

Metropolitan Agriculture

Network Analyst

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Thesis

Geographic Information Systems (GIS) are powerful computer-based tools for integrating and analyzing spatial data from multiple sources. GIS permits geographically referenced information to be stored, edited, manipulated, and analyzed to generate interpretive maps and related statistics relevant for decision making. Applications in real estate spatial analysis are gradually taking off with the introduction of personal computer-based GIS software (Barnett & Okoruwa, 1993). This is a presentation of ESRI's ArcGIS as a tool to search for a retail storefront and an agricultural location for the purpose to grow and sell products in a Metropolitan area. Some ideas for the project include an espresso store and coffee roasting location, a winery and vineyard, or a vegetable stand and farming location.

What is a topic more interesting? How about something more controversial? How about Marijuana? Legalization might, or might not be on the horizon. If current Initiatives do not make it to a public vote, this project could be converted to help other individuals, businesses, organizations, or governmental departments.

Historical Background

Cannabis cultivation for fiber a seed predates written history. Many theories surround its early psychedelic uses, including the role psychoactive plants may have played in the evolution of consciousness by introducing to us some concept of a spiritual dimension and perhaps the notion of religion (Thomas, 2006). In the early days of the United States of America, in 1619, America's first

Picture Credit: Does not want to be listed.



hemp law was enacted at Jamestown colony “ordering” all farmers to grow *Indian hemp* seed. Similarly, mandatory hemp cultivation laws were enacted in Massachusetts, Connecticut, and in the Chesapeake colonies into the mid-1700’s (Global Hemp, 2010). The word “marijuana” was adopted by Americans in the 1900s when they were introduced to new drug varieties by migrating Mexican laborers in the South West. The El Paso city council calculated that marijuana prohibition would be a convenient way of controlling the unpopular Mexicans. In 1914 passed the El Paso ordinance act of 1914, banning cannabis in the state. Marijuana became associated to unpopular ethnic minorities, as a tireless campaign of propaganda and misinformation took control of the media. On June 14th 1937 the marijuana Tax Act was passed in the United States, effectively making cannabis illegal. (Thomas, 2006).

Project Background

In the State of Washington and through the United States, there is a continual controversy and debate about the plant, Cannabis. Should it become a legal substance or remain illegal under current Federal guidelines? This project is created not to answer or debate those questions, but to utilize GIS in an awkward and interesting topic. In February, 2010, multiple news sources reported about the attempt to collect approximately 320,000 signatures in Washington State for Initiative Measure No. 1068 (I-1068). Initial reports represented an idea that marijuana would be legalized and distributed through the existing Washington State Liquor Control Board. That created a GIS project idea to map out the retail network through the state and based on various factors, locate light industrial property to create a commercial, State ran gardening operation. Through raster calculations, can we establish a scale to help shop out land for this endeavor? How can the State of Washington utilize the existing networks for transportation to retail outlets? Would legislation be able to manage this system? What would be necessary to create a location with the provisions to manufacture and distribute marijuana within the state? What attributes would be necessary to create an agricultural location (freeway access, size of available locations, expense per acre, a lack of accessibility for children, school zones, parks, usable acreage and wetlands, among other elements)? Most of the questions were too extensive for this project.

There were two spatial extents for the project. One was to focus on plotting the liquor retail sales network throughout the State. The second area would concentrate on light industrial areas and would be narrowed down to Pierce County. If necessary, the extent could be expanded to include King and Thurston County.

Originally the idea developed as a way to utilize specific elements for the identification of light industrial locations, appropriate for production and distribution of marijuana (or any other agricultural product); indoors. Network Analyst would be used to locate real-estate locations within specific distances to highways, for transportation. Additional factors, such as population density, mean ages and wages, could be used with the raster calculator to pinpoint a parcel to grow and distribute from.

Cannabis is such a broad topic; a paper could be taken in multiple directions. Research turned to gardening techniques by reading through a book written by Jorge Cervantes, *Indoor Marijuana Horticulture*. Basic elements necessary for a warehouse include: air circulation, carbon dioxide, cloning, cooling, de-humidification, fertilizers, gauges and meters, heating, humidification, lighting, male/female plants, pest and mold control, reservoirs, security, seeds, storage, type of medium, ventilation, water.

