and economic growth

Health Benefits of Active Transit

Many descendants of the catastrophic heat dome in 2021 were particularly vulnerable because they suffered from one or multiple health complications, eg; hypertension, mood & anxiety disorders, diabetes, heart failure, Alzheimer's, etc. (Egilson et al., 26). Studies are showing that cycling can drastically reduce these health complications and that increasing accessibility to seniors through electric assistance (e-bikes) can have a profound impact on their health (Sutton). Setting aside space in our transportation network for active transportation that is accessible for seniors and other vulnerable road users creates incentives to utilize these active transportation modes, resulting in a healthier population with a reduced overall likelihood of dying during extreme heat events.

E-Bikes and Improving Accessibility for the Elderly

There is a micro-mobility revolution with technology making rolling more accessible to different people through electric assistance (Anzilotti). Failing to provide All-Ages and Abilities mobility lanes and pathways to encourage our most vulnerable populations to adopt these new energy-efficient modes of transportation would be a wasted opportunity for cities across B.C.. Half-measures such as painted bike gutters and shared right-of-ways are insufficient to provide safe active transit systems for elders. Such lacklustre infrastructure will only attract the most confident and able-bodied cyclists to switch modes, so fully separated bike lanes and paths are necessary for full accessibility (Amos).

Beneficiaries

Active transit improvements would benefit all that are capable of walking, biking, or rolling any distance. Particularly, these improvements would improve the mobility of elders, children, those that cannot afford a car, and the physically disabled by providing safe spaces to travel.

Urban Greening: Urban Tree Canopy (UTC)

Raising the amount of urban greening in the city through an increase in tree canopy cover provides many benefits related to cooling surrounding environments along with additional unrelated perks. The benefits that trees provide are shading, cooling, carbon storage, rain/stormwater management, reduction in runoff helping mitigate flooding, and wildlife habitat. By raising the amount of green space, we reduce the number of impervious surfaces, such as buildings, pavement, brick, stone, and other man-made structures. Areas with greater amounts of imperviousness result in increased temperatures compared to areas with plenty of vegetation because there is less shade and moisture, which in turn means that there is less plant evapotranspiration (Nicoletti, 2019).

Stephen Sheppard, a Forestry professor at the University of British Columbia, created a tree canopy in his front yard to create shade and keep the areas surrounding his home cool. Sheppard explains the area in his front yard is cooler than the public street due to increased shade and evapotranspiration.

Evapotranspiration is a plant process that releases moisture into the air and surrounding environments over time, which in turn brings a cooling effect.

Sheppards research with the City of Vancouver, British Columbia, has shown that neighbourhoods with a natural green parasol are noticeably cooler than neighbourhoods without shades from plants.

The less greenery there is in a neighbourhood, the greater potential danger there is to people during extreme levels of heat. Higher-density areas like False Creek Flats in Vancouver have low canopy levels. Despite being close to a shoreline, it is more vulnerable to heat and other climate impacts, such as flash flooding. Altogether, people living in neighbourhoods without tree canopies and green spaces are more susceptible to higher mortality rates (CBC Vancouver News, The Cooling Effects of Urban Tree Canopies).

Campbell River, Andrew Vidoni

Urban Greening: Urban Parks

An article assessing the cooling effects of parks in various U.S. cities and how it helps mitigate urban heat islands mentions how park design can largely influence temperatures through evapotranspiration within parks and the surrounding areas. However, like most things, the law of diminishing returns applies to most areas as relative humidity levels in the air often constrain effective cooling.

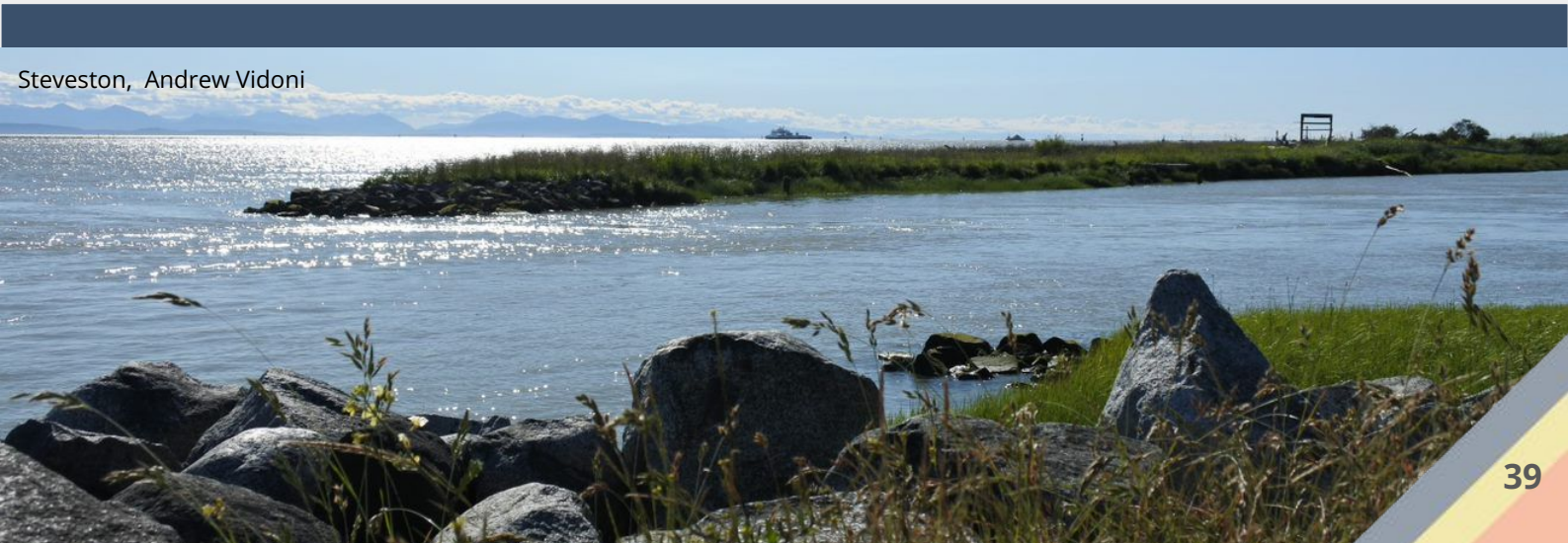
The research in the article uses ground-based measurements and remotely sensed observations to create their own indexes illustrating the effectiveness of parks in various cities. The first index is park cooling intensity, being described as the temperature difference between the park and its surroundings. The second index is the park cooling distance describing how far the park's cooling effect can reach. These indexes are the primary indicators of park vegetation's effectiveness in a particular city. In general, park cooling intensity illustrated a positive correlation. Portland, Oregon, exhibited relatively high park cooling intensity values on any given date.

On the other hand, Austin, Texas, exhibited relatively low park cooling intensity values. The three other cities: Baltimore, Chicago, and Los Angeles, displayed intermediate park cooling intensity values. The variation between the cities suggests that climate context and urban geography may account for the discrepancy of park cooling index values among the different cities.

In terms of park cooling distance, Austin exhibited a relatively high cooling distance of 221 metres, followed by Los Angeles with 165 metres and Chicago with 163 metres. Portland and Baltimore displayed a relatively significant decrease in park cooling distance. Portland has an average park cooling distance of 132 metres, and Baltimore has an average park cooling distance of 116 metres. Due to the difference in the number and size of parks in each city, the article found that it was not appropriate to directly rank the cities based on park cooling distance and park cooling intensity.

Nevertheless, the distinct differences in park cooling intensity and park cooling distance in the five cities imply that a stronger park cooling intensity may not necessarily correlate with a longer park cooling distance (i.e distance decay). Knowing this, the researcher in the article created another index known as park cooling efficiency: a ratio of park cooling intensity and park cooling distance.

From lowest to highest, Chicago had the lowest park cooling efficiency, then Baltimore, Los Angeles, Portland and the highest being Austin. Increasing the area and perimeter of parks can enhance the cooling effect, especially by improving the park's cooling distance.



Steveston, Andrew Vidoni

Urban Greening: Urban Parks

The shape of the park displayed an insignificant difference in the park's cooling indexes. A higher area of artificial impervious surfaces and buildings in Austin, Chicago and Portland displayed a reduced park cooling effect. The increase in vegetation and trees illustrated a strong positive correlation with the park's cooling indexes. Evapotranspiration sourced from vegetation and surface water evaporation displayed a majorly positive impact. The various factors and park configurations mentioned above suggest a positive correlation in the effectiveness of an urban park's cooling effect. The correlation between the various variables (park cooling intensity, park cooling distance & evapotranspiration) illustrates that park area and surface evapotranspiration are the best predictors of the park cooling effect. The article outlines that their study of the relationship between park area, evapotranspiration and the park cooling effect was all non-linear. However, with the increase of park area, the park cooling effect gradually decreases logarithmically, eventually reaching a plateau. Beyond a certain point, the increase in the park's size becomes so insignificant that its cooling range cannot go any further.

Evapotranspiration was most effective in Los Angeles and Austin, which can be explained by the relatively higher cooling efficiency of urban trees and greenery in cities with hotter and drier climates. In those cities, the smallest parks can achieve maximum potential regarding park cooling intensity and distance. This implies that parks have a substantially larger influence on the surroundings than the park itself. When a park's area is increased to a threshold, the surrounding built-up environment has an insignificant impact on the park itself, hence its reduced temperature. The cooling effect of increased evapotranspiration will generally be more beneficial in drier environments such as the Chaparral and Mediterranean biome in Los Angeles.

Therefore, the environments in cities such as Austin, Los Angeles and Baltimore (to some degree despite their humidity) are more sensitive to changes in evapotranspiration, which was elucidated in the research performed in the various cities. Since Chicago and Portland are more humid cities, the correlation between evapotranspiration and park cooling effect is not as strong as in humid cities. Hence, the size of a park's area plays a more important role than in drier cities. The findings from this particular article help people understand the spatial features of parks and their effect on surrounding urban environments (Gao, 2022).

Cypress Mountain, Andrew Vidoni

Urban Greening: Greener Buildings

Increasing surface greenery/vegetation is an effective way to mitigate the effects of climate change and the urban heat island effect on buildings and building occupants.

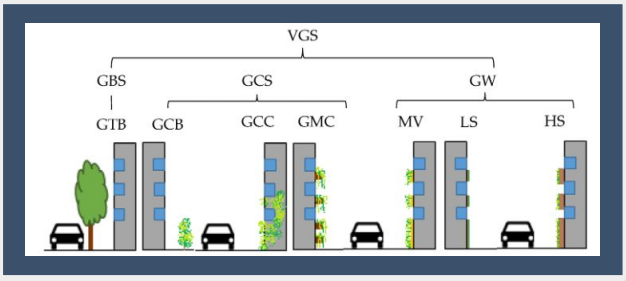
Increasing greenery in urban areas is effective as the leaves provide the main cooling effect achieved by vegetation. Green roofs, also referred to as roof gardens or living roofs, are a system of vegetation planted within a growth medium. The structural composition of green roofs can be classified into intensive, semi-intensive, and extensive categories: Intensive green roofs can accommodate a wide variety of plant species, from grasses and small shrubs to trees, supported by a substrate depth normally greater than 25 cm. Maintenance is required for fertilization, irrigation, and plant accommodation. Extensive green roofs are constructed with plant species such as herbs and grasses, set on a substrate layer between 8 and 15 cm in depth, requiring lower maintenance and less water. Semi-intensive green roofs are made by small plants such as shrubs and grass, supported by a layer of substrate typically varying between 15-25 cm in depth. They require more maintenance than an extensive green roof but less maintenance compared to intensive roof systems. Of the three systems, the most popular is extensive green roofs, as they are lighter and more easily installed on roofs than the other green roofs. In addition, these systems don't require a dedicated irrigation system to be installed, requiring less capital and maintenance than the other two (Hayes, Alexander Thomas, et al. 5).

Another form of urban greenery is Vertical Greenery Systems in buildings that have large areas of exposed façade. This system is more effective than green roofs as vertical greenery can cool multiple floors, whereas green roofs may only cool the floors directly below the roof. Vertical greenery systems include 3 categories; green barrier systems, green coating systems, and green walls. All three categories have different constructions, effects on building energy use, occupant thermal comfort, or UHI reduction.

The green coating system (GCS) includes a green climbing barrier and green climbing coating systems where plants grow up from the ground or green modular coating systems in which the plants grow from containers attached to the façade.

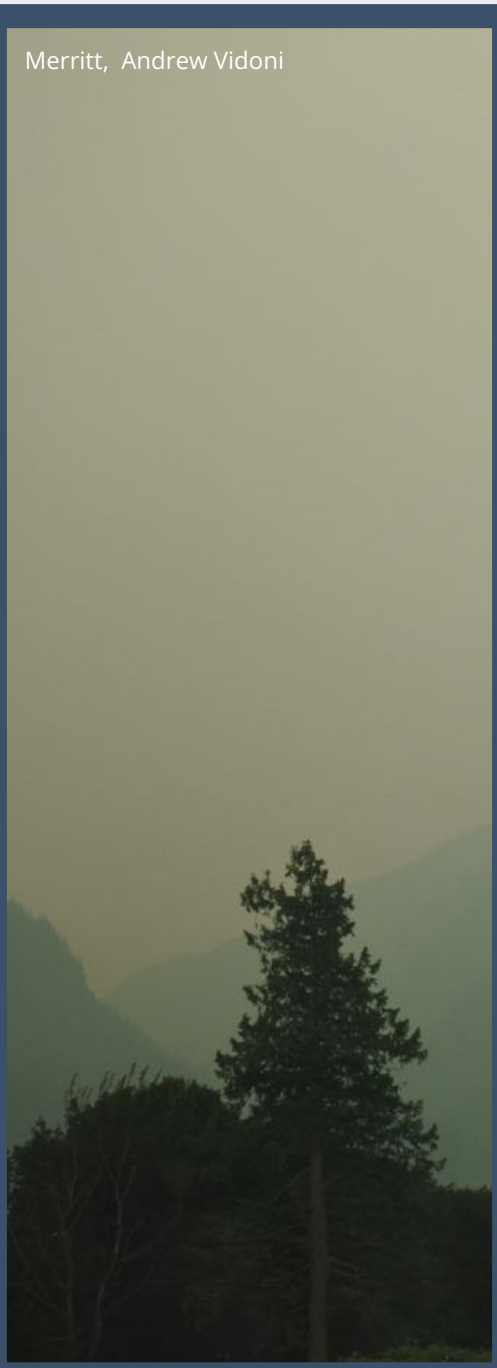
Typically, GCSs alter the thermal performance of a building by shading incoming solar radiation and creating a wind barrier that alters the exterior convective coefficients. Plants used in GCC and GCB systems climb a façade by directly attaching themselves to a surface or climbing a freestanding support structure or a lightweight support system attached to the structure. As GCB and GCC require little support, these vegetated systems can be implemented with little capital compared with other vertical greenery systems and are suited to retrofit applications.

An added benefit of GCB and GCC systems is that the vegetation can provide greater shading coverage faster than trees, which may take between 10 and 30 years to reach their cooling potential. Green modular coating systems can cover more of a façade than plants growing from the ground. The use of Green Tree Barrier (GTB) systems within the urban environment can provide the cooling potential to both horizontal and vertical surfaces through shading and lowering the ambient air temperature through transpiration from their leaves. GW systems have the potential to provide greater levels of cooling compared with GBSs and GCSs due to increased levels of transpiration from the plants and evaporative cooling from the growth medium (Hayes, Alexander Thomas, et al. 6-7). All these vertical greenery systems are effective ways to reduce the effects of heat waves in buildings. At the same time, it will provide shade to pedestrians, have cleaner air, reduce air temperatures, and most likely help with pollution and carbon emissions caused by cars. However, these systems require maintenance that will mostly depend on the residents of the building.



