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GEOG 307

Utilizing GIS to Find Suitable Plots of Land for Urban Agriculture in Montreal

1. INTRODUCTION

Urban agriculture (UA) has various environmental, social, and economic benefits such as reducing food miles and CO2 emissions, recycling waste, bringing community members together, educating people on sustainability, and providing employment and income (“Benefits of Urban Agriculture”, 2008). Many Montrealers are aware of these benefits and have established successful UA ventures such as the Santropol Roulant, The Summer School on UA, Urban Seedlings, Lufa Farms, and P3 Permaculture (Essman 2014). However, the implementation, acceptance, and productivity of UA still faces several obstacles such as lack of available land, contamination from urban areas, lack of access by the community, lack of social support, and lack of resources (Markgraf & Kay, 2011).

The objective of my semester-long project was to use GIS to find a suitable plot of land for a community garden in Montreal. I defined suitability in terms of a plot of land’s resilience to the obstacles mentioned above. My purpose was to demonstrate the potential of GIS in facilitating and promoting UA by designing a GIS-based approach for spotting suitable plots of land. I also wanted to see whether this approach was universal enough to be applied elsewhere, recognizing that types of UA vary enormously within cities and especially across cities.

I begin this paper by defining the obstacles of UA in terms of a GIS project. Next, I describe the data I obtained on Montreal, including an Urban Agriculture Survey and a collection of shapefiles related to the obstacles. I continue by summarizing how I manipulated the data to assess land availability, distance from pollution, access by community, and geodemographics. I include a cartographic model that visualizes these steps and a map that displays the results, namely three suitable plots of land: Parc Jean-Martucci, Parc de L’Ile-de-la-Visitation, and Parc du Sault-au-Récollet. Following this, I elaborate on the strengths and weaknesses of each suitable plot and recommend Parc du Sault-au-Récollet as the most beneficial location for a new UA venture. I conclude by arguing that GIS is a useful tool for analyzing suitability but that it should include real-life assessment. Other cities could employ this methodology if they gather information on demographic attitudes towards urban agriculture via surveys.

2. METHODS/PROCEDURE

(a) GIS project

My objective was to find a suitable plot of land for urban agriculture in Montreal. In my lab, I defined suitability in terms of land availability, distance from contamination, access by community, and proximity to target group.

- Land availability: I decided to focus on a specific borough (Ahuntsic-Cartierville), land type (Parks) and parcel size (> 150 m^2) to maintain consistency. The type of UA I chose was a community garden, which can range from 150 m^2 to 14,000 m^2
- Contamination: There are several sources of pollution in the city, but the main ones are major roads/highways, factories, construction, and waste disposals. According to the Environmental Protection Agency, roads can "influence air quality within a few hundred meters" (EPA, 2016).
- Access by community: In order for a parcel of land to be accessible by the surrounding community, it should be approachable by foot, bike, car, bus, or metro. Furthermore, it should be close to community centers such as schools, markets, shopping malls, or churches.
- Proximity to target group: Land should be situated in a census tract with a greater population but also a population with specific demographic characteristics that are amenable to UA.

(b) Data collection

Through the Montreal Open Data Portal, I found an "Urban Agriculture Survey" that was conducted in 2013 by the city's Division for Sustainable Development. The survey seeks to study attitudes about UA by asking participants whether they are involved in UA, what types of UA they are involved in, the practices they carry out, and their motives for not getting involved. Results showed that 42% of respondents practiced UA and that the borough with the most respondents (10%) was Ahuntsic-Cartierville. The survey concluded that there were two main types of urban farmers in Montreal:

1. **People who cultivate < 10 years**: more in the center and east (81%), more workers (71%), more French (91%), and aged between 18-49 (76%)
2. **People who cultivate > 10 years**: more in the west of island (39%), more retired (35%), older than 50 (49%), speak more English (28%)

After gathering these results, I chose to narrow my scope to Ahuntsic-Cartierville because it was the borough that was best represented by the survey results. Since the survey associated the first type of urban farmer with this borough, I sought to obtain census information on age, employment status, and language.

