

PUBLIC HEALTH MAPPING TOOLS ASSESSMENT Final Report

Provided To The Center for Public Service
Communications



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September 30, 2012

Contents

Project Description.....	3
Mobile Tablet Based Tools.....	3
Apple iPad Apps	4
Feature Mapper	4
PointRecorder and Fulcrum	7
Motion X GPS HD.....	9
EpiCollect	10
iGIS	11
GIS Kit & GIS Pro.....	12
Android Tablet Tools	12
OruxMaps	12
Web Based Tools	14
Cloud Platforms	14
ArcGIS Online	14
DataBasin.....	14
CartoDB	15
GISCloud	17
Google Fusion Tables	17
Web Mapping.....	17
Google Maps API	18
Leaflet	18
MapBox & TileMill	18
MapTiler	19
OpenLayers	20
Data Sources	20
Behavioral Risk Factors Survey.....	20
National Vital Statistics Program.....	20
National Survey on Drug Use and Health.....	20
U.S. Census Bureau	20
American Community Survey	21
Data.gov	21
FedStats.....	21
OpenStreetMap	21
National Map	21
Desktop Tools	21
Quantum GIS (QGIS)	21
Google Earth	21
ArcGIS Explorer	22
Final Recommendation	22
Field Data Collection	22
Data Sources	31
Web Data Display	31
Desktop Data Display	39
Conclusion	40

Public Health Mapping Tools Assessment Interim Report

Project Description

In lieu of developing a custom web application to support community public health monitoring, Bird's Eye View (BEV) assessed currently available tools for collecting and visualizing public health trends via maps and data. Focus was given to tools that allow a simple workflow from field data collection to storage, and display of collected data. These tools include: tools for tablet computers (Apple iPad® and Android), websites serving out useful public health related data, websites where user data can be uploaded and mapped, open source tools for developing web maps, and free/low cost desktop tools.

Each finding was evaluated and reported on. Tool descriptions include: any existing data content, functionality for data manipulation, data upload parameters (including supported file formats), other functionality offered, and any bugs encountered.

BEV attempted to find tools that when strung together in a simple workflow would allow students and researchers to collect community data and present the results in a map form. This report concludes with a final recommendation of a workflow. The world of web mapping, web based data sources, cloud resources and web mapping applications has exploded in recent years. This has resulted in more options than it was feasible to assess. Therefore, this report includes what were found to be the best of each category based on BEV's research.

Mobile Tablet Based Tools

An exciting trend in modern data collection is leveraging the power of tablet computers. Tablets are relatively inexpensive, intuitive, portable, and increasingly powerful. Additionally, both Apple's iPad and Android tablets typically ship with GPS receivers, which then allow for field data collection with accuracy perfectly suitable for conducting community assessments. Since Android is an open source operating system, open source developers tend to develop more for that operating system vs. Apples iOS. There is one particular Android app that will be covered. However, since CPSC and NLM partners have already invested in iPad's, focus will be given to low cost applications for iPad. The main criteria needed to be a useful mobile system include the ability to:

- Collect data
- Name features and enter notes
- Export data to a useful format such as KML or GPX

The ability to capture photos and geotag photos with coordinates is an additional benefit.

Apple iPad Apps

Feature Mapper

This simple app costs \$9.99 and allows users to view a Google map interface highlighting your current location. You can choose between the standard Google basemaps: street map, satellite or hybrid (Figure 1).

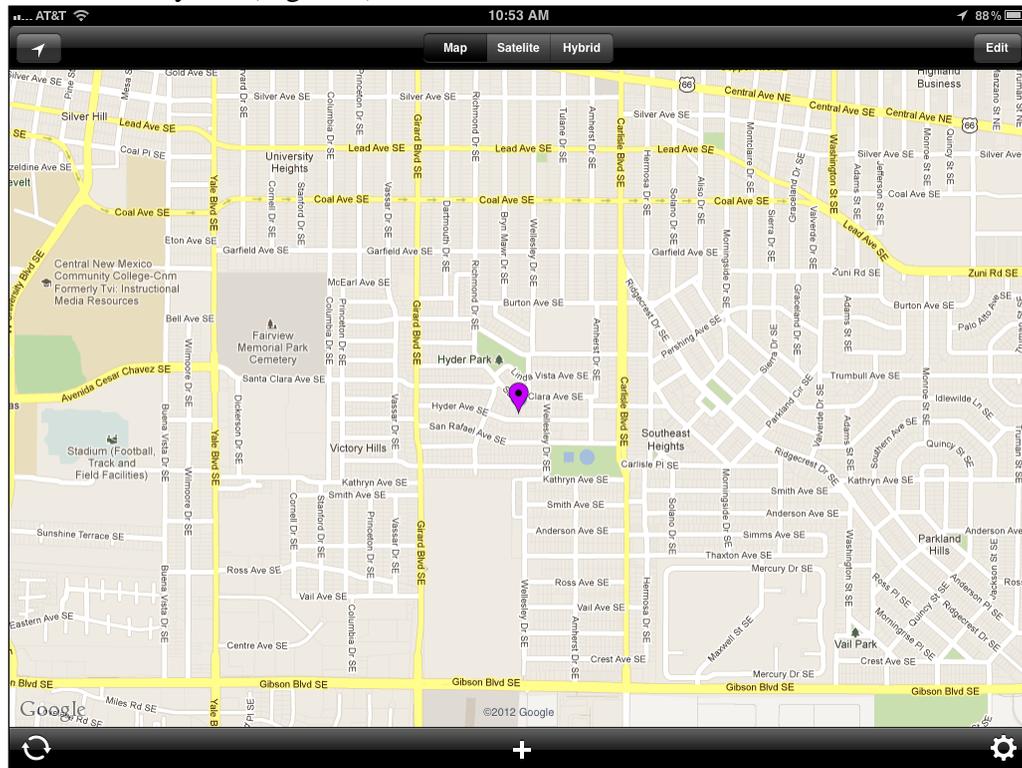


Figure 1: FeatureMapper

To save your location, simply click the plus sign at the bottom of the screen. You can then fill in the Name and Comments fields and pick an icon color. Features can be differentiated by choosing different colored icons. The collected point also includes a timestamp and coordinates (Figure 2).

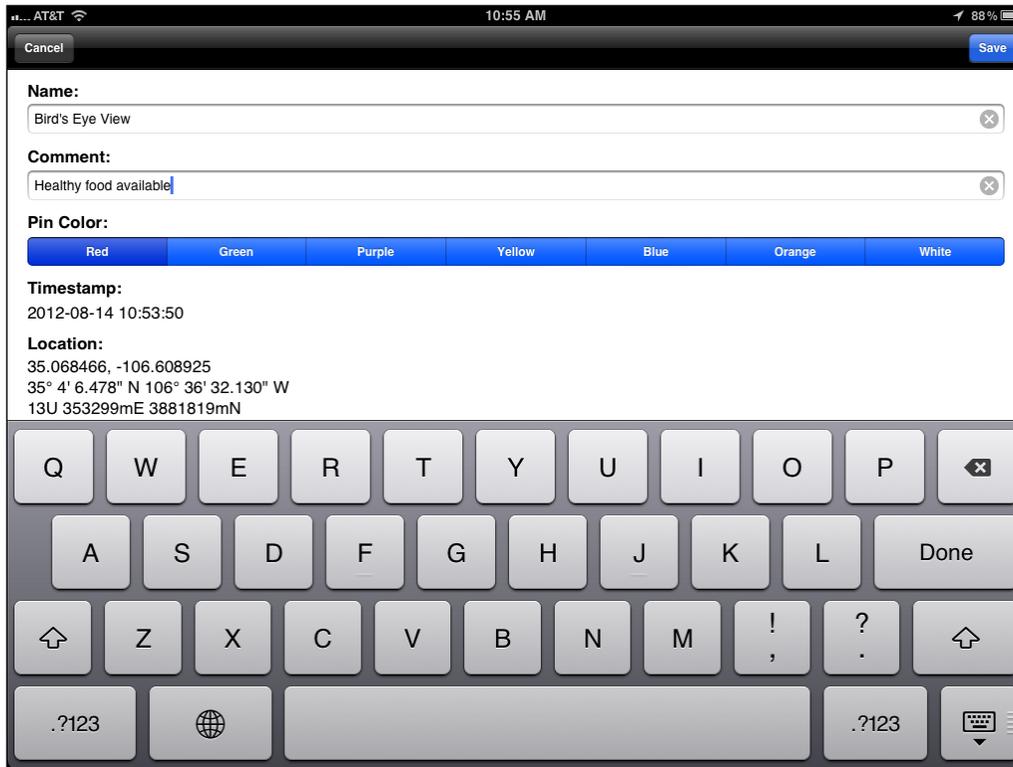


Figure 2: FeatureMapper - saving a location

The location is then saved and labeled on the main map (Figure 3).

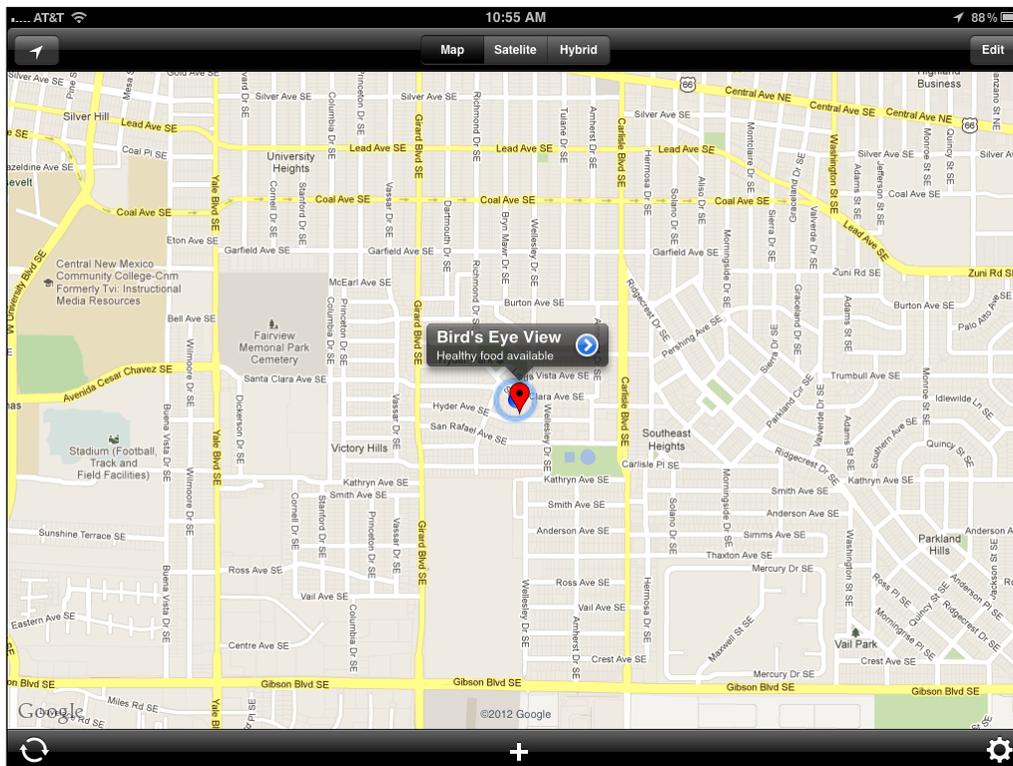


Figure 3: FeatureMapper - location saved

Once data collection is completed the data can be emailed (Figure 4) as keyhole markup language (KML) data. KML is the native format for Google Earth. Once on the desktop the data can be saved to a folder and viewed in Google Earth (Figure 5) or other GIS applications.

FeatureMapper can also import KML files that have been emailed and received on the iPad. This would allow a data collection manager to email out study area or route files in KML format to individual field workers who could use those additional base layers to help orient their data collection.

This is an extremely simple app. It's simplicity can be seen as a benefit in that it's easy to learn and intuitive. The downside is that it is not too robust. It doesn't allow you to name your own classes of field locations and doesn't allow you to determine which set of points to email out as KML. Emailed data includes the full set each time. Overall this app seems to have a high price tag for what it can do.

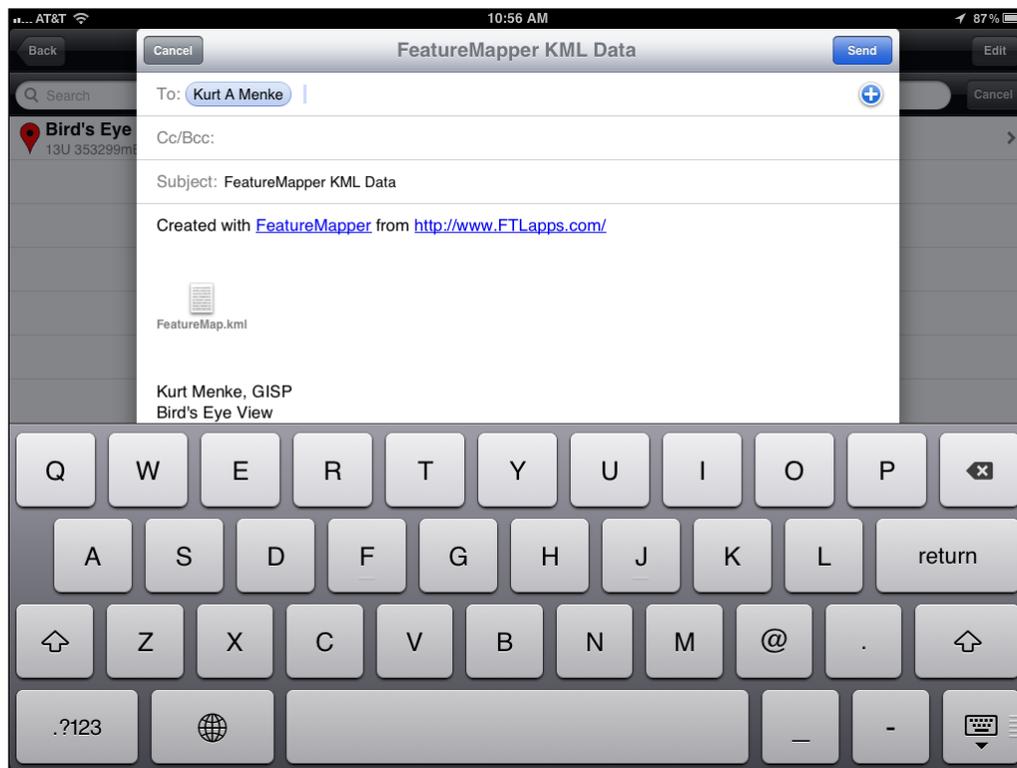


Figure 4: FeatureMapper - Email KML data

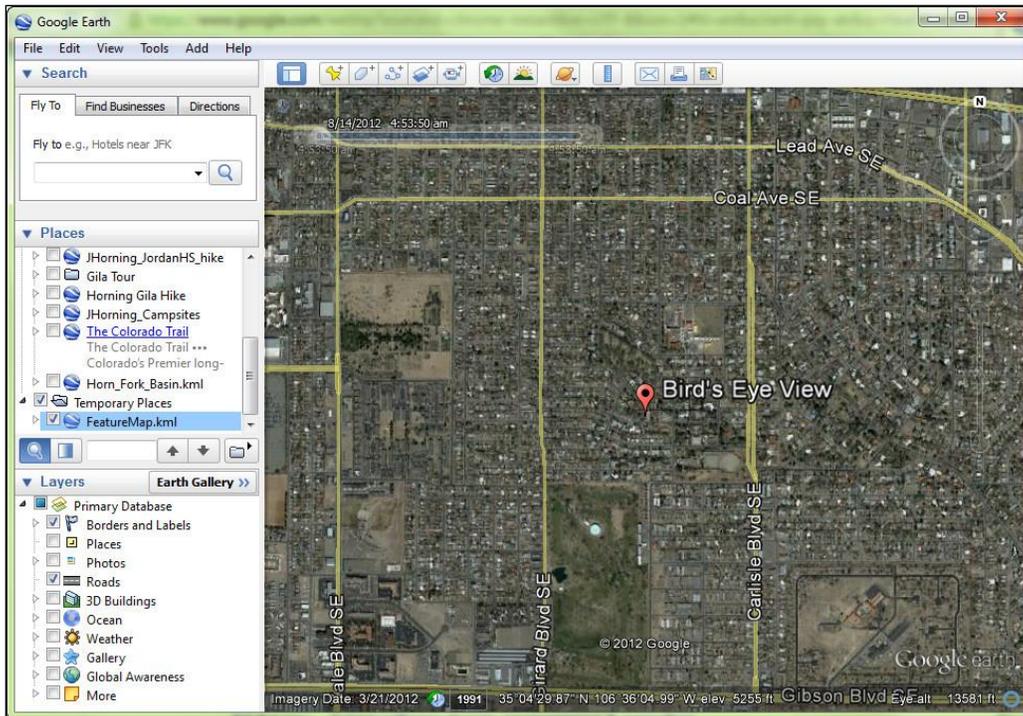


Figure 5: FeatureMapper - KML data displayed in Google Earth on the desktop

PointRecorder and Fulcrum

Both of these apps can be downloaded free of charge. They both allow for the creation of forms for GPS data collection. Collected data can then be uploaded to a cloud based server. This is where fees can be encountered. Each company offers tiers of service from free to more costly annual subscriptions which allow for more data to be collected, and for more users to have access.

