The Gap Analysis Tool for Outdoor Recreation: A Case Study in Metro Vancouver, Canada

Brent CHAMBERLAIN[1], Nalon SMITH[2], Mark VULLIAMY [2] and Erik LEES[2]

[1]Kansas State University, Manhattan, KS/USA · brentchamberlain@ksu.edu
[2]Lees + Associates, Vancouver, BC/Canada · info@elac.bc.ca

Abstract

As part of a long-term regional growth strategy, the Regional Districts of Metro Vancouver and Fraser Valley sought to better understand citizen demands and available infrastructure of outdoor recreation opportunities. This paper demonstrates a new Geodesign tool called the Gap Analysis Tool for Outdoor Recreation (GATOR) which was developed to address these inquiries, specifically to identify the facility inventory and provision of opportunities. The tool provides near real-time analyses and can inform the design and planning processes by providing relevant spatial and quantitative data. This paper shows how GATOR was used to produce a Gap analysis and lay the groundwork for making more informed decisions about the development of future infrastructure.

1 Introduction

Geodesign is quickly surfacing as a major player in spatial planning and design, requiring the development of tools which can address the complex problems we face now and in the future. Whereas more traditional static maps and analyses have been used to inform planning, the capacity to develop simulations and analyses of a design plan at multiple scales and at near real-time is fundamental to the core of Geodesign (FLAXMAN 2010). Design technologies which help improve the human decision-making process can help us become more effective stewards of our planet (GOODCHILD 2010). This paper presents a case study of how a Geodesign tool was created and used to produce large-scale spatial analyses to inform planners about the gaps in the provision of outdoor recreation.

Vancouver, British Columbia (BC) and the surrounding Metro area are well-known for providing a myriad of outdoor recreation opportunities. In 2010, dozens of municipalities supported by Metro Vancouver and Fraser Valley Regional District sought to better understand citizen demands and available infrastructure of outdoor recreation opportunities. The Districts hoped to address two major questions. First, which outdoor recreation activities are most sought after by our citizens? Second, and related to this demand, what are the gaps in our provision of these opportunities?

The outcome of the inquiry was a full Gap Analysis study led by Lees + Associates[2] (LEES) to identify the gaps between supply and demand of outdoor recreation infrastructure at present and projected for the next 30 years (LEES + ASSOCIATES 2013). The study was completed over two phases. Phase I involved the collection and analysis of survey infor-

Wissen Hayek, U., Fricker, P. & Buhmann, E. (Eds.) (2014): Peer Reviewed Proceedings of Digital Landscape Architecture 2014 at ETH Zurich.
ISBN 978-3-87907-530-0.

mation from residents in order to ascertain the demand for specific kinds of facilities and outdoor recreation opportunities. Phase II addressed the second question of existing gaps in the provision of outdoor recreation opportunities. Efforts during this phase were focused on the collection, organization and analysis of all geospatial data pertaining to outdoor recreation, green spaces, and demographics in a region consisting of nearly four million people. In the process of completing both phases, a Geodesign tool, called the Gap Analysis Tool for Outdoor Recreation (GATOR), was created. While GATOR was not envisioned as an outcome of the initial study, its creation was in fact elemental to the study. The initial aim of the project was to report on the survey data collected in Phase I, to create a Regional-wide database of outdoor recreation opportunities, and then develop static maps and reports to help inform planners. However as the project evolved, Lees identified an opportunity to produce dynamic analyses and maps that would inevitably save time and provide a way to produce maps as information changed in the future.

The primary purpose of this paper is to present GATOR and demonstrate how it was used by the Regional Districts of Metro Vancouver and Fraser Valley (Fig. 1, base). Specifically, the key elements created in Phase II of the study will be presented. The underlying data and limitations will be explained, as well as the methods and techniques used to develop the Geodesign tool. Finally, a discussion about the application and benefits of GATOR will be presented, along with a continued call for the development of effective Geodesign tools.

2 Methods: Constructing the Database and GATOR

The first part of Phase II required collating over 30 different spatial datasets from all Districts, Municipalities and Regions in the area. The first hurdle in developing GATOR was creating a database schema that could appropriately house the data and allow for future growth without knowing exactly what data would be collected and used to produce analyses. Every dataset differed, requiring a substantial amount of data conditioning to translate attributes, eliminate non-essential data and correct for numerous topological errors. The result was a schema that consisted of vector and tabular data. The point data stored locations and attributes for infrastructure such as picnic tables, swimming pools, boat launches and playgrounds. The polygon data stored park boundaries, as well as other spatially large recreation areas (e.g., ski areas). The line data stored trail information. Another table was created to store missing features which had not been spatially identified but could be joined with existing spatial features. All data were indexed so facilities could be joined whether spatially related or not. The process of conditioning and collating the data resulted in 10,000+ facilities consisting of 30+ different types of opportunities. With all the data collected and compiled into one database, the analyses could be created.

