Geography
Internal Assessment

How does environmental quality, determined by the severity of pollution and the availability of green spaces, differ between a tourist-catering area of Paris versus a residential area?

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1 Introduction

1.1 Fieldwork question

How does environmental quality, determined by the severity of pollution and the availability of green spaces, differ between a touristic area of Paris and a residential area?

In order to answer this question, the fieldwork for our paper was conducted in Paris, one of the largest and most well known cities in the world. The city itself is arranged into 20 districts, known locally as *arrondissements*, are placed in a spiral in the city. It is globally known for its high number of tourists per year, equating to around 35 million in the year 2019 alone.[1] Many of them come to visit the world-renowned Eiffel Tower, located in the VIIth *arrondissement*.[2] To add, Paris is home to 2.2 million people, who mostly live in the outer residential areas, from the XIth to the XXth *arrondissements*.

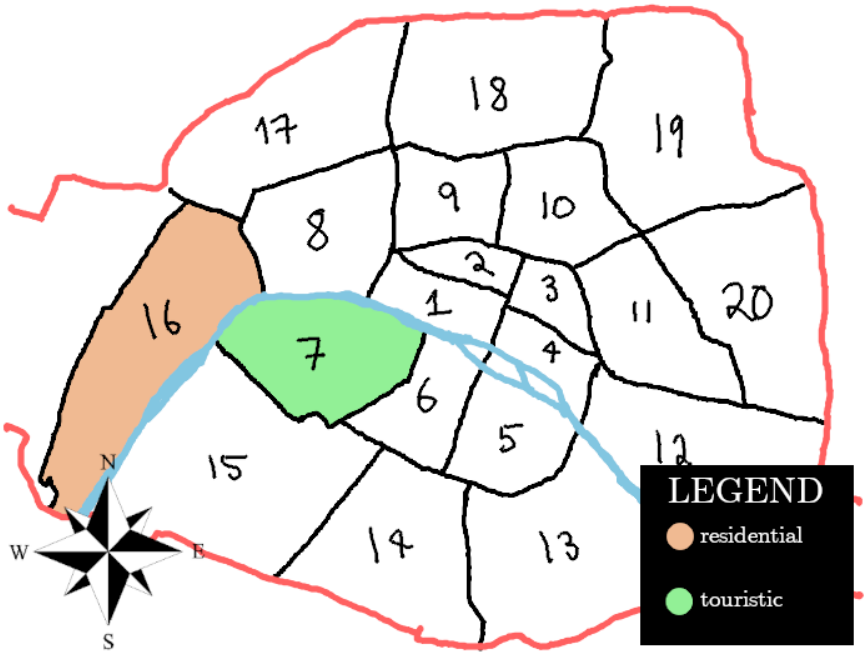

Figure 1: A map of Paris *arrondissements*, drawn by hand.

1.2 Hypotheses

1. According to the Global Development Goals of the UN, 90% of urban areas in the world had polluted air in 2016.[3] Paris was among countries that didn't satisfy WHO's air quality minimum[4] of 2018, with on average a 50% higher than normal pollution density. However, a

[1] Statista Research Department. *Hotel arrivals in Paris 2011-2019*. Apr. 2020. URL: https://www.statista.com/statistics/468164/number-tourist-arrivals-hotels-paris.

[2] CondorFerries. *Latest France Tourism Statistics & Industry Trends (2020-2021)*. URL: https://www.condorferries.co.uk/france-tourism-statistics.

[3] "The Sustainable Development Goals Report 2020". In: *The Sustainable Development Goals Report* (2020), p. 47. DOI: 10.18356/214e6642-en.

[4] *Ambient (outdoor) air pollution*. May 2018. URL: https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

counterargument to this could be that despite a higher concentration of people, tourist areas in Paris do not suffer as much from high traffic conditions from things such as typical morning rush hours, and tourists preferably using public transport or bikes.