PointRecorder was the more mature and least expensive of the two applications and will be discussed here. The foundation of the PointRecorder system is the applet. Upon download the end user is prompted to create a free account. The account is created via their website, either on an iPad or other computer.

Once the account is created one can go about creating a custom applet on the PointRecorder website. An applet consists simply of categories of locations to collect. So for the example in Figure 6, the following categories were created: Exercise Location, Fast Food, Health Food Store and Clinic. A colored symbol is chosen for each. I called this applet '*Albuquerque Community Survey*'. An applet has settings for both visibility and ability to add data to it. These settings can be set to any combination of private or public. These settings then allow a community of volunteers to all be able to share the same applet with other just within the community and not to everyone. Or an applet can be made public so everyone can add data to it. The visibility setting sets who can see the data.

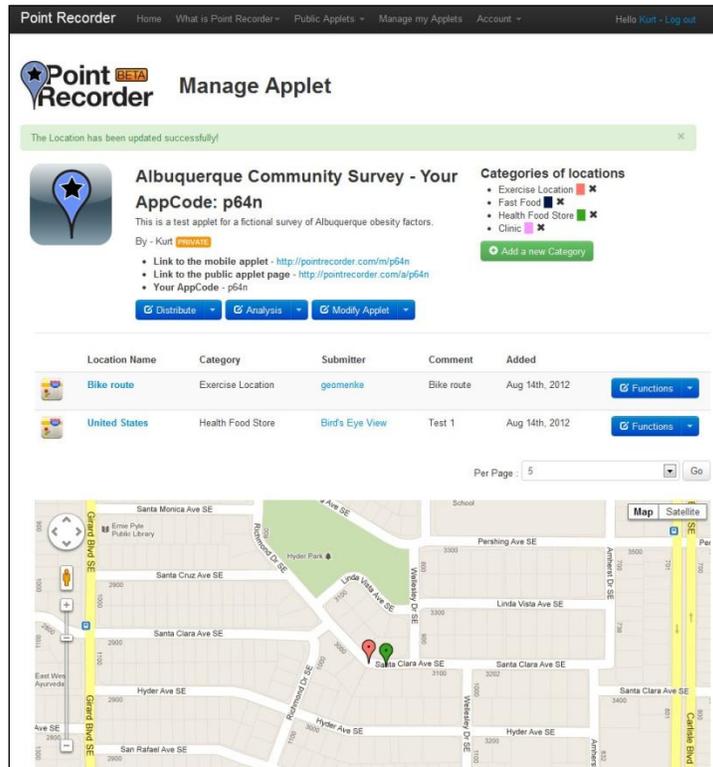


Figure 6: PointRecorder website with custom applet

Applets are managed from the PointRecords website. Figure 7 shows how you can download or forward the data in the applet, and edit/configure the applet.

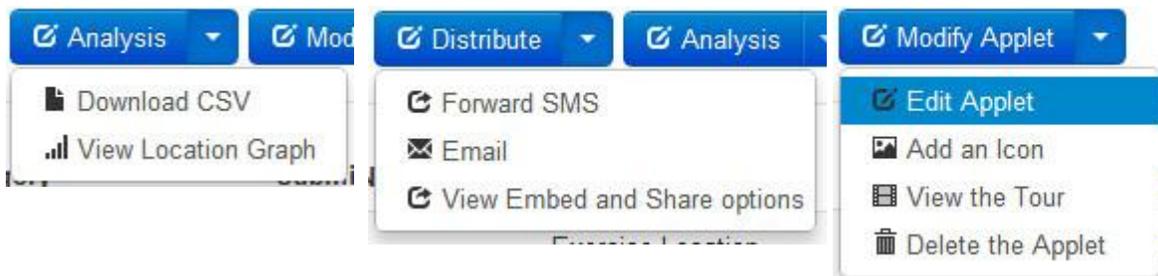


Figure 7: PointRecorder Tools

The iPad application itself has a very simple interface for adding locations. The user chooses the category and fills out the user name, email address and any comments (Figure 8). The user can then submit the location and view the map which displays all points in the applet.

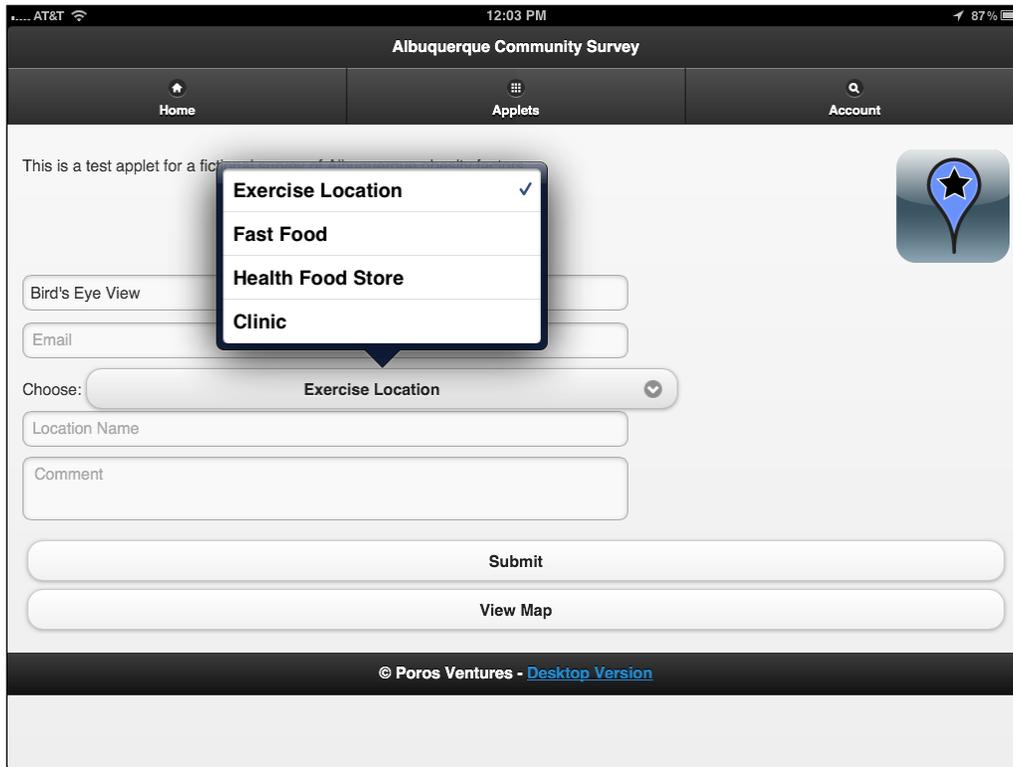


Figure 8: PointRecorder iPad application

This app is great for a free app. You can customize a community survey by creating your own applet. However, pricing information was no longer available and it was impossible to discern what limitations, if any, were associated with a free account. The iPad app itself wasn't as intuitive as it should be given the simplicity of the system. However, there is no reason this could not be part of a nice data collection solution.

Motion X GPS HD

(<http://news.motionx.com/category/motionx-gps/>)

This GPS app is more designed for outdoor recreation than scientific field data collection. Its strengths are outdoor navigation and GPS data collection. However, if all you are collecting is simple points, it can do that. It will collect GPS waypoints which are just positions collected by the GPS. You can name the point and take some notes. By default the notes column is populated by Motion X with the date and time (Figure 9). However, you could use this available notes field to type in a description. It will also collect a photo with the point. It will then allow you to email the data. It is also integrated with Facebook and Twitter. However, for serious data collection it is not as robust as other choices because it will not allow you to collect multiple points as part of the same layer. Each point is a separate file that must be emailed. Nor will it allow you to take sufficient notes about a given locale.

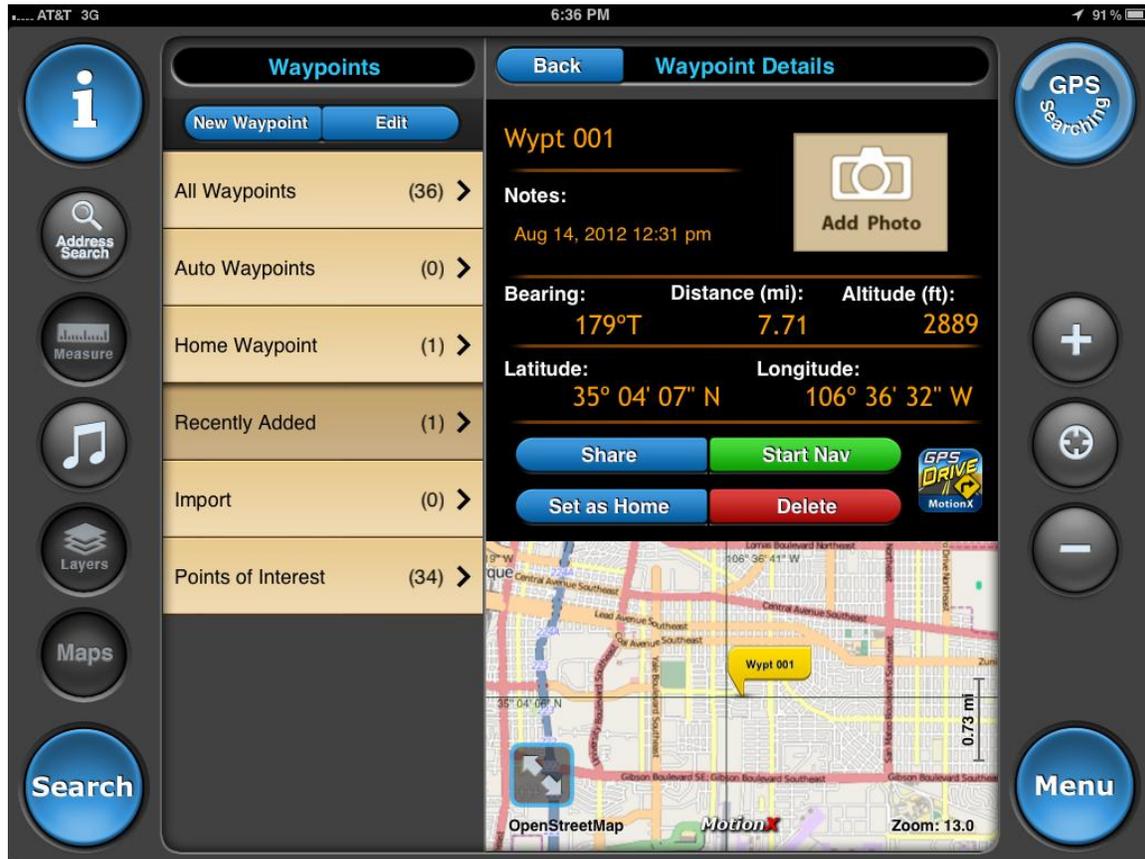


Figure 9: Motion X GPS waypoint menu.

EpiCollect

This free iPhone/iPad app is very simple and very useful. It allows you to go online and set up a project at <http://www.epicollect.net/>. Simply give the project a name and design your data collection form. The form can be set up with a variety of attribute columns. For example, type, name, description and photo. Setting up the form seemed pretty intuitive until I got into it. Then it started throwing errors and I had to figure out what it was asking for. I was able to get a sample data collection form built fairly quickly and it would go much more smoothly the second time. The project can then be uploaded via your email address to your iOS app. After data collection, you can sync the mobile app with the website. The data can then be viewed on either the app or on the website. The website also allow for the data to be exported as either an XML or CSV file. This data could then be brought into a desktop GIS such as QGIS.

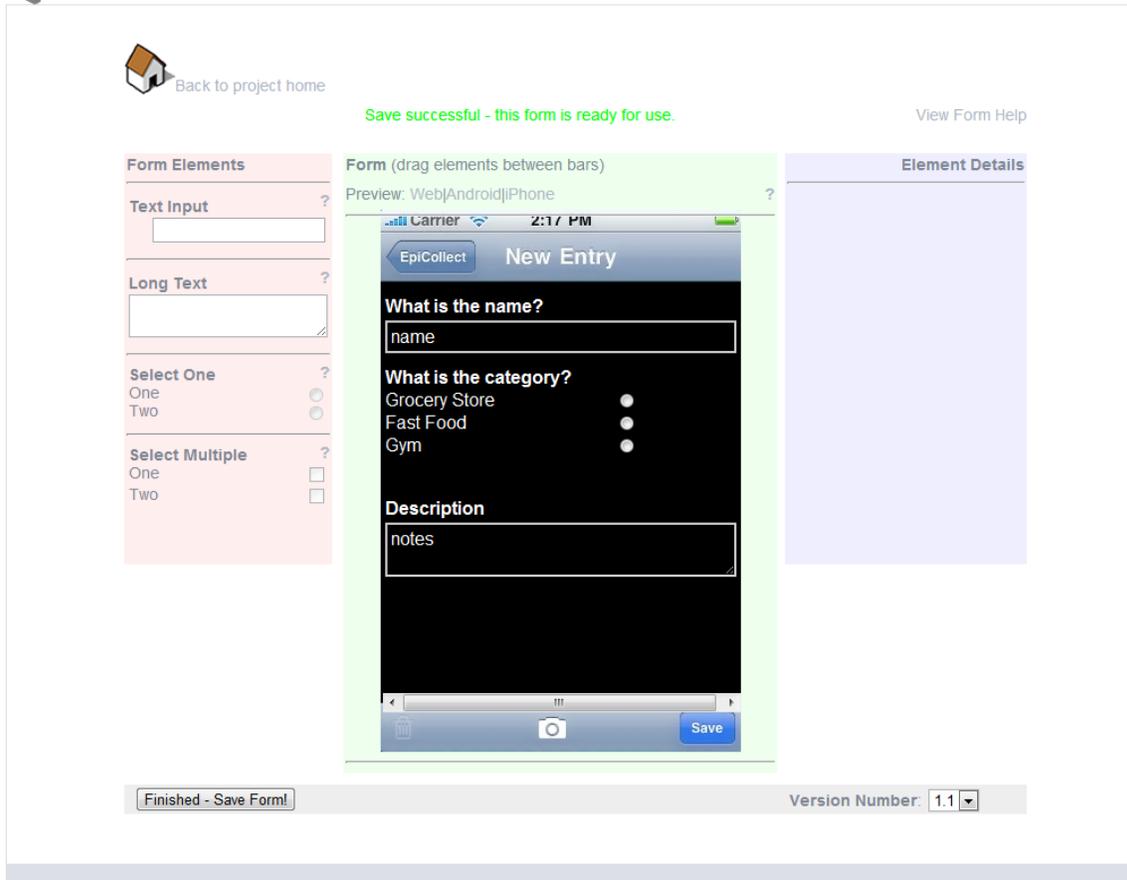


Figure 10: EpiCollect Form designer. Just drag and drop. Very easy to use.