At the onset of the project no specific analyses had been defined. It was expected that as the project continued, the Regional Districts and Lees would define which analyses would need to be produced in order to best understand the gaps in provision. However as the project progressed, significant data issues were discovered. First, there was an inconsistency in data accuracy and spatial qualities of the data between municipalities. For instance, one municipality had collected the spatial location of every park bench, and digitized the bounds of each tennis court, while another only recorded the existence of a picnic bench within a regional park. Second, a large number of facilities were not recorded in the inventory.

These holes in the data required Lees to rethink which spatial analyses could be produced and how best to move forward. In the end, Lees, in conjunction with the Regional Districts, decided to focus efforts on studying select priority opportunities.

Each analysis required designating two variables: the analysis areas and the population source. The analysis areas provide a range of potential scales, specifically the regional, municipal, planning sector, or individual zone scales. Planning sectors are sub regional areas consisting of more than one municipality, which the Regional Districts use on occasion for long-term planning. The population datasets included census blocks or transit zones, the latter which consists of aggregated census blocks designed around proximity to transit infrastructure. Dozens of analyses were conducted, but for the purposes of this report only a sample of picnicking, outdoor swimming and child play (playgrounds) are presented. GATOR was being developed in tandem with the database, and this contributed to the process of determining the appropriate analyses because limitations could be anticipated. GATOR was initially created to expedite the analyses, ensure efficiency and reduce the potential for human error. It was not originally intended to be a Geodesign tool. GATOR was developed using Esri's ArcGIS Modelbuilder, augmented with custom code and built specifically around the database schema. Modelbuilder was selected as a development platform for three reasons. First, the client preferred the use of the Esri's ArcGIS platform; second, it is an efficient method for workflow modelling; and third, it provides a high degree of transparency so that the client could investigate the logic and methods used in each analysis. GATOR consists of three primary tools: 1) measuring opportunity provision per person within an analysis area (e.g., municipality, planning sector, and region), 2) measuring opportunity provision within a facility's service radius around each facility, and 3) measuring the population served by the number of competing opportunities within a facility's coverage area. Outputs of these three tools are shown in Fig. 1.

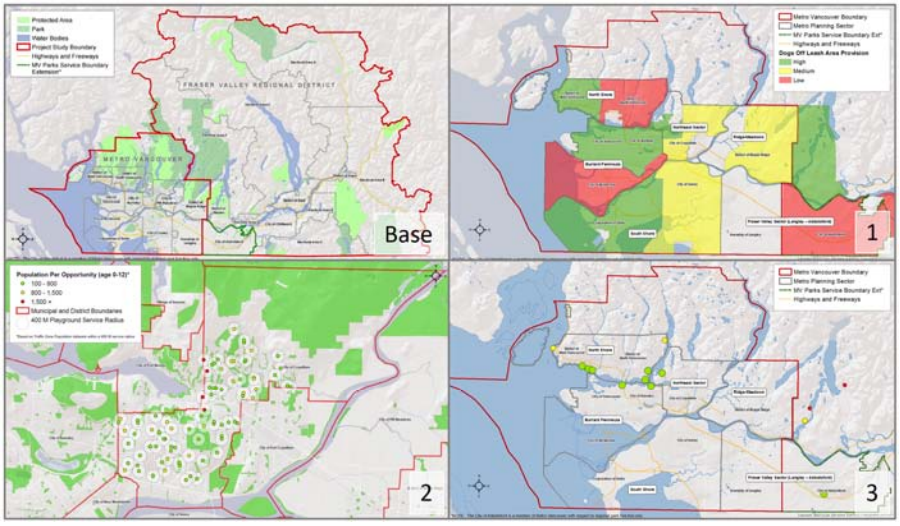

Fig. 1: GATOR uses the basemap and automates the analysis and creation of the other maps. Each map is identified with its associated numbered tool.

