Evaluating Strategies for Community-sourced Photography for Mapping Alcohol Adverts in the Urban Slums in Kampala, Uganda

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Evaluating Strategies for Community-sourced Photography for Mapping Alcohol Adverts in the Urban Slums in Kampala, Uganda

By: Joseph Madden
Abstract
Title: Evaluating Strategies for Community-sourced Photography for Mapping Alcohol Adverts in the Urban Slums in Kampala, Uganda

Abstract: The transient and temporary nature of urban slums throughout the world provide a challenge for collecting actionable data on indicators that can accurately predict factors that have both adverse and protective effects on health. By studying methods to identify hotspots of alcohol advertising more efficiently, there can be a better system for allocating resources or directing research teams to focus efforts on more in-depth studies. In this capstone, a pilot exercise performed in May 2019 explored utilizing locally sourced photographs of alcohol advertisements and then digitally mapping this data to identify and visualize areas of concern that contain a large volume of alcohol advertisements. The aim of this evaluation is to determine the feasibility of this digital mapping method to determine if it is a cost-effective tool that can accurately identify these areas of concern. In addition to the May 2019 pilot project, this paper evaluates other digital mapping projects to continue to improve accuracy, efficiency, and effectiveness.

Methodology: The purpose of this evaluation is to review the efforts and results from the May 2019 Pilot Exercise on a 100-meter block in the Makindye slum in Kampala to understand the shortcomings of the project as is and evaluate process improvements. Additionally, this paper will review similar studies or programs to identify obstacles, challenges, or essential features that will need to be explored, solved, or implemented ahead of a larger scale test or study.

Conclusions: While challenges did arise in the May 2019 Pilot Exercise, there are serviceable data that provided a strong foundation for scaling this program and utilizing this type of data collection on new projects around the world. Preliminary maps provided inside this paper show the power of the data collected while also showcasing the full range of opportunities and use cases for it.
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Lastly, I would like to say thank you to Dr. Colin Smith, who pushed me out of my comfort zone and convinced me to take on the added challenge of working on a Capstone project. While there are too many more to thank, all the professors and staff in the School of Public Health have been absolutely essential for any and all successes that I have achieved during my time at Georgia State University.
Introduction

This paper intends to identify and evaluate methods or programs that will be able to more efficiently and accurately collect data from urban slums around the world than traditional data collection. By incorporating the local community and taking advantage of advances in technology, it is the hope that a system can be developed that will help direct public health resources towards the most vulnerable populations in these highly-dense, yet hard to reach, communities. By leveraging the ubiquitous nature of smartphones with the readily available aerial map data, this exercise’s end goal is to be a useful, resource-minimal tool for identifying alcohol advertisement dense hotspots that can be utilized by public health professionals to direct resources and efforts.

Background:

Challenges of Working in Urban Slums:

As worldwide urbanization takes place, people are flocking to city centers faster than municipal governments can build safe, efficient, and planned housing units. This pressure overwhelms the systems in cities and leads to the rampant growth of urban slums. These improvised, chaotic living arrangements end up becoming hotspots for illnesses and worsening health outcomes. Traditional survey and data collection techniques are generally not as useful in collecting the data needed for governments and NGOs to adequately meet the needs of the persons living and working in these areas of town. Kampala, Uganda is no different due to its sprawling city center that has more than six unique urban slum neighborhoods. Given the general lack of resources directed towards urban slums, it’s crucial to develop a system that allows for a more efficient rating or scorecarding system for urban slums to ensure that the resources are allocated appropriately.
Alcohol and Risky Sexual Behavior:

Alcohol consumption and HIV prevalence rates among adolescents and teenagers in the urban slums in Kampala, Uganda have a wide range; however, getting actionable data from these areas is expensive and complicated. While scientists and public health professionals have linked HIV rates and alcohol use (Balachova 2017), there is still an unknown surrounding why rates vary within a given region or urban slum. With HIV rates among adolescents and teenagers rising (Swahn 2016) and endemic alcohol abuse issues (WHO 2014), this is a city that is a perfect target for public health resources and innovative methods for detecting and improving the health outcomes and thus the livelihoods of this vulnerable population.

Alcohol Advertisement and Alcohol Use Among Adolescents:

Studies have shown a correlation between alcohol advertisement and alcohol use (Anderson et al., 2009; Stautz et al., 2017), so this evaluation looks to determine a cost-effective way to map out hot spots or areas of high densities of alcohol advertisements to focus public health resources. Given the hard to reach nature of urban slums, the data collected here might be useful beyond just the scope of this project. If a cost-effective and accurate system can be found, then its use case comes in finding trouble areas to dedicate more in-depth survey and data collection.

May 2019 Pilot Exercise:

The initial idea for collecting this data is to partner with a local NGO in Kampala to have the local staff walking down pre-planned paths to take photographs via smartphone or smart digital camera of any alcohol advertising that they come across. After taking these photographs, the photos would then be uploaded to a shared cloud program. Each photo contains EXIF, or exchangeable image file format, which is the metadata that is applied to all digital cameras or smartphones in which the GPS data lives. The researcher would then process the pictures by attributing an advertisement type to standardize the data, plus any additional notes on the
content of the photo. Once the image is processed, it would be bulk uploaded into Google Earth Pro to populate a digital map for further study.

