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Persistent Nature-Led Public Life in Vancouver: A SARSE Assessment of Activity Durability and Spatial Readiness, 2018–2023

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Abstract

In the case of nature-based vitality, there can be metrics such as quantity of green areas, park availability, or temporary increase in outdoor activities. All of the above approaches have some merit. Yet, they can conflate the temporary impact on visual attention with sustainable changes that will become visible after new routines have been formed. This paper introduces SARSE and applies it to Vancouver data from 2018 to 2023 in order to distinguish between temporary disruption-related reactions and persistent activity patterns as well as environmental and perceptual factors associated with both of them and with meaningful spatial structure. There is an extensive record of annually counted numbers of observations per each image-derived activity category, Moran's I , variance inflation values, and visitation correlations for Vancouver. The temporal component takes into account pre-disruption 2018-2019 state, 2020 shock effect ratio, persistent 2022-2023 period, terminal memory of 2023 year and volatility. The spatial readiness component encompasses spatial autocorrelation, multicollinearity handling and positive correlation with visitation counts. Urban Elements and Artistic Expression achieved the largest persistently observed expansion from $B_g = 269.5$ up to 4427 observations in 2023 years and attained $A_g = 2.54$ as well. Life and Cultural Activities, Street Landscapes and Life Scenes, Natural Landscapes and Greenery, Urban Built Form and Public Realm and Traffic categories have remained above the pre-disruption level. Flowers and Plants showed the largest 2020 shock ratio ($S_g = 8.50$) but maintained rather weak 2023 memory ($M_g = 0.18$). Sentiment Score and Red Maple provided the highest visitation-weighted spatial-readiness score, followed by Number of Parks, Pyramidal European Hornbeam, Tree Height 40-50 and Park Area factors.

Keywords: urban vitality; urban nature; spatial autocorrelation; shock elasticity; public realm; social media; Vancouver; COVID-19

1. Introduction

Urban vitality is defined as observable and repeatable usage of streets, parks, waterfronts, plazas, cultural venues, retail perimeters, and local neighbourhood routes. Urban vitality is neither identical to crowdedness, land use density, nor the count of any particular type of activity. A vibrant public realm supports mobility, loitering, encounters, visual focus, recreation, cultural expression, and ordinary social interaction over time. Classical urban

theory links the condition to mixed uses, small block sizes, active building fronts, presence of pedestrians, and continuous surveillance along the street [13]. Public-space literature at human scale further argues that outdoor activities depend upon comfort levels, seating availability, boundaries, microclimate, visibility, and invitation to linger instead of move on [6, 30]. More contemporary urban design scholarship sees the concept of vitality as involving activity, form, and meaning, thus suggesting that vibrant places are both experienced and made by social interaction [19, 20].

New methods like geotagged imagery, review databases, street-level observations, volunteered geographic information, and urban sensing offer extended time periods and spatial scales of observation. These new data sources help enrich the base of planning knowledge, but need careful treatment. In cases where a place or type of activity is disproportionately present during disruption, the reason might be that daily routines were pushed outdoors, some urban subjects gained photographic appeal due to their scenic or seasonal value, or online contributions gathered in locations with distinct features. Temporary spikes of visibility should therefore not be taken as signs of ongoing vitality. From a planning perspective, what needs distinguishing is between temporary visibility and sustainable activity patterns that persist once urban routines are reordered.

An urban setting like Vancouver offers a concrete example of this distinction. Vancouver's public realm combines waterfront promenades, parks, street trees, views of mountains, residential neighborhoods, commercial strips, cultural public space, tourism, and local neighborhood movements. The period from 2018 to 2023 includes pre-disruption activity, disruption activity, and the post-disruption rearrangement of urban routines. Activities such as commuting, eating, leisure time indoors, cultural gatherings, tourism, recreation, and walking did not behave in an identical manner. Nearby outdoor destinations and visually interesting urban nature have become more frequent, but the question is whether sustained activity has been carried by plant-related attention, general urban nature and public life, or simply reliable conditions of environment and perception.

The visual background of the Vancouver public realm is represented in Figure 1. Waterfronts, park trails, street-life routes, open urban spaces, and cultural public spaces are all seen as connected urban settings.

This setting is crucial to the analysis because natural vitality is not just ecological infrastructure. It is also the lived condition of paths, edges, water scenery, known vegetation, cultural signs, and comfortable walks and pauses. Activity categories considered include greenery, street scenes, cultural life, built form visibility, traffic, green transport, waterfront recreation, food venues, flowers, and public art elements instead of just a quantity of greenspaces.

A SARSE approach is applied to the Vancouver record to identify which activity categories have proven durable until 2023 and which environmental variables correlate with visitation. The analysis is conducted in accordance with the current SARSE methodological framework and concentrates on better understanding temporal durability, spatial interpretability, and activity-environment correlation.

2. Urban vitality and spatial evidence

Urban vitality was examined from multiple academic angles. Observational urbanism highlighted the ways in which physical settings encourage optional and social activities. According to Jacobs, diverse use, dense blocks, animated frontages, and a variety of people presence at different hours are the key characteristics of district life [13]. Gehl elaborated on this idea in human-scale terms of walking, remaining, and outdoor activity [6]. Whyte demonstrated the effects of small design conditions, such as movable furniture, presence of food, edges, sunlight, and foot traffic, on plazas and sidewalks use [30]. Mehta linked social behaviour with the quality of commercial streets in neighbourhoods through the physical environment, land use patterns, and opportunities for remaining [19]. These studies still matter because they interpreted vitality through behavioural patterns in specific locations instead of as an abstract quantity.