The first tool produces a simple measure of the number of facilities within an analysis area and divides that by the number of people in that same area. This tool was developed in order to produce aggregate comparisons across municipalities (as well as regions or planning sectors), essentially providing a broad-based overview about the state of provision by each municipality. These measures provide a baseline to gauge the Level of Service (LOS) according to guidelines identified in NRPA (1996). The second tool measured the number of people that could be served by any facility within a given service radius. In this case, service radius is defined as the spatial distance from the location of the facility. A matrix of service radii were created in partnership between Lees and the Regional Districts and developed to simulate a reasonable distance that someone would travel in order to access a given opportunity. Some examples of distance radii include: 400 m walking distance to playgrounds (CPRA 1973), 16 km to outdoor swimming (NRPA 1996), and 800 m for small groups to go picnicking (NRPA 1996). The third tool builds upon the second by exploring the number of opportunities within a given facility's radius. The benefit of the third tool is that it considers that individuals may have more than one opportunity within a given distance. In essence it allowed us to model citizen options, demonstrating that citizens could choose between alternative facilities. This tool provided a more appropriate measure of provision, particularly for areas with dense population and a number of nearby facilities. Whereas the second tool measured the possible number of citizens served by each facility, the third tool modelled the capacity of service within a given area. For all tools, LOS was calculated using one of the two aforementioned population datasets. In order to calculate the population within a service radii, when radii fully or partially intersected a population zone (or polygon), that zone's population was added to the total population served.

The final step in the tool's development was ensuring the functional usability. Full documentation of each tool was created and user interfaces were made to improve the ease of use. Finally, the tool and related code was optimized to ensure an efficient analysis. The result allows planners to open a given tool, enter their spatial datasets and receive almost immediate feedback about the degree of provision. Finally, the tools were augmented with automated mapping functionality which applied the appropriate symbology, legend and title to the map, streamlining the process from question to result and automating the creation of the map and report.

3 Results and Outcomes

As originally requested, Lees produced several analyses to inform the Regional Districts about the level of service for highly demanded outdoor recreation opportunities. A few examples of the results are shown in order to highlight the range of outputs produced from GATOR. With all the data sorted and consolidated, GATOR was able to produce these results in seconds.

Fig. 2 shows an example of the level of service for picnicking per planning sector. This type of analysis provides a quick overview for planners and officials who want to compare the provision in their area against other sectors. With an appended tabular report (also automatically generated), the data derived from GATOR delivers provision per 1,000 and 100,000 residents as per NRPA guidelines.

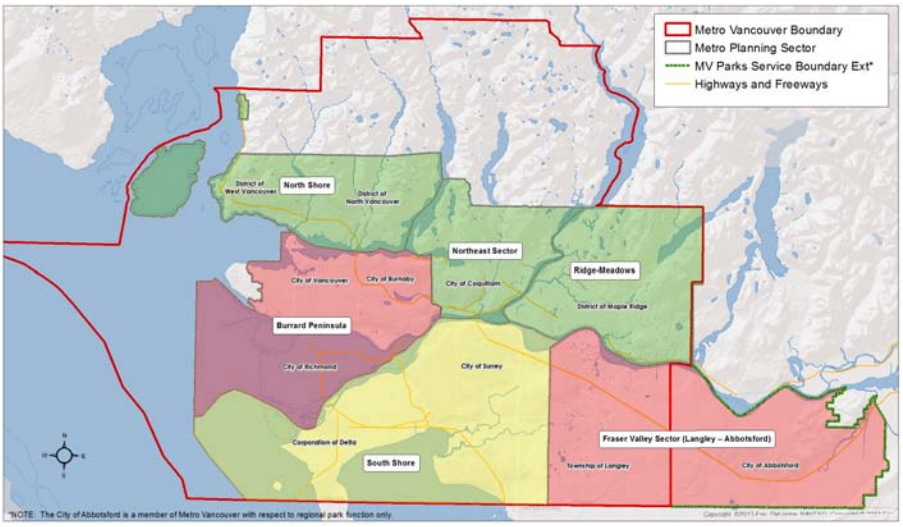

Fig. 2: Example analysis of picnicking opportunities within planning sectors. Red = low provision per capita, while green = a high degree of provision. The ranking is based on a relative comparison between sectors.

The example shown in Fig. 3 shows a sample area of playgrounds within the City of Coquitlam. The two analyses shown were based on the second tool in GATOR. This analysis measures the level of service within a facility's service radius. Note that there are two distinct scenarios: current (2011) and anticipated (2041). Based on the expected growth over the next 30 years, only a few changes in service can be observed. One of the more substantial changes will be in the Eastern part of the city where there is an anticipated increase in the number of children living within proximity to playgrounds. This phenolmenon is illustrated by the change in colour, from green in 2011, to yellow and red points in 2041. The analysis also shows large spatial gaps where no playgrounds exist within the city at all.