2. As there are more people moving about in residential areas, for example in cars for the morning commute or at noon for lunch, it can logically be theorized that noise pollution, which is obviously a function of the amount of cars, would be higher in these places. Today it is estimated that an average noise level of $60dB$ can be found in residential areas, according to the very comprehensive Bruitparif government-sponsored report.[5] This value largely surpasses the WHO's safe level of $53dB$.[6]

3. The Parisian mayor, Anne Hidalgo included the improvement of environmental quality in her campaign. The mayor has promised to make so-called "green spaces" no further than 200 meters to any person,[7] and as such, it should be hypothesized that green spaces, which include parks, agglomerations of trees, shall be distributed evenly with no difference between residential and touristic areas. The mayor emphasized on "urban forests" — places where residents and tourists alike could enjoy the company of trees while walking along the city streets.

2 Method

For our investigation, the topic in question is the environmental quality. We will compare the environmental quality of two areas, one meant as a residential one and one with a heavy tourist presence. To best represent these areas, we have chosen the XVIe and the VIIe. The XVIe is home to many housing complexes and fosters facilities aimed at catering to the residents whereas the VIIe sees many tourists as it is home to the famed Eiffel Tower and the Seine river, prime tourist attractions of Paris.

2.1 Study site choices

We chose 10 sites in total to conduct a bipolar survey, shown below in Figures 2, 3.

[5] Mairie de Paris. *PLAN DE PRÉVENTION DU BRUIT DANS L'ENVIRONNEMENT 2015 > 2020*. URL: https://www.bruitparif.fr/PPBE/75056%20-%20Paris/PPBE%20Paris%202015-2020.pdf.

[6] "Environmental Noise Guidelines for the European Region". In: (2018), p. 8. URL: https://www.euro.who.int/__data/assets/pdf_file/0009/383922/noise-guidelines-exec-sum-eng.pdf.

[7] Anne Hidalgo. *Comment Paris peut-elle être une ville encore plus végétale ?* URL: https://annehidalgo2020.com/question/comment-paris-peut-etre-une-ville-encore-plus-vegetale/.

Figure 2: Map of sites chosen for the residential area, the XVI[th] *arrondissement*. Map base layer courtesy of Google Maps, pictures seen are taken on a mobile phone.

This site was chosen as, like stated before, it is a residential area. There are other residential areas in Paris, however this one was specifically chosen for reasons of convenience.[8]

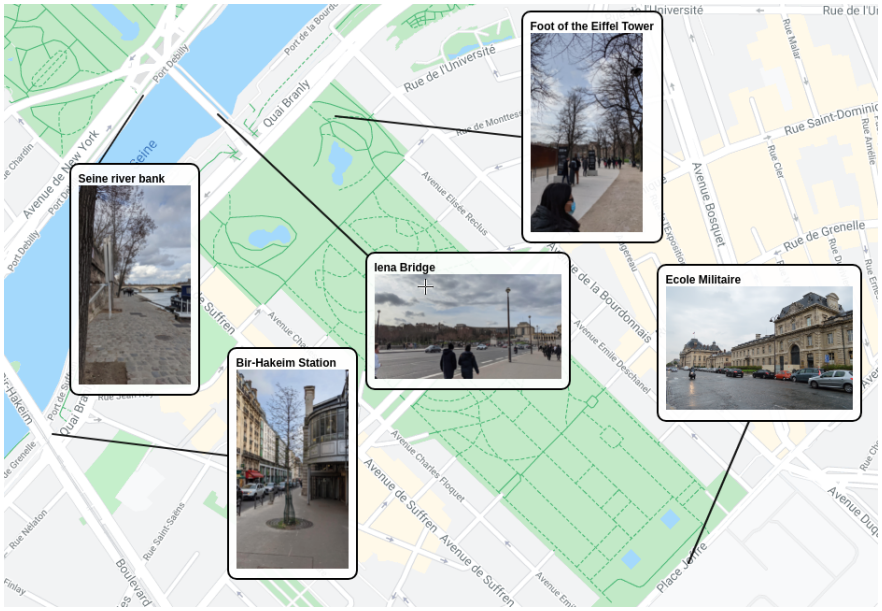

Figure 3: Map of sites chosen for the touristic area, the VII[th] *arrondissement*. Map base layer courtesy of Google Maps, pictures seen are taken on a mobile phone.