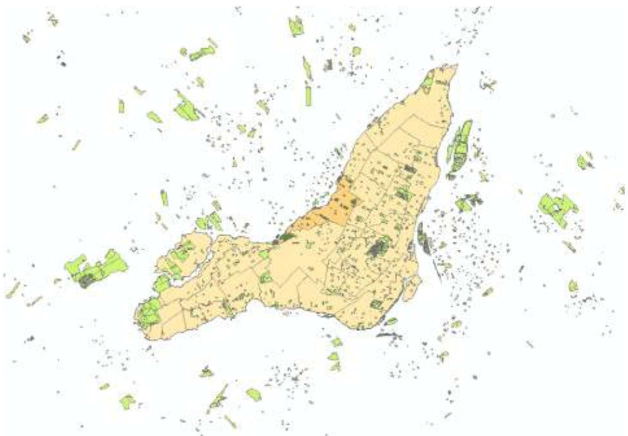
In addition to the survey, I gathered data from the TRAM Archive on the following topics:

Topic	Name	Description
Land	boroughs.shp, parks.shp	Polygon shapefiles of all boroughs and parks of Montreal
Pollution	majorroads.shp landuse.shp	A line shapefile of all major roads and highways in Montreal A polygon shapefile of all land uses in Montreal
Accessibility	streets.shp, bikeped.shp schools.shp, markets.shp	Line shapefiles of all streets, bike paths, and sidewalks in Montreal Point shapefiles of all schools and markets in Montreal
Community	census.shp language.xlsx, labor.xlsx	A polygon shapefile of all census tracts in Montreal (w/ info on age) Excel spreadsheets w/ info on work language and employment
Resources	waterinfrastructure.shp woodcanopy.shp	A line shapefile of all water infrastructure in Montreal A polygon shapefile of all forest cover in Montreal

All the shapefiles were in the same geographic coordinate system so I did not need to make any adjustments.

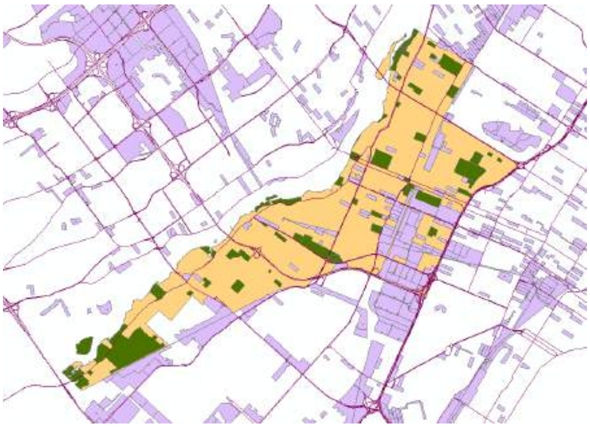
(c) Data manipulation

Land Availability

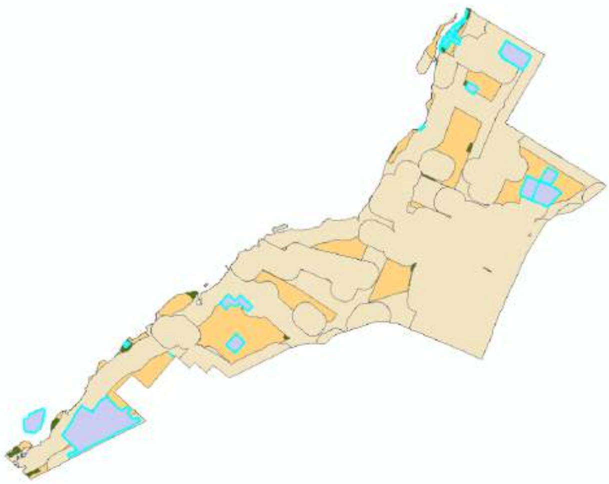


To find available land in Ahunstic-Cartierville, I played around with “*Boroughs.shp* and “*Parks.shp”*. I started by selecting the Ahuntsic borough from *Boroughs.shp* and exporting a new polygon layer called *”Ahuntsic.shp”*. I then clipped *”Parks.shp”* by *”Ahuntsic.shp”* to create a new polygon layer called *”ParksinAhuntsic.shp”*. Since my project was focusing on community gardens, which can range from 150 to 14,000 m^2, I queried *”ParksinAhunstic.shp”* to select only parks greater than 150 m^2 and created a new polygon layer called “*PotentialPlots.shp”*. I did not use a maximum size because parks larger than 14,000 m^2 could be divided into smaller parcels of land.