After reading through I-1068, it was found not to include any distribution information. It would remove state civil and criminal penalties for persons eighteen years or older who cultivate, possess, transport, sell, or use marijuana. Marijuana would no longer be defined as a “controlled substance.” Civil and criminal penalties relating to drug paraphernalia and provisions authorizing seizure or forfeiture of property would not apply to marijuana-related offenses committed by persons eighteen years or older. The measure would retain current restrictions and penalties applicable to persons under eighteen (Sensible Washington, 2010).

Winter Quarter Research

In the Winter quarter, research helped move the project into various directions. When it comes to Cannabis, the topic is not heavily covered in scholarly articles, unless it is medically connected. This

project is focused on location analysis. Most of the research collected was based on other topics for various reasons.

Informational searches started with looking up information about Cannabis effects on the body, and finished up with techniques that might suit this project. In recent times, our knowledge of cannabinoids and the endocannabinoid system has greatly advanced. With expanding knowledge, synthetic cannabinoids - including nabilone, dronabinol and a combination of synthetic Delta9-THC and cannabidiol - have been developed and tested for benefit in a variety of therapeutic indications (Turcotte & Le Dorze, 2010). Delta-9-tetrahydrocannabinol (Delta-9-THC) and Cannabidiol (CBD), the two main ingredients of the Cannabis sativa plant have distinct symptomatic and behavioral effects (Bhattacharyya et al., 2010). In the reading *Opposite Effects of Delta-9-Tetrahydrocannabinol and Cannabidiol on Human Brain Function and Psychopathology*, healthy, non-using volunteers are given Delta-9-THC, CBD, or a flour placebo in a gelatin capsule, to examine the effects on the body. Fifteen men were studied to determine the specific brain effects. The second hypothesis was that CBD pretreatment would diminish the effects of Delta-9-THC-induced psychotic symptoms. Through various tasks and tests, patients who were administered Delta-9-THC reported behavioral effects. With MRI's, following up with CBD there was no change in psychotic symptoms, and trends for a reduction was subjective. Overall, the data collected indicated that some of the effects of CBD on the brain function and psychiatric symptoms are in the opposite direction to those of Delta-9-THC. How this might be achieved at a molecular level is uncertain (Bhattacharyya et al., 2010)

Over a period of 4 years (1997-2000), British Columbia (BC) experienced tremendous growth in the illicit production and distribution of domestically grown marijuana. By the close of 2000, each policing jurisdiction in BC had adopted a particular policy in response to grow operation proliferation (Malm & Tita, 2006). Maps were created to represent how the Jurisdictional policies became more lenient or stringent. Green Team (teams trained specifically to eradicate marijuana gardens) impact of marijuana production, and contrast this with the effects of the other policy options. By using GIS to identify where policies are implemented we explore issues of effectiveness (Malm & Tita, 2010). The

number of grow operations were kept track of, along with the change in numbers over seven years. While this document is not a particular help to the specific project, it did demonstrate a direction GIS is used in helping communities.

The article *Application of Geographic Information systems in Site Selection and Location Analysis* by Albert P. Barnett and A. Ason Okoruwa, is an overview for how GIS can take multiple variables and become a tool for location analysis. When applied to site selection, it is an excellent for visual representation.

Characteristics like bank loyalty or the variety of services are not taken into account in most models. This is not very important due to the fact that nowadays nearly all banks offer similar banking services and loyalty does not seem to play a major role as it used to (Alexandris et al., 2008). This idea coupled with personal experiences in Washington State casinos demonstrates that people want convenience, but for a special form of entertainment, they will travel. The paper is ultimately written around three questions: 1) where would a bank locate new branch, 2) throughout each area, how many branches are required, and 3) where is the exact location of each branch (Alexandris et al., 2008)? The paper utilizes population density and the demand for new branches within different municipalities, in ArcGIS. All very good angles to consider with location analysis utilizing ESRI software: eventually not applicable to this project.

The article *Landscapes of Predation, Landscapes of Neglect: A Location Analysis of Payday Lenders and Banks*, by Steven M. Graves, takes a look at location analysis based on racial demography, local wages, poverty, renter-occupied homes, median house values, along with bank and payday loan locations to determine the appropriate site for a new branch. Except for the banks and payday lenders, the rest of the list is reasonable, if the information can be found.