Figure 11: The EpiCollect site with data collected from the field.

iGIS

iGIS is a free GIS app for iPads. This app allows you to upload shapefiles via iTunes (Figure 12). One could use this in combination with a free desktop software package such as QGIS to create such a point shapefile. Then the shapefile can be uploaded, and added to, in the field. I found iGIS to be non-intuitive and difficult to get started. I could not determine how to get the data layer editing functionality that it advertised and would not recommend it at this point in time.

File Sharing

The apps listed below can transfer documents between your iPad and this computer.

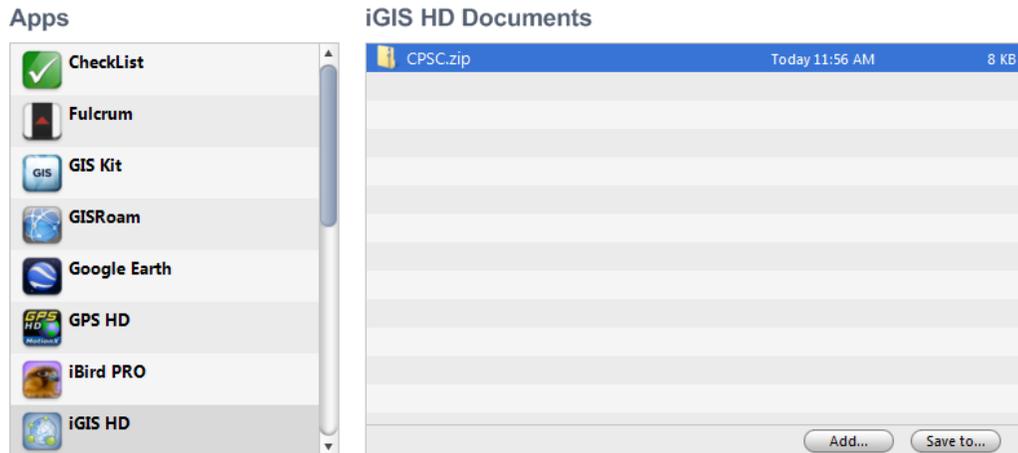


Figure 12: iGIS data upload interface in Apples iTunes.

GIS Kit & GIS Pro

(<http://gis.garafa.com>)

These are both lightweight GIS application for iOS. GIS Kit is the less expensive app and GIS Pro is the more robust app being designed for multiple users. GIS Kit was purchased for this evaluation and costs \$99 per user. That user could have the app on both an iPhone and an iPad. However, each unique user needs their own license regardless of the version. One can upgrade from within the app toe GIS Pro. GIS Pro costs \$299 and is advertised as the enterprise version of GIS Kit. It allows the user to export collected data in shapefile format vs. GIS Kit which only allows KML and GPX. GISPro also allows for sharing of GIS layers. With this feature a team of data collectors could all be working off of the same GIS layer. That is certainly a valuable feature. However, at triple the cost it is this reviewer's opinion that the extra data management needed when using GIS Kit can be easily done with the extra savings. There is also a volume discount purchasing option.

With the cost does come great functionality compared to all the other iOS apps found. This was determined to be part of the best workflow and is reviewed more thoroughly in the final recommendation section.

Android Tablet Tools

Since the reviewer does not have an Android tablet available, he was not able to evaluate or efficiently discover Android apps. Instead he relied on third party reports and reviews. Generally open source developers are working primarily with the Android platform. Therefore, Androids have many free apps that rival costly apps on Apples iOS. It worth noting that several free and open source (FOSS) desktop GIS applications have Android versions. These include QGIS and gvSIG.

OruxMaps

(<http://www.oruxmaps.com>) This is a robust free GPS mapping and photo geotagging application. This application has very similar functionality to Motion X HD. It allows for collection of waypoints and tracks on a variety of basemaps. User data, such as street

networks can also be uploaded and used as a backdrop during data collection. It allows for geotagged photos to be collected as well. It is intuitive and free.

Map Viewer



The buttons:

The upper buttons bar can be configured in two different ways:

–The new one (Recommended): Bar fixed with four buttons (Tracks—Wpts—Routes—Maps—More) and a second level for each ones, with more options.

It will grow up in the next versions.



Figure 13: OruxMaps screen with tool explanations.

Web Based Tools

These tools have been classified into three categories: Cloud platforms, Web Mapping, and Data sources.

Cloud Platforms

Cloud platforms are distinguished from Web Mapping in that they allow you to upload your data to a server and then develop your map there. Conversely web mapping applications typically require a dedicated sever. There are a lot of options developing rapidly in this world.

ArcGIS Online – This is ESRI's cloud platform (<http://www.arcgis.com/about/>) for web mapping. It allows users to create interactive maps and apps that can be shared with anyone. There is a companion iPhone/iPad app. ArcGIS online comes with a rich collection of basemaps such as aerial photography, Bing maps and topographic maps. It is a costly solution. The fees are arranged by the number of users. The base rate is \$2,500 per year.

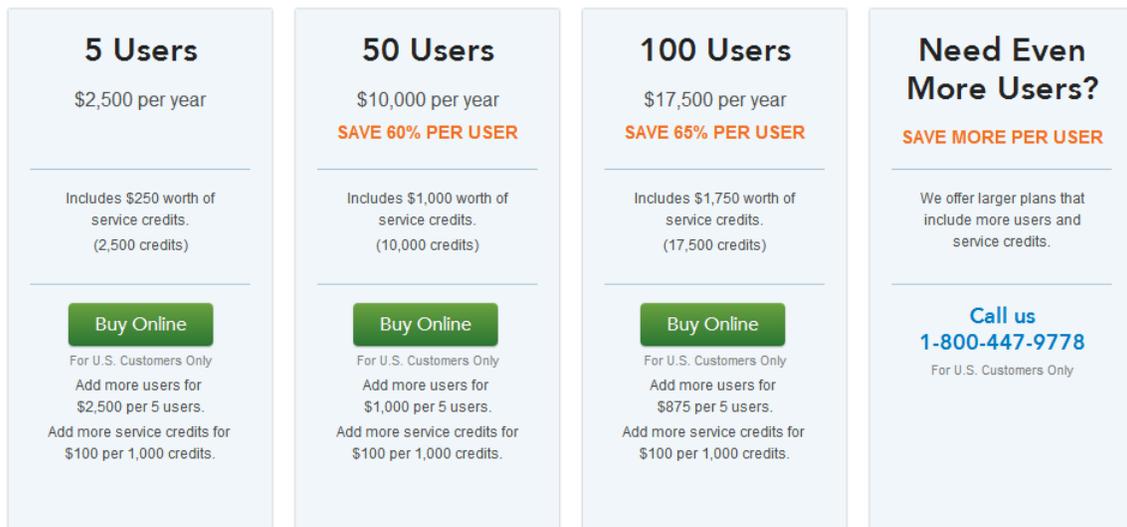


Figure 14: ArcGIS Online Pricing from <http://www.arcgis.com/about/pricing.html>

DataBasin – a social online mapping, data sharing, and visualization GIS website (<http://databasin.org/>). It is geared to conservation and environmental projects. However, anyone can use it free of charge and public health would fit within the intent of the site.

It has two main functions. First, it can be a source for data. It has search functionality and users can download GIS from the site for use in their own GIS applications. Second, it can be a map creation site. Users can create maps from a combination of basemaps, other user data, and their own data. Users can symbolize data as part of the process and determine whether their maps should be kept private, shared with groups or published for everyone.

It has been designed with a focus on being intuitive. Users do not need to be highly skilled technically. This site is part of the final recommendation and will be further reviewed as part of the there.

CartoDB - Spatial data mapping website (<http://cartodb.com/>). It can be considered a less expensive simpler version of ArcGIS Online. There is a free version which limits you to give GIS layers totaling less than 5Mb. This was used for a simple evaluation. Pricing begins at \$29/mo and goes up to \$149/month depending on the amount of online storage needed (Figure 15).

Scale and performance to meet your needs
All our plans are monthly, with no lengthy contract.

FREE Newbie server	\$29/mo Magellan plan	\$49/mo John Snow plan	\$149/mo Coronelli plan
Up to 5 tables	Up to 10 tables	Up to 20 tables	Unlimited tables
Up to 5MB	Up to 50MB	Up to 100MB	Up to 500MB
Community support	✓ Online support	✓ Online support	✓ Online support
<input type="checkbox"/> Private tables	✓ Private tables	✓ Private tables	✓ Private tables
<input type="checkbox"/> Removable brand	<input type="checkbox"/> Removable brand	<input type="checkbox"/> Removable brand	✓ Removable brand

[Sign up](#)

Upgrade to the paid servers when needed from your dashboard. First, give CartoDB a try!

Figure15: CartoDB Pricing from <http://cartodb.com/pricing>

The site allows users to upload zipped GIS layers, assuming the GIS layers fit within your accounts size limitations. Here what they are calling tables are simply GIS layers. You can then symbolize your data and share the map with others.

Hello geomenke
Need more resources? [Upgrade your account](#)

0/5 Used Megabytes

4/5 Tables created

4 tables in your account

- parks** PUBLIC less than a minute ago
4 KB / ~1 row / 6 columns: descriptio, name, created_at, updated_at...
- fast_food_restaurant** PUBLIC 1 minute ago
4 KB / ~4 rows / 6 columns: descriptio, name, created_at, updated_...
- grocery_stores** PUBLIC 2 minutes ago
4 KB / ~3 rows / 6 columns: descriptio, name, created_at, updated_...
- localstreets** PUBLIC 8 days ago
128 KB / ~563 rows / 18 columns: alternated, alternates, comments...

Wondering how to start with CartoDB?
Upload your data to a new table

[Create a new table](#)

BROWSE BY TAGS

You have not added any tags yet.
Tags are useful for organizing and filtering your tables.
To add tags to your tables, open them and enter them under the name.

Figure 16: Data tables added to an account.

The one limitation is that it only allows you to create maps with one layer at a time against their basemap. This is likely to change in the next release. It has a lot of symbology options for that one layer. Plus there are some work arounds for bringing to layers together in one map. However, the developer would have to have some rudimentary web programming skills to do this. CartoDB was very close to being considered a final data visualization tool and deserves serious consideration as it matures.

Do you want to import some data to the new table now?
You will also be able to do it later.

I want to create an empty table

- Point
- Line
- Polygon

I want to start with some imported data

I want to add some data from a URL

[cancel](#) [Create table](#)

Figure 17: The CartoDB data import form

GISCloud – (<http://www.giscloud.com/>) This is a very intuitive cloud platform for creating web maps that you can share with others. It easily allows you to upload shapefiles and kml data. You can then create maps and add data to them. The maps can then be made public or private and shared with other GISCloud users. I was very impressed with how easy it was to get up and running with minimal effort. It requires very minimal technical skill to create a map.

One can sign up for a free account if you're using it for non-commercial uses. A professional account is \$15 per month. This service can also be used for field data collection. It is possible to set up empty GIS layers on the cloud and populate them with an Android device. Since an Android tablet was not available this was not evaluated. However, it deserves serious consideration as it might make for a complete solution from data collection to online viewing. It even offers some analysis when your data is stored in a PostGIS database in the cloud. GISCloud also offers several apps including fleet management and one that allows the import of data from ESRI's ArcGIS into your GISCloud account.

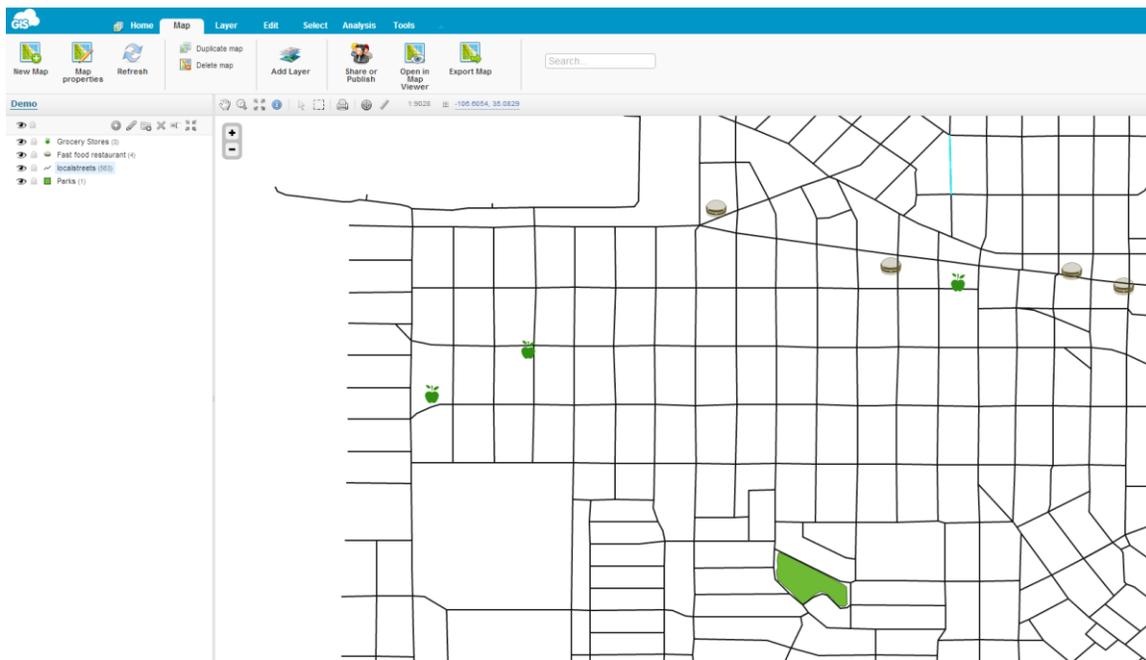


Figure 18: Map made in GIS Cloud from data collected via GIS Kit on the iPad.

Google Fusion Tables - Potentially a good site for storing data online in combination with Google Docs (<http://www.google.com/fusiontables/Home/>)

Web Mapping

This section includes only selected software's that might be easily used to quickly develop web mapping applications. There are several other notable omissions from the list such as **GeoServer** (<http://geoserver.org>), **MapServer** (<http://mapserver.org/>), and **OpenGeo** (<http://opengeo.org>). These were left off because, while they are industry leading robust applications, they require a more programming and are more suited to

building highly customized dedicated server based web applications. The following list focused on lighter weight API's for developing web mapping applications.

Google Maps API - This is the leading web mapping API. It is not open source. However, it is free to use if the site does not charge users for access. It is fairly simple to use and robust. However, it does require programming in Javascript. It is very well documented though and there are a plethora of examples, books, and code snippets available.

Leaflet - (<http://leaflet.cloudmade.com/>) Leaflet is a modern open-source JavaScript library for mobile-friendly interactive maps. As such it is very similar to the Google Maps API. Maps can be built with some fairly well documented code. Basemaps are available including OpenStreetMap.

MapBox & TileMill – (<http://mapbox.com/>) MapBox is a platform for designing and publishing fast and beautiful maps. They provide MapBox Streets, a complete customizable world base map and the open source map design studio TileMill. They also offer hosting of web applications (Figure 20).

