Potential Orienteering Map Sites in Greater Vancouver

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Abstract

Orienteering is a competitive sport involving cross-country navigation through forests, parks or urban areas at running speed. Training and competition requires specific orienteering maps to be produced. The goal of this project was to determine potential locations of new park or forest orienteering maps in Greater Vancouver, based on being a park or other forested area, accessibility by transit or major roads, area size, and being areas that have not already been mapped by Greater Vancouver Orienteering Club (GVOC). Using ArcGIS software, the analysis identified 14 potential areas. Data was found from UBC Geography and GVOC; Google Maps was referenced for additional information. Numerous GIS techniques were used to select only the areas that met the criteria. A map was produced demonstrating the proposed potential mappable areas along with already existing maps. An explanation of steps taken, analysis of results, and suggestions for improvements are included, along with maps demonstrating intermediate steps.

Project Description

The objective of our project was to determine potential areas in the Greater Vancouver region that would allow for an appropriate orienteering map. In Vancouver, orienteering is done in fairly large park areas to allow for interesting diverse terrain and enough size for the competition or training to be physically challenging. Park orienteering maps can be any combination of open, grassy areas, dense forests with paths, or through less dense forested areas. For our project, we added layers that are relevant for finding this type of appropriate areas. For our targeted areas in Greater Vancouver we focused on park areas rather generally looking at land use to determine potential areas. This provided a more accurate representation of appropriate land because forested areas are preferred over just grass covered areas which may be selected when looking at land use but less included when looking at parks.

The data was obtained from the UBC Geography G:Drive as well as some other online open source sites. The layers needed from the G:Drive were: Roads/Transit/Trails (polyline data), Rivers/Water bodies (polygon data) as well as land use and parks (polygon data). We then added the Greater Vancouver DEM (raster data) from DataBC. We additionally created a layer of point data of already Existing Orienteering Maps, obtained from GVOC (Greater Vancouver Orienteering Club, 2017). This gave us a clear indication of where not to select as a location to map because orienteering maps of those areas already had been made. Together the data obtained from these sources allowed us to create map projections showing the possible regions for orienteering maps.

Methodology of Analysis

The analysis included imputing all the various layers (excel spreadsheet of existing orienteering maps, roads, parks and recreation, various TransLink routes, Greater Vancouver shapefile, water bodies and DEM92) that needed to be considered into ArcGIS. An excel spreadsheet was created with X,Y coordinates of existing orienteering maps, exported into ArcGIS and saved as a new layer. All the layers were then converted into NAD83 UTM Zone 10 to avoid discrepancy of features when overlaid and as little distortion as possible.

The transit data came in 4 different layers (Bus stops, Canada Line stops, SkyTrain and West Coast Express stops) so the layers were merged into one. This was then exported and saved as a new layer. The parks and recreation layer consisted of areas that could not be used, such as cemeteries. To remove the areas that are unsuitable, a selection by attributes was made and a new layer was created from suitable parks areas and then exported.

Furthermore, using the DEM layer, 50 meter contour intervals were made with a Z-value of one using the contour 3D analysis tool. This was added because orienteering map locations required varied elevation to challenge the competitors. A buffer radius of 250 meters was created around the existing orienteering mapped areas. This ensures that the new orienteering map location would not be too close to these features or an area that has already been mapped would not be selected. Under the assumption that people using major roads would be either biking or driving, a 1000 meter buffer was created around existing roadways (assuming this distance was not too far given the means of transportation). A buffer of 500 meters was placed around transit stops so that ideal map areas are not too far in terms of walking distance. The buffered main roads and transit stop layers were then merged into one layer called “commute”.

Following this, all the layers (existing orienteering maps, waterbodies, commute, contour, acceptable parks and DEM92) were clipped respectively to the Greater Vancouver shapefile area. This helps to focus in on one area and discard the extra unnecessary data. At this point, we have a map that shows commuter accessibility around Greater Vancouver and park areas that are viable if they do not overlap with existing orienteering map locations. To determine what acceptable and accessible parks are, the commute layer is intersected with the acceptable parks layer to create a new layer of acceptable, accessible areas. Use the erase tool to get areas where potential new maps can be made. On the potential new maps layer, there are polygons that are adjacent to each other rather than showing one continuous park. To eliminate this problem, a dissolve and multipart to single part tool was performed on the polygons. The goal was to make adjacent polygons that had continuous land into a single parcel. Then a field was added on the attribute table and the geometry of the areas of all the polygons calculated in the acceptable accessible areas layer.

A selected by attributes was performed to isolate the areas that are greater than 200,000 meters squared (selected based on the approximate average size of existing orienteering maps). Since only an erase and buffer of the areas that already possessed an orienteering map was done earlier, the point feature that is the existing maps might not be in the park area but the map could still include that park. So, using the spatial selection method, polygons that still overlapped with existing orienteering maps were eliminated. This data was exported into a new layer. Finally, a hillshade was created out of the clipped DEM layer.

