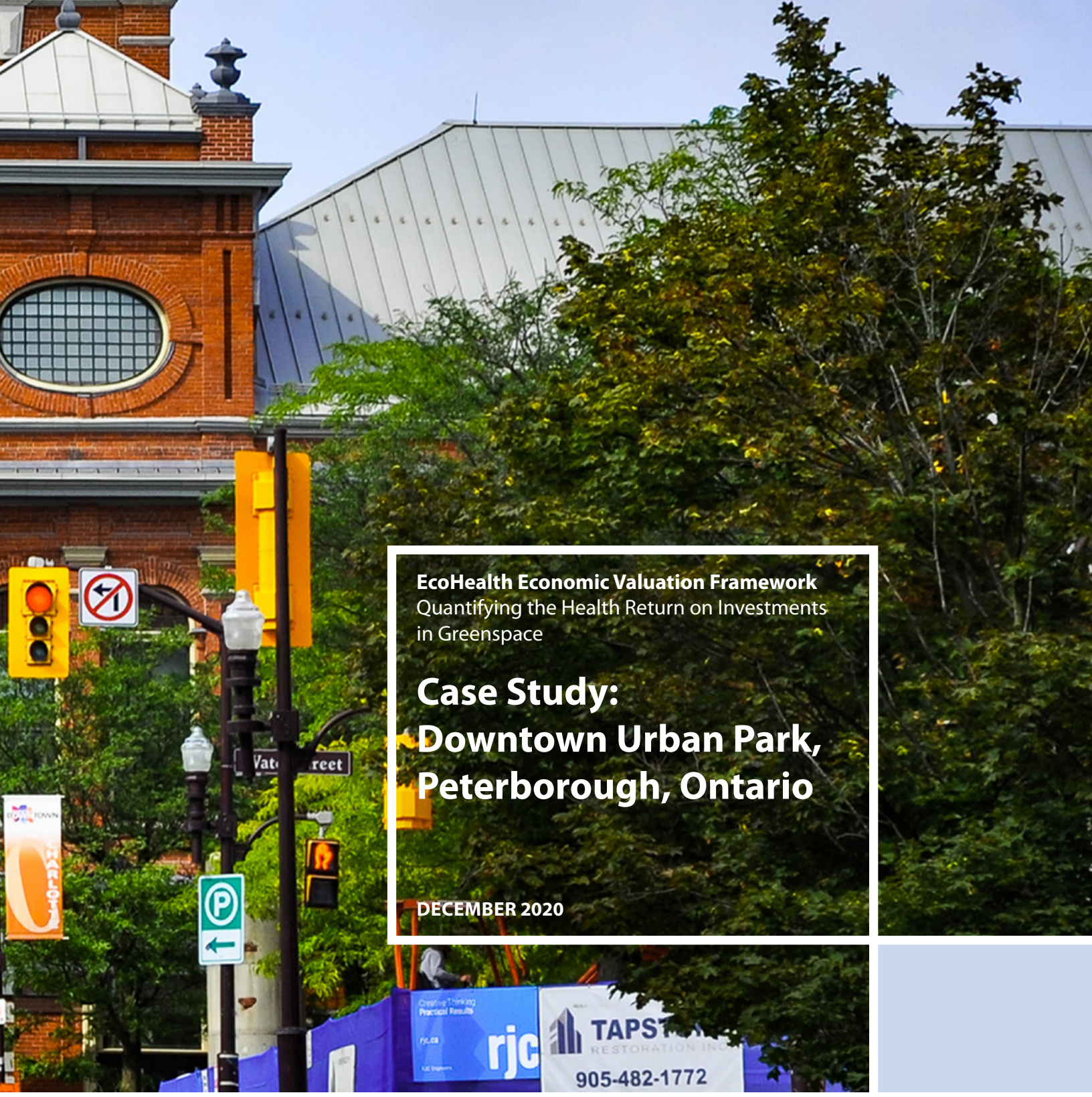

EcoHealth Economic Valuation Framework
Quantifying the Health Return on Investments in Greenspace

Case Study: Downtown Urban Park, Peterborough, Ontario

DECEMBER 2020

Prepared for the Greenbelt Foundation and EcoHealth Ontario in partnership with the City of Peterborough

By Green Analytics Corp.

Corresponding author, Jeffrey Wilson

EcoHealth ONTARIO

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ACKNOWLEDGEMENTS

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Contents

1. Background

The Downtown Urban Park site is approximately 1.1 acres in size under development in the downtown core of the City of Peterborough. When completed, the park will provide an urban greenspace alongside a variety of amenities for residents and visitors in downtown Peterborough.