Public realm studies increasingly intersected with quantitative urban analysis. Points of interest, mobility records, remote sensing, geotagged photos, street-view images, online reviews, and perception models allow for description of activities, visual quality, and environmental support across large urban areas. Goodchild described how citizens

can become sensors of space, and the concept of volunteered geographic information highlights both the importance and limitations of user-generated spatial data [5, 9]. Online images and reviews are not comprehensive censuses of activities and behaviours, yet they indicate attention patterns, experiences, and visibility that can support decision making in the planning process.



Figure 1. Vancouver public-realm context.

Urban nature is an additional aspect of vitality. Vegetation, parks, street trees, waterfront, gardens, and landscape scenery facilitate public life through comfort, recreation, sensual experiences, shade, imageability, and attachment. Research into restorative environments established a connection between nature exposure and attention recovery and stress relief [14, 28]. Public health and planning literature found connections between urban green exposure and mental well-being, physical activity, social interaction, and environmental quality [10, 15, 18]. However, these positive effects are mediated by more complex relationships involving access, availability, safety, visual appearance, and integration of green space into daily paths.

Perceptions should also be addressed. Scenic paths, outdoor landscapes, street-level greenery, and opinions about green spaces can be analyzed through crowd-sourced perception, geotagged imagery, street view images, and natural language processing [8, 16, 24, 26]. These methods do not substitute field observations, yet they show that environments are perceived and represented by users. The Vancouver dataset contains a Sentiment Score variable, and a SARSE outcome will emphasize its importance. Such outcome makes sense from a theoretical perspective because strong public life often relies upon how people perceive places, not only whether trees and parks physically exist.

The coronavirus pandemic added another reason why it was necessary to distinguish temporary activity from durable adaptations. The literature provides numerous examples of park usage changes, perceptions, and recreational behavior shifts during social distancing and changing daily routines [7, 25, 27, 29]. The results differed depending on the specific site. Some green spaces replaced indoor leisure sites, some outdoor paths were important for daily well-being, and some social interactions were constrained. Consequently, assessing urban vitality after a shock event should reveal whether the observed activity proved durable in subsequent years. Vancouver's situation is

informative due to a 2018-2023 activity timeline that includes pre-shock conditions, an immediate shock, and late-period activity potentially declining or persistent.

Spatial statistics constitute the second conceptual base. Moran's I indicates whether a variable has significant spatial structure or is a result of purely random distribution [21]. The concepts of spatial autocorrelation at local and global scales are widely used to analyze clustering and spatial dependencies in geographic datasets [1, 3]. VIF filtering is also important since environmental variables are often correlated and redundant. Variables like tree number, trunk diameter class, tree height class, and parks often demonstrate high statistical dependency, so the SARSE analysis should exclude them [4, 23]. SARSE employs the ideas carefully since a variable is more informative when spatially structured, nonredundant, and positively correlated with visitation.

3. Vancouver observations and SARSE specification

The Vancouver dataset provided by Huang et al. [12] includes 1018 dissemination area blocks, 23,035 Flickr photos, 174,113 processed review records, activity counts for five years (2018-2023), Moran's I coefficients for environmental and perceptual variables, VIF coefficients, and visitation correlations for selected nature-related variables. The activity categories are divided into the following ten groups: Flowers and Plants, Food and Markets, Green Transportation, Life and Cultural Activities, Natural Landscapes and Greenery, Street Landscapes and Life Scenes, Traffic, Urban Built Form and Public Realm, Urban Elements and Artistic Expression, and Waterfront and Outdoor Recreation Activities.

The time frame is straightforward. Pre-shock years are defined as 2018-2019. The shock year is 2020. Years 2022 and 2023 comprise late-period activity, while 2023 represents terminal memory. This way prevents excessive weighting of single-year deviations. In addition, a category could prove highly responsive to a shock in 2020 but be barely retained in 2023, which would help with post-disruption planning decisions.

For each activity category g , the reference condition is computed as

$$B_g = \frac{x_{g,2018} + x_{g,2019}}{2}. \quad (1)$$

This value is not treated as a historical ideal. It is a compact local reference against which disruption and later activity are compared. It makes categories with very different raw counts interpretable on a common ratio scale.

The immediate shock ratio is

$$S_g = \frac{x_{g,2020}}{B_g}. \quad (2)$$

A high value of S_g means that activity visibility rose sharply in 2020 relative to the 2018–2019 reference condition. It does not by itself indicate durable vitality, because a category can peak under exceptional circumstances and then decline.

Late-period persistence is calculated as

$$R_g = \frac{x_{g,2022} + x_{g,2023}}{2B_g}, \quad (3)$$

and terminal memory is calculated as

$$M_g = \frac{x_{g,2023}}{B_g}. \quad (4)$$

The persistence ratio rewards activity that remains strong over the later period, while terminal memory prevents a category from being overvalued only because 2022 was high. The 2023 value is especially important in the Vancouver record because several categories show temporary peaks that are not retained.