Distance from Pollution



I examined the distances between "*PotentialPlots.shp*" and "*MajorRoads.shp*" and "*LandUse.shp*" to determine which plots were uncontaminated. First, I queried "*LandUse.shp*" to choose only the uses that were labeled "Resource and industrial" and exported a new polygon layer called "*IndustrialLandUses.shp*". Since the Environmental Protection Agency recommended a minimum distance of 200 meters from pollution, I created 200-meter buffers around "*MajorRoads.shp*" and "*IndustrialLanduses.shp*" and merged the two buffers into a new polygon layer called "*Pollution.shp*". I finished by selecting the plots in "*PotentialPlots.shp*" that were not within nor crossed by the outline of "*Pollution.shp*". I did this instead of selecting plots that were not touching "*Pollution.shp*" because the latter approach eliminated too many plots. Finally, I exported these plots as a new polygon layer called "*CleanPotentialPlots.shp*".



Access by community


To figure out which plots from “*CleanPotentialPlots.shp*” were accessible by the community, I added “*Streets.shp*”, “*BikePed.shp*”, “*Markets.shp*”, and “*Schools.shp*” to. I then applied select by location to obtain the plots that were not only touching the routes but also within 1000 meters of the community points. I exported the refined selection of plots as a new polygon layer called “*CleanAccessiblePotentialPlots.shp*”.

(d) Geodemographic analysis

To ensure that the “*CleanAccessiblePotentialPlots.shp*” were near individuals who were more likely to accept and participate in UA, I performed calculations in the attribute tables of “*Census.shp*”, “*Language.xlsx*” and “*Labor.xlsx*”. As mentioned earlier, the majority of urban farmers in Ahuntsic are aged 20-50, employed, and francophone. Before conducting the geodemographic analysis, I clipped all three datasets by “*Ahuntsic.shp*” so that I would only examine relevant census tracts (i.e. the 53 census tracts in Ahuntsic-Cartierville).

First, I added a “TargetAge” field in the table of “*Census.shp*” which summed the populations of age groups [20-24], [25-29], [30-34], [35-39], [40-44], and [45-49] for each census tract. I then added a “PercentTargetAge” field, which calculated the percentage of people aged 20-50, and a “RankTargetAge” field, which ranked each census tract from 1 to 53 (with 53 corresponding to the highest percentage).

Second, I did not need to add a “Work” field in “*Labor.xlsx*” because it already had a field containing the number employed people in each census tract. However, similar to the previous step, I added a “PercentWork” field, which calculated the percentage of employed people, and a “RankWork” field, which ranked the census tracts accordingly.

Third, I added a “French” field in “*Language.xlsx*” which summed the number of people who spoke [French], [French/English], [French/Non-Official], and [French/English/Non-Official] for each census tract. Again, I added two fields: a

“PercentFrench” field, dividing “French” by total population, and a “RankFrench” field, ranking each census tract from 1 to 53.

Fourth, I joined the tables so that I could create a field that was based on columns from all three tables. This was the “TotalRank” field, which was the sum of the three ranks (RankTargetAge, RankWork, RankFrench) and would indicate which census tract had the best demographics (i.e. highest rank = highest total percentage of individuals aged 20-50, employed, and French-speaking).