**Purpose:**

This evaluation’s goal is to better understand the limitations of the proposed project to utilize crowd-sourced or community-led data collection to help answer public health questions in urban slums that are ultimately hard to reach via traditional data collection methods. By evaluating the May 2019 pilot project, this paper seeks to estimate its feasibility when scaled up while also improving execution for the best use of resources. The inclusion of external programs or projects helps prevent pitfalls and limitations that others have encountered, so the next exercises are more efficient. The conclusions and recommendations made at the end of this paper seek to serve the greater community and aid in efforts to provide assistance to support the most vulnerable populations across the globe.

**Review of the Literature:**

**Understanding the purpose**

*The influence of alcohol outlet density and advertising on youth drinking in urban Tanzania* (Ibitoye, Me et al. 2019)

In the study, *The influence of alcohol outlet density and advertising on youth drinking in urban Tanzania* (Ibitoye, M et al. 2019), the researchers seek to see the influence of alcohol outlet density and its effects on the youth in Dar es Salam, Tanzania. While the focus of this study was more on the availability of alcohol via alcohol shops, it talks about some of the same themes that we see in other studies performed in this region. One of the major takeaways from this study is the inverse relationship between density of alcohol shops around schools and the socio-economic status of the neighborhood. While the research teams did map out alcohol
advertisements as well, there does not seem to be a similar increase in ads as SES decreases. This will be important to keep in mind to see if a similar pattern is there when performing future iterations of the May 2019 pilot exercise at scale. It should be noted that of the two schools in the lowest SES neighborhood around Dar es Salam, one of them is missing data on advertisements.

The research teams were given Google maps and encouraged to explore unmapped roads or areas around the school sites they were assigned. A possible limitation of this study is some groups might have been more adventurous than others or that some areas off the main roads might have been perceived as more dangerous and thus were not explored. Some other variants between this study and the May 2019 pilot exercise is the manual mapping of these alcohol advertisements. In the study above, the research team was not given GPS-collection equipment, be it smartphones or a GPS receiver to digitally track the advertisements. The stated reason was safety and concerns about having expensive equipment visible during the data collection. One of the features of the May 2019 pilot exercise is that there is photographic evidence of each advertisement for quality assurance.

Interestingly, as a part of the study, the research team did equip forty students with disposable cameras to take photos of places in which youth can access alcohol. This was not limited to the .25-mile radius around the study sites, so provided a bit more information about the area. The students were then interviewed about their experiences and the photos they took, which explored the influences that seeing the alcohol outlets had on the youth in this part of the study. As a part of this, a common theme among the forty students was the sensitivity to alcohol advertisements.

It should be noted that the laws in Tanzania have changed regarding the sale of alcohol, which led many outlets to be more covert with their alcohol sales and advertisements. Additionally, the limitations stated in this study are regarding the inability to geocode the
alcohol outlets or ads and that they were unable to quantify the relationship between access and usage with the main focus being on qualitative data. This study, however, did reinforce the significant themes and motivations that are mirrored within this evaluation.

Experimental demonstration of the influence of alcohol advertising on the activation of alcohol expectancies in memory among fourth- and fifth-grade children (Dunn et al. 1999)

In this study, students in a mostly suburban and rural Central Florida county were shown both beer and soft-drink advertisements to understand the effect on students among fourth- and fifth-graders (approximately 9-11-year-olds) The researchers asked the students about the various products that had been shown to them; the ones who had seen the beer commercials had a more positive outlook on alcohol than those who had not seen the ads. This paper explains the purpose of this project, and the study is hoping to gain information in order to more efficiently tackle the challenges of alcohol advertisements and adolescents in hard to reach areas of urban slums.

The Study of Slums as Social and Physical Constructs: Challenges and Emerging Research Opportunities (Mahabir et al. 2016)

This paper, The Study of Slums as Social and Physical Constructs: Challenges and Emerging Research Opportunities (Mahabir et al., 2016), looks to all the challenges of working within urban slums. It discusses the advent of the urban slum, the size, and the problems that are ever present when trying to study the inhabitants of these areas. It posits that advances in geospatial technologies to better map slums will be useful in combatting the varied nature of the
slum itself. It discusses the cost prohibitive nature of traditional data collection in favor of remote sensing, which is now a more feasible option due to more advanced technology.

Interestingly, this paper does cover some of the limitations in remote sensing or digitally mapping slums due to consistent cloud cover that seems to plague slums. Knowing the relative inaccuracy of GPS data, it is essential to note that this would further exacerbate the issue. They go further to discuss the benefits of crowd-sourcing mapping data for understanding the nature of slums that much better. The authors discuss the Map Kibera project which seeks to map the Kibera slums in Nairobi, which is of particular interest to this project, considering the focus on another East African slum.

**Methodologies or Case Studies**

*Alcohol in urban streetscapes: a comparison of the use of Google Street View and on-street observation* (Clews et al., 2019)

In this study, *Alcohol in urban streetscapes: a comparison of the use of Google Street View and on-street observation* (Clews et al., 2019), the authors utilize Google Street View (GSV) on various streets in New Zealand to evaluate it as a tool for identifying and tracking alcohol advertisements. They concluded that it was not a sensitive enough tool to unilaterally rely on to give accurate measurements on the number of advertisements or the density. While there are benefits to finding structured or permanent buildings such as alcohol outlets or bars, the delay on updated maps is a hamper for tracking advertising. GSV’s algorithmic blurring of faces or signs also was a hindrance for accurately tracking advertisements. As the plan for the May 2019 pilot exercise was developing, this type of data collection was pitched, but in some basic exercises, it was found to be lacking, especially in low resource settings like Uganda’s urban slums. While the study confirms it to be a failure, it does raise an interesting point about using
“footpath views” or user uploaded content as a way to also quickly scan an area for study. While this is more geared towards developed regions, further studies would need to look at the universality and availability of this within Uganda or other developing countries.