TileMill - (<http://mapbox.com/tilemill/>) This application is a design environment developed by MapBox for cartography, constituting Mapnik as a renderer, Carto as a stylesheet language. TileMill comes with a desktop application that allows you to create your map. The desktop interface is shown below. It is a step up in complexity from GISCloud. Knowing how to work with internet cascading style sheets (CSS) is important here. However, the map can then be exported as an image or as a set of map tiles suitable for use in a dedicated web mapping server application.

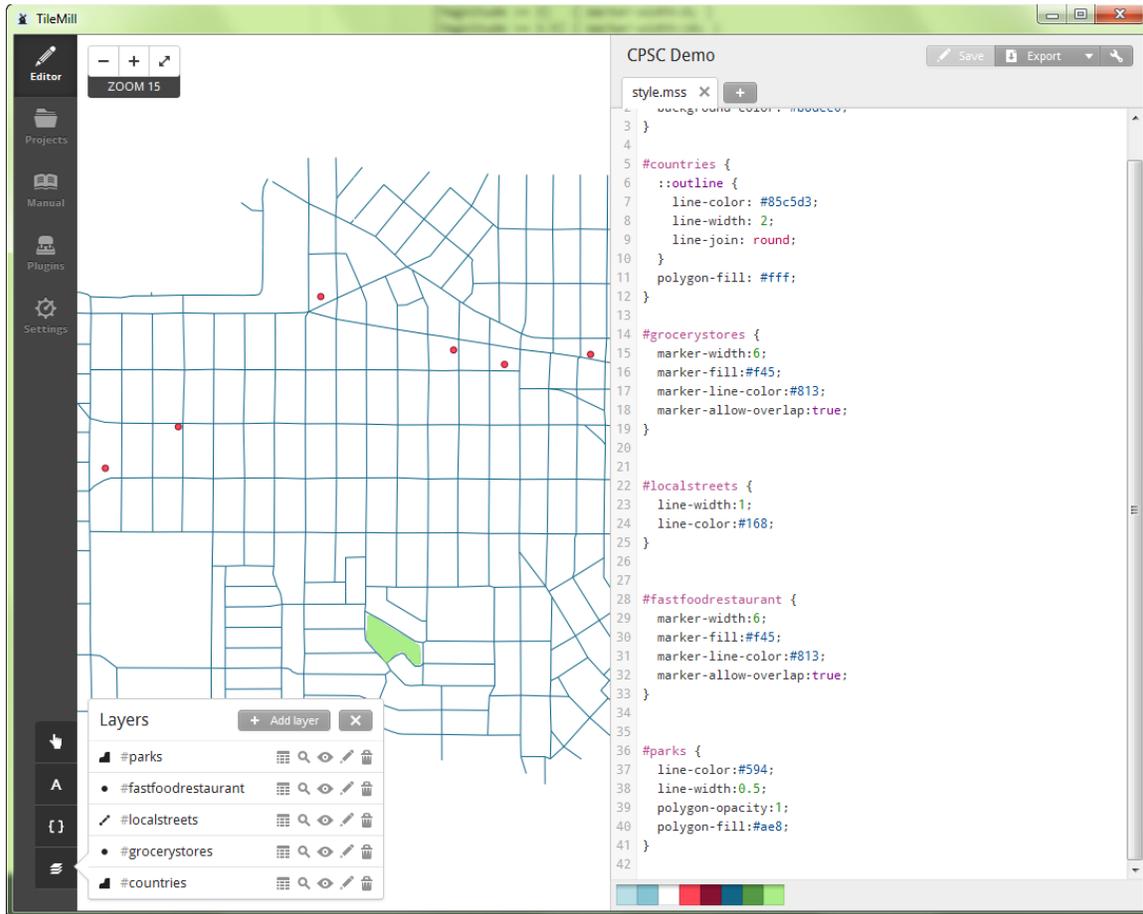


Figure 19: TileMill application with data collected via GIS Kit for iPad.

Pricing		Find the plan that's right for you.			
		See all plans	Individuals	Popular apps	High volume
Free \$0/month SIGN UP	<ul style="list-style-type: none"> 3,000 map views/month 50 MB upload storage Online support No analytics MapBox logo on maps 				
Basic \$5/month SIGN UP	<ul style="list-style-type: none"> 10,000 map views/month \$0.50 / 1,000 additional 250 MB upload storage Online support No analytics MapBox logo on maps 				
Standard \$49/month SIGN UP	<ul style="list-style-type: none"> 100,000 map views/month \$0.50 / 1,000 additional 3 GB upload storage Online support Analytics dashboard Branding-free maps 				
Plus \$149/month SIGN UP	<ul style="list-style-type: none"> 300,000 map views/month \$0.50 / 1,000 additional 10 GB upload storage Online support Analytics dashboard Branding-free maps SSL maps 				
Premium \$499/month LEARN MORE	<ul style="list-style-type: none"> 1,000,000 map views/month Volume discounts for more 30+ GB upload storage Dedicated support Analytics dashboard Branding-free maps SSL maps 24-hour response 			We offer discounts for high volume users. GET A QUOTE	

Figure 20: MapBox pricing scheme

MapTiler - (<http://www.maptiler.org/>) This is a graphical application for online map publishing. Google Maps, Microsoft Virtual Earth, and OpenStreetMap all operate with

tilled maps for each zoom level. This is in a similar category with MapBox in that MapTiler gives you tools for generating your corresponding MapTiles of your own data that you can then upload to your webserver and add to your Google mashup or similar web application.

OpenLayers – (<http://openlayers.org/>) OpenLayers is one of the leading Javascript API's for developing open source web mapping clients. It has the ability to consume just about every type of GIS data imaginable. However, it requires programming and a web server. Due to the scope of this project and a lack of a webserver it was not tried.

Data Sources

There are numerous sources of data and this section is not meant to be exhaustive. Several of the more important data sources for public health and socio-economic data were selected for inclusion in this section.

Behavioral Risk Factors Survey - (<http://www.cdc.gov/brfss/>) The world's largest, on-going telephone health survey system, tracking health conditions and risk behaviors in the United States yearly since 1984. Currently, data are collected monthly in all 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam. The data are collected by county and metropolitan statistical area. The CDC provides downloadable BRFSS data as shapefiles by state and MSA
http://www.cdc.gov/brfss/maps/gis_data.htm.

National Vital Statistics Program - (<http://www.cdc.gov/nchs/nvss.htm>) The National Vital Statistics System is the oldest and most successful example of inter-governmental data sharing in Public Health and the shared relationships, standards, and procedures form the mechanism by which NCHS collects and disseminates the Nation's official vital statistics. These data are provided through contracts between NCHS and vital registration systems operated in the various jurisdictions legally responsible for the registration of vital events – births, deaths, marriages, divorces, and fetal deaths.

They provide summary tables for the vital events they collect data on. They also have tools for interactively building queries to mine data with a free site account. They also have a mapping application that will let you see the results of a query on a map.

National Survey on Drug Use and Health - (<https://nsduhweb.rti.org/>) Provides national and state-level data on the use of tobacco, alcohol, illicit drugs (including non-medical use of prescription drugs) and mental health in the United States. They also provide the data at sub-state levels that differ for each state (county, groups of counties, census tract, parish, borough/census area, etc.).

U.S. Census Bureau - Source of a lot of important data for community health mapping including a new smart phone app (<http://www.census.gov/>). The U.S. Census provides a wealth of demographic and spatial datasets. Via the American Fact Finder (<http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml>) one can query the decennial census tables and export specific data by tracts, block groups, blocks, MSA's,

and zip code tabulation areas depending on the database being queried. They also provide the Census boundaries and many other spatial datasets including populated places, roads and railroads (<http://www.census.gov/geo/www/>).

American Community Survey - (<http://www.census.gov/acs/www/>) This is an ongoing survey that provides data every year. The data elements collected in the survey include: age, sex, race, family and relationships, income and benefits, health insurance, education, veteran status, disabilities, where you work and how you get there, where you live, and how much you pay for some essentials. The finest geography that data are collected for is the Public Use Microdata Areas (PUMAs). Data products include yearly data and aggregates over several consecutive years. The data include raw totals and weighted totals representing likely whole population figures.

Data.gov - (<http://explore.data.gov/catalog/raw/>) This is a generic portal for U.S. government data. As such it is a huge ever growing collection from numerous federal agencies.

FedStats - (www.fedstats.gov) Similar to Data.gov this is a generic source for US government statistics. Data figures have been aggregated to allow citizens to quickly access summary statistics on a variety of topics.

OpenStreetMap - (<http://www.openstreetmap.org/>) OpenStreetMap is a freely editable map of the world. It is a crowd sourced map. It can be used freely as a basemap in any GIS application. It can also be edited. There are several editors which allow users to add features to the map which then become part of the basemap.

National Map - (<http://nationalmap.gov/>) This is a collection of national spatial datasets on a variety of topics. Data can be downloaded or consumed via OGC standards such as Web Map Service (WMS) by GIS software's and GIS websites.

Desktop Tools

Quantum GIS (QGIS) - I have taught a semester long introduction to open source GIS course for the last three years, and QGIS has been the staple application for the course. I consider QGIS (<http://www.qgis.org/>) to be the leading open source GIS. It has been undergoing rapid development and now rivals many proprietary GIS's. It's a full featured GIS desktop application. It is able to read and write a huge variety of file formats such as: shapefiles, kml, gpx, and even file geodatabases. It has map design functionality, and substantial analysis capabilities. With all of that it remains fairly intuitive and user friendly. This will be included as part of the final recommendation.

Google Earth - Free data viewer (<http://www.google.com/earth/index.html>) This is a widely known "earth browser". It's a free desktop application for viewing planet earth including 3D viewing. It's the most intuitive data viewing application, requiring no technical knowledge. It's native data format is the KML file. As such it makes for a perfect data visualization application for community health care data. Many of the mobile data collection apps support KML export as does QGIS.

ArcGIS Explorer - Free data viewer (<http://www.esri.com/software/arcgis/explorer>)
This is ESRI's free data viewer.

Final Recommendation

I discovered that there are several similar tools in each niche. In some areas it was impossible to identify a clear winner. Many applications, especially in the tablet arena have yet to reach their full potential. Therefore this final recommendation will include choices along the way from data collection to final presentation. To demonstrate the workflow I collected potential obesity factors in my neighborhood. I collected several fast food restaurant locations, grocery store locations and a park boundary.

Field Data Collection - There were two main iOS iPad apps that stood above the rest when evaluated in terms of intuitiveness, functionality, price and features: GIS Kit and EPI Collect. GIS Kit excels at field data collection. It allows for custom GIS layer creation with custom attribute fields and accompanying photos. The major downside to GIS Kit is the cost at \$99 per iPad. EPI Collect was discovered just recently and remarkably is a free iPad app. It too lets you collect points in the field with custom attributes and associate photos.

Collecting Data with GIS Kit

When you first open GIS Kit on the iPad you are presented with the project manager. You can create as many projects as needed. I set up one called 'CPSCdemo'.



Figure 21: GISKit Project Manager

Simply click on a project to open it. From there you have a project console that allows you to manage your data layers, feature classes (folders), map settings, offline maps (cached map tiles for offline use), project units (metric vs. imperial) and GPS settings.

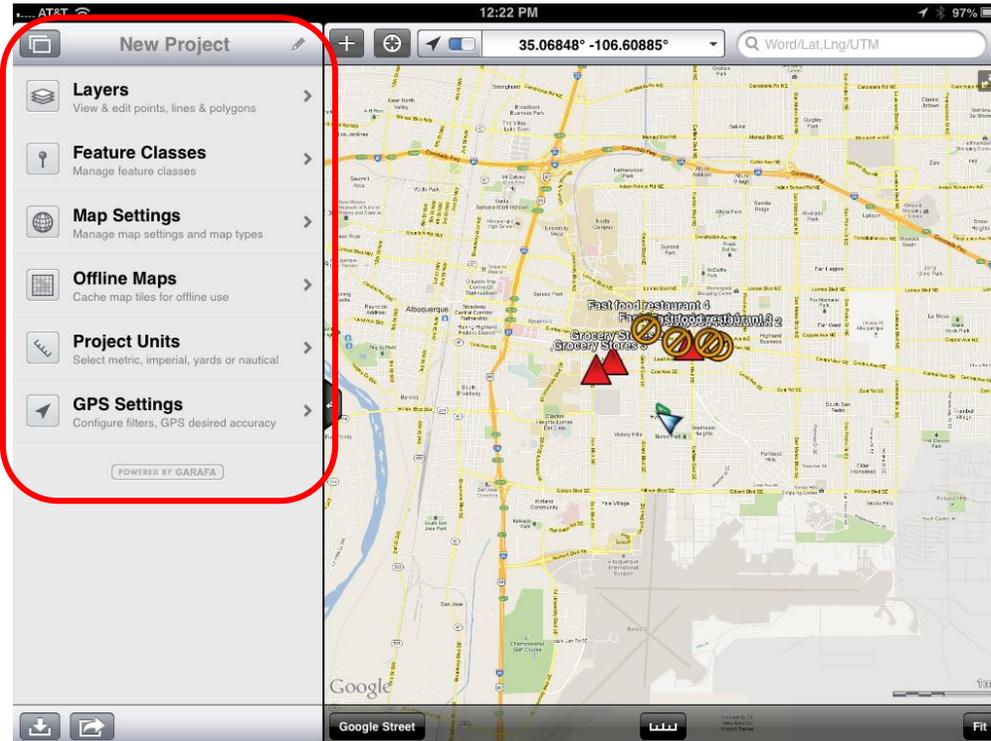


Figure: 22: GIS Kit Project Console

There is a short learning curve here to understand what their terms layers and feature classes mean and how to use them. Feature classes are essentially project folders that can hold custom layers. So you can choose one of the predefined feature classes or you can create a folder for your layers by selecting Feature Classes. I created one called Obesity (below).

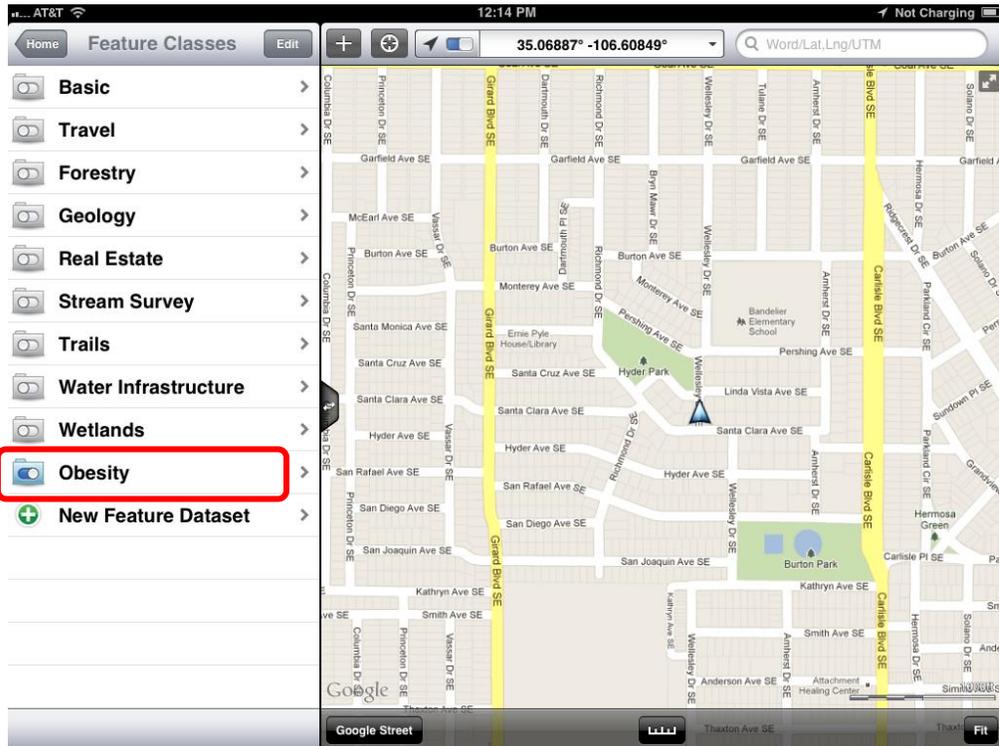


Figure 23: GIS Kit Feature Class Manager

By selecting the Obesity feature class one can then create empty GIS layers to use while out collecting data. I can choose to create several point layers and a polygon layer. Simply choose your geometry (point, line or polygon) and select for example, New Point Class, to create a point layer.