Table

Census Tract Ahuntsic Age

TargetAge	PercTargAg	RankTargAg	PercWork	RankWork	LangPop	French	PercFren	RankFren	RankTot
1710	56.4356	52	68.5	51	2075	1880	90.6024	47	150
1305	55.9366	51	64.4	49	1490	1360	91.2752	50	150
1585	48.6495	47	58.1	41	1790	1640	91.6201	51	139
1800	58.9005	53	70.1	52	2060	1760	85.4369	32	137
2550	55.5919	50	57.7	38	2645	2385	90.1701	46	134
2205	50.0909	48	64	48	2725	2380	87.3394	37	133
2005	44.8446	37	59.7	43	2500	2270	90.8	48	128
2270	45.2281	38	62.9	46	3135	2780	88.6762	40	124
2055	47.0359	43	60	44	2535	2195	86.5878	35	122
1520	42.7326	29	62.6	45	1795	1610	89.6936	45	119
1675	42.0537	26	57	35	2185	2015	92.2197	52	113
1330	40.9988	21	64.8	50	1980	1770	89.3939	42	113
1910	48.123	45	57.5	37	2135	1820	85.2459	31	113
2080	41.4673	23	57.3	36	2855	2655	92.9947	53	112
3170	48.5155	46	72.4	53	3975	2315	58.239	5	104
1390	45.3064	39	49.2	17	1575	1410	89.5238	44	100
3185	51.7213	49	54	25	3235	2615	80.8346	26	100
1660	44.2903	33	55.9	28	2090	1840	88.0383	39	100
1940	44.7211	35	56.9	34	2470	2100	85.0202	30	99
670	46.0631	44	54.9	27	810	650	80.2469	24	95
1740	41.7667	25	56.5	31	2255	1985	88.0266	38	94
1735	39.405	16	56.2	30	2020	1735	85.8911	34	80
