Innovating with Urban Nature for Health and Equity

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Supervised Research Project Report
McGill University, School of Urban Planning
2022

Acknowledgements

I would like to thank my family and friends for all their support during the completion of this report. I would like to thank the Social Sciences and Humanities Research Council (SSHRC) for funding my research at McGill University. I would like to thank the Climate Change Mitigation team at Nova Scotia Environment and the Oeuvre Durable research team for providing me with numerous opportunities for professional learning and growth. I would like to thank my professors and colleagues from the School of Urban Planning and other departments at McGill University for giving me input and insight during this project. I would especially like to thank Dr. Lisa Bornstein for her excellent and thoughtful feedback on this report.

Abstract

Nature-based solutions (NBS) are increasingly being used to build climate resilient cities. However, NBS can also improve urban health outcomes and alleviate health inequities, which is not adequately considered. Urban nature offers numerous health benefits, including improvements in physical health, mental health, developmental health, nutritional health, environmental health, and social well-being. Together, these dimensions of health provide a framework to assess the impact of nature-based interventions on urban populations, while underscoring the critical link between access to nature and improved health outcomes. However, access to urban nature is not equitably distributed. Drawing upon previous research, this study shows that low-income areas in the City of Montréal are experiencing urban green inequity. Selected NBS are assessed to understand their associated health benefits, and lessons for effective implementation are outlined based on case studies from Spain, the Netherlands, the United Kingdom, the United States, and Canada. The study then reviews Montréal's Climate Plan (2020–2030) and examines which NBS are included in the plan (i.e., trees and urban agriculture) and which NBS could be included in the plan (i.e., green roofs and pocket parks). Based on lessons from the case studies and additional research, implementation recommendations are provided for planned and potential NBS. Furthermore, key barriers hindering wider uptake of NBS are identified, which include the need for: methods to assess nature's various benefits; business models that link nature investments with health returns; and novel governance modes and partnerships. Overall, this study supports decision-makers in the implementation of NBS to impact health and equity as the City of Montréal embarks on its greening efforts through the Climate Plan.

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CHAPTER 1: INTRODUCTION

Using Nature to Promote Health and Environmental Justice in the City

"Nature is declining globally at rates unprecedented in human history" warns a landmark 2019 report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).[1] Evidence is mounting of the impending ecological collapse from climate change, pollution, and habitat destruction. To address climate change and increase sustainability, the Brundtland Report, Our Common Future, put cities at the heart of the solution. Cities are major contributors of greenhouse gas emissions; more than half the world's population lives in cities, a proportion that is set to rise to around two-thirds by 2050. Reiterating this in 2015, the Paris Agreement emphasized the growing importance of cities in achieving global targets for climate change. However, there has been increased recognition that urban sustainability encompasses other important goals, including protecting biodiversity, promoting health, and enabling equity and social justice. Thus, urban nature is being used in cities to address multiple urban sustainability challenges at the same time.[2]

Driving nature's decline is the dominant narrative that nature's only role is to provide resources for exploitation. To counter this narrative, the role of nature in cities must be reimagined. The

"new nature narrative" focuses on the intersection of nature and cities and points to opportunities to create mutual human health and environmental benefits.[3] It reorients views on nature, seeing it as a creative, resilient, and environmentally sustainable solution to many of the problems we face in cities. Urban nature interventions can address multiple urban sustainability challenges, such as disparity in access to amenities between neighbourhoods, stress, burnout, and rising levels of obesity and inactivity. These interventions can also help address infrastructural deficiencies in the face of population growth and increasingly severe weather linked to climate change.

The current supervised research project (SRP) aims to (a) understand the ways in which urban nature benefits health, (b) garner key lessons from initiatives that have implemented nature-based urban measures with a focus on improving urban health and health inequity, and (c) apply these lessons to the specific context of the City of Montréal. Montréal is a relevant and interesting city for this type of study. In 2019, a coalition of physicians called on the Government of Québec to devote more public infrastructure expenditure towards creating new green spaces in cities throughout the province. The coalition argued that doing so would lead to striking improvements in public health, citing widely established research on the relationship between neighbourhood greenness and urban health.[4] In 2020, Montréal released its Climate Plan for 2020 to 2030, which includes several urban nature interventions for the city. In light of experiences with urban greening initiatives elsewhere, this study identifies urban nature interventions included in the plan (i.e., urban trees and urban agriculture) and that could be included in the plan (i.e., green roofs and pocket parks), and provides recommendations for action.

The concept of Health in All Policies (HiAP) informs the analytical framework used in this study. HiAP strives to systematically account for the health implications of public policy decisions to improve population health, address health inequity, and contribute to sustainable development.[5] HiAP is a critical tool, as many of the drivers of health outcomes are beyond the scope of the healthcare sector. HiAP also recognizes that initiatives that improve public health outcomes are economically efficient, as they often result in increased productivity and higher tax revenues. The HiAP approach can successfully address key urban challenges, such as chronic diseases, mental health issues, and health inequities.[6] Similar to the HiAP approach, this study considers and assesses urban nature interventions in the context of human health.

To systematically account for the health and equity implications of urban nature interventions, Chapter 2 provides a literature review of what is currently known about the relationship between nature, urban health, and health inequities. It is divided into two sub-sections. The first sub-section builds the framework for assessing the health benefits of urban nature interventions by outlining the pathways that link urban nature exposure to health outcomes. The key pathways included within the scope of this study are as follows:

(1) **Physical health**: nature promotes more active lifestyles
(2) **Mental health**: nature reduces stress, restores attention, and improves cognition

(3) **Social well-being**: nature fosters social cohesion and builds sense of community
(4) **Developmental health**: nature positively influences child and adolescent development
(5) **Nutritional health**: nature improves access to nutrient-rich food, and
(6) **Environmental health**: nature buffers against environmental stressors like heat

After outlining the health benefits of urban nature, the next sub-section demonstrates that urban nature is not just a tool for improving public health, but also a means of improving health equity outcomes. This sub-section draws attention to the spatial inequities that affect the City of Montréal's more vulnerable populations (i.e., visible minorities, elderly individuals, and low-income communities). The focus on equity frames urban green space through a socio-ecological approach—acknowledging all the factors that interact to influence desired health outcomes.[7] This sub-section visualizes the environmental justice problem in Montréal, including spatial research that identifies vulnerable neighbourhoods experiencing urban green inequity.

Based on the pathways relating urban nature with urban health, the study selects urban nature interventions with clearly stated intentions to improve human health. Chapter 3 provides best practices of how urban nature interventions are being used to improve urban health outcomes. Case studies are retrieved from the Urban Nature Atlas, a comprehensive database of nature-based interventions in cities.[8] Looking at cities in Canada, the United States, the United Kingdom, the Netherlands, and Spain, this chapter outlines how nature is being brought into the city in the form of green roofs, street trees, pocket parks, community gardens, and green areas for water management. The case studies are selected for their ability to elicit multiple pathways linking urban nature to urban health.

Chapter 4 examines urban nature interventions included in Montréal's Climate Plan. The Climate Plan contains 46 actions across five sectors: mobilization of the Montréal community; mobility, urban planning, and urban development; buildings; exemplarity of the city; and governance. This chapter focuses on actions in the plan that involve or could involve the link between urban nature and health. It identifies existing organizations and programs that can be leveraged by the City of Montréal to implement selected nature-based solutions, and provides recommendations based on lessons from case studies and additional research. The chapter concludes with an overview of key issues hindering the wider uptake of nature in cities, namely: assessment methods, business models, and governance strategies.

The conclusion chapter discusses other key considerations when implementing nature in cities: the economic benefits of investing in urban nature and the possible risk of eco-gentrification. Overall, this study advances the conversation on people having a more effective, intimate, and inspiring relationship with nature in cities.

CHAPTER 2: LITERATURE REVIEW

Urban Nature's Health Impacts and Inequitable Distribution in the City of Montréal

Natural infrastructure in cities generates a broad range of benefits. In addition to providing protection during more frequent and intense weather events due to climate change, natural infrastructure decreases exposure of individuals and communities to environmental stressors such as air pollution, heat, and noise. For example, in the face of extreme weather events that involve heavy rain, natural infrastructure can reduce flood risks by increasing in-place filtration, decreasing the volume of stormwater runoff, and enhancing the natural function of floodplains.[9] At the core of this development—as there is greater recognition of urban nature's significance—is that nature provides fundamental services that contribute to social and environmental sustainability. The current study adds to this discourse by systematically considering the health benefits of urban nature interventions. It also draws attention to vulnerable areas of Montréal that have inequitable access to urban nature and thus are in higher need of such interventions.

The focus on health and equity in this section is line with the concept of Health in All Policies (HiAP). The aim of HiAP is to improve public health by incorporating health and equity considerations into decision-making across sectors and policy areas.[10] It is a critical tool, as it

addresses drivers of health outcomes that are beyond the scope of the healthcare sector and makes policymakers accountable for the health impacts of policymaking.[11]

This chapter applies the HiAP approach to urban nature interventions by outlining some of the ways in which nature improves urban health. Based on the evidence linking urban nature to health outcomes, this chapter argues that neighbourhoods that are deprived of this environmental resource are being deprived of better health outcomes.

This chapter is split into two parts: an overview of the ways in which urban nature interventions improve urban health, and a description of the interplay between environmental injustice, urban green inequity, and health inequity, specifically highlighting urban green inequity in the City of Montréal. The first sub-section provides a framework to assess the health benefits of urban nature interventions. It outlines what is currently known about the relationship between nature and urban health by categorizing some of the pathways underlying this relationship. The second sub-section visualizes urban green inequity in the City of Montréal and displays a clear link between a community's proximity to nature and its exposure to heat-related health disparities. This is illustrated through vegetation maps and urban heat island maps. Together, these sub-sections make the case that urban nature is a vital health-giving resource, and an equity-based approach is needed when implementing urban nature interventions.

Pathways Linking Urban Nature to Urban Health

Scientific evidence confirms that people who live in greener surroundings feel happier, healthier, and safer. Fundamentally, this is because we are hardwired to connect with and be in close proximity to nature. Neuroscientific findings show that reactions to nature—whether through pictorial representations or through in-situ exposure like walks in a park—produce positive affective responses in the amygdala and hippocampus,[12] which are involved in cognitive functioning and emotion regulation. Evolutionary biology-based theories argue that these responses to nature are inherent.

The Biophilia Hypothesis states that humans have an ancient and innate predilection for nature, which has been honed over the course of our evolution. This affiliation underpins a wide range of benefits for human health.[13] Similarly, the Psychophysiological Stress Reduction Theory (PSR) posits that because humans evolved and spent most of their time in natural settings, they have adapted to respond to natural stimuli either in the form of biophilia (love of nature) or biophobia (fear of certain aspects of nature, such as snakes).[14] This innate proclivity for nature is related to mental acumen through the Attention Restoration Theory (ART) which argues that experiencing nature improves cognition and is particularly restorative due to its ability to hold our attention involuntarily and elicit fascination, mystery, coherence, and the feeling of 'being away' from our everyday lives.[15]

These theories have been followed by extensive empirical research establishing that contact with nature has a positive impact on human health and well-being. While this evidence is compelling, it is not clearly understood how the health benefits of urban nature interventions should be incorporated into urban infrastructure decision-making. To support decision-making, this sub-section categorizes the health benefits of urban nature with the aim of providing a framework to assess the health impacts of various urban nature interventions. Following are a few of the key pathways by which nature in cities fosters overall community health and well-being.

Physical health

Nature promotes more active lifestyles

One of the most studied links between exposure to urban nature and improved health outcomes is increased physical activity. Evidence shows that physical activity protects against numerous diseases and health issues, such as cardiovascular disease, cancer, hypertension, obesity, osteoporosis, and premature death.[16] As compared to those living in areas with low levels of urban nature, residents living in areas with more green spaces are far more likely to be physically active and far less likely to be overweight or obese.[17] Similarly, increased physical activity is one of the main links between exposure to green space and reduced incidence of type-II diabetes.[18] Increased physical activity also leads to better overall mental health.[19] A key mediating factor between access to urban nature and increased physical activity is that activity in urban green spaces fosters greater emotional wellness and stress reduction.[20] In turn, this promotes visits to nature, which leads to better overall health. Even low levels of urban nature can impact physical activity, as greener streetscapes make routes more attractive and inviting and thus encourage greater use of active modes of transport such as walking and cycling.[21] Thus, urban nature interventions play an important role in promoting physical activity, and its associated health benefits, among city dwellers.

Mental health

Nature reduces stress, restores attention, and improves cognition

Exposure and proximity to urban nature positively affects mental health and well-being mainly through decreased stress and increased attention from reduced cognitive fatigue. Walking in natural settings elicits positive affective responses and decreases neural activity in parts of the brain associated with anxiety and depression.[22] Similarly, exposure to nature positively impacts attention and cognitive ability through elevated executive functioning, which increases self-control and improves coping skills.[23] Even passive experiences like viewing nature from a window or driving by trees, parks, and gardens, facilitate recovery from daily and chronic stressors and improve affect and cognition. A well-known study conducted by Roger Ulrich found that patients in rooms with window views of natural scenes had shorter post-operative hospital stays, fewer negative comments from nurses, and less need for narcotic analgesics, as compared to those recovering with a view of a brick wall.[24] This led Ulrich to conclude that

indirect contact with nature has therapeutic and restorative benefits. Additionally, there is a dose-response effect in this relationship, whereby more frequent and longer duration visits to green spaces lead to greater improvements in mental health and well-being.[25] Therefore, urban nature interventions can promote mental health and provide restorative experiences for city dwellers.