[8] We had 2 members of our group residing in this area.

This area in the VIIth was chosen as it is a staple of tourism in France. It is home to the famed Eiffel Tower, the Ecole Militaire building and the Seine river bank.

2.1.1 Our sampling method

The sites in the two areas were chosen using a method of stratified sampling. Considering the VIIth does indeed contain residential sites and the XVIth touristic ones, we can discard the ones that are irrelevant to our study.

2.2 Method

2.2.1 Bipolar semantic survey

The sites were visited to conduct a so-called "bipolar survey", which consisted of rating the site based on multiple criteria. This process was done by selecting a single person from our group to visit one of the sites, and complete a bipolar semantic survey. They would grade several different aspects of the site (such as general cleanliness, noise, amount of cars), and take a set of 3 images of the site.[9] Our surveys were conducted during the week of the 10th of March, 2021 in the afternoon each time. The weather was overcast and moderately cold.

2.2.2 Statistical evaluations

In order to either support or disprove our third hypothesis, it is important to study how trees are scattered in Paris, which reveals how dispersed green spaces are from one another. A statistical test called the Nearest Neighbor Index (NNI) test can provide a reasonable answer to this: if the index is similar for both sites, it can easily be said then that our hypothesis is supported. This value also reveals information about the distribution of trees: clustered, random or in a regular pattern, as seen in Figure 4 below. These values will be presented and analysed in the later section 3. Data & Analysis.

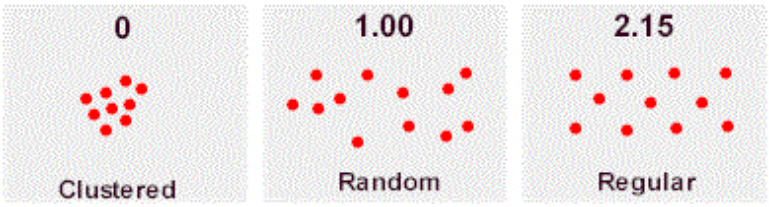

Figure 4: The NNI measures the spacial distribution of data. From a value of 0, representing a clustered pattern, to 1 (random) and to 2.15 (uniform pattern)

As individually counting trees in these areas would be a tedious task, we used the Paris OpenData platform (licensed under the permissive ODbL license[10]), owned by the government. The fact that

[9] Images taken for our study can be found at https://github.com/kinnounko/notes/tree/main/geography/ia/images

[10] *Open Data Commons Open Database License (ODbL) - Open Data Commons: legal tools for open data.* URL: https://opendatacommons.org/licenses/odbl/.

this kind of database platform exists, shows a certain level of transparency on the government's part.

We used the trees dataset procured from the library, which contains the exact coordinates of trees in the city.[11] There are also other information such as species of the tree and such, however these are cleaned from the dataset for our purposes.

A script, written in Python was tasked to calculate the NNI value, because with a dataset of over 20,000 data points this would not be possible by hand. We go through each point, and find its nearest neighbor. In order to calculate distances between these two points, we use the Haversine Formula, as the two points would be in the form of coordinates. With this information the NNI can be calculated with the simple formula

$$Rn = \frac{2\bar{D}}{\sqrt{\frac{a}{n}}}$$

where Rn is the NNI index value, $\bar{D}$ is the mean observed distance to the nearest neighbor, a is the area of the zone and n is the total number of data points.

2.2.3 Questionnaire

We also collected data from a questionnaire sent out to many people. This questionnaire contained the two questions *"Do you believe that the Passy area has more green spaces than the area around the Eiffel tower? (Not including the champ de mars)"* and *"How much litter is in the Passy area compared to around the Eiffel tower?"*. The data collected from this survey is listed in Section 3.1. We surveyed our year, which has people that live in and frequent these two areas.