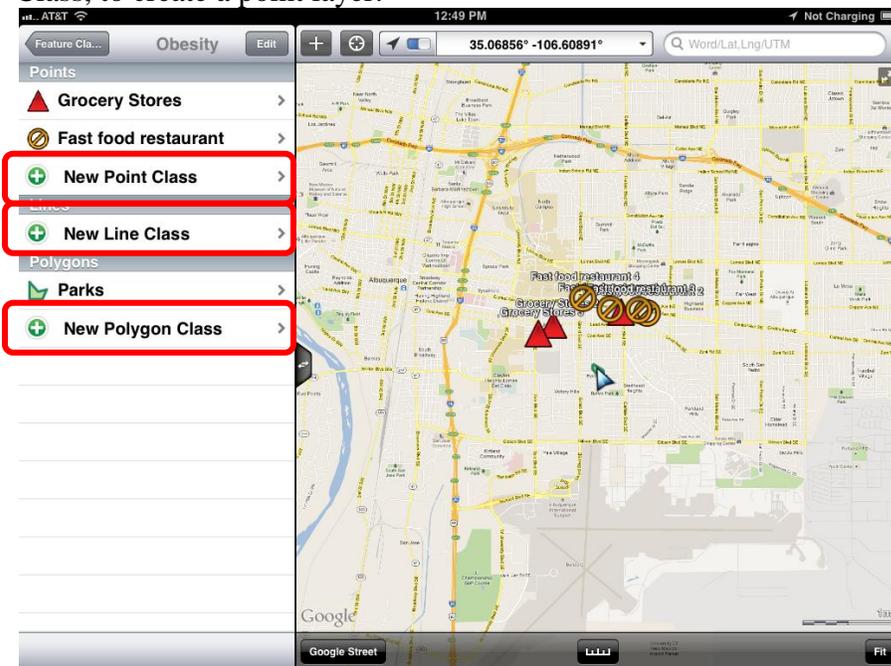


Figure 24: GIS Kit Obesity Feature Class

The create layer form then allows you to choose: the layer name, the icon that will be used on the map for that layer, and any attributes you want to populate while you're out in the field.

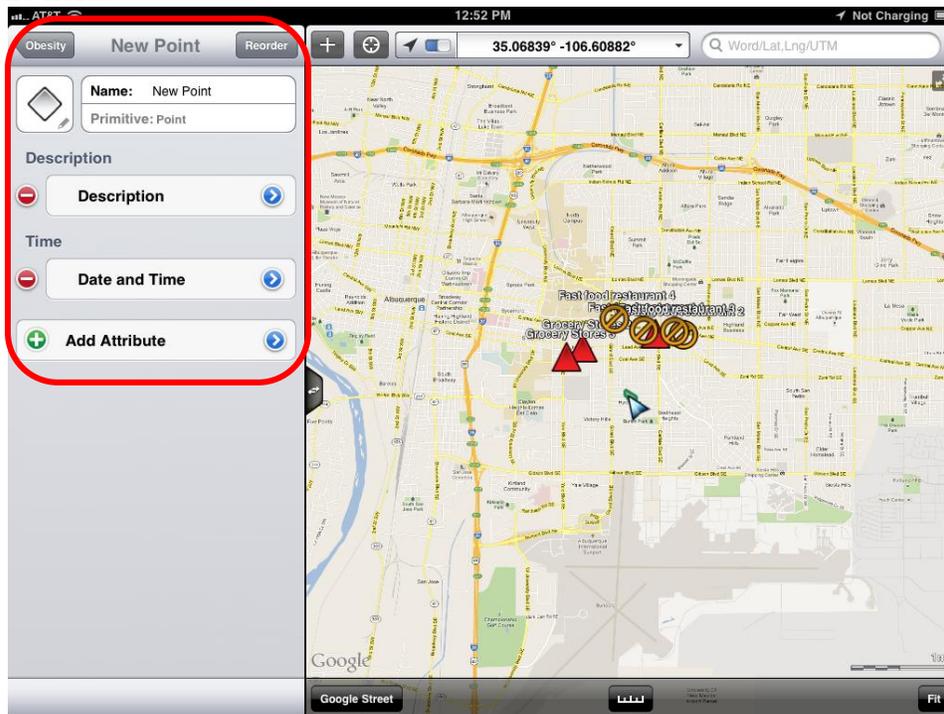


Figure: 25: GIS Kit New GIS Layer Builder

For example, when I created my Fast food restaurant GIS layer I added columns for Description, Time, Name and Photo. You have the choice of the following types of attribute: long text (name or notes), photo, number, list of values, address, website, date & time, telephone number and checkbox .

Once you've created all the layers for your data collection you're ready to go out in the field. Simply head out on foot or car and start collecting data. When you arrive at a data collection point, click the + button on the upper left corner of the map (Figure 26), and choose which layer to collect data for.

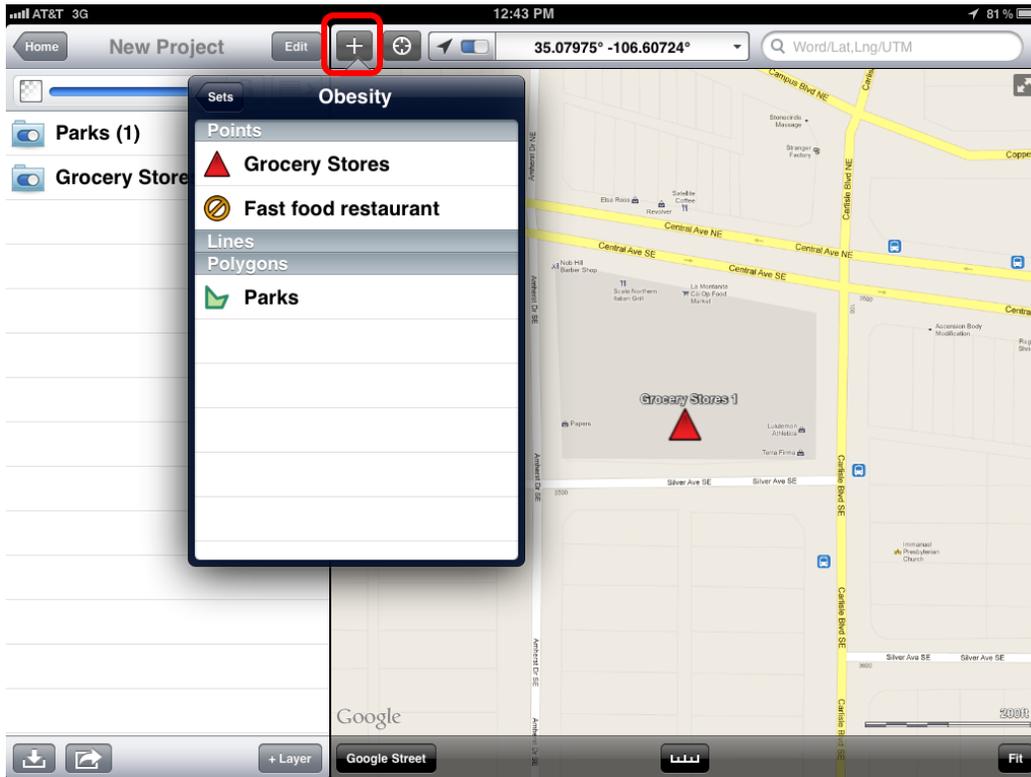


Figure 26: GIS Kit field data collection

Below I have chosen my Grocery Store layer. The app shows me the other features I've collected in this layer (Grocery stores 1-3).

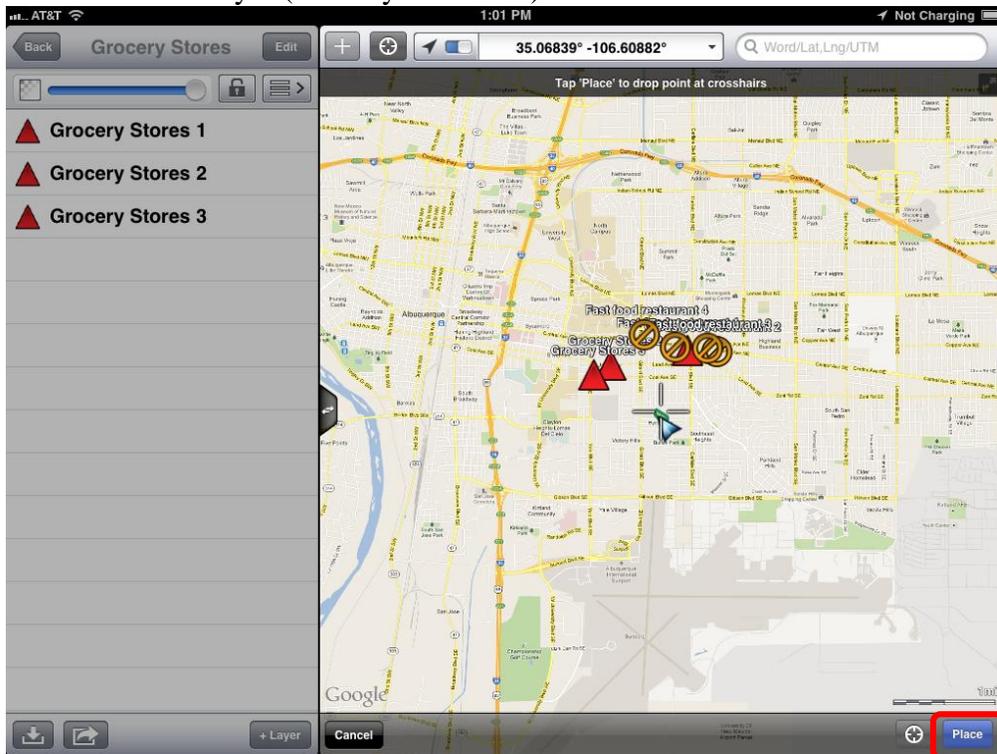


Figure: 27: GIS Kit data collection

To add another one I just tap the Place button in the lower right corner of the map and my point is added. Then I can populate my attributes including taking a photo. This app also allows you to edit the point. So if you are taking the point from the front door and you want the point to be on the roof, you can switch the background to be an aerial photo, and click Edit Point and move it to the center of the actual store (Figure 28).

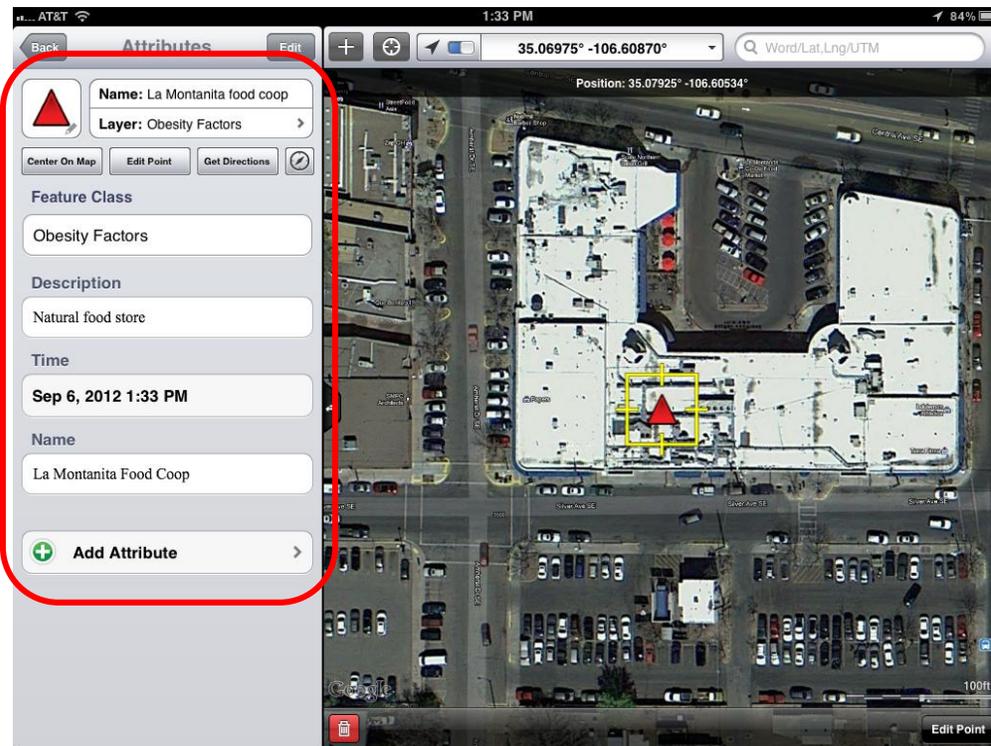


Figure 28: GIS Kit Field data collection

Next I wanted to digitize the boundary of a park. So I chose my park layer and tapped the Record with GPS button and walked the perimeter of the park (Figure 29). It worked very well. It allows the editing of polygons too (Figure 30).

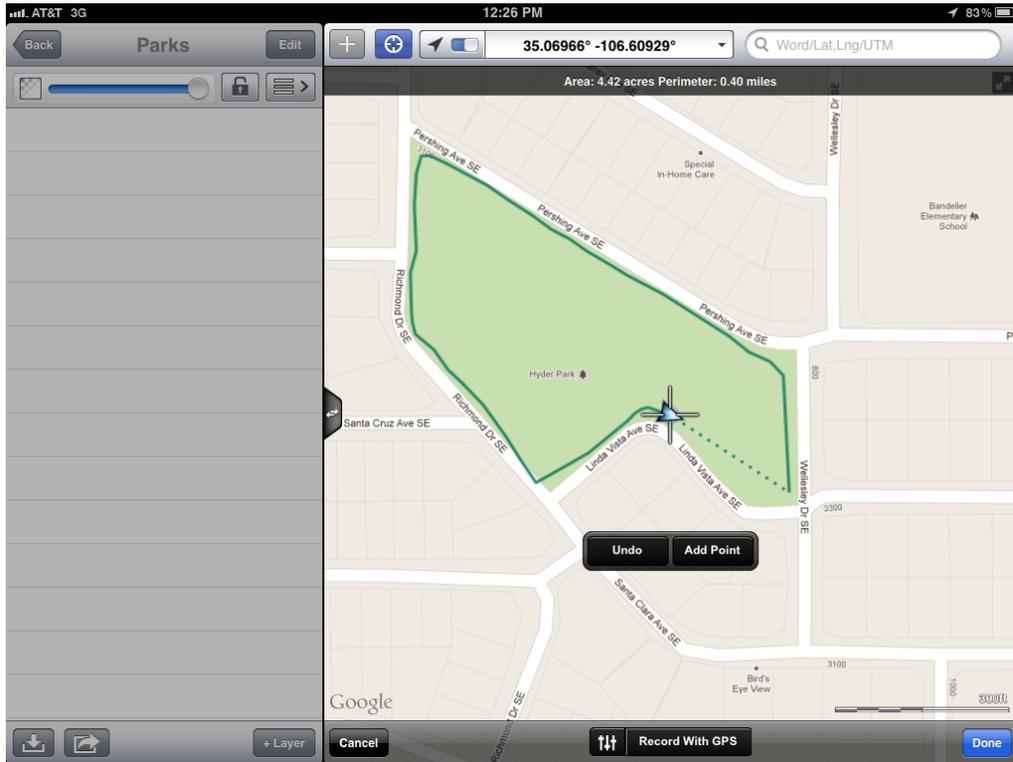


Figure 29: GIS Kit polygon data collection.

