

Feeling Nature: Measuring perceptions of biophilia across global biomes using visual AI

Supplementary Information

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Supplementary Materials

Supplementary Material 1. Place Pulse 2.0 dataset: Formulas and indicators. We converted pairwise comparisons into perceptual rating scores (Q-score), based on Dubey's and Zhang's methodology^{31,33}. For each indicator, we defined the win (W_i) and the loss (L_i) ratios of image i as follows:

$$W_i = \frac{w_i}{w_i + l_i + t_i} \quad (1)$$

$$L_i = \frac{l_i}{w_i + l_i + t_i} \quad (2)$$

where w_i , l_i and t_i represent the times when image i won, lost or equalled its paired image. The perceptual rating score (Q -score) ranging from 0 to 10 for each image i is defined as:

$$W_i = \frac{10}{3} \left(W_i + \frac{1}{w_i} \sum_{j_1=1}^{w_i} W_{j_1} - \frac{1}{l_i} \sum_{j_2=1}^{l_i} L_{j_2} + 1 \right) \quad (3)$$

where j_1 and j_2 denote the total number of images won and lost, respectively. Equation (3) simply corrects an image win ratio (W_i) by adding (or subtracting) the average win (or loss) ratio of the compared image³⁰. Once Q -scores were assigned to Google Street View (GSV) images, we obtained a double dataset of lively-oriented and beautiful-oriented urban perception preferences.

Supplementary Figures

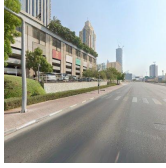
The figure displays six sequential screenshots of the 'Feeling Nature' online survey interface, arranged in a descending staircase pattern. Each screenshot is outlined with a green border.

- Screen 1 (Top):** The title page 'Feeling Nature' with the subtitle 'Measuring Biophilic perception using Visual AI'. It includes a brief introduction, a consent statement, and a 'Start Survey' button. Logos for ECPHS, TU Delft, and MIT are visible at the bottom.
- Screen 2:** A prerequisite question: '1) Have you lived in one of these cities for at least 1 year?'. It lists eight cities: Amsterdam, Barcelona, Buenos Aires, Dubai, Nairobi, Quebec City, Singapore, and Stockholm, each with a radio button for selection. A 'Next' button is at the bottom.
- Screen 3:** A pairwise comparison question: '2) Which image brings you more positive feelings?'. It shows two side-by-side street scene images. Below each image is a radio button labeled 'Left' and 'Right'.
- Screen 4:** Another pairwise comparison question: '3) Which image brings you more positive feelings?'. It shows a single image of a street scene. Below it is a text input field for comments and a 'Next' button.
- Screen 5:** Demographic questions. Question 4 asks for age group with radio buttons for '< 18', '18-24', '25-34', '35-44', '45-54', '55-64', and '65+'. Question 5 asks for gender with radio buttons for 'Male', 'Female', and 'Prefer not to answer'. A 'Next' button is at the bottom.
- Screen 6 (Bottom):** A 'Thank you for your participation!' message. It includes a 'Next Page' button and a form for optional contact information (Name, Email, Phone) with a 'Submit' button.

Supplementary Fig. 1. Feeling Nature survey. This image depicts six distinct screens comprising the online survey Feeling Nature (accessible at <https://feeling-nature-survey.vercel.app/>). The first screen presents participants with the project details, subject matter, objectives and scope, along with a concise informed consent statement required for all users before proceeding to the subsequent questionnaire. It also offers language switch options and acknowledges the research partners supporting the project (TU Delft, MIT), which is funded by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 101026318. The second frame displays the prerequisite question for selecting the city case and accessing the survey. The third and fourth pages include pivotal survey questions designed to gather data on biophilic perceptions (BP) across the eight city cases. Participants were asked to make image selections from six pairwise comparisons and provide comments on their preferences in the related comment box that follows. The fifth frame concludes the survey by requesting participants to provide personal information such as their age and gender. The final page provides acknowledgements and contact information for the survey authors.

Q2 a/b (Top Lively)

Li ∈ TL



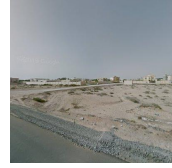
Ri ∈ TL



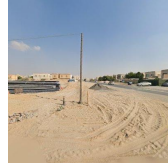
+

Q3 a/b (Bottom Lively)

Li ∈ BL



Ri ∈ BL



LEGEND

2 Feelings:

L = Lively

B = Beautiful

4 Subfolders of images resulting from MIT Pulse Place 2.0:

TP = Top Lively

BL = Bottom Lively

TB = Top Beautiful

BB = Bottom Beautiful

Other references:

i = Google Street View image related to the specific city case

Li = Left image

Ri = Right image

∈ = coming from the related 'XX' subfolder

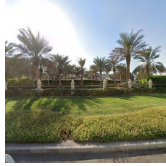
M = mixed pair based on a fixed order

(Q6 a/b, Li comes from TL, and Ri comes from BL)

(Q7 a/b, Li comes from TB, and Ri comes from BB)

Q4 a/b (Top Beautiful)

Li ∈ TB



Ri ∈ TB



+

Q5 a/b (Bottom Beautiful)

Li ∈ BB



Ri ∈ BB



Q6 a/b (M=Top/Bottom Lively)

Li ∈ TL



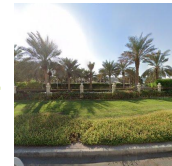
Ri ∈ BL



+

Q7 a/b (M=Top/Bottom Beautiful)