*A systematic review of the use of Google Street View in health research: Major themes, strengths, weaknesses and possibilities for future research (Rzotkiewicz et al., 2018)*

This systematic review of published articles on the use of Google Street View in health research looked at 54 qualified options to determine both the how and the purpose. These studies mainly utilized Google Street View in the Global North with few instances in the Global South to which quality deteriorated as the socio-economic level of the country decreased. One of the main limitations is the image quality, so while it can potentially save time, there is a limit due to current constraints on available photography. In the more developing countries in South America, this was especially evident. None of the studies found focused on Africa or Asia. The studies reviewed did not look at the built or natural environment through the authors note that this is an area where Google Street View could succeed. The May 2019 pilot exercise’s focus is on capturing the built environment, but the authors in this particular review note a limitation with more temporary indicators, like advertisements. Another vector that the authors identify as a key benefit is that these platforms act as repositories of photographs and maps over several years.
Optimising measurement of health-related characteristics of the built environment: 
Comparing data collected by foot-based street audits, virtual street audits and routine secondary data sources (Pliakas et al. 2017)

In this study, the researchers developed a questionnaire that isolated 100 indicators to focus on when trying to understand the effect on an area’s built-environment on geriatric health. While the research goes beyond the scope of this paper, it has some interesting points relevant to this broader evaluation as well as the more specific evaluation of the May 2019 pilot exercise and for further developing alcohol advertising density studies. Namely, their new tool could be used entirely remotely via Google Street View. As previously stated, using Google Street View was an original idea when thinking through how to evaluate urban slums, but there are enough inadequacies in the systems that made it not entirely useable.

Their research compared manual foot studies to Google Street view led studies, and the results showed that for more subjective or less permanent options, like advertisements, Google Street View was less effective. This finding confirms the initial worries of such a digital-only approach and lends credence to the change in approach and the need to take photographs to power a mapping system. The study does review the cost, in both expenses and time, differences between the foot-study and Google Street View methods and finds that the Google Street View method is faster and cheaper. Using it for looking at structure-based indicators, like green space, types of buildings, and building conditions might be beneficial when balancing the cost of a program.
Using Google Street View to investigate the association between street greenery and physical activity (Lu Y, 2017)

The study looks at using Google Street View (GSV) imagery to determine the amount of street greenery is present in a particular city, which in this case is Hong Kong. It is one of the few studies that focuses on a non-Western country so provides some different perspectives to how the GSV system works in areas that Google has not traditionally prioritized. While this study’s focus is on a different objective than the May 2019 pilot exercise, it does take a more technical and automated approach that could be modified to fit the needs of future, larger scale projects. Its use to this study is the machine learning and API techniques that are important to think about when looking for secondary analysis of data, plus it is vital to know how Google Street View would work with the more permanent structures or infrastructure elements.

Geographical information systems as a tool for monitoring tobacco industry advertising (Vardaves et al. 2009)

This study focuses on point-of-purchase advertisement for tobacco products and their densities around schools. Taking a 300-meter radius around a series of schools in Heraklion, Greece, researchers using a specialized GPS camera set out to capture advertisements. Heraklion is densely populated, so walking to school is commonplace. They also visited kiosks, bars, betting halls, and supermarkets to review the advertisements within these establishments. They focused on anywhere one could purchase tobacco products.

They took pictures of elements that were potentially on the outside of the circle and recorded the GPS data to confirm its inclusion. They did not tabulate the Marlboro-owned stores as there were too many elements, including display cases, product advertising, and general paraphernalia. The authors utilized a software called GPS Photo Link*Add to software*
that interacts with Google Earth. Produced figures and maps that showcase how the schools relate to the number of tobacco advertisements seen around the survey areas. Interestingly, nearly 80% of convenience stores had tobacco advertisements at or below a child’s eye line (approximately 1.3m tall)

They discuss the prevalence of kiosks and the effect they have on providing heightened levels of access, which is a similar issue seen in Uganda. The researchers discuss the minimal costs of the study and the highlighting of the kiosks as primary vehicles for tobacco access that are not covered by existing laws. They state that on average there is a tobacco advertisement within 20m of each school’s gates making it quite accessible.

Premise App

Premise, the maker of the Ground Truth Platform, is based out of San Francisco and seeks to crowd-source data collection by having users complete simple tasks around their city. They boast anti-fraud tools, via machine learning, that makes their data actionable. Additionally, their platform is tied to a data visualization software to produce useable reports that are fully customizable to fit the needs of a program. While this company or platform has more case studies in the for-profit sector, they have some limited case studies in international development that can be applied to the exercise and methodologies that we are seeking to evaluate in this paper.

Listed below are the two most applicable programs that they ran in tandem with both USAID and PREFAR, respectively. Moreover, while there is limited impact data, the vast number of data points referenced in their projects is encouraging.
Data-driven Zika virus control

Working with three cities in the Cali region of Colombia, Premise partnered with local ministries of health to seek to combat Zika at the grassroots level. The active use for each city varied, but in all, they captured 615,000 data points that, when integrated into the cities’ workflow, decreased the risk of breeding Aedes mosquitos in “hot spots.” They claim that this risk was reduced by 27%, but it is a limited case study, so the full effect cannot be validated.