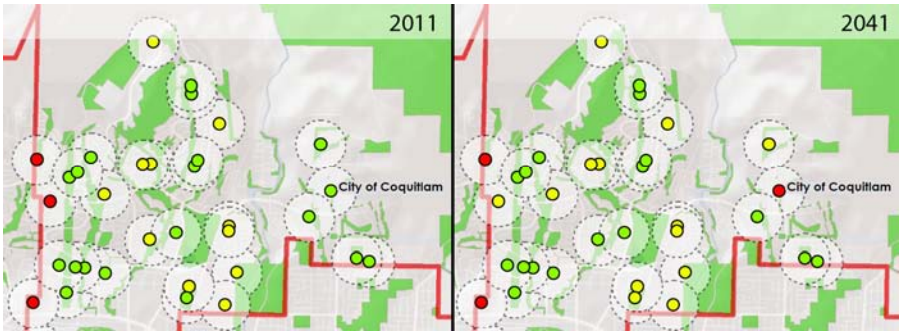

Fig. 3: Example analysis of playgrounds in the City of Coquitlam. Playgrounds are given by points along with 400 m buffers. Green = 100-800 kids which could be served by the park, yellow = 800-1,500 kids and red is >1,500 kids. The years along the top represent the population data year.

Fig. 4 shows a result derived from the third tool in GATOR. Here the output shows the level of service, but does so assuming that facilities are not independent of one another. So the analysis identifies the total number of other facilities within its own service radius, calculates the number of people within the radius and divides the total population by the number of opportunities. In effect, this reduces the number of people that one facility serves because it assumes that as one facility reaches capacity, people can choose a nearby alternative. Thus in an area with high population, such as in downtown Vancouver and North Vancouver, there can still be good provision of outdoor swimming opportunities because residents of these areas have several choices for the activity (Fig. 4). Whereas in Fraser Valley to the East, there is a lower provision of service even though the population is substantially lower.

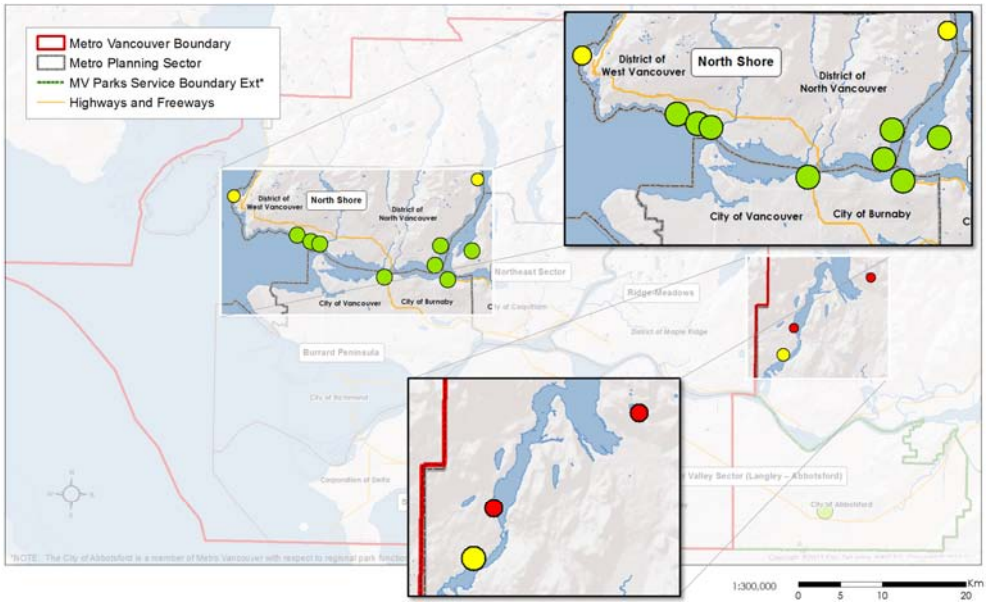

Fig. 4: Example analysis of provision based on the assumption that people will chose alternative facilities if one reaches capacity. The green dots show good provision, while the red show low.

4 Discussion and Lessons Learned

While the initial Gap analysis study was focused on the development of static results and recommendations, one of the most significant outcomes of the study was the development of GATOR. GOODCHILD (2010) suggests that design technologies, which help improve the human decision-making process, can help us become more effective stewards of our planet. GATOR does improve the decision-making and planning processes by promoting brainstorming and the evaluation of design alternatives, two critical components of the planning process (SHIM et al. 2002; GREGORY et al. 2012). Within this context, one major benefit

provided by GATOR is the ability to analyse design proposals by providing near real-time feedback about the impacts of proposed infrastructure changes.

The original goal of the study was to better understand citizen demands and available infrastructure of outdoor recreation opportunities in order to ascertain existing shortfalls and help inform future planning as part of the regional growth strategy. The primary focus of Phase II was to address the question: what are the spatial gaps in service provision of outdoor recreation opportunities? More specifically, 1) what is the difference in provision between municipalities, 2) what is the degree of service provided by each facility, and 3) what is the degree of provision and how many choices do citizens have in their vicinity? To address these questions, three different tools were created. Although the full results cannot be conveyed within this document, the results show that there are major gaps in the spatial distribution of certain outdoor recreation opportunities. Furthermore, they show that specific facilities may be more overburdened than others.

While GATOR provides an excellent platform for producing analyses, there are many improvements that can be made. One setback to the project was the limited spatial inventory. The combination of collecting and compiling data in conjunction with GATOR provided a clear picture of the data holes. Without GATOR these holes would have been more difficult to identify. Now additional features can be added and the database updated to better represent the full range of outdoor recreation facilities. Another future improvement of the tool is to change the method for calculating LOS. Currently, estimating service provision using radii is a standard within the recreation industry; however, these are not always good proxies for measuring accessibility. For instance, when radii intersect with population zones across water barriers or terrain without transit access, the LOS can be miscalculated. Rather, a more precise alternative would be to develop radii based on a network analysis of the various forms of transit and related infrastructure used to access the different facilities. For example, cars are typically used to access regional parks, so a road network would be appropriate; whereas playgrounds are more often accessed by foot, so a sidewalk network would be appropriate. Given the limited budget and lack of network datasets this was not included in the existing study. Furthermore calculating LOS relies on an established spatial relationship between the radius and the population zones. In this study a spatial intersection between population zones and service radii was employed. Another effective option would have been an inclusion of an area-weighted intersection. However, even this poses problems because not all areas of a population zone has built infrastructure as it may include roads, parking lots, green space, agricultural areas, etc. Perhaps the most effective population source would be parcel data coupled with census demographic information. While there are many ways in which LOS can be calculated, it is important to consider and communicate the caveats of the method employed and ensure that the end result provides appropriate and accurate information.

The Parks Board for both Regional Districts understand the limitations and yet remain eager to use the tool. They have made steps to improve the data inventory and see the tool being applicable to a wider array of analyses. More broadly, the tool could be modified to address similar questions but on larger scales. One of the side benefits of Modelbuilder and the specific way in which we used geoprocessing framework is that GATOR could be applied to other kinds of facilities (schools, first responders, zoning) in order to estimate the effects of decisions on population change within a community.

5 Conclusion and Outlook

GATOR offers several Geodesign-related contributions to outdoor recreation planning. It provides an easy method for continual service gap monitoring. GATOR can be used to determine areas that are poorly served and, as demographics shift over time, inform planners which facilities are likely to become over or underutilized. GATOR can also generate accurate and informative maps on-the-fly for use in public consultation and other stakeholder engagement activities. GATOR is able to link operational information to specific locations which can be updated and retrieved for consultation on a regular basis. The tool also improves inter-agency coordination and cooperation, as maps and linked information can be stored centrally, which will provide a transparent mechanism for discussion regarding future decisions.

As planners and stakeholders work together to design better spaces that improve human well-being and environmental conditions, tools like GATOR will provide a significant improvement over traditional static approaches. Through this case study we have demonstrated how a Geodesign tool was used to produce on-the-fly analyses and inform decision-makers with valuable spatial analyses.

References

CANADIAN PARKS RECREATION ASSOCIATION (1973), Recreation, Playgrounds and Vacation Camps. Ottawa, Ontario.

FLAXMAN, M. (2009), Fundamentals of Geodesign. Keynote Address, Digital Landscape Architecture Conference May 22, 2009, Valletta.

GOODCHILD, M. F. (2010), Toward Geodesign: Repurposing Cartography and GIS? Cartographic Perspectives, 66 (Fall).

GREGORY, R., FAILING, L., MCDANIELS, T., HARSTONE, M. & LONG, G. (2012), Structure Decision Making: A Practical Guide to Environmental Management. Wiley-Blackwell, West Sussex, UK.

LEES + ASSOCIATES (2013), Regional Outdoor Recreation Opportunities Study. Vancouver, BC: Lees + Associates, Metro Vancouver, and Fraser Valley Regional Districts.

SHIM, J., WARKENTIN, M., COURTNEY, J. F., POWER, D. J., SHARDA, R. & CARLSSON, C. (2002), Past, Present, and Future of Decision Support Technology. J. Decision Support Systems, 33 (2), 11-126.

NATIONAL RECREATION AND PARK ASSOCIATION (1996), Park, Recreation, Open Space and Greenway Guidelines. Eds. Mertes, J. D. & Hall, J. R., Nov. 1996.