Reacting to Climate Change

Reacting to climate change can come in two different forms: adaptation and mitigation. Adaptation involves adapting to climate change as it is. Adaptations can be short-term, such as painting surfaces to be more reflective or using urban greening as a strategy to cool cities. Mitigation involves reducing the amount of greenhouse gas emissions that are put into the atmosphere.



Merritt, Andrew Vidoni

Climate change is already affecting Vancouver through extreme weather events and rising temperatures. Major action is needed to be taken by all levels of government to reduce carbon emissions in Vancouver. Large amounts of greenhouse gases are released by burning fossil fuels, which causes global warming. According to the Intergovernmental Panel on Climate Change (IPCC), every world region contributed to heat waves by burning fossil fuels (Chandrasekhar et al.). Improving public transportation and increasing the number of biking lanes will help reduce greenhouse gas emissions. B.C. plans to have on roads 100% new cars with zero carbon by 2035 (Ministry of Environment and Climate Change Strategy 10). Therefore, there will be a need for more places to charge electric vehicles.

Moreover, buildings account for nearly a third of global carbon emissions. Indoor heating requires fossil fuels, which are some of the biggest contributors to the climate crisis (Haubursin). Air conditioners use an excess of energy to cool buildings, which leads to an exacerbation of the urban heat island effect. “The use of air conditioners also increases energy consumption – hence potentially contributing to climate change and further raises the outdoor temperature due to exhaust heat from the outdoor unit of the air conditioner” (Kondo et al. 1). Due to rising temperatures, the demand for AC is increasing, and this can be used as an opportunity to install electric heat pumps that can heat and cool buildings. Heat pumps can be more energy-efficient as they do not depend on fossil fuels to generate heat. They move heat from outside to indoors to keep homes warm during winters. It will help to decline the need for fossil fuels at home. The article analyses that “replacing space and water heaters with high-efficiency electric heat pumps achieved a modelled 70% energy efficiency gain and 93% GHGe reduction” (McDiarmid and Parker 765). However, electric heat pumps require electricity produced largely by burning fossil fuels. Therefore, promoting the use of renewable energy sources such as hydroelectricity, solar panels, and wind turbines will shift the electricity supply to low-carbon energy sources. “All fuel burning systems in the home are replaced with highly efficient electrified systems” (McDiarmid and Parker 758).

Reacting to Climate Change

Green space is essential in urban areas as they help keep the city cool and serve as beneficial to the climate. Areas with a lot of buildings are more prone to extreme heat. Planting trees helps absorb carbon dioxide and helps reduce the urban heat island effect. Trees can be planted in parks and streets to reduce extreme heat in Vancouver. The shade created by trees helps cool nearby buildings and relieves residents. Trees also reflect more solar radiation and store less energy than pavement areas. City air pollution concentrations rise in warming cities. Urban parks will help decrease the temperatures in the contiguous areas while decontaminating urban pollutants (Zoulia et al. as cited in Akbari et al. 9). B.C. aims to reach net zero carbon pollution by 2050. The government needs to respond to climate change by focusing on the city's infrastructure, like planting more trees in urban areas.

Poor urban design can elevate the effects of climate change, for example, buildings designed only for colder conditions still need to operate in hot weather.

The UK has taken an initiative known as blue-green infrastructure to support sustainable development that can reduce climate change's adverse effects. The blue-green infrastructure is becoming popular in Europe, fixing problems such as droughts, floods, extreme weather events, and insufficient rainwater soaking due to non-permeable surfaces in urban areas. An article describes the process of the blue-green network- It contains natural and semi-natural elements combined with water and vegetation. It involves the regulation of the climate of a surrounding area by shielding, through evaporation of water and transpiration from plants, or by changing the air movement and heat exchange (Raczkova et al.38).

Iona Island, Andrew Vidoni

Reacting to Climate Change

The flowchart represents the benefits of blue-green infrastructure, which also fulfills the social and cultural factors (Raczkova et al. 38). This technique has been used in Germany, Switzerland, and the Czech Republic to react to climate change (Raczkova et al. 40).

Farmers must also prepare for climate change in Vancouver as they play a vital role in mitigating greenhouse gas emissions through sustainable farming practices. The U.S. Department of Agriculture has suggested farmers install cooling systems such as water misting systems to help workers and crops during extreme heat events. Agriculture emits at least 10% of the greenhouse gases in Canada and mostly comes from livestock production, the burning of organic residues, and the heating of greenhouses with natural gas and other fuels ("The Climate 2050 Roadmap Draft").

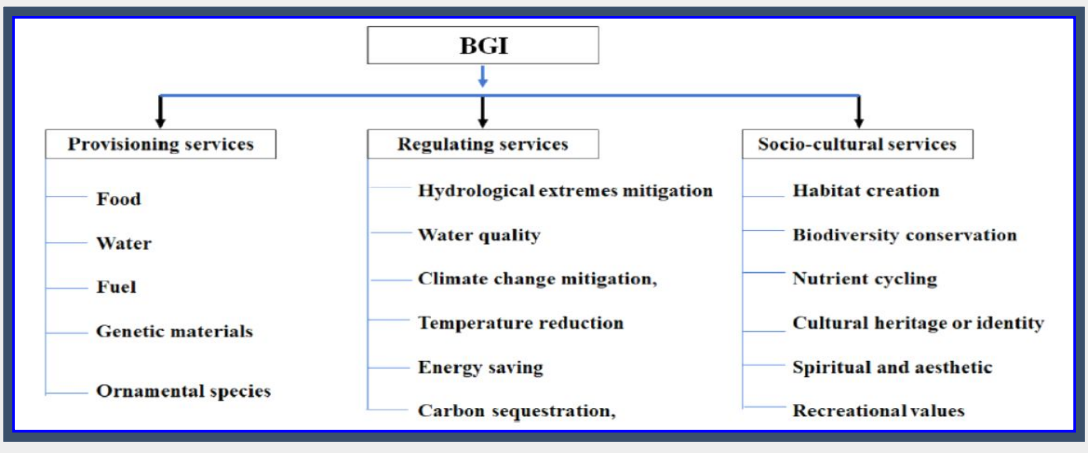
Heat waves can harm crops, raise the demand for cooling livestock barns, and increase refrigerated crop storage, leading to higher costs and energy use. It is important for farmers to educate themselves and their communities about regenerative agricultural practices, which enhance grazing practices, composting, and increasing plant diversity that will help the soil store carbon.

Farmers can favour policies that help bring awareness to extreme heat events, such as the "Pilot Extreme Weather Preparedness for Agriculture Program," which aims to increase farm-level climate resilience. Some of the suggestions include:

1. Improved Barn Cooling System
2. Heat protection for outdoor livestock by providing shades of trees (Ministry of Agriculture and Food).
3. Enhanced livestock watering to reduce heat stress
4. Improving fertilizer and manure management
5. Crop rotation helps to mitigate the need for fertilizers and pesticides, which can cause greenhouse gas emissions

Other techniques to reduce carbon emissions are using biofuels to run farm equipment such as biogas, wind, and solar energy. The agricultural sector requires support services from the B.C. government, B.C. Agricultural Council, and B.C. Greenhouse growers ("The Climate 2050 Roadmap Draft").

Some of the challenges with reacting to climate change using devices include heat pumps being too expensive, a general lack of awareness surrounding heat pumps, and it may be difficult to find installers of heat pumps (McDiarmid and Parker 759).



District Heating and Cooling

District heating and cooling systems will help reduce the emissions of greenhouse gases that are highly responsible for expediting climate change, which exacerbates extreme heat. However, the use of district heating and cooling systems across Canada is limited compared to other international examples. These systems have provided various advantages in the places where this system has been used. The objective is to distribute heat and cooling to multiple buildings through a single network instead of having individual heating and cooling systems. There are various places where this system has been used with success. There is a heating plant in Charlottetown where heat is distributed to 125 buildings by reusing the heat generated by incinerating waste and garbage (black bin), which keeps the atmosphere clean and replaces natural gas to generate electricity ("CBC"). In Toronto, cold water is drawn from the bottom of Lake Ontario to cool 85 buildings, such as government buildings, hospitals, and residential buildings. Another example is the cooling distribution system at Cornell University in the United States, where cold water is distributed to 300 university buildings through pipes by drawing water from the depths of Lake Cayuga (Thomas and Butters). Vancouver is located near the ocean. Therefore, this technology can be applied to help reduce emissions and waste heat into the atmosphere.

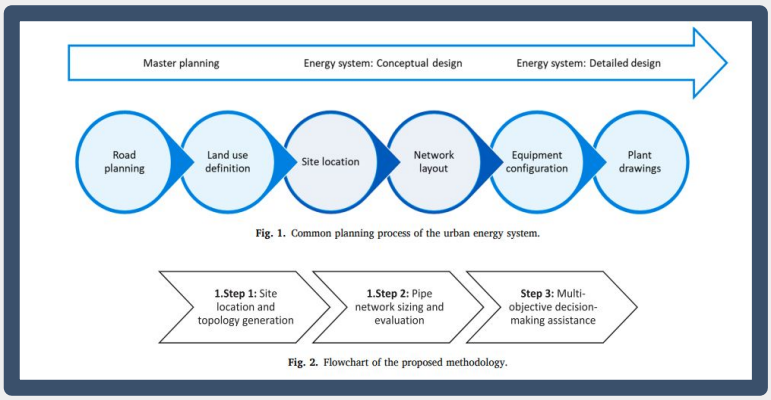
Furthermore, it is easier to control the heating and cooling of buildings as a whole rather than individually. It can be efficiently managed and maintained on a large scale. There are fewer barriers to expanding cooling capacity and fewer parts needing storage. The demand for cooling buildings is increasing due to rising temperatures (Ivančić et al. 1). This option is cost-effective as residents do not have to pay for equipment installation and will help reduce noise. It will also bring equality and enhance the standard of living, especially for low-income families who are not able to afford air conditioners. It is much more profitable than A/C and is energy efficient, whereas A/C adds to the Urban Heat Island effect and is becoming a major concern of public health, such as respiratory issues. Energy demand increases during extreme heat with cooling load due to the use of air conditioners.

CHALLENGES and CONTRIBUTIONS:

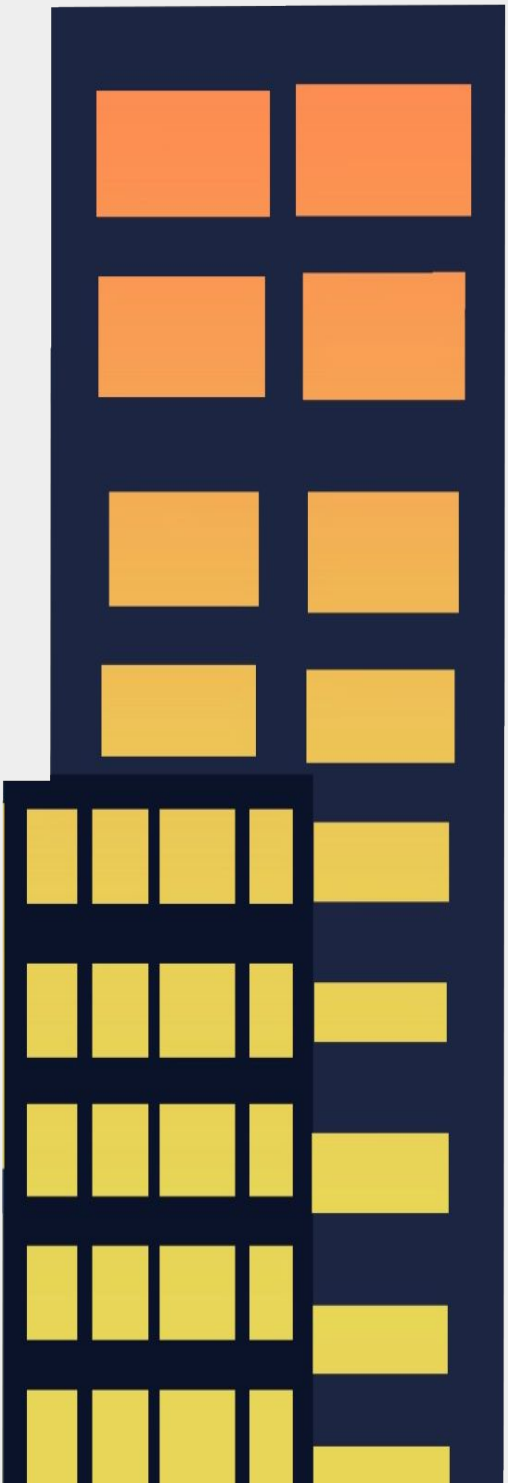
Most buildings in Canada are individually heated, so installing the infrastructure requires a large initial cost but will reduce the long-term cost and cannot be done without government help. As the design space is too large which is not possible with only a few individuals, instead, there is a of need engineering skills and knowledge that should be used to design the network (Ho et al. 1). This project requires a coordinated effort that can be implemented with the help of local government officials, energy experts, investors and community members. Secondly, natural gas is very cheap compared to renewable sources of energy.

- **Needs urban and infrastructure planning**
- **Lack of awareness of the technology**

The figure below shows the plan to implement a district thermal energy system (Ho et al.). The location of energy production power plants and network structure are two principal decisions that are not well planned and are hampering the project (Ho et al. 2).



Government Responsibility:



To lessen the consequences of heat waves and heat domes, there is an urgent and necessary need for clarity, collaboration and coordination across every level of government and clearly defined roles. Listed is one set of recommended responsibilities for the major levels of government taken from examples at home and abroad. Ultimately, these responsibilities must be decided democratically through provincial and federal communication, delegation, and legislation.

In this report the levels of government responsibility section is a combination of what is done now, and what could be done.

Included is a shortlist of some of the currently or previously available in BC as funding avenues for the policy and planning solutions mentioned within the report. This list shows a precedent of federal, provincial, and municipality support for improving climate resilience and building community.

If the evidence of long-term cost savings in healthcare, disaster relief, and infrastructure maintenance is recognized, many of these proposed solutions should have few barriers to getting the necessary funding.

Lighthouse Park, Andrew Vidoni

Levels of Government Responsibility

There are multiple levels of government which hold some part of the responsibility for deaths during heat events. We have identified ways governments currently hold responsibility or seek the means to fulfil their existing responsibilities. Differing locales will have different levels of preparedness in this regard.

<u>International alliances and partnerships:</u>

- Ecological sustainability accords
- Grave ramifications for breaking environmental accord pledges
- Reduced credit for carbon offset programs

<u>Federal/National:</u>

- Declare heat emergencies an acceptable use of emergency funds allocated for Climate Emergencies
- Give provinces the power to declare a state of Climate Emergency

<u>Provincial/Regional:</u>

- Promptly confirm the existence of a heat event when one occurs
- Approve the allocation of emergency funds

<u>Municipal:</u>

- Apply for grants and subsidies
- Lobby for infrastructure retrofitting to accommodate cooling devices
- Formulate information campaigns
- Designate cooling centres
- Word-of-mouth: Organise cultural events directed at community resilience through heat
- Provide the necessary tools and environment for citizens to live a comfortable life

Federal/Provincial Funding

Investing in Canada Infrastructure Program:

- This program by the federal government includes 33 billion in funding for infrastructure projects across Canada in partnership with the provinces.
- The program is designed to help communities reduce air and water pollution, provide clean water, increase resilience to climate change and create a clean-growth economy; build strong, dynamic and inclusive communities; and ensure Canadian families have access to modern, reliable services that improve their quality of life.
- This program allocates funding through 4 streams:
    - Public Transit stream:
        - Improve the capacity of public transit infrastructure;
        - Improve the quality or safety of existing or future transit systems; and
        - Improve access to a public transit system.
    - Green Infrastructure stream:
        - Climate Change Mitigation:
            - Better capacity to manage more renewable energy;
            - Improved access to clean energy transportation;
            - More energy-efficient buildings; and
            - Improved production of clean energy.
        - Adaptation, Resilience and Disaster Mitigation:
            - Increased structural or natural capacity to adapt to climate change impacts, natural disasters or extreme weather events.
        - Environmental Quality:
            - Upgraded wastewater treatment or collection infrastructure;
            - Upgraded drinking water treatment and distribution infrastructure; and
            - Better capacity to reduce or address soil or air pollutants.
    - Community, Culture and Recreation Infrastructure stream:
        - Improve cultural infrastructure, like museums and Indigenous heritage centres;
        - Support upgrades to recreational facilities, like arenas and both indoor and outdoor recreational spaces; and
        - Improve community infrastructure, like community centres and libraries.
    - Rural and Northern Communities Infrastructure stream:
        - Improve food security;
        - Improve road, air or marine infrastructure;
        - Improve broadband connectivity;
        - Increase access to more efficient or reliable energy sources; and
        - Improve education or health facilities (specific to the Truth and Reconciliation Commission's Calls to Action).