Social well-being

Nature fosters social cohesion and builds a sense of community

Presence of nearby nature plays a substantial role in the development of social ties among neighbours by encouraging use of common spaces, which in turn contributes to the creation of healthy neighbourhoods. Research shows that vegetation levels in common spaces can predict usage and are related to neighbourhood safety and adjustment.[26] Greener common areas with natural elements, such as trees, better facilitate opportunities for the development of social ties and shared supervision of children, especially in inner-city neighbourhoods.[27] This sense of community, where residents express high mutual trust and reciprocity, is linked with lower homicide and crime rates. Residents with higher amounts of nearby nature report fewer violent and minor crimes, and fewer incivilities.[28] Close-knit communities further foster health among residents by being better equipped to provide guidance and model behaviors that make youth less likely to participate in unhealthy behaviors such as smoking, drinking, gang involvement, or drug use.[29] Close-knit communities also mitigate mental health issues related to social isolation. Stronger social ties and reduced isolation facilitated by green common spaces also positively impact elderly individuals through lower rates of mortality, reduced suicide rates, reduced fear of crime, and better physical health.[30] Therefore, urban nature provides opportunities to fulfill social and intrapersonal needs, which has a significant impact on health.[31]

Developmental health

Nature positively influences child and adolescent development

With an increasingly digital and urbanized world, children today are experiencing a 'nature-deficit'. They are less connected to nature than any other generation in history, while experiencing rising rates of childhood obesity, attention disorders, and depression.[32] Research shows that nearby nature provides tremendous benefits to children and adolescents in cities and is an essential component of development. In many communities, the lack of safe and appealing places for play or activity is a significant contributing factor to childhood obesity.[33] Regular exposure to green spaces also provides children with mental health benefits as it buffers daily stressors and lowers the risk of psychiatric disorders associated with living in urban environments.[34] Nearby nature also provides a variety of educational benefits, with positive impact on attentional capacity, impulse control, and overall cognitive development. For children, even views of urban nature from home are positively associated with higher concentration, inhibition of initial impulses, and delayed gratification.[35] Similarly, higher levels

of nature at the boundaries of schools, commuting routes, and students' homes is associated with improvement in working memory and attentiveness.[36] There are also future-oriented benefits of greater childhood exposure to nature in terms of environmental stewardship. Research has shown that interactions with nature during childhood greatly enhance concern for the environment and motivate efforts to protect nature in adulthood. Childhood interaction with nature has been linked to adult behaviors such as recycling, voting for pro-environment candidates, and dedication to becoming environmental leaders and activists that protect nature.[37] Therefore, urban nature has a significant influence on the healthy development of urban children and adolescents.

Nutritional health

Nature improves access to nutrient-rich food

Food security, or reliable access to nutrient-rich food, has significant implications for physical and mental health. Chronic limited access to healthy food is associated with a 20%–40% increase in risk of obesity due mainly to poor nutrition.[38] In low-income neighbourhoods, lack of access to nutritious food is further limited by the presence of 'food deserts', where fast food outlets are more common than options to obtain healthy food.[39] This leads to an over-reliance on cheap, energy dense foods that are high in fat and sugar.[40] Research shows that urban nature interventions—specifically community and rooftop gardens—can bolster food security and provide opportunities for improved nutrition, which acts as an important resource for low-income communities and at-risk populations. Urban gardens can increase the consumption of nutritious food by improving household access to high quality fresh fruit and vegetables.[41] Similarly, gardening programs targeting towards older individuals have been shown to increase fruit and vegetable consumption among elders.[42] Beyond increased consumption of nutrient-rich food, urban gardens can reduce environmental risks associated with the food supply. Community or even private gardeners often employ ecological agricultural practices with low reliance on chemical fertilizers and pesticides, which in turn reduces pollution and other potential threats to public health.[43] Therefore, urban nature can support the nutritional health of communities while improving the quality of the urban environment.

Environmental health

Nature provides protection from environmental stressors

Nature provides a vital buffer in the face of increasingly severe environmental stressors that negatively impact physical and mental health. According to Health Canada, exposure to air pollution is one of the most important risk factors for premature death.[44] In urban environments, trees can directly mitigate air pollution levels by acting as natural filters for both gases and particulate matter.[45] Heat in urban areas is also a growing health risk, particularly with climate change-related extreme temperature increases. In urban areas, paved and built impervious surfaces produce an urban heat island (UHI). This in turn creates areas of increased the susceptibility to heat waves.[46] Urban greening can help to ameliorate urban heat islands

and offers cooling benefits in urban areas. During the daytime, urban parks, on average, can be more than 1°C cooler than non-green sites.[47] A park's cooling effect may also extend into adjacent urban areas as ambient air cooling may be supported by city design that optimizes air flow around parks.[48] Street trees offer cooling effects by providing shade and reducing air temperatures through evapotranspiration from their leaves.[49] Other types of urban green infrastructure, such as green roofs and green walls, can also help regulate urban temperature.[50]

Noise is also a major environmental stressor for some urban communities. The World Health Organization has identified noise pollution as a major growing threat to human health in urban areas, owing to rising traffic volumes, industrial activities, and a concurrent decrease in availability of quiet spaces.[51] Studies show that vegetation belts, especially in the form of trees and large shrubs, can also reduce noise pollution levels by providing a barrier or screen.[52] Subsequently, in neighbourhoods with more parks and green spaces, residents express significantly lower dissatisfaction and disturbance due to traffic noises.[53] Therefore, urban nature can promote environmental health through the mitigation of environmental stressors including air pollution, urban heat islands, and noise pollution.

Montréal's Environmental Justice Problem

Decades of empirical research shows that urban nature has a positive impact on human health and well-being through various pathways. There is now a growing interest in the public health benefits of providing quality, well-designed urban nature. However, studies show that urban nature is unevenly distributed across communities, with pervasive racial, ethnic, and socio-economic disparities in access to and quality of neighbourhood green space.[54] Subsequently, an emerging movement in environmental justice is to ensure that urban nature interventions and their associated health benefits are equitably distributed among all segments of the population.

As the importance of nature exposure for human well-being is established in greater detail, more equitable access to urban nature has become a focus of public health research and a priority within urban planning.[55] In cities across the world, the communities that could benefit the most from nearby nature—including low-income, racialized, and immigrant neighbourhoods; places that already face critical public health disparities—often have inadequate access to trees, parks, and gardens.[56] Historically, the environmental justice movement has focused on the inequitable distribution of environmental hazards and its associated health impacts.[57] Recently, however, traditional thinking on environmental justice has expanded towards emphasizing the positive impact of natural environments on community health and well-being.[58]

The World Health Organization states that equitable access to urban nature is necessary to promote the health and well-being of all urban residents, increase the quality of urban settings,

promote sustainable lifestyles, and enhance local resilience.[59] Over the past two decades, the inequitable accessibility to urban nature has increasingly been recognized as an environmental justice issue that warrants intervention, especially as the awareness of its importance to public health has been recognized.[60] This pattern of inequity is also visible in the City of Montréal, where it has been shown by several researchers that low-income communities—a majority of whom are ethnic minorities—are more likely to live in neighbourhoods with low levels of urban nature.

"You will see that it's the poorer class in society that go first into the emergency [department] during smog episodes and heat waves. They are the first to be impacted", says André Bélisle, founder of the Québec Association Against Atmospheric Pollution (AQLPA). Bélisle has demonstrated that, in Montréal, lower-income individuals are more likely to be hospitalized during life-threatening adverse climate events.[61] Research shows that Montréal displays significant inequities in neighbourhood health status, the burden of which disproportionately falls on socioeconomically vulnerable populations. The Québec National Institute of Public Health (INSPQ) found striking disparities in life expectancy between high-income and low-income neighbourhoods of Montréal. In certain areas of the city's east end, neighbourhoods display life expectancies that are ten-years less than more affluent neighbourhoods in the city's centre and west end.[62] These disadvantaged neighbourhoods suffer far greater rates of chronic illnesses such as obesity,[63] psychological distress, and attempted suicides.[64] The residents of these neighbourhoods also perceive their mental and physical health to be significantly worse as compared to their fellow higher income citizens.[65]

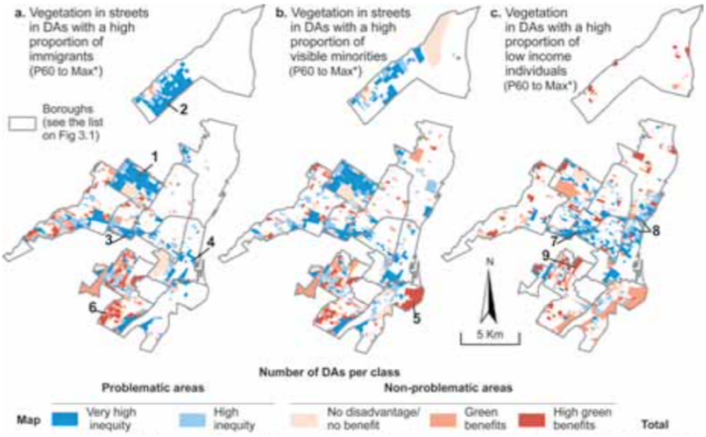
A vast body of work on neighbourhood health effects points out that through an interplay between socioeconomics, social relationships, and conditions of the physical environment, neighbourhood environments are important predictors of health outcomes.[66] Between 1991 and 1996, almost all Canadian cities became increasingly segregated by income, and thus increasingly homogeneous in terms of their social, and in turn, health status.[67] The stress of poverty alone causes adverse physiological responses, expressed as increased risk of various diseases.[68] Neighbourhood environments further contribute to the burden of health inequities for low-income communities in Canada. Those in a lower socioeconomic position often find themselves living in neighbourhood environments that are less conducive to overall health than those with higher socioeconomic status.

Research shows that green spaces may contribute to alleviating health inequities in vulnerable communities. With the presence of nearby green space, physiological stress is reduced among those living in poorer, urban neighbourhoods.[69] Income-related health inequities, including all-cause mortality and mortality from circulatory disease, are lower in populations living in the greenest areas.[70] Especially in urban communities experiencing the highest levels of exposure to unhealthy conditions, nature can offer a vital buffer against pollution and other environmental stressors such as the urban heat island effect.[71] Researchers have found that deprivation-related health inequities are smaller for those living in the greenest areas,[72] showing that green spaces may mitigate some of the negative health impacts of social inequity

in Montréal. This makes urban nature a high priority for investment in the health of low-income populations of Montréal.

Tooke et al. (2010) provided evidence of urban green inequity in three major Canadian cities—Vancouver, Toronto, and Montréal.[73] They showed that urban nature is not equitably distributed in these cities, with poor neighbourhoods tending to have less vegetation cover than affluent ones. Specifically in Montréal, Tooke et al. (2010) found that the higher an individual's income the higher the chance that they live in an area with greater amounts of vegetation. In a more detailed analysis, Pham et al. (2011) identified that certain "very high inequity areas" of Montréal, with less vegetation in streets and alleys, have an elevated presence of immigrants, visible minorities, and low-income individuals.[74] They pointed out that these high inequity areas are primarily located in Saint-Michel (1), Rivière-des-Prairies (2), Parc-Extension (3), downtown (i.e., Ville-Marie) (4), along the railway from Parc-Extension to La Petite Patrie (7), and Hochelaga (8) (Figure 1).

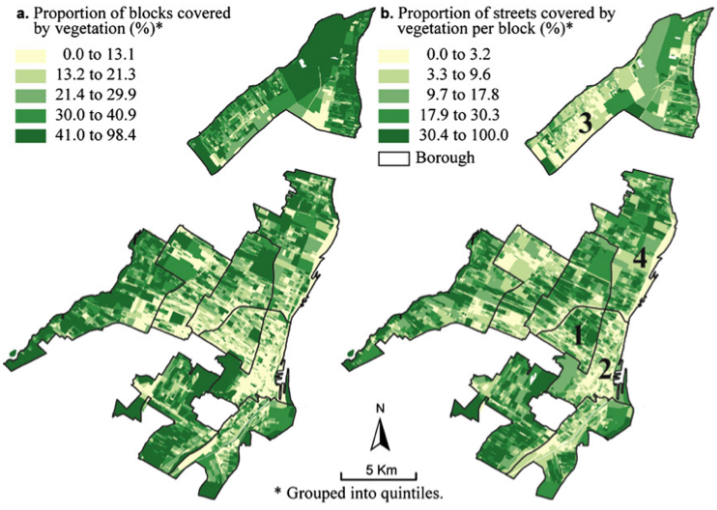
Figure 1: Problematic (high urban green inequity) and non-problematic (high green benefits) areas of Montréal.



Source: Pham, T. T. H., Apparicio, P., Séguin, A. M., & Gagnon, M., "Mapping the greenspace and environmental equity in Montréal: An application of remote sensing and GIS." 2011: 41.

In a follow-up study, Pham et al. (2012) confirmed that in Montréal low-income individuals (and to a lesser degree, visible minorities) are more likely to live in neighbourhoods suffering from disparities in vegetation cover.[75] They observed more pronounced vegetation disparities on public land (i.e., street vegetation) as compared to private land, especially in Ville-Marie (2) as well as in peripheral boroughs like Rivière-des-Prairies (3) (Figure 2). Considering that street vegetation is typically managed by public organizations, the authors concluded that this evidence points to the need for more equitable allocation of street vegetation

Figure 2: Spatial distribution of vegetation in Montréal mapped at the city block and street level.



