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INTERACT FLASH REVIEW

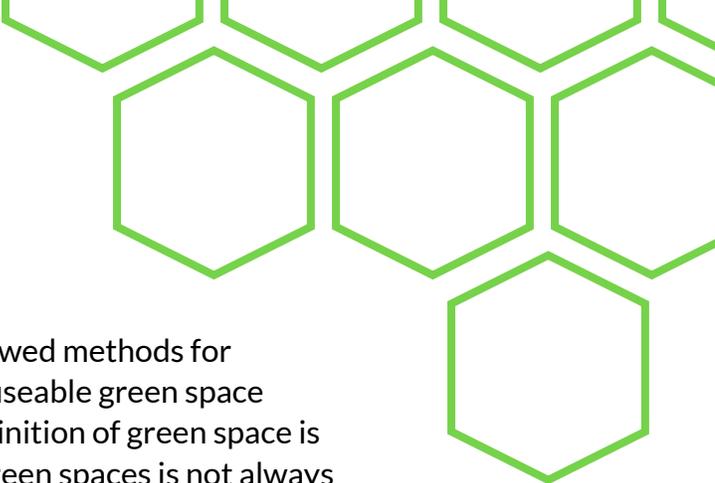
PARKS, GREEN SPACES AND
GREENNESS METRICS

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Question

The goal of this review is two-fold. First, I have reviewed methods for greenness area identification and the derivation of useable green space metrics. This stems from the fact that a common definition of green space is generally lacking [1] and spatial data on parks and green spaces is not always extensively available or up to date. Second, I have reviewed how health relates to green spaces and parks, and the various metrics used in population health surveys to assess green space exposure.

Review of measures / methods

Green space assessment

The literature showed several methods for assessing green space. The most widely used measures rely on vegetation indices, which come in many forms (NDVI, EVI, SAVI, Tasseled Cap greenness component, etc. [2]). Among these, the *Normalized Difference Vegetation Index (NDVI)* is the most frequent index appearing in health related papers. The reasons for this are that NDVI is well established, comes with a large base of comparative studies and is readily available as a standard product from USGS satellite data [3]. There have been some attempts to refine green space indices in urban contexts by using context information from GIS layers [4].

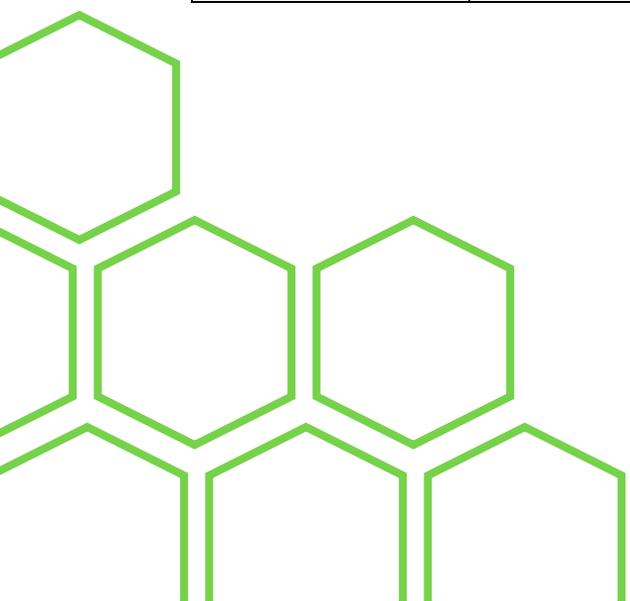
Apart from extracting greenness from satellite imagery, a new emerging approach tries to evaluate it from a walker's perspective. Using Google Street view images, an automated method calculates the proportion of green area (through a *Green View Index*) that can be seen at street-level [5].

A third category of greenness/green space measures borrows from the qualitative domain to assess the *perceived* greenness in an area, with either survey participants or trained observers assessing qualitatively the greenness in the neighborhood (extent, characteristics, etc.) [6, 7].