Federal/Provincial Funding

Disaster Mitigation and Adaptation Fund:

- The Disaster Mitigation and Adaptation Fund is a $3.375 billion national merit-based program that supports large-scale infrastructure projects to help communities better manage the risks of disasters triggered by natural hazards. Disaster Mitigation Adaptation Fund projects in British Columbia:
  - Grand Forks and Regional District of Kootenay Boundary Flood Mitigation (See project announcement news release)
  - Coastal Flood protection for the cities of Surrey and Delta, and the Semiahmoo First Nation (See project announcement news release)
  - Climate and Seismic Resilient Underground Infrastructure (See project announcement news release)
  - Skwah First Nation and City of Chilliwack flood protection (See project announcement news release)
  - Richmond Flood Protection Program (See project announcement news release)
  - Mill Creek Flood Protection (See project announcement news release)
  - Helping to protect the Cowichan Valley from the impact of climate change (See project announcement news release)

Canada Community-Building Fund:

- The Canada Community-Building Fund delivers over $2 billion every year to over 3600 communities across the country. Communities select how best to direct the funds and have the flexibility to make strategic investments across 19 different project categories. The Canada Community-Building Fund will provide British Columbia with $293,163 for the 2022-23 fiscal year for local infrastructure projects.

Smart Cities Challenge:

- The Smart Cities Challenge is a pan-Canadian competition for communities large and small that encourages communities to adopt a smart cities approach to improve the lives of their residents through innovation, data and connected technology.
- Over 200 communities across Canada participated in the first round of the Challenge, putting forward their ideas, which were adjudicated by an independent jury. In British Columbia, three applicants advanced to the finalist stage of the Challenge. Visit the Map of Applicants for more information.

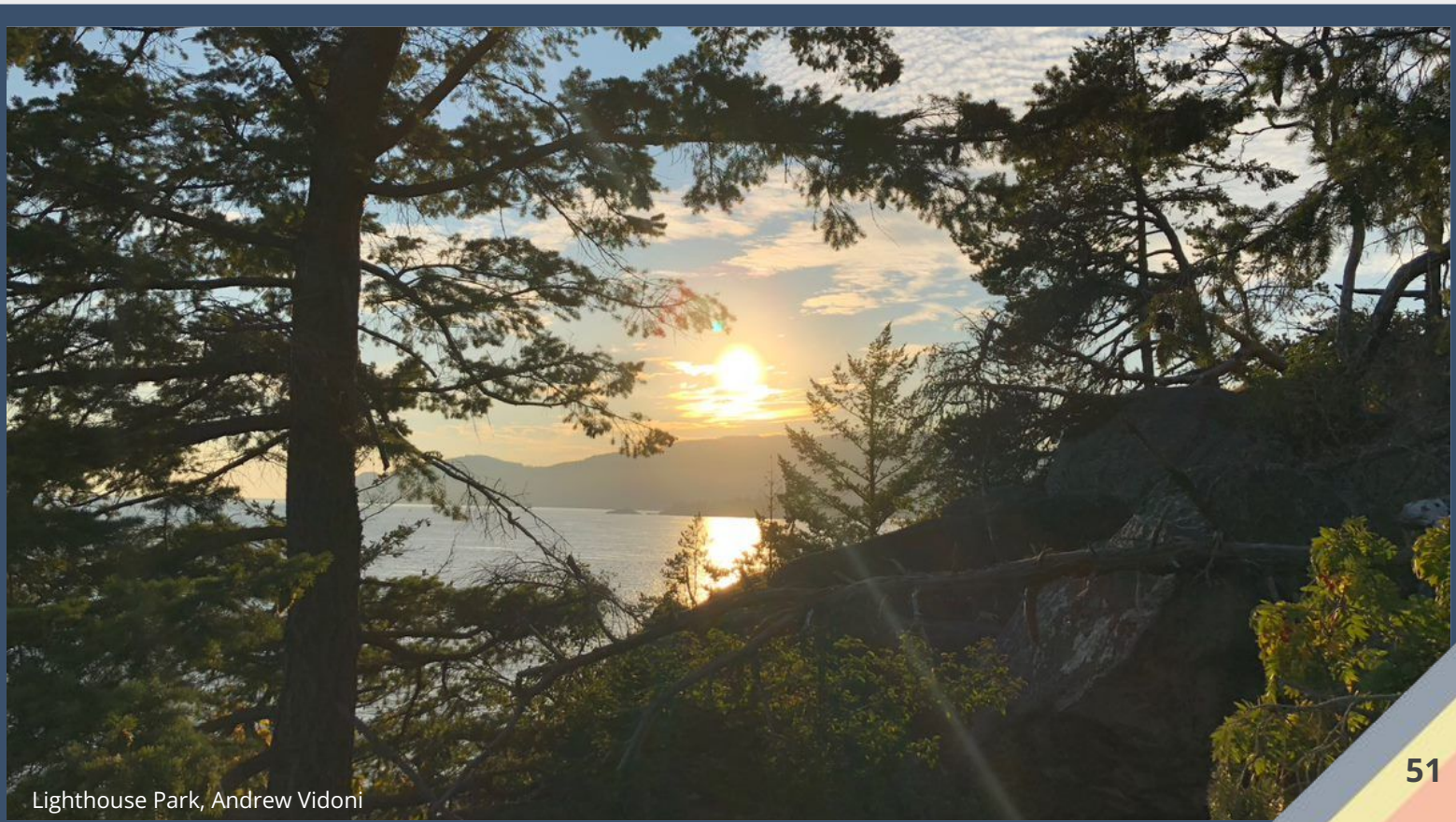
Municipal/Community Funding

The Government of Canada and the Federation of Canadian Municipalities are investing in projects across British Columbia to build stronger communities through the following programs:

- Green Municipal Fund, supporting capital projects that improve air, water and land and reduce GHG emissions.
- Municipalities for Climate Innovation Program, helping communities adapt to climate change and improve resiliency with help from programs, tools, and training.
- Municipal Asset Management Program, offering funding, training and resources to help municipalities strengthen asset management practices.

Community Funding Avenues:

- Canada Healthy Communities Fund is a $31 million investment to transform public spaces in response to COVID-19.



Lighthouse Park, Andrew Vidoni

Conclusion:

This report tackles the issues of extreme heat events and heat in general, both of which have become a more frequent problem worldwide as a result of rapid urbanization and climate change. British Columbia experienced a devastating severe heat event, leading to over 600 deaths in 2021 and unbearable living conditions during the summer for vulnerable populations. The report highlights several factors that exacerbate the issue, including a lack of social systems, inadequate housing design, and the urban heat island effect. Many of the proposed solutions within the report also work towards BC reaching its equity, climate action, and accessibility goals, while improving quality of life for all British Columbians.

The report emphasizes the importance of building strong social connections and creating age-friendly communities to tackle social isolation, which is a significant risk factor during heat waves. It also suggests improving public awareness and education about the seriousness of heat-related illnesses and providing accessible resources and support for vulnerable individuals. One way to achieve that would be to use the 811 health line to inform residents about the available resources, just as was used for the COVID-19 pandemic.

The report highlights the importance of cooling centers, wellness checks during extreme heat events, and collaboration between different stakeholders to ensure the safety of vulnerable individuals. It suggests targeted policy and planning changes to combat extreme heat, including incentivizing greener building construction and retrofits, more effective cooling systems, modern passive cooling design techniques, and rapidly increasing the Urban Tree Canopy (UTC) across the Lower Mainland.

The need for collaboration and coordination across various sectors and levels of government to mitigate the effects of heat waves and heat domes is urgent and imperative. By working together, we aim to support vulnerable populations disproportionately affected by heat waves, systemic inequalities, and create public policies and practices that treat everyone with kindness, compassion and respect.

Glossary

Atmosphere: The environmental sphere within the study of physical geography that pertains to the air An atmosphere is made of the layers of gases surrounding a planet or other celestial body. Earth's atmosphere is composed of various gases found in atmospheric layers (troposphere, stratosphere, mesosphere, thermosphere, and exosphere) defined by unique features such as temperature and pressure. The atmosphere protects life on earth by shielding it from incoming ultraviolet (UV) radiation, keeping the planet warm through insulation, and preventing extremes between day and night temperatures (Atmosphere). 42, 45, 53

Atmospheric Rivers (AR): Also known as a Pineapple Express are relatively long, narrow regions in the atmosphere – like rivers in the sky – that transport most of the water vapor outside of the tropics. An *AR* is a flowing column of condensed water vapor in the atmosphere responsible for producing significant levels of rain and snow, especially in the Western region of North America. Though many ARs are weak systems that simply provide beneficial rain or snow, some of the larger, more powerful ARs can create extreme rainfall and floods capable of disrupting travel, inducing mudslides and causing catastrophic damage to life and property (National Oceanic and Atmospheric Administration). 15, 53

Climate Justice: Climate Justice recognizes the disproportionate impacts of climate change on low-income communities and communities of colour worldwide; the people and places least responsible for climate change. It seeks solutions that address the root causes of climate change and, in doing so, simultaneously addresses a broad range of social, racial, and environmental injustices. At its core, a just transition represents the transition of fossil fuel-based economies to equitable, regenerative, renewable energy-based systems. However, a just transition is not only centered around technological change. It emphasizes employment in renewable energy and other green sectors, sustainable land use practices, and broader political and economic transformations (University of California). 53, 61, 73

Culturally Appropriate: Refers to recognizing and respecting the cultural beliefs, values, and practices of a particular group or community, especially in the context of healthcare, social interaction and/or public policy. Cultural appropriateness takes into account the fact that different cultures have their own unique ways of interpreting and responding to social and environmental challenges. This approach recognizes that what may be considered appropriate or acceptable in one culture may not be in another and that cultural diversity should be respected and celebrated. In the context of public policy, cultural appropriateness involves designing programs and services sensitive to the target population's cultural needs and preferences. This may include community members in the decision-making process, adapting communication strategies to be culturally appropriate, and ensuring that the program or service is delivered in a way that respects multicultural traditions in British Columbia. 53

Culture: Refers to the shared beliefs, values, practices, customs, and artifacts that characterize a group or society. It encompasses various elements, including language, religion, food, music, art, architecture, clothing, and social norms. Culture is not static and can change over time, often influenced by globalization, migration, and technology. It is essential to understand how societies develop and interact with each other and how they shape the physical and cultural landscape. 3, 7, 9, 17, 49, 53

Distance Decay: Distance Decay refers to the phenomenon in geography that the further apart two places or populations are, the lower the probability they will interact. Distance decay in human settlements is impacted by many factors that can be different on an individual basis. These factors can include but are not limited to: accessibility of transportation, mode of transportation, quality of transportation, and cultural/language barriers. 39, 53

Downs-Thomson Paradox: claims that improvements in the road network will not reduce traffic congestion. Explaining that traffic will increase without limit until the option of public transport (or any other form of transport) becomes faster than the equivalent trip by car. It draws the conclusion that people do not care whether they drive, walk, bike, or take the bus to any location. In other words, they just want to get from A to B in the fastest and most convenient way possible. 36, 53, 59, 69

GIS (Geographic Information System): Is an illustrative system that creates, manages, analyzes, and maps all types of data. GIS connects data to a map, integrating location data (where things are) with all types of descriptive information (what things are like there). This provides a foundation for mapping and analysis. GIS helps users understand patterns, relationships, and geographic context (What is GIS?). 9, 53, 65

Glossary

HandyDart: a door-to-door, public ride service local to Metro Vancouver that uses specially equipped vehicles designed to carry passengers with disabilities who are unable to use regular public transit without assistance. 36, 54

Human-Environment Interaction: The term human-environment interaction defines how humans influence and are influenced by our surrounding ecosystems. Humans can, for example, impact their environment by clearing trees from a forest to make farmland. By contrast, the environment may affect the behaviour of the people living within it, for example, by pushing them to develop warm clothing for colder climates (May). 54, 59, 68

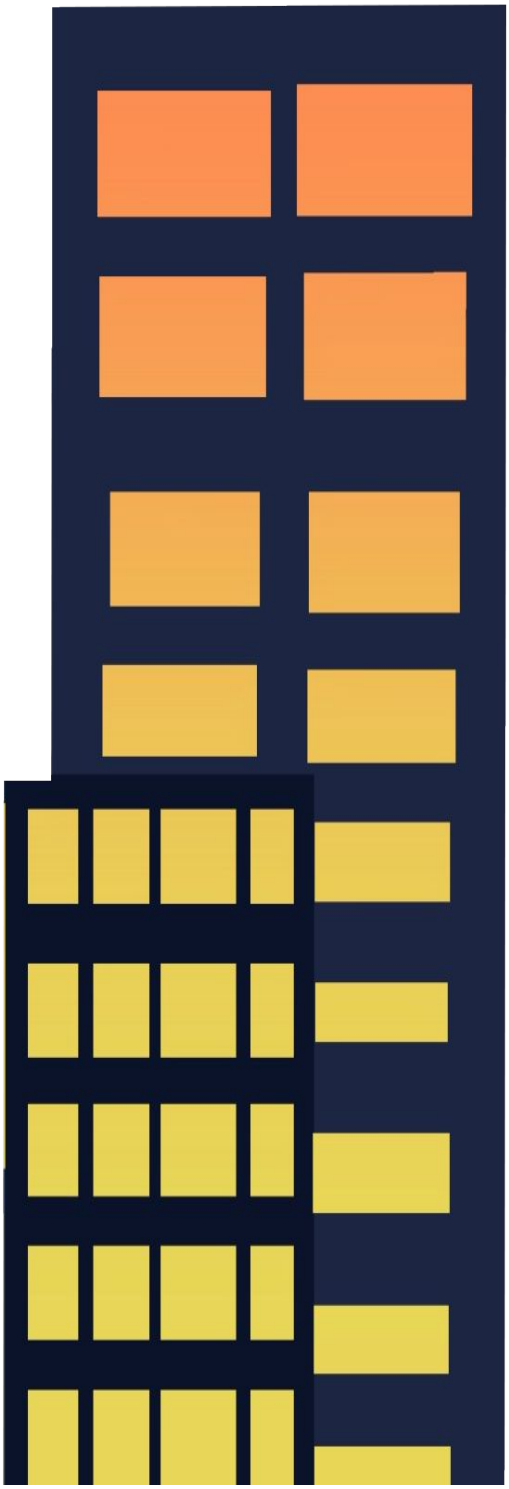
Induced Demand: Induced demand is the observed fact that if you make something easier to do, people will do it more. The phenomenon whereby an increase in supply results in a decline in price and an increase in consumption. 36, 54

Ischemic Stroke: occurs when a clot or a mass clogs a blood vessel, cutting off the blood flow to brain cells. This type of stroke accounts for the majority of all strokes. The blocked blood flow in an ischemic stroke may be caused by a blood clot or by atherosclerosis, a disease which causes narrowing of the arteries over time. Ischemic strokes can be caused by a blockage anywhere along the arteries feeding the brain (Ischemic Strokes (Clots)). 20, 54