Volatility is represented by the coefficient of variation over the full six-year sequence:

$$C_g = \frac{\sigma_{x_{g,2018}, x_{g,2019}, x_{g,2020}, x_{g,2021}, x_{g,2022}, x_{g,2023}}}{\mu_{x_{g,2018}, x_{g,2019}, x_{g,2020}, x_{g,2021}, x_{g,2022}, x_{g,2023}}}. \quad (5)$$

The volatility term reduces the score of categories that rise and fall sharply. This is necessary because volatile visibility can be attractive in a descriptive chart while remaining weak as a planning signal.

The temporal adaptability score is

$$A_g = \frac{\log_1 R_g \log_1 M_g}{1 C_g} \tag{6}$$

The logarithmic terms restrain extreme ratios, and the denominator penalizes unstable trajectories. A category therefore scores highly only when it combines late-period persistence, strong 2023 memory, and acceptable variation.

Spatial readiness is calculated for each environmental or perceptual variable j as

$$Q_j = \frac{|I_j|}{1 \log_1 VIF_j} \tag{7}$$

and

$$P_j = Q_j \max(0, r_j), \tag{8}$$

where I_j is Moran's I , VIF_j is the variance-inflation value, and r_j is the visitation correlation. The transformation retains spatially structured variables, reduces the influence of highly redundant variables, and assigns no positive readiness value when the visitation correlation is negative. The calculation does not claim that a variable causes visitation. It identifies variables that are spatially organized, statistically interpretable, and aligned with observed visitation.

The activity and spatial outputs are combined as

$$Z_{gj} = A_g P_j. \tag{9}$$

This coupled value is not a causal coefficient. It is a prioritization value that links durable activity categories with spatially ready environmental or perceptual indicators. It is useful for identifying where planning attention should be focused when the goal is persistent public life rather than short-term visibility.

The ranking produced by the temporal side of SARSE is shown in Figure 2. Urban Elements and Artistic Expression leads the ordering, while Food and Markets and Flowers and Plants occupy the lowest positions after the volatility and terminal-memory adjustments are considered.

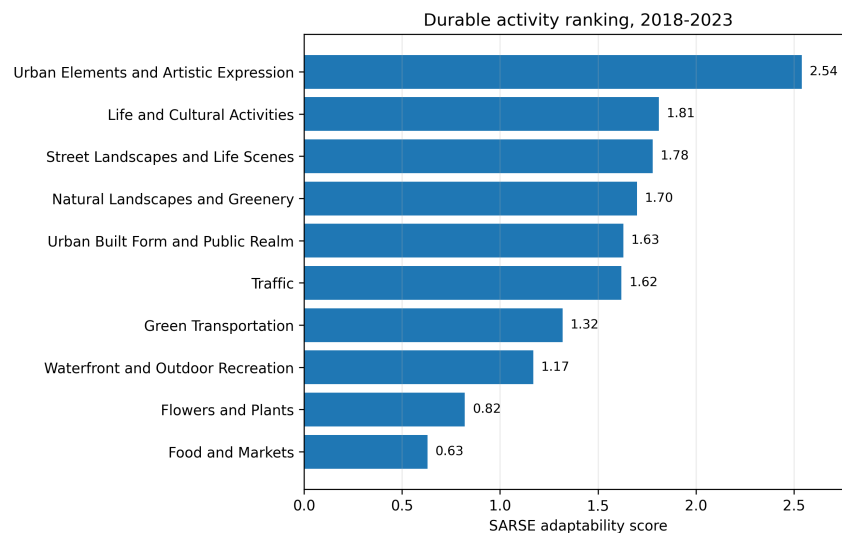


Figure 2. SARSE adaptability ranking.

This makes it clear why the procedure is more complex than a straight tally of activity. While Life and Cultural Activities have the highest absolute count for 2023, the category with the highest relative retained expansion rate compared to its reference condition is Urban Elements and Artistic Expression. Similarly, the low placement of Flowers and Plants proves that a high initial response alone is not sufficient without sustained visibility.

4. Results in time and space

Annual activity trends indicate that there was no consistent trend toward normalization in Vancouver’s public life. Certain categories continued to expand, others showed fluctuations, and yet others showed a decline after an initial peak. This is made apparent by the logarithmic plots in Figure 3.

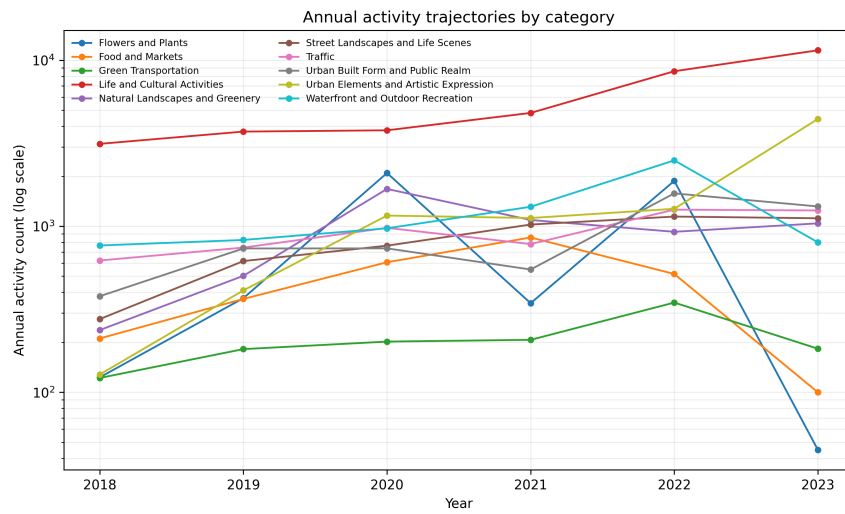


Figure 3. Annual activity trajectories.