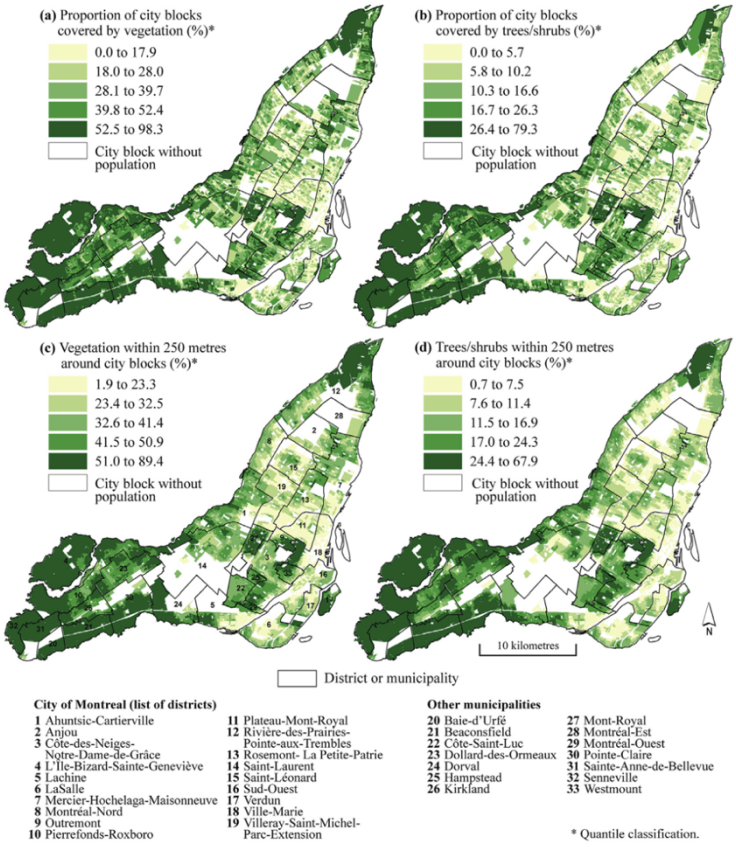
Source: Pham, T. T. H., Apparicio, P., Séguin, A. M., Landry, S., & Gagnon, M., "Spatial distribution of vegetation in Montréal: An uneven distribution or environmental inequity?" 2012: 219.

investment in the city. Similarly, Pham et al. (2013) concluded that the inequitable distribution of urban vegetation in Montréal—to the detriment of low-income, recent immigrant, and visible minority households—raises a question of equity in the benefits provided by neighbourhood vegetation.[76]

Apparicio et al. (2016) found that vegetation indicators—the percentages of vegetation within the block and within 250 meters around the block—vary considerably across Montréal.[77] They observed that blocks in more densely populated central boroughs of Montréal (i.e., Ville-Marie, Plateau-Mont-Royal, and Mercier-Hochelaga- Maisonneuve) have less vegetation than other parts of the city (Figure 3). The authors emphasized that these environmental inequities are more strongly associated with income levels rather than belonging to an ethno-cultural or racial group.

Together, the findings by Tooke et al. (2010), Pham et al. (2012), and Apparicio et al. (2016) convey a concerning reality. While more well-off households living in areas with little greenery could more easily remedy the lack of vegetation (with air conditioning or staying at their secondary residence in the country, for example), the consequences of lack of vegetation in low-income households, given the negative impacts of lack of vegetation on the public health of these populations, could be disastrous. According to Apparicio et al. (2016), this reality can be described as a "double inequity". The evidence of this double inequity is clearly conveyed when looking at the distribution of urban heat islands in the city.

Figure 3: Proportion of city blocks covered by vegetation and trees/shrubs and distribution of vegetation and trees/shrubs within 250 metres around city blocks in Montréal.

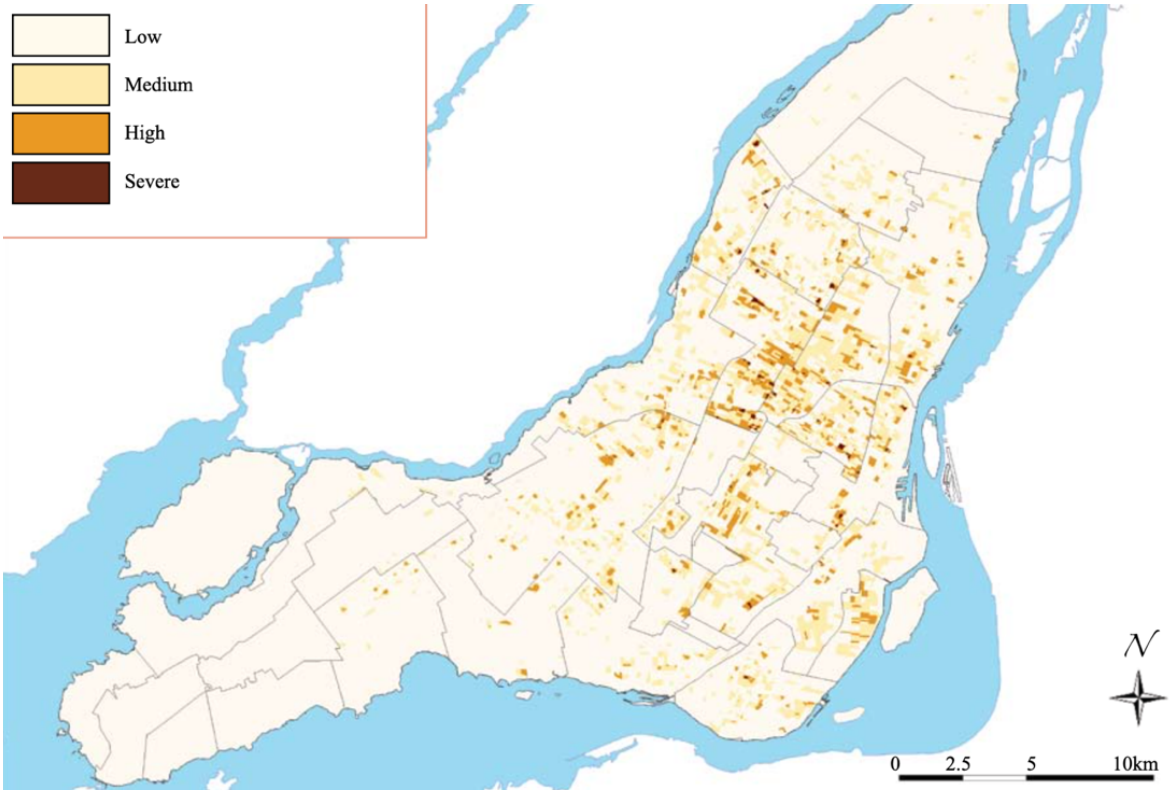


Source: Apparicio, P., Séguin, A. M., & Dubé, J., "Spatial distribution of vegetation in and around city blocks on the Island of Montréal: A double environmental inequity?" 2016: 132.

Variation in densely built environments in terms of distribution of sparse vegetation, building types, and surface materials results in disparate neighbourhood level heat risks. These physical

risks overlap with social and health risk factors resulting in disproportionate effects borne by the most vulnerable residents of high poverty neighbourhoods. In Montréal, Chan et al. (2008) identified areas that are at highest risk of the urban heat island (UHI) effect.[78] They identified these highest risk areas by mapping high presence of community members that are vulnerable to extreme heat (defined as being under five or over 65 years of age, living on a low income, or being over 65 and living alone) and areas where near-surface air temperatures were far above the regional average on a day in June 2005. Using this approach, they developed a risk map (Figure 4) indicating the distribution of areas with highest risk to UHI so that resources may be allocated accordingly. The risk map reveals that: a) the hottest areas correspond to large scale commercial and industrial uses, with an urban fabric characterized by large building and parking lots with dark surfaces and b) although temperatures in these areas are not as extreme as the industrial sectors, the most densely developed areas in the centre of the city (i.e., downtown and the neighbourhoods to its north, like Saint-Michel) are sites of elevated UHI risk. Based on the findings observed above, this shows that the distribution of environmental risk is in line with the inequitable distribution of environmental amenities.

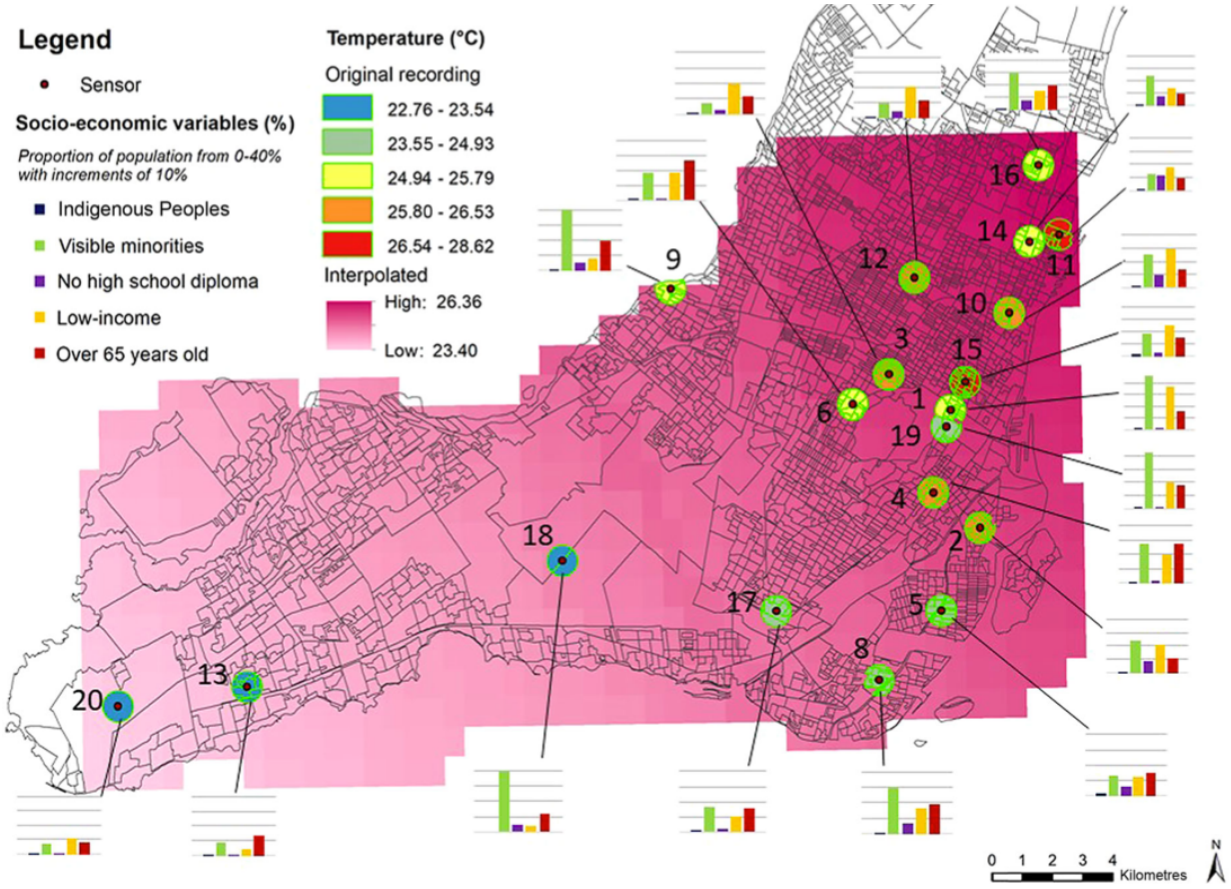
Figure 4: Spatial distribution of urban heat island (UHI) risk in Montréal based on higher vulnerability to extreme heat (i.e., children, elderly, and lower-income residents) and elevated near-surface air temperatures.



Source: Chan, C. F., Lebedeva, J., Otero, J., & Richardson, G., "Urban heat islands: A climate change adaptation strategy for Montréal." 2008: 31.

Fan and Sengupta (2021) confirmed that, in Montréal, socioeconomic status is consistently associated with exposure to urban heat.[79] Their study used in-situ sensors to test the relationship between temperature and socioeconomic characteristics as a proxy for investigating environmental injustice. Overall, they found that high night-time temperatures related to the UHI effect are more likely to be found in areas with a high percentage of low-income residents (Figure 5). These results indicate that individuals from lower socio-economic backgrounds live in warmer neighbourhoods and must be the focus of greening efforts in Montréal.

Figure 5: Spatial distribution of higher temperatures and proportion of population from various demographic backgrounds (i.e., Indigenous, visible minorities, no high school diploma, low-income, and over 65) in Montréal.



Source: Fan, J. Y., & Sengupta, R., "Montréal's environmental justice problem with respect to the urban heat island phenomenon." 2021: 7.

Towards a Solution

In May 2021, Montréal Mayor Valérie Plante stated at a press conference that "coming out of the [COVID-19] pandemic, there has to be a green recovery." While visiting Bellerive Park in

Hochelaga-Maisonneuve, the Mayor announced a 10-year, 1.8-billion-dollar plan to protect green spaces throughout the city and create pathways between them to develop 110 kilometers of green corridors linking neighbourhoods to large parks on the island. "Having amazing parks and green spaces is crucial for Montréalers," she added.[80] As outlined in this chapter, Mayor Plante's statement is supported by decades of empirical research which shows that urban nature has a positive impact on human health and well-being through various underlying mechanisms. To increase environmental, health, climate, and ecological benefits, urban nature interventions are urgently needed.

However, the development of nature-based interventions must be done equitably. Emphasis should be placed on providing the most vulnerable populations with health-giving environmental resources to improve their health and social well-being outcomes. Thus, there is growing interest in the public health benefits of providing quality, well-designed, and diverse green spaces, especially for vulnerable communities (i.e., low-income individuals, immigrants, and visible minorities) who are more likely to live in areas where vegetation is less abundant. This approach utilizes urban nature to create changes in the urban landscape that alleviate health inequities in disadvantaged and underserved neighbourhoods.