Additionally, this program in Colombia had plenty of insights about limitations that the Premise team ran into along the way. Some of the challenges aligned with what the May 2019 Pilot exercise ran into such as a lack of adoption or engagement and inaccurate GPS data, but it went a bit further to provide suitable solutions. As this program is on a larger scale, there were some positive insights gleaned that were used to help inform the recommendations and analysis in later sections.

Reducing HIV/AIDS Infections Among Young Women in sub-Saharan Africa

Premise worked with young women in sub-Saharan Africa to help increase treatment adherence. The app provided real-time data visualizations to the local health clinics while seeking to engage with the women in the program during their treatment cycles. While the case study does now showcase results or effects of their efforts, the report does show that there was significant use with almost 80,000 reports of using local health clinics and adhering to treatment filed.

In these two Premise examples, the main limitation is that the literature reviewed was official press releases from the company rather than a peer-reviewed article. While it is essential as a tool, the articles are not peer-reviewed. This distinction should not detract from the
relevance that this company has to the project’s end goals, but should be noted considering the other reviewed literature.

Map Kibera Project: Mapping Slums in East Africa

The Map Kibera project is focused on overcoming the challenges of traditional data collection within urban slums, especially urban slums in East Africa. Its focus on being entirely community-led is important for the latter aspects of the May 2019 pilot exercise, especially when trying to scale it up to be more of a crowd-sourced, real time project. Its focus on being community-led provides insights that can be utilized for future iterations of the May 2019 pilot exercise.

This program works with interesting and economically sustainable softwares that will be reviewed in later parts of this paper. Their work focusing on Health in the urban slums in East Africa also provides an outlet for partnership and growth of the existing program to capture more and more data regarding the density of alcohol advertisements. Discussed more in-depth later, the Map Kibera project is a larger scale and more broad program that the May 2019 pilot project seeks to emulate, in some parts, and concentrate in others. The process that this program went through to grow and succeed will be important to keep in mind when continuing to develop the May 2019 pilot exercise into something larger.

Methodology - May 2019 Pilot Exercise:

May 2019 Pilot Exercise with Preliminary Descriptive Results and Methodology

In order to more quickly identify high-risk hotspots of risky adolescent behavior and increased prevalence rates of HIV, the May 2019 Pilot Exercise intended to efficiently and effectively collect data on alcohol advertisements around the slums of Kampala.
The pilot study enlisted the help of Georgia State University students who walked a pre-planned route to seek out and photograph alcohol advertisements. Each team had an accompanying survey to answer questions regarding the built environment and to provide a written count of the photos taken, plus serve as a guide on their pre-planned route. Each route started from a boda stage, or informal motorcycle stand, and proceeded to walk 100 meters. The team then crossed to the other side of the street and walked 100 meters in the reverse direction. Upon reaching their initial starting point, albeit across the street, the team would then continue an additional 100-meter walk. They would cross the street and return towards the initial boda stage and thus complete a full square block of 100-meters. Without knowing the width or if there are varying widths of the street crossed, it is impossible to calculate the square-meterage covered.

These groups of students did overlap as an element of quality assurance and to provide separate photos as a way to audit the GPS data collected. Three primary photographers were using a series of Apple and Samsung smartphones to capture alcohol advertisements. After the groups finished, the owner of the smartphones then uploaded their photographs to a central cloud storage space, in this case, Google Photos. After the photos were uploaded, the team back in Atlanta processed the photos via a free EXIF data scraping application to produce an Excel document that could be further processed and have additional coding applied.
Initial Results

Of the 181 photographs taken, 166 of these photos had GPS data associated with them. 91% of the photographs containing the GPS data is encouraging, especially with limited instruction or technical support from the study designer. One of the primary photographer’s photographs did not have GPS data attached to any of the photos he or she took during his or her walkthrough. The smartphone in question was an Apple 8, but other Apple products were unaffected by this.

Objects Captured in Study

For a preliminary breakdown, please see the figure below. Alcohol advertisements make up the most significant percentage of photographs, followed by bars and shops.
Table 1. Percentage of Each Photograph Type

<table>
<thead>
<tr>
<th>Type of Photograph</th>
<th>Percentage of Photographs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar</td>
<td>28.49%</td>
</tr>
<tr>
<td>Unknown</td>
<td>0.56%</td>
</tr>
<tr>
<td>Alcohol Ads</td>
<td>62.01%</td>
</tr>
<tr>
<td>Alcohol Sachet</td>
<td>1.12%</td>
</tr>
<tr>
<td>Shops</td>
<td>7.26%</td>
</tr>
<tr>
<td>Pool/Betting/Game Hall</td>
<td>0.56%</td>
</tr>
</tbody>
</table>

Products Advertised in Photographs

Upon further analysis of the data, eight different products being advertised made up approximately 50% of the alcohol advertised. Uganda Waragi, a commercially-produced variant of the national homemade liquor, is the most prevalent alcohol advertised in the areas that were studied. It is produced by East African Breweries Limited (EABL) who also produces the fifth most prevalent Tusker. The parent or holding company for EABL is Diageo, which also owns Captain Morgan – the second most common alcohol advertisement on the list. While there are more than 37 varieties advertised, a list of the top approximate 50% of alcohol advertisements captured during the walkthrough is included in Table 2.
### Figure 2 – Example of Alcohol Advertisements in Kampala