Visual Analysis and Semantic Exploration of Urban LIDAR Change Detection is an explanation of Light Detection And Ranging (LiDAR). An interactive application allows for a rich visual exploration of the output data as opposed to more traditional output formats for this type of result. It provides the basic behaviour and capabilities of existing GIS / 3D terrain applications as well as visualizations that

allow the user to analyze the results in a number of different views (Burkiewicz et al., 2008). It would be fun to implement some three dimensional characteristics for one of the project maps. Could also be overkill: the idea was eventually eliminated.

Construction Schedule Review in GIS with a Navigable 3D Animation of Project Activities, works through the fun and limitations of 3D modeling available in ArcGIS. It goes on to add AutoCAD renderings for the creation of 4D pictures for visual planning and development. It represents the next stage in dimensional modeling, but there probably won't be time to learn and integrate CAD in this project.

Geographic information systems (GIS) are generally regarded as special types of decision support systems (DSS). A primary feature of GIS is the ability to link data to maps. For an entrepreneurship course, usage of GIS provide a unique opportunity for students to experience the decision-making process that goes into determining the location of a new business. This process includes (1) selecting multiple locations, (2) gathering data via the GIS for each location, (3) analyzing the data, and (4) recommending the best location based on the analysis of the GIS data and the special needs of the business (Fuller & Bradbard, 2009). This paragraph represents the basic fundamentals for this project, whether creating data layers, or the final map.

One of the most important decisions a retailer can make is where to locate a retail outlet. Because convenience is so important to today's consumers, a retail store can prosper or fail solely based on its location. Recently, a changing retail environment is augmenting the location importance as retail economic groups develop multi-outlet chains of small stores. After the selection of some alternative locations is made, usually with the help of real estate agencies, it is intended, in a second phase, to accomplish the final store-site choice. For this decision level, the number of commercial plus academically published models suggests that researchers feel a need for rational and formal use of information (Mendez & Themido, 2004). Along with using GIS as a break away from the norm, it is a subjective tool. My project uses GIS to locate property based on the needs that become created as the

project moves forward. The project direction has changed. The following paragraphs cover a two month metamorphosis.

Spring Quarter Progression

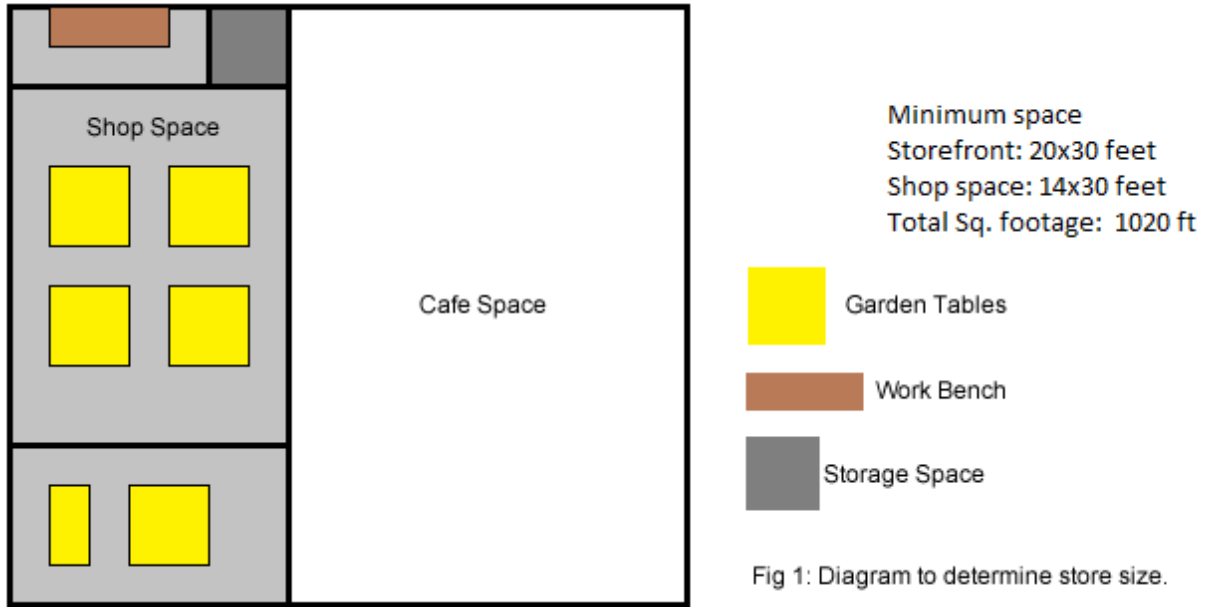
During April, the project quickly began to take shape and transform to the idea presented in the final maps. A new idea was proposed in class: look at ideas similar to a restaurant, with micro brewing facilities in the shop space. Over the past decade, the City of Tacoma has been working on a Brewery District. Policies have followed a consistent trajectory; balance redevelopment with preservation; create a sustainable mixed-use district focusing on the arts and creative sectors and incorporating a blend of residential, light industrial and commercial uses; and provide for active walking streets and pedestrian-oriented design (City of Tacoma, 2010). With these ideas in mind, it looks as if the project will fit within this mixed-use downtown Tacoma area.