There is an urgent need to protect existing green spaces and create new ones to tackle current inequities in exposure to urban nature and its health benefits in underserved areas of Montréal. As discussed in this chapter, some of the areas most in need of such interventions are Saint-Michel, Rivière-des-Prairies, Parc-Extension, downtown (i.e., Ville-Marie), Parc-Extension to La Petite Patrie, and Hochelaga. Targeted nature-based interventions can foster numerous co-benefits for community and environmental health, and in turn serve as a vehicle for alleviating health inequities. Utilizing pathways from urban nature exposure to better health outcomes, these urban greening projects should be designed and planned with deep understanding of how to maximize potential health improvements, sense of place, and foster other benefits that address the whole person and lived experience of a place rather than simply pursuing the minimum required for a design or municipal building credit.[81]

The following chapter discusses how different types of nature-based solutions are being used in various cities to promote sustainable lifestyles, increase environmental quality, improve health and well-being, and enhance local resilience. It outlines best practices that Montréal could follow to help reduce the environmental inequities that low-income people and visible minorities face. This includes interventions such as community gardens for urban agriculture, implementing green walls and roofs, planting trees along streets, and developing new, interconnected urban parks. Based on the research discussed in this chapter, the next chapter strives to understand how various types of urban nature-based interventions influence desired health, resilience, and equity outcomes.[82]

CHAPTER 3: BEST PRACTICES

Urban Nature-based Initiatives Worldwide and their Health Impacts

Greening cities to improve urban health has a long history. Over a century ago, the City Beautiful movement resulted in numerous city parks, including New York's famous Central Park. Some of the key arguments for these urban green spaces were to reduce stress for the working poor and encouraging civic pride.[83] However, critics of the movement say it was overly concerned with aesthetics at the expense of social reform. Jane Jacobs, for one, charged the movement with being too focused on the role of design and not going far enough to understand the social dimensions and complexity of the city.[84] From 1850 to the present day, park design has been limited to pleasure grounds, recreation facilities, and public space systems that link urbanites to natural areas. More recently, city parks have become an instrument of social policy with the potential for serving multiple social benefits.[85] In this context, a new paradigm of urban greening has emerged that looks to innovatively incorporate nature into cities at various scales, while maximizing environmental, economic, and equitable social benefits.

As the relationship between urbanites and nature is reframed, the concept of nature-based solutions (NBS) is capturing the imagination of communities, researchers, and planners

everywhere. For cities around the world, sustainable development has become a strategic priority. In this context, NBS, which use the natural properties of ecosystems, have shown significant potential for enabling the urban transition to sustainability. NBS is increasingly being deployed to address climate change mitigation and adaptation as cities face mounting environmental, economic, and social pressures. However, beyond benefits like managing flooding, NBS can provide multiple benefits across a range of sustainability challenges facing cities, such as securing improved health outcomes for different groups of society.

The term "nature-based solutions" was coined in the late 2000s in the context of finding solutions to the effects of climate change while protecting biodiversity and promoting sustainable livelihoods. In a position paper for the United Nations Framework Convention on Climate Change, the International Union for Nature Conservation referred to NBS as an innovative strategy to create jobs and grow the green economy. Quickly thereafter, the European Commission also took up the term.[86] Presently, it is an umbrella term referring to several approaches that use nature to improve urban sustainability and solve societal challenges. Key to the value of NBS is their potential to provide multiple benefits.

Nature-based Solutions are…

"…inspired and supported by nature; [they] are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions."

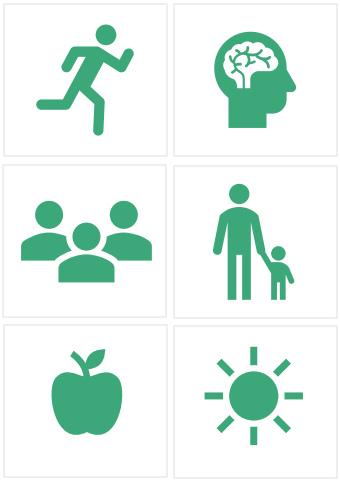
– European Commission[85]

Urban nature-based solutions are diverse—they can be used for different purposes and at different levels to yield environmental, economic, and equitable social benefits. NBS can involve various types of innovation. Technological innovation or product and process innovation, for example, describes the design of a green bus-stop that serves as an element of urban stormwater infrastructure. Another example of such innovation is a low maintenance green roof that requires minimal irrigation and care. Ecological innovation involves the creation of new natural spaces or the restoration of existing ecosystems. Social innovation may also be required when implementing NBS, including new models of collaboration, innovative business models, or changes to cultural frameworks and preferences. Systems innovation creates a systemic change by enabling interactions between technological, ecological, and social innovations. This type of innovation is typically observed in urban master plans that aim to deploy NBS to address urban challenges across the entire city.[87]

This chapter examines case studies of urban nature-based interventions to assess their potential impact on health and well-being. The interventions included in this chapter are retrieved from the Urban Nature Atlas, a comprehensive database of nature-based solutions for cities. The Atlas has been produced through systematic surveys of nature-based interventions in hundreds of cities around the world. It provides a basis for the analysis of socio-economic and innovation patterns associated with urban nature-based solutions. It categorizes interventions according to the following types: nature on buildings (e.g., green roofs and green walls or facades); grey infrastructure featuring greens (e.g., alley and street greens, green parking lots); parks and urban forests (e.g., pocket parks and neighbourhood green spaces);

community gardens and allotments; green areas for water management (e.g., sustainable urban drainage systems); blue infrastructure; green indoor areas; and intentionally unmanaged areas. To limit the scope of this report, the latter three types of interventions are excluded from examination.

Interventions selected for study are from cities in Canada, the United States, the United Kingdom, and Europe. For the typologies included within this report, interventions are selected based on their potential to impact health and well-being. Health and well-being are assessed based on the pathways linking nature to health outlined in Chapter 2, namely: physical health, mental health, social well-being, developmental health, nutritional health, and environmental health. Icons associated with each of these health benefits will be used to indicate which pathways linking urban nature with urban health are activated by each type of NBS, as per the figure on the right.



An Assessment of Urban Nature-based Solutions with Selected Case Studies

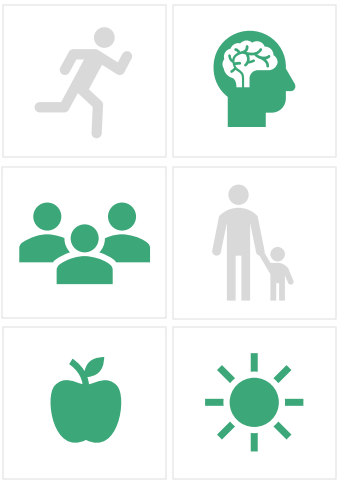
Nature on buildings

Nature on buildings often involves the greening of existing city infrastructure and privately-owned buildings—including green roofs, green walls or façades, and balcony greens, among others. In this approach, buildings are dynamic elements that interact with their surroundings and inhabitants. Thus, green solutions are being implemented in, on, and around buildings, at various scales (i.e., building, neighbourhood, and city). While green roofs have an established history, recently, with advances in technical knowledge and supported by guidelines and standards, they are increasingly considered engineered ecosystems that can be feasibly implemented.

Green roofs provide an array of sustainability and climate-related benefits. These include stormwater retention, reduction of peak flow and runoff, and improved quality of water for use. They also include efficiency benefits such as improved microclimate and reduced energy costs through their positive effect on insulation, heating, cooling, and ventilation systems within buildings. Green roofs have become important retrofitting options to reduce the

environmental impact of built infrastructure in cities and are increasingly being considered in the design stage of new buildings.[88] Green roofs also offer numerous health-related benefits.

Green roofs can help mitigate the urban heat island effect and reduce air pollution, creating more liveable urban environments.[89] Depending on the type of green roof, and the access allowed, they can foster mental health benefits by providing an escape, reducing stress, and fostering social cohesion. Mental health benefits are maximized by designing the space to be an attractive, functional, accessible, and social space. Green roofs are also increasingly being considered for urban food production, supporting urban nutritional health. Modern techniques such as vertical gardening, hydroponics, aeroponics, aquaponics, in addition to improved rooftop gardening, can offer steady supplies of fresh fruits and vegetables to urban neighbourhoods.[90]



Case Study: Portland's Ecoroof Incentive program[91]

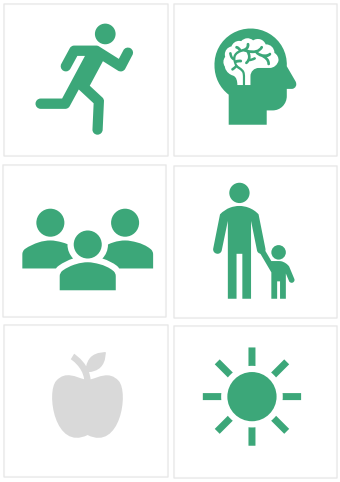
Since 2008, the City of Portland, Oregon has used various policies and programs to encourage the use of ecoroofs (vegetated roofs) throughout the city. Ecoroofs are promoted to address stormwater management, save energy, reduce pollution and erosion in waterways, create new habitats for birds and insects, absorb carbon dioxide, cool urban heat islands, filter air pollutants, and provide urban green space. From 2008 to 2012, the city used the Ecoroof Incentive program to encourage property owners and developers to construct ecoroofs. In 2018, the city adopted a mandate for ecoroofs in new buildings. These policies and programs have resulted in the construction of over 130 ecoroofs and have contributed to growing interest in the use of ecoroofs.

Currently, as part of broader efforts to increase the city's resilience to natural hazards, disasters, and climate change, Portland's ecoroofs are mainly designed to aid with stormwater management. Stormwater management principles, which prioritize the use of vegetation and infiltration to meet stormwater requirements, are used to protect against heavy runoffs and flooding, and to improve the resilience of the city's watersheds to changes in hydrology anticipated due to climate change. Beyond stormwater management, ecoroofs are incorporated into green building design to provide a more sustainable alternative to conventional roofing. Energy conservation and avian monitoring studies are also conducted on the ecoroofs.

Grey infrastructure featuring greens

Increasingly, urban infrastructure projects are integrating nature to achieve lower cost services and advance developmental goals including water security and climate resilience. In urban settings, such projects can include alley and street greening, railroad bank and track greening, riverbank greening, house gardens, greening parking lots, greening playgrounds, and increasing institutional green space, among others. A 2019 report on "Integrating Green and Gray" produced by the World Bank and World Resources Institute calls for such green infrastructure to play a bigger role in traditional infrastructure planning.[92]

Street trees are a high priority urban nature intervention for cities. Rather than considering trees a luxury, there is growing recognition of the need to add urban street trees and increase overall canopy cover. Although the implementation and maintenance of trees in urban areas is a costly task, the return on investment is substantial. In terms of climate change adaptation, trees reduce storm water runoff and flooding potential in cities. They also support biodiversity by providing essential environments for birds, squirrels, and other urban life. Below the surface, tree roots act as important soil stabilizers and habitat for insect and bacterial life to flourish.



In terms of health and well-being, street trees create safer walking environments by providing distinct edges to sidewalks and natural barriers from traffic. More pleasant walking environments increase social cohesion and promote physical activity by inviting more people to traverse public spaces. This can help foster pride, security, and trust among community members. Aesthetically, trees improve overall emotional and psychological health, and reduce stress and blood pressure. They provide protection in the face of extreme heat as significantly lower urban air temperatures are felt by those walking under or living in proximity to tree canopied streets. Trees in urban environments also filter atmospheric pollutants, reducing human health risks.[93] The mitigation of traffic, pollution, crime, social fears, and isolation that street trees provide also support the positive development of children growing up in urban environments.[94]

Case Study: Barcelona's Tree Master Plan[95]

Barcelona's Tree Master Plan is a long-term strategy, running from 2017 to 2037. It strives to ensure the presence of dynamic, healthy, and diverse urban trees to create high quality public spaces. The overall aim of the plan is to maintain a well-managed, healthy, and biodiverse woodland to improve green corridors and tackle the urban heat island effect. This includes

planting the maximum possible number of trees that are connected to the urban and natural environment and thus maximize the environmental, social, and economic benefits of the city's trees. Thoughtful tree planting will involve planting a biodiverse range of trees that are in good condition and protected with highly efficient and sustainable management, while being resilient to the climate. The plan also aims to increase the value that society attaches to trees by encouraging citizens to participate in conservation and preservation, thereby facilitating a harmonious relationship between people and trees.

According to Gabino Carballo, from the team behind Barcelona's Tree Master Plan, involving hundreds of stakeholders and creating shared understanding of the multiple benefits of urban trees was crucial for the success of the city's tree master plan. In preparing the plan, the team consulted over 700 different people—including gardeners, tree suppliers, sustainability associations, neighbourhood representatives, and public institutions—to understand their needs, viewpoints, and opinions on urban trees. The consultation process helped to create public support, improved understanding of trees and their infrastructural needs, and fostered sense of ownership of NBS. They were also able to challenge perceptions that trees are not of value and intrusive.[96]

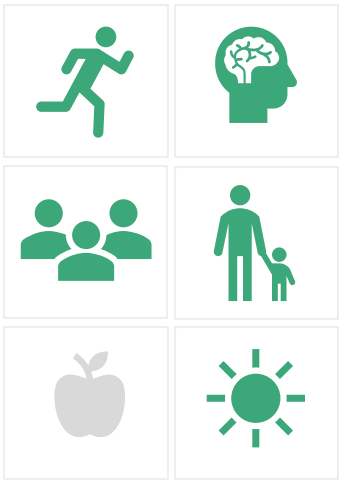
A notable feature of this intervention is the innovative application of technology to the maintenance of trees. The inclusion of technology as a support tool for the public planning and management of trees, and other green infrastructure, has become an essential municipal strategy for building up a more functional network of urban infrastructures. Examples of technology-based actions related to the management of the tree population include smart irrigation, which fosters more efficient consumption of hydrological resources for maintaining plants and structured soils, and high-tech tree wells, which improve the living conditions for root systems.[97]

Parks and urban forests

City parks and urban forests are vital components of urban communities, as they provide access to recreational opportunities and provide numerous environmental benefits. They can be integrated with infrastructure to improve water filtration, store water, reduce stormwater runoff, and mitigate flooding, making cities more resilient.[98] They help remove toxins from the air and provide oxygen, in addition to providing habitat for wildlife and promoting biodiversity.[99] Parks and urban forests are the most commonly deployed urban nature intervention to meet health and environmental equity goals. Typically, large parks with walking paths, bike paths, and playing fields are considered when linking community parks with the health benefits of active living. However, in many cities, where every parcel of land is ever more valuable, additional land for large parks is expensive and difficult to repurpose. In this context, small parks play an equally important role in providing natural spaces for health.