![Example of Alcohol Advertisements in Kampala](image)

### Table 2. Top Products Being Advertised.

<table>
<thead>
<tr>
<th>Alcohol</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uganda Waragi</td>
<td>13.51%</td>
</tr>
<tr>
<td>Captain Morgan</td>
<td>8.11%</td>
</tr>
<tr>
<td>Nile Special</td>
<td>7.21%</td>
</tr>
<tr>
<td>Club</td>
<td>7.21%</td>
</tr>
<tr>
<td>Tusker</td>
<td>4.50%</td>
</tr>
<tr>
<td>Nile Gold</td>
<td>3.60%</td>
</tr>
<tr>
<td>Eagle</td>
<td>3.60%</td>
</tr>
<tr>
<td>Dalmore</td>
<td>2.70%</td>
</tr>
</tbody>
</table>
Companies Represented in the Photographs:

In the above list, Nile Breweries makes up approximately 21% of the advertisements through its various brands, including Nile Special, Nile Gold, Club, and Eagle. Not listed above is Castle, which is another Nile Breweries product; Nile Breweries is owned by ABInBev, which is one of the largest alcohol producer and distributor in the world.

Cursory research into the producers or parent companies revealed that of the above list, they represent only three holding companies or conglomerates. These consolidations do not seem to prevent overlapping of materials distributed across the route studied.

Figure 3 – Example of Outlet Marketing

Mapping Elements:

Once the photographs are processed, the research team uploads them into Google Earth Pro to which that application can produce maps to isolate and identify hotspots for alcohol-related ads. While the May 2019 Pilot Exercise is concentrated in one place, it does show how the mapping software can work and how the GPS data can be represented on an aerial view. From this dataset, here are some initial images from how the data is processed.
These three figures are from various height, starting from a cruising jet and working down to less than 1,000 feet. Each of these views is possible to recreate with the data, and while the first one is not as relevant to this particular study, there are benefits to using it if studying multiple areas around a city. Figure 5 is a great showcase of looking across an entire city neighborhood while figure 6 gives one as close to a street-view level that is available with current technologies and limitations of the GoogleEarth Pro platform.

Figure 4 (High-Level; 37480 ft):
Figure 5 (Mid-Level; 5,506 ft):

Figure 6 (Low-Level; 921 ft)
Required Equipment:

Hardware:

This process requires the use of a smartphone or smart digital camera, but with the growing universality of smartphones – these will be more common and the recommended piece of hardware. It is vital to ensure that GPS data is present on all photos; otherwise, the GIS software will be unable to perform. Clicking the “shutter” on today’s smartphone will capture GPS data as this is the default setting on both iOS and Android phones, but cannot confirm this setting on the Windows platform until more testing is completed. For the May 2019 Pilot exercise, the students or researchers used both iOS and Android-based OS systems.

After taking the photographs, they must be uploaded to a central database. When looking at potential database systems, it will be vital for it to be accessible worldwide, so a cloud-based program would more easily fulfill that need. Finding a Cloud service that has ample storage space at a nominal price is vital for the scalability and sustainability of this program. However, another critical element is to make sure that the process of uploading and
downloading photos does not remove the EXIF data. In the May 2019 Pilot Exercise, our group utilized Google Photos as the cloud service. This platform comes with 15 gigabytes of photo storage, which is enough to get a pilot program started. While Google Photos worked in this scenario, its usefulness at a large scale or with an actual crowd-sourced program is not answered in this report. Unfortunately, there is no easy way to provide universal upload access without sacrificing protections for the existing images, so uploading would need to come from a dedicated source. Limiting access would create a chokepoint if trying to scale. This platform is adequate for smaller scale or with use with dedicated partners in the targeted location. This platform exceeded expectations for use within the May 2019 pilot.

For a fully scalable and crowd-sourced program, it is recommended to create a separate, private storage cloud that would allow for uploads from anywhere but would prevent changes from being made once uploaded. Additionally, with adequate funding and scalability, it would be beneficial to review building an application that could host files locally before transmitting them to a central server or database. This application could be used to manage better the GPS data being transferred as well, thus eliminating potential pitfalls with transferring the data from the collection point to the central database. The full benefits list of an application has been discussed within the literature review or are outside the scope of this paper and will need further review.

Software:

After uploading the photos to the central database, it will be essential to use a program to scrape the GPS data and to further add on a code or label to complete the processing of these files.

In the May 2019 Pilot Exercise, the team used a free EXIF data scraper called BR’s EXIFextracter. This free application takes digital photographs, scrapes the GPS data from each
of the photos in bulk, and produces an Excel document that pairs the data with the filename. This document can be further manipulated with additional coding or labeling thus creating a useful database. This database of GPS & file data can then be uploaded into a Google Earth Pro or another GIS program to create a digital map. The pilot study was only 181 photos, so this free application worked well for the small needs of this project. For larger projects or continually growing projects, the sheer number of photos could overwhelm this application and create problems. Looking for paid or enterprise solutions could be an expensive upfront cost to save time and money later in the project.