Three separate trends can be identified in the trajectory chart. First, Life & Cultural Activities reaches its maximum value in 2023 with 11,475 mentions. Second, the trend Urban Elements & Artistic Expression increases more rapidly at the end than the others: in particular, it grows from 1274 mentions in 2022 to 4427 in 2023. On the other hand, the trend Flowers & Plants achieves its maximum value in 2020, declines in 2021, goes up in 2022 and then decreases to reach 45 mentions in 2023.

Table 1. Activity frequencies and SARSE values.

Activity category	2018	2019	2020	2021	2022	2023	B_g	S_g	R_g	M_g	C_g	A_g
Flowers and Plants	123	369	2092	344	1877	45	246.0	8.50	3.91	0.18	1.14	0.82
Food and Markets	211	365	607	856	516	100	288.0	2.11	1.07	0.35	0.62	0.63
Green Transportation	122	182	202	207	347	183	152.0	1.33	1.74	1.20	0.36	1.32
Life and Cultural Activities	3136	3717	3784	4814	8585	11475	3426.5	1.10	2.93	3.35	0.57	1.81
Natural Landscapes and Greenery	237	503	1678	1091	926	1041	370.0	4.54	2.66	2.81	0.55	1.70
Street Landscapes and Life Scenes	276	617	764	1024	1144	1117	446.5	1.71	2.53	2.50	0.41	1.78
Traffic	622	744	978	781	1259	1245	683.0	1.43	1.83	1.82	0.29	1.62
Urban Built Form and Public Realm	379	735	736	549	1578	1316	557.0	1.32	2.60	2.36	0.53	1.63
Urban Elements and Artistic Expression	128	411	1160	1121	1274	4427	269.5	4.30	10.58	16.43	1.09	2.54
Waterfront and Outdoor Recreation Activities	766	827	972	1310	2494	800	796.5	1.22	2.07	1.00	0.56	1.17

The activity-frequency table provides the precise numbers behind the rankings. Urban Elements and Artistic Expression exhibits the most terminal memory $M_g = 16.43$ and also the greatest adaptability $A_g = 2.54$. Second place is occupied by Life and Cultural Activities with $A_g = 1.81$; Street Landscapes and Life Scenes, Natural Landscapes and Greenery, Urban Built Form and Public Realm, and Traffic still exceed 1.60. Thus, these activity types indicate a durable vitality in the public art visibility, cultural activity, life on the street, more general greenery, built public realm, and movement visibility, respectively.

The distinction between Flowers and Plants and Natural Landscapes and Greenery plays an important role in the analysis. Although Flowers and Plants achieves the maximum shock value of $S_g = 8.50$, its terminal memory score is relatively low at $M_g = 0.18$. By contrast, Natural Landscapes and Greenery experiences a lower 2020 surge of $S_g = 4.54$ but a significantly greater terminal memory value of $M_g = 2.81$. It thus emerges that the durable nature-based signal is conveyed more by landscape and greenery scenes than by flowers.

Shock response and terminal memory are illustrated directly in Figure 4, where Flowers and Plants is located in the top left region while Urban Elements and Artistic Expression is placed in the top right area.

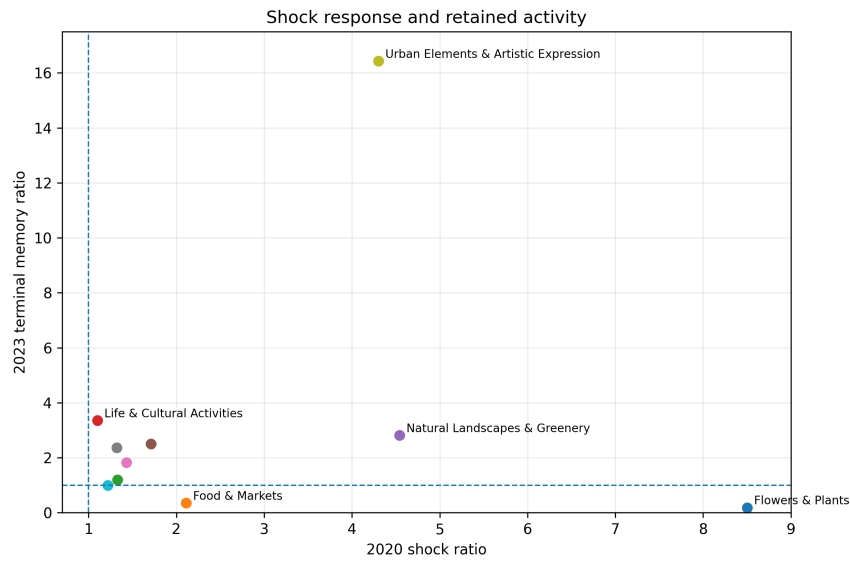


Figure 4. Shock response and terminal memory.

The scatter plot gives a compact answer to why terminal memory matters. If only the 2020 ratio were used, Flowers and Plants would appear to be the dominant nature-led activity category. Once the 2023 ratio is considered, the category becomes a weak retention case. The plot also shows that high adaptability is not limited to the largest raw activity counts. It depends on proportional late-period strength relative to the reference condition.

Table 2. Activity trajectory classes.

Activity category	Class	Interpretation
Urban Elements and Artistic Expression	Durable expander	Terminal memory reached 16.43 and produced the highest adaptability score.
Life and Cultural Activities	Durable expander	Cultural and social visibility rose to 11,475 observations in 2023.
Street Landscapes and Life Scenes	Durable expander	Everyday street-life imagery rose steadily and retained moderate volatility.
Natural Landscapes and Greenery	Durable expander	Greenery activity remained 2.81 times above the reference condition in 2023.
Urban Built Form and Public Realm	Durable expander	Built-form and public-realm visibility remained 2.36 times above the reference condition in 2023.
Traffic	Durable expander	Movement-related visibility stayed 1.82 times above the reference condition in 2023.
Green Transportation	Steady adapter	The terminal memory ratio was above one, but the expansion was smaller than the leading categories.
Waterfront and Outdoor Recreation Activities	Transitional	A high 2022 value returned close to the reference condition in 2023.
Flowers and Plants	Shock amplifier	The 2020 surge was not retained, and the 2023 value fell to 45 observations.
Food and Markets	Fragile	The 2021 rise was followed by a 2023 terminal memory ratio of 0.35.

The trajectory classification translates the numerical scores into planning language. Durable expanders are not merely active categories; they are categories that remained visible after disruption. The classification also protects against overinterpreting high but unstable years. Waterfront and Outdoor Recreation Activities illustrates this point

because it rose to 2494 in 2022 but returned to 800 in 2023, nearly identical to its reference value of 796.5. Food and Markets indicates a different weakness: its 2021 rise did not persist, and its terminal memory remained low.

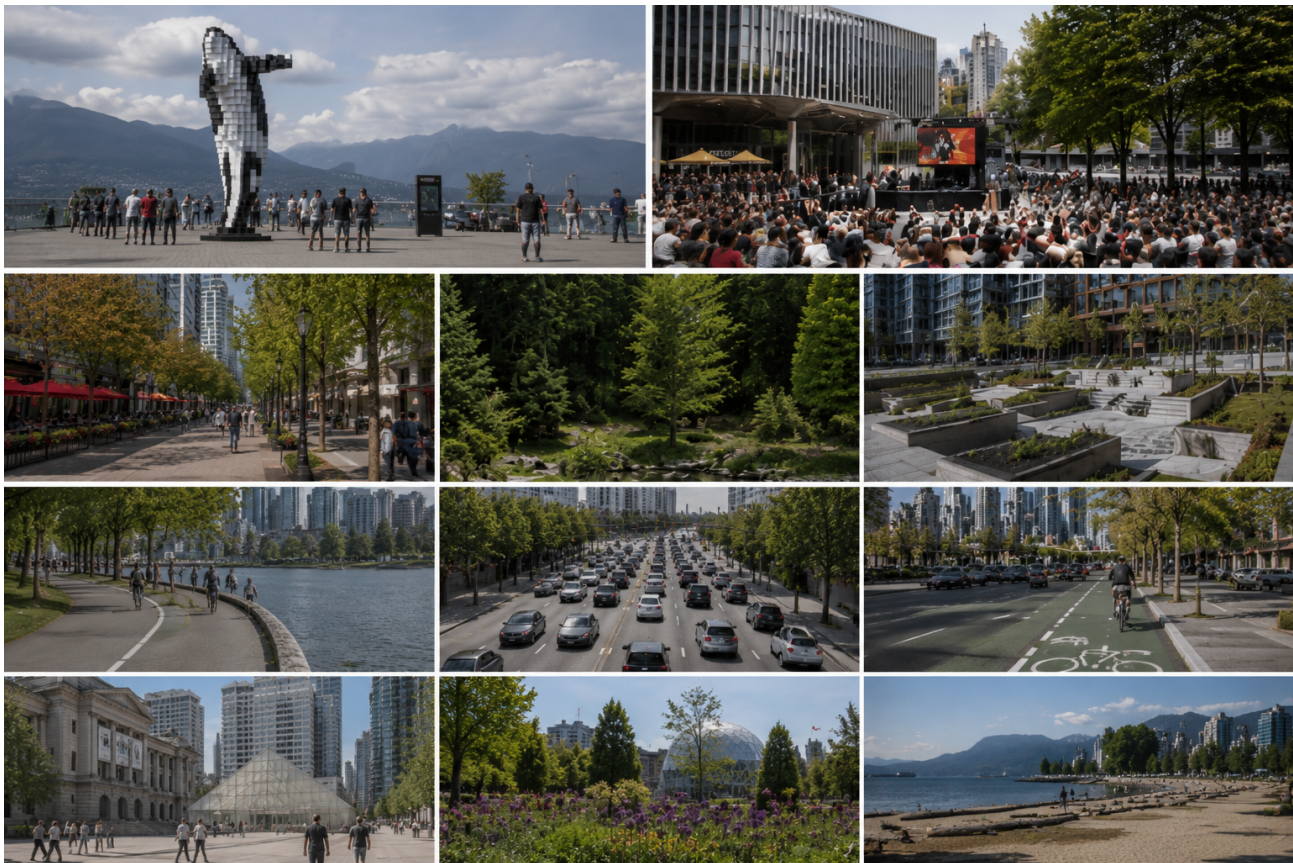


Figure 5. Durable activity settings.

The durable settings plate links the scores to recognisable public-realm conditions. Public art, cultural events, green routes, street scenes, movement corridors, and waterfront settings appear as combined urban situations rather than isolated categories. This supports the interpretation that the strongest SARSE values are not confined to single-purpose parks or single visual subjects. They represent public spaces where social activity, visual distinctiveness, greenery, and movement overlap.

Table 3. Spatial-readiness values.

Variable	Moran's <i>I</i>	VIF	Visitation <i>r</i>	<i>Q_j</i>	<i>P_j</i>
Sentiment Score	0.775	1.544	0.26	0.401	0.104
Red Maple	0.659	1.589	0.29	0.338	0.098
Number of Parks	0.673	2.037	0.16	0.319	0.051
Pyramidal European Hornbeam	0.673	1.414	0.12	0.358	0.043
Tree Height 40–50	0.670	6.061	0.14	0.227	0.032
Park Area	0.638	1.386	0.09	0.341	0.031
Tree Height 90–100	0.654	1.259	-0.02	0.360	0.000
Akebono Flowering Cherry	0.672	1.628	-0.02	0.342	0.000
Kobus Magnolia	0.666	1.369	-0.02	0.358	0.000

The spatial-readiness table shows that Sentiment Score is the strongest retained variable. Its Moran's *I* = 0.775, VIF of 1.544, and visitation correlation of 0.26 produce *P_j* = 0.104. This result gives empirical weight to the role of perceived place quality. Red Maple follows closely with *P_j* = 0.098, indicating that a recognisable vegetation variable has both spatial structure and positive visitation alignment. Number of Parks has a higher readiness value

than Park Area, suggesting that distributed access may be more relevant for visible public-life activity than total area alone.

Three variables have positive spatial structure and acceptable VIF values but receive zero visitation-adjusted readiness because their visitation correlations are negative. Tree Height 90–100, Akebono Flowering Cherry, and Kobus Magnolia therefore remain spatially structured variables but do not become positive vitality indicators in this calculation. Their ecological, seasonal, or aesthetic importance may still be substantial; the available visitation associations simply do not support a positive SARSE readiness value.

Table 4. Variables removed by VIF screening.

Variable	VIF status
Number of Trees	> 10
Trunk Diameter 0–61	> 10
Tree Height 20–30	> 10
Trunk Diameter 61–122	> 10
Trunk Diameter 122–183	> 10
Trunk Diameter 183–244	> 10
Trunk Diameter 244–305	> 10

The VIF-screening table explains why some physically meaningful tree variables are not used in the spatial-readiness score. Number of Trees, several trunk-diameter classes, and Tree Height 20–30 exceed the VIF threshold. Their exclusion prevents the calculation from repeatedly rewarding the same underlying vegetation structure through several correlated labels. This makes the retained variables easier to interpret for planning.

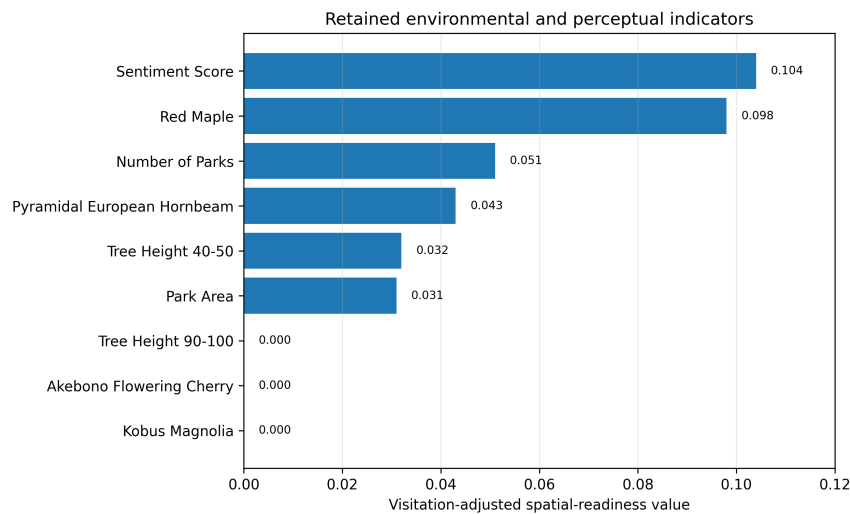


Figure 6. Spatial-readiness values.

The spatial-readiness ranking reinforces the table interpretation. Sentiment Score and Red Maple stand apart from the other retained indicators, while Number of Parks, Pyramidal European Hornbeam, Tree Height 40–50, and Park Area form a lower but still positive group. The zero values at the bottom of the ranking show that spatial clustering alone is not sufficient. Positive visitation alignment is necessary for an indicator to contribute to the SARSE vitality interpretation.

The coupling table identifies the strongest combinations of durable activity and spatially ready environmental support. Urban Elements and Artistic Expression with Sentiment Score has the highest value, $Z_{gj} = 0.265$, followed by the same activity category with Red Maple, $Z_{gj} = 0.249$. Life and Cultural Activities, Street Landscapes and Life Scenes, Natural Landscapes and Greenery, and Urban Built Form and Public Realm also pair strongly with

Sentiment Score and Red Maple. The ordering shows that durable vitality is most strongly connected to perceived quality and recognizable vegetation rather than to park area alone.

Table 5. Highest coupling values.

Activity category	Environmental or perceptual indicator	Z_{gj}
Urban Elements and Artistic Expression	Sentiment Score	0.265
Urban Elements and Artistic Expression	Red Maple	0.249
Life and Cultural Activities	Sentiment Score	0.188
Street Landscapes and Life Scenes	Sentiment Score	0.185
Natural Landscapes and Greenery	Sentiment Score	0.177
Urban Built Form and Public Realm	Sentiment Score	0.170
Life and Cultural Activities	Red Maple	0.177
Street Landscapes and Life Scenes	Red Maple	0.174
Natural Landscapes and Greenery	Red Maple	0.166
Urban Built Form and Public Realm	Red Maple	0.160

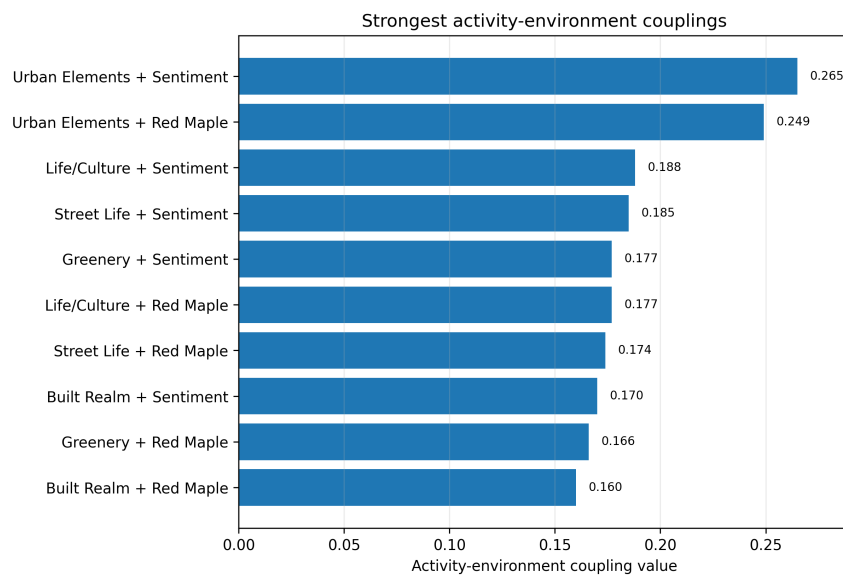


Figure 7. Activity-environment coupling.

It becomes evident from the coupling ranking as well. The leading pairs focus on two indicators: Sentiment Score and Red Maple. Both of them appeared in numerous other categories: Artistic, Cultural, Street Life, Greenery and Public Building categories. One of the implications of the SARSE result is that the most effective nature planning signal is related to the places of durable public activities supported by perceived quality and vegetation.

5. Public-realm interpretation

According to the Vancouver results, the most powerful post-disruption vitality signal was neither the most intense plant-focused surge. The Flowers and Plants category showed the greatest initial shock ratio of 4.26, yet the terminal memory in 2023 dropped to 0.18. It means that the increase in this category represented a surge of documentation rather than long-term change in nature activity. This result has some urban planning implications as a visually impressive nature category can attract many posts even if its vitality is not durable. The seasonal plantings, ornamental display and flowers photography can become interesting subjects, but the planners should ensure a durable activity signal in the future.

At the opposite end of the spectrum, Urban Elements and Artistic Expression demonstrated a lower 2020 shock

ratio but achieved the greatest terminal memory and adaptability score. Such result means that visible urban-realm elements and activities gained increasing importance with time. It is in line with the current urban-design theory that considers meaning and imageability to be critical aspects of urban environment [17, 20]. In Vancouver, the most durable public activity places appear to be recognized, memorable, photographable and revisitable. However, the vegetation level is not sufficient as the factor of activity.

In its turn, Life and Cultural Activities category revealed the social dimension of the SARSE findings. The number of photos increased from 3784 in 2020 to 11,475 in 2023. As a result, this category exceeded the reference condition. This finding is crucial for avoiding the opposition between urban nature and culture. According to the Vancouver evidence, the most vital public life occurs where green or open spaces are complemented by social activities and cultural events. The durable vitality is thus neither purely naturalistic nor commercial and consumerist. It has a complex urban structure combining movement, cultural meaning, social activity and place perception.

The most prominent durable vitality category in a nature perspective is Natural Landscapes and Greenery. The 2023 ratio was 2.81 compared to the reference and A_g reached 1.70. This result differs from the Flowers and Plants case and indicates that the broad landscape experience is more likely to become durable than plant-specific activities. For the planners, this evidence means that the primary nature categories to include are the accessible landscapes and green spaces, green routes, shaded streets, waterfront landscapes and green environments used repeatedly.

Sentiment Score is the second-strongest indicator, which is also critical in nature planning. Quality and positive emotions are often considered as qualitative factors but their SARSE result shows the contrary. The perception-based indicator turned out to be spatially structured and positively correlated with the visits. The finding aligns with the existing literature on the subject because it confirms the role of restorative environment in the development of urban areas [10, 14, 30]. A nice and tree-lined streetscape does not become an attractive place if the pedestrians feel discomfort there because of any reasons.

The Red Maple variable has great significance from the Vancouver-specific perspective. It is the third-strongest indicator that has a significant readiness value. It means that the species has a good combination of spatial structure, low redundancy and positive visitation correlation. Of course, the reason is not exclusively botanical. It may lie in recognition, visibility and seasonality of the species. Trees are experienced in the urban environment not as a uniform quantity but as a set of visible forms, canopy and other features. This interpretation fits the current literature on urban streetscapes and outdoor environments [16, 26].

Another finding with a certain implication for nature planning is the difference between Number of Parks and Park Area variables. Both categories demonstrate the positive readiness. However, Number of Parks has a greater readiness score. The implication is that the park access points may matter in the nature activity as much as total area. Big parks are indeed important for Vancouver as for any other city, but the finer-grained park network can provide daily interaction with green areas in Vancouver neighbourhoods. The finding is confirmed by the current research on urban parks [15, 18].

The performance of the Food and Markets category is not encouraging. Despite initial growth in 2021, the category declined drastically to reach the reference value again in 2023. Several mechanisms can influence the result including changes in tourism and commuting patterns, restaurants' routine and posting. The SARSE calculation does not distinguish these mechanisms but it clearly reveals that consumption-related visible activity is less durable than cultural, artistic, street life-related, greenery-related, urban and traffic-related activity.

Similar example of the late-period dynamics can be seen in Waterfront and Outdoor Recreation Activities category. The category grew substantially in 2022 but came close to its reference level again in 2023. A six-year SARSE record made this result possible while it would be difficult to detect otherwise. The waterfront remained an important category, but its late period dynamics were not as durable as other categories (e.g., artistic expression, cultural activity, street life, greenery, urban building and traffic). Terminal memory is thus an important factor to consider when identifying the post-disruption trends.

The spatial readiness part helps to avoid overinterpretation of environmental variables. Some variables have strong spatial structure but turn out to be negatively correlated with the visits, which means that they cannot become

indicators. Moreover, variables with high VIF values are not included as well. It may look like losing information, but it is helpful because of potential overlapping among the nature variables. For example, tree height and area can be included in the SARSE model but will reflect the same spatial structure. Thus, SARSE includes a limited set of variables.

The most notable spatial variables indicate nature planning priorities. The top pairs include Urban Elements and Artistic Expression, Street Landscapes and Life Scenes, Natural Landscapes and Greenery, Urban Built Form and Public Realm, Traffic and Red Maple, Street Landscapes and Life Scenes and Sentiment Score. This result shows that nature-driven urban vitality takes place at those locations where perception and recognizable vegetation enable social activity. The nature planning policy must therefore pay attention to parks, tree-lined streets and pedestrian routes, cultural activity, and waterfronts.

Figure 8 presents the conclusions of the SARSE analysis in the form of planning recommendations. Nature-led vitality should be assessed as a combination of several variables. Thus, it should be evaluated in terms of connectivity, visibility, cultural visibility, public realm and active urban edges rather than single variables. For Vancouver planners, this implies that nature-led vitality requires a public realm approach in the first place.



Figure 8. Planning interpretation.

Despite the obtained results, the study has several limitations that should be noted. The counts derived from images show only posted and visible activity, not the complete behaviour of every person. Social media users represent an incomplete sample that can be affected by overrepresentation. The review records are also selected by the reviewers themselves. The calculation does not provide causal links or estimation of individual preferences and equity impacts. All that the SARSE provides are structured and time-related associations to interpret.

Future research may consider block-level analyses as well as comparisons of weekly and weekend patterns. It could also identify seasonal dynamics of SARSE values. Future work may differentiate the analysis according to urban types including downtown, waterfronts, residential areas and mixed uses. Variables such as accessibility to transit networks, sidewalks' width and other urban infrastructure characteristics may improve the interpretation. Finally, a longer pre-disruption record would be helpful to disentangle pandemic influences from ordinary variations.

Nevertheless, the current SARSE calculation provides important insight because each value is related to a specific count, autocorrelation score, VIF score and visitation correlation.

6. Conclusions

The present SARSE results showed that the most durable post-disruption vitality was related to broader public-life categories and indicators related to nature perception rather than the strongest plant-focused surge. In particular, the greatest initial shock ratio was shown by the Flowers and Plants category, whose terminal memory fell to 0.18 in 2023. Meanwhile, Urban Elements and Artistic Expression, Life and Cultural Activities, Street Landscapes and Life Scenes, Natural Landscapes and Greenery, Urban Built Form and Public Realm, Traffic, and Green Transportation were the leading durable vitality categories.

The spatial answer turned out to be specific as well. Among the indicators, the strongest signals belong to Sentiment Score and Red Maple, followed by Number of Parks, Pyramidal European Hornbeam, Tree Height 40-50 and Park Area. Overall, it means that the nature-driven Vancouver public vitality is sustained by positive perception, recognizable vegetation, park access, cultural presence, active streets and pedestrian movement. The simple nature quantity is not enough for that purpose.

The principal implication is that nature-led urban vitality requires an integrated public realm approach in planning. Park networks, tree-lined streets and active urban edges, public art and cultural activities, waterfronts and pedestrian connections should be considered together since the most successful vitality categories and most durable spatial indicators are associated.

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