La Niña: means Little Girl in Spanish. La Niña is also sometimes called El Viejo, anti-El Niño, or simply "a cold event." La Niña has the opposite effect of El Niño. During La Niña events, trade winds are even stronger than usual, pushing more warm water toward Asia. Off the west coast of the Americas, upwelling increases, bringing cold, nutrient-rich water to the surface. These cold waters in the Pacific push the jet stream northward. This tends to lead to drought in the southern U.S. and heavy rains and flooding in the Pacific Northwest and Canada. During a La Niña year, winter temperatures are warmer than normal in the South and cooler than normal in the North. During La Niña, waters off the Pacific coast are colder and contain more nutrients than usual. This environment supports more marine life and attracts more cold-water species, like squid and salmon (National Oceanic and Atmospheric Administration). 15, 54

Mass Transit: The movement of people within urban areas by a means of using group travel technologies such as buses, trains, ferries, etc. 35, 36, 54

Third Place: social surroundings that are separate from the two typical social environments being home and the workplace. A public space for people to enjoy outside their home or place of work, such as parks, cafés, gyms, churches, bars or any other publicly accessible space. 18, 54



Glossary

Urban Containment Boundary: are areas within Metro Vancouver that have strong urban development and future growth. The UCB is used as the primary analysis area in the "Regional Tree Canopy Cover and Impervious Surfaces" study because it is where most people in the region live and work. Most of the negative impacts from impervious surfaces will be experienced within this region. It is also where losses in tree canopy cover and increases in impervious surfaces are most likely to occur through development and redevelopment (Nicoletti, 2019). 36, 55

Urban Tree Canopy: The layer of tree leaves, branches, and stems from all publicly and privately owned deciduous and coniferous trees, forests, and understory within urban settlement areas, which provide measurable ground coverage (CSLA). 13, 28, 35, 36, 38, 52, 55

Urbanisation: The absolute and/or relative growth in the number of people living in urban settlements, with reference to a single country, region, or worldwide. Many analysts have proposed related economic, social, and cultural transformations to this basic demographic fact, many of which can also be described as modernization. But attempts to identify simple linear relationships between urban growth and such factors as industrialization or the decline in face-to-face interaction have been frustrated by the great variety of changes associated with urbanization worldwide (Castree, 702). 52, 55

Vulnerable Populations: refers to groups of people at a greater risk of harm or disadvantage due to various factors such as age, ethnicity, socioeconomic status, health, and disability, among others. These populations are often more susceptible to the negative impacts of environmental, social, and economic changes and are less equipped to cope with the resulting challenges. Examples of vulnerable populations include low-income households, racial and ethnic minorities, children, the elderly, refugees and migrants, people with disabilities, and those living in areas with high levels of environmental pollution and a lack of infrastructure. 3, 9, 12, 22, 24, 25, 36, 37, 52, 55

Wellness checks: refer to the practices of emergency services personnel or concerned volunteers conducting visits or making phone calls to individuals at risk of harm to ensure their well-being. These checks may be conducted in response to requests from family members, friends, or concerned community members or as part of proactive efforts to prevent heat-related illnesses in a heat wave emergency (Bergson-Shilcock, 59-84). 7, 12, 17, 26, 52, 55, 56, 63

Lighthouse Park, Andrew Vidoni

Works Cited

"2021 Northwest Heat Dome: Causes, Impacts and Future Outlook." 2021 Northwest Heat Dome: Causes, Impacts and Future Outlook | USDA Climate Hubs, Climate Hubs. U.S. Department of Agriculture, http://www.climatehubs.usda.gov/index.php/hubs/northwest/topic/2021-northwest-heat-dome-causes-impacts-and-future-outlook. Accessed 19 Feb. 2023.

"Active Transportation" | PlanH. BC Healthy Communities Society. http://www.planh.ca/take-action/healthy-environments/built-environments/page/active-transportatio. Accessed 19 Feb. 2023.

Ahmed, Tariq, et al. "Natural Ventilation in Warm Climates: The Challenges of Thermal Comfort, Heatwave Resilience and Indoor Air Quality." Renewable & Sustainable Energy Reviews, vol. 138, 2021, p. N.PAG. EBSCOhost, https://doi.org/10.1016/j.rser.2020.110669. Accessed 19 Feb. 2023.

Akbari, Hashem, et al. "Local climate change and urban heat island mitigation techniques – the state of the art". Journal of Civil Engineering and Management, vol. 22, no. 1, 2016, pp. 1-16. EBSCOhost, https://doi.org/10.3846/13923730.2015.1111934. Accessed 20 Feb. 2023.

Anzilotti, Ellie. "E-Bikes Are Helping Keep Seniors Young." Fast Company, Fast Company, 5 Sept. 2019, https://www.fastcompany.com/90341686/the-unlikely-way-e-bikes-could-transform-how-we-age. Accessed 10 Apr. 2023.

Alcântara De Vasconcellos, Eduardo. "The Use of Streets: A Reassessment and Tribute to Donald Appleyard." Journal of Urban Design, vol. 9, no. 1, 2004, pp. 3–22. EBSCOhost, https://doi.org/10.1080/13574800420001 87686. Accessed 10 Apr. 2023.

Barker, Nat. "Water-Filled Windows Use Sunlight to Heat and Cool Buildings." Dezeen, 3 Jan. 2023, https://www.dezeen.com/2023/01/03/water-filled-glass-solar-power-energy-bills/. Accessed 10 Apr. 2023.

Bedi, Neil Singh, et al. "The Role of Cooling Centers in Protecting Vulnerable Individuals from Extreme Heat." Epidemiology, vol. 33, no. 5, 2022, pp. 611–615. https://doi.org/10.1097/ede.0000000000001503. Accessed 11 Apr. 2023.

Bergson-Shilcock, A., Zisser, A., Grinberg, A., & Gregory, E. "Police wellness checks: Law enforcement's role in recognizing and responding to mental health crises." Journal of Law and Social Policy, vol. 31, no. 1, 2019, pp. 59-84. Accessed 10 Apr. 2023.

Berisha, Vjollca, et al. "Assessing Adaptation Strategies for Extreme Heat: A Public Health Evaluation of Cooling Centers in Maricopa County, Arizona." AMETSOC, American Meteorological Society, 1 Jan. 2017, https://journals.ametsoc.org/view/journals/wcas/9/1/wcas-d-16-0033_1.xml. Accessed 10 Apr. 2023.

Braich, Baneet. "How to Outfit Buildings to Better Handle Hotter Temperatures." CBC News, CBC Radio Canada, 13 Jul. 2021, https://www.cbc.ca/news/canada/british-columbia/heat-wave-infrastructure-ac-1.6099609. Accessed 10 Apr. 2023.

Brander, Colin, et al. "Heat Wave in Metro Vancouver: How Do We Cool Hot Cities?" Viewpoint Vancouver, 14 Jul. 2021, https://viewpointvancouver.ca/2021/07/14/heat-event-metro-vancouver-june-2021-how-do-we-cool-hot-cities/. Accessed 10 Apr. 2023.

Brenna Owen, The Canadian Press. "B.C. Heat Dome Fallout: Experts Caution Against Becoming 'Airconditioned Society' as Heat Waves Get Hotter." Vancouver sun, 25 Jun. 2022, https://vancouversun.com/news/local-news/b-c-heat-dome-fallout-experts-caution-against-becoming-air-conditioned-society-as-heat-waves-get-hotter. Accessed 10 Apr. 2023.

British Columbia et al. "Bc Provincial Heat Alert and Response System (Bc Hars): 2022." Ministry of Health Environment and Climate Change Canada BC Centre for Disease Control, 2022, https://www.llbc.leg.bc.ca/public/pubdocs/bcdocs2022_2/726278/726278_Provincial_Heat_Alerting_Response_System.pdf. Accessed 10 Apr. 2023.

"Canada: Disastrous Impact of Extreme Heat." Human Rights Watch, 30 Sept. 2022, https://www.hrw.org/news/2021/10/05/canada-disastrous-impact-extreme-heat. Accessed 10 Apr. 2023.

Canada, Employment and Social Development. "Government of Canada." Canada.Ca, 26 Apr. 2017, www.canada.ca/en/national-seniors-council/programs/publications-reports/2017/review-social-isolation-seniors.html#h2.8-h3.1.

Castree, Noel, et al. "A Dictionary of Human Geography." Oxford University Press, 2013. EBSCOhost, DOI: 10.1093/acref/9780199599868.001.0001 https://www.oxfordreference.com/display/10.1093/acref/9780199599868.001.0001/acref-9780199599868;jsessionid=B337C2B9493FD06C44B639FB79FA77E8. Accessed 10 Apr. 2023.

CBC Vancouver. The Cooling Effects of Urban Tree Canopies. YouTube, 24 Jun. 2022, https://youtu.be/YCy7xtfTwK8. Accessed 15 Apr. 2023.

Chandrasekhar, A., Dunne, D., Tandon, A., & Viglione, G. "Media Reaction: South Asia's 2022 Heatwave and the Role of Climate Change." Carbon Brief, 04 May 2022, https://www.carbonbrief.org/media-reaction-south-asias-2022-heatwave-and-the-role-of-climate-change/. Accessed 10 Apr. 2023.

Chen, Ruoning, and Xueyi You. "Reduction of Urban Heat Island and Associated Greenhouse Gas Emissions." Mitigation and Adaptation Strategies for Global Change, vol. 25, no. 4, 2020, pp. 689–711. https://doi.org/10.1007/s11027-019-09886-1. Accessed 10 Apr. 2023.

Works Cited

Chung, Emily. “District Energy Is a Greener Way to Heat and Cool Buildings, and It's Starting to Catch on | CBC News.” *CBC News, CBC/Radio Canada*, 3 Dec. 2019, https://www.cbc.ca/news/science/district-energy-1.5378650. Accessed 10 Apr. 2023.

“City of Vancouver. Spaces to Thrive: Vancouver Social Infrastructure Strategy - Current State Databook.” *City of Vancouver*, 2017. https://council.vancouver.ca/20211208/documents/cfsc1StaffPresentation.pdf. Accessed 10 Apr. 2023.

Claudi de St. Mihiel, Alessandro. “A New Green Deal for Climate Challenges and Urban Generation.” *Firenze UP*, 2020, pp. 321–26. Techne, Iss 19, https://doi.org/10.13128/techne-7883. Accessed 19 Feb. 2023.

“Defining the Urban Canopy.” *Definition Sub-Group of the Urban Canopy Committee of the CSLA,* https://www.csla-aapc.ca/mission-areas/defining-urban-canopy. Accessed 19 Feb. 2023.

Derakhshan, Sahar, et al. “Smartphone Locations Reveal Patterns of Cooling Center Use as a Heat Mitigation Strategy.” *El Sevier – ScienceDirect*, vol. 150, no. 102821, 2023, pp. 1-9. https://doi.org/10.1016/j.apgeog.2022.102821. Accessed 1 Feb. 2023.

DH. *“HEATWAVE PLAN: 2011”*, 2011, pp. 1–47. Edited by: Philip Gardiner. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/216193/dh_127235.pdf. Accessed 10 Feb. 2023.

Dickson, Courtney. “Hundreds Died Because They Couldn’t Escape B.C.'S Extreme Heat. Alerts Wouldn’t Have Saved Them, Advocates Say.” *CBC*, 9 June 2022, www.cbc.ca/news/canada/britishcolumbia/bc-changes-extreme-heat-2022-1.6480993. Accessed 10 Apr. 2023.

Dubovoy, Eugene. "12 Best Tips for Cooling a Small Room without AC." *Evapolar*, 2 Dec. 2022. https://evapolar.com/blog/cool-small-room-without-ac/. Accessed 19 Feb. 2023.

Egilson, Michael, et al. “Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021.” *Gov.bc.ca, British Columbia Coroners Service*, 7 June 2022, https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf. Accessed 10 Apr. 2023.

“Emergency Alerts in B.C.” *Emergency Management BC,* Province of British Columbia, Province of British Columbia, 27 Mar. 2023, https://www2.gov.bc.ca/gov/content/safety/public-safety/emergency-alerts. Accessed 10 Apr. 2023.

“Extreme Heat Preparedness Guide.” Government of BC, BC Ministry of Health, https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/preparedbc/preparedbc-guides/preparedbc_extreme_heat_guide.pdf. Accessed 10 Apr. 2023.

Feng, Lanmeng, et al. “Optimal Planning of Urban Greening System in Response to Urban Microenvironments in a High-Density City Using Genetic Algorithm: A Case Study of Tianjin.” Sustainable Cities and Society, vol. 87, 2022, p. 104244. https://doi.org/10.1016/j.scs.2022.104244. Accessed 10 Apr. 2023.

Gao, Zhen, et al. “Toward Park Design Optimization to Mitigate the Urban Heat Island: Assessment of the Cooling Effect in Five U.S. Cities.” Sustainable Cities and Society, vol. 81, 2022, p. 11. https://doi.org/10.1016/j.scs.2022.103870 Accessed 8 Feb. 2023.

Ghosh, Aveek, and Rajashree Kotharkar. “Progress in Extreme Heat Management and Warning Systems: A Systematic Review of Heat-Health Action Plans (1995-2020).” Sustainable Cities and Society, vol. 76, no 103487, 2021. https://doi.org/10.1016/j.scs.2021.103487. Accessed 10 Apr. 2023.

Grădinaru, Simona R., et al. “Equity in Urban Greening: Evidence From Strategic Planning in Romania.” Landscape and Urban Planning, vol. 230, 2023, p. 104614. https://doi.org/10.1016/j.landurbplan.2022.104614. Accessed 10 Apr. 2023.

Graham, Drew A., et al. “The Relationship between Neighbourhood Tree Canopy Cover and Heat-Related Ambulance Calls during Extreme Heat Events in Toronto, Canada.” Urban Forestry & Urban Greening, vol. 20, 2016, pp. 180–86. EBSCOhost, https://doi-org.ezproxy.langara.ca/10.1016/j.ufug.2016.08.005. Accessed 10 Apr. 2023.

Haby, Jeff. “THE REX BLOCK.” The Weather Prediction, https://www.theweatherprediction.com/habyhints/178/. Accessed 10 Apr. 2023.

Hasan, Fariha, et al. “Effective Community-Based Interventions for the Prevention and Management of Heat-Related Illnesses: A Scoping Review.” International Journal of Environmental Research and Public Health, vol. 18, no. 16, 2021. EBSCOhost, https://doi.org/10.3390/ijerph18168362. Accessed 10 Apr. 2023.

Haubursin, Cristopher. “Why Heaters Are the Future of Cooling.” YouTube, Vox, 24 Sept. 2021, https://youtu.be/PIulbHyK0bc. Accessed 10 Apr. 2023.

Hayes, Alexander Thomas, et al. “Nature-Based Solutions (NBSs) to Mitigate Urban Heat Island (UHI) Effects in Canadian Cities.” MDPI, vol. 12, no. 7, 2022, p. 925. https://doi.org/10.3390/buildings12070925. Accessed 10 Apr. 2023.

Health Canada. “Reducing Urban Heat Islands to Protect Health in Canada.” Canada.ca, Government of Canada, 4 May 2020, https://www.canada.ca/en/services/health/publications/healthy-living/reducing-urban-heat-islands-protect-health-canada.html. Accessed 10 Apr. 2023.

Works Cited

Heelon, Mark. “Learn How to Store Medicines Safely, Even in Hot Weather.” Baystate Health | Healthcare in Western MA, Baystate Health, 21 Oct. 2021, https://www.baystatehealth.org/news/2014/07/heat-impact-on-meds. Accessed 10 Apr. 2023.

Henderson, Sarah B, et al. "Analysis of community deaths during the catastrophic 2021 heat dome." Environmental Epidemiology, vol. 6, no. 1, 2022, p. 189. https://doi.org/10.1097/ee9.0000000000000189. Accessed 11 Jan. 2023.

“Here’s How This Year’s Heatwaves Are Impacting the World, and How We Can Prepare for the Future.” World Economic Forum, 25 July 2022, https://www.weforum.org/agenda/2022/07/heat-waves-climate-change-europe-northern-hemisphere/. Accessed 11 Jan. 2023.