Here are some examples of potential programs that fit the needs of this exercise and similar projects:

1) **ExifTool**
   a. Software developed by Phil Harvey and written in Perl, an operating system, that can process large databases on a variety of image formats to produce the requisite CSV or Excel document needed to power Google Earth Pro or another GIS program. While there is no peer-reviewed system or study that focused on this program, it was consistently the top recommended software when performing a simple Google search.

2) **PhotoMe**
   a. A tool developed by Jens Duttke and written in Visual Basic that supports the common image file types and produces a file that is highly compatible with Google Earth Pro.

3) **GPS Photo Link**
a. GPS Photo Link is an enterprise level geotagging and processing software from Geospatial Experts that is ideal for larger projects. Its ability to scale and process imagery is what sets it apart, plus there are extra supporting features that are unavailable in the other programs.

b. It is not a cheap program, so it would be a limitation if working without funding mechanisms.

For the Pilot study, the authors used Google Earth Pro due to its low-cost and powerful, yet flexible, UI. As another free application, Google Earth Pro was able to accept and process the 181 photos we had quickly and easily. Its map database was relatively up-to-date, so the extra layers and pins added on by the upload made sense and were in line with the pre-planned routes taken by the study abroad students within the May 2019 Pilot Exercise.

For larger projects, there might be an advantage to utilizing a more powerful and flexible program like ArcGIS. It can utilize more customized maps and allows for uploading more modern aerial photographs compared to Google Earth Pro. This program does require a more in-depth knowledge of GIS, plus is not a free-to-use platform.

TileMill is another platform that has some interesting implications for this exercise and future studies. Its use within the Map Kiberia project put it within the realm or framework that is relevant as it is based on mapping out slums and East African slums at that. Used in tandem with GIS softwares, like ArcGIS (paid) or QGIS (open sourced), TileMap produces interactive map tiles. These map tiles are millions of images stacked together to create a maps that include pop ups or site navigations that greatly enhance traditional static images. This would be a final form for a presentation from taking the photo to distributing the data via interactive maps. In reviewing how this technology works and its end product, this could be an interesting program if the May 2019 pilot exercise was expanded to cover multiple countries and urban slums – it provides a strong, high level view that is an expansion of the Google Earth Pro UI.
The software and hardware outlined above are not the entirety of available options but do provide a baseline for what technology has been reviewed within the May 2019 Pilot exercise and other options to fulfill the requirements for being successful.

**Other Mapping Projects:**

**Premise (November 2018):**

A San Francisco start-up has developed an application or app that pays out to people who complete small tasks, i.e., locate a park and talk about the conditions there; provide photographs of a bus stop, for a small payout. While the predominant use of this platform focuses on for-profit business, they do have a humanitarian or international development arm that produced some relevant case studies. One study, funded by USAID, was focused on identifying mosquito breeding hotspots in and around Cali, Colombia. By identifying these hotspots, researchers hoped to predict and prevent an outbreak of the Zika virus more accurately. The stated purpose of the project is to empower residents of these areas to prevent outbreaks while simultaneously providing local ministries of health with additional information. It even goes further to discuss how a tool of this nature allows data collection in hard to reach areas which are beneficial for plotting areas within an urban slum.

Secondarily, the case study described above provides valuable insights and a pathway for effectively partnering with the local community and health ministries, which can be avenues for increase utilization, training, and education. These case studies also provide guidelines and learnings to help mitigate obstacles or challenges are addressed in the next section.

An app, like Premise, that is built around tracking indicators via crowd-sourcing and photography is a great model for what the May 2019 Pilot Exercise seeks to achieve at a scalable level, especially if a funder like USAID is involved.
GIS, Tobacco, & Greece

The study performed in Heraklion, Greece described in the literature review mirrors the ideas presented in the May 2019 pilot exercise but with a focus on tobacco advertisements compared to alcohol. The methodologies were similar and the end goal virtually the same, so it will provide a large amount of guidance if the pilot exercise moves forward to future stages.

One of the biggest influences is the categorization of advertisements seen around Greece that will be utilized on existing data and future data collections. Moreover, while the categorizations were not the same, they showed that the deeper levels of categorization provide richer data when creating maps. Additionally, the maps produced showcase which viewpoints or perspectives work best for various scenarios, which should make the data processing on future mapping projects more efficient.

While the cityscape for Heraklion is different and will not completely overlap with an urban slum in Uganda, there is enough overlap that future studies or programs can continue to build upon this existing field of research. Lastly, the study talks in-depth about tobacco kiosks that fall outside of the purview of the laws in Greece and the underreported effect that these can have on tobacco use rates, which applies to Uganda. Mobile kiosks or stores that serve alcohol are difficult to quantify as they generally sit within the informal sector of the economy but are also hard to count via digital map systems, like Google Street View, due to their temporary nature. By tracking these vendors more closely, these exercises or programs could provide a better understanding of their role with alcohol consumption among adolescents in Uganda.
Mapping Nairobi Slums As a Community

The Map Kibera project is a community led program seeking to provide better maps, data, and general information for the slums in and around Nairobi in neighboring Kenya. This project focused on mobilizing the residents of Kibera to collect the data that will power the project to improve the lives in the community. Understanding how they empower and mobilize their community is a key feature that needs to be incorporated into the initial phases of a project or study like the May 2019 pilot. Their five step process provides great insight, especially when paired with other projects like the Zike Citizens Network in Colombia.