3 Data & Analysis

Once our data collected, we can analyse certain patterns or appearances that do not follow a general trend. Our data is shown below in Section 3.1.

3.1 Data collected

Our results for the bipolar survey are shown in Appendix A.1 (not shown here due to large size). When tallied, the total scores for each site can be expressed as a fraction over 84, as shown in Figures 5, 6.

[11] *Les arbres*. May 2021. URL: https://opendata.paris.fr/explore/dataset/les-arbres/information.

Site	Total score
Bir-Hakeim	51
Seine river bank	69
Foot of the Eiffel Tower	45
Iena Bridge	42
Ecole Militaire	54

Figure 5: Total Bipolar Semantic scores for the VII$^{\text{th}}$

Site	Total score
Rue Davioud 1	47
Rue Davioud 2	53
Avenue Mozart	31
Avenue Paul Doumer	35
Ranelagh Garden	77

Figure 6: Total Bipolar Semantic scores for the XVI$^{\text{th}}$

When plotted on a map, these totals can be shown as percentages ($\frac{s}{84} \cdot 100$, where s is the total score) with a gradient of colors, as seen below in Figures 7, 8:

Figure 7: Each site in the VVI$^{\text{th}}$, with its respective total score expressed as a percentage for clarity, and a color assigned based on the gradient in Figure 9.

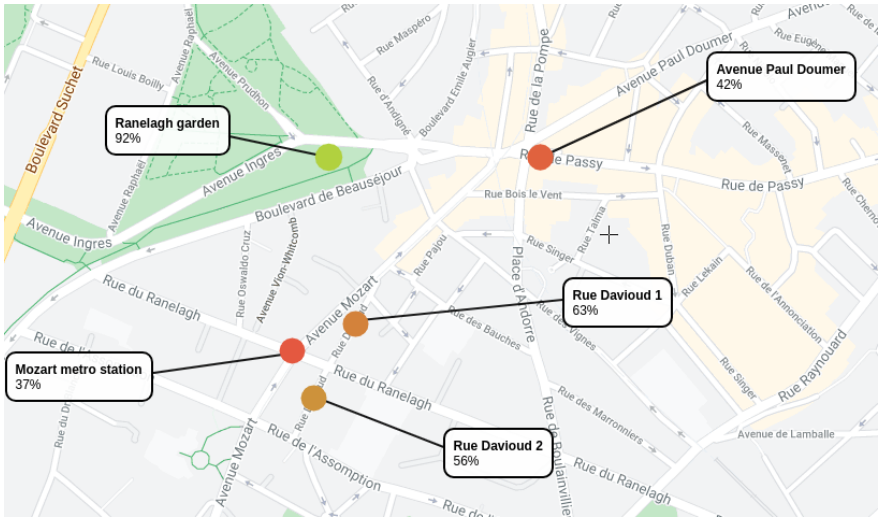

Figure 8: Each site in the XVI$^{\text{th}}$, with a percentage. Color assigned with gradient in Figure 9.

Figure 9: Gradient from red (hex color #FF0000) for 0%, to green (hex color #00FF00) for 100%.

As for images collected during our inspections of the sites, for the sake of keeping the file size of this paper down, I will not attach the images collected and they will be available for download or viewing at the URL https://github.com/kinnounko/notes/tree/main/geography/ia.

The dataset collected from the questionnaire (mentioned in Section 2.2.3) is shown in the tables in Figures 10, 11.

Answer	Number of people that agree
Significantly Less	4
Less	8
About the same	8
More	10
Significantly more	0

Figure 10: *Do you believe that the Passy area has more green spaces than the area around the Eiffel tower? (Not including the champ de mars)*

Answer	Number of people that agree
Significantly Less	3
Less	10
About the same	12
More	5
Significantly more	0

Figure 11: *How much litter is in the Passy area compared to around the Eiffel tower?*

This data can be shown in the form of a bar graph (Figure 12), in order to visualize the distribution and for further analysis.