1465	41.1286	22	52.5	21	1695	1450	85.5457	33	76
3580	46.9324	42	47.3	12	3145	2340	74.4038	20	74
1860	34.041	6	54	24	2740	2450	89.4161	43	73
1695	38.7075	14	49.7	18	2175	1935	88.9655	41	73
2380	44.7284	36	50	19	2445	1795	73.4151	17	72
750	39.6825	17	57.7	39	980	715	72.9592	16	72
1685	43.6077	31	46.6	10	1725	1425	82.6087	28	69
2685	44.5274	34	51.9	20	3075	2190	71.2195	14	68
1655	36.8269	9	57.8	40	2240	1660	74.1071	19	68
2950	41.4792	24	45.5	6	3035	2645	87.1499	36	66
1935	42.1293	27	46.4	8	2045	1700	83.1296	29	64

(0 out of 53 Selected)

Census Tract Ahuntsic Age

I selected the 10 census tracts that were touching “*CleanAccessiblePotentialPlots.shp”*, ranked them in ascending order, highlighted the top three, and exported them as a new polygon layer called “*BestDemographics.shp*”.

Table

CTs_Near_Plots

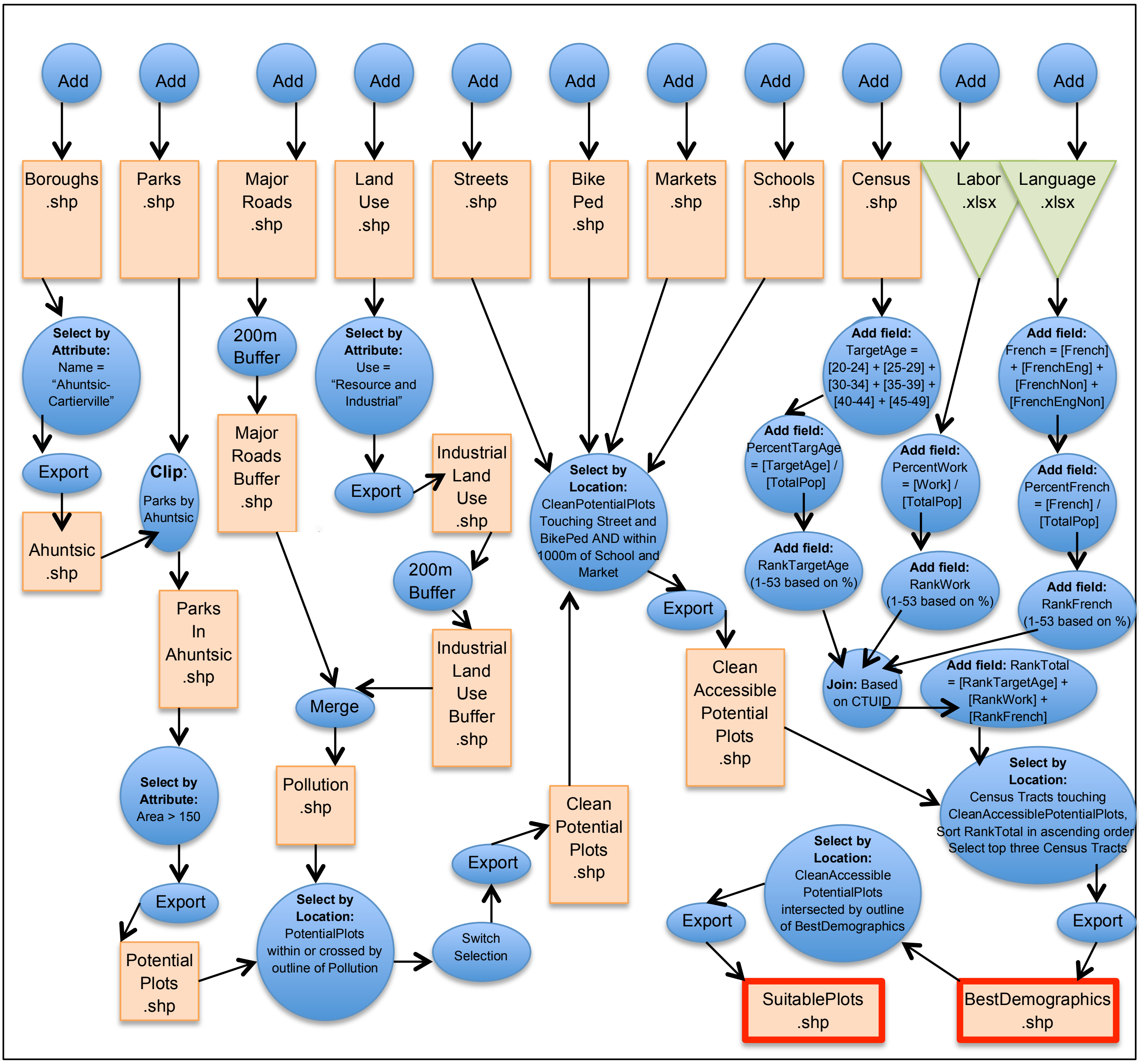
LangPop	French	PercFren	RankFren	RankTot
3135	2780	88.6762	40	124
2185	2015	92.2197	52	113
2855	2655	92.9947	53	112
2470	2100	85.0202	30	99
2740	2450	89.4161	43	73
2175	1935	88.9655	41	73
2445	1795	73.4151	17	72
2240	1660	74.1071	19	68
1495	1205	80.602	25	59
2688	1988	73.8886	18	47