The first takeaway is that this team included local ISPs in their stakeholder group. Including ISPs as a stakeholder is unique to this study and it gave the research team better access to GPS data from the carriers as well as potential opportunities to overcome a lack of data or Internet issues that can arise in low- or middle- income countries. They do include local governments, but include cultural leaders, the police or security forces, and members of the state government. Interestingly, the other programs did not seek out the help of local cultural leaders when engaging the community. Overlooking these types of community leaders can create problems or decrease mobilization within a slum or region.

After the mobilization was initiated, the team pivoted and focused on producing actionable reports or visualizations to provide to the community. However, while the May 2019 pilot exercise does produce visuals, it could be advantageous to produce different documentation or visualizations that can help convince the community on the prevalence and detriment of these advertisements.

The last element of their five step process for creating or mobilizing the community that stood out was dedicating time to lobbying and advocacy. While this might be outside the scope of the actual data collection being done in the May 2019 pilot exercise, it is an interesting point
for future studies. By writing it within the process, it gives a piece of action or end goal element to the project that could be useful for all projects to incorporate.

The Kibera project serves as a fantastic example of how to leverage the community to develop better maps for underserved areas of the world. Keeping their processes in mind when further developing the May 2019 pilot exercise or any digital mapping focused project will provide guidance for setting up a successful program. The growth of the Kibera project to the Mathare and Mukuru slums as well as the growth of the overall project from mapping to citizen journalism and media projects is a testament to their plans and guidelines being effective.

**Obstacles or Challenges:**

In reviewing the process and results for the May 2019 Pilot Exercise as well as elements brought up in the literature, a series of obstacles, challenges, and limitations arose.

**Street Harassment & Safety Concerns:**

Members of the team in the May 2019 Pilot Exercise expressed concern about street harassment during their time walking and photographing the block. The impromptu nature of this study meant that the team was not uniformed or marked in any way. It is advised to contact the local government or community to mitigate risk to a research team or NGO partners. Partnering with a local NGO also puts power back into the community by providing opportunities for grassroots organizations to lead the conversation regarding data collection, most relevant and useable data visualizations, and direction of the project.

Additionally, by including the community team in the project, the research teams will be a better known entity when traversing their planned routes. Finally, the presence of smartphones that can cause unnecessary or unwanted attention to the research groups was noted in various studies, which can raise concerns about safety. Working with the local
government or local NGOs, which can raise awareness within the community, should help mitigate these risks.

**Ensuring GPS Data Captured:**

One of the cameras was not correctly set up before starting the study, so it is vital to test the equipment being used before use, especially if a small group is doing the work. A small group is less likely to have the capabilities to provide additional quality assurance or walk duplicate routes. Test photos can be taken and uploaded to the shared space to be quickly be processed by the offsite research team, which will help mitigate this risk.

If this program is fully realized as an actual crowdsourced program, it will not be as quick or effective to fix the issue of missing GPS data. However, having a certain number of photographers should produce duplicate data that minimizes the risk of alcohol advertisements not being captured in any capacity. Further studies utilizing crowdsourced photography can help define a minimum threshold for photographers that reduces or eliminates the risks of overlooking advertisements.

**Street-View or Low-Level Quality Photography**

One of the limitations found during the processing of the pilot exercise is that the quality of aerial photos decrease as the eye altitude decreases. Eye altitude is the term that Google Earth Pro uses to describe the altitude of the user when viewing from an aerial perspective. An ideal perspective for viewing this data would be to see it in near real-time or at the street-level. Unfortunately, this is a limitation for the Google Earth Pro platform as the custom places or landmarks that are being uploaded into the system do not stay in place if trying to view the landmarks at that street-level view. While this street-view is unique to the Google Earth Pro platform, it could be replicated in a separate platform if the research team captures separate street-level footage. Custom street views could be produced that help bridge this gap in technology to help achieve stated goals within future studies or programs.
This limitation is not unique to the May 2019 pilot exercise and concern has been voiced across the literature, but no solution has been presented to help overcome this.

**Errant or Inconsistently Captured GPS Data:**

Once the data has been processed and uploaded, there have been instances of the same tagged location appearing in different locations on the map. The issue is complicated and likely cannot be genuinely rectified. GPS data can be inaccurate, which is driven by a variety of factors and influences. (ION) GPS-enabled smartphones are generally accurate to within 16ft, but the natural and built environment, trees or bridges respectively, can damper the signal and hamper results. (ION) Using a high-powered GPS receiver would mitigate these risk or inaccuracies, but this would be both expensive and prohibitive by the limited amount currently in stock. In reviewing the cost, in this case, the inaccurate data, and the benefits, the ubiquitous nature of smartphones, it is the recommendation of this team to note the inaccuracies as they appear, but the sheer amount of data should help normalize the results. Being that the purpose of this method is to identify hotspots quickly and will be used directionally, the 16ft error range should not harm results.
Community Involvement

The Zika Citizen Network’s case studies provide feedback highlighting the importance of working with local health ministries, NGOs, and governments as their ability to drum up support and enthusiasm for the project. The Premise team encourages continued efforts to gather an enormous number of users or contributors as possible; they found that the number of people who signed up to participate that did not maintain an active status was more significant than expected which slowed down their rate to reach the goals of their project. While not an obstacle, the Premise team held trainings and education sessions, in part with the local health ministries which could provide ample opportunities to engage with a local community to build relationships, increase understanding of the end goals of the project, and reach particularly vulnerable populations that are hard to reach with traditional data collection techniques.
Better Categorization of Advertisements Captured

Based on the literature and evaluation of the Greek tobacco study, there are some deeper level categorizations of the types of advertisements captured that would be useful to utilize for the May 2019 pilot exercise and beyond.