Li ∈ TB

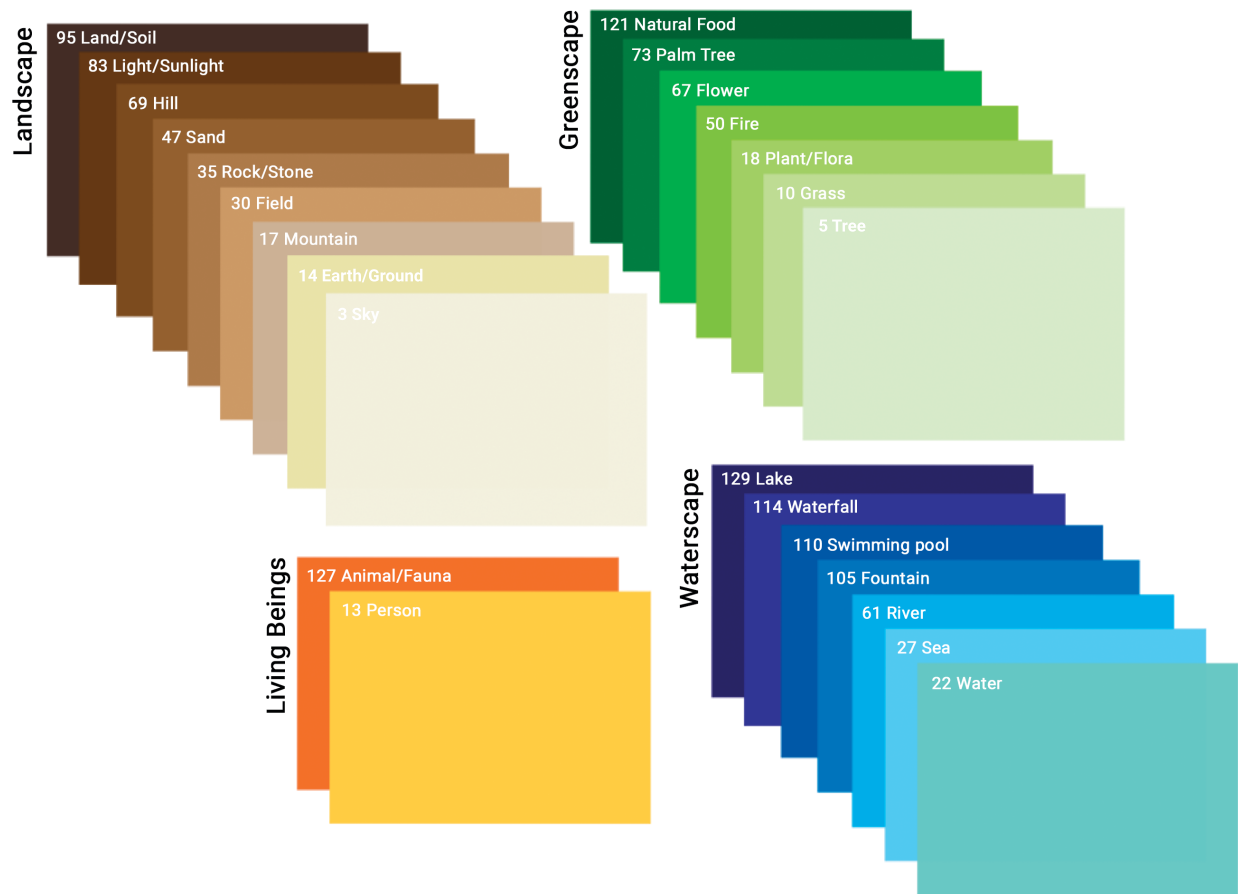


Ri ∈ BB

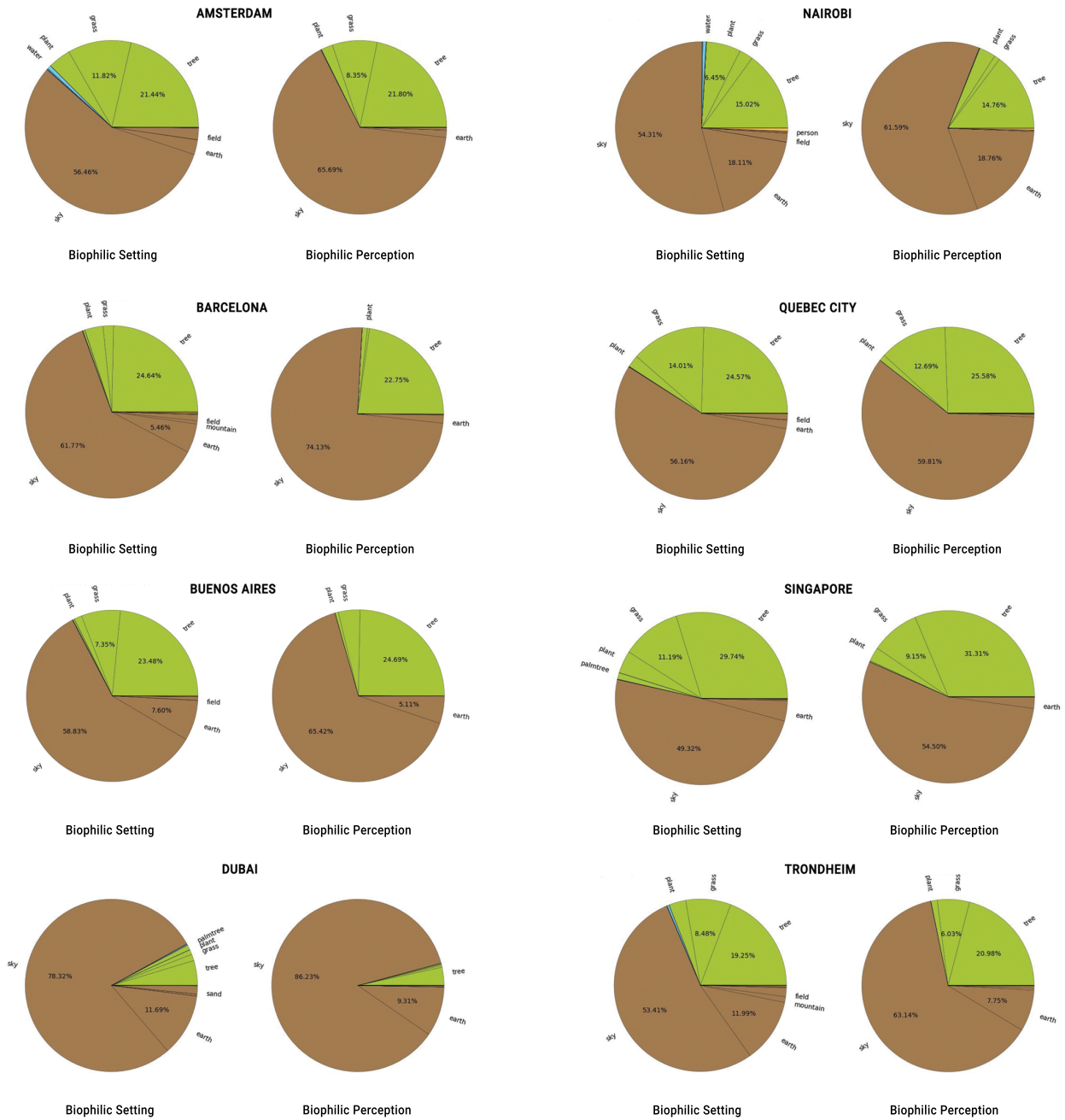


Supplementary Fig. 2. Feeling Nature survey, image comparison design. We outline the rationale behind the sequence of six pairwise comparisons presented in the core survey. Although the images may appear random to participants, each image on the right and left is selected from a specific subset containing images generated from the Pulse Place 2.0 dataset. These images represent the highest 5% of scores in 'lively' and 'beautiful' perception preferences, as well as the lowest 5% of scores in these categories. The paired images in each selection were automatically chosen from the four subsets of 'top' or 'bottom' for lively and beautiful perceptions and presented in a predetermined sequence of 'left vs. right' combinations based on the following order: Q2 - 'Top vs. Top - Lively'; Q3 - 'Bottom vs. Bottom - Lively'; Q4 - 'Top vs. Top - Beautiful'; Q5 - 'Bottom vs. Bottom - Beautiful'; Q6 - 'Top vs. Bottom - Lively'; Q7 - 'Top vs. Bottom - Beautiful'. The figure provides further details on the Feeling Nature survey design.