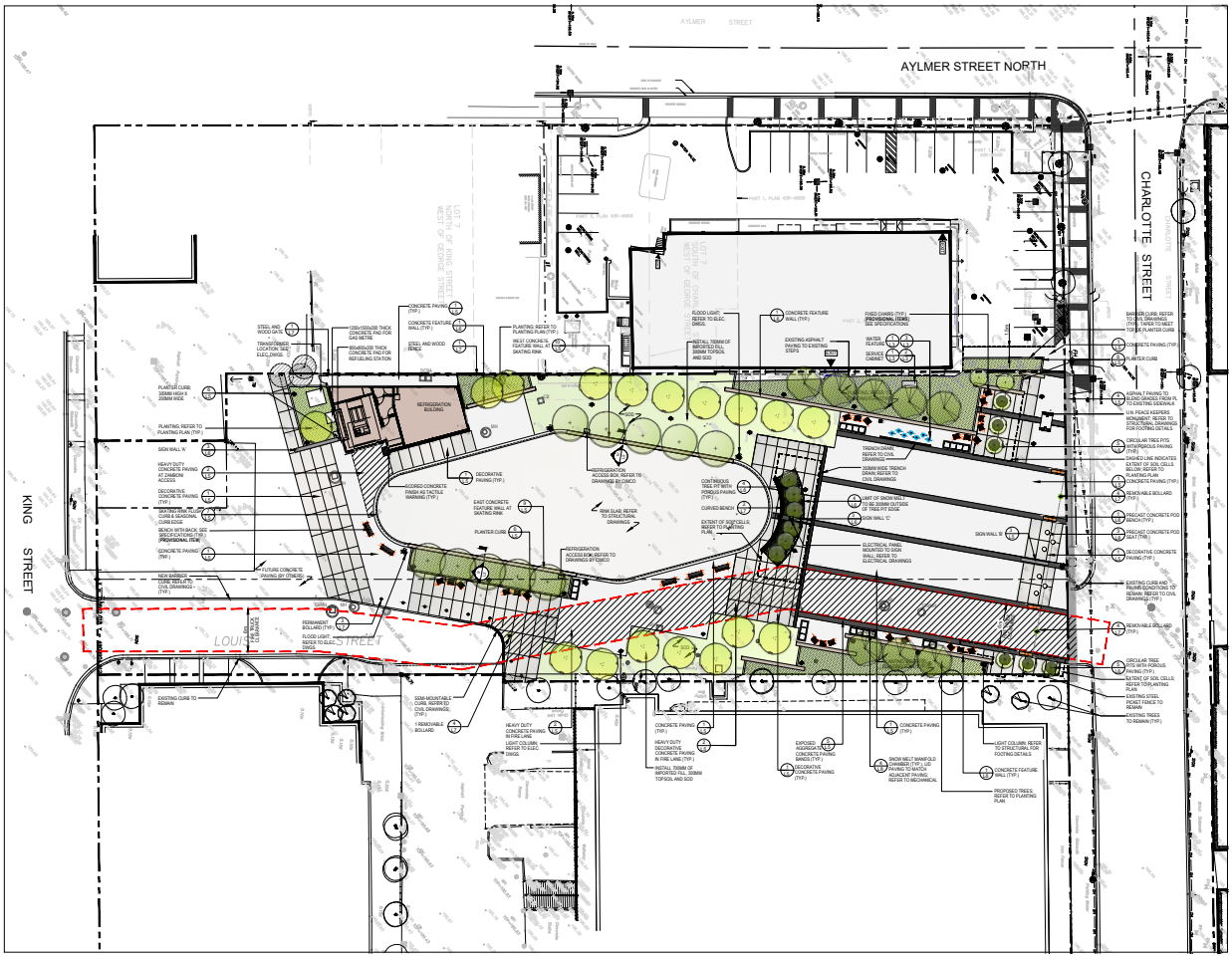
FIGURE 1: Downtown Urban Park Site

The downtown urban park under development is located at 215 Charlotte Street, Peterborough, which was previously a municipal parking lot and part of a road. The initial planning of the park was proposed to Peterborough City Council in early 2014[1]. In September of 2016, Peterborough City Council approved the conversion of the parking lot to support the development of an urban park. Demolition and removal of the parking lot began in December 2017[2]. However, since then, the construction phase has been delayed. The park is now expected to be complete near the end of 2021 at a cost of $6.5 million.[3]

1 Minutes of a Meeting of City Council Held on February 24, 2014, in the Council Chambers
2 PTBO, 2017
3 City of Peterborough 2020-2029 Capital Budget Details

The idea for a downtown urban park emerged out of the 2009 Central Area Master Plan[4], which called for the creation of a permanent, large, multi-purpose outdoor public square for gatherings and community celebrations. One of the significant advantages of this park site is its location, which is within the viewshed of the Clock Tower, a symbolic icon in Downtown Peterborough. The development of the park will assist in creating more open spaces in downtown Peterborough, promote business opportunities and improve residents' quality of life.

FIGURE 2: Downtown Urban Park Conceptual Plan (Source: LETT ARCHITECTS INC.)



The downtown urban park is designed to provide urban greenspace and a variety of amenities. Large tree planting areas are located on the sides of the park and near the water geysers. Passive seating areas will be located under the shade of the trees. The park also includes a Civic Square component, which will be used to host the Peterborough Downtown Farmers' Market every Wednesday[5]. A public art display to honour U.N. Peacekeepers will be located in the north-west area of the park. During the winter season, the hard surface in the southern area of the park can be transformed into an ice-skating surface. The park design also includes a refrigeration building, a change room and public washrooms.

4 City of Peterborough Central Area Master Plan Final Report – May 2009
5 About – Peterborough Farmers Market (Peterborough Farmgate Sales Association, n.d.)

2. Framework Overview

The economic framework applied in this case study links greenspace investments to improvements in health and wellbeing resulting in, for example, health system savings, prevented lost productivity associated with poor health and illness, and reduced mortality. Figure 3 demonstrates the connection between greenspace investments and health and wellbeing returns on investment.

The conceptual framework provides analysts and decision-makers information on the ecohealth benefits of potential greenspace investments when evaluating policies, programs and actions. It is meant to enhance the decision-making process by complementing other factors and information under consideration. The conceptual framework connects the links between greenspace investments, health outcomes, and economic benefits to inform the decision-making process.

FIGURE 3: Investing in the development of a new urban park

GREENSPACE INTERVENTION	GREENSPACE FACTOR CHANGED	RESPONSE/ PATHWAY	HEALTH AND WELLBEING BENEFITS/ OUTCOMES	ECONOMIC BENEFITS
Development of new urban park	• Accessibility • Size • Amount • Type • Amenities • Features	Increase in Use (change in number of users, type of users, frequency and/or intensity of use) Increase in Exposure (increase in tree canopy cover)	Physical Activity • Lower rates of obesity/ overweight • Improved birth weights Mental Health • Lower rates of depressions • Stress reduction • Improved cognitive function • Higher social engagement • Improved life satisfaction Exposure • Reduced air pollution • Reduced exposure to hot temperatures	Physical Health Benefits • Avoided direct cost of hospital cares, physician services and drugs due to physical inactivity • Avoided indirect cost such as short- or long-term disability Mental Wellness Benefits • Avoided costs of losses of productivity and losses in health-related quality of life from morbidity

Assigning a monetary value to greenspace investments is challenging, given the difficulties in identifying quantifiable health outcomes attributed to a policy, program, or planning decision. The evidence connecting greenspace investments to health outcomes is strongest in three areas, namely:

1. Physical health improvements associated with higher levels of physical activity
2. Mental health improvements associated with spending time in nature
3. Health improvements, avoided health system costs and loss of productivity associated with reduced exposure to air pollution (specifically reduced respiratory symptoms and incidences of cardiovascular disease) and extreme heat

The proposed approach in this case study relies on a number of assumptions supported by evidence from the literature. Assumptions draw on the most robust and well-regarded studies or integrate consistent trends shown across studies. The approach also structures the calculations in such a way that the model could be refined in the future as more locally relevant data becomes available or to reflect changes in assumptions or new knowledge. This case study emphasizes the physical and mental health benefits of investing in urban parks. However, there are also other health benefits brought by the development of a new urban park, such as a reduction in heat-related illness due to an increase in tree canopy cover in the park. As the Downtown Urban Park is also a civic square, these additional health benefits were deemed marginal and not included in the calculations.