Figure 9. An Example of POP Advertisement

Some examples of these deeper categorizations would be point-of-purchase (POP) advertising or outlet marketing. POP advertisements are the ad units that exist on the counter or around the store, so they are the ads a consumer sees when they are about to purchase. Outlet marketing is in a similar vein, but instead, at a convenience store or supermarket, it is at an alcohol outlet. An easy example of outlet marketing is table clothes furnished by Castle or Club,
as evidenced by the below figures. Taking the extra step and providing these deeper categorizations ensures that the output data will be richer and more actionable for effectively writing policy, tailored to fit the needs of future programs and a more complete or futureproof dataset. With more exercises performed and more data points produced, the categorizations will need to be evaluated or expanded so that the stakeholders are getting the best and most accurate data.

Figure 10. An Example of Outlet Marketing

Analysis and Recommendations:

In performing the May 2019 pilot exercise, the team gained an understanding of how and if a program like this would work. With this practical knowledge in hand and understanding the limitations of other programs, this paper recommends conducting larger scale tests or exercises. These tests seek to stress out the outlined processes to ensure that they can handle growth and to uncover previously unseen issues. Additionally, by enlarging the program or exercise that
expands beyond just the 100-meter block, the team will gain more insights into the GPS inaccuracies. The more significant number of photos will help the research team understand the effects of GPS range inaccuracies and its detriment on mapping density. Additionally, by growing the area surveyed to include different surveys, the team will understand how density plays an impact on adolescents in the region.

Before moving into a fully crowd-sourced model, the first step should be to seek out the local health ministries and to partner with local, grassroots NGOs. Additionally, engaging with community elders or leaders is strongly suggested as it can improve engagement and keep progress moving. Plus convincing community leaders of the value of the project might help persuade local governments or provide unique pathways to enlisting local NGOs to lend support. Even though there is generally an overlap, it would be remiss to be fail to mention that fostering relationships with religious leaders should also be a priority. Gaining the trust and support of these leaders in a community will be of the utmost importance to a successful, long-term program. After creating partnerships with local NGOs or health ministries, it is essential to engage the community and use the time to discuss the projects, the aims, and the science or benefits behind it. Having these stakeholders together does provide a unique opportunity to have access to this vulnerable population, so being as effective and efficient with this access should be a high priority.

Working hard to engage these stakeholders and gaining access to this population provides an opportunity to create collaborations and partnerships beyond just the local community. This access would be a valuable area to help educate about the effects of alcohol, so preparing education materials to discuss the harmful effects of these advertisements or more generally the effect of alcohol on the community could be beneficial. Rather than re-inventing these materials, the team recommends partnering with an existing health organization that has these materials available already. Beyond just health and education, there are opportunities to
partner with economic development organizations as well. In knowing how alcohol production can be a profitable informal business for the local community, it is advised to pursue partnerships with NGOs or government organizations that specialize in economic or job development. By presenting lucrative financial incentives via direct payment or with the promise of economic development, a team could recruit a much larger number of active participants. A program like this could have an overall positive effect on the community, and this level of access would entice organizations to get involved with the program.

Interestingly while this paper has been focused on the particular use case of tracking alcohol advertisements, the program can be modified to fit a variety of projects. Seeing that crowd-sourcing data collection via photographs that have been discussed here targeted both natural environments, with mosquito breeding grounds and physical or built environments, with alcohol or tobacco advertisements, lends credence to the idea that it applies to projects unrelated even to health outcomes.

Lastly, while not advocating relying solely on a platform like Premise, this might be an excellent opportunity to pursue as they have the infrastructure in place and experience with government partnerships, scalable programs, and interacting with USAID to provide a monetary incentive for the program. None of their existing programs touch on this subject, so it would be an opportunity for them to expand their portfolio, making this a mutually beneficial partnership. Their work in Kenya with PEPFAR does intersect with some of the ultimate outcomes that we are seeking to promote here. It also creates a different style of use case that shows the flexibility of this type of data collection.

By adhering to the recommendations from the obstacles and challenges sections and following the framework set forth in the conclusions, this project will continue to provide valuable insights and has growth potential that could innovate efforts to quickly, accurately, and
cheaply hone the targeting when seeking to better understand the influencers that affect urban slums around the world.

**Conclusion:**

This paper serves to provide a preliminary evaluation of the need to continue to improve the processes ahead of future studies or new iterations of the May 2019 pilot study. By heeding the recommendations during the planning phase and accounting for them while executing, there will be less waste and richer data produced. However, while this evaluation aims to be as comprehensive as possible, it would be unrealistic to assume it addresses all challenges that might arise. When launching new exercises or programs, it is best to ensure that continuous monitoring and evaluation is incorporated even during development phases.

While the literature reviewed above draws a correlation between alcohol advertisement densities and adolescent alcohol consumption, neither this paper nor the May 2019 pilot exercise is attempting to conclude anything additional to that. They are merely being used to track the alcohol advertisement density and understand the feasibility of using this tool for that stated goal. Further study into the data produced from these exercises would need to be done to conclude the overall public health implications of alcohol advertisement density.
References:


