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AN OPEN SOURCE WEB-MAPPING SYSTEM FOR TOURISM PLANNING AND MARKETING

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Gene Leroy Brothers
Samantha Rozier Rich
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ABSTRACT. Core retail management functions include defining market areas and profiling customers. For tourism enterprises, market areas are geographically dispersed with many customers residing beyond the immediate area surrounding the attraction. Visualization and analysis of these distributed market areas are significantly enhanced by the capabilities of Geographic Information System (GIS) technology and help to support management objectives. Unfortunately, many businesses are unable to utilize GIS due to its complexity and expense. This study develops a decision support tool for tourism planning and marketing that is customized and easy to use, employs open source software to reduce expense, and allows for broad accessibility via web delivery. Users can easily visualize and examine the spatial distribution of their own United States (US) client origins and visitation patterns along with relevant tourism-specific and general demographic information. This functionality can be beneficial in developing or augmenting business plans or marketing strategies, and for informing tourism theory.

KEYWORDS. Tourism marketing, Geographic Information System (GIS), web delivery, open source

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INTRODUCTION

Competing for new customers, while retaining current ones, is a priority for all tourism operations regardless of size, industry, or ownership. In retail management, market area analysis, customer profiling, and site selection are key functions at the core of best business practices (Applebaum, 1964; Goodchild, 1984; Huff, 1964; Huff & Sherr, 1967). For tourism-dependent retailers, a significant percentage of retail sales are to customers who are not permanent residents of the geographic area surrounding the store or attraction. Therefore, market area definition and subsequent customer profiling cannot be accomplished by simply defining distance rings or drive time polygons with respect to an attraction, but rather they should include techniques which account for the geographic dispersion of customers (Miller, 2008).

Given the ability of a Geographic Information Systems (GIS) to analyze the geographic and spatial relationships of various internal and external datasets, it is an important business tool for market area analysis and customer profiling (Bell & Zabriskie, 1978; Elliott-White & Finn, 1997; Grimshaw, 1999; Miller, 2008). The spatial analytic and visualization capabilities of GIS allow for analysis and display of past or current trends, which can provide spatial decision support beneficial in tourism planning and management (McAdam, 1999). Unfortunately, many tourism businesses do not have the capability to capitalize on these systems due to the complexity and/or expense of the GIS software. While efforts to address these obstacles continue to produce new software applications such as Environmental Systems Research Institute's (ESRI's) Business Analyst Online (BAO), BatchGeo (BatchGeo LLC, Portland, OR, USA), or QGIS (BatchGeo, 2012; ESRI Business Analyst Online, 2012; QGIS, 2012), current software applications remain limited by either one or both of the aforementioned obstacles or they lack some component of desired functionality. Additionally, these products and their contemporaries are designed for general use and therefore do not provide customized functionality for tourism professionals and researchers. This leaves the tourism industry wanting an affordable GIS tool without the complexity of traditional GIS and its extensive

functionality. The application described here will address this gap.

GIS can add value to market analysis by enhancing direct marketing and micromarketing endeavors via the conversion of data into client intelligence. Elliott-White and Finn (1997) identify this process as actionable competitive advantage. The travel and tourism industry is well suited for spatial analysis, primarily because most transactions produce a record of client names and addresses (Elliott-White & Finn, 1997), allowing for customer-specific spatial origin analysis. Tourism organizations with a database of customer street addresses or ZIP codes can use GIS to generate maps displaying where their customers live in relation to each other and to destinations. The identification of these spatial relationships among tourist origins and their collective relationship to attractions enables the evaluation and targeting of marketing efforts, customization of visitor packages, development of new opportunities, and the discovery of potential collaborative arrangements among partners (Chancellor & Cole, 2008). Furthermore, this type of analysis can identify customer clusters useful in determining locations for additional neighborhood level promotions such as newspaper advertisements or billboards (Hess, Rubin, & West, 2004). Conversely, limited past customer activity from a geographic area or neighborhood could indicate a potential new target market. Using GIS, new potential markets can be compared both geographically with respect to the attraction, and demographically to current high performing neighborhoods, which can help to form or augment marketing strategies. Organizations employing these techniques can evaluate the effectiveness of marketing and other investment initiatives, better serve current customers, and better compete for new customers.

Despite these considerable benefits, the tourism industry has adopted GIS technology slowly (Chen, 2007). Evidence suggests that in general, the application of GIS has lagged behind other information system tools in business. Keenan (2005) identifies several factors that have contributed to this lag. These include: (1) hardware requirements, (2) software complexity, (3) data availability, and (4) user training. However, the author acknowledges that due to recent

developments in each of these areas, GIS technologies are accessible to more organizations. Moreover, emerging technologies increasingly provide effective ways for diverse user groups to have access to GIS (e.g., Supak et al., 2012). Specifically, development of web-based GIS is improving accessibility and reducing complexity, thereby decreasing user training needs and allowing a wider audience with varied computer and GIS knowledge to participate.

Global trends in Internet use, along with technologies for creating and sharing geographic information through pioneering and often collaborative applications have led to the rapid development of web-based mapping (Haklay, Singleton, & Parker, 2008). As the Internet continues to change the perception and use of geographic information, web-based mapping and geoprocessing services continue to spread across many domains (Dragičević, Li, Brovelli, & Veenendaal, 2011), in some cases mirroring the advancement of desktop GIS and information technology in general (Cinnamon et al., 2009). Along with continuously evolving multifunctional desktop systems such as ESRI's ArcGIS Desktop or Geographic Resources Analysis Support System (GRASS), an explosion of development has occurred in user-focused spatial information application software (Giuliani, 2004). Many of these applications are web-based, making them more accessible to broader user groups. For example, Frehner and Brandli (2006) describe a web-based data management and analysis system designed to support an interdisciplinary approach to resource management and environmental decision support. To support this goal, the authors combined distributed ecological data repositories for endangered biospheres and animals as well as the occurrences of moss, fungi, and lichen with spatial analysis tools for attribute queries, spatial queries, and spatial overlays. In another example, Tiwari and Rushton (2010) describe a modular, web-based spatial analysis system for environmental health surveillance that can visualize the spatial patterns of disease outcomes. For the purposes of estimating individual exposures to environmental contaminants, individual-level data are automatically linked to environmental data and environmental models by geocoding. These two

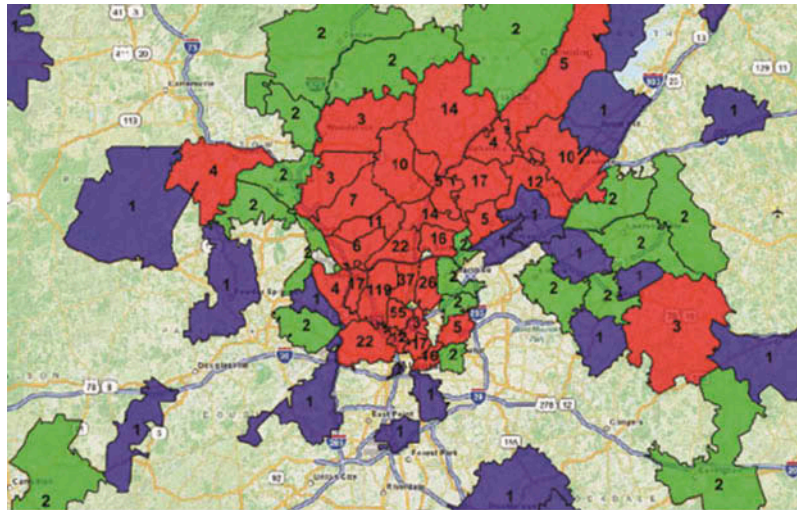
application examples have less functionality than traditional desktop GIS; however, because these applications are tailored to specific users' needs and delivered online, they are easy to use and widely accessible. By limiting functionality, customized applications allow novice users to perform only the tasks that are critical, thereby removing the complexity of universal multifunctional GIS software. Without access to customized applications, tourism professionals and researchers must rely on complicated universal software to support planning and marketing objectives or theoretical investigations. From the perspective of a tourism professional, four currently available non-customized GIS tool options are explored in the following section.