3. Park Service Area and Population Demographics

According to City of Peterborough 2019 Parks Development Standards[6], the Downtown Urban Park fits the definition of an Urban Square, which is expected to serve the residential population and local business community within 800 meters (equivalent to a ten-minute walk). The 800-meter radius service area covers 21 Dissemination Areas (D.A.s) (See Table 1). Based on the percentage of each DA that falls within the service area, it is estimated that 5,919 residents live within the service area with a population density of 2,944 people per square kilometre (29 people per hectare).

TABLE 1: Dissemination Areas within 800-meter Radius Park Service Area

DISSEMINATION AREA (DA)	AREA OVERLAP (m^2)	% OF COVERAGE IN SERVICE AREA
35150213	245446.64	10.75%
35150068	97231.46	4.26%
35150069	55154.45	2.42%
35150070	86887.55	3.81%
35150111	347240.18	15.21%
35150112	130649.78	5.72%
35150113	196449.91	8.60%
35150067	123815.57	5.42%
35150071	88797.43	3.89%
35150114	113642.05	4.98%
35150116	203884.11	8.93%
35150115	41597.09	1.82%
35150110	389594.36	17.06%
35150081	45366.33	1.99%
35150065	27503.17	1.20%
35150080	38705.51	1.70%
35150066	12786.79	0.56%
35150072	6764.09	0.30%
35150225	20977.41	0.92%
35150214	10068.69	0.44%
35150053	573.49	0.03%

6 City of Peterborough 2019 Parks Development Standards, p. 8

The demographic profile of residents in the service area presented below is based on the 2016 Census results. In the service area, the largest age group is age 65 years and above, which accounts for 21.14% of the total population. Residents aged 25 to 34 years old make up 18.09% of the population, and residents aged 15 to 24 years old represent 16.80%. More than half of the residents in the service area have a total annual income under $30,000. The majority of residents (58.88%) in the service area have completed postsecondary education.

TABLE 2: Population Demographics within Park Service Area

AGE GROUP	WEIGHTED AVERAGE DISTRIBUTION
0 to 14 years	9.58%
15 to 19 years	4.27%
20 to 24 years	12.53%
25 to 29 years	10.28%
30 to 34 years	7.81%
35 to 39 years	5.98%
40 to 44 years	4.98%
45 to 49 years	4.72%
50 to 54 years	5.69%
55 to 59 years	7.13%
60 to 64 years	5.86%
65 years and over	21.14%

INCOME GROUP	WEIGHTED AVERAGE DISTRIBUTION
Under $10,000 (including loss)	17.16%
$10,000 to $19,999	28.78%
$20,000 to $29,999	17.48%
$30,000 to $39,999	10.39%
$40,000 to $49,999	6.79%
$50,000 to $59,999	3.77%
$60,000 to $69,999	3.09%
$70,000 to $79,999	2.39%
$80,000 to $89,999	1.62%
$90,000 to $99,999	1.75%
$100,000 and over	3.26%

EDUCATION ATTAINMENT	WEIGHTED AVERAGE DISTRIBUTION
No certificate, diploma, or degree	13.97%
Secondary (high) school diploma or equivalent	26.05%
Postsecondary certificate, diploma or degree	58.88%
Apprenticeship or trades certificate or diploma	6.61%
College, CEGEP or other non-university certificate or diploma	24.36%
University certificate or diploma below bachelor level	1.40%
University certificate, diploma, or degree at bachelor level or above	27.20%

4. Festivals and Events Attendance Estimation

The Peterborough Downtown Farmers' Market had been located on the Louis Street Parking Lot from 2011 but was later relocated due to the development of the park in 2018. When the construction is completed, the Farmer's Market will move back to the urban park. Currently, the Farmers' Market has over 50 stalls and 33 vendors at peak season. The market is open on Wednesdays for 4.5 hours from May to October. Based on data from a British Columbia study, farmer's markets in urban centers with a similar population base and similar numbers of vendors have an average hourly crowd of under 200 people[7]. Therefore, it is estimated that the farmer's market will generate 900 visits weekly. According to the 2009 National Farmers' Market Impact Study[8], 69% of shoppers use vehicles to reach the market and 21% walk. The estimated 900 weekly visits will, therefore, generate 189 leisure walking activities.

7 Economic and Social Benefits Assessment, Provincial Report, British Columbia, Canada (Connell, 2012)
8 National Farmers' Market Impact Study 2009 Report (Farmers' Markets Canada, 2009)

5. Health Benefit Estimation

Parks in the urban environment encourage physical activity, improve mental health, can reduce exposure to air pollution and hot weather, and increase life satisfaction among users and those living in the vicinity of the park (See Section 6 for supporting research). This section estimates the physical health benefits, mental health benefits, air quality improvement benefits and associated economic values attributed to the development of the Downtown Urban Park. Estimates associated with reductions in heat-related-illness as a result of increased canopy cover have not been included in this case study but could be estimated in future analysis.

5.1. Park Access and Park Users Calculation

The calculation of park access and park users are derived from a study by Natural England in 2011[9] with 6,821 participants. The research includes a study of the frequency of greenspace visits by perceived access (very easy, easy, more difficult) to greenspace. Drawing on the literature and target distances for access to greenspace commonly adopted by jurisdictions in Canada, the three levels of perceived access are equated to three distance measures: very easy, equivalent to distances of 400 metres or less (approximate walking distance 5 minutes); easy, equivalent to distances between 400 metres and 1km (approximate walking distance 10 minutes or less); more difficult, equivalent to distances between 1km and 2km (approximate walking distance 20 minutes or less or a short car ride). Based on this assumption, a weekly user rate for residents within the 800-meter service area of the downtown urban park is then estimated to be 27.05% of the population (1,601 residents) within the service area. The population who live within the service area but do not use the park in a given week is 4,316 (72.95% of the population).

Park users in this estimation refer to people who live in the service area of the urban park and access the park regularly. The estimated park users and population of residents within the service area are used to perform calculations regarding physical health benefits and mental health benefits in the following sections. Festivals and events will also bring in additional users who live outside of the urban park's service area. Those irregular park visitors are excluded from the estimations in this section.