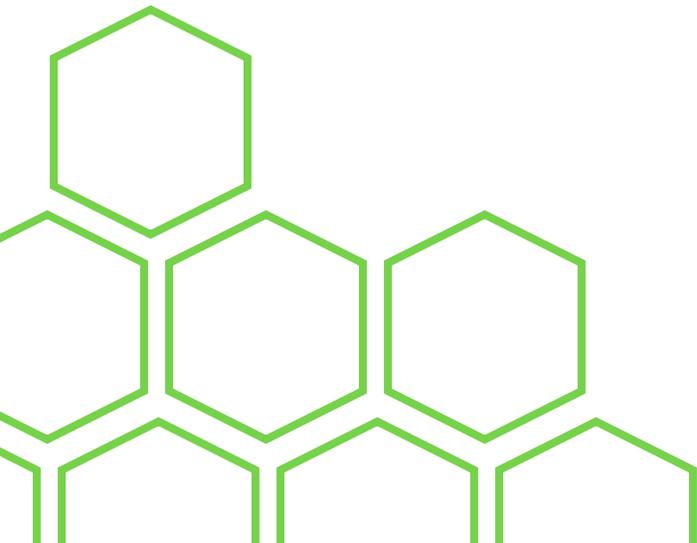
It must be noted that, greenness and green space are not interchangeable terms. While the first one describes in its broadest sense "level of vegetation, ranging from sparsely-landscaped streets to tree-lined walkways to playfields and forested parks" [8], the second one tends to be given a variety of definitions depending on the discipline [1]. In this review, we refer to greenspace as urban vegetated space.

Table 1: Methods for greenness/green space assessment

Measure	Definition	Developed or used by	Comments
Normalized Difference Vegetation Index (NDVI)	<p>Indicator of overall greenness based on land surface reflectance of visible and near infrared parts of spectrum</p> $NDVI = \frac{NIR - Red}{NIR + Red}$	[9, 10]	<ul style="list-style-type: none"> ○ Sufficiently stable to permit meaningful comparisons of seasonal and inter-annual changes in vegetation growth and activity ○ More accurately represents “greenness” than “greenspace” ○ Cannot be used to differentiate among all forms of natural space or to identify the accessibility of a specific parcel
Enhanced Vegetation Index (EVI)	<p>Optimized vegetation index</p> $EVI = G \times \frac{NIR - Red}{NIR + C1 \times Red - C2 \times Blue + L}$	[11, 12]	<ul style="list-style-type: none"> ○ Responsive to canopy structural variations, including leaf area index (LAI), canopy type, plant physiognomy, and canopy architecture



Urban Neighborhood green index (UNGI)	Indicator to Evaluate, quantify and compare various neighborhoods in terms of amount and distribution of green structure	[4]	<ul style="list-style-type: none"> ○ Based on NDVI + neighborhood structure ○ Not only assess greenness but also quality of green space and distribution within neighborhood
Streetscape greenery	Score rating quantity and quality of streetscape greenery in neighborhood	[6]	<ul style="list-style-type: none"> ○ Street-level greenery assessment ○ Quantity and quality (variation, maintenance, orderly arrangement, absence of litter, and general impression) of streetscape greenery collected by observations
Google Street View based Green View Index	Ratio of green pixels to total number of pixels in panoramic Google street view images $\text{Green View} = \frac{\sum_{i=1}^6 \sum_{j=1}^3 \text{Area}_{g,ij}}{\sum_{i=1}^6 \sum_{j=1}^3 \text{Area}_{t,ij}} \times 100\%$	[5]	<ul style="list-style-type: none"> ○ Street-level greenery assessment ○ Automatic extraction of GVI from GSV images