Pocket parks can be a creative way to introduce neighbourhood spaces for nature encounters that benefit everyone. They promote active lifestyles, and thus improve physical and mental

health. The exposure to natural features like trees and flowers further impacts mental health by improving cognitive functioning, elevating general mood and attitude, reducing stress, and restoring the mind from mental fatigue. Pocket parks also improve social well-being as the presence of urban nature promotes community connections, while views of green space from homes is linked with greater sense of well-being and neighbourhood satisfaction. These social benefits extend to children and adolescents, as active involvement in community greening and nature restoration projects, like pocket parks, strengthen intergenerational ties and organizational empowerment.[100] If implemented well, pocket parks contribute to enhancing biodiversity, reducing pollution, and mitigating climate change. They also reduce the intensity of the urban heat island effect, especially if trees are planted and pocket parks are strategically linked together with green corridors and green belts to cover more area of land in the city.



Case Study: Sheffield's Love Square[101]

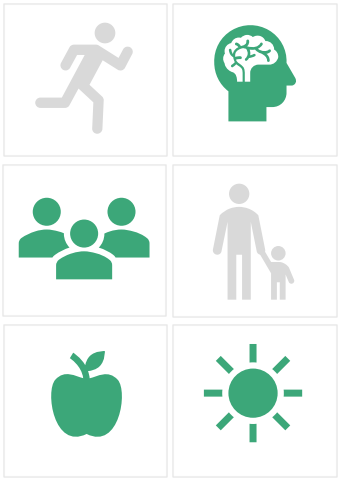
Sheffield's Love Square is an innovative pocket park that transforms a derelict site by putting a living garden back into the city. It combines nature and wildlife with a social space for residents and workers. Features include wildflower meadows, lawns, and a mini wetland lined with bird-friendly trees. The mini wetland, or 'rain garden', increases soil and vegetation coverage, which soaks up excess rainwater after a storm, reduces the danger of flash flooding, and is a prime example of water-sensitive urban design. Love Square is an example of unique and versatile urban greening in that it combines nature and wildlife with social and activity spaces.

Rethinking the boundaries between urban spaces and nature, the goals of the project were to use the landscape to solve urban flooding while creating a relaxing space that gives health and well-being benefits to locals through a clean and healthy urban environment in the middle of the city. Furthermore, transforming a disused and derelict site into a new pocket park has also enabled young people from many backgrounds to interact with, develop, and maintain a new garden. Thus, it has become a valuable training and learning resource. Love Square is also transforming the corridor linking Sheffield's business district with the rest of the city centre with a strong emphasis on flood prevention and connection with nature.

Community gardens and allotments

Community gardens do not have the same degree of impact as parks and urban forests, but they are a vastly underprovided resource in cities. Gardening is a widely preferred outdoor leisure activity for stress relief[102] that, owing to the lack of space, is not proportionately enjoyed

by vast numbers of urban residents. The situation is more severe for immigrants who live in cities and have deep cultural attachments to agriculture, but do not have access to gardens. In response, community gardens offer underserved urbanites the opportunity to partake in producing nutritious food, while engaging with a hub of activity in the community.



Community gardens come in various forms that determine their benefits. In terms of environmental impact, they can improve air and soil quality, increase biodiversity, and reduce neighbourhood waste through composting. Contributing to climate resilience, they can replace impervious urban areas, improve water infiltration, and positively impact the urban micro-climate. Acting as community hubs, they provide opportunities for nutritional education, creation of social ties, and the integration of new community members into neighbourhoods. Garden maintenance activities can promote moderate physical activity. Effects on mental health are more pronounced due to the aesthetic improvement, social benefits, and space for relaxation provided by community gardens.[103]

However, the most significant impact of community gardens is the notable increase in neighbourhood consumption of fruits, vegetables, and their associated nutrients. Taking part in gardening initiatives can improve dietary habits and nutritional education. Urban residents are much more likely to consume greater servings of fruit or vegetables if they or a family member participates in a community gardening project.[104] These benefits are particularly important for urban residents living in food deserts, where low accessibility to nutritious foods causes numerous health issues. The addition of community gardens not only addresses potential environmental inequity issues but also improves nutritional health by increasing the availability and consumption of fruits and vegetables.

Case Study: Utrecht's Food for Good Initiative[105]

Food for Good is an urban farm that brings together citizens, especially disadvantaged groups, to work together and grow healthy crops in a sustainable way. Social cohesion is at the heart of the initiative as it facilitates social integration of vulnerable groups, including unhoused people and individuals dealing with addiction and psychiatric disorders. Organic agriculture principles are applied, by planting species that attract crop protecting insects from invasive plant and animal species for example, which promotes sustainable agriculture. The community garden also provides educational opportunities through trainings workshops and tours. The garden promotes nutritional health and food security as healthy crops are grown and made available to unhoused and low-income citizens. It also improves mental and physical health by creating opportunities for recreation and relaxation.

Hans Pijls, founder of the Food for Good urban farm believes his project generates several different types of value for the city, including boosting employment, education, improving

economic value of surrounding properties, promoting climate resilience and urban biodiversity, and generating positive effects for health and well-being. Despite adding value in several domains, the initiative mainly receives one type of public funding: 80% of funding comes from foundations for creating space for community care. The funds received reflect higher subsidies levels for making special arrangements for community members that need more guidance.

To ensure its survival, Food for Good cooperates with local entrepreneurs to generate 15% of their funding, such as working with a beekeeper who sells honey and with a local pizza academy to educate refugees on making pizzas and help them land a job. The initiative also tried to generate some its own income to cover the remaining 5% of funding by selling vegetables grown on the farm to food co-operations, which are organizations that buy food from farms in and around Utrecht, and to citizens who buy food directly from farms. They also have a small shop and a few restaurants where people buy food. The small percentage of income from selling food is attributed to the small scale of growth of urban farming in the city. Despite the small proportion of revenue, selling vegetables is a celebrated component of the daily life of volunteers who grow food.[106]

Green water management

Renewal and expansion of urban water infrastructure provides opportunities to re-design, retrofit, and better manage water resources. Green water management, including rain gardens, bioswales, and sustainable urban drainage systems, use low-impact development to reduce flow to pipes and drains. These nature-based systems can also be integrated into nearby larger park parcels, conservation lands, and community open spaces to further improve quality of life. In designing such systems, more variety in the plant composition can increase bioswale function and enhance biodiversity. Depending on how they are implemented, these systems offer numerous health and community co-benefits.

Larger **green areas for water management** that are linked to local parks and active transit systems promote more physical activity. Roadside green infrastructure can improve the quality of experience of daily users. Brief encounters with or even views of nearby nature can ease stress and anxiety and restore the mind from mental fatigue. Incorporating well-designed seats and benches that provide places for rest amplify these benefits to mental health. Stormwater holding parcels that are designed with multiple zones of function and benefit, where naturalistic vegetation is framed by more refined and manicured spaces, invites people to interact and gain the benefits of exposure to nature.[107]

Case Study: Greening in Laval[108]

In May 2019, the Government of Canada and the Federation of Canadian Municipalities announced an investment of $2.8 million in four green infrastructure projects in the Greater Montréal Area, with the aim of helping municipalities to adapt to climate change and reduce greenhouse gas emissions.[109] This includes $750,000 in funding for the City of Laval's integrated collaborative strategy to mitigate the effects of urban heat islands through demineralization and tree planting. This greening project aims to replace impermeable surfaces such as asphalt with vegetation and trees (i.e., demineralization), which would allow water to infiltrate the soil and mitigate the impact of urban heat islands, on both public and private land. While 12-13% of the territory in Laval is impacted by urban heat islands, the project targets population areas that are particularly vulnerable or exposed to heatwaves.

In addition to reducing the community's vulnerability to heatwaves and increasing the city's overall canopy cover, the project is expected to have numerous positive environmental, social, and economic impacts. For example, in terms of climate change adaptation, the project aims to document the effectiveness of greening on the reduction of ambient outdoor temperature and on urban heat islands. Expertise is provided by the Université du Québec à Montréal, the public health directorate of Laval, and OURANOS, a consortium on regional climatology and adaptation to climate change. They will assist with targeting sites with vulnerable populations and installing air temperature sensors to evaluate the effect of the interventions on the surrounding temperature.

From Sites to Systems

Given the benefits of urban nature for urban health, agencies and organizations are working to create more green space in cities. As urban nature-based solutions (NBS) are implemented, the design quality of individual sites is a key consideration. Merging or co-designing various types of NBS can tease out greater co-benefits from green spaces. Green infrastructure can achieve essential ecological functions in the community, in addition to creating environments that support health. For instance, bioswales and green streets that are installed to improve stormwater management, can also be designed to serve as micro-parks that offer rest and enjoyment. Larger parks can serve functions of recreational amenities, while also containing spaces that mitigate stormwater or improve air quality. Water management and transportation infrastructure, usually thought of as being dedicated to one use, may include opportunities to insert smaller parks and green spaces, making them multi-purpose. This approach is especially useful for communities where there is little land available for green spaces, or it is prohibitively expensive for public purchase.

It is also important for nature to be incorporated in cities with a big picture in mind by adopting a systems outlook in planning. Often, green spaces in the city are disconnected and lack a sense of cohesion. Thus, city officials, planners, and community members should think of ways to stitch together existing green spaces to form connected sites. Planning that unifies sites into systems of green spaces provides ongoing opportunities to access nature's benefits and fosters a more accessible and enjoyable nature experience. Multiple points of access encourage more exploration across the system, which in turn contributes to better mental and physical health outcomes. In this way, deliberately considering the health and well-being potential of the arrangement and connectivity of green spaces across communities and cities can further improve people's lives.

Using the discussed nature-based solutions and case studies, the next chapter provides recommendations for the proposed urban nature-based interventions in Montréal's Climate Plan for 2020 to 2030. The aim of this next chapter is to provide recommendations that inform policies, programs, and planning decisions that will enhance green spaces and their health benefits.

CHAPTER 4: RECOMMENDATIONS

Bringing Nature to Montréal through the Climate Plan

In November 2019, a coalition of 125 doctors called on the Government of Québec to increase the amount of green space in cities across the province. The coalition argued that increasing the city space dedicated to greenery would lead to striking improvements in public health. They cited widely established research on the positive effects of neighbourhood greenness on health of urban populations, including reduced stress, obesity, ADHD, cognitive decline, and social isolation. Additionally, they conveyed that urban nature helps improve students' academic performance, combats heat islands, and contributes to climate resilience. They further reasoned that the ensuing health benefits of more green space would significantly reduce health care costs for the province. The coalition called on the Government of Québec to devote an additional $170 million a year, about one per cent of the province's overall spending on public infrastructure, to the creation of new green spaces in cities throughout the province.[110]

Greening and green inequities are central to government policy debates in Montréal; they were campaign issues in the 2021 mayoral race. "Access to community green spaces shouldn't

be affected by geography or socioeconomic status", says Balarama Holness, mayoral candidate in the 2021 Montréal municipal election. Citing academic studies linking green spaces with positive health outcomes, Holness asserted that Montréal must "develop green spaces, community gardens, and sports infrastructure in lower-income boroughs across the island."[111] One of the studies cited by Holness includes Pham et al. (2012), discussed in Chapter 2 of this report, which shows that low-income people and visible minorities in Montréal have more limited access to urban nature.

The City of Montréal aims to improve its levels of urban nature. In December 2020, Valérie Plante, who was re-elected Mayor of Montréal in November 2021, unveiled Montréal's Climate Plan for 2020 to 2030. According to Mayor Plante, the Climate Plan will "enable Montréal to improve the quality of life of its population in the short, medium, and long term through a recovery that we hope will be green and inclusive."[112] Therefore, through its Climate Plan the City of Montréal aims to position itself as a leader in environmental justice and in the fight against climate change. Urban nature interventions will play a crucial role in the Climate Plan as, in addition to building climate resilience, they offer numerous co-benefits for health and equity.

This chapter describes the elements of the Climate Plan related to greening and provides recommendations for actions in the plan that involve urban nature interventions and their associated benefits for climate resilience, public health, and environmental justice. Urban nature-based actions included in the plan involve planting trees, particularly in communities vulnerable to heat waves, and promoting urban agriculture. This chapter identifies gaps in the Climate Plan, identifying parts of the Plan that could potentially benefit from select urban nature interventions. Urban nature interventions recommended in this study include incentivizing green roofs through building sector actions and incorporating pocket parks into climate resilience hubs. Applicable case studies discussed in the previous chapter and additional research are drawn upon to inform recommendations. Furthermore, for each type of urban nature intervention, some existing organizations and programs are outlined that can be leveraged by the City of Montréal when implementing greening initiatives.

Montréal's Climate Plan: Focus on Green and Inclusive

In its Climate Plan for 2020 to 2030, Montréal has proposed several climate and environmental actions to ensure a successful ecological transition. The plan consists of 46 actions, 16 of which are identified as key actions, that aim to have a particularly significant impact on mobilization of the community, reduction of greenhouse gas (GHG) emissions, and adaptation to climate change. The proposed actions are grouped into five areas of intervention, referred to as sectors, which include: (1) mobilization of the Montréal community, (2) urban planning and urban development, (3) buildings, (4) the exemplarity of the city, and (5) governance.

Several of the actions in the plan will potentially have a positive impact on the health of Montréalers. For example, under sector 2, which deals with mobility, urban planning, and urban development, the city commits to deploying sustainable mobility services equitably throughout its territory. This goal has significant implications for health as the greatest reductions in GHG emissions over the next decade are expected to be in the transportation sector, and reduction in emissions will lead to positive health outcomes. This study focuses on actions in the plan that involve urban nature interventions and their associated health benefits.