Hintz, Marie Josefine, et al. “Facing the Heat: A Systematic Literature Review Exploring the Transferability of Solutions to Cope with Urban Heat Waves.” Urban Climate, vol. 24, 2018, pp. 714–727. https://doi.org/10.1016/j.uclim.2017.08.011. Accessed 10 Apr. 2023.

“History of Umbrella and Parasol.” Umbrella History - Facts and History of Umbrella, http://www.umbrellahistory.net/. Accessed 10 Apr. 2023.

Ho, Chi-On, et al. “Graph-Based Algorithmic Design and Decision-Making Framework for District Heating and Cooling Plant Positioning and Network Planning.” Advanced Engineering Informatics, vol. 50, 2021, p. 101420. https://doi.org/10.1016/j.aei.2021.101420. Accessed 10 Apr. 2023.

Hong Y.J., et al. “Expanded Orientation of Urban Public Health Policy in the Climate Change Era: Response to and Prevention of Heat Wave in Paris and Seoul: A Brief Review.” Iranian Journal of Public Health, vol. 51, no. 7, 2022. EBSCOhost, https://doi.org/10.18502/ijph.v51i7.10080. Accessed 21 January, 2023

Ian.A, Smith, et al. “Urban Green Space and Albedo Impacts on Surface Temperature across Seven United States Cities.” Science of Total Environment, vol. 857, no. 159663, 2023. https://doi-org.ezproxy.langara.ca/10.1016/j.scitotenv.2022.159663. Accessed 10 Apr. 2023.

Ioannis Kousis et al. “Phosphorescent-Based Pavements for Counteracting Urban Overheating – a Proof of Concept.” *Solar Energy, Pergamon*, vol. 202, 2020, pp. 540-552. https://doi.org/10.1016/j.solener.2020.03.092. Accessed 10 Apr. 2023.

Irfan, Umair. “How Heat Waves Form, and How Climate Change Makes Them Worse.” *Vox*, Vox, 23 June 2021, https://www.vox.com/22538401/heat-wave-record-temperature-extreme-climate-change-drought. Accessed 10 Apr. 2023.

Ivančić, Aleksandar, et al. “Performance Assessment of District Energy Systems with Common Elements for Heating and Cooling.” *Energies*, vol. 14, no. 8, 2021, p. 2334. https://doi.org/10.3390/en14082334. Accessed 10 Apr. 2023.

Kafeety, Amani, et al. “Social Connection as a Public Health Adaptation to Extreme Heat Events.” *Canadian Journal of Public Health*, vol. 1, no. No, 2020. https://doi.org/10.17269/s41997-020-00309-2. Accessed 20 Apr. 2023.

Kim, Ree Ho, et al. “The Effect of Porous Block Pavement with Rainwater Storage on Heat Island Mitigation.” *Advanced Materials Research*, vol. 586, 2012, pp. 310–315. https://doi.org/10.4028/www.scientific.net/AMR.586.310. Accessed 10 Apr. 2023.

Kojima, Mitsutoshi, and Kenichi Nakashima. “A Study of Mist Spraying System by Urban Transportation.” *Design for Innovative Value Towards a Sustainable Society*, 2012, pp. 720–23. EBSCOhost, https://doi.org/10.1007/978-94-007-3010-6_144. Accessed 10 Apr. 2023.

Komac, Blaž, et al. “Urban Heat Island in the Ljubljana City.” *Counteracting Urban Heat Island Effects in a Global Climate Change Scenario*, 2016, pp. 323–44. EBSCOhost, https://doi.org/10.1007/978-3-319-10425-6_12. Accessed 10 Apr. 2023.

Kondo, Kayoko et al. "Balancing conflicting mitigation and adaptation behaviours of urban residents under climate change and the urban heat island effect" *Elsevier Sustainable Cities and Society*, no. 65, 2021. https://doi.org/10.1016/j.scs.2020.102585. Accessed 1 Mar. 2023.

Lazaruk, Susan. “The 434 in Metro Vancouver Who Died in Heat Dome Mostly Elderly, Poor, isolated, female.” *Vancouver Sun*, 26 Feb. 2022, https://vancouversun.com/health/local-health/the-434-in-metro-vancouver-who-died-in-heat-dome-mostly-elderly-poor-isolated-female. Accessed 10 Apr. 2023.

Ledwith, M., & Springett, J. (2022). *Participatory Practice: Community-based Action for Transformative Change* (2nd edition). Bristol University Press. Accessed 10 Apr. 2023.

Lee, Hyunjung, and Helmut Mayer. “Maximum Extent of Human Heat Stress Reduction on Building Areas Due to Urban Greening.” *Urban Forestry & Urban Greening*, vol. 32, 2018, pp. 154–67. https://doi.org/10.1016/j.ufug.2018.04.010. Accessed 10 Apr. 2023.

Li, Pei-Yuan, and Zhi Wang. “Environmental Co-benefits of Urban Greening for Mitigating Heat and Carbon Emissions.” *Journal of Environmental Management*, vol. 293, no. 112963, 2021. https://doi.org/10.1016/j.jenvman.2021.112963. Accessed 10 Apr. 2023.

Liang, Kevin E., and Tom Kosatsky. “Protecting Rural Canadians from Extreme Heat.” *CMAJ*, vol. 192, no. 24, 2021, pp. 657-658. https://doi.org/10.1503/cmaj.200004. Accessed 10 Apr. 2023.

Lozzio, Corinne. “Let's Make 2022 the Year of the Sunbrella.” *Popular Science*, 17 May 2022, https://www.popsci.com/reviews/best-sun-umbrellas/. Accessed 10 Apr. 2023.

Works Cited

Martinez, Gerardo S. et al. “Heat-Health Action Plans in Europe: Challenges Ahead and How to Tackle Them.” *Environmental Research*, vol. 176, no. 108548, 2019. https://doi.org/10.1016/j.envres.2019.108548. Accessed 16 Apr 2023.

May, Rita. “Human-Environment Interaction: Definition & Examples.” *Utopia*, 27 Dec. 2022, https://utopia.org/guide/human-environment-interaction-definition-examples/. Accessed 10 Apr. 2023.

McCabe, Kirsty. “What Is a Heat Dome?” *Royal Meteorological Society*, 11 Aug. 2021, https://www.rmets.org/metmatters/what-heat-dome. Accessed 10 Apr. 2023.

McDiarmid, Heather, and Paul Parker. “Accelerating the 1.5°C energy transition for Canadian residential buildings through selective direct electrification with heat pumps.” *The Canadian Geographer / Le Géographe canadien*, vol. 66, no. 4, 2022, pp. 756-768. https://doi.org/10.1111/cag.12786. Accessed 10 Apr. 2023.

Metro Vancouver “Climate 2050 Roadmap Draft: Agriculture.” *Metro Vancouver*, http://www.metrovancouver.org/services/air-quality/climate-action/climate2050/regional-priorities/agriculture/updates/Pages/default.aspx#:~:text=We%20created%20a%20roadmap%20to,soil%20for%20long%2Dterm%20productivity. Accessed 10 Apr. 2023.

Ministry of Agriculture and Food. “Extreme Weather Preparedness for Agriculture Program.” *Province of British Columbia*, 22 Mar. 2023, https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/programs/extreme-weather-preparedness. Accessed 10 Apr. 2023.

Ministry of Environment and Climate Change Strategy. “Climate Preparedness and Adaptation Strategy.” *Province of British Columbia*, 30 Jan. 2023, https://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation/cpas. Accessed 10 Apr. 2023.

Mochrie, Paul. “Memo to Mayor & Council.” *City of Vancouver*, 10 Mar. 2022. https://vancouver.ca/files/cov/2022-03-10-council-memo-planning-for-extreme-heat.pdf. Accessed 10 Apr. 2023.

Mochrie, Paul. “Memo to Mayor & Council.” *City of Vancouver*, 15 Jun. 2022. https://vancouver.ca/files/cov/2022-06-15-updates-to-extreme-heat-response-plans-for-2022.pdf. Accessed 10 Apr. 2023.

Mofrad, Fahimeh, et al. “The Discourses, Opportunities, and Constraints in Canberra’s Green Infrastructure Planning.” *Urban Forestry & Urban Greening*, vol. 74, 2022. https://doi.org/10.1016/j.ufug.2022.127628. Accessed 19 Mar. 2023.

National Disaster Management Authority. “Heatwave Action: House Owners’ Guide to Alternate Roof Cooling Solutions.” *Ministry of Home Affairs*, Government of India, April 2021. https://ndma.gov.in/sites/default/files/PDF/Guidelines/Cool-Roof-Handbook.pdf. Accessed 19 Mar. 2023.

News, CBC. “Coroner’s Report on B.C. Heat-Dome Deaths Calls for Greater Support for Populations at Risk.” *Www.cbc.ca, CBC,* 7 June 2022, www.cbc.ca/amp/1.6480026. Accessed 21 Apr. 2023.

Nicoletti, Leonardo, and Josephine Clark. "Regional Tree Canopy Cover and Impervious Surfaces." *Metro Vancouver*, Aug. 2019, http://www.metrovancouver.org/services/regional-planning/PlanningPublications/EcologicalHealth-TreeCanopyCoverImperviousSurfaces.pdf. Accessed 10 Apr. 2023.

NOAA. “Basic Wave Patterns.” NWS JetStream, *NOAA's National Weather Service*, 12 Aug. 2019, https://www.weather.gov/jetstream/basic. Accessed 10 Apr. 2023.

NOAA. “What Is a Heat Dome?” *NOAA's National Ocean Service*, National Oceanic and Atmospheric Administration, 31 Oct. 2019. https://oceanservice.noaa.gov/facts/heat-dome.html. Accessed 10 Apr. 2023.

NotJustBikes. *Do Your Buses Get Stuck in Traffic? Traffic Solutions & The Downs-Thomson Paradox*. YouTube, 9 Mar. 2020, https://www.youtube.com/watch?v=RQY6WGOoYis. Accessed 10 Apr. 2023.

NSCC Singapore. *NSCC Webinar - Preparing Singapore for Climate Change*. YouTube, 9 Nov. 2021, https://www.youtube.com/watch?v=79-p-luIOXY&t=302s. Accessed 19 Feb. 2023.

Oquendo-Di Cosola, V. et al. "A systematic review of the impact of green walls on urban comfort: temperature reduction and noise attenuation" *Elsevier Renewable and Sustainable Energy*, no. 162, no. 112463, 2022. https://doi.org/10.1016/j.rser.2022.112463. Accessed 6 Apr 2023.

“Parasol Definition & Meaning.” *Merriam-Webster*, https://www.merriam-webster.com/dictionary/parasol. Accessed 16 Apr 2023.

“Passive Solar Design." *Williams College*, https://sustainability.williams.edu/green-building-basics/passive-solar-design/. Accessed 19 Feb. 2023.

Pelmorex Corp. “Wireless Alert.” *Alert Ready Emergency Alert System*, 23 Dec. 2021, https://www.alertready.ca/wireless/. Accessed 16 Apr 2023.

Peltier, Elian. “As Extreme Heat Becomes New Normal in Europe, Governments Scramble to Respond.” *The New York Times*, 26 July 2019, https://www.nytimes.com/2019/07/26/world/europe/france-europe-extreme-heat.html. Accessed 16 Apr 2023.

Philip, Sjoukje Y., et al. “Rapid Attribution Analysis of the Extraordinary Heat Wave on the Pacific Coast of the US and Canada in June 2021.” *Earth System Dynamics*, vol. 13, no. 4, 2022, pp. 1689–1713. https://doi.org/10.5194/esd-13-1689-2022. Accessed 16 Apr 2023.

Works Cited

Raczkova, Andrea, et al. “Adaptive Reactions to Climate Change by Implementation of Blue- Green Infrastructure in a Set of Urban Zones in Central Europe.” *SGEM International Multidisciplinary Scientific GeoConference EXPO Proceedings*, vol. 21, no. 3.2, 2021, pp. 35–42. https://doi.org/10.5593/sgem2021V/3.2/s12.06. Accessed 16 Apr 2023.

Rempel, Alexandra R., et al. “Improving the Passive Survivability of Residential Buildings during Extreme Heat Events in the Pacific Northwest.” *Applied Energy*, vol. 321, 2022, p.119323. https://doi.org/10.1016/j.apenergy.2022.119323. Accessed 16 Apr 2023.

Rittenberry, Ronnie. "Conditioning the Air: The Journal of Industrial Health, Occupational Medicine and the Surgery of Trauma." *Occupational Health & Safety,* Vol. 74, no. 5 2005, pp. 76-81. https://www.proquest.com/docview/221054882/fulltextPDF/4A8B01CEE5F448F9PQ/1?accountid=37673. Accessed 16 Apr 2023.

Romito, Kathleen, et al. “Social Connections.” *Myhealth.alberta.ca*, 9 Feb. 2022, myhealth.alberta.ca/health/Pages/conditions.aspx?hwid=abl0295&#:~:text=What%20are%20social %20connections%3F. Accessed 21 Apr. 2023.

Sauter, Daniel, and Marco Huettenmoser. “Liveable Streets and Social Inclusion.” *URBAN DESIGN International,* vol. 13, no. 2, 2008, pp. 67–79. https://doi.org/10.1057/udi.2008.15. Accessed 21 Apr. 2023.

Schibuola, Luigi, and Chiara Tambani. “Performance Assessment of Seawater Cooled Chillers to Mitigate Urban Heat Island.” *Applied Thermal Engineering*, vol. 175, 2020. https://doi.org/10.1016/j.applthermaleng.2020.115390. Accessed 21 Apr. 2023.

Schwaab, Jonas, et al. “The Role of Urban Trees in Reducing Land Surface Temperatures in European Cities.” *Nature Communications*, vol. 12, no. 1, 2021. https://doi.org/10.1038/s41467-021-26768-w. Accessed 21 Apr. 2023.

Sheng, Maggie, et al. “Assessing thermal resilience of an assisted living facility during heat waves and cold snaps with power outages.” *Building and Environment*, vol. 230, no. 110001, 2023. https://doi.org/10.1016/j.buildenv.2023.110001. Accessed 21 Apr. 2023.

Shin, Mirim, et al. “The Effects of Fabric for Sleepwear and Bedding on Sleep at Ambient Te: NSS.” *Nature and Science of Sleep*, vol. 8, 2016, pp. 121—131. https://doi.org/10.2147/NSS.S100271. Accessed 21 Apr. 2023.

Shirao, Liu et al. “Suburban greening and suburbanization changing surface urban heat island intensity in China.” *Building and Environment*, vol. 228, no.109906, 2023. https://doi.org/10.1016/j.buildenv.2022.109906. Accessed 10 Apr. 2023.

Smith, I.A. et al. “Urban Green Space and Albedo Impacts on Surface Temperature across Seven United States Cities.” *Science of Total Environment,* https://media.wbur.org/wp/2022/11/Smith_Fabian_Hutyra_2023.pdf. Accessed 10 Apr. 2023.

Staff, Carbon Brief. “Media Reaction: South Asia's 2022 Heatwave and the Role of Climate Change.” *Carbon Brief,* 19 May 2022, https://www.carbonbrief.org/media-reaction-south-asias-2022-heatwave-andthe-role-of-climate-change/. Accessed 10 Apr. 2023.

Statistics Canada. “Landline and Cellular Telephone Use by Province, 2019.” *Statistics Canada, Government of Canada*, 22 Jan. 2021, https://www150.statcan.gc.ca/n1/daily-quotidien/210122/t002b-eng.htm. Accessed 10 Apr. 2023.

Stinson, Adrienne, and Avi Varma. “The Best Ways to Reduce Body Heat .” *Medical News Today, MediLexicon International*, 10 Aug. 2022, https://www.medicalnewstoday.com/articles/326235. Accessed 15 Apr. 2023.