(3 out of 10 Selected)

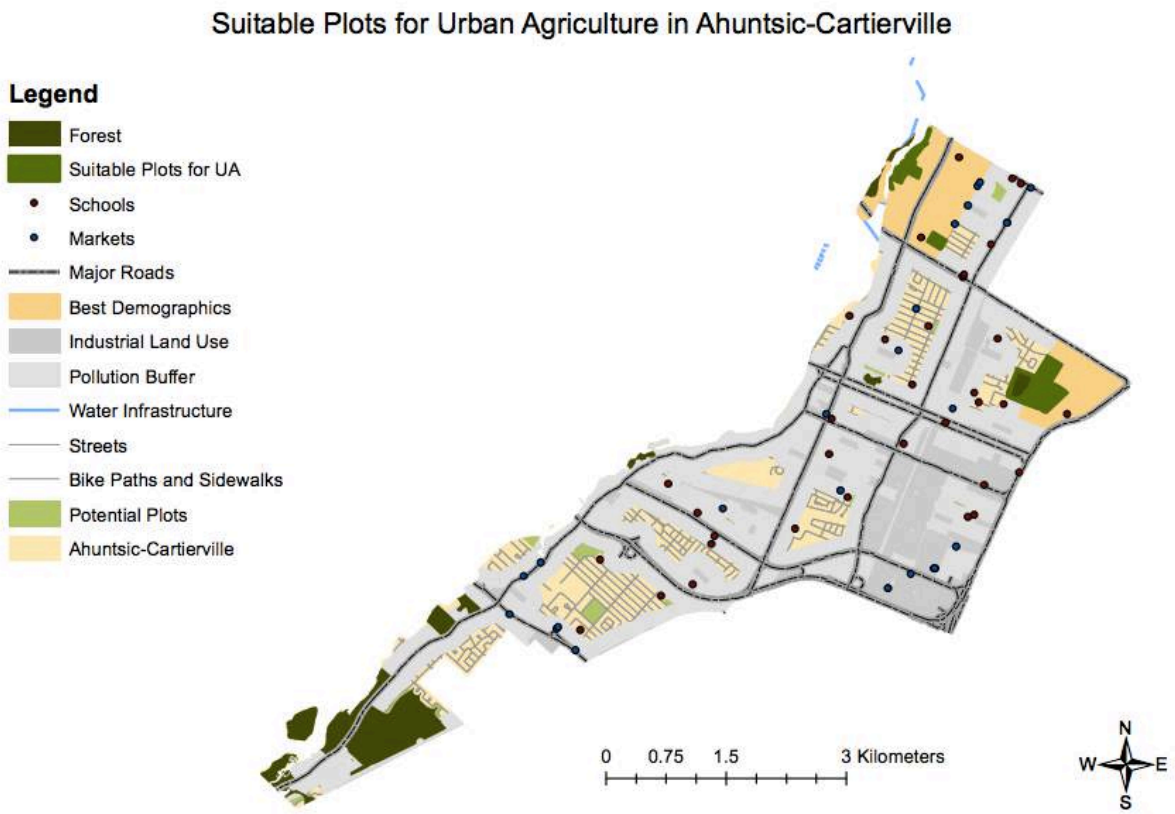
CTs_Near_Plots

My final step was to remove plots in "*Cleanaccessiblepotentialplots.shp*" that were not touching the top three census tracts in "*BestDemographics.shp*" and to export the final selection into a new polygon layer called "*Suitableplots.shp*". The overall process-of-elimination technique led me to three suitable plots: *Parc Jean-Martucci, Parc de L'Ile-de-la-Visitation, and Parc du Sault-au-Récollet.* On my final map, I incorporated shapefiles of water infrastructure and forest cover to provide additional information.

(e) Cartographic model



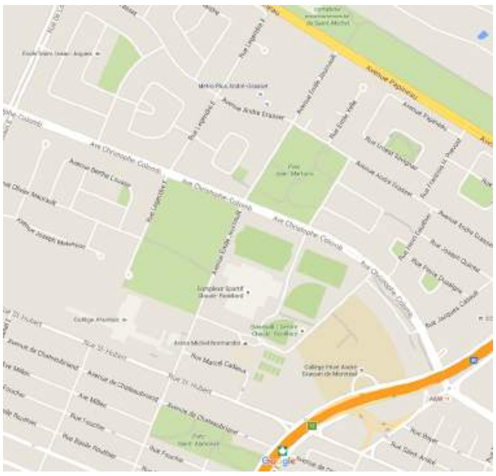
(f) Map



3. DISCUSSION/RESULTS

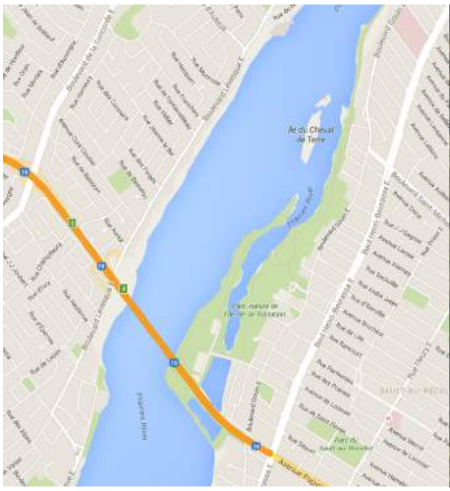
To gain further insight, I analyzed the plots using GoogleMaps (satellite and street view)

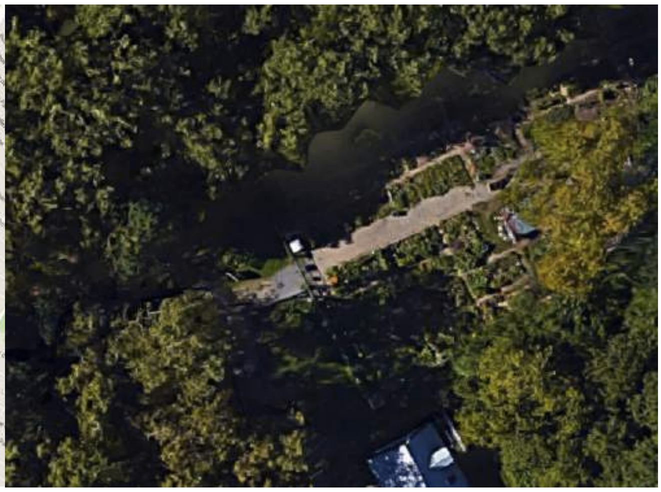
Suitable plot 1: Parc Jean-Martucci



The first plot is in a central location. It is situated near a sports complex, a public middle school and a private middle school, making it very accessible to the community and particularly visible to the younger demographic. It already has an urban garden called the Jardin Communautaire Saint-Sulpice (“L’arrondissement”, 2009). However it is not near any sources of water and, though it is 200 meters away from pollution, it remains quite close to major roads such as Avenue Papineau and the Metropolitaine Highway.