Nature-based solutions included in the Climate Plan

The two actions in Montréal's Climate Plan that clearly rely on nature-based solutions (NBS) involve urban trees (Action 20) and urban agriculture (Action 22). Both actions are part of sector 2 of Montréal's Climate Plan. The actions within this sector aim to reimagine public space to be safer and more user-friendly. Priority is given to deploying sustainable mobility with actions that reduce motorized vehicle travel and encourage use of public transit. However, the city also intends to rethink urban planning by making the city greener and increasing its resilience to climate hazards including heat waves and heavy rain. To do so, Montréal is planning to increase its tree canopy cover and promote urban agriculture. Following is an overview of the NBS in Montréal's Climate Plan related to urban trees and urban agriculture. Existing organizations and programs are identified that are already engaged in these NBS and thus can be leveraged by the City of Montréal. Recommendations are provided that can improve these actions based on learnings from the Barcelona Tree Master Plan, Utrecht Food for Good initiative, and additional research.

Plant trees to mitigate urban heat islands and promote health

As seen in Chapter 3, urban trees offer numerous health benefits. Increasing the number of trees in Montréal is one of the most significant actions being taken by the city to better adapt to climate hazards. In Action 20 of Montréal's Climate Plan, the city intends to plant 500,000 trees on public and private property between 2020 and 2030. Priority will be given to areas that are vulnerable to heat waves, which will be determined by detailed mapping. The city will support boroughs in identifying potential planting sites, including sites that need to be demineralized. However, tree planting efforts will be limited by the density of the built environment and extensive mineralized surfaces (e.g., asphalt, cobblestone, concrete). To meet this challenge, Montréal will set aside sizeable funds in its Ten-Year Capital Expenditures Program to reach 50 per cent of its target. Additionally, to increase the proportion of protected areas, the city will call upon the provincial and federal government and the private sector to fully achieve its target. Some of the existing assets that will contribute to Montréal's success in this endeavour are SOVERDI and the Urban Forest Action Plan (Plan d'action forêt urbaine).

Assets: SOVERDI, the Urban Forest Alliance, and the Urban Forest Action Plan

Montréal is well-positioned to achieve its aim of planting 500,000 trees thanks in part to existing organizations and ongoing initiatives. For example, Montréal is collaborating with the Société de verdissement du Montréal métropolitain (SOVERDI), a non-government organization (NGO) that implements urban greening strategies. As part of Montréal's Urban Forest Action Plan, SOVERDI and members of the Urban Forest Alliance have planted and maintained more than 70,000 trees on private and institutional land between 2012 and 2020, with aims to increase the number of trees to 180,000 covering 25% of Montréal's territory by 2025. This experience has prepared SOVERDI to meet the challenge of coordinating the planting of 200,000 trees on private and institutional (non-municipal) land as part of Montréal's Climate Plan. In recent years, SOVERDI and their collaborators have achieved a planting rate of 10,000 trees per year. In 2021, the first year of the climate plan, they have almost doubled this rate by coordinating the planting of 17,000 trees. Montréal is funding these efforts by allowing SOVERDI to offer participating companies up to 60% reduction in the cost of planting trees on their land.[113]

The participation of the private sector is essential for greening efforts as private and institutional land represents 66% of Montréal's territory. To reach private landowners, the city and SOVERDI created the Urban Forest Alliance, a coalition of 50 NGOs dedicated to increasing Montréal's canopy cover on private land. With funds provided by the city and investments from major stakeholders like CN, Port de Montréal, and Hydro Québec, the coalition conducts targeted tree planting campaigns for institutional, commercial, and industrial landowners, as well as residents. In addition to carrying out greening projects as owners, volunteers, or financial investors, these leaders are committed to creating a city-wide greening movement by encouraging other owners to green their land. The partnership conducts outreach in the community, the institutional sector (i.e., education, health, culture, and heritage), and the private sector (i.e., residential, community, industrial, and commercial).[114]

Despite these assets, there are several challenges that still need to be overcome. The city faces inequitable funding and capacity challenges within its boroughs, with some struggling with scarce human and financial resources to maintain the existing tree canopy. A steady source of new trees is also an obstacle to cost-effective planting strategies. Currently, Montréal has its own nursery, with around 80,000 trees of different species at different stages of development, that provides a third of trees planted in Montréal's boroughs annually.[115]

Recommendations

Apart from the various obstacles to tree planting efforts outlined above, there are additional factors to consider. Following are key recommendations for the City of Montréal's tree planting

efforts. The recommendations are based on the Barcelona Tree Master Plan case study, as discussed in Chapter 3, and additional research in the Montréal context.

Plant trees as connected green infrastructure using structural soil and optimized tree pits where possible

To maximize the trees' contribution to the environment, Montréal's Climate Plan outlines several practices that will be adopted to ensure the optimal growth of trees. These practices include selecting species that are diverse and most resilient to climate change, increasing the underground space for roots, updating the irrigation and maintenance method for young plants, protecting trees during construction work, and adjusting pruning practices to favour tree robustness and longevity. These practices will also be mandated for trees planted on private property. The following practices, which are garnered from the Barcelona case study, can help bolster the effectiveness of Montréal's tree planting efforts:

- *Plant trees as connected green infrastructure* to provide more benefits and form a larger habitat for biodiversity. Large tree networks integrated with green corridors offer a means of distributing nature throughout the city. This development strategy can also help to address urban green inequity between neighbourhoods of the city.
- *Use structural soil innovations* that allow vehicles and people to move and circulate above the ground, while offering each tree opportunity to find nutrients, air, and water to promote natural root system development underground. Combining structural soil with sustainable urban drainage systems can help trees get water in a more natural way, sustainably manage irrigation water, and obtain maximum benefits.
- *Optimize tree pits* by creating permeable surfaces in tree pits, making tree pits bigger, planting other species in them, and distributing them in a more connected way throughout the city.

Engage various stakeholders and the public to support planting strategies and grow appreciation for urban trees

Montréal's Climate Plan does not outline a stakeholder engagement strategy for their tree planting efforts. As demonstrated in the Barcelona case study, fragmented management of urban trees by individual districts and private landowners is not sufficient. Therefore, involving a wider range of stakeholders is key to the success of tree planting efforts. The following practices will help to create public support and foster sense of ownership of trees and other NBS:

- *Consult different stakeholders* to allow the city to recognize various needs, viewpoints, and opinions on urban trees, while creating a shared understanding of the multiple benefits of urban trees. These stakeholders include suppliers (e.g., tree suppliers), practitioners (e.g., gardeners), professional associations (e.g., sustainability experts and neighbourhood representatives), and public institutions (e.g., public works, public

health, and parks departments). A key advantage of wide consultation is that it starts the conversation and helps the city determine strategies for the success of tree planting efforts.

- *Advance knowledge of trees* and their value and services among the public. People often have a limited understanding of trees in the city, failing to see them as valuable infrastructural assets. Encouraging citizens to participate in conservation and preservation may also improve appreciation and respect for trees in the city.

Plant trees to combat urban heat islands in areas of the city experiencing urban green inequity

Montréal's Climate Plan indicates that tree planting efforts will be prioritized in areas that are vulnerable to heat waves. The southwest and eastern parts of the city, which were traditionally home to industry and factory workers, today have higher proportions of low-income individuals and visible minorities. These communities are more vulnerable to illness and death during heatwaves. Increased tree cover in these areas would help cool the air and provide a refuge during heatwaves.[116] It may be more expensive and challenging to plant trees in areas that have a high concentration of industry and transport infrastructure, given that surfaces are often covered with pavement and asphalt. However, greater investment in these areas is justified by potentially higher societal benefits.[117] This strategy also offers an opportunity to address urban green inequity in the city. As outlined in Chapter 2, low-income populations of Montréal that live in hotter urban areas are also more likely to live in areas with less vegetation cover. Areas most in need of attention, as identified by several researchers, include Saint-Michel, Rivière-des-Prairies, Parc-Extension, downtown (i.e., Ville-Marie), Parc-Extension to La Petite Patrie, and Hochelaga.

Use technology to monitor trees and raise public awareness of the importance of urban trees

In their approach to managing urban trees, Montréal's Climate Plan does not mention the use of technological applications. Technology based approaches for managing the tree population can include smart irrigation, which helps monitor consumption of hydrological resources, and high-tech tree wells, which improve the living condition of root systems. Technology can also be used for monitoring urban trees and engaging the public with their surrounding urban trees. For example, the Urban Forest Monitoring app developed by the PaqLab research laboratory at the Université du Québec à Montréal (UQAM) allows specialists and members of the public to monitor the urban forest around the Pierre-Dansereau Science Complex. It includes an interactive map that lists the 1,567 trees present within one square kilometer of area. Not only can this help the city manage its urban trees, but it can also help members of the public better understand the importance of trees in an urban environment. Although this app is limited to a small area of Montréal, its approach can be expanded to other parts of the city as well.

Equity consideration: Plant trees in vulnerable areas while avoiding eco-gentrification

As Montréal conducts tree planting efforts in vulnerable communities, which are often visible minority and low-income neighbourhoods, concurrent measures should be implemented to mitigate the risk of eco-gentrification. Green space projects that upgrade neighbourhoods lead to owners inflating property values after such upgrades. As a result, low-income residents are pushed towards undesirable living conditions.[118] To avoid harming low-income citizens, future greening programs should focus on reducing heat while avoiding eco-gentrification. Measures that can mitigate eco-gentrification are discussed in greater detail in Chapter 5.

Promote urban agriculture to develop healthy communities

In addition to improving existing green spaces, increasing protected areas, and growing the city's tree canopy cover, practices linked to urban agriculture are part of Montréal's greening efforts. Urban farms provide numerous health benefits, as discussed in Chapter 3. The city recognises in its Climate Plan that urban agriculture improves access to healthy foods and, by promoting sustainable agriculture practices, strengthens the city's capacity to adapt to climate change.

Currently, Montréal has several initiatives in place to promote urban agriculture in collaboration with committed partners. To develop urban agriculture even further, the city will work with various stakeholders and local actors to establish an integrated vision of urban agriculture for the city. For example, during the COVID-19 related health crisis, the Botanical Garden was called upon to expand the area available to produce vegetables, which were then distributed to citizens in need through community organizations. Experts from the Botanical Garden also offered support to residents looking to implement their own vegetable gardens. As mentioned in the Climate Plan, the city will collaborate with such experts and partners that are active in the field to promote urban agriculture.

Assets: Santropol Roulant's Agriculture Program

Montréal is home to several organizations that can be leveraged to promote healthy and equitable urban farming in communities. One such organization is Santropol Roulant. Their projects aim to build a healthy and just food system by supporting local and organic agriculture while ensuring that crops are accessible to all regardless of socio-economic status or level of mobility.[119] Acting as a care farm, Roulant prioritizes social activities that engage the elderly or people with loss of autonomy by keeping them active in the community through programs like Meals-on-Wheels and community workshops. Such activities also offer educational opportunities for collective and intergenerational learning. Through their volunteer programs they share their model of organizing and decision making which allows participants to learn about various aspects of urban agriculture while engaging with their community. Additionally,

Roulant works closely with community collaborators for broader transformations in food security. Using their experience and reputation, they advocate for and represent marginalized communities when working with various political and community actors.[120]

Santropol Roulant's agricultural production sites provide models of a local and resilient agriculture in addition to being a launching pad for young farmers. The agriculture sites demonstrate promising methods and solutions for healthy ecosystems, diversified vegetable production, and local distribution of local produce. It's also a way to provide healthy foods to their various programs. For example, **The Ferme du Roulant farm**, located on the western tip of the Island of Montréal, supports the Meals-on-Wheels and organic baskets programs. These programs make organic produce accessible to individuals that have low socioeconomic status and reduced mobility. During the summer, the farm hires young farmers and hosts Community Farm Day which educates Montréalers about the importance of local and organic agriculture.

Recommendations

Following are key considerations as the City of Montréal promotes urban agriculture initiatives throughout its territory over the next decade. The recommendations are based on the case study of Utrecht's Food for Good program, as discussed in Chapter 3, and additional research in the Montréal context.

Foster social integration of community members through urban farming initiatives

Urban agriculture is not only an environmental initiative but also an act of community revitalization and collective efficacy. To improve their societal value, and encourage growth, social integration should be a key aspect of urban farms. Urban agriculture offers an opportunity to bring together residents that reflect society. Putting social integration at the heart of urban farming can help all Montréalers engage with their communities, while being in relaxing green surroundings.

Recognize the true value that urban farms bring to communities

The city could communicate the true value of urban farms when making funding decisions to support urban agriculture initiatives like Santropol Roulant. In addition to providing nutritious food and building climate resilience, urban agriculture can improve employment, education, property values, and health. Local governments must reassess the worth they place on urban agriculture and recognize the various domains in which it positively impacts the city. Structural changes that recognize the true value of urban farms are needed to generate long-term stakeholder support, which is integral for the success of urban agriculture.

Find a balance between overregulation and free-for-all regulation

Urban farming can be limited by lack of appropriate zoning bylaws and cultural stigmatisms toward the potential rural-urban mix in a city. When developing farming friendly zoning bylaws,

it should be kept in mind that too many regulations (e.g., mandating a perimeter fence of a specific height around a garden) can limit access to urban farming practices by adding financial barriers to project implementation. A balance must be struck to avoid 'free-for-all' regulation by providing structure and guidelines that are helpful for initiatives.[121]

Provide more space for the proliferation of urban agriculture

Availability of space for urban agriculture is an issue as contamination in urban areas is a widespread problem. Different mechanisms can be used to rehabilitate contaminated soils and create space for urban farming. For existing and newly created space that can be potentially used for farming, measures should be put in place to deal with pressure from major development projects. Once the space is made available for farming, financial support can be provided to urban agriculture entrepreneurs to help offset the cost of renting space.