At this same timeframe, Professor Matthew Kelley, Ph. D. proposed the idea that might simplify the project. Use ESRI's ArcGIS Network Analyst extension to locate separated warehouse and store locations, within a specific distance. With concerns that the appropriate parcel and building parameters might not be found, this would free up limitations.

Mapping

Since this analysis will only be covering areas within the Tacoma city boundaries, parcels were first purged from the Pierce County 'Land_Use_Existing' layer, using the 'zoning' layer for the City of Tacoma. Using 'select by location' option, 7,095 properties were chosen out of 300,170 parcels to create a new Shapefile: TacomaStoreLanduse. The 'TacomaWareLanduse' layer was created with 2,045 properties.

To determine what zoning would be accurate for the project, a visit to the Tacoma *Title 13: Land Use Regulatory Code* would be necessary. The Municipal Code has a 'district use table' to help out the research process, with multiple use options to determine the appropriate zoning for the needs of this



analysis. Considering the context of this business, the storefront was compared to ‘brewpubs/taverns’. The zoning used will be: C-2, NCX, CCX, UCX, UCX-TD, RCX, CIX, M-1, M-2, and PMI. The warehouse could be compared to ‘industrial, limited’ or ‘light industrial’: UCX-TD, CIX, M-1, M-2, and PMI. The ‘select by attribute’ option was used to dissect all parcels needed for this exercise out of the ‘zoning’ layer. The selected areas are exported to new layers specifically for the needs of the store, and then the warehouse.

As research continued, it became apparent that there was no source for building square footage within the available parcel layers. Estimates would have to be created, or 7000 sites would have to be visited around the city.

For enough square footage to provide various services (coffee, pastries, and other snacks and beverages, in addition to Marijuana), a diagram (Fig. 1) was created to estimate the storefront size. The minimum size was determined to be about 600 sq. feet. That size was doubled to determine a maximum building size search value. Since building footage was not available, the area was doubled again, to 2400 sq. ft. for the parcels maximum footage.

The warehouse location in the analysis is based on the most intricate article that could be found on a Medical Marijuana gardening operation in Cannabis Culture Magazine, Issue 71. The 4800 square foot building is located on several acres, is used as a basis to determine what properties would be applicable. Since the building was so overwhelmingly large based on the patients it provides for, the square footage was rounded down to 4000, and used as a search parameter within the attribute table. To provide for future expansion or distribution, the maximum acreage should not be a concern.

A Geodatabase and the Feature Dataset was created in existing files to help organize the Shapefiles and maps. All layers downloaded or created throughout the project would be imported into the 'agricultural_research' Geodatabase or the 'PierceCounty' Feature Dataset. 'Basemap', 'zoning' 'Land_Use_Existing', 'Parks', 'School_Grounds', and 'Taxpar' datasets were downloaded from the Washington State Geospatial Data Archive (WAGDA) website. The 'TET474332' raster layer was also loaded from the WAGDA archive. The Washington State basemap and City of Tacoma boundaries, and 'TacStreet' (includes a speed limit attribute) datasets were purged from Lab Assignments in the University of Washington (UW) GIS and Spatial Analysis Certificate Program. An aerial layer was also used from ESRI's website to analyze the current property use during analysis.

To prepare the TacStreets layer for Network Analysis, additional fields were created for the attribute table. 'LengthMiles' represents the road segment length, in miles. The 'Shape_Length' field was multiplied by a converted value of 0.000189393939393939, to convert the column from feet to miles in the 'LengthMiles' column. To create the numbers needed for the 'DriveMinutes', for the determination of the drive time in minutes, the formula looked like: $([\text{LengthMiles}] / [\text{SPEEDLIMIT}]) * 60$. To determine the 'WalkMinutes' attribute column, the formula looked like: $([\text{LengthMiles}] / 3) * 60$ (Kelley, 2010).