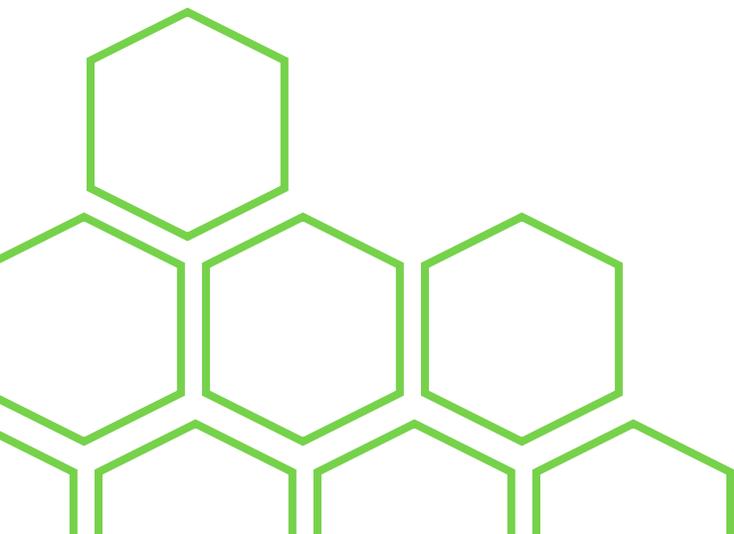


Green space metrics and health

There is considerable evidence of an association between health and green space [13-15] and various metrics have been used to assess this association. Table 2 shows a summary of which metrics has been related to what health outcome while Table 3 gives some details on the studies themselves.

Table 2: Matrix of metrics vs. health outcomes

Measure	Physical Health	Mental Health	Physical Activity	Social cohesion / participation	Other health related outcome
NDVI	[15, 16]	[14-17]	[14, 15, 17]	[14, 17]	[9, 15]
Park proximity		[17]	[9, 14, 17, 18]	[14, 17]	[9, 18]
% of park within NH	[19]	[17, 19]	[17]	[17]	[9]
% of tree cover					[9]
% of street canopy					[9]
Perceived greenness		[6, 14]	[6]	[6]	
SOPARC			[7]		
ParkIndex			[20]		[20]
Natural space index		[10]		[10]	



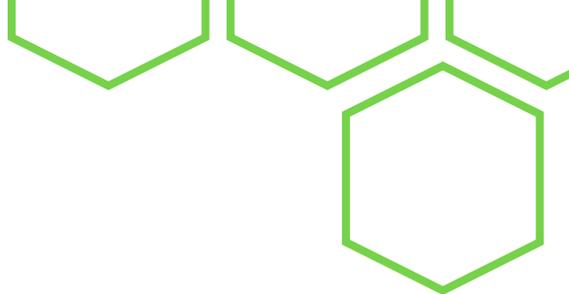
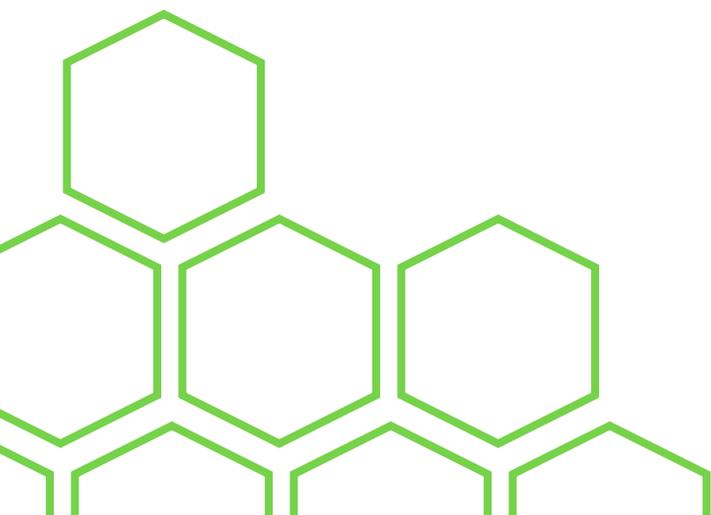