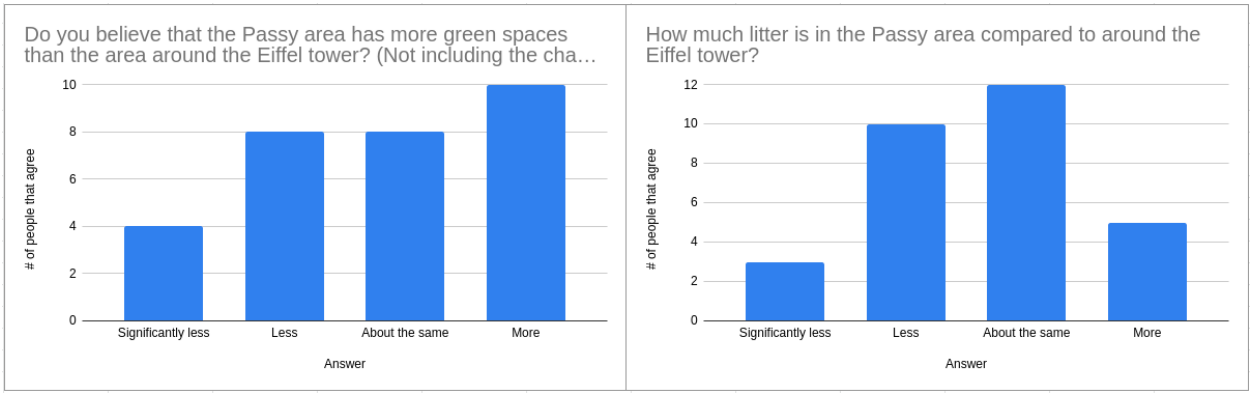

Figure 12: Graphs representing aforementioned data in Figures 10, 11

3.2 Analysis

4 Conclusion

4.1 Evaluation

There are some processes in our paper that would be done differently if done now. To list the ones I managed to find at the time of writing:

- The computer program does not seem to take into account an area of greenery in the VII$^{\text{th}}$, which can change the NNI value found for the VII$^{\text{th}}$. This area includes parks and such, however the map (generated also with the computer program) does not show trees in this location. This should have been investigated, however due to constraints related to time, I could not.
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Notes

This paper is written with the aid of the typesetting software LaTeX. On a PDF viewer, the sections in the table of contents can be clicked to access that section.

All media and information related to this IA can be found on the URL https://github.com/kinnounko/notes/tree/main/geography/ia. This includes images, the LaTeX source code to this paper, and the Python program used to calculate the NNI value.

References

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Open Data Commons Open Database License (ODbL) - Open Data Commons: legal tools for open data. URL: https://opendatacommons.org/licenses/odbl/.

Les arbres. May 2021. URL: https://opendata.paris.fr/explore/dataset/les-arbres/information.

A Appendix

A.1 Bipolar survey results

Shown below are our results from our bipolar semantic survey:

XVIth residential area:

AVENUE MOZART

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism			X					No vandalism
Noisy				X				Calm
Crowded			X					Spacious
Lots of cars	X							No cars
Lots of smokers					X			No smokers
Lots of litter		X						No litter
Poorly maintained				X				Well maintained
No nature	X							Lots of nature
Overfilled bins		X						Empty bins
No recycling bins		X						Lots of recycling bins
Foul / polluted air				X				No noticeable odor
Lots of dog feces		X						No dog feces
							Total:	31/84

RUE DAVIOUD

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism		X						No vandalism
Noisy					X			Calm
Crowded					X			Spacious
Lots of cars				X				No cars
Lots of smokers					X			No smokers
Lots of litter			X					No litter
Poorly maintained				X				Well maintained
No nature								Lots of nature
Overfilled bins					X			Empty bins
No recycling bins				X				Lots of recycling bins
Foul / polluted air			X					No noticeable odor
Lots of dog feces		X						No dog feces
							Total:	47/84