The 'Select by Attribute' and 'Select by Location' tools were constantly used to eliminate unqualified parcels and create new datasets. The layers for parks, schools, stores, and warehouses, were all converted to points before being used in Network Analyst. The 'Tacoma_ND' Network Dataset was created within the 'PierceCounty' Feature Dataset. The data frame, 'Project Analysis' was created to

separate Analyst from other maps, in an attempt to keep the ArcMAP Table of Contents clean. The 'Default Breaks' were changed for each Network Analyst layer. The school and parks layers were set at five minute walking distance. The warehouse and store analysis became set to ten minute drive times. The number of warehouse parcels was too vast and had to be cut down by purging properties based on additional 'current conditional uses': Education, Group Quarters/Other, Mobile Homes, Multi-Family Residential, Open Space/Recreation, Public Facilities, Quasi-Public Facilities, Resource Land, Single-Family Residential, Residential Outbuildings, and Transportation, Communication, Utilities. Warehouse parcels over 87,120, or two acres, were eliminated. The ten minute driving distance was reduced by five, to keep the drive within Tacoma city limits.

The Parks, Schools, and Store layers only took a few minutes to run through Network Analyst. The Warehouse layer, with 1156 locations, took over 1 ½ hours to finish. After the fact, it was realized, the Warehouse layer would not be needed.

Store and Warehouse locations were eliminated within the five minute walk to any parks or schools. At this point, if there was more time for the project, the remaining parcels could be passed off to a Real Estate Agent and eliminated based on their availability. The locations could be rated further based on what resources would be invested to make necessary land and building improvements. Since there is not a Real Estate or Construction Consultant working with the project, the assumption was taken that all parcels are available and investment money is not a concern.

It was determined that warehouse locations would be locked and secured from outside influences. There is minimal concern for the distance from parks and school. The excessive parcel count, pushed the project into a direction where the properties should be eliminated, no matter what the exterior appearance would be. The buffer from parks and schools was extended to a ten minute walk. Intervals for the Store analysis were changed to 1, 2, 3, and 4 minutes.

The project was now down to 47 possible store locations, and 591 warehouses parcels. Parcels were eliminated below 10,000 square feet in the warehouse layer and 1600 feet for the store parcels. Originally, it was not expected to have such an abundant number of locations. Parks and schools were

run through Network Analyst to determine the walking radius of 12 and 15 minutes. Every property within the 15 minute walk time was deleted.

The focus switched to the most condensed group of parcels, with the highest area of traffic. The idea was to visualize Tacoma and determine areas with good access for transportation and deliveries. I was also looking for areas of higher customer traffic. An aerial layer from ESRI was added to pick out other flaws around town. Of the nine remaining store locations, two were near the Port of Tacoma, in an area surrounded by industry and shipping. Although, convenient to warehouse space, they were too far away from a potential customer base. Four store locations were in an area near the Tacoma Mall. Great for customer access, but upon review of ESRI's aerial layers, the locations had new home construction; too expensive to purchase and rebuild. Two shops did not have any warehouses within five minutes. As it looked like the search would have to be started from scratch with new parameters, one isolated property was found on the boarder of Tacoma, along I-509. The location had four parcels within 4 minutes, two were vacant. The location is not well traveled, but has good visibility from the freeway.

The final storefront point is a sliver along the freeway, directly next door to a parcel perfect for the warehouse. There are also three other parcels that could be looked at; two have existing buildings. The five points were exported to new layers. An aerial shot was downloaded from WAGDA for the final layout.

Conclusion

Final concerns and feasibility issues could be looked at within a business plan. This project is in a form to represent a realistic use to the ESRI's ArcGIS software and the Network Analyst extension. Options could be modified for additional or lessened detail with further development. In retrospect, Analyst did create a simple way to dissect the parcel search. If the project was reworked, I might choose a project topic that is more comfortable to talk about in public: winery and an indoor vineyard. An additional change includes running GIS around raster calculations. The analysis could be based around wages and demography density. In any case, this process created a reasonable outcome. The final parcel

cluster could house this new type of business, as a separate warehouse and storefront, an integrated store and garden, or the original idea of a business ran by the State of Washington.

Final Parcel Selection Layers:



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