GIS OPTIONS TO SUPPORT TOURISM PLANNING AND MARKETING OBJECTIVES

Consider a fictitious tourism business, Western North Carolina Bed & Breakfast (WNC B&B). Assume WNC B&B wants to learn about their current clientele (where do they live, do they cluster, what is their socio-economic background?) to determine if existing marketing efforts are producing clients, and to determine where to spend future marketing dollars. Because their market area is geographically dispersed, the managers at WNC B&B could benefit from visualizing how their clients' origins vary across geographic regions as well as the level of variability within a region (i.e., are there any sub-regions with extremely high client concentrations adjacent to sub-regions of low client concentrations?). One way to accomplish this goal is to create a choropleth map (also called a thematic map), where each spatial unit is filled with a uniform color or pattern representing a single attribute such as client frequency (Figure 1).

With only universal multifunctional GIS options available to WNC B&B, the business managers might select one of the four software options shown in Figure 2 to examine the geographic distribution of their client origins. These four programs are not a complete representation of currently available software, but they are well established examples representing two types of

FIGURE 1. Choropleth/thematic map displaying WNC B&B's total client count by ZIP code for the greater Atlanta area. The solid red region in north Atlanta and its suburbs represents an abundance of clients, and the lack of shading in south Atlanta represents a dearth of clients. This map gives instantaneous insight as to the effectiveness of geographically targeted current marketing efforts. This intuition also can support the preparation of marketing strategies to inform future campaigns.



software development methodology and two types of software delivery styles. The development methods are proprietary, and Open Source Software (OSS) and the delivery styles are desktop and web delivery. Notice only the desktop GIS software provides the ability to produce a personalized choropleth map (see Figure 2). This and other limitations as well as advantages for each software product are discussed in the following paragraphs.

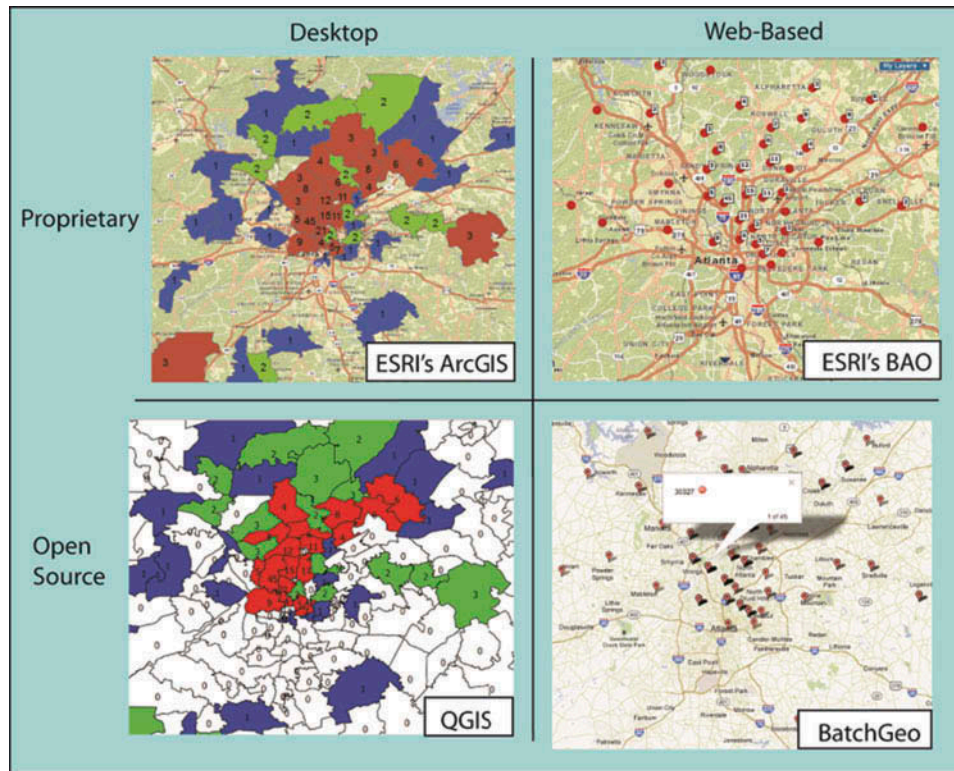
For proprietary desktop GIS, ArcGIS 10.1 for Desktop Basic, ESRI's most minimal commercial release, has a starting price of USD1500 that does not include recurring licensing fees applicable after the first year (*ArcGIS 10.1 for Desktop Basic*, 2012). To produce a choropleth map with this product, WNC B&B must first purchase the product, find the proper geometry shapefiles (ESRI's proprietary spatial data format), and then employ someone who is trained in its multifunctional design. Caution must be taken as erroneous outputs are possible when improper or incomplete procedures are implemented. The software user must choose the correct methodological approach and isolate the required functions out of hundreds to achieve the objective. Specifically, the approach

for this objective includes aggregating and geocoding client data on a spatial scale of interest, while ensuring inclusion of all possible data.

Advancements in OSS have transpired recently for both desktop and web-based mapping applications. QGIS is one example of an OSS universal multifunctional desktop GIS counterpart to ArcGIS Desktop (QGIS, 2012). This program is free for download; however, the software user still must have appropriate hardware and software training. QGIS has a more limited tool set than its costly competitors, but the OSS community continues to develop and update tools regularly. Therefore, QGIS and other similar programs (e.g., GRASS, uDig, OpenJump, gvSIG) make appealing options for users operating in resource-constrained environments who have GIS skills and no reservations about complex software. WNC B&B would save money using a program such as QGIS when compared to ArcGIS Desktop, but all of the complications described above regarding the intricacies of using ArcGIS Desktop to create a choropleth map would still exist. These complications coupled together with limited software support may present too large a challenge for a casual user.

Universal multifunctional proprietary web-based mapping applications can reduce both

FIGURE 2. Example software options for exploring the geographical distribution of client origins. Each product has at least one limitation related to cost, complexity, or display options. These are all universal multifunctional GIS tools, none of which is tourism-specific.



the complexity and expense of GIS; however, only customized implementations specifically designed for targeted user groups truly minimize complexity. ESRI's BAO is an example of a proprietary web-mapping application that is somewhat customized in that it has reduced functionality when compared to desktop GIS, but it is not fully customized in that its functionality is designed for a broad set of business users (ESRI Business Analyst Online, 2012). To accomplish a varied set of business related tasks, this product offers multiple tabs, functions, and interface options which can be overwhelming for novice users. Although both the price and the complexity are greatly reduced when compared to ArcGIS Desktop, as a user can get a single-day license for USD 149 or the most basic annual subscription for USD 995 (<http://www.esri.com/software/bao/pricing>), this tool still may be financially unfeasible for some organizations, and limitations still exist in terms

of representing users' personal data. If WNC B&B were to use BAO, managers could easily calculate distance rings or drive time polygons around the B&B to represent market areas, but this technique would not be appropriate for a tourism business whose clients are dispersed. Alternatively, managers could upload their own client data as a spreadsheet, but they would encounter file size and record number restrictions. Additionally, they could only display their data as points with frequency labels, so the communicative impact of a personalized choropleth map would be lost. There is one non-point method to display user data, but it requires an ESRI proprietary shapefile, and it does not support thematic shading. Although this product would provide limited personalized spatial insights for WNC B&B's managers, it is worth noting that it does provide continuous thematic maps for hundreds of demographic and lifestyle variables at all spatial scales.