25 Biophilic Classes



Supplementary Fig. 3. Biophilic classes. Within the Dense Prediction Transformer (DPT) model, which classifies, detects and segments images of urban settings by labelling each pixel based on 150 semantic classes, we identified 25 biophilic classes (BC). These classes encompass nature-based features or elements, as well as living beings. This figure illustrates how we grouped the 25 BC into four main biophilic categories of cityscapes: greenscape (tree, grass, plant/flora, fire, flower, palm tree, natural food); landscape (sky, earth/ground, mountain, field, rock/stone, sand, hill, light/sunlight, land/soil); waterscape (water, sea, river, fountain, swimming pool, waterfall, lake); living beings (person, animal/fauna). The DPT model can only recognise visible elements via pixels. Therefore, three of the four natural elements were present as BC and included in a distinct category. Fire, considered a living natural element traditionally associated with greenery, was embodied in the greenspace category.



Supplementary Fig. 4. BS and BP by diversity including biophilic ‘sky’ class. This figure presents the complete results for biophilic settings (BS) diversity and biophilic perceptions (BP) diversity calculated for all 25 BC. The pie charts show the relative prevalence of the specific BC across the eight case studies, with BS diversity on the left side and BP diversity on the right side. ‘Sky’ emerges as the predominant BC due to its disproportionate number of pixels in each GSV image processed via DPT, overshadowing the genuine diversity among the other BC illustrated in Fig. 3 in the main article.

Supplementary Tables

Supplementary Table 1. Global biome classification. This table summarises sources referring to global geographical classification, such as life zones, biomes (or biome-types, zonobiomes), ecosystems (or ecozones) and domains, from 1947 to 2020. In addition to literature sources, interactive maps issued by National Geographic and NASA are also included. Grey columns highlight all sources that explicitly classify the globe through biomes, ranging from a minimum of 7 to a maximum of 17 biomes. Based on this review, we selected eight terrestrial biomes that are highly urbanised and commonly found in various classifications, along with eight city cases representing each biome.

City	BIOMES													
	Major Terrestrial Biomes	Sources												
		Literature										Interactive Maps		
		1967 Holdridge 36 Life zones	1967 Allen 7 Biome types	1981 Holdridge 9 Biomes	1982 Whitaker 9 Biomes	1984 Goodall 16 Terrestrial Ecosystems	1978 Walter 9 Zonobiomes	1988 Schultz 9 Ecoregions	1989 Bailey 4 Domains	1992 Penland 17 Biomes	2001 Olson & Dinerstein 14 Terrestrial Biomes	2008 Forman 8 Terrestrial Biomes	2019 National Geographic 14 Biomes	2020 NASA 7 Biomes
Amsterdam	F O R E S T	Cool temperate moist forest Cool temperate wet forest Cool temperate rain forest Warm temperate dry forest Warm temperate moist forest Warm temperate wet forest Warm temperate rain forest	Deciduous Forest	Temperate Deciduous Forest	Temperate Rainforest Temperate Seasonal Forest	Temperate Deciduous Forests Temperate Broad-Leaved Evergreen Forests West Coastal Ecosystems Dry Coastal Ecosystems	Warm temperate Humid	Humid mid-latitudes	Humid Temperate Domain	Temperate Deciduous Forest Cold deciduous forest Broad-leaved evergreen / warm mixed forest	Temperate Broadleaf & Mixed Forests Temperate Coniferous Forests	Temperate Deciduous Forest	Temperate Broadleaf & Mixed Forests Temperate Coniferous Forests	Temperate Deciduous Forest
Singapore		Tropical dry forest Tropical moist forest Tropical wet forest Tropical rain forest Subtropical dry forest Subtropical moist forest Subtropical wet forest Subtropical rain forest	Tropical Forest	Tropical Forest	Tropical Rainforest Tropical Seasonal Forest/Savanna	Tropical Rain Forest Ecosystems Wetland Forests Marsh, Swamp, Bog, Fen, Moor	Tropical Equatorial	Tropics with winter rain Tropics with winter rain Subtropics with winter rain	Humid Tropical Domain	Tropical Rainforest Tropical Seasonal Forest Tropical Dry Forest/Savanna	Tropical & Subtropical Coniferous Forests Tropical & Subtropical Dry Broadleaf Forests Tropical & Subtropical Moist Broadleaf Forests Mangroves	Tropical Forest	Tropical & Subtropical Coniferous Forests Tropical & Subtropical Dry Broadleaf Forests Tropical & Subtropical Moist Broadleaf Forests Mangroves	Rainforest
Quebec		Boreal dry scrub Boreal moist forest Boreal wet forest Boreal rain forest	Taiga	Woodland Coniferous Forest	Boreal Forest	Coniferous Forests	Boreal	Boreal zone	Cool conifer forest Cool mixed forest Taiga	Boreal Forests/Taiga	Northern Coniferous Forest	Boreal Forests/Taiga	Coniferous Forests	
Barcelona		G R A S S L A N D	Warm temperate desert scrub Warm temperate thorn scrub	Chaparral	Woodland/ Shrubland	Mediterranean-Type Shrublands Mediterranean and Related Shrublands	Mediterranean	Dry mid-latitudes	Humid Temperate Domain	Xerophytic woods/shrub	Mediterranean Forests, Woodlands & Scrub	Mediterranean	Mediterranean Forests, Woodlands & Scrub	
Buenos Aires	Tropical thorn woodland Subtropical thorn woodland		Grassland	Grassland	Temperate Grassland/ Cold Desert	Natural Grasslands	Continental	Warm grass/shrub	Temperate Grasslands, Savanna & Shrublands	Grassland	Temperate Grasslands, Savanna & Shrublands	Grassland		
Nairobi	Tropical desert scrub Subtropical desert scrub		Tropical Savanna	Tropical Savanna	Tropical Savannas	Dry tropics and subtropics	Dry Domain	Savanna	Tropical & Subtropical Grasslands, Savanna & Shrublands	Savanna	Tropical & Subtropical Grasslands, Savanna & Shrublands	Shrublands		
Dubai	D E S E R T	Warm temperate desert Tropical desert Subtropical desert	Desert	Desert	Subtropical Desert	Temperate Deserts/Desert Hot Deserts and Arid Shrublands	Subtropical	Hot desert	Deserts & Xeric Shrublands	Deserts	Deserts & Xeric Shrublands	Desert		
Trondheim		Subpolar dry tundra Subpolar moist tundra Subpolar wet tundra Subpolar rain tundra Cool temperate desert scrub	Tundra	Tundra	Tundra	Polar and Alpine Tundra	Polar	Polar/ Subpolar zone	Polar Domain	Tundra Cool grass/shrub	Tundra	Tundra	Tundra	

Supplementary Table 2. Feeling Nature survey participant data. This table provides an overview of participant data from the Feeling Nature survey, organised by city. It includes the amount of gathered and evaluated feedback, distinctions between native language and English inputs, as well as age- and gender-based groups.

		Case Studies							
		Amsterdam	Barcelona	Buenos Aires	Dubai	Nairobi	Quebec City	Singapore	Trondheim
Feedback Final No		52	69	52	55	57	59	59	61
Evaluated Feedback No		50	50	50	50	50	50	50	50
Native Language Feedback		1 (Dutch)	5 (Spanish)	21 (Spanish)	0	50 (English)	9 (French)	50 (English)	3 (Norsk)
English Feedback		49	45	29	50	50	41	50	47
Age	18-25	14	6	4	21	9	8	11	19
	26-40	30	29	30	20	31	25	30	21
	41-55	5	12	11	8	8	14	8	9
	>55	1	3	5	1	2	3	1	1
Gender	Male	15	22	21	21	21	25	18	27
	Female	32	24	27	28	28	25	30	23
	Other	2	1	1	0	0	0	0	0
	Prefer not to answer	1	3	1	1	1	0	2	0

Supplementary Table 3. BS and BP by intensity and coverage. This table provides an overview of the results obtained from DPT image modelling. These results include normalised and non-normalised values for intensity and coverage related to BS and BP for each city.

				AMSTERDAM				
					All GSV Images		All GSV Images	
					Biophilic Setting	Biophilic Perception	Biophilic Setting	Biophilic Perception
					INTENSITY	COVERAGE Unweighted	COVERAGE Weighted	COVERAGE Unweighted Norm
Prog No	Class No	Class Category	Label					
1	5	Greenscape	Tree	0.825174825	0.113914683	0.093999528	0.379643727	0.331836739
2	10	Greenscape	Grass	0.573426573	0.062797928	0.036010001	0.209286801	0.127122353
3	18	Greenscape	Plant/Flora	0.41958042	0.022509584	0.009444581	0.075017741	0.033341218
4	50	Greenscape	Fire	0	9.66E-09	0	3.22E-08	0
5	67	Greenscape	Flower	0	3.89E-05	0	1.30E-04	0
6	73	Greenscape	Palmtree	0	6.90E-06	0	2.30E-05	0
7	121	Greenscape	Natural Food	0	6.47E-07	0	2.16E-06	0
8	22	Waterscape	Water	0.104895105	0.003600046	0.000377627	0.01199788	0.001333098
9	27	Waterscape	Sea	0.020979021	3.55E-04	7.44E-06	1.18E-03	2.63E-05
10	61	Waterscape	River	0.055944056	0.000807328	4.52E-05	2.69E-03	1.59E-04
11	105	Waterscape	Fountain	0	1.64E-05	0	5.46E-05	0
12	110	Waterscape	Swimming Pool	0	5.27E-06	0	1.76E-05	0
13	114	Waterscape	Waterfall	0	5.11E-06	0	1.70E-05	0
14	129	Waterscape	Lake	0.020979021	0.000408907	8.58E-06	1.36E-03	3.03E-05
15	3	Landscape	Sky	0.944055944	0.300056803	0.283270408	1	1
16	14	Landscape	Earth/Ground	0.405594406	0.014559335	0.005905185	0.048521929	0.020846458
17	17	Landscape	Mountain	0.055944056	0.000197191	1.10E-05	0.00065718	3.89E-05
18	30	Landscape	Field	0.181818182	0.011573185	0.002104216	0.038569982	0.007428293
19	35	Landscape	Rock/Stone	0.013986014	4.83E-05	6.75E-07	0.000160828	2.38E-06
20	47	Landscape	Sand	0	4.06E-05	0	0.000135257	0
21	69	Landscape	Hill	0	7.42E-05	0	2.47E-04	0
22	83	Landscape	Light/Sunlight	0.013986014	8.39E-06	1.17E-07	2.80E-05	4.14E-07
23	95	Landscape	Land/Soil	0.013986014	4.54E-06	6.34E-08	1.51E-05	2.24E-07
24	13	Living Being	Person	0.125874126	0.000404906	5.10E-05	0.00134943	0.000179924
25	127	Living Being	Animal/Fauna	0	6.07E-06	0	2.02E-05	

BARCELONA								
					All GSV Images		All GSV Images	
					Biophilic Setting	Biophilic Perception	Biophilic Setting	Biophilic Perception
					INTENSITY	COVERAGE Unweighted	COVERAGE Unweighted Norm	COVERAGE Weighted Norm
Prog No	Class No	Class Category	Label					
1	5	Greenscape	Tree	0.687022901	0.100787071	0.069243026	0.398867379	0.306821061
2	10	Greenscape	Grass	0.145038168	0.008060027	0.001169012	0.031897762	0.005179978
3	18	Greenscape	Plant/Flora	0.213740458	0.01412286	0.003018626	0.055891574	0.013375761
4	50	Greenscape	Fire	0	1.09E-07	0	4.33E-07	0
5	67	Greenscape	Flower	0	1.49E-05	0	5.89E-05	0
6	73	Greenscape	Palmtree	0.053435115	0.001535939	8.21E-05	0.006078518	0.000363672
7	121	Greenscape	Natural Food	0	1.42E-06	0	5.60E-06	0
8	22	Waterscape	Water	0.015267176	2.55E-04	3.89E-06	0.001009427	1.73E-05
9	27	Waterscape	Sea	0.007633588	5.55E-05	4.24E-07	2.20E-04	1.88E-06
10	61	Waterscape	River	0	6.72E-06	0	2.66E-05	0.00E+00
11	105	Waterscape	Fountain	0.007633588	1.97E-05	1.51E-07	7.81E-05	6.68E-07
12	110	Waterscape	Swimming Pool	0	6.06E-06	0	2.40E-05	0
13	114	Waterscape	Waterfall	0.007633588	4.81E-06	3.67E-08	1.90E-05	1.63E-07
14	129	Waterscape	Lake	0	2.91E-06	0.00E+00	1.15E-05	0.00E+00
15	3	Landscape	Sky	0.893129771	0.252683163	0.225678856	1	1
16	14	Landscape	Earth/Ground	0.20610687	0.022349174	0.004606318	0.088447421	0.020410943
17	17	Landscape	Mountain	0.053435115	0.002454791	1.31E-04	0.009714896	5.81E-04
18	30	Landscape	Field	0.030534351	0.004691207	1.43E-04	0.018565571	0.00063472
19	35	Landscape	Rock/Stone	0.007633588	6.83E-05	5.22E-07	0.000270437	2.31E-06
20	47	Landscape	Sand	0	5.33E-05	0	0.000210775	0
21	69	Landscape	Hill	0.022900763	0.001150201	2.63E-05	4.55E-03	1.17E-04
22	83	Landscape	Light/Sunlight	0.022900763	6.51E-06	1.49E-07	2.58E-05	6.61E-07
23	95	Landscape	Land/Soil	0.007633588	9.08E-06	6.93E-08	3.59E-05	3.07E-07
24	13	Living Being	Person	0.435114504	0.000724479	0.000315231	0.002867143	0.001396813
25	127	Living Being	Animal/Fauna	0	1.12E-06	0	4.45E-06	0

				BUENOS AIRES				
					All GSV Images		All GSV Images	
					Biophilic Setting	Biophilic Perception	Biophilic Setting	Biophilic Perception
					INTENSITY	COVERAGE Unweighted	COVERAGE Weighted	COVERAGE Unweighted Norm
Prog No	Class No	Class Category	Label					
1	5	Greenscape	Tree	0.938461538	0.120878964	0.113440259	0.39909747	0.377441018
2	10	Greenscape	Grass	0.492307692	0.037865168	0.018641313	0.125016729	0.062023803
3	18	Greenscape	Plant/Flora	0.376923077	0.007655483	0.002885528	0.025275562	0.009600795
4	50	Greenscape	Fire	0	5.51E-08	0	1.82E-07	0
5	67	Greenscape	Flower	0	6.40E-06	0	2.11E-05	0
6	73	Greenscape	Palmtree	0.069230769	0.001453341	0.000100616	0.004798394	0.000334772
7	121	Greenscape	Natural Food	0	2.84E-06	0	9.38E-06	0
8	22	Waterscape	Water	0.015384615	0.000448005	6.89E-06	0.001479145	2.29E-05
9	27	Waterscape	Sea	0.015384615	2.54E-05	3.91E-07	8.40E-05	1.30E-06
10	61	Waterscape	River	0	1.11E-05	0	3.66E-05	0.00E+00
11	105	Waterscape	Fountain	0	5.28E-06	0	1.74E-05	0
12	110	Waterscape	Swimming Pool	0	9.68E-07	0	3.19E-06	0
13	114	Waterscape	Waterfall	0	2.62E-06	0	8.66E-06	0
14	129	Waterscape	Lake	0	7.16E-06	0.00E+00	2.36E-05	0.00E+00
15	3	Landscape	Sky	0.992307692	0.302880808	0.300550956	1	1
16	14	Landscape	Earth/Ground	0.6	0.039146458	0.023487875	0.129247075	0.078149394
17	17	Landscape	Mountain	0.053846154	0.000364049	1.96E-05	0.001201955	6.52E-05
18	30	Landscape	Field	0.046153846	0.003225249	1.49E-04	0.010648574	0.000495283
19	35	Landscape	Rock/Stone	0.007692308	1.48E-04	1.14E-06	0.000487306	3.78E-06
20	47	Landscape	Sand	0.023076923	3.88E-05	8.94E-07	0.000127948	2.98E-06
21	69	Landscape	Hill	0.007692308	3.26E-05	2.50E-07	1.07E-04	8.33E-07
22	83	Landscape	Light/Sunlight	0	6.37E-07	0.00E+00	2.10E-06	0.00E+00
23	95	Landscape	Land/Soil	0	2.38E-06	0.00E+00	7.86E-06	0.00E+00
24	13	Living Being	Person	0.253846154	0.00065907	0.000167302	0.002176004	0.000556652
25	127	Living Being	Animal/Fauna	0	8.27E-06	0	2.73E-05	0

				DUBAI				
					All GSV Images		All GSV Images	
					Biophilic Setting	Biophilic Perception	Biophilic Setting	Biophilic Perception
Prog No	Class No	Class Category	Label					
1	5	Greenscape	Tree	0.644927536	0.023172846	0.014944806	0.059589947	0.039578397
2	10	Greenscape	Grass	0.253623188	0.006000831	0.00152195	0.015431388	0.004030586
3	18	Greenscape	Plant/Flora	0.217391304	0.004583981	0.000996518	0.011787901	0.002639082
4	50	Greenscape	Fire	0	4.71E-09	0	1.21E-08	0
5	67	Greenscape	Flower	0.02173913	5.95E-05	1.29E-06	1.53E-04	3.43E-06
6	73	Greenscape	Palmtree	0.166666667	0.004676903	0.000779484	0.012026853	0.002064311
7	121	Greenscape	Natural Food	0	3.08E-07	0	7.92E-07	0
8	22	Waterscape	Water	0.043478261	0.000535842	2.33E-05	0.00137794	6.17E-05
9	27	Waterscape	Sea	0.065217391	7.03E-04	4.58E-05	1.81E-03	1.21E-04
10	61	Waterscape	River	0	1.34E-05	0	3.45E-05	0.00E+00
11	105	Waterscape	Fountain	0	1.76E-05	0	4.53E-05	0
12	110	Waterscape	Swimming Pool	0	2.30E-05	0	5.91E-05	0
13	114	Waterscape	Waterfall	0	4.80E-07	0	1.24E-06	0
14	129	Waterscape	Lake	0	6.77E-06	0.00E+00	1.74E-05	0.00E+00
15	3	Landscape	Sky	0.971014493	0.388871736	0.377600092	1	1
16	14	Landscape	Earth/Ground	0.702898551	0.058023427	0.040784582	0.149209678	0.108009991
17	17	Landscape	Mountain	0.050724638	0.000121855	6.18E-06	0.000313354	1.64E-05
18	30	Landscape	Field	0.079710145	0.001727512	0.0001377	0.004442369	0.000364672
19	35	Landscape	Rock/Stone	0.014492754	6.29E-05	9.12E-07	0.000161798	2.41E-06
20	47	Landscape	Sand	0.137681159	0.00748087	0.001029975	0.019237372	2.73E-03
21	69	Landscape	Hill	0.028985507	8.74E-05	2.53E-06	2.25E-04	6.71E-06
22	83	Landscape	Light/Sunlight	0.014492754	1.31E-05	1.90E-07	3.37E-05	5.03E-07
23	95	Landscape	Land/Soil	0.014492754	3.13E-05	4.53E-07	8.04E-05	1.20E-06
24	13	Living Being	Person	0.166666667	0.000285537	4.76E-05	0.00073427	0.000126031
25	127	Living Being	Animal/Fauna	0	3.41E-06	0	8.77E-06	

				NAIROBI				
					All GSV Images		All GSV Images	
					Biophilic Setting	Biophilic Perception	Biophilic Setting	Biophilic Perception
					INTENSITY	COVERAGE Unweighted	COVERAGE Unweighted Norm	COVERAGE Weighted Norm
Prog No	Class No	Class Category	Label					
1	5	Greenscape	Tree	0.846153846	0.09397635	0.07951845	0.276654813	0.239622279
2	10	Greenscape	Grass	0.353846154	0.016195575	0.005730742	0.047677782	0.017269118
3	18	Greenscape	Plant/Flora	0.415384615	0.040335784	0.016754864	0.118743584	0.050489398
4	50	Greenscape	Fire	0	3.06E-08	0	9.01E-08	0
5	67	Greenscape	Flower	0	3.20E-05	0	9.41E-05	0
6	73	Greenscape	Palmtree	0.053846154	0.000711402	3.83E-05	0.002094281	0.000115433
7	121	Greenscape	Natural Food	0.030769231	7.56E-05	2.33E-06	2.23E-04	7.01E-06
8	22	Waterscape	Water	0.153846154	0.00349958	0.000538397	0.010302333	0.001622415
9	27	Waterscape	Sea	0.023076923	6.44E-04	1.49E-05	1.89E-03	4.48E-05
10	61	Waterscape	River	0.023076923	0.000244796	5.65E-06	7.21E-04	1.70E-05
11	105	Waterscape	Fountain	0.007692308	3.24E-05	2.49E-07	9.55E-05	7.52E-07
12	110	Waterscape	Swimming Pool	0	2.00E-05	0	5.90E-05	0
13	114	Waterscape	Waterfall	0	5.08E-06	0	1.50E-05	0
14	129	Waterscape	Lake	0.015384615	6.00E-05	9.22E-07	1.77E-04	2.78E-06
15	3	Landscape	Sky	0.976923077	0.339688109	0.331849153	1	1
16	14	Landscape	Earth/Ground	0.892307692	0.113263119	0.101065552	0.333432686	0.304552689
17	17	Landscape	Mountain	0.084615385	0.000370872	3.14E-05	0.001091802	9.46E-05
18	30	Landscape	Field	0.130769231	0.010057232	0.001315177	0.029607254	0.003963176
19	35	Landscape	Rock/Stone	0.046153846	5.87E-04	2.71E-05	0.001727358	8.16E-05
20	47	Landscape	Sand	0.069230769	0.001752392	0.000121319	0.005158825	3.66E-04
21	69	Landscape	Hill	0.030769231	0.000226229	6.96E-06	6.66E-04	2.10E-05
22	83	Landscape	Light/Sunlight	0	2.31E-07	0.00E+00	6.81E-07	0.00E+00
23	95	Landscape	Land/Soil	0.023076923	4.63E-05	1.07E-06	1.36E-04	3.22E-06
24	13	Living Being	Person	0.492307692	0.003582393	0.00176364	0.010546124	0.005314582
25	127	Living Being	Animal/Fauna	0.015384615	6.94E-05	1.07E-06	2.04E-04	3.22E-06

				QUEBEC CITY				
				All GSV Images			All GSV Images	
				Biophilic Setting	Biophilic Perception		Biophilic Setting	Biophilic Perception
INTENSITY	COVERAGE Unweighted	COVERAGE Weighted	COVERAGE Unweighted Norm	COVERAGE Weighted Norm				
Prog No	Class No	Class Category	Label					
1	5	Greenscape	Tree	0.95620438	0.143598973	0.137309967	0.43748002	0.427685692
2	10	Greenscape	Grass	0.832116788	0.081872899	0.068127814	0.249429066	0.212200847
3	18	Greenscape	Plant/Flora	0.481751825	0.013472295	0.006490302	0.041043885	0.020215645
4	50	Greenscape	Fire	0	1.72E-09	0	5.25E-09	0
5	67	Greenscape	Flower	0	4.58E-05	0	1.39E-04	0
6	73	Greenscape	Palmtree	0.00729927	2.14E-06	1.56E-08	6.51E-06	4.86E-08
7	121	Greenscape	Natural Food	0	1.25E-07	0.00E+00	3.79E-07	0.00E+00
8	22	Waterscape	Water	0.02919708	0.000313562	9.16E-06	0.00095528	2.85E-05
9	27	Waterscape	Sea	0.03649635	1.26E-04	4.60E-06	3.84E-04	1.43E-05
10	61	Waterscape	River	0	1.79E-05	0.00E+00	5.47E-05	0.00E+00
11	105	Waterscape	Fountain	0	3.75E-06	0.00E+00	1.14E-05	0.00E+00
12	110	Waterscape	Swimming Pool	0	1.09E-07	0	3.31E-07	0
13	114	Waterscape	Waterfall	0	1.80E-06	0	5.47E-06	0
14	129	Waterscape	Lake	0	8.87E-06	0.00E+00	2.70E-05	0.00E+00
15	3	Landscape	Sky	0.97810219	0.328241214	0.32105345	1	1
16	14	Landscape	Earth/Ground	0.284671533	0.009364155	0.002665708	0.028528273	0.008303005
17	17	Landscape	Mountain	0.109489051	0.000394415	4.32E-05	0.001201602	1.35E-04
18	30	Landscape	Field	0.160583942	0.00652011	0.001047025	0.019863776	0.003261217
19	35	Landscape	Rock/Stone	0	1.39E-04	0.00E+00	0.000424475	0.00E+00
20	47	Landscape	Sand	0	1.24E-05	0	3.77E-05	0.00E+00
21	69	Landscape	Hill	0.01459854	2.00E-04	2.91E-06	6.08E-04	9.07E-06
22	83	Landscape	Light/Sunlight	0	6.45E-07	0.00E+00	1.96E-06	0.00E+00
23	95	Landscape	Land/Soil	0.00729927	4.34E-06	3.17E-08	1.32E-05	9.86E-08
24	13	Living Being	Person	0.109489051	0.000102487	1.12E-05	0.000312229	3.50E-05
25	127	Living Being	Animal/Fauna	0	1.56E-06	0.00E+00	4.75E-06	0.00E+00

				SINGAPORE				
					All GSV Images		All GSV Images	
					Biophilic Setting	Biophilic Perception	Biophilic Setting	Biophilic Perception
					INTENSITY	COVERAGE Unweighted	COVERAGE Weighted	COVERAGE Unweighted Norm
Prog No	Class No	Class Category	Label					
1	5	Greenscape	Tree	0.864285714	0.16226175	0.140240512	0.603089191	0.574596788
2	10	Greenscape	Grass	0.671428571	0.061024051	0.040973291	0.226812206	0.167876751
3	18	Greenscape	Plant/Flora	0.521428571	0.023139162	0.01206542	0.086002885	0.049434729
4	50	Greenscape	Fire	0	7.32E-08	0	2.72E-07	0
5	67	Greenscape	Flower	0.014285714	5.27E-05	7.53E-07	1.96E-04	3.09E-06
6	73	Greenscape	Palmtree	0.142857143	0.006631138	0.000947305	0.024646397	0.003881322
7	121	Greenscape	Natural Food	0	2.65E-06	0	9.85E-06	0
8	22	Waterscape	Water	0.014285714	0.000396732	5.67E-06	0.001474559	2.32E-05
9	27	Waterscape	Sea	0.021428571	6.19E-05	1.33E-06	2.30E-04	5.43E-06
10	61	Waterscape	River	0	8.35E-06	0	3.10E-05	0.00E+00
11	105	Waterscape	Fountain	0	1.64E-05	0	6.08E-05	0
12	110	Waterscape	Swimming Pool	0.007142857	2.86E-06	2.04E-08	1.06E-05	8.36E-08
13	114	Waterscape	Waterfall	0	2.48E-06	0	9.22E-06	0
14	129	Waterscape	Lake	0	5.17E-06	0.00E+00	1.92E-05	0.00E+00
15	3	Landscape	Sky	0.907142857	0.269051	0.244067693	1	1
16	14	Landscape	Earth/Ground	0.457142857	0.020714755	0.009469602	0.076991926	0.038799081
17	17	Landscape	Mountain	0.042857143	0.000318767	1.37E-05	0.001184782	5.60E-05
18	30	Landscape	Field	0.042857143	0.001229877	5.27E-05	0.004571167	0.000215961
19	35	Landscape	Rock/Stone	0.028571429	1.23E-04	3.52E-06	0.000458022	1.44E-05
20	47	Landscape	Sand	0.021428571	0.000105783	2.27E-06	0.000393169	9.29E-06
21	69	Landscape	Hill	0.014285714	1.28E-04	1.82E-06	4.74E-04	7.47E-06
22	83	Landscape	Light/Sunlight	0.078571429	1.79E-05	1.41E-06	6.65E-05	5.76E-06
23	95	Landscape	Land/Soil	0	2.83E-06	0.00E+00	1.05E-05	0.00E+00
24	13	Living Being	Person	0.078571429	0.000259362	2.04E-05	0.000963988	8.35E-05
25	127	Living Being	Animal/Fauna	0	5.23E-06	0	1.94E-05	

					TRONDHEIM				
					All GSV Images		All GSV Images		
					Biophilic Setting	Biophilic Perception	Biophilic Setting	Biophilic Perception	
					INTENSITY	COVERAGE Unweighted	COVERAGE Weighted	COVERAGE Unweighted Norm	COVERAGE Weighted Norm
Prog No	Class No	Class Category	Label						
1	5	Greenscape	Tree	0.867647059	0.122158819	0.10599074	0.360393123	0.33223741	
2	10	Greenscape	Grass	0.566176471	0.053813377	0.030467868	0.158760301	0.095504244	
3	18	Greenscape	Plant/Flora	0.301470588	0.020191006	0.006086995	0.059567536	0.019080226	
4	50	Greenscape	Fire	0	0	0	0.00E+00	0	
5	67	Greenscape	Flower	0.007352941	0.000112833	8.30E-07	3.33E-04	2.60E-06	
6	73	Greenscape	Palmtree	0.014705882	4.13E-06	6.08E-08	1.22E-05	1.91E-07	
7	121	Greenscape	Natural Food	0	3.78E-07	0	1.11E-06	0	
8	22	Waterscape	Water	0.051470588	0.002186801	0.000112556	0.006451504	3.53E-04	
9	27	Waterscape	Sea	0.066176471	6.49E-04	4.30E-05	1.92E-03	1.35E-04	
10	61	Waterscape	River	0.007352941	0.000119204	8.77E-07	3.52E-04	2.75E-06	
11	105	Waterscape	Fountain	0	6.41E-06	0	1.89E-05	0	
12	110	Waterscape	Swimming Pool	0	2.72E-06	0	8.03E-06	0	
13	114	Waterscape	Waterfall	0	7.61E-06	0	2.24E-05	0	
14	129	Waterscape	Lake	0.014705882	6.62E-05	9.73E-07	1.95E-04	3.05E-06	
15	3	Landscape	Sky	0.941176471	0.338959905	0.319021087	1	1	
16	14	Landscape	Earth/Ground	0.514705882	0.076113785	0.039176213	0.224550999	0.122801328	
17	17	Landscape	Mountain	0.308823529	0.006794791	2.10E-03	0.020046002	6.58E-03	
18	30	Landscape	Field	0.176470588	0.010490043	0.001851184	0.030947739	0.005802701	
19	35	Landscape	Rock/Stone	0.044117647	9.06E-04	4.00E-05	0.002674162	1.25E-04	
20	47	Landscape	Sand	0.022058824	0.000246119	5.43E-06	0.000726101	1.70E-05	
21	69	Landscape	Hill	0.198529412	0.001571705	0.00031203	4.64E-03	9.78E-04	
22	83	Landscape	Light/Sunlight	0.051470588	1.31E-05	6.72E-07	3.85E-05	2.11E-06	
23	95	Landscape	Land/Soil	0.014705882	6.29E-05	9.26E-07	1.86E-04	2.90E-06	
24	13	Living Being	Person	0.102941176	0.000146849	1.51E-05	0.000433235	4.74E-05	
25	127	Living Being	Animal/Fauna	0	7.20E-06	0	2.12E-05	0	

Supplementary Table 4. BP by cosine similarity. This table illustrates the results of textual analysis processed by Bidirectional Encoder Representations from Transformers (BERT), expressing BP in the form of cosine similarity scores. These values are associated with 25 BC per city, ranging from 0 to 1.

		BP by cosine similarity (BERT)							
		City Cases							
Class Category	Class Label	Amsterdam	Barcelona	Buenos Aires	Dubai	Nairobi	Quebec City	Singapore	Trondheim
Greenscape	Tree	0.63	0.62	0.69	0.60	0.61	0.66	0.63	0.57
Greenscape	Grass	0.64	0.60	0.63	0.62	0.63	0.58	0.62	0.64
Greenscape	Plant/Flora	0.61	0.62	0.61	0.62	0.64	0.58	0.60	0.60
Greenscape	Fire	0.24	0.29	0.25	0.26	0.25	0.23	0.24	0.22
Greenscape	Flower	0.50	0.51	0.48	0.52	0.50	0.47	0.50	0.54
Greenscape	Palmtree	0.41	0.39	0.34	0.39	0.36	0.30	0.34	0.30
Greenscape	Natural Food	0.30	0.34	0.31	0.34	0.38	0.25	0.32	0.30
Waterscape	Water	0.37	0.35	0.28	0.32	0.32	0.22	0.29	0.27
Waterscape	Sea	0.42	0.41	0.37	0.38	0.38	0.32	0.37	0.39
Waterscape	River	0.32	0.28	0.26	0.27	0.29	0.25	0.25	0.23
Waterscape	Fountain	0.32	0.30	0.23	0.29	0.29	0.18	0.23	0.23
Waterscape	Swimming Pool	0.38	0.35	0.31	0.35	0.34	0.25	0.32	0.32
Waterscape	Waterfall	0.32	0.30	0.27	0.28	0.28	0.29	0.27	0.27
Waterscape	Lake	0.27	0.22	0.21	0.22	0.24	0.21	0.20	0.21
Landscape	Sky	0.51	0.56	0.54	0.49	0.48	0.46	0.53	0.55
Landscape	Earth/Ground	0.45	0.46	0.43	0.44	0.47	0.38	0.42	0.42
Landscape	Mountain	0.37	0.38	0.36	0.34	0.34	0.37	0.35	0.40
Landscape	Field	0.52	0.49	0.52	0.52	0.53	0.49	0.50	0.55
Landscape	Rock/Stone	0.38	0.39	0.33	0.35	0.35	0.27	0.32	0.33
Landscape	Sand	0.49	0.50	0.46	0.51	0.47	0.37	0.45	0.46
Landscape	Hill	0.56	0.55	0.52	0.52	0.53	0.51	0.51	0.53
Landscape	Light/Sunlight	0.57	0.64	0.57	0.61	0.59	0.48	0.60	0.59
Landscape	Land/Soil	0.55	0.51	0.55	0.52	0.56	0.53	0.51	0.53
Living Being	Person	0.52	0.59	0.55	0.55	0.54	0.44	0.52	0.47
Living Being	Animal/Fauna	0.33	0.34	0.33	0.35	0.37	0.29	0.32	0.32

Supplementary Table 5. BP by specificity. This table presents a synthetic framework of BP values based on the results of topic cluster modelling. It outlines the qualitative indicator of specificity, which associates the highest values of BP with cityscape elements grouped into four main topic clusters (nature-based environment, anthropogenic environment, feelings and concepts, city identifier) and 14 sub-topic clusters (greenscape, landscape, waterscape, living beings, built environment, mobility and infrastructure, human activity, neighbourhood and community, urban mood, positive feelings, aesthetics, abstract concepts, vitality and movement, local features). Each topic or sub-topic is represented by the number of items mentioned in survey comments and their related preference percentages.

SPECIFICITY																				
City	Clusters No	Nature-based Environment						Anthropogenic Environment						Feelings & Concepts				City Identifier		Item No
Amsterdam	10	Items			Percentage			Items			Percentage			Items		Percentage		Items	Percentage	509
		249			49%			141			28%			96		19%		22	4%	
		Greenscape		Landscape	Waterscape		Living Beings	Built Environment		Mobility & Infrastructure		Human Activity		Positive Feelings		Aesthetics	Abstract Concepts	Local Features		
		155	31%	57	11%	30	6%	7	1%	81	16%	60	12%	62	12%	26	5%	8	2%	
Barcelona	9	Items			Percentage			Items			Percentage			Items		Percentage		Items	Percentage	420
		212			50%			142			34%			39		9%		27	6%	
		Greenscape		Landscape	Waterscape		Living Beings	Built Environment		Mobility & Infrastructure		Human Activity		Positive Feelings		Vitality & Movement		Local Features		
		108	26%	85	20%	0	0%	19	5%	74	18%	54	13%	14	3%	29	7%	10	2%	
Buenos Aires	10	Items			Percentage			Items			Percentage			Items		Percentage		Items	Percentage	505
		275			54%			156			14%			69		14%		5	1%	
		Greenscape		Landscape	Waterscape		Living Beings	Built Environment		Mobility & Infrastructure		Neighborhood & Community		Positive Feelings		Vitality & Movement		Local Features		
		164	32%	96	19%	2	0%	13	3%	68	13%	64	13%	24	5%	66	13%	3	1%	
Dubai	9	Items			Percentage			Items			Percentage			Items		Percentage		Items	Percentage	393
		213			54%			107			27%			63		16%		10	3%	
		Greenscape		Landscape	Waterscape		Living Beings	Built Environment		Mobility & Infrastructure		Urban Mood		Positive Feelings		Local Features				
		135	34%	74	19%	1	0%	3	1%	45	11%	36	9%	26	7%	63	16%	10	3%	
Nairobi	10	Items			Percentage			Items			Percentage			Items		Percentage		Items	Percentage	401
		166			41%			132			33%			84		21%		19	5%	
		Greenscape		Landscape	Waterscape		Living Beings	Built Environment		Mobility & Infrastructure		Human Activity		Positive Feelings		Aesthetics		Local Features		
		104	26%	44	11%	1	0%	17	4%	27	7%	77	19%	28	7%	74	18%	10	2%	
Quebec City	9	Items			Percentage			Items			Percentage			Items		Percentage		Items	Percentage	542
		321			59%			115			21%			95		18%		11	2%	
		Greenscape		Landscape	Waterscape		Living Beings	Built Environment		Mobility & Infrastructure		Human Activity		Positive Feelings		Aesthetics		Local Features		
		236	44%	65	12%	8	1%	12	2%	60	11%	55	10%	69	13%	26	5%	11	2%	
Singapore	10	Items			Percentage			Items			Percentage			Items		Percentage		Items	Percentage	459
		221			48%			113			25%			116		25%		9	2%	
		Greenscape		Landscape	Waterscape		Living Beings	Built Environment		Mobility & Infrastructure		Human Activity		Positive Feelings		Aesthetics		Local Features		
		149	32%	68	15%	3	1%	1	0%	41	9%	64	14%	8	2%	94	20%	22	5%	
Trondheim	9	Items			Percentage			Items			Percentage			Items		Percentage		Items	Percentage	580
		270			47%			107			18%			192		33%		11	2%	
		Greenscape		Landscape	Waterscape		Living Beings	Built Environment		Mobility & Infrastructure		Human Activity		Positive Feelings		Aesthetics		Local Features		
		131	23%	129	22%	5	1%	5	1%	51	9%	56	10%	143	25%	49	8%	11	2%	

Supplementary Table 6. BP by gender-based specificity. This table summarises the values of BP gathered from male and female participants in the Feeling Nature survey. For each city, the number of cityscape elements (items) perceived more positively is grouped into the four main topic clusters (nature-based environment, anthropogenic environment, feelings and concepts, city identifier) and 14 sub-topic clusters (greenscape, landscape, waterscape, living beings, built environment, mobility and infrastructure, human activity, neighbourhood and community, urban mood, positive feelings, aesthetics, abstract concepts, vitality and movement, local features) considered under the qualitative indicator of specificity.

SPECIFICITY																	
City Case	Gender-related data			Nature-based Environment				Anthropogenic Environment					Feelings & Concepts				City Identifier
	Gender	Participant No	Item No	Greenscape	Landscape	Waterscape	Living Beings	Built Environment	Mobility & Infrastructure	Human Activity	Neighborhood & Community	Urban Mood	Positive Feelings	Aesthetics	Abstract Concept	Vitality & Movement	Local features
Amsterdam	Male	15	161	52	22	12	1	22	18				21	6			7
	Female	32	347	103	35	18	6	59	42				41	20	8		15
	Tot	47	508	155	57	30	8	81	60				62	26	8		22
Barcelona	Male	22	157	45	26	0	3	31	22	6			14				4
	Female	24	263	63	59	0	16	43	32	8			15				21
	Tot	44	420	108	85	0	19	74	54	14			29			10	27
Buenos Aires	Male	21	218	73	47	0	4	32	24		8		26				2
	Female	27	287	91	49	2	9	36	40		16		40			1	3
	Tot	48	505	164	96	2	13	68	64		24		66			3	5
Dubai	Male	21	154	61	28	1	2	15	9			9	24				5
	Female	28	239	74	46		1	30	27				17	39			5
	Tot	44	393	135	74	1	3	45	36			26	63				10
Nairobi	Male	21	180	40	19	1	6	17	34	14			36	3			10
	Female	28	221	64	25		11	10	43	14			38	7			9
	Tot	49	401	104	44	1	17	27	77	28			74	10			19
Quebec City	Male	25	210	85	23	2	4	27	31				27	5			6
	Female	25	332	151	42	6	8	33	24				42	21			5
	Tot	50	542	236	65	8	12	60	55				69	26			11
Singapore	Male	18	196	58	26			15	32	5			47	7			6
	Female	30	263	91	42	3	1	26	32	3			47	15			3
	Tot	48	459	149	68	3	1	41	64	8			41	64			9
Trondheim	Male	27	292	76	65	5	5	22	26				70	20			3
	Female	23	288	55	64			29	30				73	29			8
	Tot	50	580	131	129	5	5	51	56				143	49			11