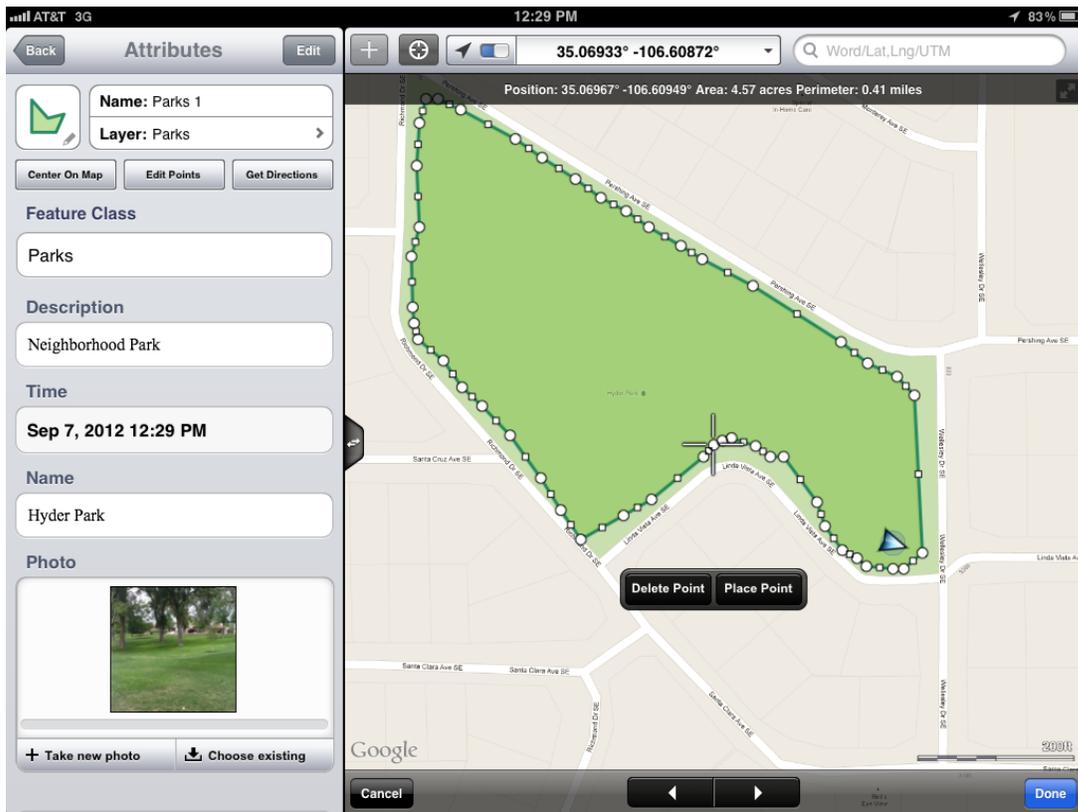


Figure 30: GIS Kit polygon editing.

Once finished the data can be exported to Google Earth KML/KMZ or GPX data. Either file format works for the data viewing solutions.

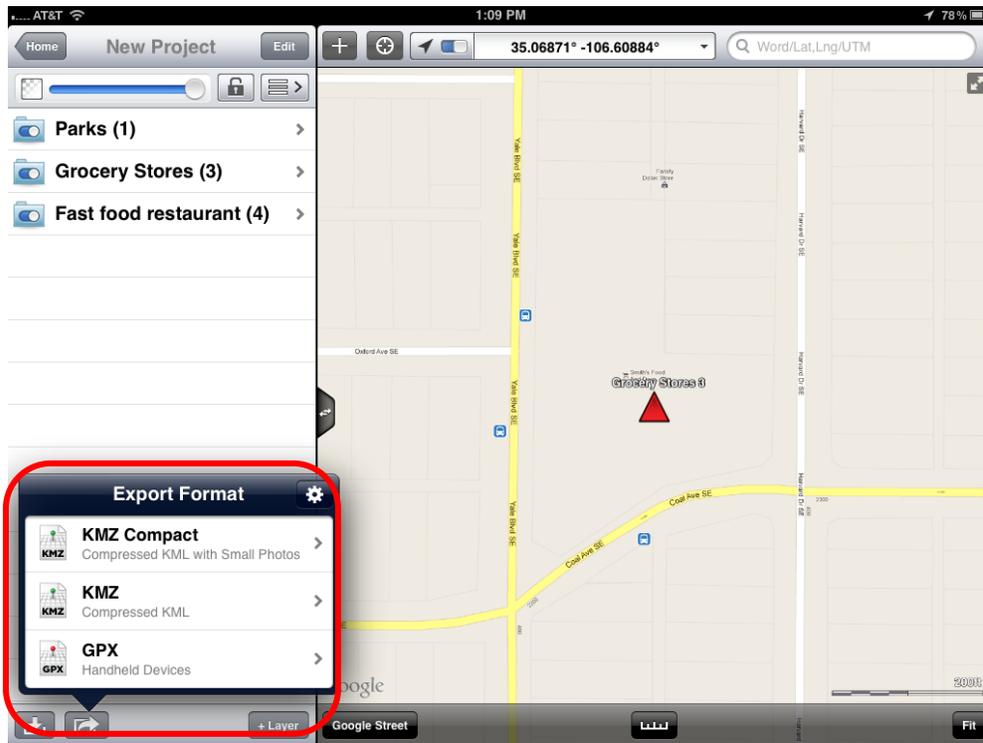


Figure 31: GIS Kit data export

The data can be exported via iTunes or email. Figure 32 shows the data being emailed as a KMZ file for use in other desktop or web applications.

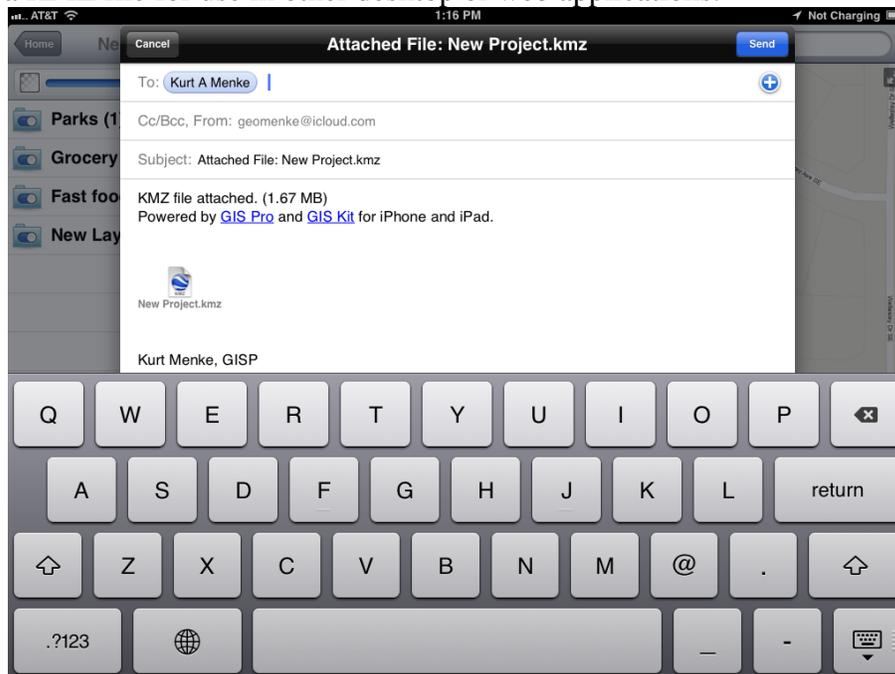


Figure 32: GIS Kit data export

EPI Collect

The first step with using EpiCollect is to go online and set up a project at <http://www.epicollect.net/>. Simply give the project a name and design your data collection form. The form can be set up with a variety of attribute columns. For example, type, name, description and photo. Setting up the form seemed pretty intuitive until I got into it. Then it started throwing errors and I had to figure out what it was asking for. I was able to intuit how to troubleshoot it, but the documentation is sparse. It would go much more smoothly the second time. You drag and drop the attribute types you want onto the form to build your table for field data collection (Figure 34). The project can then be synced via your email address to your iOS app. This app was used with my iPhone and it worked well. iPhones are even more portable than an iPad, so it was very handy. From your iOS app you sync and your project appears. You simply go into your project, choose new entry and collect points and populate your attributes.

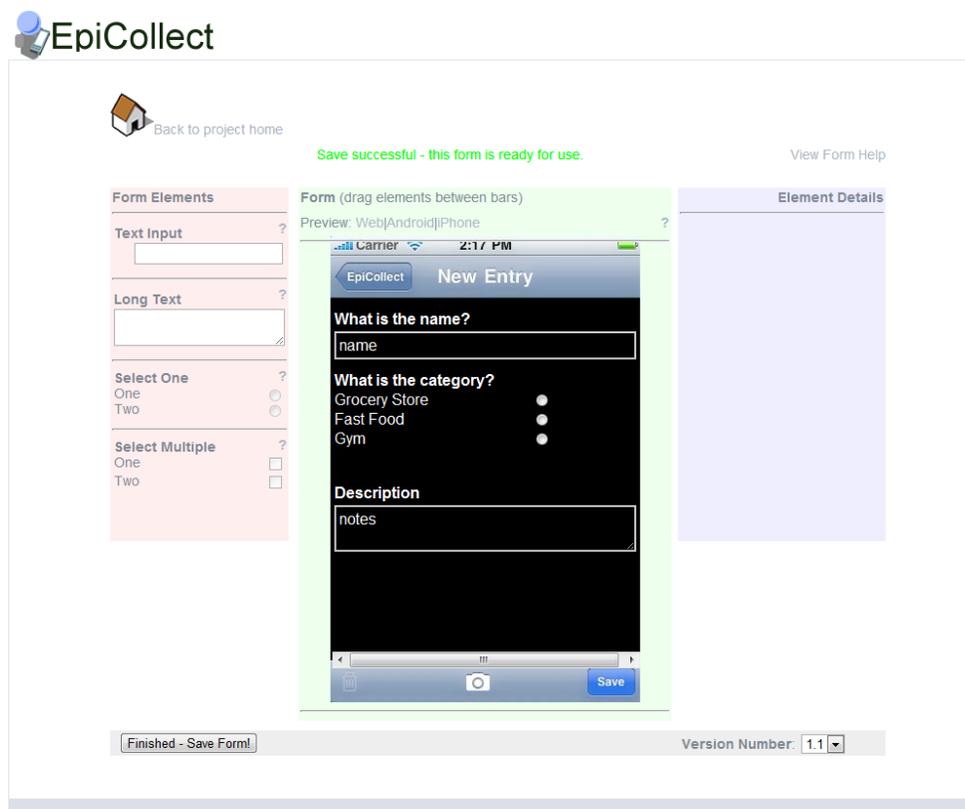


Figure 34: EpiCollect Form designer. Just drag and drop. Very easy to use with some experience.



Back to project home

The project CPSC has the following EpiCollect entries:

CPSC Entries								
Add entry	Edit entry	Remove entry						
title	Created	Latitude	Longitude	Altitude	What is the name?	What is the cate...	Description	Photo
La Montanita	2012-09-24 21:1...	35.0685428697	-106.608898844	1579.45251465	La Montanita	grocery	Health food store	http://epicollects...

Figure 35: The EpiCollect web site with data collected from the field.

After data collection, you can sync the mobile app with the website. You can go to the website and see your data online (Figure 35). The data can then be viewed on a map either the app on your mobile device, or on the website. The website also allow for the data to be exported as either an XML or CSV file. This data can then be brought into a desktop GIS such as QGIS.

QGIS allows for the data to be saved into numerous formats including KML for GoogleEarth viewing. The only limitations to using EPICollect vs GIS Kit is that EPICollect can only collect points while GIS Kit can also collect lines and polygons. GIS Kit also allows for field editing of your data, while EPICollect does not. The data would have to be edited back in the office via QGIS.

Data Sources - Any of the data sources listed earlier can be used in concert with field collected data. I did not include this in the sample workflow because the possibilities are endless. However, I did obtain the Albuquerque city streets layer from the CABQ GIS website to use with final data display in GISCloud to give the results some context.

Web Data Display - Google Earth and GISCloud were found to be the best data visualization options.

Google Earth

Keyhole Markup Language (KML) is the native format for Google Earth (GE). Since the data can be exported out in Google Earth format from GIS Kit, and KML data can be produced from EPICollect via QGIS GE is a natural fit as a data viewer for either. GE is also a very intuitive earth browser, requiring no technical knowledge, and provides a very nice data visualization platform. If field work was done with GIS Kit the data come through into Google Earth with the same symbology. Each feature is also labeled by type (Figure 36). This solution can be used by anyone.

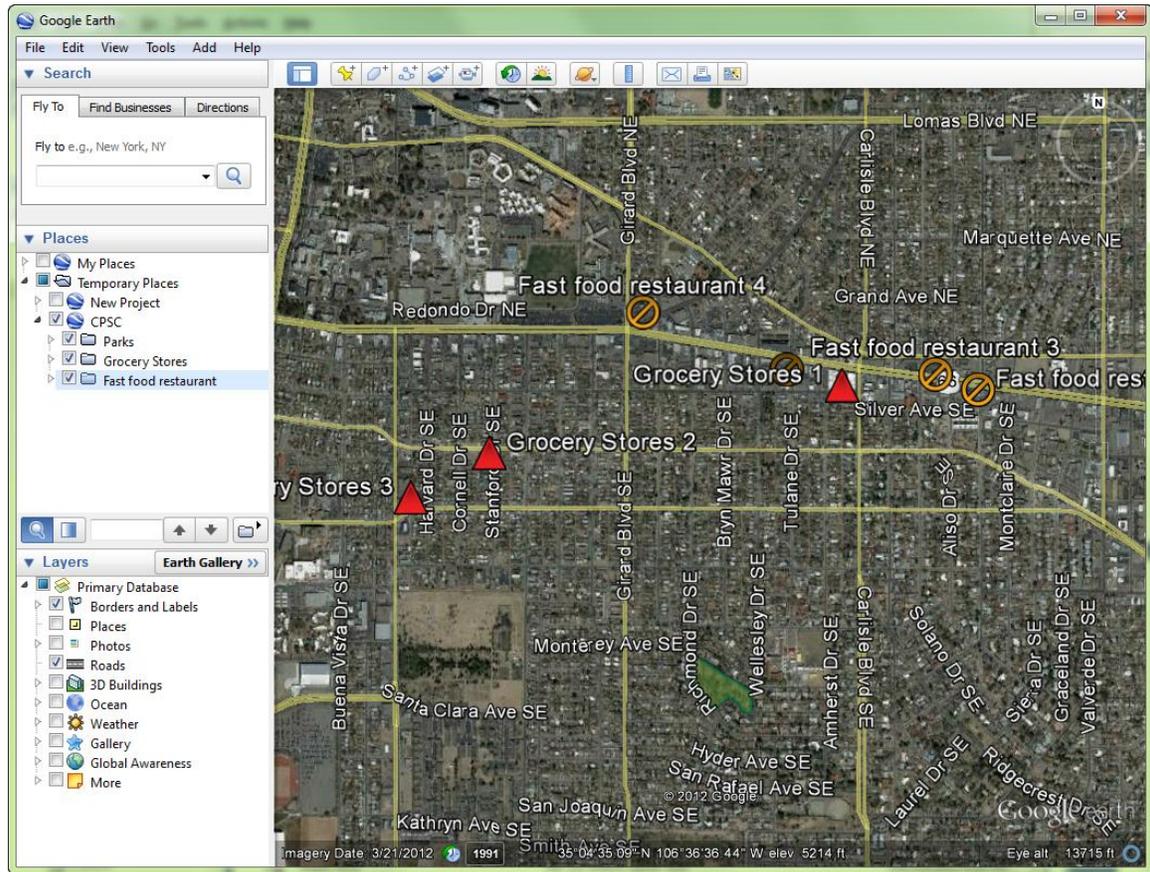


Figure 36: Field data collection seen in Google Earth

By clicking on any of the features, one gets a nice pop up window showing the attributes including the photo! This can be seen in figure 37.