TABLE 3: Weekly User Rate based on Perceived Park Access and Park Distance

ACCESS TO GREEN SPACE	DISTANCE/PROXIMITY	WEEKLY USER RATE
All green spaces		
Very easy	Within 400m	42.00%
Easy	Between 400-1,000m	28.00%
More difficult	Between 1,000-2,000m	20.00%
Service Area Average	Within 800m	27.05%

9 Natural England. (2011). Natural England Commissioned Report NECR067. Greenspace Access, Greenspace Use, Physical Activity and Overweight. Retrieved July 8, 2020, from http://publications.naturalengland.org.uk/publication/40017

5.2. Physical Activity Calculation

Numerous studies indicate that parks create physical health benefits by attracting people outdoors and encouraging physical activities. Supporting research can be found in Section 6.1. The calculation of physical activity indicator uses the estimation of the population in the catchment area, the estimation of the weekly park user rate, the national health survey results and also various statistical findings from the literature. The population of both park users and non-park users in the catchment area are derived from the previous estimation. Then, in those two groups, the number of people who are physically active is calculated. The results are adjusted by scalers, as summarized in Table 4. The scalers (Risk Ratios) are converted from statistical findings (Odds Ratios) in the ecohealth literature, using the conversion function suggested by Osborne (2006)[10].

Physical Activity Indicator Calculation:

*= Users (both park and non-park) * % of those who are physically active * Scalers*

As a starting point, all communities are assumed to have a baseline level of residents that engage in 150 minutes or more of moderate to vigorous physical activity (MVPA) per week of 16.40%, a national average that is derived from the 2017 Canadian Health Measures Survey[11].

Based on the estimation of the park user rate (see the previous section), residents within the 800-meter service area are grouped into park users and non-park users. Scalers are then estimated based on findings by Kaczynski (2009)[12]. For park users, the presence of a park and its amenities increase park-based physical activities by 1.12 times (odds ratio:1.15). For non-park users, the presence of a park increases neighbourhood-based activities by 1.14 times (odds ratio: 1.17).

Park amenities and facilities also have a positive association with park use and park-based physical activities. Following Kaczynski's (2014)[13] list of park features, the amenities and facilities that the Downtown Urban Park offers is similar to the function of playgrounds. Therefore, a scaler of 1.71 (OR: 1.98) is applied to the function,

10 Osborne, J. W. (2006). Bringing Balance and Technical Accuracy to Reporting Odds Ratios and the Results of Logistic Regression Analyses. Best Practices in Quantitative Methods, 385-389. doi:10.4135/9781412995627.d30

11 Statistics Canada. Table 13-10-0388-01 Household population meeting/not meeting the Canadian physical activity guidelines

12 Kaczynski, A. T., Potwarka, L. R., Smale, B. J. A., & Havitz, M. E. (2009). Association of Parkland Proximity with Neighborhood and Park-based Physical Activity: Variations by Gender and Age. Leisure Sciences, 31(2), 174-191. doi:10.1080/01490400802686045

13 Kaczynski, A. T., Besenyi, G. M., Stanis, S. A., Koohsari, M. J., Oestman, K. B., Bergstrom, R., . . . Reis, R. S. (2014). Are park proximity and park features related to park use and park-based physical activity among adults? Variations by multiple socio-demographic characteristics. International Journal of Behavioral Nutrition and Physical Activity, 11(1). doi:10.1186/s12966-014-0146-4

TABLE 4: Scalers used in Physical Activity Indicator Calculation

	ODDS RATIO		CONVERTED SCALER	
Presence of Park	Park-based PA	Neighbourhood-based PA	Park-based PA	Neighbourhood-based PA
1 Additional Park within 1km	1.15	1.17	1.12	1.14

Source: Kaczynski et al, 2009; Mytton et al, 2012

Park Amenities and Facilities	Park-based PA	Neighbourhood-based PA	Park-based PA	Neighbourhood-based PA
Playground	1.98	-	1.71	-
Sports field	1.05	-	1.04	-
Baseball field	1.73	-	1.55	-
Swimming pool	1.26	-	1.21	-
Splash pad	2.07	-	1.76	-
Basketball court	1.69	-	1.52	-
Tennis court	1.78	-	1.58	-
Volleyball court	2.42	-	1.96	-
Trail	1.65	-	1.49	-
Fitness station	7.92	-	3.71	-
Skate park	5.25	-	3.09	-
Dog park	1.48	-	1.37	-
Green space	1.43	-	1.34	-
Lake	1.72	-	1.54	-

Source: Kaczynski et al, 2014; Schipperijn et al, 2013

Calculations:

# of park users (people living in the park service area who use the park at least once a week) being physically active after the development of the downtown urban park

*= Total population in the catchment area (5,919) * Proportion of park users (27.05%) * Proportion of them being physically active before the development of the downtown urban park(16.40%) * Scaler (Increased park-based physical activity) due to the presence of a new park (1.12) * Scaler (Increased park-based physical activity) due to park amenities and features (1.71)*

= 502 (rounded number)

# of non-park users (people living in the park service area who do not use the park) being physically active after the development of the downtown urban park

*= Total population in the catchment area (5,919) * Proportion of non-park users (72.95%) * Proportion of them being physically active before the development of the downtown urban park(16.40%) * Scaler (Increased neighbourhood-based physical activity) due to the presence of a new park (1.12)*

= 793 (rounded number)

Total # of people being physically active after the development of the downtown urban park= 1,301

Change in # of people being physically active due to park development = 339

Note: The proportion of residents within the park service area who already meet the recommended physical activity goal before the development of the park is assumed to be the Canadian average (16.40% of Canadian meet recommended MVPA goals). The calculation only considers people who live within the park service area.

TABLE 5: Breakdown of Physical Activity Indicator Calculation

URBAN PARK	Type of PA	Population Catchment	% to Total Population	% of People engage in >= 150 mins MVPA	Physically Active Population	Park Presence Scaler	Park Features Scaler
Users							
Park users	Park-based	5,919	27.05%	16.40%	263	1.12	1.71
Non-park users	Neighbourhood-based		72.95%	16.40%	708	1.14	-
Total					**971**	**1,101**	**1,310**
Change							**339**

Thus, the development of the downtown urban park will result in an additional 339 residents within the 800-meter coverage area being physically active and meeting the physical activity goal (at least 150 mins of MVPA) as recommended by Canadian Physical Activity Guidelines.

5.3. Mental Wellness Indicator Calculation

Self-reported life satisfaction, happiness, and improved mental wellbeing are associated with spending time in urban parks. Supporting research can be found in Section 6.2. The mental wellness indicator calculation applies to residents living within the 800-meter park service area. The literature indicates that urban parks and other greenspaces improve residents' life satisfaction and mental health condition.