Discussion and Results

In our initial proposal, we wanted to include data for accommodations, such as campsites and hotels, and land use. However, as we did the analysis we decided to exclude these sources of data. For the hotels and campsites, we did not find enough data for campsites in British Columbia as they only had data on sites around Vancouver Island. Furthermore, as we did the analysis, we found that accommodations were not as necessary for orienteering does not usually span over days unless for competitions, so for majority recreational use accommodation data was not needed. Initially, we also planned on assessing potential areas based on their proximity to accommodations, but as mentioned instead we determined that it was not as necessary as a determinant and that transportation was more important factor in terms of accessibility.

As for the land use, because we decided to use parks as our basis for potential orienteering sites, land use became irrelevant as other zonings were irrelevant and unnecessary to add to our analysis and map. One of our potential layers of data was going to be of vegetation data, but the data was of all of British Columbia and was too coarse for our project area of just Greater Vancouver. In relation to our focus on parks as the main locations of where our potential map sites will be, the variation between vegetation cover we assume would be generally fine for running through. Also, because the focal areas are public parks and the sport of orienteering being relatively non-invasive, not requiring development of buildings or restructuring the landscape, the variance of land use and where maps should be avoided because of endangerment is minimized.

For our contour lines, we used the contour analysis tool to create contour lines from our DEM of Greater Vancouver from DataBC as our DEM data from the G Drive did not cover all of Greater Vancouver. Using the contour analysis tool, we made contour lines with an interval of 20 meters to show some variation as referencing the existing maps from the Greater Vancouver Orienteering Club showing 2 meter contours, without being too muddled in the final map.

Our first set of data to analyze was the modes of transportation and accessibility to our potential map sites. We decided to use data of the major roads in Greater Vancouver and Greater Vancouver's transit system containing the stops of the Canada Line, SkyTrain Line, bus, and West Coast Express. We had originally thought of including the bus and train routes, but they would be irrelevant as commuters could only get on and off at designated stops. We also limited our transportation buffer to major roads because between our data there were inconsistent pockets of finer road data, making the resultant analysis be inconsistent and with only major roads our timing estimates would be more consistent than if we considered smaller side streets. We decided to buffer the transit stops at 500 meters and the roads at 1000 meters. We chose 500 meters for the transit stops because we assumed that people commuting by transit would be travelling by foot or by bicycle, so we chose a comfortable walking distance at less than ten minutes. As for commuting on the main roads, we assumed people would be travelling by car or by bicycle, so chose a distance by cycling commute times being roughly twice as fast as by foot and roughly less than ten minutes, thus doubling the buffer distance. These estimates were assessed by using Google Maps and using its directions function to map the distance and time to travel from the UBC Bus Loop (the old UBC Bus Loop currently not in use anymore, updated by Google Maps) to the Irving K Barber Library. This estimate showed a distance of 600 meters and an estimate of seven minutes travelling by foot and 5 minutes travelling by bicycle. We merged both the resultant buffers of the roads and transit stops to create one continuous layer to mark transportation and commute accessibility.

The next set of data came from our points of existing orienteering maps. From the Greater Vancouver Orienteering Club (GVOC) website and their list of already mapped orienteering sites, we copied that data into Excel, taking the coordinate data of the points of location of their existing maps in decimal degrees. From the X,Y data points we imported this data into ArcMap as point features and converted it from decimal degrees to our projection. From these points, we estimated a buffer distance of 250 meters to buffer the average size of the existing orienteering site so that potential sites would not overlap existing ones. The 250 meter buffer distance was estimated from the GVOC's existing orienteering map for Queen Elizabeth Park, which has a radius of about 450m and in comparison to other maps by the GVOC above average. Our above average consideration for our buffer is so that we can account for the uneven shapes of existing orienteering maps to the extent of above average maps. These buffered polygons now show where we do not want potential map sites to be.

From our parks and recreation data, from the attribute table we selected land parcels listed as other parks and parks/sports fields to create a new layer out of, eliminating undesired areas such as cemeteries and swimming pools. With this acceptable parks layer we did a intersect analysis with our buffered commute layer to determine which parks were within an acceptable commute by foot, bicycle, and car. Then, with remaining parks acceptable by transportation, we used the erase tool to eliminate any areas where estimated existing maps would be to determine the total areas for our potential maps.

After erasing the existing maps, our goal was to find park land that was greater than 200,000 meters squared in area for our potential map sites, with the size based on our estimated size of average existing orienteering maps. We noticed that there were parks which were adjacent to each other, but because they were separated by land titles their areas were separated. We decided that with park parcels that were adjacent to each other there would be no issue with running through both parks as these park boundaries would not impose any barricades as, for example, country border boundaries would. Using the dissolve tool we merged all potential park polygons together and then separated them spatially using the multipart to single part tool so that adjacent polygons would merge and create one continuous polygon and area. From this new layer, using the attribute table added a field for park area and calculated the geometry for the polygons. After the areas were calculated, we selected the polygons where the park area was equal or greater than 200,000 meters squared to get potential map sites that were of a decent size.