RUE DAVOIUD 2

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism						X		No vandalism
Noisy	/	/	/	/	X	/	/	Calm
Crowded					X			Spacious
Lots of cars						X		No cars
Lots of smo	X							No smokers
Lots of litter							X	No litter
Poorly maintained						X		Well maintained
No nature		X						Lots of nature
Overfilled bins				X				Empty bins
No recycling bins			X					Lots of recycling bins
Foul / polluted air						X		No noticeable odor
Lots of dog feces			X					No dog feces
								Total : 53/84

AVENUE PAUL DOUMER

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism		X						No vandalism
Noisy		X						Calm
Crowded		X						Spacious
Lots of cars	X							No cars
Lots of smokers			X					No smokers
Lots of litter				X				No litter
Poorly maintained						X		Well maintained
No nature		X						Lots of nature
Overfilled bins			X					Empty bins
No recycling bins				X				Lots of recycling bins
Foul / polluted air				X				No noticeable odor
Lots of dog feces			X					No dog feces
								Total: 35/84

RANELAGH JARDIN

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism							X	No vandalism
Noisy						X		Calm
Crowded						X		Spacious
Lots of cars							X	No cars
Lots of smokers							X	No smokers
Lots of litter						X		No litter
Poorly maintained							X	Well maintained
No nature							X	Lots of nature
Overfilled bins						X		Empty bins
No recycling bins						X		Lots of recycling bins
Foul / polluted air							X	No noticeable odor
Lots of dog feces					X			No dog feces
								Total: 77/84

VIIth touristic area:

BIR HAKEIM METRO STATION

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism						X		No vandalism
Noisy		X						Calm
Crowded					X			Spacious
Lots of cars				X				No cars
Lots of smokers					X			No smokers
Lots of litter			X					No litter
Poorly maintained			X					Well maintained
No nature			X					Lots of nature
Overfilled bins				X				Empty bins
No recycling bins					X			Lots of recycling bins
Foul / polluted air					X			No noticeable odor
Lots of dog feces						X		No dog feces
								Total: 51/84

FOOT OF THE EIFFEL TOWER

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vanc	X							No vandalism
Noisy				X				Calm
Crowded		X						Spacious
Lots of cars				X				No cars
Lots of smokers			X					No smokers
Lots of litter			X					No litter
Poorly maintained						X		Well maintained
No nature						X		Lots of nature
Overfilled bins					X			Empty bins
No recycling bins			X					Lots of recycling bins
Foul / polluted air						X		No noticeable odor
Lots of dog feces			X					No dog feces
								Total: 45/84

BANK OF THE SEINE

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism						X		No vandalism
Noisy							X	Calm
Crowded						X		Spacious
Lots of cars							X	No cars
Lots of smokers						X		No smokers
Lots of litter				X				No litter
Poorly maintained					X			Well maintained
No nature				X				Lots of nature
Overfilled bins						X		Empty bins
No recycling bins					X			Lots of recycling bins
Foul / polluted air							X	No noticeable odor
Lots of dog feces						X		No dog feces
								Total: 69/84

ECOLE MILITAIRE

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism		X						No vandalism
Noisy					X			Calm
Crowded						X		Spacious
Lots of cars		X						No cars
Lots of smokers		X						No smokers
Lots of litter				X				No litter
Poorly maintained					X			Well maintained
No nature					X			Lots of nature
Overfilled bins						X		Empty bins
No recycling bins					X			Lots of recycling bins
Foul / polluted air				X				No noticeable odor
Lots of dog feces					X			No dog feces
								Total: 54/84

PONT D'IÉNA

NEGATIVE	1	2	3	4	5	6	7	POSITIVE
Lots of vandalism							X	No vandalism
Noisy					X			Calm
Crowded	X							Spacious
Lots of cars		X						No cars
Lots of smokers		X						No smokers
Lots of litter			X					No litter
Poorly maintained						X		Well maintained
No nature		X						Lots of nature
Overfilled bins			X					Empty bins
No recycling	X							Lots of recycling bins
Foul / polluted air					X			No noticeable odor
Lots of dog feces						X		No dog feces
								Total: 42/84