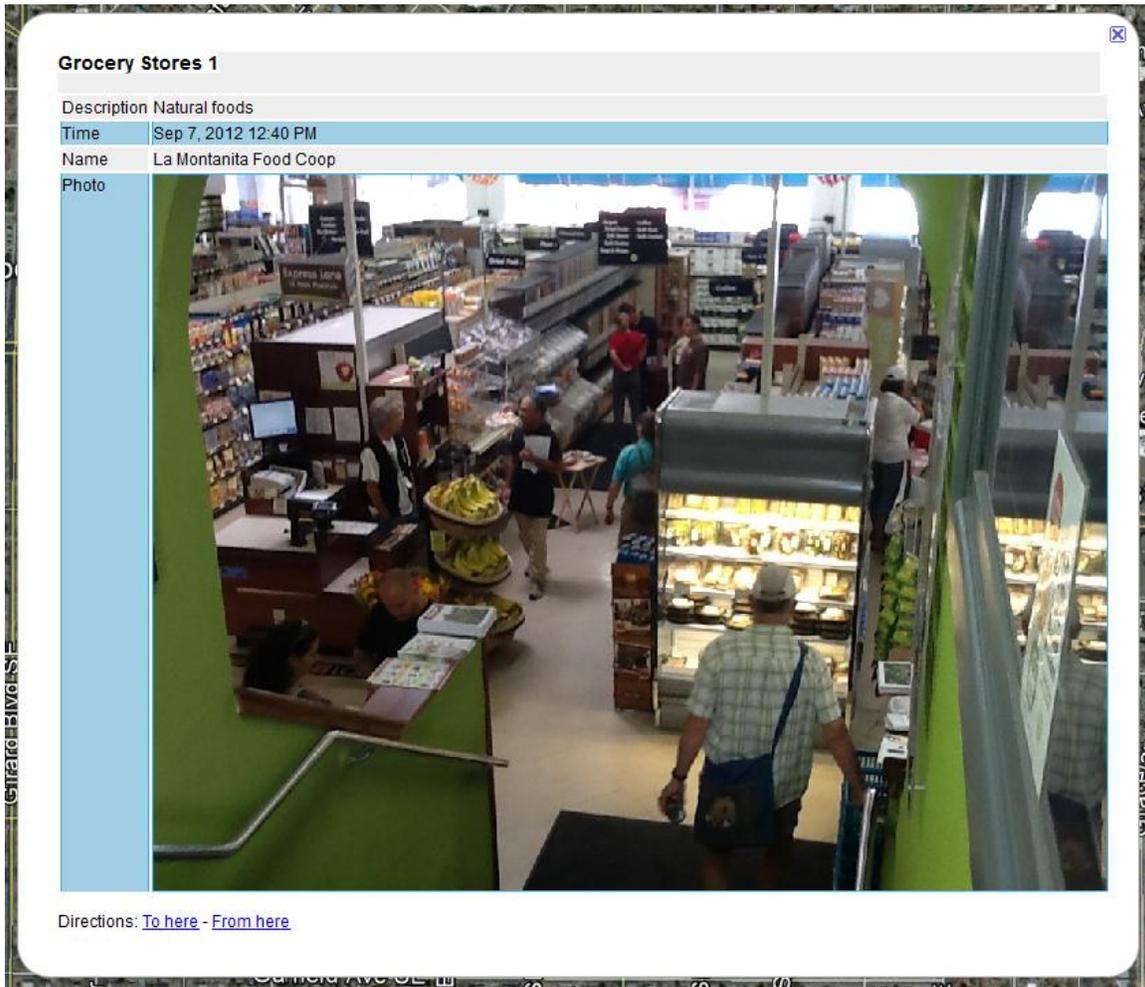


Figure 37: Data attributes seen in Google Earth Pop Up

GISCloud

A more sharable and distributable platform is the GISCloud service. This was very intuitive and extremely impressive. Simply go the website, set up a free account and create a new map. Their pricing scheme is very affordable and was covered in the initial discussion of GISCloud.

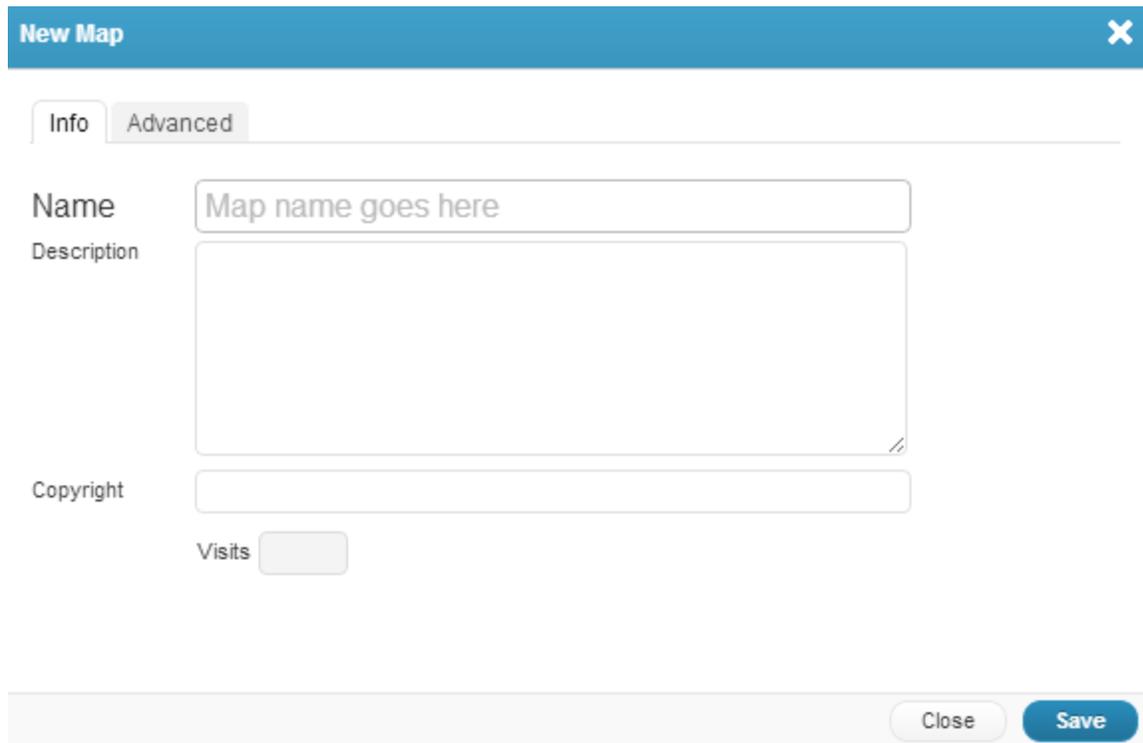


Figure 38: GIS Cloud New Map

Once the new map is created you see a blank map with intuitive controls.

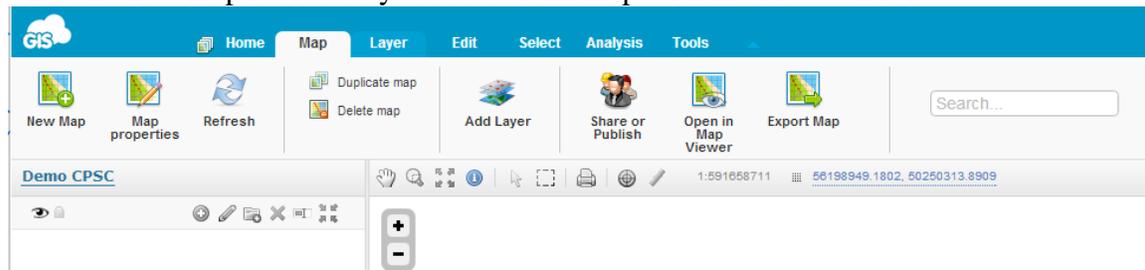


Figure 39: GIS Cloud Map Controls

Simply click Add Layer and browse your file system for the KMZ files. The files are quickly uploaded to your cloud account. Any layers you've uploaded can be used in any other maps you decide to create.

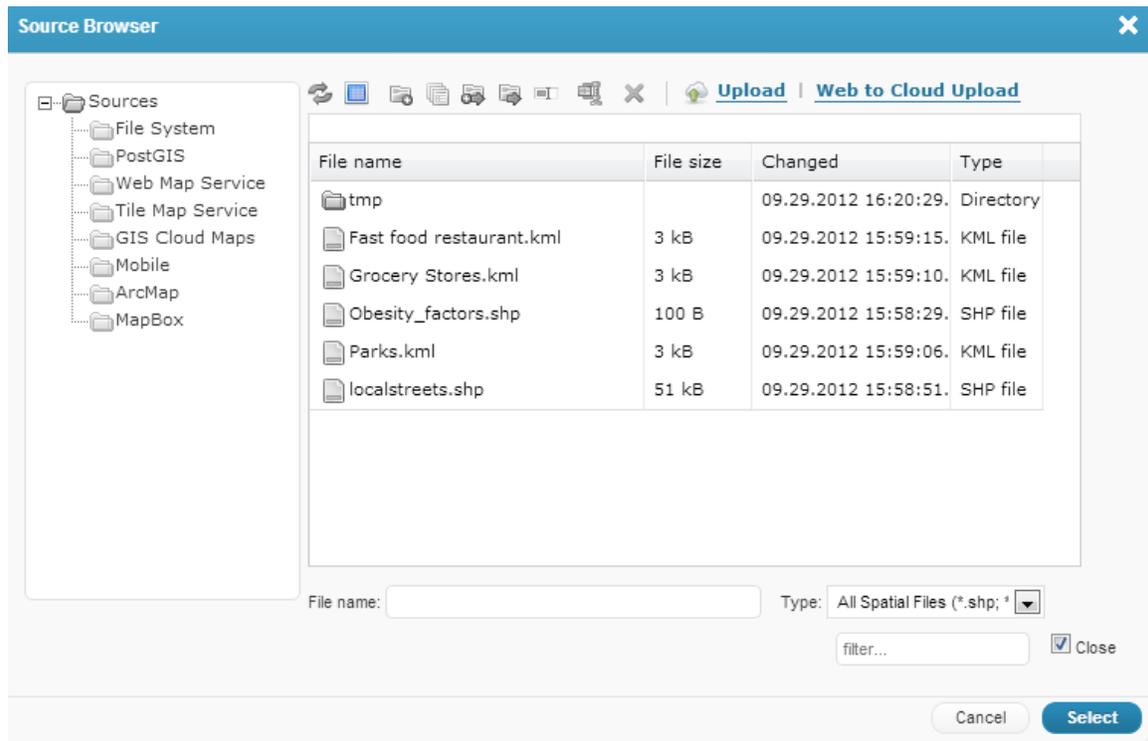


Figure 40: GISCloud Data Upload

It accepts KML/KMZ as well as, shapefiles, GPX and geotiffs. Data upload happens flawlessly.

From there you can click on individual layers and edit their properties (Figure 41). This includes the layer name, the symbology, labels and other aspects of the data. The data can also be edited with features being moved or added. Attribute columns can also be added.

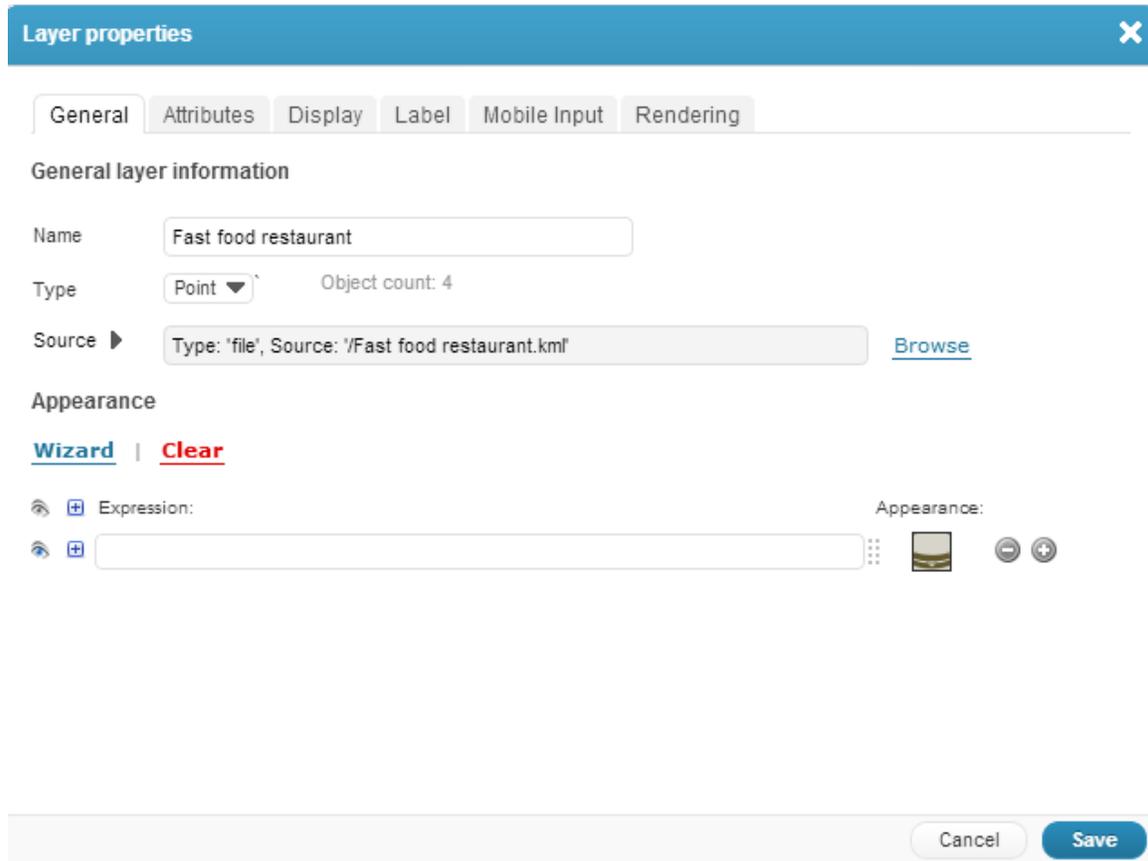


Figure 41: GIS Cloud Layer Properties.

Once your map is set up you can share it with others. The following link is for the map I created from the GIS Kit field data collection and uploaded to GISCloud.
<http://editor.giscloud.com/map/70350/demo>

This platform also has some basic analysis tools that are available if your data are in a PostGIS database. Fortunately there are some very intuitive tools for importing your uploaded data into a new PostGIS database. To do this click the Tools tab and choose Database Manager (Figure 42).