What we noticed comparing the existing orienteering maps to our potential maps sites at this point was that some potential map sites surrounded the existing orienteering maps. Because of our decision to eliminate areas from the potential park areas to calculate the area using the erase tool, we essentially had holes in the middle of some of our polygons for potential map sites. This meant that for some of our parks there was already an existing orienteering map but because of the size of the actual map or the placement of the point to determine spatially where the map was, it did not cover all the park space itself. Even though assessing the area available there would be enough area to create a potential map by our standards, it would be redundant to have two maps for the same park. In this case, we eliminated any intersecting potential map sites by existing orienteering sites using the select be location tool as an intersect would not have been possible as when we erase from the potential park polygons it left an empty space, therefore in using the intersect tool none of the polygons were actually touching each other.

In the end, we found 14 polygons that had the potential to becomes new orienteering map sites. Because of the small number of polygons, we thought it would be beneficial to use Google Maps to identify as best we could the polygons as using the dissolve and multipart to single part tools erased any naming attribute data. For the final map, we created a hillshade using the DEM of Greater Vancouver, showing alongside the 50 meter contour lines, the potential map locations, and existing orienteering maps for reference. We decided to show where existing orienteering maps were on our final map to give reference to where new maps might be better to give variety in locations around Greater Vancouver or to give spatial representations of where locations should be around based on clustering of existing ones. For our representation of the final map we decided to zoom in to Greater Vancouver only showing to the extent where potential maps would be so that the viewer could see them better without having to insert inset maps, which would have been many of them. As for the contour lines, in areas where potential map locations area they are a bit sparse, which in hindsight we could have decreased to interval to maybe 25 meters, but when looking at the whole map of Greater Vancouver anything under 50 meters looked too fine for the areas North of Greater Vancouver, so we kept it at 50.

Error and Uncertainty

Our biggest source of uncertainty would be our estimations for existing orienteering maps. There was discrepancy between both the areas and sizes of the existing maps and each would unique to its own, especially in reducing the organic shape of the maps to a buffered circled. For example, some maps are bigger than others. Such as the buffered area for Pacific

Spirit Park is a small buffered circle but the map for that area is all of the park, even though the map shows it as "acceptable" for potential new map areas. In reality we would have wanted polygons to represent each of the existing maps, thus not ever estimating smaller maps, underestimating larger maps, and accounting for their size in spatial analyses, but it was not in our means. Thus, we were careful in using averages and slightly overestimating in our buffer as to produce as precisely potential locations rather than including locations that may later be determined unviable.

For our contour lines, we decided to create one from the DEM layer instead of using natural contour lines, so our lines stop and end. These contour lines were not the most accurate as looking towards the bottom of our map it shows lines that seem to represent buildings more that contours. We would have used natural contour lines but from the data that we found, it did not cover our entire project area or that the lines were too fine without a method of only selecting a desired interval. Because we could select our desired intervals by making the contour lines from the DEM we chose this method. In the end, for our analysis we decided that the slope of the land was not so much of a deciding factor as was transportation and proximity of existing orienteering maps and with existing maps contour lines were drawn at 2 meter intervals and visually that was not applicable in showing on our final map clearly.

One other source of error came from our decision to use data from 1999. This data listed our project area as Greater Vancouver, as we now refer to as Metro Vancouver. This clearly shows how dated some of our data is being now 18 years old, for example the expansion of the SkyTrain’s Millennium Line Evergreen Line expansion would have not been included. However, we decided to keep our title of our map in reference to Greater Vancouver instead of the current name of Metro Vancouver to remain faithful to our source data.

Further Research and Recommendations

This project hugely narrowed down potential map locations to 14 in the Greater Vancouver area. Nonetheless, it did not narrow it down to a single ideal location. To do this, several other analyses could be performed. Data with tree densities would ideally be found, potentially based of off satellite imagery to determine which one would be better suited for running through. Undergrowth information could also be found which would be useful because areas with less undergrowth are better for orienteering. Site visits of the potential maps could also be used if data is not available, since it is narrowed down to only 14 areas. This would also be useful for checking for hazards or other potential problems before a site is decided upon. LIDAR data of the area with very precise contour detail could be used to verify if the area would be good for creating and interesting, technical orienteering map. An analysis of parking availability could also be added. Permissions information, perhaps from the City of Vancouver or various other Municipalities should be consulted before creation of a map. Besides that, this project could be taken further to consider areas beyond the Greater Vancouver area, as many of those areas would potentially be good orienteering maps and could be fairly accessible to Vancouver orienteers, at least by car. Another option would be to determine areas that could potentially be used for urban or ‘sprint’ orienteering maps rather than the park or forest maps that this analysis found. Sprint orienteering maps are normally areas such as university campuses with a variety of interestingly shaped and sporadically oriented buildings that people are allowed to run around. Areas for ski-orienteering could also be found.

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Appendix A

Data Visualization

Refer to attached map series for analysis process:

1. Transit stops and major roads
2. Buffered commute routes
3. Selected parks
4. Buffered existing orienteering maps locations
5. Intersect of parks and existing orienteering map locations
6. Acceptable and accessible parks for the new map location
7. Acceptable and accessible parks for the new map location that are greater than 200,000m^2
8. Selection of potential parks that do not intersect with already existing map locations
9. Potential new map locations
10. Potential orienteering map sites in Greater Vancouver (final map)

Appendix B

Refer to attached flowchart of data analysis.