Equity consideration: Provide food to marginalized communities and advocate for their food security needs

Offering alternatives solutions to traditional food systems while providing space for community engagement allows urban farms to take a leadership role in neighbourhoods. To support marginalized communities, initiatives like Santropol Roulant prioritize partnerships with organizations working with Black, Indigenous, and immigrant communities. During the COVID-19 pandemic, they produced and, with the help of community organizations, distributed free frozen meals and baskets of vegetables from the Urban Agriculture Program to Indigenous families or low-income families in the East Plateau sector. Such programs can be scaled up and replicated elsewhere to improve food security in marginalized communities. Additionally, well-established urban agriculture initiatives can use their experience and reputation to support marginalized communities through advocacy and representation.[122]

Nature-based solutions that could be included in the Climate Plan

Of the types of NBS discussed in Chapter 3 of this study, the ones not mentioned clearly in Montréal's Climate Plan include green roofs and pocket parks. There are several ways in which these NBS could be incorporated into the Plan. This study identifies proposed actions in the Plan that could potentially involve these NBS and provides recommendations based on lessons from case studies of Portland's ecoroof incentive program, Sheffield's Love Square pocket park, and additional research.

Incentivize green roofs through building sector actions

The third group of actions in the Montréal Climate Plan, which deals with the building sector, aims to reduce GHG emissions and address vulnerability to climate hazards. Energy

consumption in residential, commercial, and institutional buildings generates approximately one third of Montréal's GHG emissions,[123] making it a high priority to renovate the city's building stock to be more energy efficient and fully powered by clean energy. In terms of vulnerability to climate hazards, the city is concerned about increasingly heavy rain episodes in Montréal along with heat waves that already present a challenge in many parts of the city. As seen in Chapter 3, green roofs can help with stormwater retention and heat island mitigation, in addition to promoting energy efficiency and providing health benefits.

Therefore, green roofs should be included in Sector 3 of Montréal's Climate Plan. The actions in this sector include (a) financing programs through which property owners can obtain a loan to carry out energy efficiency and climate adaptation work and (b) technical support from energy efficiency specialists. For example, Action 26 involves developing a funding program for building owners to support healthy and environmentally sound renovation. Programs like this can also be used to accelerate and optimize the deployment of green roofs that promote energy efficiency and adaptation to climate change. Additionally, measures can be put in place to ensure that these building improvements are not beyond the reach of vulnerable communities.

Assets: From Lufa Farms to Santropol Roulant, Green Roofs are a Growing Trend

Since their arrival in Montréal in the mid-2000s, hundreds of green roofs have been implemented on buildings throughout the city. Supporting principles of sustainable urban planning and offering numerous benefits to building owners, green roofs are a growing trend in Montréal. An example of large-scale green roof operations is **Lufa farms**, which currently has four rooftop greenhouses in Montréal with overall production feeding up to 2% of Montréal families. Customers subscribe to receive a produce basket at one of Lufa's hundreds of neighbourhood pickup locations across the city. Lufa farms' rooftop greenhouse initiatives show that high-yield year-round rooftop farming is a sustainable and commercially viable way to feed cities.[124] As compared to Lufa farms, which is a model of large-scale green roof operations, **Santropol Roulant** offers a model of a small-scale green roof installation. Their rooftop garden is used to grow food that is sent to the kitchen for their Meals-on-Wheels program.[125]

Such organizations can lend their expertise and participate in efforts to promote green roofs in Montréal. For instance, in spring and summer of 2007, Santropol Roulant collaborated with Alternatives International and the McGill University School of Architecture to incorporate productive growing in a concrete covered, prominent urban corner of the University's downtown Montréal campus. The resulting Edible Campus initiative has demonstrated how productive planting can be woven into public spaces while exploring strategies for increasing food production and improving spatial quality in the city.[126] This type of initiative can potentially be expanded to other university campuses and across the city.

Recommendations

To improve the inclusion of green roofs in cities it is important to identify and overcome barriers, set guidelines and standardization, establish policies, incentives, and strategies, leverage organizations delivering NBS, and promote awareness and dissemination by investing in education.[127] Portland's ecoroof incentive program, and similar efforts in other regions, offer lessons in implementing regulatory tools, providing educational resources, and making green roofs available to all by making green roofs a part of the Climate Plan's building sector investments. In doing so, the following actions are recommended:

Overcome barriers related to the financial costs of implementing green roofs

High initial construction and maintenance costs, limited funding, and long delays before earning a return on investment are some of the main obstacles associated with implementing green roofs. Innovative funding programs that recognize the public benefits of green roofs can help reduce the higher upfront capital costs and support widespread implementation. Montréal can provide financial subsidies (e.g., $5 per square foot) for green roof projects that are designed to manage stormwater and can be feasibly built within two years of receiving funds. Projects should also be assessed for their size, ratio of green roof to total area of roof, visibility, innovation, and opportunity to engage diverse communities.

Bolster guidelines and standards for implementing green roofs

To maximize return on investment, guidelines and standards can be mandated to ensure that green roofs are being implemented in a way that maximizes vegetation coverage and climate resilience. In 2015, the Régie du bâtiment du Québec (RBQ), the provincial regulator of building construction, released its Technical Criteria for the Construction of Green Roofs (Critères techniques visant la construction de toits végétalisés). This document outlines the types of vegetation, the layers of materials to be installed, and the technical guidelines for growing vegetation on roof systems on new and existing buildings.[128] Montréal can develop a more recent document with updated mandates such as the following: new buildings with a net building area of at least 20,000 square feet must have a green roof that covers 100% of the building area; the green roof must achieve 50% reduction in annual stormwater runoff volume.

Use policies, incentives, and strategies that proliferate green roofs in urban areas

Financial investment and standardization of green roofs must come with policies that incentivize expansion of green roofs on new and existing buildings. Section 2.5 of Montréal's Master Plan, which aims to promote high quality architecture and urban landscapes, shows that the city aims to develop and implement incentives that encourage innovations, such as green roofs, in new construction or renovation projects.[129] To act on this aim, Montréal can learn from **Toronto's Eco-roof Incentive Program**.[130] In this program, eligible green roof projects receive $100 per square metre up to a maximum of $100,000. The city also provides a step-by-step

guide that includes tips for choosing a green roof contractor and determining if a structural assessment is needed, the type of green roof that can be implemented, and the type of plants that can be added. The guide also shows how to gather supporting documents to obtain a planning permit and begin construction. Such policies, incentives, and guidelines can help encourage building owners to think about implementing green roofs.

Leverage organizations with experience and expertise in implementing green roofs

Beyond economic and regulatory support, technical support is necessary to provide property owners implementing green roofs with sufficient information. Leveraging organizations that are involved in NBS to provide technical support to property owners can reduce their uncertainty and encourage them to implement green roofs. Organizations like Lufa farms and Santropol Roulant can lend their expertise in these efforts. However, more specialized organizations that are one-stop units for advice on technical details, financing, and planning permit applications can be even more effective. For example, **Green Roofs for Healthy Cities** is a member based non-profit organization that has developed and manages a list of qualified Green Roof Professionals (GRPs) that are well-versed in the best practices of the design, installation, and maintenance of green roofs.[131] Toronto's Eco-roof Incentive Program recommends contacting a GRP to provide technical and financial advice at the start of the project. Similarly, Montréal can leverage the experience and expertise of such organizations to support the implementation of green roofs in the city.

Provide opportunities for awareness and dissemination of knowledge related to green roofs

To engage a wide variety of stakeholders and the public, the city can provide educational support by offering classes, tours and events involving pilot projects, and online resources for 'do-it-yourself' green roofs and professional green roof service providers. Montréal can leverage organizations like Green Roofs for Healthy Cities to help increase the awareness of the many social, economic, and environmental benefits of green roofs through education, advocacy, professional development, and celebrations of excellence. They can also provide training through the Living Architecture Academy which offers comprehensive in-class and online courses taught by industry experts. The courses provide information on green roof design, installation and maintenance practices, and integrated water management, among other topics.[132]

Equity consideration: Enhance green roof incentives for vulnerable communities

When implementing interventions like green roofs, effort must be made to extend the benefits to lesser served communities as well. Tax incentive programs can be enhanced for certain prioritized districts to make them more accessible for lesser served communities.[133] For example, New York City has designated priority community districts that can receive an enhanced tax abatement for green roof installation. Properties within the priority districts receive a tax abatement of $15 per square foot for the installation of a green roof. All other community districts receive the standard tax abatement of $5.23 per square foot.[134] Priority

districts are selected by considering factors which identify areas that can benefit from green roofs the most. The main factor considered is the potential for urban heat island reduction from green roof construction. A Heat Vulnerability Index is used to assess heat-related mortality based on neighborhood characteristics, such as but not limited to green space, poverty, daytime summer surface temperature, and households reporting air conditioning.[135] Similar equity-based criteria with enhanced financial incentives for priority districts can be included in a potential green roof policy strategy in Montréal.

Incorporate pocket parks into climate resilience hubs

The first group of actions in the Climate Plan aims to engage the Montréal community in the ecological transition of the city. To achieve this, Montréal will collaborate with and support residents, businesses, institutions, organizations, and city staff that are currently working towards greater sustainability and resilience. To facilitate changes in behaviour, programs will be created that educate, mobilize, engage, and equip, while taking intercultural and intergenerational differences into account. Financial and technical support will also be provided to local initiatives and environments conducive to experimentation will be created.

Pocket parks can be incorporated in this group of actions as an urban nature intervention that mobilizes the community and involves them in local ecological activities. For example, Action 9 of the Climate Plan aims to make districts greener, favour urban agriculture, increase social cohesion, and promote urban safety by fostering the emergence of local climate resilience hubs. As seen in Chapter 3, pocket parks can provide all these benefits in addition to supporting climate resilience and promoting public health. Sheffield's Love Square pocket park, and other such ecological projects, offer lessons on how to incorporate urban nature into local climate resilience hubs while engaging the community.

Assets: Small Parks Renaming Program and the Montréal Urban Ecology Centre's Role in the Active Neighbourhoods Canada Project

Montréal is home to an abundance of parkland in the form of major urban parks, neighbourhood parks with numerous amenities, charming city squares, and sprawling nature parks. However, more work can be done to introduce smaller sized pocket parks into neighbourhoods to bring the benefits of urban green space closer to where people live. In this effort, Montréal can rely on some existing initiatives.

The **small parks renaming program** is part of a move by the City of Montréal to name more streets and landmarks after women, as only six percent of the city's 6000 place names are currently named after women. Projet Montréal, the party of Mayor Valérie Plante, believes that several small parks could be prime candidates to bear women's names.[136] In 2018, a small park located between two residential buildings in the neighbourhood of Snowdown, in western

Montréal, was named after Michelle-Arthus, wife of Jean Décarie, considered to be among Montréal's first settlers.[137] As part of this move towards greater inclusion, new pocket parks could also be implemented and named after women and visible minority figures. This offers a way to not only bring green space to neighbourhoods but also to recognize Montréal's history and diversity through place names.

The **Active Neighbourhoods Canada (ANC) project** was launched by the Public Health Agency of Canada to address the impact that the built environment has on public health in Canadian cities. It is a partnership of organizations across Canada using participatory urban planning and intersectoral collaboration to reach their goal of green, active, and healthy neighbourhoods. They facilitate changes in policy and the built environment that impact health through urban designs that increase physical activity and community connection. They also aim to address health inequities by focusing on communities that experience marginalization and need investments in healthy public spaces.[138]

One of the partnering organizations is the **Montréal Urban Ecology Centre (MUEC)**, which is working to develop, pilot, and share innovative approaches to co-designing active and green neighbourhoods. Their participatory urban planning approach fosters community linkages, encourages connection with natural systems, and fosters a sense of belonging among citizens. This approach also gives voice to people who have historically experienced marginalization from planning processes.[139] Pocket parks are one of the NBS that could be implemented as part of these efforts to incorporate greening, health, and equity into the design of neighbourhoods.

Recommendations

Pocket parks can be implemented in climate resilience hubs and active neighbourhoods while promoting participatory urban planning. This can be done by incorporating principles of community-driven inclusive urban ecological restoration.[140] This approach provides opportunity for diverse voices to be heard within the restoration planning and green space implementation processes in communities. It opens space for dialogue around uneven access to resources and knowledge, socioeconomic status and green space, and conflicting values and ideas about nature. Creating relationships and strengthening networks can generate additional support for nearby greening projects and empower other local community development projects. Following are ways in which principles of inclusive urban ecological restoration and park design can be used to implement pocket parks that positively impact neighbourhoods.

Foster sense of community by involving residents in the planning of local pocket parks

Partnering with diverse community members and organizations leads to local green spaces that reflect the needs of the community. The Montréal Urban Ecology Centre is one example

of an organization that is currently engaged in participatory urban planning and can be leveraged to implement pocket parks in neighbourhoods. Engaging residents not only fosters sense of community, but, in the long-term, it also leads to more stable urban greening projects that are of greatest utility to the local community.

Create opportunities for community engagement through the design of pocket parks

Community involvement in the greening of vacant urban land decreases crime and enhances feeling of security among community members. Designing pocket parks with elements and amenities that promote social interaction can mitigate social isolation. Pocket parks offer space for residents to meet regularly and create linkages and relationships not only with the land but also with their neighbours and neighbourhood. Similarly, immigrant community members can benefit as these spaces can provide the possibility of connecting newcomers with the landscape and people of their adopted neighbourhood.

Equity consideration: Provide additional support for pocket park implementation in low-income neighbourhoods

When engaging in inclusive ecological restoration, the city must prioritize projects in low-income and vulnerable areas to provide benefits of urban green space where they are most needed, while offering learning and skill-building opportunities. As seen in the Sheffield Love Square case study, the city can provide deeper support by ensuring that the pocket park and climate resilience hub will integrate properly into the surrounding area. Additionally, the city can provide design advice and guidance during the community's planning process and help gain planning permission for the project.