Mental Wellness Indicator Calculation:

= ***Improved Life Satisfaction*** *(Users * Park Acreage * Increased Life Satisfaction Score/Park Acreage/Person)*

+ ***Improved Mental Health Condition*** *(Residents in Park Service Area * Percentage Improvement in Mental Health Condition)*

Improvement of residents' life satisfaction is calculated by multiplying the population coverage with the improvement in life satisfaction scores per person. An additional acre of parks within a resident's living environment increase the life satisfaction score by 0.007 points (on a 1-5 scale), measured by the Satisfaction With Life Scale (SWLS)[14].

Park access also improves mental health. A study in Australia by Wood and colleagues (2017) found that the presence of a neighbourhood open space, which serves as the recreational and social focus of a community, leads to an increase of 0.15 points measured by The Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (on a 14-70 continuous scale)[15]. When converted to a percentage measure, the 0.15 point increase is equivalent to an improvement of 0.2%. It is assumed that for residents within the park service area, the presence of the downtown urban park will lead to a 0.2% improvement in their mental health condition.

14 Pfeiffer, D., Ehlenz, M. M., Andrade, R., Cloutier, S., & Larson, K. L. (2020). Do Neighborhood Walkability, Transit, and Parks Relate to Residents' Life Satisfaction? Journal of the American Planning Association, 86(2), 171-187. doi:10.1080/01944363.2020.1715824

15 Wood, L., Hooper, P., Foster, S., & Bull, F. (2017). Public greenspaces and positive mental health – investigating the relationship between access, quantity and types of parks and mental wellbeing. Health & Place, 48, 63-71. doi:https://doi.org/10.1016/j.healthplace.2017.09.002

6. Economic Value Calculation

In this section, the economic value of various health benefits, as mentioned in the previous section, is estimated based on research findings and case-specific assumptions. The summary of supporting research can be found in Section 8.

6.1. Physical Activity Benefits

The economic value of physical health benefits is estimated based on the avoided direct health care costs of physical inactivity.

Physical Activity, Monetary Value Calculation:

*= Number of People being Physically Active * Avoided Health Care Costs Associated with Physical Inactivity*

Research in Canada found that in the year 2012, the total annual direct health care cost of physical inactivity was $289.65 per person (Krueger et al., 2014)[16], which is equivalent to $323.69 per person in 2019 when adjusted for inflation[17].

TABLE 6: Breakdown of Monetary Indicator Calculation for Physical Health Benefit

LOUIS ST URBAN PARK	CHANGE IN PHYSICALLY ACTIVE POPULATION	AVOIDED COST PER PERSON	TOTAL AVOIDED COST
Users			
Park users	240	$323.69	$77,787
Non-park users	99	$323.69	$32,090
Total	**339**		**$109,877**

Calculations Breakdown:

Total avoided annual cost related to physical activity = Change in the physically active population within the park service area (339) * Avoided annual health care cost per individual ($323.69)

= 109,877

The avoided annual health care cost due to increased levels of physical activity attributed to the development of the downtown urban park is estimated to be $109,877.

16 Krueger, H., Turner, D., Krueger, J., & Ready, A. E. (2014). The economic benefits of risk factor reduction in Canada: Tobacco smoking, excess weight and physical inactivity. Canadian Journal of Public Health, 105(1). doi:10.17269/cjph.105.4084

17 Inflation adjusted by applying Consumer Price Index to the monetary value. Statistics Canada. Table 18-10-0005-01 Consumer Price Index, annual average, not seasonally adjusted

6.2. Mental Wellness Benefits

Mental wellness benefits attributed to the development of downtown urban park include improved life satisfaction and reduced burden of mental health problems or illness.

6.2.1 Improved Life Satisfaction

The monetary indicator calculation of mental wellness benefits applies to residents within the 800-meter park service area. Life satisfaction improvement from the presence of parks is measured by the amount of income increase that results in an equivalent increase in life satisfaction scores.

A one point increase in life satisfaction (on a 0-10 scale), is equivalent to a per capita income increase of US$26,000 ($2008)[18]. When converted to a 1-5 scale, a one-point increase in life satisfaction is equivalent to an approximate CAD$82,589 ($2019) increase in annual per capita income.

Calculations Breakdown:

Equivalent wealth increase in park service area

*= Population within park service area (5,919) * Park acreage (1.2) * Increased life satisfaction per individual per 1 acre of park (0.007) * Equivalent annual wealth increase for each individual ($82,589)*

= $4,106,292

TABLE 7: Breakdown of Monetary Indicator Calculation for Life Satisfaction Gain

LOUIS ST URBAN PARK	Population	Park Acreage	Increase in Life Satisfaction Score per individual per 1 acre of Park	Equivalent Wealth Increase for 1 point LS Increase	Equivalent Wealth Increase for each Individual	Equivalent Total Wealth Increase in Park Service Area
Residents within Service Area	5,919	1.2	0.007	$82,589	$694	$4,106,292

For the 5,919 residents within the park service area, each of them will experience a 0.0084 point increase in life satisfaction as measured by SWLS. Such improvement is equivalent to a wealth increase of $694 for each individual. For the entire park service area, the improvement of residents' life satisfaction equals a wealth increase of $4.1 million.

18 Lora, E., & Chaparro, J. (2008). The Conflictive Relationship between Satisfaction and Income. SSRN Electronic Journal. doi:10.2139/ssrn.1820930

6.2.2 Reduced Burden of Mental Problem or Illness

The literature indicates that in 2003, the economic burden of mental illness in Canada was $50,847 million, including direct medical cost, productivity loss, and loss in health utilities[19]. After adjusting for inflation, the amount is equal to $67,268 million in 2019. Per individual, the economic burden of mental illness in Canada is $1,950.