BatchGeo is an example of a web-based mapping application that utilizes the simple and customizable OSS application program interface (API) Google Maps™ API (BatchGeo, 2012; Crowley, 2011). BatchGeo's interface is easy to use and there are both free and professional versions, so a user can choose to eliminate purchase expense entirely. Like BAO, this program offers the ability to input personal client data for geocoding as points, but unlike BAO there is no supporting demographic and lifestyle data provided to set a user's information in a broader business context. Additionally, the display of client frequency for any given map location can only be viewed one point at a time by clicking on that point and viewing the pop-up window. This product also would leave WNC B&B managers without the ability to identify geographic client concentrations, a major benefit of choropleth mapping. As Google and others continue to improve their offerings, a choropleth mapping tool may exist on the horizon. Jackson (2011) believes that OSS will become more common as organizations driving much of the software innovation today are not in the business of selling software. This is important for the adoption of GIS because in resource-constrained environments, proprietary software solution implementation has limitations.

For those who lack resources for GIS hardware and software as well as other related GIS investments, such as training or staff expertise, OSS solutions are desirable (Moreno-Sanchez, Anderson, Cruz, & Hayden, 2007). The generally common aspects of OSS include transparency of development and the freedom to build more complex systems out of readily available building blocks (Kilamo, Hammouda, Mikkonen, & Aaltonen, 2012). OSS components eliminate the need to initially pay for proprietary software, some of which have recurring licensing fees. Moreno-Sanchez et al. (2007) catalog some of the other benefits of employing OSS, including user-based community development and support, smooth learning curves that make them accessible to more novice developers, and more modest computer hardware requirements. Although there are limitations to the services that OSS can provide, some literature proposes that OSS web-based GIS have reached a stage of maturity,

sophistication, robustness, stability, and user friendliness rivaling that of commercial, proprietary GIS and web-based GIS server products (Boulos & Honda, 2006).

In summary, when a tourism business such as WNC B&B is interested in examining the geographic distribution of their clients, there exist both proprietary and OSS desktop and web-based mapping GIS tools to support this task (see Figure 2). Regardless of delivery or development method, all of the tools described above are non-discipline specific. Desires for industry- or discipline-specific web-mapping applications have led to selective customized system development using proprietary software (e.g., ArcGIS Mapping APIs) and OSS (e.g., OpenGeo Suite). The literature in many disciplines describes examples of customized web-based mapping applications including those for landscape ecology (Frehner & Brandli, 2006), natural resource management (Kearns, Kelly, & Tuxen, 2003), forest management (Xie et al., 2011), agriculture (Serrano, Jiménez-Hornero, Gutiérrez de Ravé, & Jodral, 2008), public participatory GIS (Hall, Chipeniuk, Feick, Leahy, & Deparday, 2010), and public health (MacEachren, Crawford, Akella, & Lengerich, 2008; Supak et al., 2012). Currently in the field of tourism, no descriptions of proprietary or OSS web-based mapping applications appear in the literature. Customized web-based mapping tools are needed to address this application gap. The MapMyClients application described here is as an initial effort to address this gap in the form of an OSS web-mapping tool for tourism planning and marketing, which can also be used to inform tourism theory.

SYSTEM REQUIREMENTS AND OBJECTIVES

Working with tourism research specialists and through the study of related work, the following tourism planning and marketing GIS functional requirements were identified:

- Upload tabular client or transaction data.

- Aggregate client data on a spatial level of interest to determine the frequency of visitation for each spatial unit.
- Determine and assign classification values based on visitation frequency as well as tourism-specific and general demographic data for each spatial unit.
- Display classification values for client frequency and demographic data as thematic map layers.
- View/visualize personalized data along with other geographic features to provide locational context.
- Examine and explore the spatial distribution of client clusters to support identification of desirable and undesirable locations for marketing.
- Examine and determine rudimentary customer profiles from demographic map layers.
- Confirm if targeted marketing efforts are successful.
- Use OSS components to provide these services.

The system should allow tourism professionals and researchers to upload client or transactional data lists as spreadsheets. These data can then be processed quickly and returned as spatial frequency thematic map layers, where the area within each spatial unit of aggregation is symbolized by color to represent the total number of transactions or clients originating from that location. When overlaid with geographically matched demographic, socio-economic, and consumer behavior data, this thematic map can help a user achieve four objectives:

- A user will learn about his or her current clientele. Answering questions such as where do the clients live, do they cluster, and what characteristics define their socio-economic background can aide a user in better servicing current clients.
- A user can determine if existing marketing efforts are producing clients (if the locations of targeted marketing efforts are known).
- A user can determine current clientele profiles to predict future clientele in

alternative geographic areas with similar demographics.

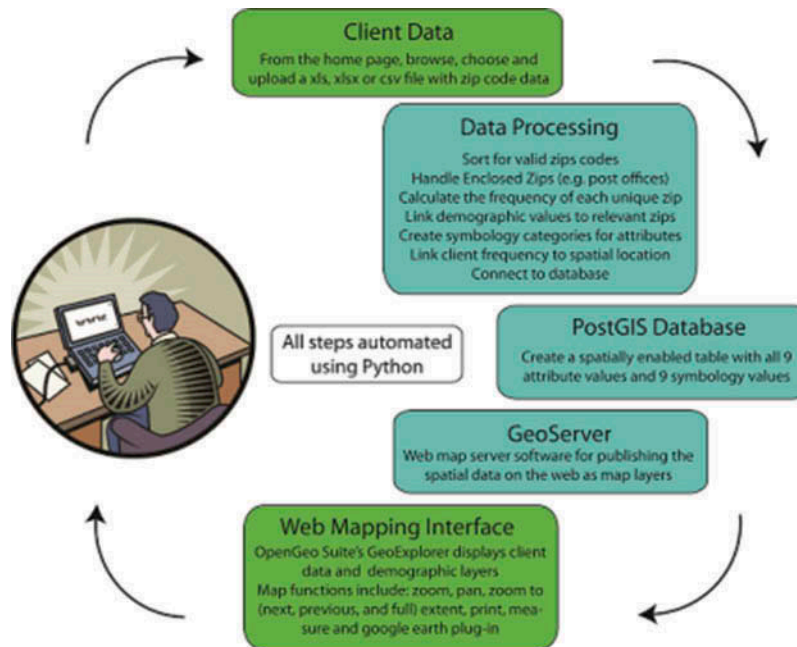
- A user can then determine whether to market to existing client neighborhoods or the alternative geographic areas discovered through the analysis, or both.