Enabling the Wider Uptake of Urban Nature in Montréal

Nature-based solutions (NBS) offer multiple benefits and can be feasibly implemented as part of Montréal's Climate Plan over the coming decade. Certain parts of the plan are already making use of nature-based interventions, such as planting urban trees to mitigate the urban heat island effect and promoting urban agriculture to promote community health. Other parts of the plan do not mention nature-based interventions but can clearly benefit from them. NBS that could be added to the plan include incentivizing green roofs as part of building sector investments and incorporating pocket parks in climate resilience hubs.

The recommendations in this chapter outlined several actions that can help with the City of Montréal's greening efforts. These include economic measures such as providing funding support and tax incentives for various urban nature initiatives; public-oriented measures such as education, mobilization, and new forms of community engagement, collaboration, and

cross-learning; and practical measures such as leveraging the expertise of existing organizations and programs when implementing NBS. In addition to these considerations, some other key barriers need to be addressed to enable the wider uptake of NBS in Montréal. These barriers relate to assessment methods, business models, and governance strategies.[141]

Develop quantitative and qualitative assessment methods to determine the true value of urban nature interventions

The first barrier hindering wider uptake of NBS is assessment methods. There is clear evidence and widespread awareness that urban nature can provide numerous environmental, social, and economic benefits. However, there is limited understanding of how to assess these benefits within an urban context. Currently, assessment tools tend to focus on the ecological benefits of urban nature interventions, while the economic and social value of such interventions is unaccounted for. Additionally, different stakeholders have different priorities when assessing these measures. The city takes a more economic approach whereas the community tends to focus on improvements in quality of life. Therefore, approaches are needed that assess NBS by considering the various types of benefits that urban nature provides.

Depending on the type of NBS, how it will be assessed, and for what purpose, impacts can be determined in terms of quantitative or qualitative values. For example, the health benefits of having street trees can be used to quantify the effect of investing in this NBS in terms of the impact on healthcare spending. Qualitative approaches involve conducting well-being surveys before and after implementing NBS or directly observing how people are benefiting from the intervention. However, assessing social impacts and collecting qualitative data is challenging and costly. Despite the complexity and resource-intensity of assessing environmental, social, and economic impacts, these investments are valuable. The results of such efforts inform how to effectively design and implement NBS to achieve the desired impact and to scale up such solutions to be implemented more widely.[142]

Use business models that connect green space investments with economic savings from better public health

After determining how nature-based interventions will be assessed, another important consideration is how they will be financed. Therefore, the second barrier hindering wider uptake of NBS is business models. NBS are not compatible with traditional business models. Therefore, NBS are financed by municipalities and governments. However, public funds are often limited. Additionally, there is lack of collaboration across government departments to share budgets and resources towards a collective project or aim. In this context, more complex business models can be utilized that involve multiple sources of private, public, or mixed funding. There is a need to experiment with new business models for NBS that can be replicated in different urban contexts.

To make a business case for urban nature interventions, investments in green spaces should relate to the health benefits and the associated economic value of improvements in public health. This helps better understand the value of green space investments and supports informed program, policy, and planning decisions. EcoHealth Ontario collaborated with the Greenbelt Foundation and Green Analytics to produce a **conceptual framework to understand the business case for ecohealth**. This framework first involves relating green space investment (i.e., the size and amount of green space or programs and policies that increase the use of existing green spaces) with improved health and well-being through various pathways. These pathways include physical health, mental health, exposure to environmental stressors, and climate resilience. Then, based on the health benefits and outcomes that are to be expected (e.g., lower rates of obesity from increased physical activity), a monetary value is associated to the green space investment. This monetary value is determined through the economic savings associated with reduced burden of illness, decreased use of health services, and increased productivity (Chapter 5 provides a more detailed discussion of the economic benefits of urban greening). Finally, a business case is made for specific green space investments by comparing the health returns to the cost of the urban nature intervention.[143]

This conceptual framework is a model of how the decision-making process can be informed by making apparent the connections between green space investments, improved health outcomes, and economic savings resulting from better health. It enhances the overall decision-making process by complementing other factors and information under consideration. However, such frameworks need to be expanded to consider the potential harms associated with green space investments (e.g., increased time in green space heightens risk of exposure to ticks carrying Lyme disease) and the potential for ecological marginalization, where new or improved green spaces can increase property values and force low-income residents to move out (Chapter 5 provides a more detailed discussion of the risk of eco-gentrification). Keeping these limitations in mind, decision-makers in Montréal can use this conceptual framework as a guide to understand the business case for specific green space investments and inform policies, programs, and planning decisions aimed at enhancing green spaces. Such tools can also be used to communicate the business case and rationale for more green space investments to various stakeholders and the public.

Develop governance approaches that engage multiple public and private actors

Municipal governments are central in assessing and financing NBS, but their capacity to act relies on multi-level governance structures and the development of different modes of governance. Therefore, the third barrier hindering wider uptake of NBS is governance strategies. There is strong evidence of the value of involving various actors in a collaborative approach towards the design, implementation, maintenance, and monitoring of NBS. Municipal governments should work with various stakeholders and communities to create the partnerships, plans, and demonstration projects that are needed to accelerate the uptake of NBS. In addition to strong visions and strategic planning, governance approaches are needed that engage multiple public and private actors in dialogue and work together to address

common problems. This may require municipalities to reallocate and share responsibilities with private actors. It can involve new partnerships with schools, hospitals, senior centres, community centres, residents, and neighbourhood associations. Developing new governance approaches is critical as the success of urban nature interventions relies on consulting various stakeholders, capturing their ideas, engaging them in discussion, addressing conflicts, and inviting them to work together on brining projects to life.

To support the wider uptake of NBS, it is critical to determine the methods of assessing their value, the business models that will fund their implementation, and the governance strategies that will be involved in their planning. However, it is also important to consider the combination of measures that will support the successful implementation of NBS. From the initial idea to the implementation, the wider uptake of NBS requires that we understand the key assessment, business, and governance challenges facing projects on the ground. It also requires us to innovate pathways to deal with these challenges concurrently while prioritizing vulnerable communities that are in greatest need of NBS. By considering the various recommendations included in this chapter and understanding the conditions that enable NBS to become widely established, this study contributes to developing urban nature in the City of Montréal and advancing its benefits for citizens.

CHAPTER 5: CONCLUSION

Other Considerations for Implementing Nature in Cities

Nature-based solutions (NBS) are increasingly being pursued to build climate resilience in cities. However, the impact of NBS on urban health and alleviation of health inequities is often not adequately considered in these efforts. Chapter 2 showed that several pathways link urban nature to improved urban health outcomes. These pathways include, but are not limited to, improvements in physical and mental health, social well-being, developmental health, nutritional health, and environmental health. Together, these pathways provide a framework for assessing the many dimensions of health and help determine the health impact of nature-based interventions on urban populations. They also indicate that urban nature of various forms are critically important amenities for the public to access nature's health benefits and thus should be distributed equitably throughout the city.

Implementing diverse forms of accessible and connected green spaces can be used as an approach for alleviating health inequities in vulnerable and low-income communities.[144] "I think greening is a big part of the solution," says Karine Forgues, from the Québec Department of Public Health. She adds that, "If we address issues in the local environment, it can make

significant changes in the disparities of health, and that is very important in Montréal."[145] As discussed in Chapter 2, several researchers have conveyed the urgency to target vegetation-deprived areas of Montréal with greening initiatives that will tackle current inequities in exposure to urban nature. These areas are primarily located in Saint-Michel, Rivière-des-Prairies, Parc-Extension, downtown (i.e., Ville-Marie), Parc-Extension to La Petite Patrie, and Hochelaga. In such areas, urban planners and public health practitioners are increasingly looking towards urban nature interventions as a tool for public health, and, in particular, health equity outcomes.

Various types of urban nature interventions elicit different pathways that link urban nature exposure with positive health outcomes. In Chapter 3, selected NBS were assessed for their impact on various health outcomes. The selected NBS within the scope of this study include green roofs, street trees, pocket parks, community gardens, and green areas for water management. Case studies from Spain, the Netherlands, the United Kingdom, the United States, and Canada provided lessons on implementing each type of NBS. Adding to the best practices, the chapter also discussed how connected systems of urban green spaces can make nature's benefits more accessible to all, providing an effective method of addressing green infrastructure and health inequities.

NBS are mainly being used in the context of climate change adaptation in cities. However, climate action that involves NBS also improves public health by addressing health needs and alleviating health inequities. Examining Montréal's Climate Plan for 2020 to 2030, Chapter 4 outlined NBS included in the plan (i.e., trees and urban farms) and NBS that could be included in the plan (i.e., green roofs and pocket parks) to maximize health outcomes. Based on previously outlined case studies and additional research, recommendations were provided for implementing planned and potential NBS. Existing organizations and programs were identified that can be leveraged by the City of Montréal to implement the selected types of NBS. Additionally, key barriers hindering the wider uptake of NBS were identified. These barriers include the need for: qualitative and quantitative assessment methods that consider the various ecological, social, and economic benefits that urban nature provides; business models that relate the health benefits of investing in urban nature with the economic benefits of improved public health; and new types of governance modes and partnerships.

It is important to note that there are other actions in the Climate Plan that involve or could potentially involve urban nature but are not within the scope of this study. Action 8, which aims to educate Montréalers about the ecological transition and prioritize the resilience of people in vulnerable areas, will maximize the use of its network of large parks to ensure that youth living in underprivileged areas can access the social and environmental benefits of nature. Additionally, under this action the city will support local initiatives that use contact with nature to educate youth about urban ecology and community action. Action 10 aims to measure and support the development of Montréalers' social capital. This action can potentially involve urban nature by combining greening initiatives with community development resulting in an inclusive participatory activity that positively influences both the natural and social capital of a

community. Action 18 aims to encourage the greening of off-street parking lots near metro stations, train stations, and reserved lanes. Such greening efforts can potentially provide mental health benefits of improved aesthetics, mitigate the urban heat island effect, and improve stormwater management. Action 19 aims to increase the proportion of protected areas on Montréal's territory by creating new parks and green corridors, along with wetlands and water environments. This action will not only support wildlife movement and plant dispersal, which are essential for maintaining and developing biodiversity, but will also provide more healthy environments for citizens. Although these actions were not discussed in this study, they are promising indicators of the City of Montréal's commitment to improving levels of urban nature.

Economic Benefits of Investing in Urban Nature

Absent from this study is detailed discussion of how the decision-making process of investing in nature is enhanced by linking health outcomes with economic benefits. Currently, analysts and decision-makers utilize economic frameworks that link green space investments to improvements in health and well-being through metrics such as health system savings, prevented lost productivity associated with poor health and illness, and reduced mortality.[146] When valuing green space investments as a form of public health intervention, the health economics literature focuses on valuing specific health outcomes associated with exposure and proximity to green space. Articulated pathways link the green space investment (e.g., increasing canopy cover) to economic benefits (e.g., health system savings from reduced incidence of adverse health effects/diseases attributed to poor air quality and extreme heat). Although there is a noticeable gap in this area of research, some key Canadian studies have attempted to place an economic value on the health outcomes linked with exposure to green space.

In the City of Toronto, researchers found that living in neighbourhoods with higher tree density is associated with better health perception and significantly less cardiometabolic conditions.[147] The researchers assigned an economic value to the health benefits of living in tree dense neighbourhoods based on decreased use of health care services. Overall, they found that having 10 more trees in a city block, on average, improves health outcomes in ways comparable to a $10,000 increase in annual personal income, moving to a neighbourhood with a median income that is $10,000 higher, or being seven years younger. Similarly, it has been estimated that the amount of air pollution removed by trees and shrubs across Toronto could be valued at $20.4 million in avoided health care costs.[148] More indirectly, positive health outcomes from increased physical activity attributed to green space exposure could be linked to the direct and indirect health care costs of physical inactivity in Canadian adults.[149] Similarly, positive mental health outcomes could be linked to the direct and indirect impacts of anxiety and depression on Canada's health care spending and forgone gross domestic product (GDP) due to lost productivity.[150]

The health benefits of potential green space investments can thus be linked with economic benefits to inform the decision-making process when evaluating policies, programs, and actions. By utilizing economic frameworks, practitioners and decision-makers can develop the business case for specific urban nature investments that will enhance levels of greening while providing beneficial health and economic outcomes.

Risk of Eco-gentrification When Investing in Urban Nature

Implementing nearby nature to address environmental inequity can create a paradox by triggering eco-gentrification as natural amenities make neighbourhoods more expensive and lead to the displacement of lower-income residents.[151] To mitigate eco-gentrification, lessons can be learned from parks-related anti-displacement strategies (PRADS).[152] Community engagement is viewed as crucial for implementing PRADS. In the early stages of green space development projects, community members should be involved in design, decision-making, and investment strategies. Community organizations can facilitate this community engagement. Equity-oriented methods should also use multidisciplinary approaches by integrating provision of affordable housing, job training and creation, and support for small businesses as part of greening efforts. Such approaches allow existing residents to have a stake in an improving neighbourhood. Additionally, efforts should be made to influence system-wide changes in public policies (e.g., green space funding measures that require anti-displacement strategies) alongside project-specific efforts (e.g., non-profits building affordable housing units near new parks). Policies and practices like these are needed to ensure that urban nature interventions are introduced into low-income communities in ways that limit the possibility of displacement.

Increasing urban green space should be one of the top priorities for every policy and decision-maker in the City of Montréal. The numerous ecological, environmental, climate, health, and economic benefits of urban nature provide strong rationale for urgently greening the city and bringing green spaces closer to where people live. This study discusses various types of NBS, their benefits, associated best practices, and recommendations for action. Together, this information supports decision-makers in the implementation of NBS that will enhance all dimensions of long-term health. As the City of Montréal embarks on its greening efforts through the Climate Plan, there are several obstacles that need to be overcome. However, a collective effort involving numerous stakeholders across disciplines and sectors can make it possible to overcome obstacles, implement urban nature throughout the city, and improve the health of citizens, especially those that are currently experiencing urban green inequities.

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