TABLE 8: Breakdown of Monetary Indicator Calculation for Mental Health Benefits

LOUIS ST URBAN PARK	POPULATION	MENTAL ILLNESS ECONOMIC BURDEN PER PERSON	% IMPROVEMENT IN MENTAL HEALTH CONDITION	TOTAL AVOIDED ECONOMIC BURDEN
Residents within Service Area	5,919	$1,950	0.20%	$23,084

Calculations Breakdown:

Avoided mental illness economic burden

*= Population within park service area (5,919) * Mental illness economic burden per person ($1,950) * % improvement in mental health condition for each individual (0.20%)*

= $23,084

6.3. Air Quality Health Benefits

Urban greenspaces provide additional health benefits associated with reduced exposure to air pollutants. While the Downtown Urban Park serves primarily as an urban square, large areas of tree plantings are located on the sides of the park and near the water geysers. Under tree plantings, there will be passive seating areas (refer to figure 2). The tree canopy cover attributes to the reduction of air pollutants in the park environment. Nowak and colleagues (2018) found that for the city of Peterborough, the value (savings) per hectare of tree canopy cover is equivalent to $561 in 2010. After adjusting for inflation, this value is equal to $653 in 2019.

According to the city of Peterborough Parks Development Standards (2019), the park aims to provide at least 40% tree canopy cover by the end of the tenth year after its opening. It is assumed that downtown urban park will provide a 40% tree canopy cover each year.

Calculations Breakdown:

Savings resulted from tree canopy cover

*= Park Size (0.4856 hectares) * Tree Canopy Cover (40%) * Annual savings per hectare of tree canopy ($653)*

= $126.84

19 Lim, K. L., Jacobs P Fau - Ohinmaa, A., Ohinmaa A Fau - Schopflocher, D., Schopflocher D Fau - Dewa, C. S., & Dewa, C. S. A new population-based measure of the economic burden of mental illness in Canada. (1481-8523 (Electronic)).

TABLE 9: Breakdown of Greenness Benefits Calculation

LOUIS ST URBAN PARK	PARK SIZE (ha)	TREE CANOPY COVER	ANNUAL SAVINGS PER HECTARE	TOTAL SAVINGS
Air Quality Health Benefits	0.4856	40%	$653	$126.84

The development of the Downtown Urban Park will provide an annual saving (reduced economic burden of air-pollution related health cost) of $126.84 attributed to tree canopy cover.

6.4. Heat Exposure Health Benefits

In addition to improved air quality, greenspace and specifically urban canopy cover can reduce exposure to heat providing respite from heat-related stress (Bowler et al., 2010; Lafortezza et al., 2009).

As a small urban square, the current plan indicates at maximum 60 trees will be planted in the park. While the shading provided by the trees will be beneficial, the impact of the trees on reducing surface level temperature and determining the number of people benefiting from the reduced exposure to heat is out of scope of the current study.

7. Annual Health Return on Investment

The economic benefits attributed to improvements in health and wellbeing from investments in urban greenspace are usually omitted in cost-benefit calculations and the planning and budgeting process. In this section, the health return on investment (HROI) is calculated to support the construction of a business case for investments in urban greenspace.

TABLE 10: Breakdown of Annual Health Return on Investment

LOUIS ST URBAN PARK	AVOIDED ECONOMIC BURDEN DUE TO PHYSICAL INACTIVITY	AVOIDED ECONOMIC BURDEN DUE TO MENTAL ILLNESS	AVOIDED ECONOMIC BURDEN DUE TO AIR POLLUTION	TOTAL AVOIDED COSTS
Annual Health Return	$109,877	$23,084	$127	$133,088
				ECONOMIC VALUE (WEALTH RISE) OF IMPROVED LIFE SATISFACTION
				$4,106,292
				TOTAL HEALTH RETURN ON INVESTMENT
				$4,239,380

As shown in Table 10, the calculations in the previous sections estimate that, in total, the development of the Downtown Urban Park will create an annual avoided cost of $133,088. The total avoided costs include avoided economic burden due to physical inactivity, mental illness and air pollution. If we include the economic value of improved life satisfaction, the total annual health return on investment equates to $4.24 million.

The development of the Downtown Urban Park was estimated to cost $6.5 million according to the city of Peterborough 2020-2029 Capital Budget[20]. Assuming an annual 2% inflation rate and a 5% discount rate, the avoided costs will accumulate to $3.5 million in 50 years following the opening of the park, which covers more than half of the initial development cost. When including the economic value of improved life satisfaction, the total health return on investment in one year is equivalent to 65% of the initial development cost. The HROI will pay back the initial development cost in 1.5 years.

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The estimations and calculations presented in this case study focus on the economic value of physical health benefits, mental health benefits and reduced air pollutants from investing in a new urban park in downtown Peterborough. The results represent a portion of the park's value. Other park values might include but are not limited to heat island reduction in the city centre, social benefits beyond individual mental health (e.g., community cohesion, community engagement and reduced isolation), and business attraction due to enhanced downtown environments. The study focuses on the service area (800-meter radius) of the proposed downtown urban park and thus excludes the health benefits experienced by park users from outside this area suggesting that the health benefits presented in this study underestimate the full benefits. Of particular note is the skating rink during winter seasons, which could attract a substantial number of park users. The skating rink will encourage leisure physical activity during winter months when outdoor physical activities are limited.

8. Supporting Research

This section outlines a number of health benefits associated with urban parks, focusing primarily on human health benefits resulting from use or exposure to park greenspaces, park features and amenities. The majority of studies found were from peer-reviewed literature, and in addition, where available, reports from grey literature were included. Key search terms included a combination of greenspace, urban parks, health benefits and/or outcomes, the economic value of various health benefits.

8.1. Physical Activity Benefits

Numerous studies indicate that the use of urban greenspace leads to physical health benefits by attracting people outdoors and encouraging physical activities. Regular physical activity has been shown to reduce chronic diseases such as coronary heart disease, type 2 diabetes, high blood pressure and colon cancer (Toftager, 2011). The Canadian Physical Activity Guidelines recommend at least 150 minutes of moderate- to vigorous-intensity aerobic physical activity per week for adults (CSEP, n.d.). However, only 16.40% of Canadian meet the recommended level of weekly physical activity (Statistics Canada, 2017).

Parks are considered as a major form of urban greenspace. Studies of park use among North American parks in urban settings have found that the percentage of park users that engage in moderate to vigorous physical activity ranges from 18%-62% (Cohen et al., 2007; Hamilton et al., 2017; Holliday et al., 2017). Factors influencing the intensity and frequency of physical activities usually include neighbourhood demographics, socio-economic conditions, park proximity, park sizes, park amenities and features. This case study emphasizes the impact of park proximity, park size and park amenities on physical health.

8.1.1. Park Proximity and Park Size

Natural outdoor environments and active living environments are positively associated with residents' physical health. Triguero-Mas et al. (2017) found that the availability of higher residential natural outdoor environments is associated with more MVPA during weekdays. A study in Ottawa, Canada, found that residents living in the upper quartile of active living environment on average spent 1.4 hours more on recreational physical activities (Villeneuve et al., 2018).

The literature indicates that residents' distance to the nearest park has a positive association with moderate-to vigorous-intensity physical activities (MVPA). In a study of Danish parks, Toftager et al. (2011) found that people living further away from parks were less likely to conduct MVPA.

Park sizes also have an impact on residents' time spent on physical activities. A Canadian study showed each additional hectare of parks within 1 kilometre of residents' homes increased the odds of participating in 150 or more minutes of MVPA by 2% (Kaczynski et al., 2009). The study also found that each new park within 1 km of residents' homes increased the odds of engaging in 150 or more minutes of MVPA by 17% (Kaczynski et al., 2009).

8.1.2. Park Amenities and Features

The literature suggests that park amenities and park features influence the duration, intensity and location of physical activities. In a study of 33 parks in Ontario, Canada, Kaczynski et al. (2008) found that a greater number of both facilities (OR: 1.85) (e.g., path, trail, playground and basketball court) and amenities (OR: 1.49) (e.g., bike rack, historical or educational feature, shelter, restroom and drinking fountain) was significantly associated with increased odds of physical activities in a park. Among all the park amenities and features, paved trails, unpaved trails, and wooded areas had the most significant positive impact on park-based physical activities (OR=32.31, 7.11, 6.75). Similar findings were included in a study of Danish urban greenspaces, in which Schipperijin et al. (2013) found that walking/cycling routes and wooded areas have a significant positive association with physical activities. Park features also provide urban greenspace to a community. A study in Doetinchem, Netherlands, found that more urban greenspace was associated with more time spent on bicycling (OR: 0.17) and sports (OR: 0.07).

8.1.3. Assigning a Monetary Value

Numerous studies found that physical inactivity in Canada has substantial health and economic impact. Krueger et al. (2014) estimated an annual economic burden attributed to physical inactivity of $9.988 million Canadian dollars (2012) ($289.65 per individual). The estimation includes both direct costs, such as costs of hospital care, physician services and drugs and also indirect costs, such as short- and long-term disability.

8.2. Mental Wellness Benefits

Self-reported life satisfaction, happiness, and improved wellbeing are associated with spending time in nature. Maller, a leading authority on the health benefits of nature, contends that increasing access and exposure to greenspace and natural areas may be the most effective population-wide strategy for promoting mental wellbeing (Maller et al., 2006). Maller's statement reflects over 30 years of research demonstrating that contact with nature reduces stress and increases a sense of personal wellbeing (Hartig et al., 2014; Shanahan et al., 2016). Empirical studies have shown that being in nature reduces cortisol levels and blood pressure (Van den Berg & Custers, 2011; Hartig et al., 2003). While explanatory pathways are not well understood, studies consistently find that people feel better in nature. Contact with nature is positively associated with increased self-esteem, higher life satisfaction, cognitive function and better job performance (Bowler et al., 2010; Bratman et al., 2012; Kaplan & Kaplan, 1989; White et al., 2013;). Hazer and colleagues (2018) found an increase in time spent in nature reliably predicts a statistically significant reduction in perceived stress in a population. Shanahan and colleagues (2016) found individuals who made extended visits to greenspaces reported lower rates of depression and lower blood pressure. Based on their analysis, visits to outdoor greenspaces of 30 minutes or more during the course of a week could reduce the population prevalence of depression and high blood pressure by up to 7% and 9%, respectively.

8.2.1. Life Satisfaction

Several studies indicate that spending time in parks and other greenspaces improve life satisfaction. A population-wide study in England examining self-reported life satisfaction, happiness and feelings that life is worthwhile and park use found that gains in life satisfaction, happiness, feeling that life is worthwhile are associated with greenspace use (Fields in Trust, 2018). Pfeiffer and colleagues (2020) summarized that parks promote subjective wellbeing through its greenness and opportunities for engagement, socializing and exercise. Their study in metropolitan Phoenix found that people who had greater perceived neighbourhood park access had higher life satisfaction. Each additional acre of parks within the neighbourhood increase residents' life satisfaction score by 0.007 on a 1-5 scale measured by the Satisfaction With Life Scale (SWLS).

8.2.2. Mental Health Condition

Parks that provide urban greenspaces have shown to support mental health and reduce feelings of depression, anxiety and stress. Kragsig and Stigsdotter (2013) found that the most critical perceived sensory dimensions provided by small public urban greenspaces were 'social,' 'serene' and 'nature.' In an Australian longitudinal study of 48 months, Wood and colleagues (2017) found that the presence of a neighbourhood open space, which serves as the recreational and social focus of a community, leads to an increase of 0.15-point measured by The Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (on a 14-70 continuous scale). In a cohort study of 46,786 participants in Australia, Astell-Burt and Feng (2019) found that exposures of 30% of total greenspace (OR: 0.46; 95% CI: 0.29-0.69) and tree canopy specifically (OR: 0.69; 95% CI: 0.54-0.88) were associated with a lower incidence of psychological distress.

8.2.3. Assigning a Monetary Value

Life satisfaction is often associated with income rise and an increase in personal wealth. Lora and Chaparro (2008) found that to increase average life satisfaction by 1 point on a 0-10 scale in a developed country with a per capita income of US$10,000, a per capita income of $36,000 would be needed. However, increased income contributes to increased life satisfaction with diminishing returns.

Mental illness creates economic burden due to direct costs associated with healthcare and insurance and also indirect costs such as short- or long-term disability, losses of productivity and losses in health-related quality of life from morbidity. Lim and colleagues (2008) estimated that in Canada 2003, the total economic burden of mental illness was $50,847 million.

8.3. Air Quality Health Benefits

Air pollution is one of the leading contributors to cardiac, respiratory, and lung cancer-related mortality. A natural approach to reducing air pollution is through tree planting in urban greenspaces. Urban greenspaces are associated with cooler, cleaner air at the site, neighbourhood and city level (Zupancic et al., 2015). Through a meta-narrative systematic review, Zupancic and colleagues (2015) found that parks with compact multi-layering of diverse species have the greatest benefits in terms of cooling and air-pollution mitigation. Konijnendijk and colleagues (2013), in a systematic review of urban park benefits, found that most of the studies confirmed that urban parks help remove air pollutants. In the review of a Québec City pilot project, Health Canada (2020) stated that tree planting decreases the surface temperature and improves air quality. Nowak et al. (2013) estimated the value of improved air quality provided by trees in the City of Toronto. Across the city, it was estimated that trees and shrubs remove 1,430 metric tonnes of air pollution (CO, NO2, O3, PM10, SO2) valued at $20.4 million in avoided health care costs. The valuation approach accounted for avoided healthcare expenses (i.e. cost of illness and willingness to pay to avoid illness), productivity losses associated with specific adverse health events, and the value of a statistical life in the case of mortality. Another study by Nowak et al. (2018) on the benefits of tree canopy cover in 86 cities in Canada revealed that tree coverage was able to eliminate 16,500 tons of pollution from the air and contributed to health benefits amounting to 227.2 million Canadian dollars in 2010. It also prevented 22,000 occurrences of acute respiratory symptoms and 30 occurrences of human mortality throughout the cities. Besides removing air pollution, greenspaces provide numerous benefits by sequestering carbon, reducing air temperature, and increasing the aesthetics of an area.

8.4. Benefits associated with reduced exposure to hot temperatures

In addition to improved air quality, greenspace has been linked to respite from heat-related stress (Bowler et al., 2010; Lafortezza et al., 2009). A study by Pengelly et al. (2007) found that over a 50-year period (1954-2004), an average of 120 deaths per year in the City of Toronto were related to heat, the most common cause of mortality among weather-related disaster types over the study period. Moreover, Berardi, Jandaghian, & Graham (2020) carried out a study to understand the cooling effect of increasing existing canopy cover by both 50% and 80% in neighbourhoods of the City of Brampton and Caledon. The results showed that a 50 and 80 percent increase in current tree canopy coverage has the potential of cooling up to 0.39 degrees and 1.51 degrees for the Brampton neighbourhood and 0.59 degree and 1.29 degrees for the Caledon neighbourhood.

9. Appendices

9.1. Appendix 1: Methodology

The estimation of physical activity benefits from investing in urban greenspace starts with an estimate of the population coverage. People who directly benefit from urban greenspace consist of local residents and visitors (e.g., event attendants who do not live in the park catchment area). A base participation rate, which measures the proportion of people who are already meeting the physical activity goals as guided by health officials, is adapted from empirical data or past studies. Urban greenspaces encourage physical activity through multiple mechanisms. For example, distance from residents' homes to an urban greenspace, area of urban greenspace, its amenities and features might influence the participation rate. Those influences are quantified from statistical findings in the literature to scalers and are then applied to the function.

The first function equates to the increase in the population of those who meet recommended physical activity goals attributed to the investment in urban greenspace. Economic value is then calculated by multiplying the change in a physically active population by the economic burden of physical inactivity per individual per year.

Increased number of people who meet recommended physical activity goals resulted from the new investment of urban greenspace:

= Population Coverage (# of people living in the proximity of an urban greenspace) * Participation Rate (% of people who are already meeting physical activity goals before the new greenspace investment) * Scalers

The economic value of physical activity benefits:

= Increased number of people who meet recommended physical activity goals resulted from the new investment of an urban greenspace * Economic burden of physical inactivity per person per year

The estimation of mental health benefits from investing in urban greenspace follows a similar approach as that of physical health benefits. Firstly, the population coverage of urban greenspace is estimated. The estimated population is then used to calculate improved life satisfaction and enhanced residents' mental health condition.

As noted in the literature review, research strongly indicates that spending time in greenspace improves residents' life satisfaction. The improvement in life satisfaction is related to the size of the greenspace, the duration of contact with greenspace and specific characteristics of the greenspace. Scalers are adopted from statistical findings in ecohealth literature. In general, a scaler should measure the percentage improvement of a resident's life satisfaction score as result of the investment, improvement or change in an urban greenspace. The economic value is then calculated by multiplying the population base with the percentage improvement in life satisfaction and the replacement cost for obtaining a similar improvement in life satisfaction. An often-used replacement cost is the amount of individual wealth increase that can result in the same scale of rise in life satisfaction.

Greenspace access also reduces mental illness and improve visitors' overall mental health condition. The literature suggests that the degree of improvement varies by the type of greenspaces, duration of stay and unique characteristics of greenspaces. The economic value of improved mental health condition is calculated by multiplying the population coverage with scalers and the economic burden of mental problems/illness per person per year.

The economic value of improved life satisfaction:

= Population Coverage * Life satisfaction scaler (Improvement in individual life satisfaction score) * Replacement cost for experiencing similar improvement

The economic value of improved mental health condition:

= Population Coverage * Mental health condition scaler (% improvement in individual mental health condition) * Economic burden of mental problems or illness per person per year

Another benefit brought by urban greenspaces is the reduction of air pollutants. Literature suggests that the amount of air pollutants removed varies by the type and the size of greenspaces. For urban parks, this benefit is usually attributed to the tree canopy cover in parks. Therefore, the economic value of removed air pollutants is calculated by multiplying the size of tree canopy cover in an urban park by the annual savings of removed air pollutants per hectare of tree canopy cover.

The economic value of reduced air pollution:

= Park Size * Tree Canopy Cover in percentage * Annual savings per hectare of tree canopy due to removed air pollutant

9.2. Appendix 2: Scaler Conversion

The majority of ecohealth literature uses logistic regression for analysis and measures statistical findings using odds ratio (OR). However, interpreting ORs correctly is challenging. The calculations presented previously use scalers to quantify the impact of various park characteristics on health. The scalers used are Risk Ratios (RRs) which are converted from ORs. Using ORs as scalers directly will often result in an overestimate of the outcomes. An example is given below for illustration.

Example:

Supposing a new park is built in a community. Prior to the park development, 20 out of 100 residents in the community have met the recommended physical activity goals. The development of a park encourages residents to participate in physical activities. As a result, now 40 out of 100 residents meet the recommended physical activity goals

The odds ratio, in this case, would be $\frac{40/60}{20/80} = \mathbf{2.67}$ while the risk ratio is equal to $\frac{40/100}{20/100} = \mathbf{2.00}$.

The development of a new park results in a 200% rise in the physically active population. If using the OR (2.67) as a scaler, the calculation outcome would overestimate the health benefits.

The conversion used in this case study follows Osborne's (2006) function, as presented below:

Conversion Function (Osborne, 2006)**:**

$$RR = \frac{OR}{[(1 - P_0) + (P_0 \times OR)]}$$

RR = Relative Risk (Risk Ratio)
OR = Odds Ratio
P_0 represents the proportion of non-exposed individuals that experience the outcome in question

10. References

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