PROTOTYPE DEVELOPMENT

To meet the functionality requirements as well as the desired objectives specified, the MapMyClients customized web-based mapping application was developed. Because the software components on which a web-mapping system is built determine its data handling and analytical capabilities (Rinner, Moldofsky, Cusimano, Marshall, & Hernandez, 2011), selection of these components was thoughtful. Ultimately, OpenGeo Suite Community Edition's three tiered OSS stack was selected ("OpenGeo Suite", 2011) because it bundles the key software components necessary to deliver the desired web-mapping functionality. These components include a spatial database management system (PostGIS for PostgreSQL), a web map server (Geoserver), and a web map application interface for displaying and manipulating data on a website (GeoExplorer API). Built with an OSS stack and web-delivered, MapMyClients provides ease of access to its users as well as possible expansion to mobile devices in the future.

The MapMyClients workflow in Figure 3 illustrates how backend data processing steps combined with OSS stack components produce and display choropleth map layers of client origin frequency as well as supplemental demographic data. Each of the steps in the flow chart are automated using Python (Python, 2012), thereby removing the necessity for a user to be familiar with GIS methodology and syntax. Because choropleth maps require data aggregation over a defined spatial area, the scale of aggregation was determined prior to prototype development. For the US, the smallest scale of spatial representation is the census block and the largest is by region (typically containing multiple states). The selection of ZIP code

FIGURE 3. The MapMyClients workflow is automated using Python. The backend data processing steps combined with OSS stack components produce and display choropleth map layers of client origin frequency as well as supplemental demographic data. Green boxes represent steps where the user can interact with the application, and blue boxes are steps that are automated and require no additional effort on the part of the user.



level aggregation allows for the broadest use of the application because some users may only have access to ZIP code level data, and full address data would be required for aggregation to smaller spatial units.

After a user uploads his/her own client data with a valid ZIP code field, the file is read and the contents of the ZIP code field are stored for further processing. Both numeric and text data types are acceptable ZIP code inputs, affording minimal file preparation on the part of the user. ZIP code boundaries are created by the United States Postal Service with an objective of providing efficient mail service (Miller, 2008), but there are approximately 10,000 fewer tabulated ZIP code boundaries than total ZIP codes with point representation. These ZIP codes without tabulated boundaries, termed “enclosed ZIP codes,” belong to specific buildings (e.g., post offices) or clusters of buildings (e.g., universities). These enclosed ZIP codes have spatial footprints far smaller than their standard ZIP

code counterparts, where the median spatial area is 66.4 square miles. To ensure minimal data omission, enclosed ZIP codes are automatically swapped out for their parent ZIP code boundary (i.e., the ZIP code by which they are enclosed), a step which can easily be overlooked when using traditional desktop GIS.

After the replacement of enclosed ZIP codes, the number of occurrences for each unique ZIP code with a valid spatial boundary is counted. This count becomes the total client count (frequency) by ZIP code attribute. All unique ZIP codes are then matched with supporting data from ESRI’s BAO data repository. The supporting data include six demographic, socio-economic, and consumer behavior metrics: (1) 2010 median age, (2) 2010 median home value, (3) 2010 median income, (4) 2010 percent of population over 25 years with a bachelor’s degree, (5) average annual dollar amount spent on travel, and (6) average annual dollar amount spent on lodging. Additionally, the

2005 population and population density per square mile for each unique ZIP code are identified. The distribution of client frequency values and supplemental data values are used to classify each of these nine datasets into three categories of symbology. A quantile style classification methodology was selected as it lets users interpret these categories using the common sense notion of even thirds of data. This classification method aims to put an equal number of unique ZIP code values into high, medium and low groupings based on client frequency; however, maintaining an exactly equal number of ZIP codes among the groups may not be possible for datasets whose frequency distributions are skewed (e.g., over one-third of the zip codes have a client-origin frequency of one).

Both the value and classification information for the nine data attributes of interest are written to a PostGIS database as a table, where each row represents a unique ZIP code. This table is then served to the web using Geoserver, and a layer is created for each attribute of interest. A predefined Styled Layer Descriptor (SLD) file is applied to each of the nine layers so that each ZIP code boundary is shaded according to its specific classification category (high, medium, and low) for that attribute. The SLD also supports the labeling of attribute values for each unique ZIP code, for each of the nine layers, to give the user more detailed information and the ability to see how widely the values range within a classification category. An additional layer is also included that displays client frequency classification shading with the ZIP code as the label to provide identification information for the user. Finally, these 10 map layers are automatically loaded into a new browser tab and displayed using a modified version of the GeoExplorer API. The map interface includes standard web-mapping navigation options such as zoom, pan, zoom to next and previous extents, and zoom to full extent, as well as specialty tools such as print, measure, and a Google Earth plugin to allow ground visualization. To maximize ease of use, only the web page provided for data upload (Figure 4) and the returned map page (Figure 5) are viewable by the user.

MAPMYCLIENTS PROTOTYPE USAGE EXAMPLE

The MapMyClients implementation described above is currently a working prototype available to members of the Travel and Tourism Research Association as well as others who have taken an interest in the application as a result of Facebook or LinkedIn promotions. Revisiting WNC B&B can help demonstrate a typical user's experience including interpreting map layer results. Remember that WNC B&B wants to learn about their current clientele (where do they live, do they cluster, what characteristics define their socio-economic background?) to better service them and to determine if existing marketing efforts are producing clients. Also, learning about current clientele can help the managers determine where to spend future marketing dollars using geographically focused channels (e.g., print, radio/TV, the Yellow Pages, direct mail, or trade show booths). Specifically, the managers want to know if there are any regions with extremely high client concentrations. After ruling out the current non-discipline-specific GIS options presented in Figure 2, WNC B&B managers decide to try MapMyClients to answer their questions. While on the home page (Figure 4), the managers can watch instructional videos detailing how and why to use MapMyClients, and they can read simple written instructions for choosing and uploading appropriate client data. Some basic map navigating instructions also are given.

As noted on the home page, appropriate inputs include non-aggregated client data in one of three data formats (xls, xlsx, and csv), which contain at least one field of five-digit or nine-digit US ZIP codes as text strings or as numbers. If the ZIP codes are input as numbers, conversion to the string data type ensures leading zeros are included for those records with ZIP code values less than 10000, thereby reducing valid ZIP code omission. No limitations on file size or record number restrict the application's usage, but the word "zip" (with any variety of capitalization) must appear in the header of the ZIP code field. Fields other than those including the word "zip" have no influence on the process, so client data file

FIGURE 4. The MapMyClients home page (<http://152.1.0.195:8888/mapmyclients/index.html>). Numbered instructions help walk users through the application experiences starting with two demonstrational videos detailing how and why to use MapMyClients.

HOME | SAMPLE DATA | PROJECT BACKGROUND | ABOUT ME | NCSU GIS | CONTACT INFORMATION

MapMyClients
Web Mapping for Tourism Professionals

Welcome to MapMyClients
GIS tourism applications need not be expensive or complex!

MapMyClients is a new, easy to use, web delivered mapping application designed to give tourism professionals the ability to visualize the origins and grouping of their US clients to aide in the development or augmentation of marketing strategies. For more information see [Project Background](#).

1. Watch Demo Videos:
[How to Use MapMyClients](#)
[Why to Use MapMyClients](#)

2. Choose a File:
 Choose a local excel (.xls or .xlsx) or comma separated value (.csv) file with non aggregated US client data for spatially visualization or use the sample data provided.
[Sample Data](#)
 The letters "zip" must appear in the header of at least one field. There must be at least 3 valid unique (5- or 9- digit) US zip codes in that field.