Table 3: References to survey on green space and health

Reference	Measures / methods	Study Details	Findings
[9]	Residential green space measures : <ul style="list-style-type: none"> - NDVI - % green space - % tree cover - % street tree buffers - Park proximity 	Birth cohort from 2005 to 2009 in Austin, Texas (n = 88,807) and Portland, Oregon (n = 90,265)	<ul style="list-style-type: none"> - Varying degrees of correlation between the five different green space metrics - Consistent negative associations between the different green space metrics and % households living under the poverty line, % unemployed, % Hispanic, and % without a high school education - Unadjusted associations demonstrated consistent protective effects of green space exposures on birth weight, no longer statistically significant once adjusted <p><u>Limitation</u> :</p> <ul style="list-style-type: none"> - Residential exposure only, no time-activity patterns
[20]	Park characteristics: <ul style="list-style-type: none"> - Distance to nearest park - Number of parks within 1-mile NH - % park space within 1-mile NH - Average park quality index <p>Creation of a new ParkIndex measure = probability of park use based on park characteristics above</p>	Survey among adults (n=891) about park use, Kansas City, 2010 + mapping of all parks in KC using GIS and Community Park Audit Tool	<ul style="list-style-type: none"> - Two park summary variables were positively associated with park use—the number of parks and the average park quality index within 1 mile - ParkIndex represents a standardized metric of park access that combines elements of both park availability and quality, which was developed empirically

			and can be represented spatially
[6]	Qualitative and quantitative perceived greenness	Data on self-reported health and proposed mediators were obtained for Dutch adults by mail questionnaires (N = 1641) in June 2007	<ul style="list-style-type: none"> - Both quantity and quality of streetscape greenery related to perceived general health, acute health-related complaints, and mental health - Stronger relationship for quality than quantity - Stress and social cohesion were the strongest mediators
[17]	<ul style="list-style-type: none"> - NDVI - Park acreage - Distance to the nearest park 	In-person interviews conducted with 1544 adults (18-75 yrs) living in Chicago, Sept. 2002 - Apr. 2003	<ul style="list-style-type: none"> - Neighborhood green is found to encourage both social support and physical activity - no evidence that distance to the nearest park influences physical activity, social support, or stress - Neighborhood park acreage is found to be directly connected to physical activity and social support, but not stress - Neighborhood vegetation level is found to be directly connected to social support and stress, but not physical activity - park acreage shows much more positive impact on health and well-being than the overall neighborhood vegetation level

[19]	- Percentage of green space within a 1-km radius and a 3-km radius, from the Dutch National Land Cover Database (2001)	Face-to-face interviews with 4529 Dutch adults, 2001 Perceived mental health, perceived general health & stressful life events	- Limited effects of green space on health - Relationships of stressful life events with perceived general health significantly moderated by amount of greens space in larger radius
[18]	- Green space accessibility: road distance to the nearest green space, classified by type	Postal survey among Bristol (UK) citizens about their local community, their lifestyle, health, and some personal details (N = 6821)	- Proximity to park associated with higher level of PA and lower risk to be overweight or obese - association with PA, but not with overweight or obesity, remained after adjustment for respondent and neighborhood characteristics
[16]	Same as [19]	Postal survey with 380 000 people (76.5% response rate) + morbidity data from electronic medical records from GP serving a population of 345 143 people	- lower annual prevalence rate of disease clusters for green neighborhood - stronger relation for anxiety disorder and depression
[7]	SOPARC: a new measure to assess park characteristics as well as visitors' PA levels	Data were collected in eight large parks in Los Angeles	- Focus on parks and park uses rather than individuals -



Recommendations and Conclusions

Based on the review, I recommend using the NDVI as well as park proximity and proportion of park within neighborhood for INTERACT. These three metrics are commonly used, are pretty robust and require spatial data that is readily available. However, depending on the urban interventions followed in Montréal (e.g. green back alleys, street greening, etc.), some other specific metrics might be used or developed.

Summary Table

Recommended measure(s)/method(s)	Data requirement	Feasibility/applicability
NDVI	Landsat, Spot, MODIS satellite imagery (can be obtained pre-computed for some USGS images)	Images availability for some specific periods can be limited
Park proximity	Park / green space layer	Network analysis from residence to closest park
% of park within neighborhood	Park / green space layer	Intersection of park layer with neighborhood layer (network or circular buffers, polygons from VERITAS)

How to Cite

Thierry B. (2019). Parks, Green Spaces and Greenness Metrics. Retrieved at www.teaminteract.ca/flashreviews.

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