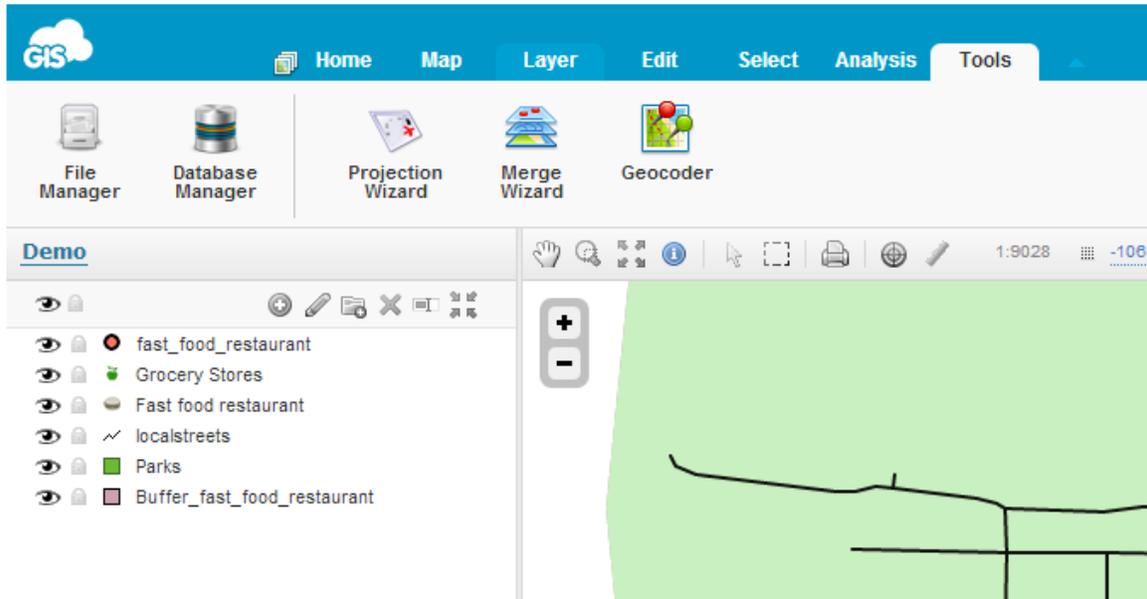


Figure 42: GIS Cloud Tools Menu

The Manager lets you create a new database and import any of your layers into that database.

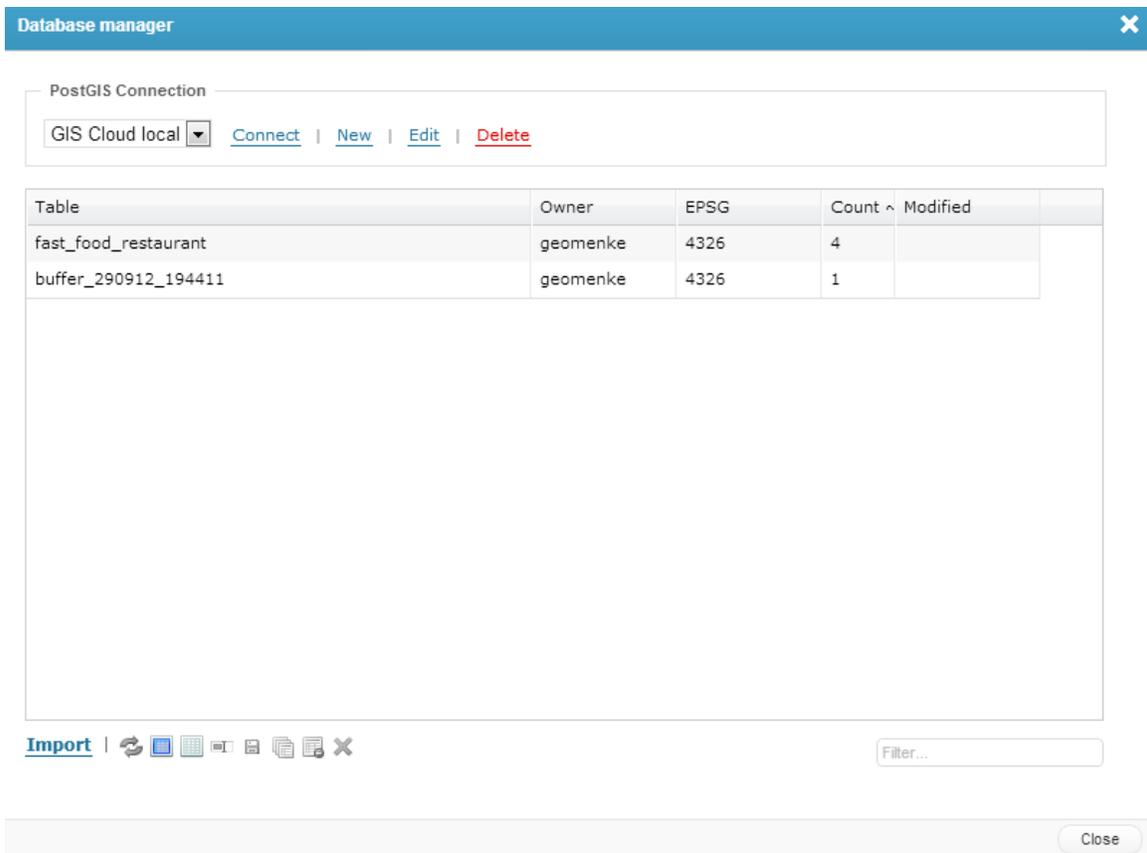


Figure 43: GISCloud Database Manager

Once your data has been converted to a geodatabase feature class click the Analysis tab and select buffer.

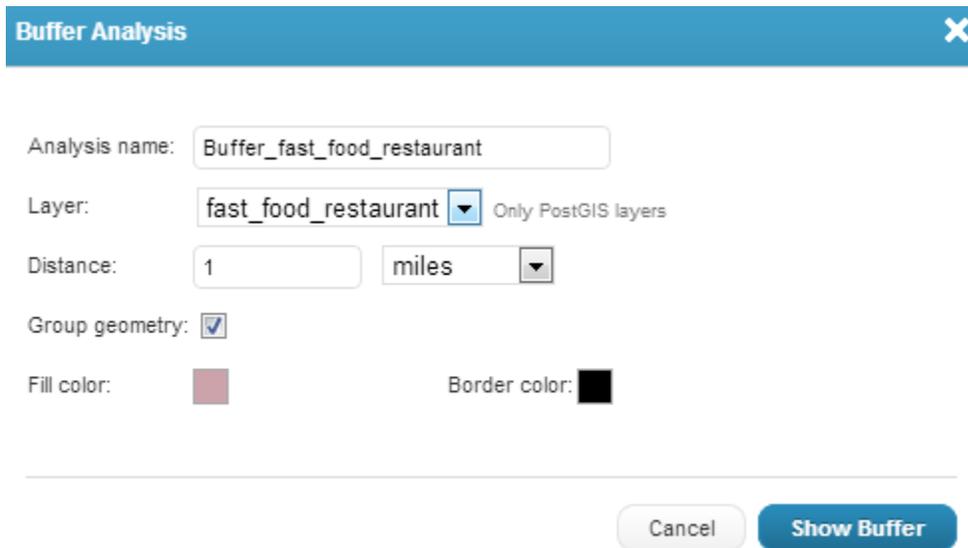


Figure 44: Buffer tool

For example, I buffered the fast food restaurant locations by one mile. The green areas below are within a mile of a fast food restaurant.

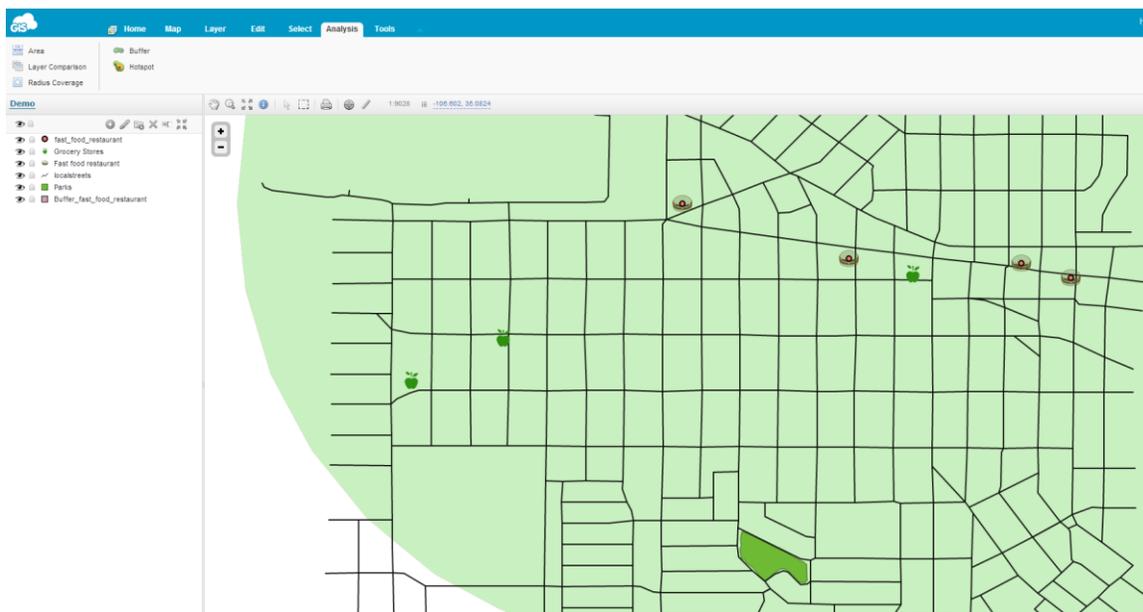


Figure 45: GIS Cloud Buffer Analysis

Surprisingly, GIS Cloud makes for a very robust web mapping platform that is more intuitive and more functional than either of the web mapping applications developed by CPSC/NLM in the past.

Desktop Data Display - For desktop display there is really no other software required other than Quantum GIS. There are several other options such as MapWindow, gvSIG, uDIG and GRASS GIS. However, I am well versed in all of these tools and even teach a semester long an open source GIS course each summer. There is no doubt that QGIS is the leading open source desktop GIS. It is intuitive and extremely powerful. It will accept all the formats that might be created by the field data tools covered in this assessment.

Below the data collected were exported from GIS Kit as GPX files.

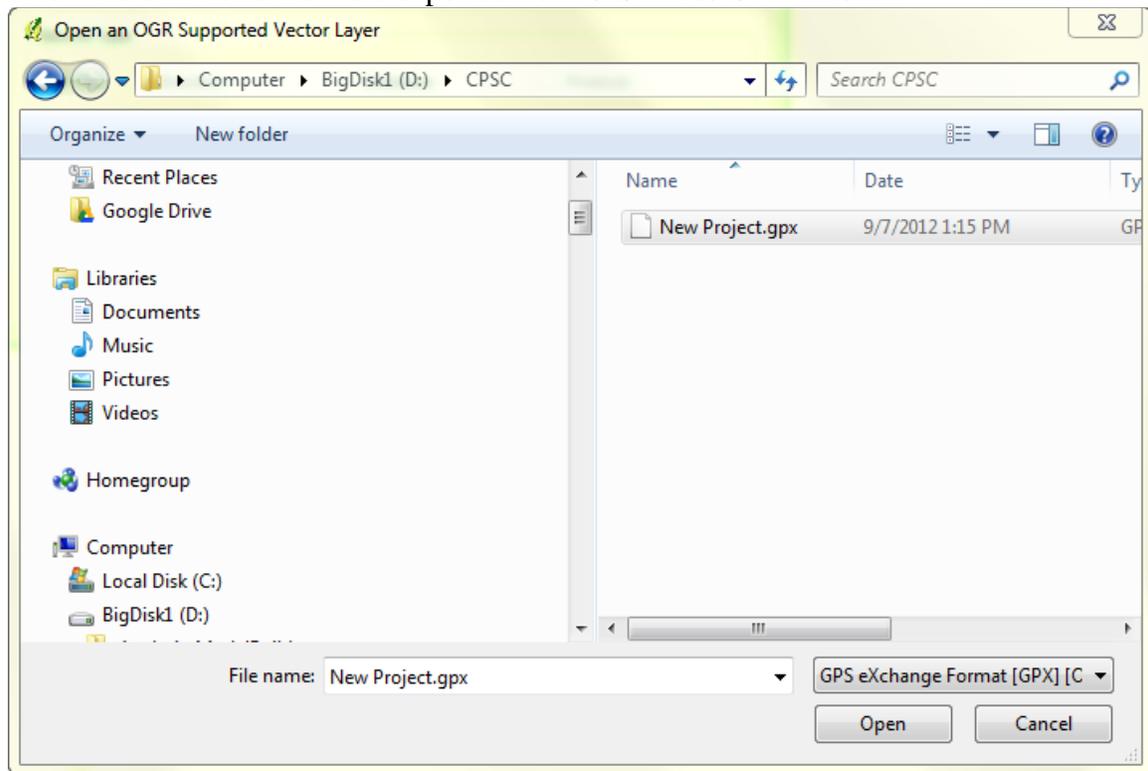


Figure 46: Adding data to QGIS

Once added the data can be displayed and symbolized. There are a variety of basemaps available such as Google, OpenStreetMap and Bing. Also the analysis tools are there to conduct any type of analysis that would be needed. A great desktop solution free of charge.

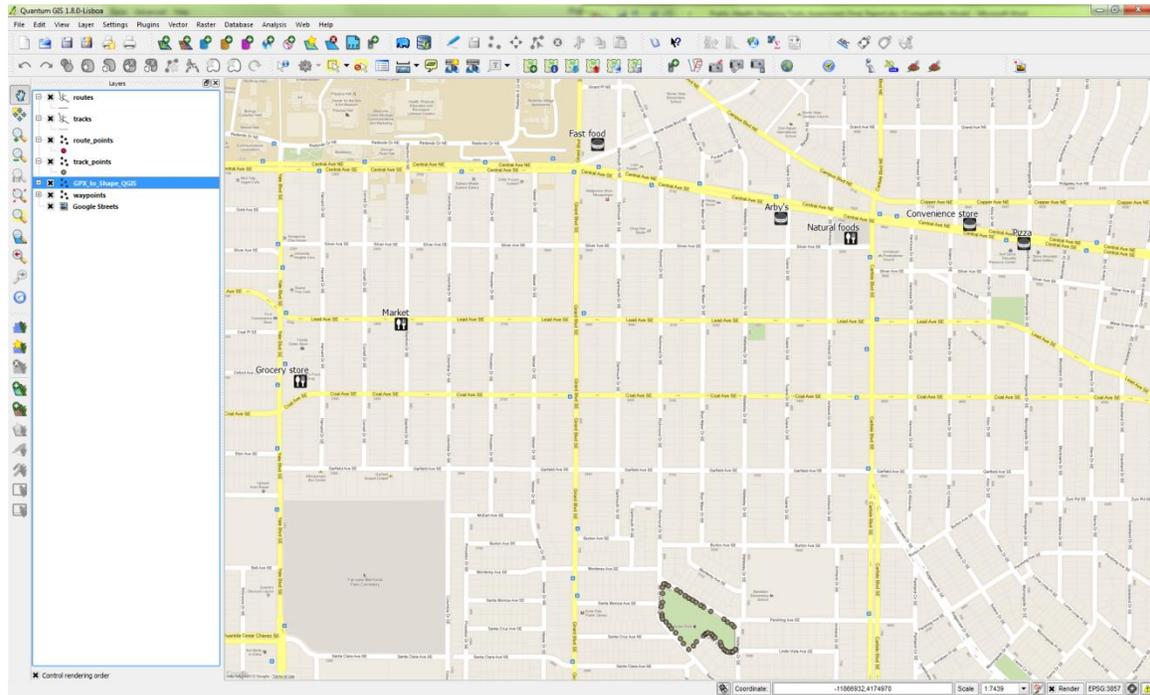


Figure 47: QGIS with field data collection with Google Maps as the basemap.

Conclusion

There is a rapidly expanding array of free and low cost tools available for a complete workflow from planning → data collection → analysis and viewing/presentation/sharing of results. The more I looked the more I found, and this report covers only the best iOS options found. Using Android platforms in the field would open up another universe of low cost tools.

The workflows outlined in the last section should provide several options for very affordable yet functional field based public health data collection efforts. This area is growing quickly. It should be noted that this report is a snapshot in time. Within six months to a year many of the options outlined here but not considered for the final recommendation, may be better than those chosen. Or there may be new tools that were not covered that deserve consideration.