3. Upload Here:
 Browse for the file of interest and when its name is populated in the text box, click the upload button.

 A new tab or window automatically will open (if popups are enabled) and your map will load in under 20 seconds.
 Repeat this process for any datasets or subset of your data you desire.

Data Usage & Security:
 Only you will be able to see the map that is returned after you upload data.
 Regardless of the number of fields in the uploaded file, only the zip code field will be utilized.
 The uploaded data will automatically be deleted after the map layers appear.

4. Navigate the Map:
 Zoom in on areas of interest by double clicking or by using the map tools on the top right or the plus/minus buttons on the map.
 Explore data layers on the left panel:
 1) total client count by zip code and zip code
 2) average annual dollar amount spent on travel and spent on lodging
 3) median age, income and home value
 4) percentage of the population 25 years or older with a bachelor's degree
 5) total population and population density
 Initially, only the total client count by zip code layer will be visible.
 Click the box next to the layer name to make additional data layers visible. You may want to view only one at a time.
 Select the print tool in the upper right to keep or share this information.
 *Supplemental Data from ESRI
 Usefulness & Usability Survey

HOME | SAMPLE DATA | PROJECT BACKGROUND | ABOUT ME | NCSU GIS | CONTACT INFORMATION
MapMyClients

preparation does not require field deletion or any additional user effort. After the managers determine an appropriate file, they only need to click the mouse three times to browse, choose, and upload that file. Within 20 seconds of clicking the upload button (see Figure 4), a new tab will open and a map similar to that in Figure 5 will appear.

After examining the map layers returned (see Figure 5), the managers at WNC B&B recognize the high concentration of customers residing in the southeastern US and they decide to take a closer look at the Charlotte, Greensboro, and Research Triangle Area (Raleigh, Durham, and Chapel Hill) in North Carolina (NC), as

these areas have the highest client concentrations. As the managers zoom into this central region of NC, they get a clearer picture of where the client origin concentrations are the highest (Figure 6). At this level of zoom, the color coding of attributes by ZIP code is discernible as red, green, and blue for the high, medium, and low values respectively. In the southern Charlotte metropolitan area, a cluster of 11 unique ZIP codes has a total of 105 clients, with a single ZIP code within this cluster housing 38 clients. This visitation pattern, including the spatial groupings of these high-count ZIP codes, would not be noticeable by simply looking at the uploaded data file. In the

FIGURE 5. Automatically returned map results for WNC B&B's client data upon uploaded. The client origins are primarily focused in the southeastern United States. The table of contents on the left side allows for all 10 data layers to be toggled off and on. There are several options for changing zoom level including the drop down menu at the bottom right and the plus/minus navigation bar on top left. The print, measure, and Google Earth plugin appear at the top right.

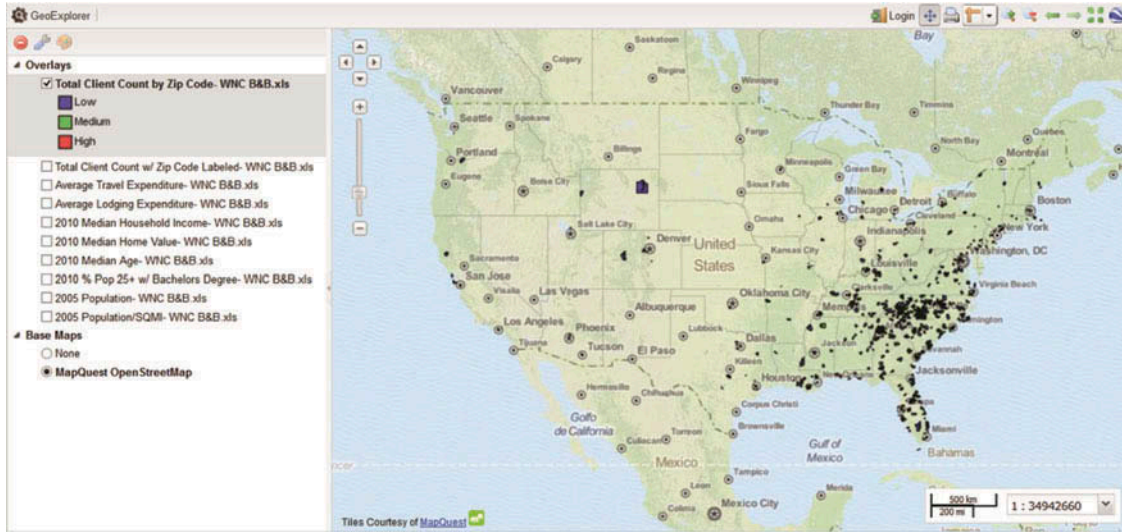
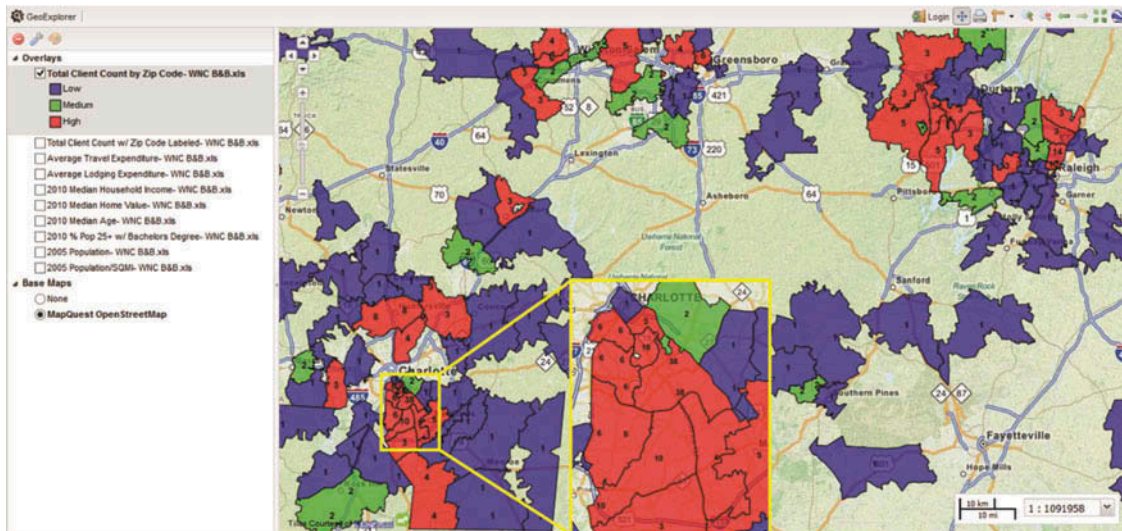


FIGURE 6. Total client count (frequency) by ZIP code for WNC B&B clients in the Charlotte, Greensboro, and Research Triangle Area (Raleigh, Durham, and Chapel Hill) of NC. Southern Charlotte has a significant client cluster with 105 clients. This visitation pattern would not be discernible by simply looking at the uploaded data file. Geographic areas with high client concentrations could merit neighborhood level promotions such as billboards or newspaper advertisements.



Research Triangle Area, there is a cluster of 34 clients in north Raleigh as well as a cluster of 24 clients in the Chapel Hill area. The Greensboro and Winston-Salem areas have client clusters with lower client frequencies comparatively, but these areas support the pattern observed across central NC of urban and suburban interest in WNC B&B. Investigation of the 2005 population map layer (Figure 7) helps elucidate how client clusters are influenced by total population. Not surprisingly, the noted areas of concentrated clients have some of the highest total populations. If managers are unfamiliar with the region, examination of the 2005 population density map layer (not shown) could help them differentiate which areas are urban, suburban, and rural.

Once the managers identify the high-frequency client clusters, they want to probe deeper into the supplemental map data layers to learn about these clients. Figures 8–11 show some of the key characteristics of the clients, but do not represent the full set of map layers available to the managers. The average travel expenditure (Figure 8) and median household income (Figure 9) maps nearly

mirror each other, with higher values of each associated with the urban and suburban locations corresponding to high-frequency client clusters. One area the managers should flag for future geographically target marketing is western and southwestern Raleigh, where both median income and average travel expenditures are in the highest category, but client frequency is currently relatively low. When the managers examine the median age (Figure 10) and educational attainment (Figure 11) map layers, they find patterns that complement those of the travel expenditure and median household income map layers. The same urban and suburban areas with high client frequencies tend to have lower median ages and a higher percentage of the population over 25 years of age with a bachelor's degree, relative to the surrounding rural areas. Identifying these urban and suburban client clusters where younger, higher income, more highly educated people spend more on travel allows the managers to refine their current marketing strategies. These identified areas could benefit from additional neighborhood level promotions such as billboards or newspaper advertisements or, if WNC B&B

FIGURE 7. Population by ZIP code for WNC B&B clients in the Charlotte, Greensboro, and Research Triangle Area (Raleigh, Durham, and Chapel Hill) of North Carolina. This map layer is useful in determining if/how population influences the total client count. A population density map layer is also available for assessing the level of urbanization.

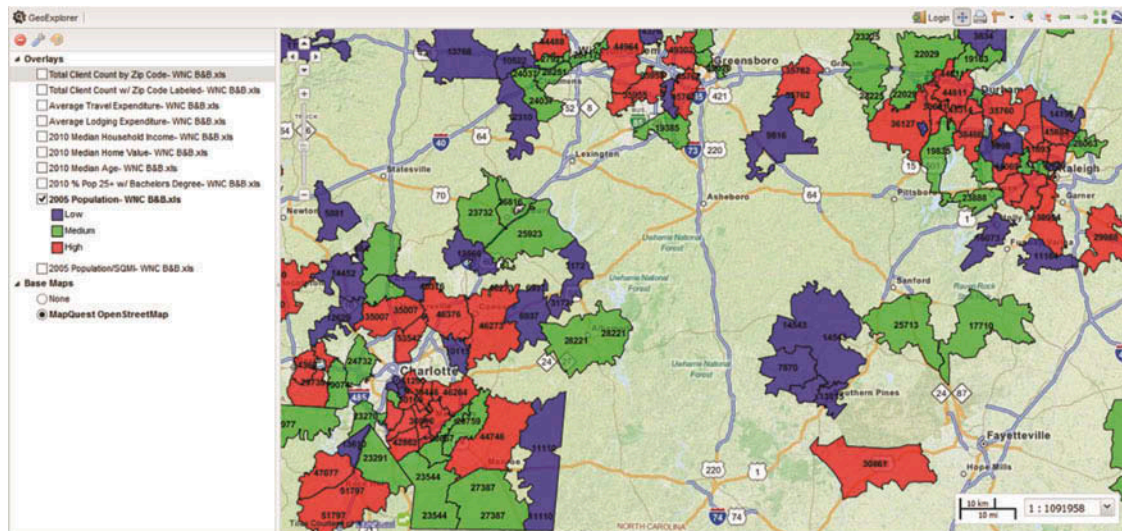


FIGURE 8. Average travel expenditure by ZIP code for WNC B&B clients in the Charlotte, Greensboro, and Research Triangle Area (Raleigh, Durham, and Chapel Hill) of North Carolina. This tourism-specific map layer shows that the geographic regions of high client-frequency are largely the same as the regions where people are willing to spend more on travel related expenses.

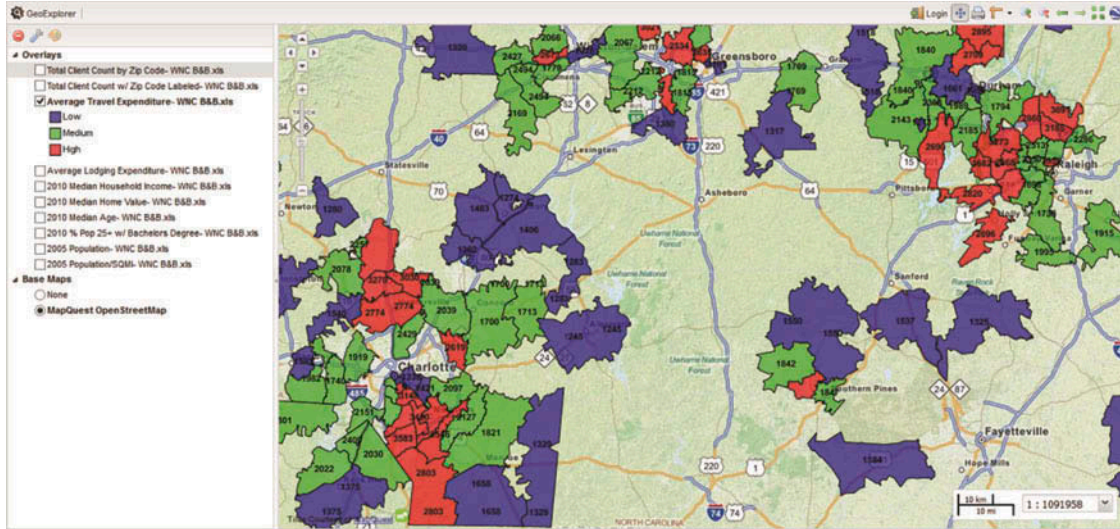


FIGURE 9. Median household income by ZIP code for WNC B&B clients in the Charlotte, Greensboro and Research Triangle Area (Raleigh, Durham & Chapel Hill) of North Carolina. This map layer mirrors that of the travel expenditures map layer. This result intuitively makes sense because higher household incomes translate to more available funds in household budgets for non-necessities such as travel. This map layer does provide new insight about southwestern Raleigh, where both median income and average travel expenditures are in the highest category, but client frequency is relatively low. This area might prove to be a valuable new market.

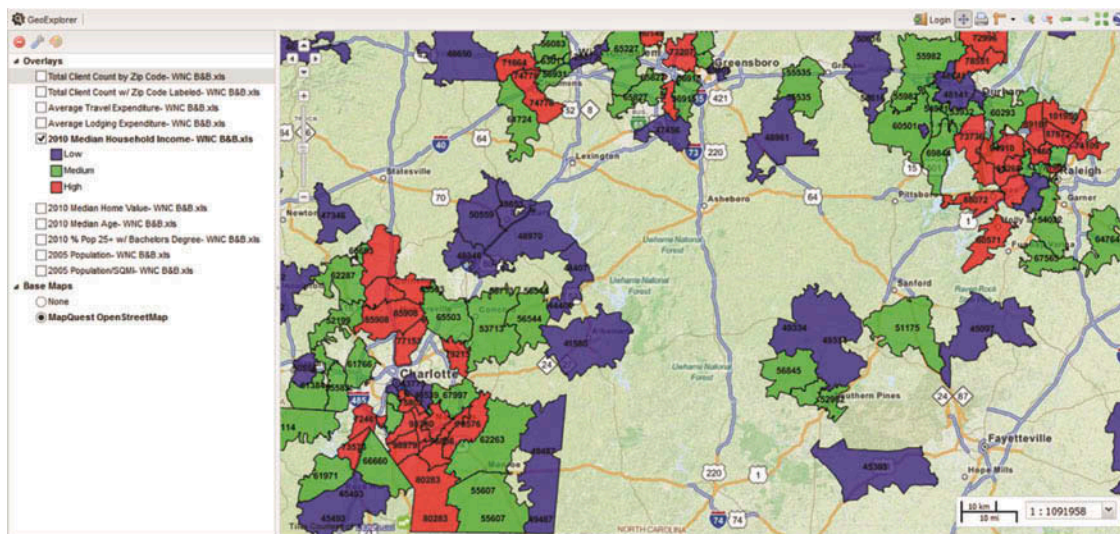


FIGURE 10. Median age by ZIP code for WNC B&B clients in the Charlotte, Greensboro, and Research Triangle Area (Raleigh, Durham, and Chapel Hill) of North Carolina. This map layer shows urban areas have populations with lower median ages.

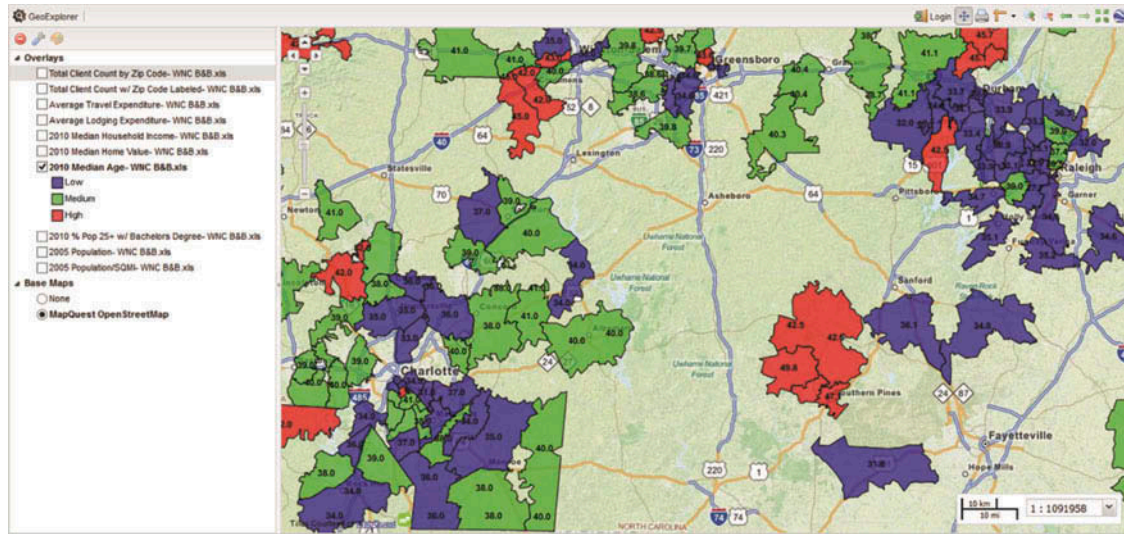
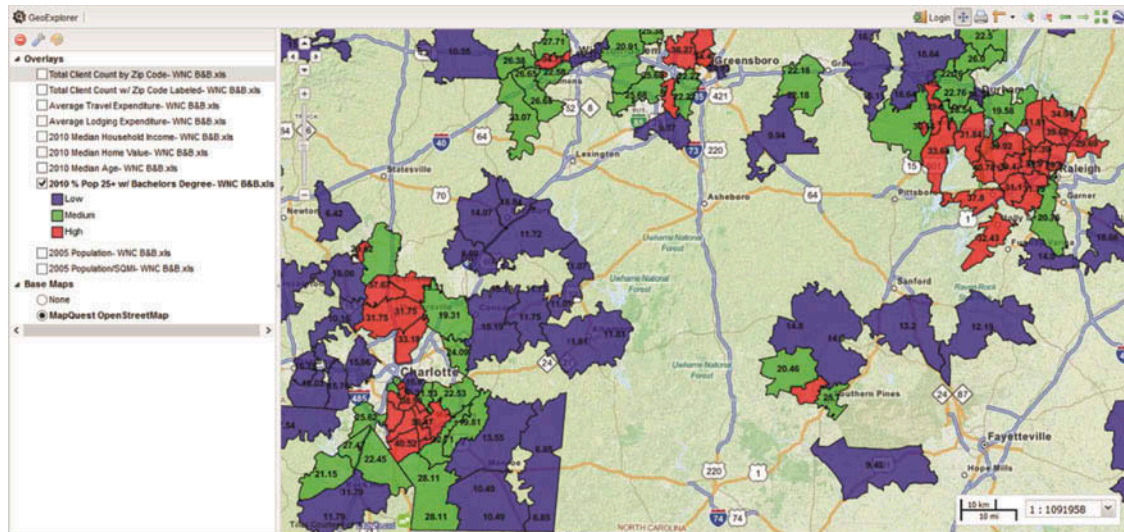


FIGURE 11. Percent population over 25 years of age with a bachelor's degree by ZIP code for WNC B&B clients in the Charlotte, Greensboro, and Research Triangle Area (Raleigh, Durham, and Chapel Hill) of North Carolina. Managers continue to grow a customer profile after examining this map layer. Their high-count client ZIP codes or customer clusters are in urban and suburban areas where the population is more likely to be highly educated, younger, earn higher incomes, and spend more money on travel.



managers are already employing targeted marketing efforts in these areas, this map could validate their current marketing strategy.

IMPLICATIONS FOR TOURISM THEORY

While MapMyClients directly addresses the practical needs of tourism professionals and researchers, it also provides a tool for exploring and informing theoretical constructs important to tourism research, such as market segmentation and tourism flow modeling. Many market segmentation studies employ sophisticated modeling techniques including clustering methods, mixture models, mixture regression models, mixture unfolding models, profiling segments, and dynamic segmentation (Wedel & Kamakura, 2000) in an effort to improve destination marketing. For example, McKercher (2008) tests the hypothesis that market segments, for a single origin market, transform unevenly as origin–destination pair distance increases. After clustering Hong Kong residents who had traveled internationally based on age, household income, education, self-reported level of travel experience, and package tour purchase propensity, the author found that aggregate market profiles changed with distance between these residents and 11 international urban destinations, with the segments becoming generally better educated, older, and more affluent with increased distances between residents and destinations.

One goal behind a study such as McKercher's (2008) is to provide tourism researchers and practitioners with tourism behavior findings from which they may extrapolate or infer general and specific information, which hopefully will inform new research objectives and can be applied to business practices. For researchers, the specific market profile findings related to Hong Kong residents may be applicable to other markets, but short of repeating the analysis with data for different origin–destination pairs, it would be difficult to test this theory for other markets. MapMyClients provides users with a method to test McKercher's theoretical hypothesis that market segments transform unevenly as origin–destination pair distance increases, not through complicated clustering

techniques, but rather through simplistic visual analysis. Although MapMyClients does not offer a formal clustering technique, it does present many of the factors included in McKercher's (2008) market segmentation analysis such as age, household income and education. Through examination of the map layers in MapMyClients, users can deduce how customer profiles change with distance from the source, just as McKercher (2008) did. This ability to provide less formal market segmentation analysis extends and informs tourism marketing theory.

In addition to market segmentation, identifying spatial relationships is often desirable in order to understand, model, and forecast tourism flow and other forms of tourism behavior. Building on the importance of geographic distance to marketing theory and modeling, MapMyClients provides users with the ability to investigate the foundation of many tourism demand models. The distance decay model, utilized in recreation and tourism research in the 1960s and 1970s as a proxy for forecasting, predicts an inverse relationship between distance and willingness to travel. This relationship was based on the observed trade-off between the investment of time, money, or effort to achieve the travel and the time one can spend at the end destination. More generally, demand will peak at some distance relatively close to a source market and then decline as distance increases. Although it has fallen into disuse of late, distance decay principles are still implicit in current modeling and forecasting of tourist flows (McKercher & Lew, 2003) and Eldridge and Jones (1991) go as far as to recognize distance decay as one of the key laws of geography. MapMyClients can visually test the predictions of the distance decay model by presenting the spatial distribution and frequency of customers relative to the tourism attraction or event. This is demonstrated in the WNC B&B example, where the total client count map (see Figure 5) supports the model that demand peaks at some distance relatively close to the source (western NC) and then declines as distance from that source increases.

Tourism demand modeling and forecasting are important areas in tourism research and have attracted much attention from both academics and practitioners (Song & Li, 2008), with 420 studies on the topic published during the

period 1960–2002 (Li, Song, & Witt, 2005). Unfortunately, these efforts have not been successful according to Witt and Song (2001) and Li et al. (2005) who posit that the performance of forecasting models varies according to the data frequencies used in the model estimation, the destination–origin country/region pairs under consideration, and the length of the forecasting horizons concerned. Despite these performance issues, model development and specification continue largely using secondary data and either time series or econometric techniques.

Among the 121 models examined by Song and Li (2008) published since 2000, the tourist arrival variable, or the measurement of total tourist arrivals from an origin to a destination, continues to be the most popular measure of tourism demand. Often the use of the tourist arrival variable is for a large scale origin or destination and it represents data aggregation over a large region or entire country (e.g., Falocci, Panicià, & Stanghellini, 2009; Khadaroo & Seetanah, 2008). As many of these studies attempt to establish forecasting principles that could be used to guide practitioners in selecting forecasting techniques (Song & Li, 2008), researchers should try to develop techniques that are applicable to both large- (e.g., France) and small-scale attractions (e.g., WNC B&B). When analyzing a single destination or a small-scale group of destinations, using forecasting techniques developed using aggregated travel data may not be applicable. In these cases, understanding and estimating tourism demand may require further investigation. MapMyClients offers an accessible alternative approach to conventional forecasting models that can be useful in this effort, as it is designed to examine total tourist arrivals from multiple origins to a single destination, so destination data aggregation does not occur. Although future tourism flows cannot be estimated, demand can be studied, as many of the parameters included in tourism flow modeling are visually presented in MapMyClients. These parameters include spatially significant tourist arrival data, basic client profiles, and origin–destination distances. The consideration of these factors is not only useful in understanding the current or past demand for a site/event-specific attraction, but future demand can be influenced with this knowledge.

LIMITATIONS, USEFULNESS, AND USABILITY

The internet has profoundly changed the way we derive and share information. With the explosion of web-based mapping and web-based GIS, new instances of customized, cost effective, user friendly applications appear regularly. Despite the great potential for web-based mapping in the field of tourism, no customized web-mapping instances appear in tourism literature. Although MapMyClients is a first step to addressing this gap, it has limitations both in performance and function. The main performance limitation is the speed with which layers load and update, which is affected by both client-side and server-side factors. As client-side factors are beyond our control, only server-side performance can be improved. Streamlining the Python script which reads and processes client data and produces Geoserver map layers in addition to implementing a server with a faster processor could reduce the time needed to initially load map layers. Another way to increase Geoserver performance is to enable server-side caching of web-mapping service tiles, thereby eliminating the need for redundant calls. Functional improvements considered for future development range from adding a simple buffer tool to the inclusion of a geographically weighted regression tool, which could be used to identify relevant predictors (demographic attributes) and to estimate the effect of these predictors on the total client count.

Notwithstanding these limitations, this first-generation prototype has been in place since November 2012. Both Google Analytics™ and a usability/usefulness survey hosted by survey-monkey.com (SurveyMonkey, 2012) are in place to track usage and catalog general feedback that may be helpful for improving future versions of the application. From Google Analytics, repeat visitors represent above 40% of total web traffic for the home page, indicating that MapMyClients provides a service that is attractive enough to sustain participation. The survey results support the conclusion that the application is meeting its design objectives with responses such as “[MapMyClients] confirms that the target audience for our marketing

program was being reached successfully". Potential improvements mentioned in the survey include the incorporation of additional demographic and social data such as home ownership, social network usage, and the presence of children. Additionally, the ability to map other user-specific attributes from uploaded data such as the total dollar amount spent or total room nights stayed (for hotel data) was mentioned in one survey response. This functionality was considered for the first-generation prototype of MapMyClients, but because only some users would have numeric attributes to take advantage of this feature, it was not included.

METHODOLOGICAL CONSTRAINTS AND CONCLUSIONS

MapMyClients illustrates the value of determining client frequency clusters and identifying demographic characteristics based on geographic locations for the purposes of understanding existing customers more fully and targeting new prospects more precisely. Aggregating client data on the ZIP code scale for choropleth map display allows for the identification of clusters or regions of high interest in tourism services. Additional demographic information associated with these client clusters provides a simplistic method for customer profiling; however, associating demographic characteristics with ZIP codes is not without weakness. The caveat to the approach of using ZIP code scale demographic information is lack of spatial precision. The assumption that the characteristics of a ZIP code as a whole are homogeneous and a reasonable approximation of each household in that ZIP code may not be valid. See Miller (2008) for a detailed discussion of the benefits and limitations of using ZIP codes and census block groups for demographic proxies. Given that this tool is fulfilling an application gap with no software expense to the user and it is intended for those who may not have previously utilized GIS due to its complexity or cost, the lack of within-ZIP-code demographic precision should not deter potential MapMyClients users. The general

demographic pattern of variability from ZIP code to ZIP code in conjunction with the client origin concentration results should satisfy the data precision needs of most users.

The utility of web-mapping applications in the tourism arena is clear. MapMyClients can inform tourism theory as well as to help improve service to existing customers, and support highly focused marketing initiatives targeted at new prospects, potentially leading to new revenue streams. The OSS platform used in this prototype supports these objectives and proves that software innovation does not need to come from organizations in the business of selling software. Furthermore, GIS-data-driven intelligence does not need to be expensive or complicated to provide an actionable competitive advantage. The added value of GIS is not exclusive to businesses that have geographically dispersed clientele; however, in the absence of the ability to perform simple market area analysis, GIS is a necessity. Other businesses who wish to define market areas and profile customers could also benefit from a client mapping system such as MapMyClients. Although originally designed for tourism professionals, virtually any small business (retailers, medical practices, exercise studios, etc.) could capitalize on a modified version of this application with different industry-specific data and the same general demographic information. MapMyClients provides improved accessibility to GIS leading to more spatial pattern identification, improved tourism planning and marketing strategies, and the ability to inform theoretical constructs within the tourism field. The findings of this research improve the empirical understanding of OSS web-mapping as a medium to achieve discipline-specific goals and provide an immediate tool for the tourism industry and research community.

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