Stone, Brian, et al. “Urban Form and Extreme Heat Events: Are Sprawling Cities More Vulnerable to Climate Change than Compact Cities?” *Environmental Health Perspectives*, vol. 118, no. 10, 2010, pp. 1425–1428. https://doi.org/10.1289/ehp.0901879. Accessed 15 Apr. 2023.

Strategy, Environment and Climate Change. “B.C. Launches Stronger Climate Plan for a Better Future.” *Environment and Climate Change Strategy,* 25 Oct. 2021, https://news.gov.bc.ca/releases/2021ENV0065-002025. Accessed 15 Apr. 2023.

Surrey Emergency Program. “Surrey’s Extreme Heat Response Guideline - 2022.” *Surrey Emergency Program*, 2022. https://www.surrey.ca/sites/default/files/media/documents/2022%2006%2015%20Surrey%20Extreme%20Heat%20Response%20Guideline_.pdf. Accessed 19 Mar. 2023

Sutton, Mark. “Riding an Electric Bike Drops Heart and Cancer Risks, Finds German Study.” *Cycling Electric*, 11 Apr. 2023, https://www.cyclingelectric.com/news/riding-an-electric-bike-drops-heart-and-cancer-risks-finds-german-study. Accessed 15 Apr. 2023.

Swain, Daniel. “California Dodges Worst of Historic Pacific Northwest Heatwave, but Long-Duration Heatwave Still Likely Inland. plus: Significant Monsoonal Surge next Week?” *Weather West*, Weather West, 25 June 2021, https://weatherwest.com/archives/9778. Accessed 15 Apr. 2023.

Teyton, Anaïs, et al. “A Longitudinal Study on the Impact of Indoor Temperature on Proximal Heat-Related Symptoms in Older Adults Living in Non-Air-Conditioned Households.” *ISEE Conference Abstracts*, vol. 2021, no. 1, 2021. https://doi.org/10.1289/EHP10291. Accessed 15 Apr. 2023.

“The Cooling Effects of Urban Tree Canopies.” YouTube, CBC News , 24 June 2022, https://youtu.be/YCy7xtfTwK8.

“The Highs and Lows of Air Pressure.” *UCAR, Center for Science Education*, https://scied.ucar.edu/learning-zone/how-weather-works/highs-and-lows-air-pressure. Accessed 21 Jan. 2023.

Works Cited

"The History of Umbrellas: From Its Origins to the Present Day." Beau Nuage, 25 Feb. 2020, https://www.beau-nuage.fr/en/?fc=module&module=prestablog&controller=blog&id=8. Accessed 15 Apr. 2023.

Thomas, Terence H., and Chris P. Butters. "Thermal Equity, Public Health and District Cooling in Hot Climate Cities." *Proceedings of the Institution of Civil Engineers - Municipal Engineer*, vol. 171, no. 3, 2018, pp. 163–172. https://doi.org/10.1680/jmuen.17.00020. Accessed 15 Apr. 2023.

Tomeldan, Michael V., et al. "'Shared Growth' Urban Renewal Initiatives in Makati City, Metro Manila, Philippines." *Journal of Urban Management*, vol. 3, no. 1-2, 2014, pp. 45–65. https://doi.org/10.1016/s2226-5856(18)30083-9. Accessed 15 Apr. 2023.

UC Center for Climate Justice. "What Is Climate Justice?" *University of California*, 16 July 2022, https://centerclimatejustice.universityofcalifornia.edu/what-is-climate-justice/. Accessed 15 Apr. 2023.

"Urban Forest Strategy" – *Vancouver.ca*. https://vancouver.ca/home-property-development/urban-forest-strategy.aspx. Accessed 15 Apr. 2023.

"Vancouver-Plan-2022-09-23-1.pdf." https://vancouverplan.ca/wp-content/uploads/Vancouver-Plan-2022-09-23-1.pdf, Accessed 11 Feb. 2023.

Vox. *Why Cities Should Plant More Trees. YouTube*, 22 Dec. 2016, www.youtube.com/watch?v=aKyvGHycngM. Accessed 24 Jan. 2023.

Vox. *How America's Hottest City Is Trying to Cool Down. YouTube*, 20 Sept. 2021, https://www.youtube.com/watch?v=ZQ6fSHr5TJg . Accessed 26 Mar. 2023.

Walker, Jarrett. "The Photo That Explains Almost Everything (Updated!)." *Human Transit*, 21 Sept. 2012, https://humantransit.org/2012/09/the-photo-that-explains-almost-everything.html. Accessed 15 Apr. 2023.

Wark, Joe. "Land Acknowledgements in the Academy: Refusing the Settler Myth." Curriculum Inquiry, vol. 51, no. 2, Jan. 2021, pp. 191–209. EBSCOhost, https://doi.org/10.1080/03626784.2021.1889924 Accessed 19 Mar. 2023.

"Where Does 'Umbrella' Come from?" Merriam-Webster, Merriam-Webster, https://www.merriam-webster.com/words-at-play/where-does-umbrella-come-from-history. Accessed 15 Apr. 2023.

"Wireless Public Alert Awareness Faqs" https://www.pcmobile.ca/en/help/plans-add-ons-and-services/wireless-public-alert-awareness-faqs/. Accessed 15 Apr. 2023.

World Health Organization, "Protecting the Public and Minimizing Health Effects from Heat: Towards the Development of a Heat-Health Action Framework for the Prefecture of Hyogo, Japan." *Centre for Health Development*, 2013. https://extranet.who.int/kobe_centre/sites/default/files/pdf/Technical_report_Heat_health_action_framework_HyogoPrefecture_19MAR13_final.pdf. Accessed 15 Apr. 2023.

Annotated Bibliography

"2021 Northwest Heat Dome: Causes, Impacts and Future Outlook." 2021 Northwest Heat Dome: Causes, Impacts and Future Outlook | USDA Climate Hubs, Climate Hubs. U.S. Department of Agriculture, http://www.climatehubs.usda.gov/index.php/hubs/northwest/topic/2021-northwest-heat-dome-causes-impacts-and-future-outlook. Accessed 19 Feb 2023.

An article explaining what was impacted by the 2021 heat dome. The events that led up to the heat dome are complex, but the heat dome itself was caused by a high-pressure system.

A New Green Deal for Climate Challenges and Urban Generation. Firenze UP, 2020., pp. 321–26. Techne, Iss 19 (2020), https://doi.org/10.13128/techne-7883.

An article containing an interview with Dr. Eduardo Bonifico related to the new green deal and how the Bonifico group has used urban greening to deal with the effects of climate change.

Active Transportation | PlanH. planh.ca/take-action/healthy-environments/built-environments/page/active-transportation.

An article explaining why public transit can benefit the general population in both health and well-being. This article also explains why public transportation matters for local governments.

Ahmed, Tariq, et al. "Natural Ventilation in Warm Climates: The Challenges of Thermal Comfort, Heatwave Resilience and Indoor Air Quality." Renewable & Sustainable Energy Reviews, vol. 138, Mar. 2021, p. N.PAG. EBSCOhost, https://doi.org/10.1016/j.rser.2020.110669. Accessed 19 Feb 2023.

This article discusses low cost ventilation solutions and urges for there to be research about natural ventilation, along with solar chimneys and windcatchers.

Akbari, Hashem, et al. "Local climate change and urban heat island mitigation techniques – the state of the art". Journal of Civil Engineering and Management, vol.22, no. 1, Jan. 2016, pp. 1-16. EBSCOhost, https://doi.org/10.3846/13923730.2015.1111934

A paper proposing mitigation techniques for urban heat islands and local climate change, including reflective surfaces, urban greening and cool pavements.

Alcântara De Vasconcellos, Eduardo. "The Use of Streets: A Reassessment and Tribute to Donald Appleyard." Journal of Urban Design, vol. 9, no. 1, Feb. 2004, pp. 3–22. EBSCOhost, https://doi.org/10.1080/1357480042000187686.

An article explaining how analyzing the use of streets through a social and political lens can reveal equity issues.

Anzilotti, Ellie. "E-Bikes Are Helping Keep Seniors Young." Fast Company, Fast Company, 5 Sept. 2019, https://www.fastcompany.com/90341686/the-unlikely-way-e-bikes-could-transform-how-we-age.

A news article describing the health benefits of biking for seniors, particularly in reducing Parkinson's symptoms.

Barker , Nat. "Water-Filled Windows Use Sunlight to Heat and Cool Buildings." Dezeen, 3 Jan. 2023, https://www.dezeen.com/2023/01/03/water-filled-glass-solar-power-energy-bills/.

This article discusses how a British company is using water filled windows to lower energy costs while cooling and heating houses.

Bedi, Neil Singh, et al. "The Role of Cooling Centers in Protecting Vulnerable Individuals from Extreme Heat." Epidemiology, vol. 33, no. 5, 16 June 2022, pp. 611–615, https://doi.org/10.1097/ede.0000000000001503. Accessed 11 Sept. 2022.

This study analyzes the use of cooling centres during heat events.

Annotated Bibliography

Bergson-Shilcock, A., Zisser, A., Grinberg, A., & Gregory, E. (2019). Police wellness checks: Law enforcement's role in recognizing and responding to mental health crises. Journal of Law and Social Policy, 31(1), 59-84.

A discussion of wellness checks and how police are involved during mental health crises.

Berisha, Vjollca, et al. "Assessing Adaptation Strategies for Extreme Heat: A Public Health Evaluation of Cooling Centers in Maricopa County, Arizona." AMETSOC, American Meteorological Society, 1 Jan. 2017, https://journals.ametsoc.org/view/journals/wcas/9/1/wcas-d-16-0033_1.xml

In Maricopa County, preventing heat related illnesses and death is a high priority. This text systematically evaluates cooling centres

Braich, Baneet. "How to Outfit Buildings to Better Handle Hotter Temperatures." CBC News, CBC Radio Canada, 13 July 2021, https://www.cbc.ca/news/canada/british-columbia/heat-wave-infrastructure-ac-1.6099694.

Many solutions to hot temperatures are proposed in this article, such as building size and design, radiant cooling, and larger windows.

Brander, Colin, et al. "Heat Wave in Metro Vancouver: How Do We Cool Hot Cities?" Viewpoint Vancouver, 14 July 2021, https://viewpointvancouver.ca/2021/07/14/heat-event-metro-vancouver-june-2021-how-do-we-cool-hot-cities/

This article discusses ways to cool down the city for future heat waves, including planting trees and coating surfaces with reflective material.

Brenna Owen, The Canadian Press. "B.C. Heat Dome Fallout: Experts Caution Against Becoming 'Airconditioned Society' as Heat Waves Get Hotter." Vancouversun, 25 June 2022, https://vancouversun.com/news/local-news/b-c-heat-dome-fallout-experts-caution-against-becoming-air-conditioned-society-as-heat-waves-get-hotter

This article states that focusing solely on air conditioning ignores proven solutions to high temperatures, and discusses urban design techniques that can reduce death tolls.

British Columbia et al. Bc Provincial Heat Alert and Response System (Bc Hars) : 2022. Ministry of Health Environment and Climate Change Canada BC Centre for Disease Control 2022. https://www.llbc.leg.bc.ca/public/pubdocs/bcdocs2022_2/726278/726278_Provincial_Heat_Alerting_Response_System.pdf.

The BC Provincial Heat Alert and Response System has information about extreme heat events and how to mitigate damages during pre-season, Heat Warning, during an Extreme Heat Emergency, and post-season.

"Canada: Disastrous Impact of Extreme Heat." Human Rights Watch, 30 Sept. 2022, https://www.hrw.org/news/2021/10/05/canada-disastrous-impact-extreme-heat.

A news report about inadequate government support during the 2021 heatwave in BC, and how risks were compounded for disabled people and the elderly.

Canada, National Seniors Council. Who's at Risk and What Can Be Done about It?: A Review of the Literature on the Social Isolation of Different Groups of Seniors, Employment and Social Development Canada, 2017.

The rapidly aging population of Canada means that up to 16% of seniors can experience social isolation, but more research is needed in order to tackle this complex issue.

Castree, Noel, et al. A Dictionary of Human Geography. Oxford University Press, 2013. EBSCOhost, search.ebscohost.com/login.aspx?direct=true&db=cat05664a&AN=lang.b1978900&site=eds-live&scope=site

A book containing 2,000 definitions of geographical terms, concepts, "...biographical entries, acronyms, organisations, and major periods and schools in the history of human geography".

Annotated Bibliography

CBC. “Coroner’s Report on B.C. Heat-Dome Deaths Calls for Greater Support for Populations at Risk.” Www.cbc.ca, CBC, 7 June 2022, www.cbc.ca/amp/1.6480026. Accessed 21 Apr. 2023.

An article on how heatwaves affect different populations and how longer term planning and alert systems are needed.

Chandrasekhar, A., Dunne, D., Tandon, A., & Viglione, G. “Media Reaction: South Asia's 2022 Heatwave and the Role of Climate Change.” Carbon Brief, 19 May 2022, https://www.carbonbrief.org/media-reaction-south-asias-2022-heatwave-and-the-role-of-climate-change/.

An analysis of how different types of media and different groups have covered the heat crisis.

Chen, Ruoning, and Xueyi You. “Reduction of Urban Heat Island and Associated Greenhouse Gas Emissions.” Mitigation and Adaptation Strategies for Global Change, vol. 25, no. 4, Springer Science+Business Media, Apr. 2020, pp. 689–711. https://doi.org/10.1007/s11027-019-09886-1.

Tianjin, China was taken as a case study zone to examine and quantify the results of heat mitigation methods. Urban greening was found to be one of the most effective methods.

Chung, Emily. “District Energy Is a Greener Way to Heat and Cool Buildings, and It's Starting to Catch on | CBC News.” CBC News, CBC/Radio Canada, 3 Dec. 2019, https://www.cbc.ca/news/science/district-energy-1.5378650.

District energy systems have an endorsement from the United Nations Environment program. District energy systems can produce local energy and reduce energy costs for consumers.

City of Vancouver. “Stay Safe in the Summer Heat.” Staying Safe in Hot Weather | City of Vancouver, 2023, https://vancouver.ca/home-property-development/hot-weather.aspx.

Government resource showing locations of cooling centers and Vancouver’s plan for heatwaves.

City of Vancouver. Spaces to Thrive: Vancouver Social Infrastructure Strategy - Current State Databook. City of Vancouver, 2017. https://council.vancouver.ca/20211208/documents/cfsc1StaffPresentation.pdf

Spaces to Thrive’s main goals are to address insufficient community spaces, a lack of reconciliation, insufficient funding and loss of community spaces, among other goals in the same vein.

“Defining the Urban Canopy.” CSLA, Definition Sub-Group of the Urban Canopy Committee of the CSLA, https://www.csla-aapc.ca/mission-areas/defining-urban-canopy.

Article defining the meaning of urban canopy, and explaining why the urban canopy is important.

Derakhshan, Sahar, et al. Smartphone Locations Reveal Patterns of Cooling Center Use as a Heat Mitigation Strategy, vol. 150, no. 102821, 23 Jan. 2023, pp. 1-9. E/sevier, ScienceDirect, https://doi.org/10.1016/j.apgeog.2022.102821. Accessed 1 Feb. 2023.

Using cell phone data to understand how people move around during a heatwave, researchers were able to assess which cooling centers were being used.

Dickson, Courtney. “Hundreds Died Because They Couldn’t Escape B.C.'S Extreme Heat. Alerts Wouldn’t Have Saved Them, Advocates Say.” CBC, 9 June 2022, www.cbc.ca/news/canada/britishcolumbia/bc-changes-extreme-heat-2022-1.6480993.

An overview of the 2021 heat dome from several perspectives, including a disabled perspective.

Dubovoy, Eugene. "12 Best Tips for Cooling a Small Room without AC" evapolar, 2 Dec. 2022. https://evapolar.com/blog/cool-small-room-without-ac/. Accessed 19 Feb. 2023.

An article that outlines low cost ways to cool a room or a house without an air conditioner.

Annotated Bibliography

Egilson, Michael, et al. "Extreme Heat and Human Mortality: A Review of Heat-Related Deaths in B.C. in Summer 2021." Gov.bc.ca, British Columbia Coroners Service, 7 June 2022, https://www2.gov.bc.ca/assets/gov/birth-adoption-death-marriage-and-divorce/deaths/coroners-service/death-review-panel/extreme_heat_death_review_panel_report.pdf.

In late June 2021, British Columbia (BC) experienced an unprecedented heat dome (or Extreme Heat Event, EHE) which resulted in record temperatures across many parts of the province over several days. 619 deaths were identified as being heat-related.

Emergency Management BC. "Emergency Alerts in B.C." Province of British Columbia, Province of British Columbia, 27 Mar. 2023, https://www2.gov.bc.ca/gov/content/safety/public-safety/emergency-alerts.

Explanation of emergency alerts in British Columbia, who can make emergency alerts, and the ways in which alerts are given to the public.

England, DH. HEATWAVE PLAN: 2011, 2011, pp. 1–47. Accessed 10 Feb. 2023. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/216193/dh_127235.pdf

The Heatwave Plan for England, which explains future heatwave trends in England, complications for the health sector, and how to prepare for said heatwaves.

"Extreme Heat Preparedness Guide." Government of BC, BC Ministry of Health, https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/preparedbc/preparedbc-guides/preparedbc_extreme_heat_guide.pdf

With rising temperatures and greater variability in climate, extreme heatwaves will become more common. There are strategies and preventative measures that can be employed to reduce safety risks, especially for the sick and elderly.

Feng, Lanmeng, et al. "Optimal Planning of Urban Greening System in Response to Urban Microenvironments in a High-Density City Using Genetic Algorithm: A Case Study of Tianjin." Sustainable Cities and Society, vol. 87, 2022, p. 104244., doi:10.1016/j.scs.2022.104244.

Development of a spatial model that takes into account the best places for new green space. This development was done using geographic information systems.

Gao, Zhen, et al. "Toward Park Design Optimization to Mitigate the Urban Heat Island: Assessment of the Cooling Effect in Five U.S. Cities." Sustainable Cities and Society, vol. 81, June 2022, p. 11. Science Direct, https://doi.org/10.1016/j.scs.2022.103870 Accessed 8 Feb. 2023.

An article that discusses how parks cooled nearby areas and what factors impacted the Urban Heat Island effect.

Ghosh, Aveek, and Rajashree Kotharkar. "Progress in Extreme Heat Management and Warning Systems: A Systematic Review of Heat-Health Action Plans (1995-2020)." Sustainable Cities and Society, Elsevier, 29 Oct. 2021, https://www.sciencedirect.com/science/article/abs/pii/S2210670721007538.

This study conducts a systematic review to critically assess the advent and development of Heat Health Action Plans (HHAPs) with a special focus on its integration with urban planning policies.

Grădinaru, Simona R., et al. "Equity in Urban Greening: Evidence From Strategic Planning in Romania." Landscape and Urban Planning, vol. 230, Elsevier BV, Feb. 2023, p. 104614. https://doi.org/10.1016/j.landurbplan.2022.104614.

Examining equity and access to green infrastructure in Romania. The study found that equity was addressed superficially, but this did not correlate to green space availability.

Annotated Bibliography

Graham, Drew A., et al. "The Relationship between Neighbourhood Tree Canopy Cover and Heat-Related Ambulance Calls during Extreme Heat Events in Toronto, Canada." Urban Forestry & Urban Greening, vol. 20, Dec. 2016, pp. 180–86. EBSCOhost, https://doiorg.ezproxy.langara.ca/10.1016/j.ufug.2016.08.00.

This article explains that areas with less than 5% canopy cover had roughly 5 times as many heat-related calls for an ambulance when compared to areas with more than 5% canopy cover.

Haby, Jeff. "THE REX BLOCK." *The Weather Prediction*, https://www.theweatherprediction.com/habyhints/178/

A blog post explaining what rex blocks are and how they form.

Hasan, Fariha, et al. "Effective Community-Based Interventions for the Prevention and Management of Heat-Related Illnesses: A Scoping Review." International Journal of Environmental Research and Public Health, vol. 18, no. 16, Aug. 2021. EBSCOhost, https://doi-org.ezproxy.langara.ca/10.3390/ijerph18168362.

Studies and proposed reviews discussing how heat has an impact on low and middle income countries, along with effective public health responses.

Haubursin, Cristophe. "Why Heaters Are the Future of Cooling." Edited by Adam Freelander, YouTube, Vox, 24 Sept. 2021, https://youtu.be/PlulbHyK0bc.

As 2070 approaches, more and more homes will need air conditioners or other cooling devices to help cope with the heat. One proposed solution is to use heat pumps instead.

Hayes, Alexander Thomas, et al. "Nature-Based Solutions (NBSs) to Mitigate Urban Heat Island (UHI) Effects in Canadian Cities." MDPI, 30 June 2022, https://doi.org/10.3390/buildings12070925

Nature based solutions to urban heat islands includes increasing green space in cities and increasing the level of reflectivity.

Health Canada. "Reducing Urban Heat Islands to Protect Health in Canada." Canada.ca, Government of Canada, 4 May 2020, https://www.canada.ca/en/services/health/publications/healthy-living/reducing-urban-heat-islands-protect-health-canada.html.

This report focuses on advice for reducing outdoor temperatures and discussing the causes behind high temperature zones in cities and urban areas.

Heelon, Mark. "Learn How to Store Medicines Safely, Even in Hot Weather." Baystate Health | Healthcare in Western MA, Baystate Health, 21 Oct. 2021, https://www.baystatehealth.org/news/2014/07/heat-impact-on-meds.

Advice on why safe medicine storage matters, how temperatures affect medication, and where to store medication in your home.

Henderson, Sarah B, et al. "Analysis of community deaths during the catastrophic 2021 heat dome" Environmental Epidemiology, 6:e189, doi:10.1097/EE9.0000000000000189. Accessed 11 Jan. 2023.

Readily available data was analyzed to inform modifications to the public health response during subsequent events in summer 2021 and to guide further research.

"Here's How This Year's Heatwaves Are Impacting the World, and How We Can Prepare for the Future." World Economic Forum, 25 July 2022, https://www.weforum.org/agenda/2022/07/heat-waves-climate-change-europe-northern-hemisphere/

An article discussing how the northern hemisphere suffered during the heatwaves, how larger heat waves are becoming normal, and the things people can do to mitigate heat.

Hintz, Marie Josefine, et al. "Facing the Heat: A Systematic Literature Review Exploring the Transferability of Solutions to Cope with Urban Heat Waves." Urban Climate, vol. 24, 2018, pp. 714–727., https://doi.org/10.1016/j.uclim.2017.08.011.

The purpose of this study is to gain a better overview of solutions to extreme heat events and ultimately of their transferability.

Annotated Bibliography

Ho, Chi-On, et al. "Graph-Based Algorithmic Design and Decision-Making Framework for District Heating and Cooling Plant Positioning and Network Planning." Advanced Engineering Informatics, vol. 50, 2021, p. 101420., https://doi.org/10.1016/j.aei.2021.101420.

A paper that proposes "a novel algorithmic design and decision-making framework that uses multiple simultaneous criteria to generate and evaluate design alternatives of site selection and pipe network layout."

Hong Y.J., et al. "Expanded Orientation of Urban Public Health Policy in the Climate Change Era: Response to and Prevention of Heat Wave in Paris and Seoul: A Brief Review." Iranian Journal of Public Health, vol. 51, no. 7, July 2022. EBSCOhost, https://doi.org/10.18502/ijph.v51i7.10080. Accessed 21 January, 2023

The policies of response to and prevention of heat waves in France in 2003 and in South Korea in 2018 were compared and reviewed to see how public health policy orientation was being expanded in connection with urban and social policies.

Ioannis Kousis et al. "Phosphorescent-Based Pavements for Counteracting Urban Overheating – a Proof of Concept." Solar Energy, Pergamon, 14 Apr. 2020, https://www.sciencedirect.com/science/article/pii/S0038092X20303388?via%3Dihub.

This article discusses phosphorescent-based paving and checks the heat retention of phosphorescent based pavement against traditional concrete.

Irfan, Umair. "How Heat Waves Form, and How Climate Change Makes Them Worse." *Vox*, Vox, 23 June 2021, https://www.vox.com/22538401/heat-wave-record-temperature-extreme-climate-change-drought

An explanation of heat waves, the weather patterns behind them, and how heat wave impacts can vary depending on a person's location, health and income.

Ivančić, Aleksandar, et al. "Performance Asse- ssment of District Energy Systems with Common Elements for Heating and Cooling." Energies, vol. 14, no. 8, 2021, p. 2334., https://doi.org/10.3390/en14082334.

Calculating different energy performances between systems is difficult, but this paper aims to rectify that.

Kojima, Mitsutoshi, and Kenichi Nakashima. "A Study of Mist Spraying System by Urban Transportation." Design for Innovative Value Towards a Sustainable Society, Jan. 2012, pp. 720–23. EBSCOhost, https://doi.org/10.1007/978-94-007-3010-6_144

This study proposes misting stations on buses and urban transport in order to combat the urban heat island phenomenon.

Komac, Blaž, et al. "Urban Heat Island in the Ljubljana City." Counteracting Urban Heat Island Effects in a Global Climate Change Scenario, Jan. 2016, pp. 323–44. EBSCOhost, https://doi.org/10.1007/978-3-319-10425-6_12.

The city of Ljubljana has a climate map- this report is a study of temperature modelling and UHI project actions within the city.

Kafeety, Amani, et al. "Social Connection as a Public Health Adaptation to Extreme Heat Events." Canadian Journal of Public Health, vol. 1, no. No, 16 Mar. 2020, https://doi.org/10.17269/s41997-020-00309-2. Accessed 20 June 2020.

Addressing risk caused by social isolation is key for reducing mortality during a heat event.

Kim, Ree Ho, et al. "The Effect of Porous Block Pavement with Rainwater Storage on Heat Island Mitigation." Advanced Materials Research, vol. 586, Trans Tech Publications, Ltd., Nov. 2012, pp. 310–315. Crossref,doi:10.4028/www.scientific.net/amr.586.310.

Impermeable surfaces in cities worsens damage from environmental disasters like extreme heat events- This report studies how those surfaces impact the formation of urban heat islands.

Annotated Bibliography

Kondo, Kayoko et al. "Balancing conflicting mitigation and adaptation behaviours of urban residents under climate change and the urban heat island effect" Elsevier Sustainable Cities and Society, no. 65, 2021 https://doi.org/10.1016/j.scs.2020.102585 . Accessed 1 Mar, 2023.

This article discusses how people may use air conditioning in a heatwave (adaptive or mitigative) and some cooling behaviours.

Lazaruk, Susan. "The 434 in Metro Vancouver Who Died in Heat Dome Mostly Elderly, Poor, isolated, female" Vancouver Sun, 26 Feb. 2022, https://vancouversun.com/health/local-health/the-434-in-metro-vancouver-who-died-in-heat-dome-mostly-elderly-poor-isolated-female

Out of the 595 deaths that occured during the heat dome, 434 of them were elderly, poor, isolated and female. It's more common for elderly women to live on their own, so they were at a higher risk during the heatwave.

Ledwith, M., & Springett, J. (2022). *Participatory Practice: Community-based Action for Transformative Change* (2nd edition). Bristol University Press.

Practical theory generated from people's lives and participation are the best way to go about transformative change.

Lee, Hyunjung, and Helmut Mayer. "Maximum Extent of Human Heat Stress Reduction on Building Areas Due to Urban Greening." Urban Forestry & Urban Greening, vol. 32, May 2018, pp. 154–67. EBSCO host, https://doi-org.ezproxy.langara.ca/10.1016/J.ufug.2018.04.010.

Numerical simulations were carried out for five different sized building areas in the city of Stuttgart (Southwest Germany) on the heat wave of 4 August 2003.

Lee, Michael Joseph, et al. "Chronic Diseases Associated With Mortality in British Columbia, Canada During the 2021 Western North America Extreme Heat Event." AGU, Geohealth, 15 Mar. 2023, https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2022GH000729.

The results of this study show that mental illness increase the risk of heat related illness during a heatwave.

Li, Pei-Yuan, and Zhi Wang. "Environmental Co-benefits of Urban Greening for Mitigating Heat and Carbon Emissions." Journal of Environmental Management, vol. 293, Elsevier BV, June 2021, p. 112963. https://doi.org/10.1016/j.jenvman.2021.112963.

Discussion of how urban green space reduces carbon dioxide emissions and improves overall cooling.

Liang, Kevin E., and Tom Kosatsky. "Protecting Rural Canadians from Extreme Heat." CMAJ, CMAJ, 15 June 2020, https://www.cmaj.ca/content/192/24/E657.

Rural communities in Canada are particularly vulnerable to extreme heat, and this paper suggests there should be more research on the matter.

Lozzio, Corinne. "Let's Make 2022 the Year of the Sunbrella." Popular Science, 17 May 2022, https://www.popsci.com/reviews/best-sun-umbrellas/.

Parasols can shield one's skin from the sun, keeping people cool and reducing the risk of overexposure to UV rays.

May, Rita. "Human-Environment Interaction: Definition & Examples." Utopia, 27 Dec. 2022, https://utopia.org/guide/human-environment-interaction-definition-examples/.

Human-environment interaction can be how humans alter an environment, or how environments alter people. This article gives several examples.

McCabe, Kirsty. "What Is a Heat Dome?" RMetS, Royal Meteorological Society, 11 Aug. 2021, https://www.rmets.org/metmatters/what-heat-dome

An article explaining how heat domes form and explaining what they are.

McDiarmid, H. and Parker, P. (2022), Accelerating the 1.5°C energy transition for Canadian residential buildings through selective direct electrification with heat pumps. The Canadian Geographer / Le Géographe canadien, 66: 756-768. https://doi.org/10.1111/cag.12786

A proposal for switching from direct fuel switching to heat pump technology, showing specific numbers related to energy gain and reduction of GHGs.

Annotated Bibliography

Metro Vancouver "Climate 2050 Roadmap Draft: Agriculture." Metro Vancouver, http://www.metrovancouver.org/services/air-quality/climate-action/climate2050/regional-priorities/agriculture/updates/Pages/default.aspx#:~:text=We%20created%20a%20roadmap%20to,soil%20for%20long%2Dterm%20productivity

Updates for the Climate 2050 roadmap, which discusses climate action related to becoming carbon neutral and action related to agriculture.

Ministry of Agriculture and Food. "Extreme Weather Preparedness for Agriculture Program." Province of British Columbia, Province of British Columbia, 22 Mar. 2023, https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/programs/extreme-weather-preparedness.

The province of British Columbia is accepting farm and ranch applications for provincial cost-share funding related to extreme weather events.

Ministry of Environment and Climate Change Strategy. "Climate Preparedness and Adaptation Strategy." Province of British Columbia, Province of British Columbia, 30 Jan. 2023, https://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation/cpas.

An outline of 4 pathways for adjusting to climate change, specifically for British Columbia.

Mofrad, Fahimeh, et al. "The Discourses, Opportunities, and Constraints in Canberra's Green Infrastructure Planning." Urban Forestry & Urban Greening, vol. 74, Aug. 2022. EBSCOhost, https://doi-org.ezproxy.langara.ca/10.1016/j.ufug.2022.127628. Accessed 19 Mar. 2023.

Green infrastructure is a way of making cities more adaptable. However, this requires decision making and several regulations. Comprehensive planning is important for sustainability.

Monchrie, Paul. To: DL Date: 6/15/2022 3:27:56 Pm - Vancouver.ca. https://vancouver.ca/files/cov/2022-06-15-updates-to-extreme-heat-response-plans-for-2022.pdf

A set of email memos explaining updates to Vancouver's extreme heat policy for 2022.

National Disaster Management Authority. "Heatwave Action: House Owners' Guide to Alternate Roof Cooling Solutions." Ministry of Home Affairs, Government of India, April 2021. Accessed 19 Mar. 2023, https://ndma.gov.in/sites/default/files/PDF/Guidelines/Cool-Roof-Handbook.pdf

Suggestions for roof cooling methods, specifically for homeowners in India.

Nicoletti, Leonardo, and Josephine Clark. "Regional Tree Canopy Cover and Impervious Surfaces." Metro Vancouver, Aug. 2019, http://www.metrovancouver.org/services/regional-planning/Pages/default.aspx.

This long-range plan strives to manage anticipated growth to the region. It was co-created and supported by all municipalities in the region, as well as TransLink.

NOAA. "What Is a Heat Dome?" *NOAA's National Ocean Service*, National Oceanic and Atmospheric Administration, 31 Oct. 2019, https://oceanservice.noaa.gov/facts/heat-dome.html.

A team of scientists funded by the NOAA MAPP Program investigated what triggers heat domes.

NOAA. "Basic Wave Patterns." NWS JetStream, NOAA's National Weather Service, 12 Aug. 2019, https://www.weather.gov/jetstream/basic.

An explanation of jetstream weather patterns.

Slaughter, Jason "NotJustBikes". "Do Your Buses Get Stuck in Traffic? Traffic Solutions & The Downs-Thomson Paradox." YouTube, YouTube, 9 Mar. 2020, https://www.youtube.com/watch?v=RQY6WGOoYis.

In places like Toronto, 40% of people walk to work because it is faster than taking a car. Alternatives to cars, including public transport and biking should be addressed by city governments and urban planning.

Annotated Bibliography

NSCC Singapore. NSCC Webinar - Preparing Singapore for Climate Change (3 Nov 2021). YouTube, 9 Nov. 2021, https://www.youtube.com/watch?v=79-p-luIOXY&t=302s. Accessed 19 Feb. 2023.

A video from NSCC Singapore discussing how technologies, innovations and research can prepare Singapore for the impacts of climate change.

Oquendo-Di Cosola, V. et al. "A systematic review of the impact of green walls on urban comfort: temperature reduction and noise attenuation" Elsevier Renewable and Sustainable Energy, no. 162, 2022, https://doi.org/10.1016/j.rser.2022.112463. Accessed 6 Apr 2023.

Green walls are similar to green roofs and can provide similar benefits to urban greening, with the added benefit of noise reduction.

"Passive Solar Design" Williams College, https://sustainability.williams.edu/green-building-basics/passive-solar-design/. Accessed 19 Feb. 2023.

This article discusses how to build structures in a way that can either improve or reduce heat retention, such as landscaping, building windows on the south side of the house, and thermal chimneys.

Pelmorex Corp. "Wireless Alert." Alert Ready Emergency Alert System, 23 Dec. 2021, https://www.alertready.ca/wireless/.

The home page of Wireless Alert, an emergency system that can be used to broadcast emergency messages through radio, satellite, television and cellular devices.

Peltier, Elian. "As Extreme Heat Becomes New Normal in Europe, Governments Scramble to Respond." The New York Times, 26 July 2019, https://www.nytimes.com/2019/07/26/world/europe/france-europe-extreme-heat.html

A discussion of the 2003 heatwave in Europe that killed 15,000, and a discussion of how France is dealing with heat waves now and in the future.

Philip, Sjoukje Y., et al. "Rapid Attribution Analysis of the Extraordinary Heat Wave on the Pacific Coast of the US and Canada in June 2021." Earth System Dynamics, vol. 13, no. 4, 2022, pp. 1689–1713., https://doi.org/10.5194/esd-13-1689-2022.

Observed temperatures during the 2021 heatwave are considered to be impossible outside of the influence of climate change. This report analyzes which areas of the US and Canada experienced the hottest temperatures using mathematical models and mapping.

Raczkova, Andrea, et al. "Adaptive Reactions to Climate Change by Implementation of Blue- Green Infrastructure in a Set of Urban Zones in Central Europe." SGEM International Multidisciplinary Scientific GeoConference EXPO Proceedings, 2021, https://www.sgem.org/index.php/component/jresearch/?view=publication&task=show&id=8303&Itemid=

Blue-green infrastructure is rapidly catching on in Europe. Blue-green infrastructure uses water and vegetation to mitigate the effects of extreme heat.

Rempel, Alexandra R., et al. "Improving the Passive Survivability of Residential Buildings during Extreme Heat Events in the Pacific Northwest." Applied Energy, vol. 321, 2022, p.119323., doi:10.1016/j.apenergy.2022.119323.

Portland, Oregon had some of the highest temperatures during the 2021 heat dome, but passive cooling techniques lowered peak indoor temperatures by up to 14 degrees Celsius.

Annotated Bibliography

Rittenberry, Ronnie. "Conditioning the Air."Occupational Health & Safety, May 2005, pp. 76–81.

An article suggesting misting stations, fog, fans, fog fans, and special fog effects to keep players cool on the NHL fields.

Robine, J.-M., et al. "Heat-Health Action Plans in Europe: Challenges Ahead and How to Tackle Them." Environmental Research, Academic Press, 19 June 2019, https://www.sciencedirect.com/science/article/abs/pii/S0013935119303457?via%3Dihub.

A plan outlining new evidence about heat-health governance, urban design, greening and other topics in relation to covering current and upcoming challenges relating to climate change.

Romito, Kathleen, et al. "Social Connections." Myhealth.alberta.ca, 9 Feb. 2022, myhealth.alberta.ca/health/Pages/conditisaspx?hwid=abl0295&#:~:text=What%20are%20socil%20connections%3F. Accessed 21 Apr. 2023.

An article discussing what social connections are and why they're important.

Sauter, Daniel, and Marco Huettenmoser. "Liveable Streets and Social Inclusion." URBAN DESIGN International, vol. 13, no. 2, 2008, pp. 67–79., https://doi.org/10.1057/udi.2008.15.

Street traffic can affect social relations in neighborhoods. This paper studied several factors such as interactions and the use of public space.

Schibuola, Luigi, and Chiara Tambani. "Performance Assessment of Seawater Cooled Chillers to Mitigate Urban Heat Island." Applied Thermal Engineering, vol. 175, July 2020. EBSCOhost, https://www.sciencedirect.com/science/article/abs/pii/S1359431120311595

Using seawater as a heat transfer fluid reduces energy costs (compared to air cooling technology) by 23.5%.

Schwaab, Jonas, et al. "The Role of Urban Trees in Reducing Land Surface Temperatures in European Cities." Nature Communications, vol. 12, no. 1, 2021, https://doi.org/https://www.nature.com/articles/s41467-021-26768-w.

Land surface temperatures and land cover data was analyzed in 293 European cities to understand the effect that urban trees had in reducing overall temperatures.

Sheng, M., Reiner, M., Sun, K., & Hong, T. (2023). Assessing thermal resilience of an assisted living facility during heat waves and cold snaps with power outages. Building and Environment, 230, 110001. https://doi.org/10.1016/j.buildenv.2023.110001

An assisted living facility would frequently have power outages during extreme weather events. This report analyzes why this is the case, and the effects of these events.

Shin, Mirim, et al. "The Effects of Fabric for Sleepwear and Bedding on Sleep at Ambient Te: NSS." Nature and Science of Sleep, Dove Press, 22 Apr. 2016, https://www.dovepress.com/the-effects-of-fabric-for-sleepwear-and-bedding-on-sleep-at-ambient-te-peer-reviewed-fulltext-article-NSS

This report discusses the heat retention properties of wool and the heat dispersing properties of cotton when they are used for sleepwear and bedding.

Shirao Liu, Kaifang Shi, Yizchen Wu, Yuanzheng Cui, Suburban greening and suburbanization changing surface urban heat island intensity in China, Building and Environment, Volume 228,2023, 109906, ISSN 0360-1323, https://doi.org/10.1016/j.buildenv.2022.109906.

A study about surface urban heat islands intensity, showing that urban greening and suburbanization levels are able to reduce the urban heat island effect.

Smith, I.A. et al. "Urban Green Space and Albedo Impacts on Surface Temperature across Seven United States Cities. "Science of Total Environment, https://www.sciencedirect.com/science/article/abs/pii/S0048969722067638, 2022

A study that shows trees are more effective at reducing temperatures than grass cover.

Staff, Carbon Brief. "Media Reaction: South Asia's 2022 Heatwave and the Role of Climate Change." Carbon Brief, 19 May 2022, https://www.carbonbrief.org/media-reactOn-south-asias-2022-heatwave-andthe-rol-of-climate-change/.

India Meteorological Department (IMD) said the maximum temperatures in India was highest in 122 years. During March observed temperature and the average temperature was highest in India and Pakistan across the globe.

Annotated Bibliography

Statistics Canada. "Landline and Cellular Telephone Use by Province, 2019." Statistics Canada, Government of Canada, 22 Jan. 2021, https://www150.statcan.gc.ca/n1/daily-quotidien/210122/t002b-eng.htm.

Statistics from each province and from the overall country about how many people use cell phones, landlines, both or neither.

Stinson, Adrienne, and Avi Varma. "The Best Ways to Reduce Body Heat ." Medical News Today, MediLexicon International, 10 Aug. 2022,https://www.medicalnewstoday.com/articles/326235.

Tips and tricks on reducing body heat, including recommendations about checking your thyroid health.

Stone, Brian, et al. "Urban Form and Extreme Heat Events: Are Sprawling Cities More Vulnerable to Climate Change than Compact Cities?" Environmental Health Perspectives, vol. 118, no. 10, 2010, pp. 1425–1428., https://doi.org/10.1289/ehp.0901879.

A report that states "low-density, sprawling patterns of urban development have been associated with enhanced surface temperatures in urbanized areas."

Strategy, Environment and Climate Change. "B.C. Launches Stronger Climate Plan for a Better Future." B.C. Launches Stronger Climate Plan for a Better Future, 25 Oct. 2021,https://news.gov.bc.ca/releases/2021ENV0065-002025.

The government of British Columbia has put together a plan to transition away from fossil fuel usage and towards clean energy solutions, also known as CleanBC 2030.

Surrey Emergency Program. Surrey's Extreme Heat Response Guideline - 2022. Surrey Emergency Program, 2022. Accessed 19 Mar. 2023, https://www.surrey.ca/sites/default/files/media/documents/2022%2006%2015%20Surrey%20Extreme%20Heat%20Response%20Guideline_.pdf.

The emergency plans for the City of Surrey during extreme heat events, outlining actions that can be done to mitigate damages.

Sutton, Mark. "Riding an Electric Bike Drops Heart and Cancer Risks, Finds German Study." Cycling Electric, 11 Apr. 2023, https://www.cyclingelectric.com/news/riding-an-electric-bike-drops-heart-and-cancer-risks-finds-german-study.

The positive health effects of riding an electric bike and the reasons as to why someone would buy an electric bike over a traditional bike.

Swain, Daniel. "California Dodges Worst of Historic Pacific Northwest Heatwave, but Long-Duration Heatwave Still Likely Inland. plus: Significant Monsoonal Surge next Week?" *Weather West*, Weather West, 25 June 2021, https://weatherwest.com/archives/9778.

Discussion of the 2021 heatwave and the weather conditions that contributed to its severity, such as atmospheric ridges.

Teyton, Anaïs, et al. "A Longitudinal Study on the Impact of Indoor Temperature on Proximal Heat-Related Symptoms in Older Adults Living in Non-Air-Conditioned Households." ISEE Conference Abstracts, vol. 2021, no. 1, 2021, doi:10.1289/isee.2021.p-648.

A paper studying the effects of high temperatures on adults older than 60.

"The Cooling Effects of Urban Tree Canopies." YouTube, CBC News , 24 June 2022, https://youtu.be/YCy7xtfTwK8.

Experts are urging BC urban planners to preserve urban green canopies, which they say will help mitigate the effects of extreme heat.

"The Highs and Lows of Air Pressure." UCAR, Center for Science Education, https://scied.ucar.edu/learning-zone/how-weather-works/highs-and-lows-air-pressure. Accessed 21 Jan. 2023.

This artifact describes and explains air pressure and how it works.

"The History of Umbrellas: From Its Origins to the Present Day." Beau Nuage, 25 Feb. 2020, https://www.beaunuage.fr/en/?fc=module&module=prestablog&controller=blog&id=8.

Umbrellas have been a long standing invention, and this article discusses where they come from and how they came about.

Annotated Bibliography

Thomas, Terence H., and Chris P. Butters. "Thermal Equity, Public Health and District Cooling in Hot Climate Cities." Proceedings of the Institution of Civil Engineers - Municipal Engineer, vol. 171, no. 3, 2018, pp. 163–172., https://doi.org/10.1680/jmuen.17.00020.

A report that proposes that district cooling is the only way to combat the urban heat island effect and surveys the use of district cooling, along with its benefits.

Tomeldan, Michael V., et al. "'Shared Growth' Urban Renewal Initiatives in Makati City,Metro Manila, Philippines." Journal of Urban Management, vol. 3, no. 1-2, 2014, pp. 45–65., https://doi.org/10.1016/s2226-5856(18)30083-9.

Researchers in Makati City are providing ideas for urban renewal, both in green space and in rejuvenating neighborhoods.

Urban Forest Strategy - Vancouver .https://vancouver.ca/home-property-development/urban-forest-strategy.aspx

A website outlining the city of Vancouver's plan to replant trees.

"Vancouver-Plan-2022-09-23-1.pdf." https://vancouverplan.ca/wp-content/uploads/Vancouver-Plan-2022-09-23-1.pdf, Accessed 11 Feb. 2023.

The Vancouver 2050 plan, which goes over future land use in the city, guiding strategies, and methods to make Vancouver more livable and affordable in the years leading up to 2050.

Vox, director. How America's Hottest City Is Trying to Cool Down. YouTube, Vox, 20 Sept. 2021, https://www.youtube.com/watch?v=ZQ6fSHr5TJg . Accessed 26 Mar. 2023.

Phoenix, Arizona is using urban greening to reduce temperatures and as an adaptation to climate change.

Vox. "Why Cities Should Plant More Trees." YouTube, 22 Dec. 2016, www.youtube.com/watch?v=aKyvGHycng. Accessed 24 Jan. 2023.

One proposed solution to air pollution is to plant more trees, as particles stick to tree leaves. Trees are also proven to reduce temperatures nearby. However, trees can only clean and cool the air within a 100 foot radius.

"What Is Climate Justice?" UC Center for Climate Justice, University of California, 16 July 2022, https://centerclimatejustice.universityofcalifornia.edu/what-is-climate-justice/

Climate justice is about reconciling with communities who are hurt by the climate crisis, in particular people who are low income or marginalized.

Walker, Jarrett. "The Photo That Explains Almost Everything (Updated!)." Human Transit, 21 Sept. 2012, https://humantransit.org/2012/09/the-photo-that-explains-almost-everything.html.

An article that features an image showing how many cars, bikes and busses it takes to fit 50 people, and how that compares to space in cities.

Wark, Joe. "Land Acknowledgements in the Academy: Refusing the Settler Myth." Curriculum Inquiry, vol. 51, no. 2, Jan. 2021, pp. 191–209. EBSCOhost, https://doi.org/10.1080/03626784.2021.1889924. Accessed 19 Mar. 2023.

A Canadian point of view on how land acknowledgements are in need of criticism and how these actions contribute to rewriting indigenous and settler history.

"Wireless Public Alert Awareness Faqs" https://www.pcmobile.ca/en/help/plans-add-ons-and-services/wireless-public-alert-awareness-faqs/.

A 'before you ask questions' page about emergency alerts that you can get through your phone.

World Health Organization, "Protecting the Public and Minimizing Health Effects from Heat: Towards the Development of a Heat Health Action Framework for the Prefecture of Hyogo, Japan." https://extranet.who.int/kobe_centre/sites/default/files/pdf/Technical_report_Heat_health_action_framework_HyogoPrefecture_19MAR13_final.pdf, 2013.

A report that will help the prefecture of Hyogo with prevention of heat related illnesses.