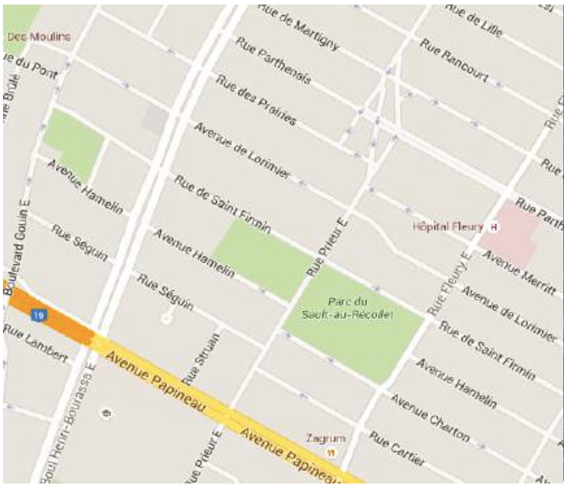
Suitable plot 2: Parc de L’Ile-de-la-Visitation





The second plot can be found along the Prairies River, an attractive feature considering the agriculture must be supplied with water. Compared to first plot, it is farther from major highways but also more distanced from the community. Interestingly enough, this plot also has an urban garden called Jardin Sault-au-Recollet (“L’arrondissement”, 2009). Certain elements weaken its suitability for UA such as the presence of invasive species (i.e. weeds, insects, snakes) and the overpowering shade of the trees.

Suitable plot 3: Parc du Sault-au-Récollet



The third plot is located in between the other two plots and boasts a happy medium between them: it is closer to water than the first plot and more integrated in the community than the second plot. Furthermore, it receives a strong amount of sun exposure and is near a middle school, high school, and commercial street. One downside of the park is that it is relatively close to Avenue Papineau, which could pollute its air quality. Unlike the other plots, it does not already have an urban garden. Thus, implementing one here would benefit a new group of people. All factors considered, I recommend Parc du Sault-au-Récollet as the most suitable for UA.

4. CONCLUSION

Though urban agriculture is gaining traction in Montreal, it is important to confront challenges such as the lack of available land, contamination from urban areas, the lack of access by the community, the lack of social support, and the lack of resources. These challenges slow the implementation, acceptance, and productivity of urban gardens and prevent urban areas from reaching their full potential in sustainable development. In this project, I hypothesized that if I could eliminate these challenges one by one, I could hone in on a plot of land that was clean, accessible, and in close proximity to the best demographics and thus suitable for community gardening. I began this paper by defining the challenges in terms of a GIS project and describing the proxy data I found to represent them. Following this, I summarized the steps of my methodology, explaining how I used a process-of-elimination approach to remove areas that were impure, remote, and surrounded by less enthusiastic citizens. After explaining how I obtained my most suitable plots of land, I included a cartographic model to visualize the steps of my methodology/analysis and a map to show the locations of my three final suitable plots of land. In my discussion, I examined the advantages and disadvantages of each suitable plot. Parc Jean-Martucci is located in the residential heart of the borough while Parc de L'Ile-de-la-Visitation is at the edge, bordering the river. Both plots already have urban gardens. Parc du Sault-au-Récollet does not have an urban garden and boasts similar positive features of (i.e. near community and water). I thus recommended Parc du Sault-au-Récollet as the most beneficial plot for implementing a UA venture, as it that would reach a newer, larger audience. Though this project demonstrated GIS's utility in analyzing land suitability, it did not include real-life assessment or take into account factors such price of land, soil quality, and neighborhood dynamics. My recommendations for future projects would be to include the locations of existing UA ventures beforehand. One could apply this process-of-elimination approach in other cities where UA is less popular. In order to do so, one would need to find local data on appropriate land types (i.e. parks, backyards, balconies), sources of pollution, transportation routes and attitudes concerning UA.

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